

# Electronics and Telecommunications Research Seminar Series

8th Workshop Proceedings  
1 April 2009



Prof. RE Sheriff (Editor)  
School of Engineering, Design and Technology



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# 8<sup>th</sup> Research Seminar Series Workshop

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School of Engineering, Design and Technology

University of Bradford

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## FOREWORD

This is the eighth workshop to be organised under the postgraduate programmes in electrical and electronic engineering (EEE). The workshop concludes the Research Seminar Series, which has provided a platform for disseminating the latest research activities in related technologies through its weekly seminars.

The EEE courses cover a broad range of technologies and this is reflected in the variety of topics presented during the workshop. In total, thirty-three papers have been selected for the proceedings, which have been divided into seven sections.

The workshop aims to be as close to a ‘real’ event as possible. Hence, authors have responded to a Call for Papers with an abstract, prior to the submission of the final paper. This has been a novel experience for many, if not all of the contributors. Clearly, authors have taken up the challenge with enthusiasm, resulting in what promises to be an interesting and informative workshop.

Prof RE Sheriff

Editor and Research Seminar Series Workshop Chair

1 April 2009



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## Fixed-Mobile Convergence

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**Abstract** - The telecommunications scene today seems to be divided between fixed-line and mobile providers. This is rather inconvenient for users who have to subscribe to different providers, pay multiple bills and use different terminals to utilize both fixed and mobile telecom services. Subscribers want the quality of fixed services with the flexibility of mobile services.

Fixed-Mobile Convergence (FMC) is the buzz-word that describes the seamless integration of fixed-line and mobile telecom services as a better option to Fixed Mobile Substitution (FMS) by the addition of mobility to the triple play of voice, data and video/TV already available on fixed lines. FMC aims to bridge the wireline/wireless divide and it makes commercial sense for business end-users and service providers especially integrated operators (with fixed-line and mobile activities).

This paper explains FMC from the three different perspectives of Terminal Convergence, Network Convergence and Service Convergence. It also takes a look at the key facilitators for FMC such as the 3GPP-inspired IP Multimedia Subsystem (IMS) and Universal Mobile Access (UMA) which allows end-users to preserve their service experience as they handover and roam when in transit between networks. This paper concludes by highlighting the consequence of FMC to all players in the telecoms sector.

**Keywords:** FMC, Mobile Virtual Network Operator (MVNO), IMS, Femtocells

### I. INTRODUCTION

Traditionally, there has been independence in telecommunication networks, services and devices clearly operating on different platforms and under different regulations. Fixed-line telecommunications have been known to provide voice and data services with high reliability. The need to add video/TV to their services and offer triple play offerings brought about network upgrades via technologies such as fibre-optics and thus supporting broadband capabilities. The fixed-line Telco industry is massive and gets good revenue accrued from internet, Digital Subscriber Lines (DSL), hosting, provision of data transport services such as Synchronous Optical Networking (SONET) and its dedicated high capacity lines for bandwidth-hungry clients. It provides the spine for the internet and still offers the best data speeds[1].

However, great data speeds and fixed-line broadband have not been able to suppress the rapid migration to wireless services. More and more people are being attracted by the convenience and cheap tariff offered by mobile broadband services. Also, with the increasing need to serve rural areas and new markets, wireless broadband provides the best option[1]. This has led to the evident decrease of fixed operators' Average Revenue per User (ARPU). The International Telecommunications Union (ITU) estimated that the annual global expenditure on mobile services by subscribers quadrupled what was spent on fixed services in 2008. Consumer behavior has threatened the continued existence of fixed line

telecommunications and fueled the idea of Fixed Mobile Substitution (FMS)[2].

The strategy to combat the exodus of traffic to wireless options is not a complete teardown of traditional telecommunications but the dissolution of network boundaries through the merger of networks, services and terminals via a cost-effective unified platform. This is the goal of Fixed Mobile Convergence (FMC)[3]. This paper aims to give a broad overview of FMC, its enablers and its impact on the telecommunications sector.

### II. FMC VIEWPOINT

Fixed Mobile Convergence involves the union of fixed-line and mobile wireless network technologies in a way that telecommunication service providers can serve both technologies on the same platform and consequently provide the media-rich content consumers crave. FMC brings about a business makeover for the operator and a reduction in operation costs while bringing convenience for end users. Operators can explore new business models via key enabling technologies while consumers can fully experience quadruple play[4].

FMC is considered from the three perspectives of Network Convergence, Terminal Convergence and Service Convergence. Network convergence implies seamless access to mobile and fixed networks on an integrated platform, terminal convergence denotes a single device being able to access a range of technologies and service convergence entails the bundled combination of data, voice, video plus value added services. Terminal convergence and service convergence concentrate on user experience and services while network convergence simplifies their operation[4].

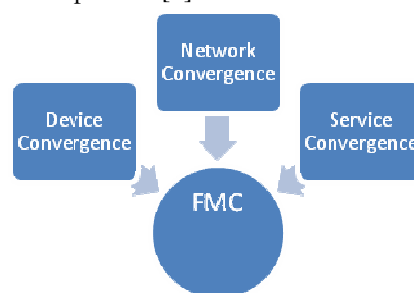


Fig.1. Successful FMC entails convergence in these areas

#### A. Terminal Convergence

Time was when device terminals were purpose-specific and had no support for other functions. Good examples are set-top boxes and PSTN phones[3]. A consumer that changes activity such as leaving home for office and vice versa has to change devices and access networks. Inconveniencies arise from disparity in experience and service options when switching.



Fig.2. Terminal Convergence [5]

Mobile phones were initially designed for voice communications but these days they offer more. Device innovation has led to the production of multi-radio, multifunction and multi-mode devices which characterize terminal convergence[3]. Multi-radio interfaces allow for access over circuit and packet switched networks. Multifunctionality can be seen in smart phones and PDAs which in addition to voice have multimedia options such as music players, organizers, camera, games, FM radio, audio/video recorders, high memory capacity, Bluetooth, Wi-Fi capabilities and an internet browser[6]. This is the most recognized type of convergence. Terminal convergence removes functionality restrictions on devices and network access limitations.

#### B. Service Convergence

The goal of service convergence is the provision of easy-to-access feature-rich multimedia services simultaneously. Operators have an excellent enabler for providing this convergence in the IP Multimedia Subsystem (IMS). IMS came about through the 3<sup>rd</sup> Generation Partnership Project (3GPP) in conjunction with Telecoms & Internet Converged Services & Protocols for Advanced Networks (TISPAN) and its research towards the evolution of mobile networks but has now been extended to accommodate heterogeneous networks such as fixed lines and WLAN[7]. IMS has now become a base for the access of multimedia services from wireline and indeed wireless devices. It removes the difficulty posed by interoperability between different service platforms by facilitating user-friendly services whenever and wherever on any device via its framework. Operators can launch new and innovative value added services with ease to excite their existing customers in addition to winning more subscribers[4].

VoIP and Instant Messaging (IM) have also been instrumental to the cause of service convergence. The former's impact being felt most with IP phones compatible with fixed VoIP and mobile VoIP [4].

#### C. Network Convergence

For an end-user, network convergence refers to the delivery of a unified voice and multimedia service experience. This means easy use of the same services across all networks. The dissolution of network barriers between IP networks, PSTN and PLMN's into a network that is compatible with any access technology is what network convergence means to an operator. This denotes a removal of "network islands" and consequently,

movement to an all IP network via an IMS common platform. The design of a common core network for convergence enables multiple access and network resource reuse. Operators can then offer quadruple play services to end users with a bundled service fee. This makes good business sense as it makes convenient billing for end users as well as helps improve operators CAPEX and OPEX[3 , 4].

### III. FMC FACILITATORS

The following technologies have been the key drivers for FMC and have been instrumental to its success

#### A. IP Multimedia Subsystem (IMS)

IMS is a strong facilitator for FMC. IMS is a 3GPP-motivated framework for IP multimedia services. IMS was initially developed to leverage 3G networks in supporting IP multimedia to end users. Session Initiation Protocol (SIP), an Internet Engineering Task Force (IETF) protocol, is used as the signaling method for IMS and is one of the leading signaling protocols for VoIP. SIP allows multimedia services including VoIP to be available across networks[7]. IMS offers a fraction of the FMC solution and requires Telco vendors to build their services on its IP based platform. That's why it is considered as a subsystem[4]. IMS provides service convergence that traverses fixed and mobile networks including devices.

The IMS architecture as seen in Fig. 3 consists of the following layers:

- Device layer: users are spoilt for choice with device selection due to the device layer in the IMS architecture. Computers, smart phones, PDAs can connect to the IMS network via this layer. A PSTN gateway is also available for IP connectivity to traditional analogue telephony[8].
- Transport Layer: initiation and termination of SIP sessions. The transport layer converts analogue-to-digital data formats and an IP packet format. It connects media such as DSL, Wi-Fi, GPRS, SIP and 3G networks to the IP network. It also manages the PSTN gateway[8].
- Control Layer: the core element here is the Call Session Control Function (CSCF). It handles SIP registration. The Home Subscriber Station (HSS) database holds subscriber information such as telephone records and IP address thus user info is centralised[9].
- Service Layer: sits atop the IMS network architecture layer. Application servers are responsible for running services. They host and execute services in addition to interfacing with the control layer via the SIP protocol. It also helps to reduce the load on the control layer. Application servers include;
  - Presence Server: manages real-time whereabouts of a user for communication

- Group List Management Server: assigns access rights to network users and supports instant messaging
- Instant Messaging Server: facilitates sending and receiving of rich multimedia content[8].

#### Benefits of IMS:

- Provision of a unified platform: With a standardised platform that supports reusability, service creation by operators is made easy
- Provision of multimedia services with QoS mechanisms: fast and reliable internet access in 3G networks as compared with 2/2.5G networks does not alter quality service delivery
- IMS helps operators with billing: various charging schemes are supported and this helps operators manage tariffs based on some services.
- Presence: users are accessible to services irrespective of their location[8].

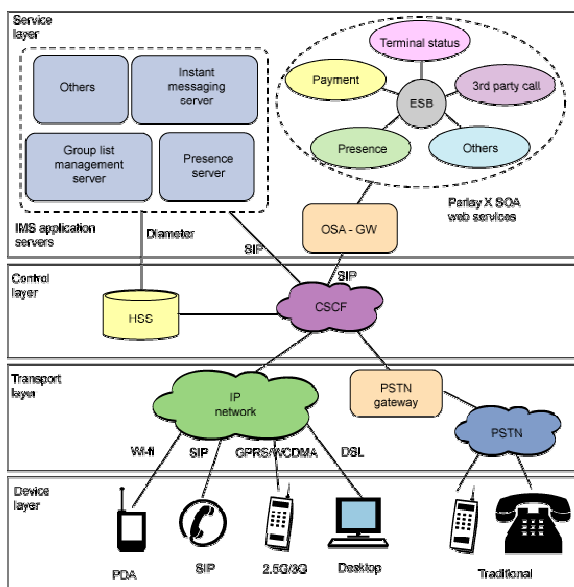


Fig.3. IMS Architecture[8]

#### B. Universal Mobile Access (UMA)

UMA is a gateway-based solution that equips service providers to offer roaming and handover between cellular networks and private/public spectra principally through dual-mode terminals. Special gateways are placed at mobile network edges and end users in possession of dual-mode terminals can access both WLAN and cellular connections.

In Fig. 4, a UMA-enabled dual mode terminal can access UMTS/GSM voice and GPRS data services as well Wi-Fi access. The UMA Network Controller (UNC) communicates with the mobile core network through 3GPP ratified interfaces. User experience during

handover and roaming is seamless.

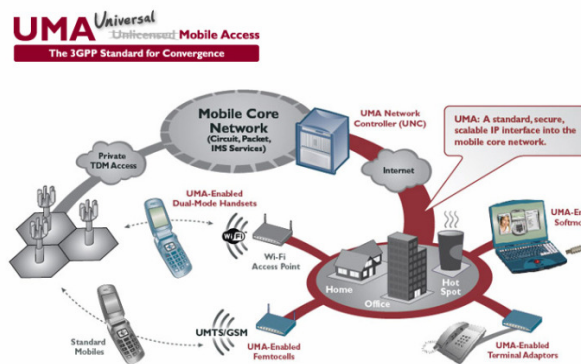


Fig.4. UMA Architecture[10]

Open specifications by various leading Telcos and work with 3GPP standards has supported UMA's acceptance and interoperability issues are not a problem. Growing UMA service opportunities include UMA-enabled Femtocells, UMA-enabled Softmobiles and UMA-enabled Adaptors[10].

#### C. Femtocells

Femtocells or rather Access Point Base Stations are "low-power access points that operate in licensed spectrum to connect standard mobile devices to a mobile operator's network using residential DSL or cable broadband connections[11]."

The wide area cellular network provides coverage to the user when outside the femtocell network and when the user drifts back in, its traffic is supported by the internet connection. While most FMC designs need a new terminal which works in dual mode to implement their convergence, all a femtocell needs is the deployment of a new access point[12].

Advantages of femtocell technology to operators are:

- Better indoor coverage
- Increased capacity: obtained by reducing traffic load on cellular networks
- Reduced backhaul rates: local DSL/Cable provides backhaul traffic
- Innovative services: bundled services offering quadruple play. VoIP and Wi-Fi have an avenue to be explored

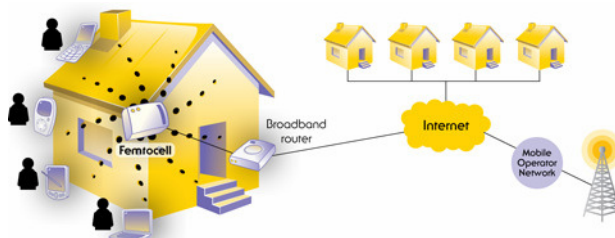


Fig.5. FemtoAccess Technology[11]

All these merits leave the operator with reduced costs and reduced expenses. To the end users, the femtocell technology advantage is the single device for communication everywhere (presence) with cheap fixed-like rates and good service experience at home[12].

#### IV. MAJOR PLAYERS IN THE FMC MARKET

Industry players have reacted to the concept of FMC in many ways. For some, profitability seems dim while others have changed their business models to tap into its opportunities for new and media-rich services. Fixed operators, integrated operators, VoIP players and not forgetting device manufacturers look best fit to reap fully from FMC.

##### A. *Integrated Operators*

These are operators having both fixed and mobile facilities. They provide FMC offerings. They get the best from both worlds of converged fixed and mobile services and provide the 4play of voice, data, video and mobility with convenient billing. This is attractive to end users and so they have a large customer base, good returns and lower operating costs.

##### B. *Pure Fixed-Line Operators*

Fixed line operators are still in the mix of high profit industry players. They offer triple play incentives and are now looking to complete convergence to keep their customer base.

##### C. *Mobile Operators*

Mobile operators attempted to choke out fixed line operators and Fixed Mobile Substitution (FMS) seemed to be on course. But with FMC, mobile operators have realized the need to offer bundled services to improve the quality of their value added services and in the long run increase their profits[13].

##### D. *Cable TV*

Cable and wireline operators have always been in tandem because of the DSL/Cable competition. Cable TV operators have taken advantage of convergence and have triple and 4play services to rival integrated operators without TV offerings[13].

##### E. *Virtual Network Operators (VNO)*

The profitable auction of bandwidth brought about VNOs. They are operators that lease spectrum from Mobile Network Operators (MNOs) and are therefore referred to as Mobile Virtual Network Operators (MVNO) or from Fixed Network Operators (FNO) thus called Fixed Virtual Network Operators (FVNO) in order to provide telecommunication services. With FMC, hybrid xVNOs are springing up[3].

Apart from integrated network operators, other players need to form partnerships and alliances in order to fully harness the advantage FMC brings.

#### V. FMC EVOLUTION

The success of FMC hinges on solutions that are implemented on the IMS framework and distributed over a wide range of devices. As mentioned earlier, preservation and optimisation rather than a complete teardown of long-established services and networks is envisaged with new business models facilitating richer services for the end user and reduction in operating costs for the operators.

#### VI. CONCLUSION

The pursuit of a universal ubiquitous device running multiple services on a unified network platform typifies Fixed Mobile Convergence. FMC aims to bridge the divide between fixed line and mobile service offerings and at the same time ensure convenience and quality service experience for end users. FMC brings a breath of fresh air to the telecommunications industry by encouraging innovative, feature-rich services via a common framework and positively affecting Telco operators' capex and opex. Even with regulatory issues impeding its explosion, FMC remains a significant concept for the advancement of telecommunication models.

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# An Overview of Mobile Computing

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**Abstract:** One of the key driving forces behind today's development in computer technology is human desire to be able to "communicate at any time, any place, anywhere" wirelessly without the limits of distance. The major development issues covered by mobile computing are flexibility, mobility and ease of use. Mobile computing is the efficient replacement of desktop computers, smaller in size, less power consumption and able to do same processing, such as PDAs, Pocket PCs, and Laptops etc.

The type of transmission used for mobile computing is existing wireless and cellular networks, will be dramatically influenced by developments in these networks. Implementation of 4G and WiMAX will completely change the communication mechanism of mobile computing. Developments in mobile applications such as wireless broadband internet, integrated GPS in devices, wireless access to remote data base, are all the parts of mobile computing.

Mobile computing is emerging as today's hottest and rapidly evolving technology in the industry of wireless communications which allows transmission of data from remote locations to other remote or fixed locations. This paper provides overview of basic concepts of mobile computing along with current and future applications and challenges, and also some major benefits of this technology.

**Keywords:** Mobile Computing, Wireless Communication, Future applications and challenges

## I. INTRODUCTION

Until last decade, concept of computer directly drives to a desktop computer connected to a fixed positioned server through a physical link[1 1-5]. However, with the advent of laptop, drastically evolution of wireless network and rapidly increasing user demand brought about the birth of ubiquitous or mobile computing[2].

According to Mark Weiser[3], "Ubiquitous computing does not just mean computers that can be carried to the beach, jungle or airport. Even the most powerful notebook computer, with access to a worldwide information network, still focuses attention on a single box."

Evolution in existing cellular networks and development of more compact, faster and enhanced functional portable devices forms a good combination of mobile computing.

## II. UBIQUITOUS OR MOBILE COMPUTING

Ubiquitous or Mobile computing can be defined as a system composed of portable devices such as PDAs, Laptops, Smart phones, and cellular networks which provides all services to mobile user as they move from

place to place, in the same way as a desktop computer connected to a physical link[4].

World is going mobile in nature, describes the need for mobile computing. Some of reasons which make mobile computing of great interest are: Ubiquitous Computing are wireless networks "capable of interconnecting hundreds of high-speed devices for every person"[5]. It is the latest emerging technology which enables users to communicate anytime and anywhere, even in aero planes now. Ubiquitous computing has taken great economic significance; industrial products have become "smart" due to their integrated information processing capacity[6]. It is not a stand alone thing; in fact, it is a multidisciplinary and multi-institutional effort with huge potential for improvements. Everyday computing is more emphasized by providing continuous interaction moves computing from a localized tool to a constant presence[7].

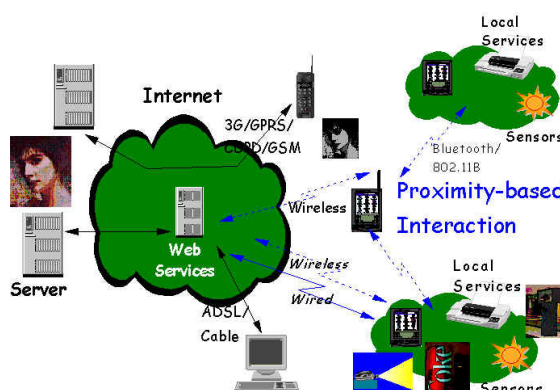


Fig 1: Mobile Computing Environment

Mobile computing is clear explanation of Moore's Law, which states that "the number of transistors per chip, and consequently the power of microprocessors, doubles about every 18 months." Now microprocessors have become so cheap that they are being used in almost all electrical devices, cars, household appliances, toys, and mobile phones. Evolution in microprocessor leads to Smartphone and PDAs which can work more likely as a desktop computer.[6]

Third Generation Mobile Network is the key driving force of mobile computing. With the help of UMTS and HSDPA data rate is much higher. However, to get efficient and desirable characteristics in mobile computing, great care should be taken for:

- Location Management
- Handover Management

- Computing Platform
- Communication Device
- Communication Bandwidth

System architecture and set of protocols in mobile computing must satisfy the following requirements[2]:

- User behaviour, network capability, computing platform
- Provide for integrated access to services
- Allow for ad-hoc access to services
- Quality of service (QOS), bandwidth,
- Geographical dimensions, number of users
- File synchronization
- Location services, etc

Multidisciplinary behaviour of mobile computing is the contribution of database systems, file systems, operating systems, network systems, wireless communications, low power low cost radio technology, Micro-electro-mechanical systems (MEMS) sensor technology and nanotechnology[2].

The ultra connectivity created by mobile computing causes many other possibilities by the integration of sensors and actors into the web of ubiquitous computing. Mobile computing does not only provide instantaneous access to information but also attempts to give instantaneous access to books, tools and people transforming them into surveillance things[5]

The major goal achieved by wireless communications today, is continuous connection even if user moves around between different networks. WiMAX will probably be the dominating standard when released because of higher data rate. Wireless internet has become more common and data rates are compared to data rates in wired networks[8].

Many people think wireless communication as ancestor of mobile computing. Security, mobility, portability, user integrity, should be taken great care when designing a mobile computing environment[2 , 8]

### III. WIRELESS NETWORKS

Mobile computing does not provide connectivity only to the internet through the existing cellular networks; however, there are also other networks which operate with in a specific organization or area. The general and basic architecture is shown in fig 2, which consists of two entities: mobile host and fixed host. The fixed host often called Mobile Support Station (MSS) or Home Base Node (HBN) communicates to mobile node via wireless connection.

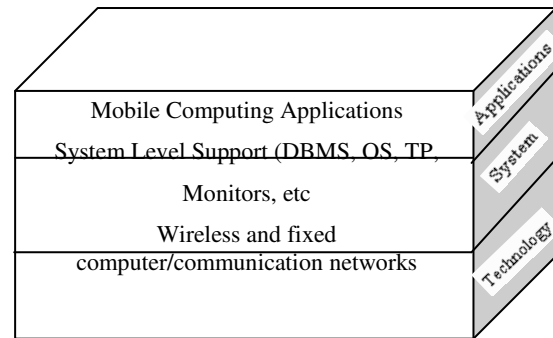


Fig 2: Layered view on Mobile Computing System

Cellular Networks are the most commonly use wireless connections in mobile computing. Each mobile unit is connected to a fixed network via wireless connection. The race started from the advent of GSM network and reaches to UMTS and HSDPA networks. In GSM data rate was limited to 9.6 Kbits/s, but in HSDPA it has reached to 3.6 Mbits/s. With the implementation of WiMAX users will be able to get data rate of up to 72 Mbits/s. General diagram of a GSM networks demonstrates the connectivity of Mobile Station (MS) to a network[9].

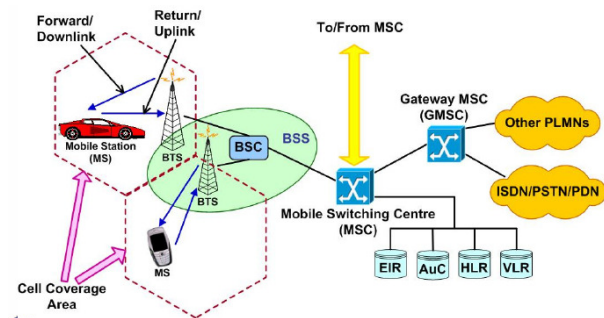


Fig 3: General Diagram of a GSM Network

The working functionality of mobile computing in different networks is different. To access the internet or any other network which is directly or indirectly connected to internet, use GSM Network. However, if a network is designed with in the organization in the same building has different mechanism of access. Depending on the network type, different protocols are used; one of the most common and basic protocol is Wireless Application Protocol (WAP). But with the advent of 3G systems it has enhanced to Open Service Interface (OSI) Model and TCP/IP. WAP is the traditional and fundamental protocol used for data transmission in GPRS [10]. There is a Mobile Data Base Station (MDBS) in each cell which is responsible for relaying data between mobile stations and Mobile Data Intermediate Systems (MDIS)[11].

There are also some other example like Bluetooth, Infrared, Wireless LAN. These are short range networks which can work 1-100 meters range. Users can be connected to access points through these wireless connections to access different services.

### IV. ADVANTAGES OF MOBILE COMPUTING

There are numerous advantages of this latest technology. Some of them are as follows:

- The 1<sup>st</sup> and major advantage of this emerging technology is it provides connectivity “anytime, anywhere, and anyplace”. Successful completion of “Wireless Cabin Project” this technology has made possible to use all services in aero planes. Users can use internet on their mobile and laptops, can make phone calls, and send SMS/MMS in the same way they use at home or office.
- Very small, light weight, compact and less power consuming mobile computers which can perform the same functionality as desktop computers.
- Central Data Base System is accessible from anywhere by authorised mobile user, which has drastically reduced paper work for different organisations. Most of the companies use mobile computing for their field work.
- Manual data input to computers has changed to automatic scanning. With the help of PDA scanners no need to input data manually. All we need to do scan the bar code and press enter.
- High reliability of data - different security mechanisms has made mobile computing more secure.

#### V. CHALLENGES AND LIMITATIONS

The fundamental challenge to mobile computing is bandwidth and latencies. Mobile connectivity is relatively lower in bandwidth, higher error rate and recurrent in disconnection, which cause latencies in data transmission for users[12].

Security is the 2<sup>nd</sup> major issue in mobile computing. The system should be such efficient and secure so that it can provide critical security to users. An efficient protocol is needed which can manage security level for each session. If the user security level is not high then he could only access less critical data. There are also some other issues with security regarding wireless transmission. Authentication is vital because wireless access makes network attachment too easy[8].

The other big challenge to mobile computing is Mobility Management. As user is always keep changing its location, surety of continuous connection is of great importance. Mobility in 3G networks includes location management, handover management and mobility state model. Mobility in IP based networks includes Macro Mobility and Micro Mobility[10].

Portability has been a big issue until recently but it has been resolved so far. In portability, major concern was local storage and power. But flash chip memory is getting bigger day by day and also research for chemical batteries will completely resolve this issue. However battery technology has also been developed so that they can run mobile device for a long time.

Software and hardware developed for mobile computing is network dependent. For each kind of

network we have to design a separate set of software and hardware. Applications developed for smart phones cannot be executed on a PDA and vice versa [13].

Cost of mobile computing devices has been a great issue but this technology is being cheaper day by day. Wireless data transmission is the major cost issue. Still it is more expensive than the ordinary wired data transmission.

For specific wireless network, licence is a big problem. Most of the wireless transmission is free but for some special networks we have to purchase licence to transmit over the air.

#### VI. APPLICATIONS OF MOBILE COMPUTING

Mobile computing is being used in numerous ways in today's life[14]. There are hundreds of different mobile devices available which perform hundreds of different functions. Windows based PDAs can work much more similar as a laptop. We can view edit Microsoft Office documents. Brows internet, email, chat etc. Even we can remotely control a computer through a mobile phone. Some of the major applications of mobile computing are as follow [11]:

For estate agents it is easier to obtain current real estate information by accessing multiple listing services, either at home or outside in the field. They can provide sufficient immediate information to client about specific home or neighbourhood. They can also provide quotation of loan approval at the spot.

Immediate retrieval of information is crucial where emergency services are involved. Mobile computing made it possible. Information regarding the incident like address, type of incident can be transmitted quickly to one or more mobile unit which are in the vicinity of the incident using mobile computers.

Mobile computing can also be used in courts by defence counsel. When the opposing counsel references a case which they are not familiar with, they can access direct real time online legal database services to obtain information relative to that specific case. Hence access to wealth information is possible by mobile computing.

Managers can always be connected to their company's database through mobile computing. Whatever the matter is, critical presentation to major customers or sharing latest market information, at a small recess revision of presentation or call meetings for discussing respond to new proposal, mobile computing can leverage competitive advantages.

Access to stock information in different environment e.g. factory, warehouse, retail store etc is ideally be done by small portable electronic mobile devices. No need to count each item manually, just scan using a mobile computer which is directly connected to the database server.

Intercommunication between the bank and the point of sale in a superstore or restaurant is required when paying by credit/debit card. In order to achieve verification process, communication can take place quickly and securely over cellular channels using a mobile unit.

Mobile computing provides complete information of dispatched jobs to taxis using centrally controlled

dispatcher with several mobile units (taxis). Dispatch office could be known by taxis' current whereabouts by real time GPS tracking system. This system not only provides information about job but also voice guided navigation help to reach there. In secure deliveries i.e. Securicor, this system allows the central computer to be able to track and receive status information from all of its mobile secure delivery vans.

There is no need to sign a paper on receiving deliveries; touch screen PDAs connected to central computers has reduced paper work and manual entries. Traffic warden is using a mobile computer to keep record of wrong parking.

Mobile computing can also be used in many other ways e.g. email paging specially for business person to never miss any important email. Wireless security systems, voice guided door to door navigation systems, thumb recognition for police investigation, wireless voting system are also some examples of mobile computing applications[11].

#### VII. FUTURE

The effective progress in microelectronics and convergence of communications and information technology is the fundamental unit of mobile computing evolution. Fulfilling Moor's law devices has become smaller in size and faster in speed. What can we expect in this regard from this rapidly growing technical progress? It seems technological revolution will lead us to tiny processors communicating spontaneously with each other[6].

If paper can be transformed into a computer or, conversely, computers into paper, the practical significance of such a development cannot be overestimated: but Nokia Morph and Microsoft Surface will make it possible[13].

Objects are clearly identified and recognized by electronic labels i.e. Radio Frequency Identification (RFID) tags, and therefore linked in real time to an associated data record held on the Internet or in a remote database. If everyday objects can be uniquely identified from a distance and furnished with information, this opens up possibilities of automated warehousing or supermarkets without cashiers[6].

Advent of Nanotechnology will drastically make revolutions in mobile computing. This technology based on the diameter of less than a human hair microprocessor. Mobile computers will be more compact and efficient in speed with this technology. With successful implementation of WiMAX world of mobile computing will be drastically changed. Communication will be faster up to 72 Mbits/s[10].

The upcoming devices will be different in sizes and shapes to perform different tasks. It is assumed that the user interface will be based on speech recognition, gesture recognition, or some other advanced natural input mode technology depending on their size and shape[6].

Wearable computing devices will replace the current potable devices to keep people informed, connected and entertained. It is expected that mobile computing device

will not only be "portable," but also, to a certain degree, become part of our clothing and be worn more or less directly on our bodies. Nokia Morph is the biggest example of wearable mobile devices [13].

#### VIII. CONCLUSION

In this paper we discussed the overview of mobile computing. It is a shift paradigm to future computing and communication technology. Mobile computing is being used at a large scale in big organisations. In near future it will replace much of desktop computing. Evolution in cellular network will change it completely. New software and hardware are to be developed to overcome all future predictions.

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## Media Independent Handovers

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**ABSTRACT:** As wireless technology increases we came to a fact that diversity in access of wireless devices increases and all of them operates on different frequencies. Mainly these wireless devices works on technology includes GSM,WI-FI, UMTS, CDMA, Wimax and Wi-Lan .In order to make subscriber more flexible during communication they been provided with mobile wireless devices with ability to multimode access the different technology like GSM,UMTS,CDMA,802.3,802.11,802.16 .

Media Independent handover is a standard that specifies the ability to access 802.3, 802.11, 802.16 and cellular systems technologies to optimize the heterogeneous handovers as well as to facilitate handovers within the same system for IEEE 802 and cellular systems. So that the subscriber could be provided with both seamless communication session and IP continuity when moves between different networks. This research paper will explain media handover's framework design principles, services and reference for link-layer technology.

**Keywords:** Gsm, UMTS, CDMA, Wi-Lan, 802.3, 802.11, 802.16, Media independent handover, link-layer technology.

### I. Introduction:

a) *Scope:* In this research paper we are going to define the optimization procedure handovers between IEEE 802 networks and cellular networks as well as between the heterogeneous IEEE 802 networks.

b) *Overview:* The purpose of this paper is to provide the seamless service to heterogeneous network during the handover whether it is in the region of different network likewise if it is IEEE 802 and it is in the cellular network. This standard provides link layer intelligence and other network information to upper layers to optimize the handover between heterogeneous network .this includes the media types like GSM, Wimax, UMTS, 3g and IEEE 802 family.

This research paper defines the handover between both mobile and stationary user. For mobile user handover occurs when a mobile user moves and enters in to a region where service or media or even wireless channel changes while in case of stationary user when surrounding network changes, making one network more attractive than other network whom which user was connected. If user selects an application that requires higher data rate than available current link, necessitating the link adaptation to provide the higher data rate. In all the cases the seamless service continuity is an important factor.

In this research paper we are going to discuss about the use of information which are available at mobile node and also in infrastructure of network. Information's such as adjacent channels information, mobile user information and higher service layer availability.

The handover procedure initiates on the basis of different network parameters and then trigger. The parameters

include signal quality, time difference between synchronization, transmission rates and error rates.

### II. Architecture:

a) *General:* This standard generally supports the types of handover, includes two types of handovers which are "hard handover "and "soft handover".

**Hard handover** "break before make": a handover process in which the connection is briefly broken by one base station (BS) before being re-established by another as a mobile station (MS) moves out of the range of the first and into the range of the second.

**Soft handover** "make before break": a handover process in which the connection is established by the second base station (BS) before being broken by the first as a mobile station (MS) moves out of the range of the first and into the range of the second.

The elements which are involved in making handover decisions like handover control, handover policies and handover algorithm are generally handled by communication system itself. The following overview going to give the different factors which are involve in making of handovers decisions.

b) *Seamless service or service continuity:* The term service continuity is defined as the ability to maintain a continuous service session across network and devices during and after the handover while the loss due to error should be minimal. Service continuity normally depends on quality of service (QOS) like if a user need to handover to new access area and found that QOS is unacceptable then higher layer decide not to do handover or to terminate the session depend on defined policies. This standard going to define such things.

c) *Application class:* Various applications have different properties or characteristics for delay or data loss depends on different environment and this plays a vital role in handover.

d) *Quality of service:* The ability to provide different priority to various applications, users and data flows, guaranteeing a certain level of performance to a data flow.

In terms of media independent handovers we consider two types of QOS.First the QOS experienced by an application during the process

of handover. Secondly the QOS which is involves a part in decision of handover. The requirement of QOS is to provide the seamless service end-to-end. For providing the seamless connectivity end-to-end it is necessary to minimize the handover latency and packet loss in order to minimize the delay and loss of transmitted information in order to minimize the handover.

- e) *Network identification*: This standard defines the information that helps in finding network and other specification such as link type, link identifier, and link quality and link availability.
- f) *Selection of network*: The process in which mobile node select the connection or services for connectivity of network layer called network selection. This connectivity based on QOS, network preference or subscription, cost and operator policies. In case of media independent handover these factor plays vital role.
- g) *Handover policies*: This standard is to perform the whole process of handover and make network selection entity more efficient and it do that with the help of Command service, Event service and information service.

### III. General design:

- a) *Media independent handover function design principle*: Media independent handover function is a logical entity which helps user to handover on the basis of input. It provides information to upper layer in terms of services. These services based on technology whose got different protocols information of different access network. Where higher level mobility management protocols specify handover signalling mechanism for vertical handovers although has got defined signalling for horizontal handovers. This standard provides support to remote event as well.
- b) *QoS design principle*: Every application communicates via communication channels which are generally composed of different segments and each of these segments are under different authorities. So, in order to transfer number of bits correctly the information can be grouped in to small numbers of sets known as classes of service and IEEE 802 standards follows them.

### IV. Media independent handover function events:

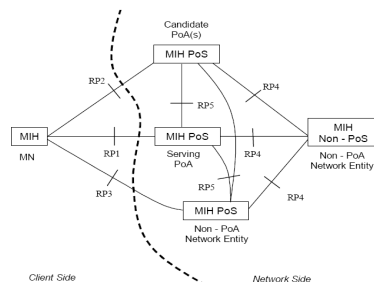
Whenever any of events occur it change the behaviour and state of physical, data link layer and logical link layer. These event services are generally indicate the action management and command status.

- a) *Event origination*: Whenever user need to handover independent of media a command invoke by its device as well as media independent handover function.
- b) *Event destination*: Upper layer always carries the information about event or we can say media independent handover function. When the user is in the node of the destination where it needs to be handover established a subscription mechanism that allows the mobile node to subscribe the event in order to carry out event.
- c) *Flow of service*: In any event messages often propagates from physical layer and travels towards upper layer but in case of remote event it happens peer to peer, message propagate in upper layer of one protocol stack to another upper layer protocol stack of network entity while network entity is connected to other protocol stack. Normally event service is used to detect when handover needed.
- d) *Media independent handover command service*: The command service is responsible of controlling the physical layer, data link layer and logical link layer. Where higher layer are responsible for making decision for handover according to appropriate link.
- e) *Command origination*: Command always generated by user as well as media independent handover function in order to link.
- f) *Command destination*: The information about destination lies in lower layer which been located in protocol stack that originated command.
- g) *Command service flow*: In command messages often flows from user to media independent function and then to lower layer but in case of remote event it happens peer to peer, message propagate in upper layer of one protocol stack to another upper layer protocol stack of network entity. During the handover, mobile node and network needs to exchange some information related to available best networks. Once the selection of new network completed then routing of all information packets are controlled by mobility management protocols. Commands allow mobile node and network to communicate about the best available network and handovers.

### V. Media independent handover function framework:

The following framework going to define communication between different media independent handover function within the mobile node and network.

- a) *Media independent handover function communication model:*



Following are the different roles assigns by communication model to media independent handover function.

- i. Media independent handover function to mobile node.
- ii. Media independent handover point of service on the network entity that includes serving point of access of mobile node.
- iii. Media independent handover point of service on the network entity that includes a candidate point of access of mobile node.
- iv. Media independent handover point of service on a network entity that does not includes point of access for the mobile node.
- v. Media independent handover non-point of service on a network entity that does not includes point of access for the mobile node.

The communication model also defines the reference point between different instances of media independent handover function.

- i. RP1 between the Media independent handover function on Mobile Node and a Media independent handover point of service on the Network Entity of the serving point of access.
- ii. RP2 between the Media independent handover function on Mobile Node and Media independent handover Point of service on the Network Entity of the candidate Point of access.
- iii. RP3 between the Media independent handover function on Mobile Node and Media independent

handover Point of service on a non-Point of access network entity.

- iv. RP4 between Media independent handover function Point of service and Media independent handover non-Point of service instance in distinct Network Entities.

v. RP5 Between two Media independent handover Point of service instances in distinct Network Entities.

### VI. Media independent handover function services:

Media independent handover function services are responsible for managing and configuring the handover between two heterogeneous systems. The media independent handover function services mainly includes two services media independent command service and media independent information service.

- a) *Media independent handover service management:*

This is responsible for providing the media independent handover services among different media independent handover functions. Media independent handovers are configured on the basis of following primitives functions.

- i. *Media independent handover event subscription:* This function is perform in order to confirm if the service is supported by media independent handovers.
- ii. *Media independent handover capability discovery:* This function is performing in order to find the best possible node for handover.
- iii. *Media independent handover registration:* This is to perform the registration with the node for handover.

- a) *Services management primitives:* There are mainly two types of services primitives Local and remote which indicate the media independent handover for local and remote user. Following are the services primitives which used in case of both local and remote user.

- i. *Media independent handover capability discovers:* This is used for discovering the capabilities of local and remote media independent handover function.
- ii. *Media independent handover register:* This is used to register with remote media independent handover function.
- iii. *Media independent handover deregister:* This is used to deregister with remote media independent handover function.
- iv. *Media independent handover Event subscription:* This is used for the subscription of one or more media independent handover with remote or local media independent handover function.

- v. *Media independent handover Event unsubscription:*  
This is used for the unsubscription of one or more media independent handover with remote or local media independent handover function.

### VII. Media independent handover event services:

The events are invoked by local or remote entity. In case of remote entity supporting protocols are needed to support the event. Event normally invoke from lower layer or upper layer either by mobile node or network. In order to start an event mobile node have to be subscribe. The event services are mainly dividing in to two which are as follows. Media independent handover events The events originate within the media independent handover function. Link events The events that originate below the media independent handover function and terminate at media independent handover function.

- a) *Link event subscription:* Media independent handover function search for every present devices and interfaces, when link event subscription initialize. After searching of devices and interfaces, Media independent handover function subscribes with their link layer individually.
- b) *Media independent handover event subscription:* In media independent handover event subscription media independent handover generates a list of events to media independent handover function for every receive notification. The event can be both local and remote while media independent handover function is responsible for accepting or rejection of subscription notification depending on availability.

Following are Link events: Link detected. In this link of a new access network has been detected. This event is typically generated on the Mobile Node when the first Point of Access of s network is detected. Linkup. In this connection is established and link is available for use. Link Down. In this connection is broken and link is not available for use. Link Parameters Report. This event is used for the specification of threshold values of link which determines the power. Link Going Down. This reports about the conditions of link that connection loss is imminent. Link Handover Imminent. This specifies that handover is required based on changes in link conditions. Link Handover Complete. This event shows that link handover to a new network is completed.

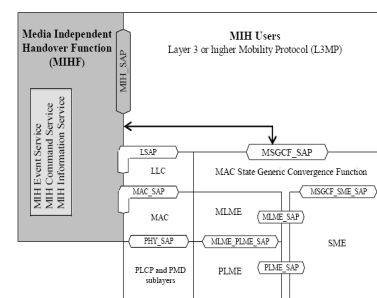
*Media independent handover event:* Following are the events related to independent handover. Media independent handover Link Detected this is generated when new network link detected. This event is typically generated on the Mobile Node when the first Point of Access is detected. Media independent handover Link Up. This generated when connection is established and link is available for use.

Media independent handover Link Down. This generated when connection broken. Media independent handover Link Parameters Report. When Link parameters crossed a

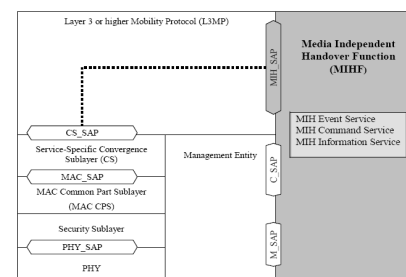
specified thresh-old and need to be reported. Media independent handover Link Going Down. This generated when Link conditions are bad and connection loss is due. Media independent handover Link Handover Imminent. This event generated when changes in the link conditions or additional information available in the network. Media independent handover Link Handover Complete. This generated when link handover completed.

### VIII. Media independent handover function reference model:

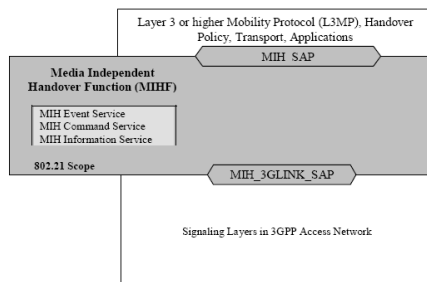
- a) *Media independent handover function reference model for IEEE 802.* This reference model is designed for different link layer technology with consistent with IEEE 802 standard. Media independent handover is responsible for message transferring to same media independent handover function on layer2 and layer3. these messages contain information about different access network. In case of IEEE 802 media independent handover service access point is responsible to specify the interface for user.



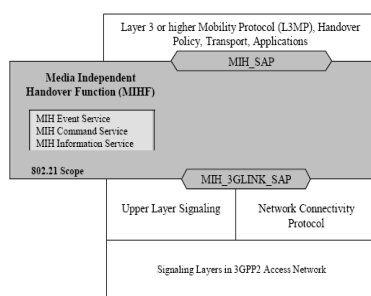
- b) *Media independent handover function reference model for Wimax:* The management service access point and control service access point are same between media independent handover function and network control center. The management service access point specifies the interfaces between media independent handover function and management center. Which is responsible for transferring the packets to wimax base stations while control access point specifies the interface between media independent handover function and control plane. Both management and control services access points are responsible for the transaction of messages between same media independent handover function.



- c) *Media independent handover function reference model for 3GPP*: The protocol architecture is decided by 3GPP standard. Where we got media independent handover service access point and media independent handover 3G link service access points. Media independent handover service access point works on layer 3 and above while media independent handover 3G link service access point deals with network access. Media independent handover function normally has command, event and information services.



- d) *Media independent handover function reference model for 3GPP2*: The protocol architecture is also decided by 3GPP standard. Where we got media independent handover service access point and media independent handover 3G link service access points. We have got primitive information such as upper layer signalling and point to point protocol. They can directly be used by logical link layer service access point and point to point service access point. Where logical link layer is responsible for receiving signalling from upper layer about the condition of link i-e link is good, link is going down etc. whereas point to point service access point is used to initiate event.



## XI. Conclusion:

Media independent handover is very necessary with in increasing of technology especially when most of them have got different platform. This is the only one way to make them all technologies compatible with each other and this going to start an evolution in telecommunication world.

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# Digital Video Broadcast to Handheld Devices (DVB-H): The Mobile TV solution

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**Abstract** - The television (TV) industry has dabbled in mobile TV in the past with devices like the pocket TV, but with undesirable results. The ubiquity of the mobile phone presents the industry with another chance in the form of a widely accepted, computationally capable device while still yearning for an efficient technique of conveying digital signals to these devices. Building on the success of the Terrestrial Digital Video Broadcasting (DVB-T), the Digital Video Broadcasting (DVB) project developed a standard to tackle this problem.

Digital Video Broadcasting-Handheld (DVB-H) standard is an offshoot of DVB-T which provides a robust, reliable method for TV broadcasts as well as other broadcast services to handheld devices. It was published by the European Telecommunications Standards Institute (ETSI) in November 2004 and is designed to work with small, battery-powered portable devices. This paper presents an overview of this standard and its clever innovations - time slicing, Multiprotocol Encapsulation-Forward Error Correction (MPE-FEC) and 4K mode. It also looks at the market deployment, challenges and growth expectations of the technology.

**Keywords:** Digital Video Broadcasting-Handheld (DVB-H), MPEG-2, OFDM, IP Datacast.

## I. INTRODUCTION

The increasing demand for mobile TV services created a void in terrestrial video broadcasting. The cellular companies stepped in to capitalise on their advantage through 3G TV services, but this proved very problematic because of the constraints it put on network capacity[1]. Owing to success of tests carried out by the Digital Video Broadcasting (DVB) group (sponsored by the EU: MOTIVATE (2000) and Multimedia Car Platform (2002) projects, which showed the possibility of mobile reception using Terrestrial Digital Video Broadcasting (DVB-T)) and shifts in consumer trends, the DVB group focussed on delivering technical specifications aimed at the transmission of good quality multimedia contents to handheld devices[2].

In order to achieve this, the DVB would have to take into consideration the unique problems associated with mobile receivers. These include:

- Power constraints introduced because these devices are battery powered.
- As the target users are mobile, there would have to be specifications for seamless handover between cells when the user moves across cells.
- The inherent problems associated with multipath mobile channels
- The specification should also include channel bandwidth sizes that would enable global

acceptance and be adaptable for various transmission bands.

- Also, the system would be backward compatible with all other forms of digital transmission (like satellite, cable and terrestrial).

With these goals in mind, the DVB-H standard was conceptualised and ratified. The DVB-H standard belongs to a family of standards defined by the DVB group of which it was the first for terrestrial transmission to handheld devices. It was designed to operate on the DVB-T physical layer and has a few additions to help counter the error prone mobile channel[3], as illustrated in Fig. 1. The subsequent sections will present the features of the DVB-H system. First, we will look at the DVB-T physical layer. Next, we will explore the modifications made by the DVB-H and then present an overview of the proposed DVB-H network.

## II. DVB-T PHYSICAL LAYER

### A. SOURCE CODING

DVB-T was introduced in 1997 to foster the dawn of digital television. It specified MPEG-2 as its source coding method in order to meet up with data rates recommended by the ITU-R Recommendation BT.601[4]. MPEG-2 makes use of irrelevance reduction techniques to compress data (video, audio and auxiliary data like video text) from studios at data rates of 166 Mbps to about 5 Mbps. MPEG-2 offers methods for coding television signals of different qualities ranging from Standard Input Format (SIF)-similar to VHS-to High Definition TV (HDTV). This made it an excellent candidate for DVB-T. The DVB group published some specifications ([5]) to restrict the implementations of MPEG-2 in DVB systems thus simplifying and ensuring compatibility of different vendor equipments.

It is capable of multiplexing video and audio data from different sources into one single data stream. The system defines functions which help in identifying these multiple data sources by making available information about transmission paths while synchronising video and audio in order to maintain uniformity of lip movement[4]. MPEG-2 packetizes its input data and includes control information; afterwards it combines these packets into one single data stream. This, results in either a program stream (PS) or a transport stream (TS), the latter of which is used in DVB-T due to its adaptability to error prone channels. Each TS packet is 188 bytes long with the first 4 bytes used as the packet header. The packet header contains the synchronisation (sync) byte and the program identifier (PID). The remaining 184 bytes are used to carry the payload.

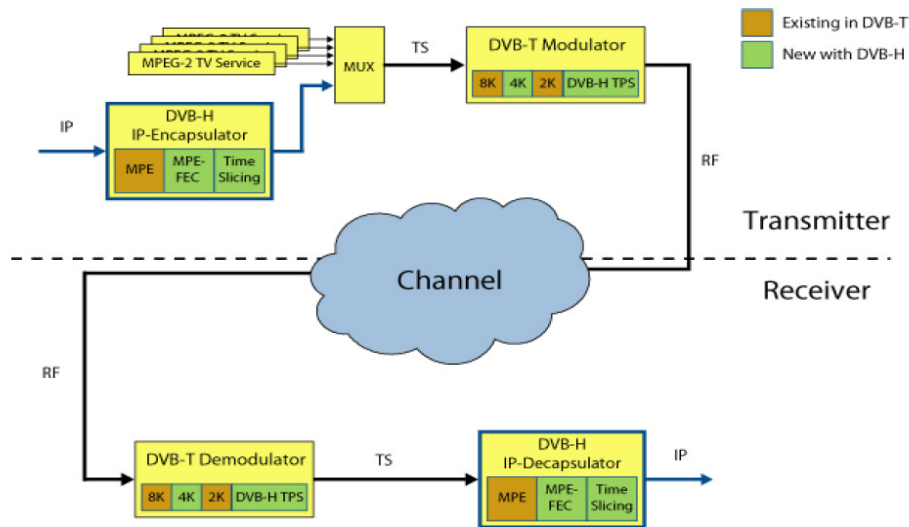


Fig. 1. DVB-H system (sharing a MUX with MPEG-2 services).

### B. CHANNEL CODING AND MODULATION

The TS consists of the baseband signal required for transmission. Before transmission, the baseband signal is subjected to a string of channel coding and error protection processes which will require Forward Error Correction (FEC) mechanisms at the receiver in order to reverse the effects of the wireless channel. Fig. 2 illustrates this process which involves combining the output bit stream of a pseudorandom noise generator with the baseband signal (implemented by a feedback register). The result is a flat power-density spectrum[6]. Note that the sync byte of the TS is unaffected by this process and the decoders are informed of the starting point of the sequence through an inverted sync byte.

The next three blocks in Fig. 2 represent the error protection methods implemented by the DVB-T encoder. The outer error protection is implemented using a Reed-Solomon (RS) (255 239) code that is shortened to fit the TS packet size. This means that the first 51 bytes are set to zero and discarded thus converting the code to a RS (204 188) code[6].

The outer interleaver re-orders the bytes to protect against long burst errors. This is implemented using a convolutional interleaver of interleaving depth  $I = 12$  and base delay  $M = 17$ [4].

The inner error protection is a convolutional encoder of basic code rate  $1/2$ . A range of code rates has been specified by the DVB depending on the puncturing mechanisms used, they include  $1/2$ ,  $2/3$ ,  $3/4$ ,  $5/6$ ,  $7/8$ .

The next stage is the inner interleaver which carries out its interleaving in two sections. First, 126 successive bits are combined to form a block. These

blocks are then further rearranged using a bit interleaver to produce larger blocks (symbols) and then more interleaving using a symbol interleaver follows. Depending on the Orthogonal Frequency Division Multiplexing (OFDM) mode used, the second section of interleaving outputs a non-sequential stream which has intervals at points where additional carriers can be inserted. A detailed description of the entire process can be found in [4].

OFDM was chosen by the DVB because it is resistant to multipath effects of the wireless channel and it can support Single Frequency Networks (SFN). There are two variants of OFDM defined for DVB-T which involve the use of 6817 carriers (8K mode) or 1705 carriers (2K mode)[7, 8]. These OFDM symbols are preceded by guard intervals (GI) to increase their resistance to echoes. DVB-T specifies three modulation schemes; QPSK, 16-QAM, 64-QAM. Table 1 shows the choice of OFDM parameters for Non-hierarchical DVB-T transmission. DVB-T also specifies parameters for hierarchical transmission, which simply means that two independent data streams can be transmitted with the same signal but using different modulation schemes[6].

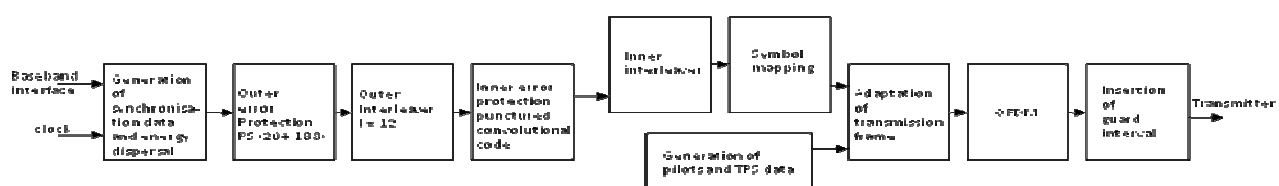


Fig. 2. Block diagram of DVB-T encoder

**Table 1.** DVB-T Parameters for Non-Hierarchical transmission

| OFDM mode                    | 2K                        |                   |                   | 8K                 |                    |                   |
|------------------------------|---------------------------|-------------------|-------------------|--------------------|--------------------|-------------------|
| No. of carriers K            | 1705 (0...1704)           |                   |                   | 6817 (0...6816)    |                    |                   |
| Band-width (RF Channel)      | 6 MHz                     | 7 MHz             | 8 MHz             | 6 MHz              | 7 MHz              | 8 MHz             |
| Spacing                      | 5.71 MHz                  | 6.66 MHz          | 7.61 MHz          | 5.71 MHz           | 6.66 MHz           | 7.61 MHz          |
| Carrier spacing              | 3348 Hz                   | 3906 Hz           | 4464 Hz           | 837 Hz             | 977 Hz             | 1116 Hz           |
| Duration $T_{\text{symbol}}$ | 299 $\mu\text{s}$         | 256 $\mu\text{s}$ | 224 $\mu\text{s}$ | 1195 $\mu\text{s}$ | 1024 $\mu\text{s}$ | 896 $\mu\text{s}$ |
| GI                           | $1/4$                     | 75 $\mu\text{s}$  | 64 $\mu\text{s}$  | 56 $\mu\text{s}$   | 299 $\mu\text{s}$  | 256 $\mu\text{s}$ |
|                              | $1/8$                     | 37 $\mu\text{s}$  | 32 $\mu\text{s}$  | 28 $\mu\text{s}$   | 149 $\mu\text{s}$  | 128 $\mu\text{s}$ |
|                              | $1/16$                    | 19 $\mu\text{s}$  | 16 $\mu\text{s}$  | 14 $\mu\text{s}$   | 75 $\mu\text{s}$   | 64 $\mu\text{s}$  |
|                              | $1/32$                    | 9 $\mu\text{s}$   | 8 $\mu\text{s}$   | 7 $\mu\text{s}$    | 37 $\mu\text{s}$   | 32 $\mu\text{s}$  |
|                              | $1/64$                    | 4 $\mu\text{s}$   | 4 $\mu\text{s}$   | 4 $\mu\text{s}$    | 19 $\mu\text{s}$   | 16 $\mu\text{s}$  |
| carrier modulation           | QPSK, 16-QAM, 64-QAM      |                   |                   |                    |                    |                   |
| Inner code rate              | $1/2, 2/3, 3/4, 5/6, 7/8$ |                   |                   |                    |                    |                   |

### III. DVB-H SYSTEM

The physical layer of the DVB-H (much like the DVB-T) defines procedures for encoding the source data, outer coding and interleaving, inner coding and interleaving, modulation, symbol mapping and OFDM transmission. Unlike the DVB-T, it incorporates some elements at the link layer geared towards mobile reception such as time slicing; which reduces the average power consumption of the receivers and allows for the seamless handover between service areas[3 , 9 , 10 , 11]. Also, an optional multiprotocol encapsulation-forward error correction (MPE-FEC) is introduced. This improves the Carrier-to-Noise (C/N) and Doppler performances of the system in mobile channels[3 , 9 , 10 , 11]. Details of these features follow in subsequent sections.

Four modifications were made to the DVB-T physical layer, these include:

- Two bits added to the Transmitter parameter signalling (TPS) to identify the DVB-H services and possible use of MPE-FEC.
- Another mode of OFDM transmission was added; the 4K mode. This increases the flexibility of the system and also enables single-antenna reception in Single Frequency Networks (SFN) at high speeds.
- The addition of an in-depth interleaver which improves the noise tolerance levels of the system to those possible with the 8K mode.
- An additional 5-MHz channel bandwidth to be used in non-broadcast bands. This allows DVB-H to be adopted in parts of the world that already have the originally specified frequency and bandwidths occupied.

DVB-H also specifies the Service Information standard (DVB-SI) which allows the receiver to verify that

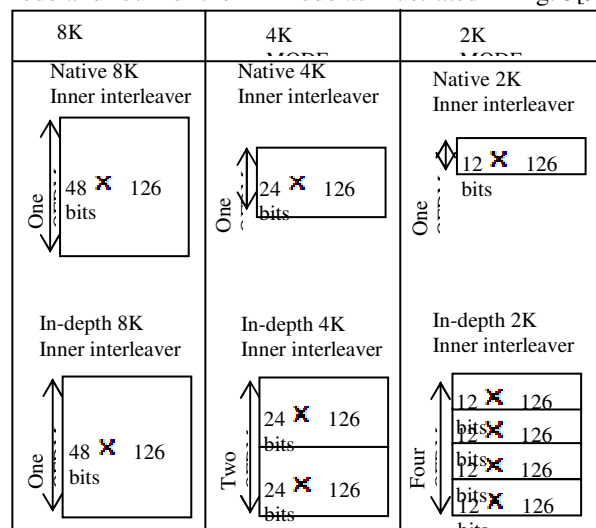
transmitted packets within the MPEG TS contain DVB-H services.

#### A. 4K MODE

The main drive towards the introduction of the 4K mode was to expand the level of flexibility offered by DVB-H in relation with network planning. Both previous modes had their advantages and limitations when it came to network deployment. The 2K mode offered high quasi-error free data rates at extremely high speeds and was suitable for SFN transmission but had very limited transmit range. Conversely, the 8K mode, although suitable for SFNs, provided very large transmitter distances but with low data rates. It was also not very efficient at high speeds. Hence, the 4K mode was created to compromise both strengths and deliver relatively fast data rates at high speeds with the added advantage of acceptable transmit distance capabilities[9]. In the 4K mode we have a transmission scheme that allows for cost effective SFN cell sizes at useful data rates.

#### B. IN-DEPTH INTERLEAVER

The process of interleaving spreads the data over multiple OFDM symbols. This increases the system's resilience to noise and errors but it also increases the demodulator's burden. The receiver will now require a large amount of memory to store the continuous received data before demodulation which in turn increases the amount of power utilised by the receiver. The solution to this problem was to set the memory capacity of the 8K receiver as a maximum and incorporate an in-depth interleaver for both the 4K and 2K modes. This would then spread the data over two OFDM symbols for the 4K mode and four for the 2K mode as illustrated in Fig. 3[9].



Since most mobile demodulators were equipped with RAM and logic to cater for 8K signals, this solution imposed no additional cost on the mobile receivers[2].

#### C. TIME SLICING AND MPE-FEC

DVB-H services are time multiplexed and transmitted in bursts. These burst transmissions offer the DVB-H receiver an option to save power while waiting for the

next transmission. Time slicing refers to a process where the receiver turns off its front end without disrupting the user's service, much like how the mobile station operates in a mobile network. This process allows the receiver to conserve power as well as search for alternative frequencies on which the service is being broadcast. This period also offers the receiver an excellent opportunity to perform seamless handovers between adjacent cells[1, 2, 9].

All DVB-H payloads comprise of IP-Datagrams or other network layer datagrams encapsulated in MPE-sections. MPE is the method specified by the DVB project for use in transmitting MPEG-TS packets in the DVB-H. Using a forward error correction scheme with MPE is an optional choice for DVB-H and it involves applying RS parity data to each time sliced burst. This results in an MPE-FEC frame. This MPE-FEC frame comprises of an application data table (ADT), used to carry the IP datagrams, and an RS data table containing the RS data[2]. The size of an MPE-FEC frame is 256-1024 rows by 256 columns (191 for ADT and 64 for RS data table) and is signalled in the service information (SI). The IP datagrams of individual bursts are fed into the ADT vertically from the upper left corner, column by column (with the possibility of zero padding for small datagrams). The 64 RS parity data bytes are calculated from the 191 IP datagram.

A combination of MPE-FEC with time slicing greatly improves the C/N performance of a system. Measurements in [2] show that the C/N performance of a DVB-H system implementing both features reaches values attained when antenna diversity is used. There is slight down side to this in the form of reduced throughput[2] resulting from added overhead of the MPE-FEC section. However, [2] suggests using a much weaker convolutional code rate for the DVB-T to alleviate this problem.

#### IV. DVB-H NETWORKS AND SERVICES

DVB-H was designed to operate in the VHF-III, UHF-IV/V and L bands[3], where one 8MHz band would be able to deliver 30-50 multimedia streaming services. These services will be made available via IP datacasting (IPDC). IPDC refers to the use of a hybrid network involving mobile communication networks (GPRS/UMTS) and DVB-H networks to provide multimedia services[12]. It is a point-to-multipoint distribution system which offers a platform to convey existing IP-based content, for example web-pages, video streams, through a mobile broadcast. These multimedia services could range from legacy TV broadcasts to interactive TV services[1].

DVB-H networks can be implemented as either standalone networks or shared with DVB-T networks. When deployed in an existing DVB-T network, the DVB-T network has to be retrofitted for portable indoor reception and DVB-H recognition at the transmitter. On the hand, a dedicated DVB-H network allows for greater planning flexibility. Most of these kinds of networks will be implemented using SFNs (having coverage areas dependent on the FFT size, guard intervals and

geographic properties) and will incorporate all the features of the DVB-H[2].

#### V. MARKET AND GROWTH EXPECTATIONS

As with all new technologies, market penetration is always key to survival and profitability. DVB-H's current competitors include Terrestrial Integrated Services Digital Broadcasting (ISDB-T), Digital Multimedia Broadcasting (T-DMB), ATSC-M/H, Qualcomm's Forward Link Only (FLO), to mention but a few. Breaking into such a market would be tough. However, with the adoption of DVB-H by EU, TTA and other bodies, DVB-H has a fighting chance of becoming the global standard for delivering TV to handheld devices. Currently, the different spectra used by different regions of the world and the battle between mobile operators and TV content providers pose the greatest threats to DVB-H[13].

Nevertheless, DVB-H has already been deployed in many European countries like the UK, Germany, Italy, Spain and so on. This number is expected to rise as the gradual switch from analogue to digital TV finalises and frees up much needed spectrum in these countries.

#### VI. CONCLUSION

The key features of DVB-H have been presented and have proven to be efficient additions to the standard. With the continuous demand for mobile multimedia content by consumers and the backing of major corporate partners like Nokia and Ericsson, DVB-H is set to become the global standard for mobile TV.

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# An Architecture and Mobility Management in Hybrid 3G Cellular and WLAN Networks

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**Abstract-** Wireless and mobile networks have witnessed an enormous achievement in the last few years. Nevertheless, there is no any particular category of wireless and mobile network that can definitely withstand all sorts of service requirements. To be candid, it is very uncommon for any single class of existing wireless and mobile networks to concurrently provide both wide coverage and high bandwidth services. Therefore, in order to provide supplementary and comprehensive services, an integrated hybrid is required to combine the high bandwidth efficient of wireless technology and wide area coverage capability of mobile network.

In this paper, a novel architecture for seamless unified working of the WLAN and 3G mobile cellular network is presented. This architecture is a hybrid model with supplementary mobility management controls that is compared with the existing architectures. In the same vein, the intermediary of making use of IP Multimedia Subsystem (IMS) for coupling and real-time session management is also considered.

Furthermore, an innovative mobility technique that utilizes the existing functionalities advantage of SIP proxy server integrated with Call State Control Functions (CSCFs) and Home Subscriber Server (HSS) that allow mobility support during the vertical handoffs is also implemented.

**Keywords:** Hybrid, WLAN and 3G Cellular Networks, Mobility management.

## I. INTRODUCTION

The new generations, which involve evolutions of wireless and mobile networks over the recent years, have outstandingly produced great deployments. What actually ascribed for these enormous achievements are unrelenting and frequently demands for better service satisfaction by the users. For instance, an average cellular data user nowadays is pampered with the high-speed internet access either at the office or home but regrettably encountered dawdling connectivity to cellular data networks such as GPRS, UMTS and CDMA 1X. These eventually resulted into the huge demand to, by some means; make available superior data rate of communication over the networks.

However, with objective of addressing this challenge, the development of third generation (3G) wireless networks was accomplished and deployed. In spite of this development, users' yearnings for better condition of services have not been met due to the inherent limitations in 3G wireless network and its failure to deliver promised performance and throughput. Consequently, 4G is now proposed as the next generation of wireless networks that

will replace 3G networks sometimes in future [1]. However, given that 4G networks are still in proposed stage and thus not expected to be deployed for years to come, an alternative solution to this must be provided.

Thus, since it is possible to provide high mobility in 3G cellular networks, while WLANs are also best recognised by their comparatively higher bandwidth, hence, ubiquitous data services and very high data rates across heterogeneous networks may be achieved by using WLANs as a complement to cellular data networks [2]. Essentially, there must be a need for efficient interworking mechanisms for WLANs and 3G cellular data networks that will resourceful utilize both each unique characteristics in an effective hybrid system.

Resourcefully, the hybrid of WLAN into cellular networks would allow users in "hot spot" areas to exploit the high-speed wireless network and while outside the range of a hot-spot coverage area, would still be enable to access network through the use of cellular data networks. The incorporating characteristic of WLANs with 3G wireless data networks produced various technical challenges, like seamless vertical hand over across WLAN and 3G radio technologies, security, common authentication, unified accounting and billing, WLAN sharing among several 3G wireless data networks, and coherent Quality of Service (QoS) [3][4]. Although, these challenges were moderately addressed by 3rd Generation Partnership Project's (3GPP's) IMS specifications; as an arbitrator for standardize a real-time session negotiation and management.

The remainder of this paper is structured as follows, in section II, each modelling system behind the WLANs, 3G Cellular networks, and IP multimedia system (IMS) networks are considered. The different components that drive each of the network architectures to function are likewise investigated. Section III presents current technical developments in the WLANs/3G Cellular IMS internetworks and the architecture model. The mobility management technique that support and illustrates the interworking feasibility of the IMS networks is likewise considered in the section (IV) that follows. Last section (V), finally draws the conclusion and recommendation for the future research work on the system.

## II. BACKGROUND: OVERVIEW OF NETWORK MODEL SYSTEMS

### *II (a) 3G Cellular Network Architecture*

Recent advancement in the technology has greatly influenced the data rate speed particularly with evolution of GPRS(General Packet Radio Service) on GSM networks, 1X technology on CDMA networks and current UMTS/3G networks. An UMTS network is built on foundation of the 3rd Generation Partnership Project (3GPP). Basically, 3G is a radio modulation technology that provides greater throughput of bits per Hertz; this paved way for the provision of the subscriber application services that require higher bandwidth. The two principal 3G technologies in the marketplace today are WCDMA/UMTS and 1xEV-DO. The model comprises of two fundamental components: The UMTS core network (UCN), and the UMTS terrestrial radio access network (UTRAN). The UCN has two division networks: *Circuit-Switched* and *Packet-Switched*. The former provide voice and circuit switched services while that latter take care of routing packet –based services over the networks.

Operationally, the circuit switched domain contains mobile switching centre (MSC) that perform the task of routing voice calls and the gateway MSC (GMSC) with configuration access to other public switched telephony or ISDN networks. On the contrary, the packet-switched domain comprises Serving GPRS Support Node (SGSN), Gateway GPRS Support Node (GGSN), and other functional units with responsibilities of routing, maintaining, and billing particulars of the data services. The SGSN and the GGSN play major role in UMTS ability to support packet based data services over the wireless mobile network, internet access and connectivity. Conclusively, UTRAN part is responsible for the wireless access to the UMTS network services. UTRAN is based on a collection of Radio Network Controllers (RNC), and a base station referred to as Node B. NodeB provides wireless access for mobile subscribers while the RNC performs services of management and control function within the UTRAN. Figure 1 below illustrates the basic architecture of UMTS network.

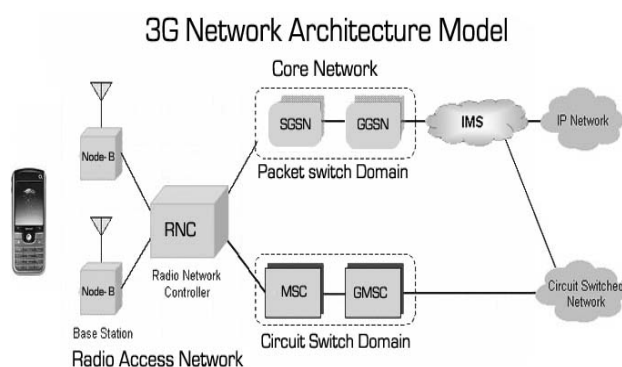


Fig 1: Basic UMTS Network Architecture.

## II (b) WLAN Network Architecture

The IEEE802.11 describes the standard for wireless local networks (WLANs). According to the standard, the WLAN runs in two distinct modes. It is either ad-hoc or infrastructure mode. Infrastructure mode supports its

incorporation with wireless networks where an Access Point (AP) controls the communication between the mobile stations within its radio coverage area otherwise called Basic Service Set (BSS). All the mobile stations that are associated with an AP communicate with one another via the AP and each mobile station can only attach to one AP at a time.

Moreover, a set of APs can be interconnected over an IP routed network with the aid of an access router to perform the function of the WLAN/PWLAN IP network. In this case, the APs provide radio interface to the WLAN network and IP packets exchanging take place via the access routers. Therefore, at a certain point in time, a mobile station is connected with a single AR. Fig 2 below shows the basic network architecture

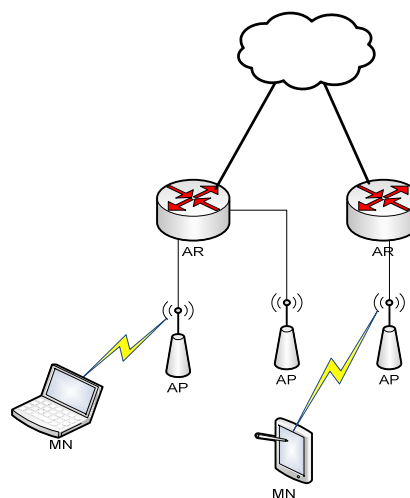


Fig 2: Basic IEEE802.11 WLAN/PWLAN Architecture.

## II (c) IP Multimedia Subsystem (IMS)

The IMS was instituted by UMTS releases five and six within its core network [2] [6]. The institution emphasizes key requirement characteristics for multimedia sessions control and IP multimedia services over a UMTS network. It describes a comprehensive architecture and structure that facilitate the unification of voice, video, data and mobile network technology over an IP-based infrastructure.

However, the IMS is featured with a numerous of significant mechanisms so as to facilitate these services. Parts of these mechanisms are: *session negotiation and management, Qos, local mobility management, and Authentication, Authorize and Accounting (AAA) function*. The major elements for this network framework are, Call State Control function (CSCFs) and the Home Subscriber Server (HSS). The CSCFs performs the functions of address translation, service switching, negotiation and handling of the subscriber profile. Its roles in the overall network can be likewise categorised into *Interrogating – CSCF (I-CSCF), Serving- CSCF (S-CSCF) and Proxy-CSCF (P-CSCF)* which represents the first contact point in the IMS network. P-CSCF is located in the same network as GGSN and either is in the home

network or the visiting network. As a result of this, P-CSCF can be able to forward the session initiation protocol (SIP) registration and session negotiation messages to the mobile Host's (HM) home network.

Similarly, I-CSCF is the access passage to the home network from a visited network and with the aid of the Home Subscriber Server (HSS); the I-CSCF will be able to select the appropriate Serving-CSCF. The S-CSCF is the node element that eventually support the real user registration and session control for the IMS network. HSS has a common interface with the I-CSCF, S-CSCF and database that is integrated with Home Location Register (HLR) in HSS. This acts as a repository for subscription and location. The Media Gateway control function (MGCF) interconnected with circuit switch networks with the aid of the appropriate IMS Media Gateway (IMS-MGW) allows the integration of Public Switched Telecommunication Network (PSTN) and other mobile networks services. Fig 3 below dramatically illustrates the overall elements architecture.

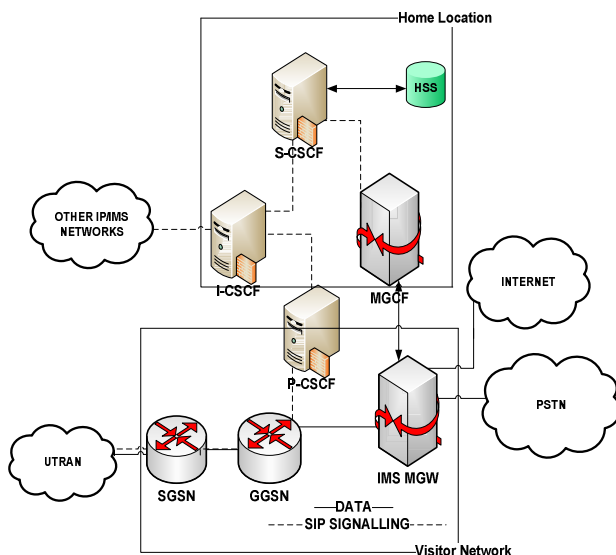


Fig3: IMS Architecture

### (III). WLAN-CELLULAR INTERWORKING ARCHITECTURES

The recent integration of WLAN-Cellular networks technique can be generally categorized into three generic approaches: *Tight coupling*, *Loose coupling* and *Peer-to-Peer networking*, according to the 3GPP classifications for GPRS and WLAN (802.11b), CDMA 1X and WLAN (802.11) integrations and each differs in the mode of application with cellular data network (GPRS/UMTS).

#### III (a) Tight coupling

In this approach, the WLAN is directly connected to the GPRS/UMTS core network. Hence, all the data traffic goes through the UMTS core network. Thus allow service provider to completely monopolise the ownership and operation of the WLAN network. The main functional element in this system is the GPRS interworking function (GIF) that emulated an IEEE 802.11 Extended Service

Set (ESS) to a Serving GPRS Support Node (SGSN) through Iu-ps interface [2] [7]. The benefit of this approach is that the UMTS mobility management method can be apply directly. The disadvantage is the generation of bottleneck at the SGSN as a result of influx increases in data traffic flow routed via the WLAN.

#### III (b) Loose coupling

Loose tight coupling offers another alternative to tight coupling. In this approach, WLAN network acts as access and complementary network to the GPRS/UMTS Cellular network. Thus, it is not connected directly to the core GPRS/UMTS network. In this scenario, transporting signal over an IEEE802.11 WLAN to the UMTS CN resulted into authentication, authorisation and accounting (AAA). The major advantage of this technique is that the data traffic that is routed directly via an IP network prevents the generation of bottleneck at core network. The disadvantage of loose coupling is hand-offs may be less efficient and mobility is considered when the user is out active session. This is the implemented methodology in this paper (fig 4).

#### III (c) Peer-to-Peer Networking

Another popular approach is peer-to-peer network. It is regarded as an extension to the loose coupling architectural approach that treats the two networks as peers [2] [8]. The framework for mobility technique is through the deploying mobile IP (MIP) and AAA servers. Although, this may not be the best application due to limitation in the mobile IP protocol itself for roaming and thus only capable of provide limited access.

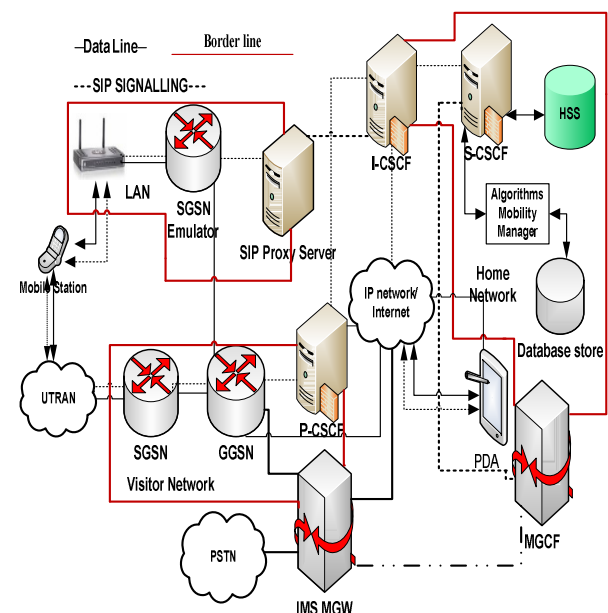


Fig 4: Interworking Architectural Model

Conclusively, the model presented above is anticipated to provide a Mobile Station (MS) the maximum available level of access to the UMTS services. The IMS is

considered as an Intermediary system in order to optimally perform interworking function between the WLAN and the UMTS networks and its unique characteristics for real –time session negotiation and management enable its appropriate application here. Furthermore, a novel approach, termed algorithms mobility manager, to activate and manage vertical handoffs is likewise described by the system [2].

#### IV. INTERWORKING VIABILITY PROCEDURES AND MOBILITY MANAGEMENT

##### IV (a) Data Routing and Signalling Procedure

Data flow originates from MS via the SGSN and the GGSN from the visitor network perspective and arrive the destination network with various hand offers support for Home – GGSN and Visitor – GGSN of user data roaming and routing from 3GPP/UMTS network service operator. In this way, the data flowing avoided the IMS network. Therefore, the IMS is expected to use different paths for user data and signalling through the network.

Alternatively, SIP signalling information instigated by the MS also gets to the destination through Universal Terrestrial Radio Access Network (UTRAN) via the SGSN, GGSN and the CSCFs exit to their respective destination. It is pertinent to say here that MS cannot establish any session without early activation request message to the S-CSCF through P-CSCF and I-CSCF. Both SGSN and GGSN act only as routers and are not partaking in SIP signalling.

Conversely, the originated signal from the WLAN is routed through router (SGSN emulator) to the UMTS GGSN. In this manner, it emulates the WLAN as alternative SGSN integrated to the same UMTS network. Thus, the protocol functionalities of the BSS is sidelined and the traffic bottleneck of UMTS from high volumes of WLAN traffic may be likewise moderated

##### IV (b) Session Procedure Setup

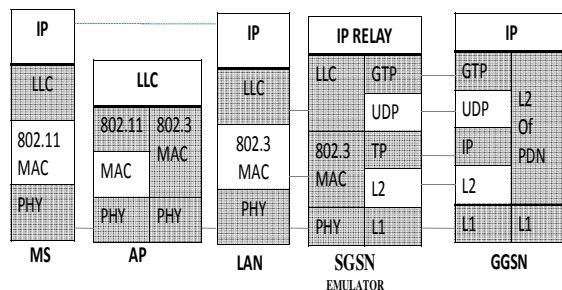


Fig 5: Protocol Stack (SGSN Emulator)

In the Fig 5 above, essential component functionality is required in SGSN emulator for effective mobility support. Therefore, the institution of SIP session within UMTS and IMS environment with various functions guarantee the feasibility of the service. The Mobile station selects appropriate cell after it has been powered on and thereby

get ready for data session establishment. The process of data connection (SIP registration) is thereby initiated for the SIP and related services. To begin with, MS has no prior knowledge of IP address of the P-CSCF; therefore, registration is initiated by two methods: *Attach and Packet Data Protocol (PDP) context activation message sequences*. The PDP context activation acquires IP address for MS and creates a relationship for this IP address between SGSN and GGSN that is required to carry SIP identical signalling message to the P-CSCF via the GGSN and from this process, MS has an ability to identify the P-CSCF with the UMTS SIP network registration.

Preceding the setting up of a SIP session, the MS is to activate service registration process to let the IMS know its location. In this way, the MS performs as a SIP client and relays a SIP registration signal to its home network via the P-CSCF. However, the SIP registration service takes place when the Home subscriber server (HSS) of the MS got notification of its current location purposely requiring HSS to update its profile correspondingly in HSS buffer memory. In response to this, HSS queries the subscriber profile within if allow to register in the network according to its current status with operator restriction and grant of authorisation to the network. Once approved, an appropriate S-CSCF for the MS is allocated and its subscriber status is signalling to the appropriate S-CSCF.

Sequence to the above processes, the MS enters standby state to establish a multimedia or voice call session procedure. This Procedure is firstly initiated by a SIP INVITE message originated from the source MS and forwarded by P-CSCF to the S-CSCF through the I-CSCF and ultimately to the destination with Session Description Protocol (SDP) attachment. Hence, the two end points pass through the SDP negotiation stage and the resources reservation is supported for the session by the network thereby confirming session setup by exchanging SIP OK and ACK information between the session terminating and initiating points. Mobile station can now begin to exchange data while the session is in progress.

##### IV(c) Mobility Management

Vertical handoff procedure is initiated from UMTS network to WLAN when MS detects the presence of a WLAN in its surrounding. This takes place when MS moves from UMTS network to the WLAN. The handoff is not essentially triggered by signal decay of the current system. The metrics that support in triggering a vertical handoff are basically the network conditions (available bandwidth and delay, user preference, etc.) instead of the physical layer parameters (received signal strength, signal-to-interference ratio, etc.) [2][9].

However, after vertical handoff is initiated, mobility management schema is required to maintain continuity of service (i.e. roaming of the system) and one approach for managing this is by integrating a new network unit called

the Mobility Manager (MM) within the IMS [2] [10]. The handoff management is established on metrics like statistics, existing load on access router, MS's priority users' profile, etc. All these are stored and regularly updated in database that is associated with MS. As illustrated in Fig 4 above.

#### V. CONCLUSION AND RECOMMENDATION

The work presented in this paper is hybrid modelling of 3G cellular and WLAN networks integrated with IMS interface due to its unique ability to manage real time session service. An innovative framework for mobility support and QoS of service is presented. The application of a SGSN emulator system to avoid large volume of traffic from UMTS core network is likewise a contributed effort to this research knowledge subject. Therefore, for effective seamless data roaming, QoS during vertical handoff and large volume of traffic that may be generated from the WLAN network, more research work should be done and tailored on the mobility manager.

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## Evolution Towards 3G UMTS Systems

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**ABSTRACT-** Mobile network systems have evolved to accommodate the growing usage of mobile phones, and the escalation of different types of applications brought into use on the mobiles phones such as video conferencing, internet access, navigation capabilities etc. This inspired the introduction of 2.5/3G networks in 2001/2003, for example EDGE and UMTS which will be the focus of this report.

EDGE was introduced as a way to provide higher data rates as compared to traditional GSM/GPRS and in a way prepare for smooth transition to UMTS network. The report will broadly discuss the transition focusing on the differences between the two networks and the kind of applications they support.

The network systems are classified based on the data rates they provide, applications they support, modulation schemes used etc and these criteria will be the basis of the comparison between the network systems.

UMTS networks provide a peak data rate of 2Mbit/s while EDGE networks provides only 474kbit/s, hence it provides high quality data and voice transmissions which makes it the most suitable network to meet the 21<sup>st</sup> generation's needs. UMTS uses a similar structure as EDGE and GPRS systems, with the introduction of a new radio access network (UTRAN) to support the changes in the modulation scheme and the air interface.

**Keywords:** UMTS, EDGE, GPRS, UTRAN, GSM, 3G systems, Modulation schemes, multiple access techniques, Packet switched domain, Circuit Switched Domain

### INTRODUCTION

The introduction of GSM in the early 1990s represented a revolution in mobile communications. Even unto this day GSM is still the foundation of most mobile networks, and one cannot deny the fact that the 3G mobile systems have evolved from the GSM as well.

There were a number of factors which influenced systems to evolve over years, the need for higher data rates, need for better quality of service are only a few of them. GSM systems provided only voice services and as a result another system had to be developed which could allow data transmissions, and in GPRS this was achieved.

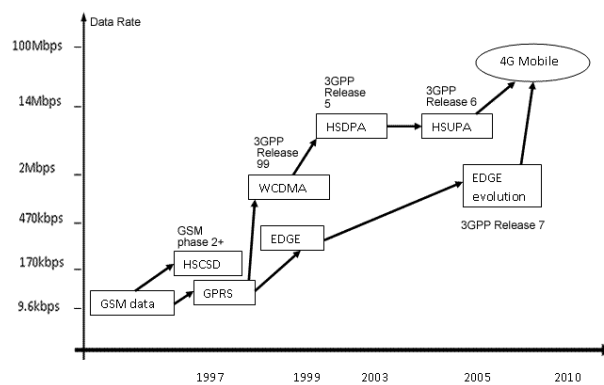


Figure 1: mobile service evolution

GPRS falls under a category of systems called GSM Phase 2+ and it was directly derived from GSM. In 1999 3GPP released under standard by the name EDGE, using an 8-PSK modulation scheme to provide higher data rates and also this was the introduction of third generation standards (UMTS). Third generation systems were seen as the means to satisfy the demand for bandwidth, and even though the systems took long to be rolled out commercially they were meant to provide higher data rates and a better quality of service as compared to preceding systems.

This research paper will focus more on third generation systems (e.g. UMTS) and how it evolved from GSM/ GPRS networks and also the EDGE network system will be discussed. EDGE network system is considered a 2.75G network and some believe it paved a way for much faster and efficient systems such as UMTS hence the reason why it cannot be overlooked.

### EDGE

This mobile system was first introduced in 1999/2000 which then was considered as a new technology. EDGE is an acronym which stands for Enhanced Data Rates for GSM Evolution and as the name suggest it offers much higher data rates over the air interface as compared to GSM/ GPRS networks. This is due to the Introduction of 8-PSK as a modulation scheme and this in the actual sense tripled the data rates provided by systems preceding EDGE (GSM, GPRS) [1].

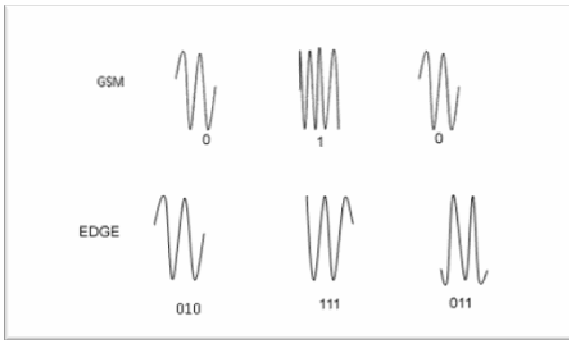


Figure 2: GSM versus EDGE number of bits

EDGE is achieved by introducing a new modulation technique to the already existing GPRS system, the whole other infrastructure is left unchanged except for some few changes in the software installed in the PCU and SGSN for example to support the new additional signalling requirements.

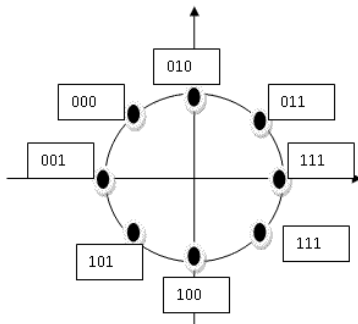


Figure 3: EDGE 8-PSK modulation scheme [5]

EDGE as compared to GSM/ GPRS networks used 8-PSK modulation scheme which means it transmits three bits a time as shown in **figure 2**, this means higher data rates which is advantageous but on the other hand transmitting 3 bits at a time calls for bandwidth expansion (around three-times more).

EDGE uses the same radio interface as GSM and it has capability to transport both IP-based and voice based traffic. EDGE provides data rates of up to 474kbit/s per user even though this has now changed due the evolution of systems over the years. EDGE co-existing with 3G W-CDMA can provide even higher data rates of around 2Mbit/s.

### UMTS

UMTS is an acronym which stands for Universal Mobile Telecommunications System, which falls under the IMT-2000 standard. IMT-2000 is the mother standard for all 3G networks, of which UMTS is one of them. UMTS can also be referred to as 3GSM to emphasize the fact that it evolved from the basic Global System for Mobile Communications (GSM). UMTS can be defined as follows:

*'A mobile cellular communications system belonging to the family of third generation systems defined in the IMT-2000 framework. UMTS network architecture comprises a radio access network referred to as UTRAN (Universal Terrestrial Radio Access Network) and a core network based on the one specified for GSM Phase 2+ (GSM/GPRS networks)' [2]*

### UMTS NETWORK ARCHITECTURE

UMTS system can be divided into two main segments:

1. The access network called UTRAN
2. Core Network (for routing and switching)

There are two network domains in the UMTS architecture, namely:

1. Circuit switched domain: centred on GSM components like the mobile Switching centres (MSCs). Its function entails reserving resources at call setup and provides circuit switched service.
2. Packet Switched Domain: centred on GPRS support nodes

The UMTS domains are dependent on two backbone networks, one which is based on Integrated Service Digital Network (ISDN) technologies, carries voice traffic, while the second is based on IP world technologies and it is responsible for data traffic. The two UMTS domain are both connected to the access network, which is shared by both types of traffic through the Iu interface.

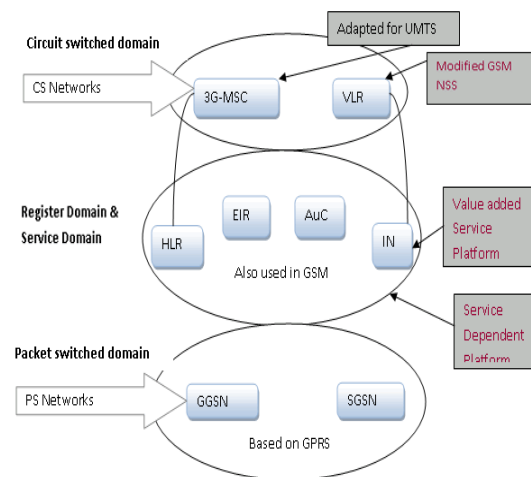


Figure 4: UMTS domains

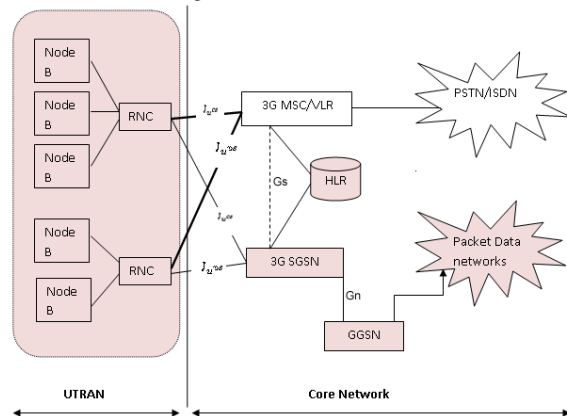


Figure 5: UMTS backbone networks

It cannot be left unnoticed that the original GSM network infrastructure is where the circuit switched

UMTS backbone is derived and until today the infrastructure is mostly based on this original GSM network, whereas the packet switched UMTS backbone is a development of GPRS (General Packet Radio Service) packet switched network in the GSM network. In the actual fact, the Core network for UMTS is directly evolved from the GSM infrastructure though the access networks are totally different.

The two backbones constituting the UMTS architecture are going to be discussed in details to expose the connection between UMTS and GSM/GPRS networks

### **Circuit Switched Backbone**

The circuit switched domain of UMTS network is derived from the GSM network therefore there is no doubt that it inherited many of the features of today's GSM network. As in the present day GSM network, UMTS circuit switched domain is used for providing voice services, however due to recent explosive growth of the Internet; we can speculate that very soon innovative services (i.e. non voice services) will use the Internet Platform (IP) platform. In advanced versions of UMTS we can expect voice services to migrate to IP as shown by several current trends. When UMTS was developed, most of the architectural structures for voice services in second generation mobile systems were adopted, it is therefore fair to say understanding basic principles of the GSM network will make it easier for one to be able to analyse the new systems.

### **GSM Overview**

The GSM will be discussed briefly to show how the UMTS circuit switched backbone was derived from it. The Figure 6 shows the basic GSM switching architecture.

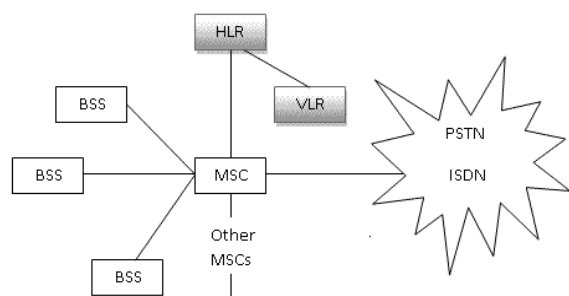


Figure 6: GSM switching architecture

Main GSM network components are as follows:

- **MSC (Mobile switching Centre)**
  1. Monitors group of adjacent BSSs
  2. Controls call signalling
  3. Coordinates hand-over procedures between BSSs, when mobile terminal changes physical location
- **BSS (Base station Subsystem)**
  1. Manages radio resources
  2. 'Interface between the radio channels and the physical link channels used to transmit information on the ground'[3]
- **HLR (Home Location Register)**
  1. Stores user profiles and identification-authentication parameters

2. Updates information of location of mobile terminal
- **VLR (Visitor Location Register)**
    1. Authentication-identification parameters stored locally by the VLR
    2. Tracks mobile terminal movement to radio cell level

### **GSM Signalling and Switching**

There is a resemblance of ISDN network in the GSM network overall architecture, as in fixed ISDN network switches a 64 kbit/s PCM (pulse code modulation) circuit on each link between the MSCs and between the MSCs and the gateway node to other ISDN/PSTN networks is used for each call which is set up [3]. In GSM, TDMA multiple access scheme is used whereby each user has access to the band for a short time (traffic burst) [6]. Each user is allocated a timeslot when he can transmit, in that way making it possible for users to share the band.

The difference is that in GSM at the interface a 16kbit/s circuit is used between an MSC and a BSS for each call set up. Due to the GSM voice coding 16kbit/s is resulted but as a way of saving radio interface resources, voice coding is done at 13kbit/s instead of the original 64kbit/s used in PCM coding. The mobile terminal up to the MSC makes sure the lower coding rate is maintained, wherever data is 're-coded in a 64kbit/s stream compatible with the PSTN's PCM coding' [3].

In GSM architecture's signalling network uses Common Channel (SS7) protocols and services. The Mobile Application Part (MAP) protocol has been developed from SS7 protocols and it is used in GSM to handle dialogue between Home Location Register (HLR), Visitor Location Register (VLR) and MSC for managing mobility and authentication procedures.

### **UMTS Circuit Switched Architecture**

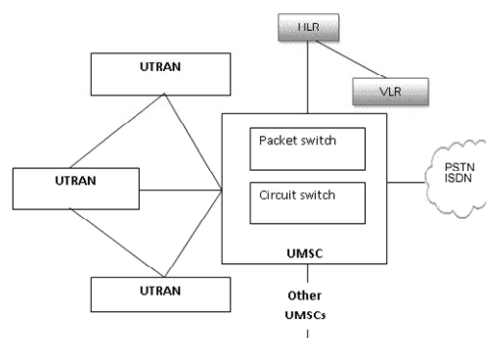


Figure 7: circuit switched UMTS network

As the figure 7 above illustrates, it can be seen that the UMTS network architecture is similar to that of the GSM network, only that in UMTS network a new radio interface is introduced and the BSS is replaced by the UTRAN. A UMTS MSC is used as well with capabilities of both packet and circuit switching. The Core Network and main interfaces remains the same.

### **From GSM to UMTS**

Second generation systems such as GSM differ a great deal from third generation systems such as UMTS, the major difference being the adoption of the new radio

interface. This new interface was to make it possible to acquire higher data rates, with this ensuring flexibility of services and applications. The highest applicable data rate that can be achieved with a W-CDMA interface is 2Mbit/s, though there are a wide range of intermediate rates also available, thus making it possible for the system to support new services in the future. This decision to introduce this new system as to move away from GSM was expedient because in the GSM system the only channel additional to the voice channel is the 9.6kbit/s channel which rarely can cope with information transmission. On the other hand UMTS circuit switching infrastructure as compared to GSM voice channels should be able to set up, maintain and release circuits at different speeds, with significantly complex process as compared to today's 64kbit/s switching architecture.

UMTS transport architecture was designed to provide services to both circuit switched part of the platform and to the Packet switched part. On the other, GPRS as a second generation system was an addition to GSM and as a result its transport network was separated from that used to transport voice. [3]

In the second generation systems there was a need for a new transport and switching architecture, a transport system which was optimised to allow telephony and data transmission to be integrated together and in UMTS this was achieved.

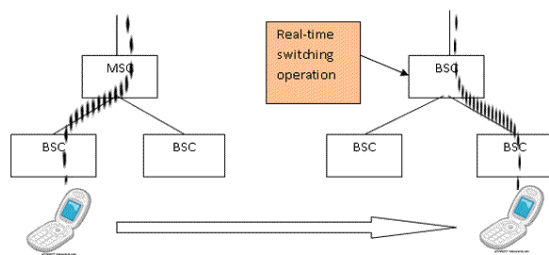


Figure 8: hand-over between BSCs in the GSM system

#### From GSM hand-over to UMTS streamlining

Hand-over is the term describing the process of transferring an on-going call or data session from the radio base station which the mobile terminal is connected to another without loss of service. The mechanism has evolved with each system put into place and it has been revised time and time again to suit the particular system requirements. In UMTS the  $I_{ur}$  interface facilitates hand-over procedures.

In GSM, hand-over between two BSCs involves the MSC through and operation of switching the voice path to the new interface connecting MSC and BSC (figure 8).

The GSM hand-over has to be performed in real time, this as a way to minimise the impact of hand-over on the quality of the services

provided.

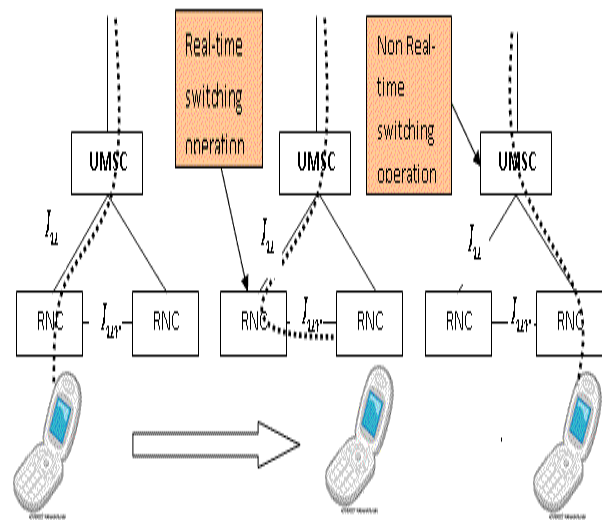


Figure 9: UMTS streamlining

On the other hand UMTS Radio Access Network (UTRAN) uses  $I_{ur}$  to manage hand-over on its own without involving the MSC, thus the procedure is done much faster and simpler (figure 9).

When the UMTS hand-over takes place, the UMSC-RNC interface  $I_{ur}$  is extended via the  $I_{ur}$  interface which links the two RNCs. This redirection procedure also known as streamlining, is designed to increase the efficiency of terrestrial circuits used by optimising resources available.

#### PACKET SWITCHED BACKBONE

The UMTS packet switched domain side of the architecture was derived from the GPRS system architecture and many of its features resemble the latter. GPRS was developed by ETSI (European Telecommunications Standards Institute) to extend the GSM system in order to permit packet data transmission. GPRS adds IP based capabilities to GSM network; therefore network operators can offer efficient radio access to external IP-based networks such as the internet.

#### GPRS network Overview

An introduction of a new class of logical networks entity called GSN (GPRS Support Node) to the GSM network resulted in a GPRS network, a network capable of packet data transmission. The GSN nodes controls connections between different networks, and perform a variety of functions including:

1. Subscriber management
2. Billing and security
3. Mobility management
4. Roaming and geographic routing [4]
5. Packet transmission

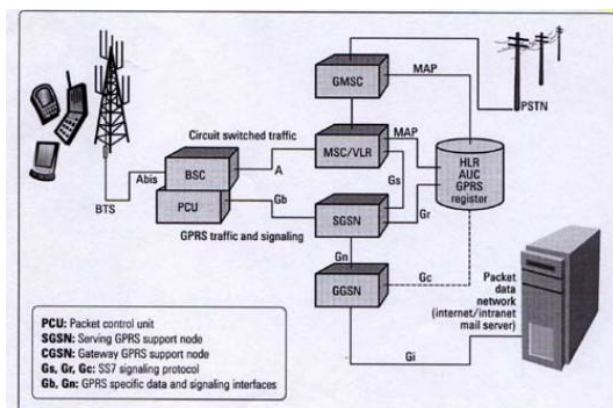


Figure 10: GPRS network structure

### GPRS Support Nodes

GPRS support nodes are switches needed to route packets; there are two functional entities which need to be discussed, which are:

1. **Gateway GPRS support node (GGSN):** this is the node that routes packets to the current location of the mobile terminal, this means it has to have access to the Home Location Register in order to obtain the required location information.
2. **Serving GPRS support node (SGSN):** this node initiates a mobility management context for a connected mobile terminal. It also performs ciphering for packet-oriented traffic.

Both of the GSNs are capable of collecting charging data, for example the SGSN will collect *details about the volume of data (Kbytes of Mbytes) transferred by the user* [4] whereas the GGSN collects *charging information detailing subscriber access to public data network (PDN)* [4].

### UMTS packet switched network architecture

The architecture of the packet switched backbone of the UMTS system takes resemblance of the GPRS system, where the UTRAN based on W-CDMA replaces the BSS. An air interface  which connects the Core network to the radio access network manages both the packet switched component and the circuit switched component of the network.

### From GPRS to UMTS

Various steps have been taken by standards-writing organisations to inherit some features of GPRS onto the third generation systems (UMTS), for example features such as mobility management protocols and the GPRS architecture. The two areas of interest which cannot be overlooked are: mobility management and quality of service control. Information technology is increasingly contributing towards these areas and an IP backbone makes it possible that new mechanisms could be added onto the UMTS network's packet switching part.

### UMTS and W-CDMA

Second generation mobile systems use a combined FDMA/TDMA access schemes to control users accessing the channel whereas UMTS use a different scheme called CDMA (Code division Multiple Access). Users are allowed to transmit at the same frequency and at the same

time, since they are given a unique code, to differentiate their transmission from the other users. This means users can share bandwidth more efficiently as compared to GSM/GPRS systems.

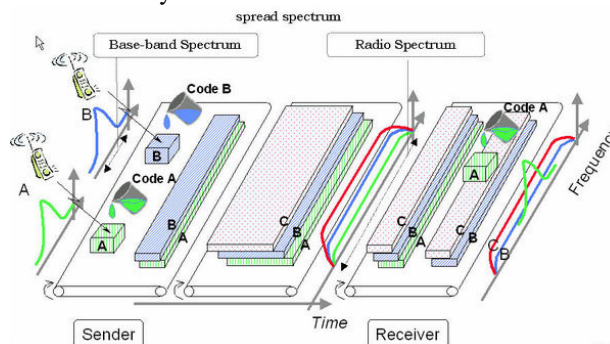


Figure 11: CDMA illustration

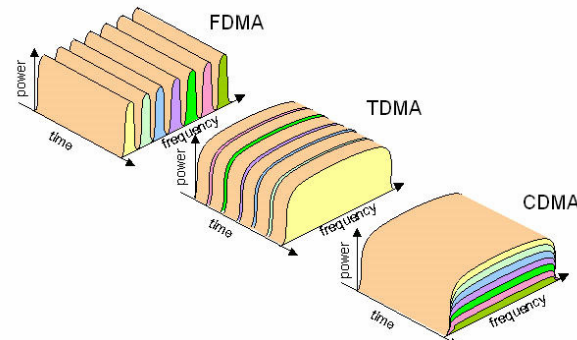


Figure 12: Comparison of cellular access schemes

One other advantage of CDMA as used in UMTS is that it completely eliminates interference between various signals, hence users are given that assurance of quality that whatever they transmit will be transmitted efficiently.

### Future Developments

We would like to acknowledge the fact that, due to many factors UMTS specifications and requirements are evolving through definition and succeeding introduction of annual publishing of standards. The foregoing paragraphs describe Release 99 UMTS network infrastructure completed and approved by 3GPP in 1999. The releases that followed entirely depended on Release 99 as it was the first specified release for third generation mobile systems. Release 2000 abandons the double backbone structure in order to pass to a single network structure through which both packets switched and circuit switched networks will be managed. As UMTS evolves with each Release made, certain assumptions are made, namely:

1. *The network architecture is based on IP packet technology in order to provide real time and non real time services simultaneously.*[3]
2. The network infrastructure is derived from the current GPRS network.
3. Mobile terminals are IP based and service is integrated through IP
4. The system should provide better quality services as compared to current systems
5. The system should be more reliable than existing systems

6. The network system should be improved to be guarantee support for real time multimedia services
7. Today's common channel (SS7) transport is replaced by all IP-based transport

### CONCLUSIONS

The mobile systems have evolved to the current systems and will continue to improve with time. The research paper showed how the classic GSM network evolved to the current third generation network (UMTS), and how each system differed in terms of their infrastructure and functions.

| Network systems | Modulation scheme | Standards | Implementation |
|-----------------|-------------------|-----------|----------------|
| <i>GSM data</i> | TDMA/FDMA         | 9.6kbps   | 9.6kbps        |
| <i>HSCSD</i>    |                   | 57.6kbps  | 28.8kbps       |
| <i>GPRS</i>     | TDMA/FDMA         | 171kbps   | 57.6kbps       |
| <i>EDGE</i>     | 8-PSK             | 470kbps   | <470kbps       |
| <i>UMTS</i>     | WCDMA-FDD/TDD     | 2048kbps  | 384kbps        |

Table 1: network systems and data rates

Table 1 compares system in terms of the data rates it provides, and it can be seen that UMTS provides higher standard data rates as compared to other systems.

As many network operators continue to commercially roll UMTS out, mobile phones will take place for home computers, and instead of people accessing internet at work or at home only they are able to access it through their mobile phones wherever they are keeping them in touch with the world around them. This brings a different picture altogether about mobile systems of today. The evolution of mobile systems will continue to change people's lives all over the world as they keep improving.

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# LTE and WiMAX: Precursors to 4G

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**Abstract-** The demand for mobility, improved performance and capabilities, particularly for data services, has given rise to convergence which is one of the trends of evolution in the communications industry. The emerging cellular standard, 4G (fourth generation mobile communication system) is being driven by the visions of high data transmission rate with low latency and ubiquitous wireless connection on an all-IP platform.

Mobile WiMAX (Worldwide Interoperability for Microwave Access) and the 3GPP LTE (Third Generation Partnership Project Long Term Evolution) both satisfy the two IMT-Advanced requirements of delivery of up to 100 Mbps and use of OFDM-based technology and thus are the technologies being focused on for the 4G standard. A third technology, UMB (Ultra Mobile Broadband), was also being considered until late last year when its development was halted, leaving the race to LTE and WiMAX.

WiMAX networks are already being deployed while LTE is yet to be rolled-out. This is not viewed as a disadvantage by the proponents of LTE as it will be run on the existing 3G (UMTS) infrastructure whose percentage of penetration world-wide is already high. This paper focuses on these two competing but complementary technologies for the realisation of the targets of 4G cellular wireless systems.

**Keywords:** WiMAX, LTE, 4G systems

## 1. INTRODUCTION

The cellular wireless industry is aggressively moving towards a 4G (fourth generation cellular system) world. Whereas 3G (third generation cellular system) standardisation and roll-out took almost a decade, the activities surrounding the adoption and development of 4G standards are moving at much faster rate [1]. This emerging generation of wireless networks is meant to provide high speed data rates at high capacity and support a numerous range of services and applications at low cost. They will have global roaming capabilities, provide high quality mobile services and interwork seamlessly with other radio access systems with a significant improvement in performance and quality of service (QoS) [2,3].

The existing 2G (second generation cellular system) or 3G networks do offer mobile voice of excellent quality and narrowband data services, and the data rates of 3G are equally fast. But the 4G will be the first IP-centric network (based on an all internet protocol) [1]. This hinges on the outstanding characteristic of IP, its transparency principle- IP over everything and everything over IP: music, voice, games, and data as IP packets. 4G thus will support all types of traffic services on a single converged platform giving it much more flexibility than the previous generations of cellular technology lacked [1].

4G systems will be based on the orthogonal frequency division multiplexing (OFDM) and multiple-input multiple output (MIMO) antenna technologies. OFDM is a powerful transmission technique based on the principle of simultaneously transmitting many narrow-band orthogonal frequencies- OFDM subcarriers. In theory, their orthogonality eliminates interferences between the channels. The use of MIMO antenna technology exploits the space and time diversity of the channels on the different radio paths for the improvement of the reception sensitivity and channel capacity [4]. The OFDM-MIMO air interface will certainly bring about significant spectral efficiency improvement, allow implementation at a lower cost and make use of already existing cell site infrastructure [1].

Interestingly, there is so much confusions in the industry where 4G is concerned. To some, 4G is already here especially the proponents of mobile WiMAX (Worldwide Interoperability for Microwave Access). On the basis of what defines a mobile generation, which includes new terminals and spectrum, a completely new interface and about four times the capacity of the previous generation, one school of thought believes only LTE (Long Term Evolution), and possibly WiMAX qualify as new generations. Some others say it is defined by a service set [5]. This paper does not address the issue of this confusion but will focus solely on the features of LTE and mobile WiMAX, the two technologies whose developments are geared towards achieving the IMT-Advanced requirements.

The rest of the paper is organized as follows. First, there is a review of the two technologies: LTE and mobile WiMAX, including their architectures and subsequent developments towards a 4G system, then the paper will go on to compare these two technologies as they converge to 4G broadband wireless access systems. This comparison will focus on the physical layer aspects of the two standards' radio access technology. The major building blocks for the next generation wireless cellular systems will also be presented, followed by the conclusion of the paper.

## II. LONG TERM EVOLUTION

Due to the rising demands for bandwidth and high capacity, the limits of the current networks are constantly highlighted. In 2005, the 3GPP standardization body started developing a next generation standard that is solely IP-based. This involved LTE program which concentrated on new radio network and air interface architecture design and SAE (Service Architecture Evolution) program which dwelt on the design of a new

core network infrastructure. These were later joined to form a single design program- Evolved Packet System (EPS). However, by that time, LTE was the abbreviation that was dominant in literature and thus it stuck [6].

LTE, a standard based on an all-IP network, OFDM technology and smart antennas, is viewed by some as 3GPP's reaction to the emergence of WiMAX promoted by IEEE (Institute of Electrical and Electronics Engineers) standards body rather than just an improvement of HSPA (High Speed Packet Access). A group worth mentioning – Next Generation Mobile Networks (NGMN) represents an enormous customer base: China Mobile Communications Corporation, KPN Mobile NV, Orange SA, T-mobile International, Sprint Nextel Corporation, NTT DoCoMo Inc and Vodafone Group PLC are behind the drive for LTE [5].

The design goals for LTE as published in NGMN group whitepaper [7] include the following:

- Increase in throughput (downlink speed of 100Mbit/s and 50Mbit/s uplink speed for 20MHz spectrum)
- Scalable bandwidth
- Low latency
- Improved spectrum efficiency
- Backward compatibility with earlier releases and compatibility with other systems
- Lesser time for state changes

#### A. LTE Architecture

Fig. 1 shows the network architecture of LTE system as proposed by the 3GPP [8]

The LTE SAE core when compared to the core network of UMTS is less complex. The Base Stations in LTE are referred to as enhanced Node Bs. They perform air interface traffic management autonomously and also ensure quality of service since the radio network contains no central controlling element anymore.

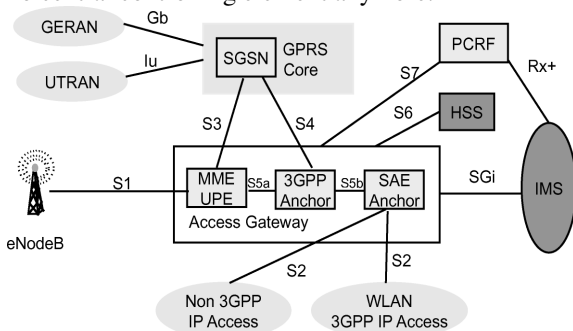


Fig. 1 LTE SAE Network Architecture

The enhanced Node Bs also handles handovers for active mobiles either directly communicating with each other via the X2 interface or the access gateway [6].

The Access gateway includes these logical elements:

- MME (Mobility Management Entity) that performs similar tasks as the SGN (Serving GPRS Support Node) in UMTS network.

- UPE (User Plane Entity) and 3GPP Anchor that perform functions of the SGSN user plane, GGSN (Gateway GPRS Support Node) and some functions of the RNC (Radio Network Controller).
- SAE Anchor that provides access to the non 3GPP systems [5].

The HSS (Home Subscriber Server) generates authentication data for user access to the evolved system.

The removal of the circuit switched core and the RNC, hence the need for soft handover flattened the network and thus achieved the goal of SAE which is to reduce network costs (operating expenses (OPEX) and capital expenditures (CAPEX)) and make it less complex.

#### B. Features of LTE

Also included in the features of LTE is the support of MBMS (Multimedia Broadcast Multicast Service) which gives the network the capability of delivering multimedia stream services such as mobile TV.

LTE was initially developed for use in paired spectrum with frequency division duplex (FDD) so it could be deployed in already existing bands or spectrum. The time division duplex (TDD) mode was focused on to be used in conjunction with time division synchronous code division multiple access (TD-SCDMA) in order to allow for coexistence.

LTE employs OFDM for the downlink transmission i.e. from the base station to the user terminal.

However, in the uplink, that is, from the terminal to the base station, due to the drawback with normal OFDM of very high Peak to Average Power Ratio (PAPR), LTE utilises a pre-coded version of OFDM named Single Carrier Frequency Division Multiple Access (SC-FDMA). This improves coverage, reduces power consumption in the power amplifier and gives better cell-edge performance. SC-FDMA achieves this by putting the resource blocks in units such that the need for linearity is reduced.

LTE supports QPSK, 16QAM, and 64QAM modulation schemes in both the downlink and uplink transmissions.

On the premise of a totally new air interface and improved data rate, one can say that LTE is 4G, however, LTE has now been registered as a 3G technology with the ITU (International Telecommunication Union). The 3GPP has come up with yet another study item called "LTE advanced", an improved version of LTE to represent its IMT advanced technology (4G) [5,9].

### III. MOBILE WiMAX

Mobile WiMAX is a rapidly growing broadband access technology that provides an alternative to wired broadband access like cable, enabling mobile internet applications at low-cost. The WiMAX Forum, responsible for the certification of broadband wireless products, standardised the mobile WiMAX - IEEE 802.16e-2005, which includes many new functionalities and features for the support of mobility and enhanced quality of service (QoS) lacking in the 802.16-2004.

Major infrastructure vendors like Intel, Nortel, Alcatel-Lucent, Motorola and Nokia Siemens Networks are backing this technology.

It allows users to obtain broadband connectivity of up to 50 km without the need of direct line of sight with the base stations and provides shared data rates of up to 70Mbit/s.

WiMAX and LTE share many basic properties, however, standards development and eventual deployment of WiMAX has a head start over LTE [6].

The key objectives on which WiMAX was built include the following:

- Employment of OFDM-based multiple access (OFDMA) with scalable bandwidth in downlink and uplink.
- Advanced MIMO schemes which allows for spectral efficiency through the use of multiple antennas and RF chains at the base stations and the mobile stations.
- Open standard interfaces allowing for network interoperability.
- An all-IP access and core service networks to support different deployment models.

These provide flexible bandwidth as well as highly efficient air interface to the WiMAX network when compared to that of the existing and evolving 3G radio access networks [10].

In addition, the above objectives of the technology make it quite attractive to operators without an already existing network for several reasons:

- The network architecture of WiMAX based on an all-IP platform makes the deployment and operation cost really low.
- WiMAX can be operated in unused frequency bands yet to be auctioned.
- Competition with fixed line high-speed Internet solutions
- Availability of WiMAX network equipment as the roll-out is already underway [6].

#### A. WiMAX Network Architecture

WiMAX has a flexible architecture that accommodates a very large range of options in deployments in terms of scale-small or large; coverage area-rural, sub-urban, or urban; topology type-mesh, flat, hierarchical; and usage models- co-existent of nomadic, fixed, portable, and mobile [11].

Figure 2 below shows the WiMAX reference architecture- concepts and interfaces [5].

The network logically consists of three parts:

- Subscriber Station/Mobile Stations (SS/MS): term used to refer to both fixed and mobile device terminals used by the end user to access the network.
- Access service network (ASN): consists of one or more base stations and one or more ASN

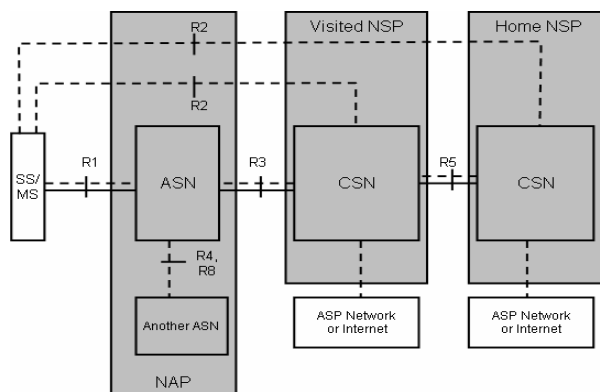


Fig.2 WiMAX Forum WiMAX Architecture

gateways. These are connected over an IP cloud and represent the network functions set required to provide radio access to the end user.

- Connectivity service network (CSN): comprises of network elements such as home agent, routers, user databases, AAA proxy/servers and interworking gateways for the support of MBMS and location-based services. CSN, the core network, provides IP connectivity to the subscribers of WiMAX [10].

#### B. Features of WiMAX

The mobile WiMAX standard supports both TDD and FDD duplex modes though the WiMAX Forum initially defined TDD mode.

The standard employs Scalable OFDMA (SOFDMA) in the downlink and uplink transmission unlike the OFDM version used in fixed WiMAX. This gives the mobile WiMAX technology the capability to comply with diverse frequency regulations worldwide with its bandwidth scalability. Spectral efficiency also is improved by the use of smart antenna technologies with the SOFDMA.

Like LTE, WiMAX supports QPSK, 16QAM and 64QAM, but also BPSK.

WiMAX has been deployed in countries like Pakistan and India where it serves as an alternative to fixed lines for mobile broadband services. In South Korea, WiBro offer a wider range of services such as VoIP, IMS (IP Multimedia Services) services, E-commerce, Location-based services, instant messaging, mobile TV amongst others.

WiMAX, like LTE, is set to compete in order to make the IMT-Advanced 4G requirements with the IEEE 802.16m working group, as the current mobile WiMAX has been officially adopted as ITU's IMT-2000 i.e. 3G technology. The new standard will employ the use of several carriers to increase data rates, new frame structure to reduce delays, and introduction of self organization and inter base station coordination for reduced interference from neighbouring base stations and user terminals [6].

TABLE 1  
COMPARISON OF LTE AND WiMAX

| Aspect                                                                        | LTE                                           | Mobile WiMAX                          |
|-------------------------------------------------------------------------------|-----------------------------------------------|---------------------------------------|
| Network Architecture                                                          | Flat, All-IP network                          | Flat, All-IP network                  |
| Access Technology                                                             | DL: OFDMA<br>UL: SC-FDMA                      | SOFDMA in DL and UL                   |
| Frequency Band                                                                | Existing and new frequency bands (~2GHz)      | 2.3-2.4GHz, 2.496-2.69GHz, 3.3-3.8GHz |
| Channel Bandwidth                                                             | 1.25-20MHz                                    | 1.25-28MHz                            |
| Peak Rates<br>DL<br>UL                                                        | 100Mbps<br>50Mbps                             | 75Mbps<br>25Mbps                      |
| Duplex mode                                                                   | FDD initially                                 | TDD initially                         |
| Cell Radius                                                                   | 5km                                           | 2-7km                                 |
| Spectrum efficiency                                                           | 5[bits/sec/Hz]                                | 3.75[bits/sec/Hz]                     |
| Cell capacity                                                                 | >200 users @ 5MHz<br>>400 users for larger BW | 100-200 users                         |
| Mobility                                                                      | Up to 250km/hr                                | Up to 120km/hr                        |
| Aspects                                                                       | LTE                                           | Mobile WiMAX                          |
| Evolution                                                                     | GSM/GPRS/EGPRS/UMTS/HSPA                      | IEEE802.16a through 16d               |
| Standardisation coverage                                                      | IEEE802.16e PHY and MAC CN                    | RAN (PHY + MAC) + CN                  |
| Schedule forecast:<br>Standard completed<br>Initial deployment<br>Mass market | 2007<br>2010<br>2012                          | 2005<br>2007 through 2008<br>2009     |

#### IV. COMPARISON

LTE and mobile WiMAX are presently the two competing technologies on the race to the next generation cellular system. Yet, both have a lot in common.

Table 1 gives the key elements of a comparison between these standards as they move to 4G. The comparison will concentrate on the physical layer aspects of the radio access technology of these two standards [12].

The comparison table shows that the 3GPP's LTE and mobile WiMAX standards, both from different standardisation bodies are similar technically but with some subtle differences. They differ in terms of evolution legacy and expected time of deployments.

The early start of mobile WiMAX makes it quite attractive to service providers, both new and existing cable providers, for mobile broadband access. The service providers in the developing world will adopt mobile WiMAX for mobile broadband wireless access largely due to lack of infrastructures. However, in the developed world, the 3G and 3.5G service providers will naturally evolve to LTE [12].

#### V. FUTURE GENERATION TECHNOLOGIES

The fourth generation wireless mobile communication systems has great promises of satisfying the ever-increasing growth of user demand and improving the limitations of the existing generation of mobile systems. The seamless integration of already existing and new

networks, user terminals, and services offered will also be a huge step-up for 4G systems [13].

Four key building blocks have been identified for new generation radio technologies. Some are already adopted by the two competing standards on the migration path to 4G, LTE and mobile WiMAX. These major blocks are briefly discussed below.

##### A. OFDMA.

OFDMA is a multiple access scheme whereby the data streams from multiple users are multiplexed orthogonally onto the downlink sub-channels and uplink sub-channels. It is based on OFDM which is a form of frequency division multiplexing with high resistance to multipath fading and other severe channel conditions when compared to other multiplexing methods. This is of great benefit as cross channel interference is highly reduced and thus spectral efficiency is improved.

LTE and WiMAX are both based on this technology.

##### B. Spatial Processing

This involves the use of MIMO smart antennas at the base stations and mobile terminals i.e. use of multiple antennas at the transmitter and also at the receiver. This improves communication performance without additional transmit power or bandwidth as data throughput and coverage area are increased. MIMO systems use adaptive

beam forming, transmit/receive diversity and spatial multiplexing techniques in transmission.

A combination of MIMO systems and OFDMA technology allows for efficient use of bandwidth and combats multipath effects. The two precursors to 4G are already based on this MIMO-OFDM technology

#### C. Radio Relay/Mesh Networks

Wireless mesh networks (WMN) represents a way to route data between nodes through hopping. It can be seen as a special type of wireless ad hoc network. Mesh networks maintains signal strength by breaking long distances into continuous set of hops that are shorter. Each node as well performs routing functions. This may enable wide area broadband access and offer economic advantage (because of reliability) to future technologies.

#### D. Software-Defined Radio (SDR)

SDR is used to describe a system whereby hardware components such as filters, amplifiers, detectors are instead implemented using software. Though a new technology, its benefits are powerful. To equipment manufacturers, it enables products to be implemented based on same platform architecture giving rise to quick introduction of new products. It equally reduces time and costs of operation and maintenance. To the service providers it allows flexibility as new features and capabilities can be added to existing infrastructure and to the end-users, it enables ubiquitous wireless communications [9, 14].

### VI. CONCLUSION

In this paper, the overview of both mobile WiMAX and LTE were given including their architectures and some of their features. The network standards were compared focusing on the radio access physical layer aspects.

Convergence of the standards will bring about the support of multimode and reconfigurable devices. It will also be a big boost to the cellular world in terms of capacity and bandwidth satisfaction, improvement in performance, reliability of service and reduction in terminal costs.

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## 4G Communications Technology

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**Abstract:** In the recent years, with the rapid development of data communications and multimedia services, the 4G (fourth-generation) mobile communications has already been the most pop research area of communications technology, which able to adapt the operation of mobile data, mobile computing and mobile multimedia. Users can access information on an “anytime, anywhere” with a seamless connection. 4G mobile communications technology set 3G and WLAN in one and be able to transmit high-quality video images. It provides higher data rates than 3G. In this paper, base on the research of development background of 4G technology, a brief comparison between 3G and 4G mobile communications has been done. Moreover, the principal technologies which will be used in the 4G mobile communications system were analyzed, including OFDM (Orthogonal frequency-division multiplexing), smart antenna technology, Software-Defined Radio (SDR), Multi-User Detection (MUD), IPv6. 4G mobile communications will bring us a real freedom of communications, and will completely change our life and even the social form. In my research, I will detailed describe the main advantages of 4G communications system as well. However, there are substantial technical problems exist in the process of specific implementation. In order to smooth and comprehensive implementation of 4G communications, more researches are required.

The development outlook of 4G will be shown in the end of the paper, we believe that the 4G wireless communications network technology will give us infinitely surprise in the future.

**Keywords:** 3G, 4G, WLAN, OFDM, smart antenna technology, SDR, MUD, IPv6

### I. Introduction

The third-generation mobile communication system (3G) is a new generation of mobile communications system that is able to satisfy the ITU (International Telecommunications Union)’s IMT-2000/3GPP system standards. It requires good network compatibility and can be meet a number of global roaming between different systems. Not only provide voice and low speed data services to subscribers, but also offer a wide range of multimedia services [1]. Currently, 3G standards which have been approved by ITU include: WCDMA, CDMA2000, and TD-SCDMA. 3G provided higher transmission rates: a minimum speed of 2Mbit/s and maximum of 14.4Mbit/s. Compare with 2G, although 3G have a lot of advantages, there are a great many undesirable areas in 3G technique, such as [2][4],

- 1) Leak of global uniform standards.
- 2) Voice exchange architecture is not pure IP-way, but still inherited the 2G circuit-switched system.

- 3) Operations and business management are not enough flexible.
- 4) The application of streaming media (video) is not satisfied.
- 5) Due to the high-speed data transmission of 3G is immature, lead to the limited access speed.
- 6) Problems of safe flaws, such as, exist excessive security algorithms and easy to attack authentication protocol.

Thereby, the future mobile communication system is characterized by high-speed and open network structure is termed the fourth-generation mobile communications (4G). Although there is no precise definition of 4G, the main objective of 4G is to achieve an all IP-based integrated system and provide reliable transmission. People expect to solve the above problems through establish 4G standards [3].

### II. The Development of 4G System

Any technology towards to a maturation situation needs a process of evolution. From GSM, GPRS to 4G technology development is require a long period, and these technologies can exist simultaneously. As we know that the first generation mobile phone adopted the analog cellular communication technology, which can only provide a regional voice services, with bad communication effect, dissatisfied security performance and limited communication region. The GSM communication technology appeared with the rapid development of mobile phone, which are used in narrowband TDMA and permit eight groups operate at the same time in one cellular. It is a digital mobile phone system that based on European standards and to determine the frequency range between 900 to 1800MHz. GSM been used in 1991, it has already became the standard of Europe and Asia, and operate in more than 100 countries in 1997. But the data transmission rate was only 9.6 Kbit/s. Digital mobile communications is a second-generation mobile phone (2G), it generally uses the GSM or CDMA technology. In allusion to the defects of GSM, a new communication technology GPRS was introduced in 2000, this is a transition technology basis on the GSM technology. After that, EDGE technology be launched by communication operators, which is a kind of communication technology between the existing second-generation and third-generation mobile networks, therefore, it called "second half generation " technology. WCDMA is a symbol technology in 3G wireless communication. WCDMA not only deal with voice,

image data and express connect to internet through effective use of broadband, but also combined with MPEG-4 technology to deal with the real dynamic images.

### III. The Characters of 4G System

At present, both industry and academia general consider that 4G is based on IP and with non-symmetrical data transmission capability which rate more than 2Mbit/s. It will be capable of providing between 100Mbit/s and 1Gbit/s speeds respectively in the mobile environment and a static environment. It also can be support many applications for next generation network (such as, mobile high-definition television video, real time audio, mobile TV, etc). 4G can be described as an integrated multi-functional broadband mobile communication system. The future 4G system should be having the following basic conditions [5]:

- 1) With a high communication speed which between 10Mbps to 20Mbps, the highest speed up to 100Mbps.
- 2) Have a wider bandwidth. Each channel will occupy 100MHz or more bandwidth. That is equal to 20 times of W-CDMA 3G network.
- 3) Compare with 3G system, capacity even more than one to two orders of magnitude in 4G system.
- 4) Achieve a real seamless roaming. 4G carry out global uniform standard that will enable meet "seamless connectivity" between any type of media, communication host and network. The real implementation of a mobile phone can be communicate in anywhere of the world.
- 5) Highly intelligent network. Adopt intelligent signal processing technology for a variety of complex environments which in different channel condition, 4G system will be a high degree of autonomy and self-adaptive network.
- 6) Good coverage performance. The high-speed variable transmission rate is supplied by good coverage ability. For the indoor environment, cell radius becomes smaller because of high-speed transmission.
- 7) Based on the all IP network. Ipv6 is adopting in 4G system, which will be able to realize the voice and multimedia services on IP network.
- 8) Achieve different QoS (Quality of Service) business. 4G system offers different quality of business through dynamic bandwidth allocation and transmission power regulation.
- 9) More flexible communication. For example, glasses, watches or powder box may become 4G terminals.

- 10) More cheap for communication fee.

According to the current research results and experts' prognostication, 4G communication system will be operated in commerce after 2010.

### IV. A Comparison of 3G and 4G

#### A. Network Architecture

3G network is a strict hierarchical structure which including the core network, access network and user equipment, for example, UMTS (Universal Mobile Telecommunications System) architecture was shown in Figure 1. Core network divided into three domains (Circuit-Switched, Register and Service, Packet-Switched), it provides connection management, session management and mobility management. UTRAN (UMTS Terrestrial Radio Access Network) is responsible for radio resource management, mobile users through UTRAN to access the core network [4].

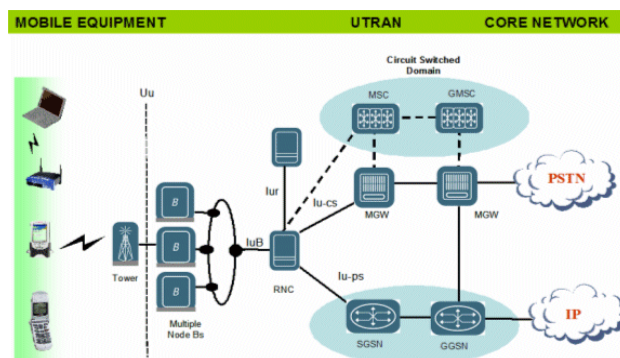


Figure 1. UMTS Network Architecture

For the network architecture, the most obvious difference in 4G system is that the close-knit cellular network in 3G system will be substituted by a single global cellular core network which is using all-digital and all-IP technique. The core network can support different access schemes, such as, IEEE802.11a, WCDMA, Bluetooth, HyperLAN and so on. This is an evolution process for a whole intelligent network [6]. 4G network architecture is shown in Figure 2.

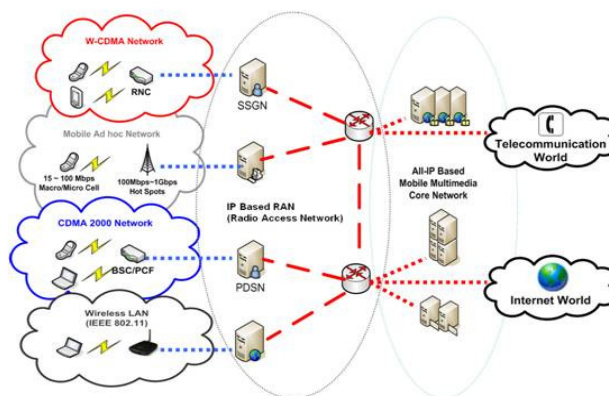


Figure 2. 4G Network Architecture

## B. Mobile Terminals

The characters of 4G system determine mobile terminals are different from 3G's. 4G mobile terminal should be able to support High-speed and wide bandwidth requirements simultaneously, it should also ensure that adapt to different air interface requirements and different QoS indexes. In order to compatible with different air interfaces, mobile terminals should have ability of software update, and complete the update through download the software items. In addition, the format of terminal is diversification in 4G system (glasses, watches). However, terminals in 3G system are homogeneous, main element is mobile handset. Compared to 3G terminal, the future 4G mobile terminal with the following Characters [4] [7]:

- 1) A stronger interaction performance (more convenient access for individual and network).
- 2) A higher network connectivity (wireless devices can available make network through Ad-hoc mode).
- 3) A rich personalization services (support cellular phone, paging, GPS positioning, etc).
- 4) The dynamic self-reconfiguration capability (can be self-adaptive to change business demand and network conditions).
- 5) Enhanced security features (embedded fingerprint authentication).
- 6) Enhanced speech recognition.

## C. Mobility Management

Mobility Management determines whether or not the clients are able to normal communications, roaming and switching in floating range. Mobility management is composed of location management and handover management. When subscribers operate a call or packet transmission, the location management to ensure that network can be find out the attachment point at moment. If the mobile terminal changes its attachment point of access to network in the process of movement, handover management should hold the network connection for subscriber.

### ➤ 3G Strategy

The UMTS network divided into numbers of location areas. Each area has corresponding number which is used for identification and it is composed of one or more routing areas. It must regist (change location register, cycle register or switch machine register approach) if a mobile station enter a new location area.

HLR (Home Location Register) preserves the user information and location information. The former includes identification code, service type and so on. The latter includes VLR (Visited Location Register)'s position of the current register place as well as the corresponding

MSC (Mobile Switching Center)'s position. HLR will update the location information when a subscriber roaming to other VLR, and the VLR of the new register place will obtain a new user information from the HLR [1].

3G system has three kinds of handover approaches: soft handover (happened at the mobile station placed in different base stations), softer handover (same base station but different sectors), and hard handover (between different networks) [4].

### ➤ 4G Strategy

4G supports two-level mobility which includes link-layer mobility and network layer mobility. The former is mobility between the isomorphism mobile networks and the latter used in heterogeneous mobile networks which is special in view of heterogeneous situation for 4G system. Mobile IP provides a global mobility approach but due to it does not support real-time management and high-speed transparent switching function, thereby, it not suitable for 4G system. IPv6 has been in rapid development because of increased support for mobility, its use of layered addressing structure, and use IPSec to ensure security, in addition, it also using packet switching and improve the QoS mechanism.

Improved Mobile IPv6 is a network layer mobility management strategy, it adopts a approach of optimization routing to resolve triangular routing problem effectively [7]. IPv6 is independent of access approach that making roaming management becomes simple and effective.

Compare to 3G systems, handover management in 4G system has the following advantages:

- 1) Handover process can finish automatically in absence of user interfere.
- 2) The mobile node with wireless technology interface or software radio technique can select the most suitable wireless network automatically.
- 3) When the mobile node is roaming between different service providers, the data can be automatic and smooth redirect to a new wireless network.

## D. Security Mechanism

Existing security scheme of 3G system is main achieve the security calls between users. Obviously, security flaws still existence, such as, no user's digital signature, key generation mechanism is not enough security, much more algorithm, vulnerable to attack authentication protocol, etc.

4G system is a heterogeneous network, therefore the current existing security scheme of 3G does not apply to 4G network. For example, encryption and decryption keys are fixed length in 3G security scheme, which is not satisfied the different requirements for different operation in 4G environment. At present, the overall direction of 4G security scheme has been confirmed. It clean that should

based on IPv6 and require authentication, authorization, auditing and accounting (AAAA) [8]. Can be foreseen, 4G security scheme will be a lightweight, composite, reconfigurable security mechanism that in order to enhance the security performance of mobile equipment [11].

## V. Key Technique in 4G system

### A. Orthogonal Frequency Division Multiplexing (OFDM) technology

The core technology using in the fourth-generation mobile communication system is OFDM which is a kind of multi-carrier modulation. Its main idea is [9]: make a channel divided into a number of orthogonal sub-channel and high-speed data signal be converted into parallel low-speed sub-data streams, modulation be transmitted on each channel. Orthogonal signal are separated at the receiver through using of related technologies. Thus, it can be reduce the mutual interference between the sub-channels. Signal bandwidth of each sub-channel is less than the relevant bandwidth. Thereby, every sub-channel can be seen as the smooth decline which can eliminate the intersymbol interference. But because of the bandwidth of each sub-channel is only a part of original channel's bandwidth, so channel equalization has become relatively easy.

### B. Multiple Input Multiple Output (MIMO) technology

MIMO system which with multiple antenna elements at both link-ends, it can be effective against the decline of wireless channel and great enhance the utilization rate of the spectrum. In other word, it can be substantially increase the channel capacity without increasing the bandwidth and total transmission power. In the dense multipath scattering environment, MIMO system takes full advantage of the space independent antenna to obtain spatial diversity. Multiple antenna technology provides diversity in the decline situation and generates multiple space channels through using antennas. However, it is impossible all channels occur fading simultaneously. Thus, it is greatly improving the system capacity. MIMO has the following advantages [6] [9]:

- 1) Reduces the intersymbol interference (ISI).
- 2) Improve the spatial diversity gain.
- 3) Enhance the wireless channel capacity and spectrum efficiency.

### C. Smart Antenna Technology

Smart antennas is using Space Division Multiple Access (SDMA) technology which distinguish the signals in same frequency and same timeslot through utilize transmission direction differences of signal. Signal coverage area is dynamic change, the main-beam collimate to user direction and the side lobe or nulling aim at the direction of interference signals. It can be able to track the users and monitor environmental changes

automatically. It also provide a high quality uplink and downlink signal for each user, so as to achieve the purpose is that repress interference and accurate extract effective signal [7].

### D. Software-Defined Radio (SDR) technology

In the 4G system, in order to achieve an ideal communication situation which means "any person at any place in any form access to network". At least, it should make sure that mobile terminal be able to fit all types of air interfaces, can seamless roaming in any kind of network environment, and can be convert between different types of operations. This means that the software will become very complicated in 4G system. Therefore, the experts proposed that introduce the Software Defined Radio Technology which is based on modern communication theory and make the digital signal processing as the core, supported by microelectronics technology as well as [10]. SDR's central idea is: construct a all-purpose hardware platform with character of open, standardized and modularization. To achieve various functions by using software, such as, work frequency, modem type, data format, encryption mode, communications protocol and so on. Arrange the location of broadband A/D and D/A converter as close as possible to the antenna in order to develop a new generation wireless communication system with high degree of flexibility. In these many key technologies of 4G, SDR technology is a bridge to the future 4G. In addition, it reduced the capacity of silicon chip, thus reducing the price of arithmetical unit. Moreover, its open architecture will also permit multi-operator intervention.

### E. IPv6 Technology

4G communication system chooses based on IP all-packet approach to transmit data stream, so IPv6 technology will become the core protocol for next generation network. The following considerations are main reasons for using IPv6 [8] [11]:

- 1) Enormous address space. In a predictable period, it provides a sole global address for any network equipment.
- 2) Automatic Control. IPv6 supports two kinds of Address Auto-configuration mode separate for stateless and status.
- 3) Quality of Service. From the view of protocol, IPv6 and current IPv4 have the same QoS, but IPv6 can provide different services.
- 4) Mobility. Mobile IPv6 can provide greater flexibility in the new function and new services.

## VI. Conclusion

4G mobile communication system mainly solves the issues which are not achieved by of 3G, it including the non-unified standards and seamless roaming in global area. At present, 3G technologies almost mature and

operate in commercial. The development of 4G will be based on 2G/3G. Seek to maximum decrease the investment of in mobile communications construction to achieve the smooth transition from 2G / 3G to future 4G.

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# Analogue and Digital Filters: Theory, Applications and Impact on Technology

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**Abstract:** The word Filter refers to purification of something wanted while removing unwanted others. In the World of electrical signals, it means selecting signals of specific band of frequencies while rejecting or attenuating signals of other frequencies. The filter theory was initially introduced by two scientists in 1915 independently, G. Campbell, American and K. Wagner, German.

Today, filters are widely used devices in electrical and electronic circuits and you can not imagine any electric or electronic system or device without a filter. They can be found, for example, in radio, TV, GSM, landline telephone, radar, and sonar and satellite circuits. Filters have also found many applications in signal processing. They remove distortion and noise from the signal.

Filters can be broadly classified into analog and digital filters. Analog filters are those which deal with analog signals and digital filters are those ones which deal with digital signals. Filters are further classified into other types- according to selection of frequencies- and the most common types are: a low-pass filter, a high-pass filter, a band-pass filter, a band-reject or band-stop filter and an all-pass filter.

In my research paper, I am going to give brief definitions of both digital and analog filters, comparison between them, their types, applications, their impact on technology, their importance, how they have changed our life and I will briefly discuss some filter designs.

**Keywords:** Filters, analog, digital, impact on technology.

## I. Introduction

Most of people have little, if no idea about electrical filters. In the electrical World, Filters are those devices which allow certain band of frequencies of a signal to pass through and block or attenuate others. They are very important parts in any electrical or electronic circuit. How can we imagine a circuit without a filter, in one form or another? All we can say: thanks to two scientists; G. Campbell, American and K. Wagner, German who were the first introduced the basic idea of electrical filters independently in 1915 and invented the electric-wave filter. Then, after them, two filter theories were evolved, one was called Classical Filter Theory developed in 1920s by Campbell, Zobel, and other scientists. The other filter theory was called Modern Filter Theory worked by Cauer, Darlington with others in 1930s. The latter theory has given approximation to the new filter theory which is being used nowadays. Since that time the filter technology has been and still expanding and developing [1], [2].

The electrical filters can be classified into broad categories, Analog filters and Digital filters. The filters which process analog or continuous-time signals are called analog, while those which deal with digital or discrete-time signals are called digital filters. Further more, the analog filters may be also classified as passive or active and this depends on their realizations and elements used in their construction [1].

In the early 1940s, the concept of digital filtering was introduced. It can be said that the simulation of analog filters has evolved to the digital filters.

Unlike, the analog filter circuit which consists of resistors, capacitors and inductors, the digital filters can be implemented as Large-Scale-Integration (LSI) and Very-Large-Scale-Integration (VLSI) circuits for many special purposes [4].

There are many advantages of digital filters over the analog filters and I will mention them later in this research. However, there are some disadvantages of these digital filters.

The applications of analog and digital filters have changed our life in many different ways. For example, digital filters make us talk easily through mobile telephones, listen and watch to each other from very far distances all over this World. In this research paper, I will discuss these applications and their effects on technology.

## II. Analogue Filters:

In a very simple way, the Analogue Filter is a system which has an input of continuous-time signal and gives another form of continuous-time signal as an output, as the following figure (Fig. 1) shows:



Fig.1 Symbolic representation of an Analogue Filter [2]

Further, the Analogue Filters can be defined into five basic types according to the frequency bands selected: [1]

1. *Low-Pass* filters: are those filters which allow lower frequencies, say from zero frequency up to some frequency.

2. *High-Pass filters*: are the ones whose passband is from some frequencies to infinity.

3. *Band-Pass filters*: which select specific band of frequencies to pass from the given input frequency band range, say from some frequency to another.

4. *Band- Reject filters*, (sometimes called band-stop filters): are those filters which reject specific band of frequencies while allowing others to pass.

5. *All-Pass filters*: they are, as their name implies, the filters which allow all input band frequency-range to pass and not rejecting any frequency.

The above five mentioned filters can be illustrated by the following figure (Fig.2):

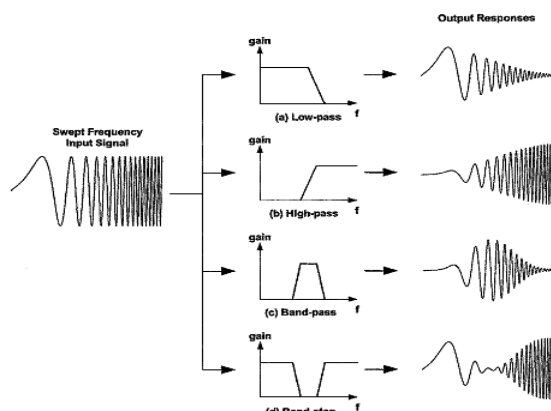


Fig.2 . Five common analogue filter types and their effect on a swept frequency input signal [3]

The materials used in constructing Analogue Filters are very simple, such as resistors, capacitors, inductors, but some filters use electronic devices such as transistors and operational amplifiers. Some other filters employ mechanical crystals and switching elements [2].

The following figure (Fig.3) shows the elements used to implement four different types of analogue filters (low-pass, high-pass, band-pass and band-stop or reject). The elements are simply Resistors (R), Capacitors (C) and Inductors (L), and these types of circuits are called RLC circuits.

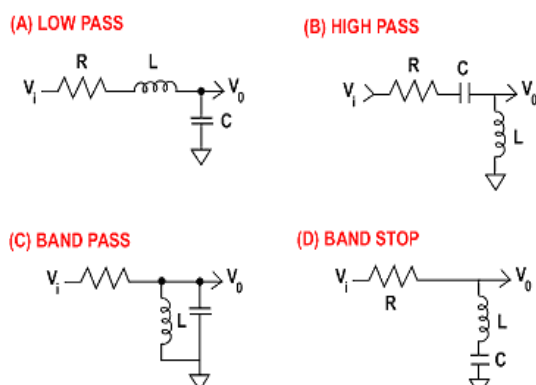


Fig.3 Resistors(R), Capacitors (C) and Inductors (L) are simply used to implement Low-pass, high-pass, band-pass and band-reject analogue filters [3]

### Passive and Active Filters:

Analogue filters can be classified as passive or Active, depending on the elements used for its implementation. The Passive filter circuits are those circuits which can be built by using resistors (R) and capacitors (C) only and do not require an external power source other than the input signal, while Active filter circuits contain active devices in addition to resistors (R) and capacitors (C), such as voltage amplifiers or buffer amplifiers .i.e. vacuum tube, or solid-state transistor or operational amplifier). [1], [5], [6].

Here I want to give short definitions for the passive and active devices, because most of people get confused between these two types. The passive device is the one which consumes but does not produce energy. For example, resistors, capacitors, tunnel diodes, glow tubes, and other dissipative and energy-neutral elements are called passive. On the other hand, the active device is the one that produces energy, such as current and voltage sources. [6].

### Passive Filters:

Passive filters are one type of analogue filters, made of passive elements and do not require any external power supply. Examples of passive filters are voltage, current transmission lines, and TV signal splitters. A practical example of a TV splitter is shown by the following picture, Fig.4. : [6]



Fig.4. TV signal splitter with of a passive High-pass filter (left) and a passive low-pass filter (right). [6]

The passive filters have some good advantages over the active filters as the following:[6]:

1. More stable than the active filters.
2. Active filters are not suitable to be used for large rate signals, tens of amperes or hundreds of volts.
3. Passive filters do not consume any power other than the signal power.
4. Cheaper compared with active filters.
5. When they are used with linear filters, they are more linear than that when active filters are used.

Some applications of passive filters are in speakers crossover design, power distribution networks and power supply by-passing because as I mentioned above

passive filters are suitable for high voltage and current ratings and also inexpensive.[6]

### **Active Filters:**

Active filters are another type of analogue filters, built of passive elements in addition to other electronic components such as amplifiers and they are connected to a power source.[5]

Unlike, Passive Filters, Active Filters are mostly used in integrated circuit (IC) design where they are cheap and easy to be implemented on the IC circuits.[5]

The following Figure (Fig.5.) shows an example of a high-pass active filter, it is a one circuit configuration of active filters called the Sallen Key topology and the operational amplifier is used as a buffer amplifier in this circuit.[5]

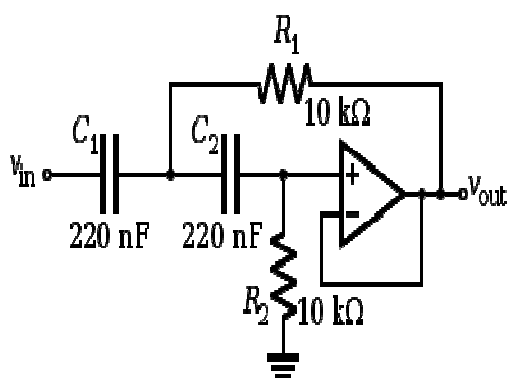


Fig. 5. High-pass active filter, the Sallen Key configuration.[5]

Here I want to mention some circuit configurations of the active filter without details: [5]

1. Sallen and Key filter.
2. State variable and Biquadratic filters.
3. Twin T filter.
4. Dual Amplifier Bandpass (DABP) filter.
5. Wien notch filter.
6. Multiple Feedback filter.
7. Fliege filter.
8. Akerberg Mossberg filter.

In comparison with passive filters, active filters have also some advantages:[5]

1. No inductors are added to active filters while that is being done sometimes for passive filters to improve their Quality factor (Q), which make them little expensive.
2. The frequency response shape, the Quality factor (Q), and the tuned frequency can be adjusted easily in the active filters by tuning resistors.
3. The amplifier used in active filter which is buffering the filter from electronic elements is useful in away that it prevents any effects on the shape of the frequency response.

### **Requirements needed to design an Active Filter**

To design an Active filter, some specifications must be fulfilled as the following:[5]

1. The desired frequency must be specified, i.e. we have to choose the type of filter required, either low-pass or high-pass or band-pass or band-stop (reject) filter.
2. Impedance specification must be determined for input and output of the filter. This may limit the filter circuit configurations.
3. We should reduce the amount of unwanted signal frequency to the filter input to make the designed filter more efficient.
4. The passband ripples of the frequency response should be reduced by adjusting the damping factor (reciprocal of Quality factor Q) in order to get the desired phase and time responses.

### **Active filter types according to the response shape**

Playing with damping factor (reciprocal of Quality factor Q) has yielded different types of the Active Filters according to the shape of the response, some of them are as follows: [5]

1. Chebyshev Filter: it has a little peaking ripple in passband before its corner.
2. Butterworth Filter: characterized by a flat amplitude response.
3. Bessel Filter: it has good overshoot response and good time delay.
4. Elliptic Filter: sometimes called Cauer Filter, It has a notch outside the passband to generate a greater slope in this region.

Figure. 6 below shows frequency responses for Chebyshev, Butterworth and Elliptic filters.

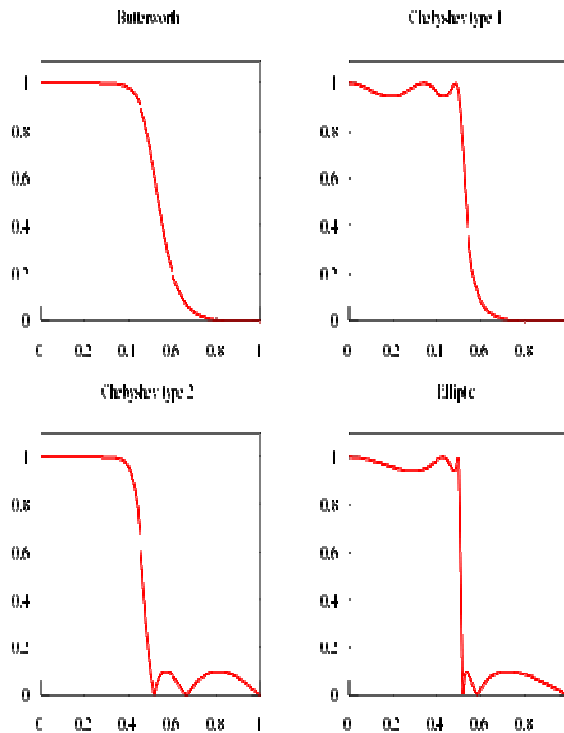


Fig.6 Frequency responses for Butterworth, Chebyshev and Elliptic filters. The only difference between Chebyshev (type 1) and (type 2) is the ripple factor ( $\epsilon$ ), where  $\epsilon = 1$  for type 1 and  $\epsilon=0.01$  for type 2. [7]

Although the new technology has turned to Digital Filters, but the research is still in progress to develop and improve the efficiency of Analogue Filters, because for some devices it is needed to employ Analogue Filters better than Digital filters to save cost.

### III. Digital Filters

Digital Filters are those type of filters which process discrete-time signals or sequences of data as an input and gives different form of discrete-time signal or sequences of data as an output. They are widely used nowadays in many applications and more than the Analogue Filters.

The conceptual representation of the Digital Filters is the same as that for the Analogue Filters. The only difference is inputs, outputs and signal or data processing.

The Digital Filters have many useful advantages over the Analogue Filters, which make them more preferred, some of the are: [4]

1. Digital filters are smaller in size.
2. They have lower element tolerances.
3. Accuracy high for Digital Filters
4. More reliable and trusted more than the Analogue Filters.
5. Higher ability to share multiple filtering tasks.

Only one disadvantage of Digital Filters can be noticed which is the quantization error due to limited word lengths in representation of signals and parameters, and

this problem can be omitted sometimes and careful design of the Digital Filter is to be considered. [4]

#### Digital Filter types according to the frequency selection

As in the Analogue Filters, Digital Filters can be classified low-pass, high-pass, band-pass and band-stop or reject filters according to the application used.

#### Digital Filter types according to the Impulse Response:

Two types of Digital Filters: [8], [9]

1. **Finite Impulse Response (FIR) filters:** these types of filters have exactly linear phase response and unconditionally stable, because its transfer function has no poles, i.e. no denominator. Their filtering equations can be give by:

$$y(n) = \sum_{k=0}^{N-1} h(k)x(n-k) \quad (1)$$

$$H(Z) = \sum_{k=0}^{N-1} h(k)Z^{-k} \quad (2)$$

Where the equation (1) is the FIR filter difference equation In time domain, equation (2) is the transfer function,  $h(k)$  are the impulse response coefficients of the filter,  $k = 0, 1, 2, \dots, N-1$  are the coefficients of the filter,  $N$  is the filter length,  $x(n)$ ,  $y(n)$  respectively are the input and output of the filter.

The FIR Digital can be easily implemented using main three elements:

1.  $z^{-1}$ , unit delay component.
2. Multipliers for coefficients.
3. Adders, to get the result.

The Digital Filter is called transversal or non-recursive filter, because its output values can be specified by its previous values of the input data.

#### 2. Infinite Impulse Response (IIR) filters:

The definition of the (IIR) Digital can be taken from its following filtering equations:

$$y(n) = \sum_{k=0}^{\infty} h(k)x(n-k) \quad (3)$$

Equation (3) can be expressed as:

$$y(n) = \sum_{k=0}^N a_k x(n-k) - \sum_{k=1}^M b_k y(n-k) \quad (4)$$

The transfer function of the (IIR) filter is then given by:

$$H(z) = \frac{\sum_{k=0}^N a_k z^{-k}}{1 + \sum_{k=1}^M b_k z^{-k}} \quad (5)$$

where  $h(k)$ ,  $k$ ,  $x(n)$  and  $y(n)$  are as described above except that  $k = 0, 1, 2, \dots, \infty$ , and  $a_k$  and  $b_k$  are the coefficients of the IIR digital filter.

#### **FIR Digital Filter: Advantages and Disadvantages** [8], [9]

##### **Advantages:**

1. Always stable.
2. Has linear phase response.
3. Easy to make any response.
4. Has no memory.
5. Possible to replicate any impulse response.

##### **Disadvantages:**

1. Un-economical to build sharp cut-off of the response.
2. It gives zero response only, because it has no poles.

#### **IIR Digital Filter: Advantages and Disadvantages** [8], [9]

##### **Advantages:**

1. Economical more than FIR filter for some purposes.
2. More flexible than FIR filter.
3. The poles and zeros can be easily determined.
4. It can be found its standard form.
5. Gives higher degree of cut-off and best stop band attenuation.

##### **Disadvantages:**

1. Stability is un-guaranteed.
2. Not easy to design directly.
3. Bad phase characteristics.

#### **IV. Analogue and Digital Filters: Advantages and Disadvantages:** [8], [9]

##### **Analogue Filters: Advantages**

1. Can handle higher signal bandwidth, in real time, than digital filters.
2. Not affected to Analogue-to-Digital-Conversion(ADC) and round-off noises.

##### **Analogue Filters: Disadvantages**

1. Their precision is limited to some stopband attenuation, typically between 60 to 70 dB.
2. Bigger in size than Digital Filters.
3. Analogue Filter hardware, sometimes, need to be replicated when filtering several inputs and out puts.
4. Filter efficiency is effected by environmental changes.

##### **Digital Filters: Advantages**

1. They can give linear phase response which is not possible with Analogue Filters.
2. Not effected by environmental changes.
3. Their frequency response can be easily adjusted in programmable processor which is used in adaptive filters.
4. One Digital Filter can filter different inputs and output with no need to replicate the hardware.
5. Digital Filters are smaller in size compared with Analogue Filters.
6. Their precision is limited only by word-length (number of bits used).
7. Digital Filter performance is higher than the Analogue Filters.
8. They can work at lower frequency limits and within wide frequency ranges.

##### **Digital Filters: Disadvantages**

1. Limited speed due to less bandwidth of signals, in real time, which Digital Filters can handle.
2. Digital Filters are affected by Analogue-to-Digital Conversion (ADC) and round-off noises during computations due to finite word-length problems.
3. Digital Filters take longer times, than Analogue Filters to be designed and developed, especially hardware design.

#### **V. Analogue and Digital Filters: Applications**

Many and many, thousands if not millions of applications in many different fields of Analogue and Digital filters can be seen or found in our real life, and I can not mention all them in this paper, I shall mention some of them.

**1. In TV antenna signal splitter:** a passive low-pass and high-pass Analogue Filters are used to receive the signal, (Fig.4 above). [6]

**2. In TV set:** an Analogue filter inside the TV set is used, called *TV Tuner Filter* and its responsibility is to keep a list of frequencies, where each frequency is corresponding to a channel for given a country or region. [10]

**3. In electric transmission lines:** passive Analogue Filters are used to enhance voltage and current transmissions. [6]

**4. In radio tuning system:** an Analogue Filter is used to tune the signal and get the required channel.

**5. In some loudspeakers:** Analogue Filters are used to enhance the sound.

**6. In digital photographic images:** a digital filter is used to reduce the visible noise and enhance the image. [11]

**7. In facsimile:** a digital filter is used since sometimes fax messages sent or received are in a form of digital signals.. [8]

**8. Satellites used for weather purposes:** digital filters are adapted to receive high quality weather maps. [8]

**9. Military purposes:** many digital filter are used for secure communications, missile guidance, radar and sonar digital signal processing.

**10. In Mobile telephony:** digital filters are use to send and receive a high quality signals.[8]

**11. Personal computers:** many digital filters inside the computer to process data.

**12. Digital audio and video:** digital filters inside give good quality sounds and pictures. [8]

**13. Digital phones:** digital filters receive/send very clear sound signals.[8]

**14. In telecommunications:** digital filters are often used for echo cancellation, spread spectrum, video conferencing and data communications. [8]

**15. In biomedical purposes:** many digital filters are x-ray storage, ECG analysis and scanner devises. [8]

**16. Digital television:** uses digital filters to produce very clear picture and sound.

**17. Digital cameras:** uses digital filters to produce high resolution picture.

**18. Digital music, digital CDs and DVDs and digital films:** all adapting digital filters for digital signal processing.

**19. In data compression:** for example: MPEG, MP3 and MP4, are using digital filters to process high quality digital signal.

**20. Digital radio and video in automobiles:** use digital filters to produce clear sound or picture.

## **VI. Analogue and Digital Filters: Impact on Technology**

Analogue and Digital filters have effected and still affecting the technology in many different ways:

1. They have lead scientists to invent and improve many types of filters for different purposes, like IR cut filters used in digital imaging, security and military purposes and Air filters used in medical applications.

2. They have enabled the human beings to discover many different diseases, like cancer and the most dangerous disease: AIDS.

3. Analogue and Digital filters have helped the scientists to discover what is inside the earth, like minerals and oil, and what is in the earth core, like magma.

4. They have helped the scientists to discover what is in the deep Oceans and Seas by using water digital cameras and other digital devises which adapting digital filters inside.

5. On the security side, they have enabled the computer and network engineers to find new ways to protect the sent and received data from network hackers, like ATM bank data and secure information.

6. In Satellite telecommunications, Analogue and Digital Filters have helped Communication Engineers to find methods to send and receive data and information overseas to get high quality communication services and with minimum noise.

7. Analogue and Digital Filters have helped the scientists to develop and improve the quality of many service machines, e.g. cleaning machines, washing machines, sewing machines, cutting machines and some Industry machines.

## **VII. Conclusion**

1. The filter theory is very essential for any one who wants to study filters, and without it we can not understand the filter behavior.

2. Analogue and Digital Filters are very important devices in our life. However, research is still in progress to improve and develop them so we can achieve the high quality performance from equipment and machines adapting these filters, hence excellent services.

3. The Impact of Analogue and Digital Filters on Technology is very critical. They have affected the technology in many various fields to improve and discover many different machines and devices.

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## RFID Smart Home

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**Abstract:** RFID Smart Home is a modern home which is completely automated home where we don't need keys to open door for an authorized person and items in the home like car keys, shoes, remote controls etc., can be traced by their position, and also notify us by E-Mail or SMS if any product is missing in the home. Now-a-days Humans can't remember the each position of our items like door keys, car keys, shoes, remote controls, etc., when they are in hurry mood, and also we can't track our pet's position. If we need to find any item we need not search it, instead by using RFID technology just we need to check in our computer or palmtops or even by our mobile phones to trace item position. Now by using the latest technologies like RFID we can easily able to track the position our items even by sitting in our office also. By depending on the signal strength from the tag to the nearest antenna we can able to find the exact location our item. From the RFID reader the information is sent to the server through internet by connecting wireless interface to the RFID reader in real time. And through we are going to get an automated E-Mail and Text Message to our mobile.

**Keywords:** Radio Frequency Identification, Tracking items, automated E-mail and Text message.

### I. INTRODUCTION

#### Auto ID-Technologies

There are many Auto ID-Technologies among them

- 1) Barcode
- 2) RFID

1).Barcode: Barcode is classified into two types

- a. *Linear*  
The linear Barcode uses black and white and stripes of different width to encode number.
- b. *Matrix*  
The matrix Barcode uses two-dimensional arrays of black and white patches to encode information.

- In the barcodes, the scanner using lasers read the data than it is stored in information system.

#### 2. Radio Frequency and Identification [RFID]:

In Twelfth Night, Shakespeare wrote, "Some are born great, some achieve greatness, and some have greatness thrust upon them." RFID is one of the more recent four-letter abbreviations to have greatness thrust upon it in a flurry of industry mandates, governmental legislation, and hyperbole [1]. RFID stands for Radio Frequency Identification this term describes about any system of identification where in an electronic device that uses radio frequency or magnetic field variations to communicate is attached to an item [1]. The two most talked-about components of an RFID system are the tag, which is a device that can recognize the presence of RFID tags and read the information stored on them. The RFID

reader is able inform another system about the presence of the tagged items. The system with which the reader communicates and runs software that stands between reader and applications. This software can be called as RFID middleware [1].

Much of the recent interest surrounding RFID has arisen from mandates and recommendation by government agencies such as the U.S Department of Defence (DoD) and the Food and Drug Administration (FDA), and from a few private sector mega corporations. For instance, in an effort to improve effiance, Wal-Mart called for its top 100 suppliers to begin providing RFID tags by early 2005 on pallets shipped to its stores [1]. Now-a-days most of the companies are trying to use the RFID tags on their products for easy shipping and tracking of their goods. RFID uses electromagnetic (radio) waves a part of electromagnetic spectrum. The IC and the antenna together called as RFID Transponder or TAG. The Tag attached to the object with unique identification and it can read by the device called Interrogator.

### II. RFID SYSTEMS

A typical RFID system is divided into two layers.

1. *Physical Layer.*
2. *Information Technology Layer.*

#### 1. Physical Layer

Physical layer consists of one or more Radio Frequency Tags, one or more Interrogators, one or more Antennas and Development environment [2].

#### 2. Information Technology Layer

This layer consists of one or more host computers connected to readers and appropriate software to interface readers with the computer like device drivers, middleware etc [2].

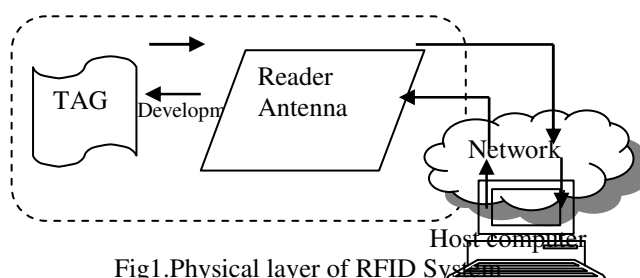


Fig1. Physical layer of RFID System

### III. RFID SOFTWARE

RFID software is divided into two groups

- A. Middleware

## B. Enterprise Application.

### A. Middleware:

Middleware directly interacts with RFID physical layer, collects data from reader, attaches business process information to data, stores data it supplies data to enterprise application.

Middleware also manages, monitors and configures hardware.

Middleware forms a conduit between the enterprise application used to manage business process and hardware components.

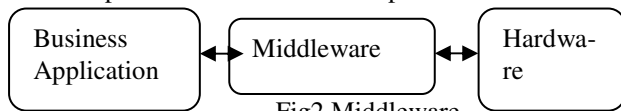


Fig2.Middleware

### B. Enterprise applications:

It is also called business applications, use middleware, together data from RFID readers, this type of data is then used to manage business [1].

### RFID Standards and Regulations:

- Standards are created by industry consortiums such as Electronic Product Code (EPC) global or International organisation for Standards (ISO).
- EPC global is non profit industry organization.
- EPC global has developed some standards such as
  - a. *Generation2(Gen2)*  
Gen2 defines rules for communication between the tag and reader.
  - b. *Application Level Events(ALE)*  
ALE standards define rules for data collection and filtering and reader management and monitoring.

## IV. PHENOMENON WHILE DATA TRANSFERRING WIRELESSLY

Due to multipath, the actual received signal level is a vector sum of all signals incident from any direction or angle of arrivals. Multipath of the signals causes variations in power density within an antenna beam. Some signals added to the direct path, while other signals subtract from the direct signal path. Thus, it creates bright and dark spots with in the antenna radiation pattern [2].

*Hotspot:* Hotspot or bright spot refers to spaces within the antenna beam where power density is higher than normal.

*Coldspot:* Coldspot refers to spaces within the antenna beam where power density is lower than normal. Hot and cold spots makes the antenna radiation pattern look like swish cheese [2].

*Reflection:* Reflections occurs when a propagating electromagnetic wave impinges upon an object that has very large dimensions compared to wavelength of the propagating wave. Surfaces of a conductive material reflect signals more than non conductive materials [2].

*Diffraction:* It occurs when the radio path between the transmitter and receiver obstructed by a surface that has sharp irregularities [2].

*Scattering:* It occurs when the medium through which the wave travels consists of objects with dimensions that are small compared to the wavelength and where the number of such objects per unit volume is large [2].

*Refraction:* Refraction is change in direction and speed of travel when radio waves move from a medium of one refractive index to another with a different refractive index [2].

*Fading:* Fading is variation of signal strength with time. It happens because of the time dependent random changes in multipath. A fade is constantly changing 3D phenomenon [2]. Fade zones always tend to be small, multiple areas of space within an Iz that causes periodic attenuation of a received signal. It is always impossible to estimate signal, strength accurately at various points in an Iz due to random nature of fades [2].

*Modulation and Encoding:* The combination of coding and modulation schemes determines the bandwidth, integrity, and tag power consumption. The carrier wave is radio wave of a specific frequency and amplitude broadcast by the transmitter to carry information. The information is passes by modulating carrier wave.

*Inductive and Backscatter coupling:* Passive tags always do not have an active transmitter that communicates with the interrogator. Passive tags couple the transmitter to the receiver by either load modulation or backscatter depending on whether the tags are operating in the near field or far field of the interrogator. Coupling is transformation of energy from one form to another. Inductive coupling uses near filed effects and backscatter coupling uses far field effects. When the primary magnetic field begins at the antenna and induces electric field lines in space, this area is known as *near- field* of antenna. The zone where the electromagnetic field separates from the antenna and propagates into free is space known as *Far- field* of an antenna. The boundary between near- field, far -field depends on frequency of transmission and size of transmitting antenna. The transmitting antennas that are electrically small compared to wavelength ( $\lambda$ ) of transmission appropriate outer

edge( $r$ ) of near field given by  $r = \frac{\lambda}{2\pi}$ . For transmitting antennas that are electrically large compared to a wavelength ( $\lambda$ ) of transmission, the approximate outer edge( $r$ ) of the near field is given by  $r = 2D^2/\lambda$  where  $D$  is the largest dimension of the antenna. RFID system are designed to minimize any incidental electric field generation, with near field, the magnetic field strength attenuates according to the relationship  $1/d^3$ . The magnetic field intensity decays rapidly as the inverse cube of the ( $d$ ) between the interrogator antenna and the tag. When the magnetic field strength is translate into power available to the tag, the power attenuates according to  $1/d^6$ .

To transmit the data from the tag to the interrogator, a load resister connected in parallel with the antenna is switched ON and OFF in time with the data stream to be transmitted. By changing the resonant properties of its

antenna, the tag makes itself a good or poor reflector. This varies the strength of the signal reflected from the tag, creating a pattern that is detected at the interrogator as data, this technique is referred to as modulated backscatter.

#### V. PROPERTIES OF RFID SYSTEMS

The properties of a given RFID system depend on several key parameters such as frequency and power:

- The **range** of a RFID system depends on the frequency, power of the reader, and the material between the tag and the reader. The presence of metal and liquids reduces the range of the ultra high frequency RFID systems. The range can be up to a few meters for passive systems but in excess of 100 m for active systems due to the onboard battery that facilitates increased radio transmitter power.
- The tag **size** increases at lower frequencies (LF), since the tag incorporates the antenna, and larger antennae are needed to transmit lower frequencies. The chip can be as small as 1 mm<sup>2</sup>, but the antenna is much larger (of the order of centimeters). The antennae for LF tags are metal wire coils, but for higher frequencies they can be printed onto paper using conductive inks.
- As the frequency increases, the **read rate**, and thus the amount of data that can be transferred in a given time, increases. This is important when many tagged goods need to be read in a short time.
- The **cost** of tags tends to decrease as the frequency increases, although active tags cost much more than passive tags, irrespective of frequency. Also, the longer the range required and the more information stored, then the more costly the tag [3].
- More number of RFID tags should be available to make efficient use of this technology.
- As we use metal ID then there will be the uniqueness of each ID.

#### VI. PROBLEMS OF RFID

- a. *Cloning Problem:* The secret information is stored on each tag, and it has chance of cloning.
- b. *Tracking Problem:* This occurs when response of the tag were constant.
- c. *Reader Collision:* It occurs when the signals from two or more readers overlap.
- d. *Tag Collision:* When many tags are present in small area.
- e. The material of the object to which the tag attached may change the property of the tag [2].
- f. RFID can use for fewer distances.
- g. RFID tags cannot tell the difference between one reader and other reader.

#### VII. ADVANTAGES OVER OTHER TECHNOLOGY

- The bar code is probably the most familiar computer readable tag, but the light used to scan a laser over a bar code imposes some limitations. Most importantly, bar code requires a direct "Line of Sight," so the item has to be right side up and facing in the right direction, with nothing blocking the beam between the laser and the bar code [1].
- If the barcode label is spoiled then item cannot be scanned.
- Standard barcodes identify only the manufacturer on the product, not the unique item.
- Barcode usually has limited data storage capacity.
- Most of the other forms of ID, such as magnetic strips on credit cards, also must line up correctly with the card reader or to be inserted into the card reader in a particular way.
- Biometrics are used for identifying people, but optical and finger print recognition each require you to at least face the camera.
- Voice recognition always works better if you are not calling your passphrase over your shoulder [1].
- An RFID tag has a mechanism for identifying an item at a distance, with much less sensitivity to the orientation of the item and reader. A reader can be able to identify tag even if it is not facing towards it direction.
- RFID reduces the use of humans to work.
- Collects the data automatically while business processes are being performed.

#### VIII. CLASSIFICATION OF RFID TAGS

There are three types of tags

- i. *Active Tags.*
- ii. *Passive Tags.*
- iii. *Semi Passive Tags.*
  - i. *Active tags:* In the active tags there will be a power source such as battery embedded in it which is used to transmit the data and also to provide the power to the chip. These active tags can be used when there is requirement to transmit data for high distances about 100 metres.
  - ii. *Passive Tags:* In the passive tags there will be no power source and power to the tag is generated by the Electromagnetic waves of the RFID antenna. These passive tags can be able to read only up to few metres.
  - iii. *Semi Passive Tags:* Even in the Semi passive tags there will be power source to the microchip but this power source is used when there is requirement of data transmission. Semi passive tags are used for high distance data transmission.

#### IX. METHODOLOGY

1. *Programming the tag.*
2. *Antennas arrangement.*
3. *Antennas interfaced with RFID reader.*

4. *RFID reader can be interfacing with the server.*
1. *Programming Tag:* Each tag which placed on the item must be programmed such that each item name is stored. The programming can be done in script language.
2. *Antenna Arrangement:* Antenna arranged around the house such that the signals from the antenna cover all over the house.
3. *Antenna interference with RFID reader:* Antenna interfaced with the RFID reader where the antenna continuously sends the signals to the tags around its diameter.
4. *RFID Reader interfacing with server:* Now a days in markets there are different types of RFID readers are available dependent on type of application. In the server, we maintain the database of the items.

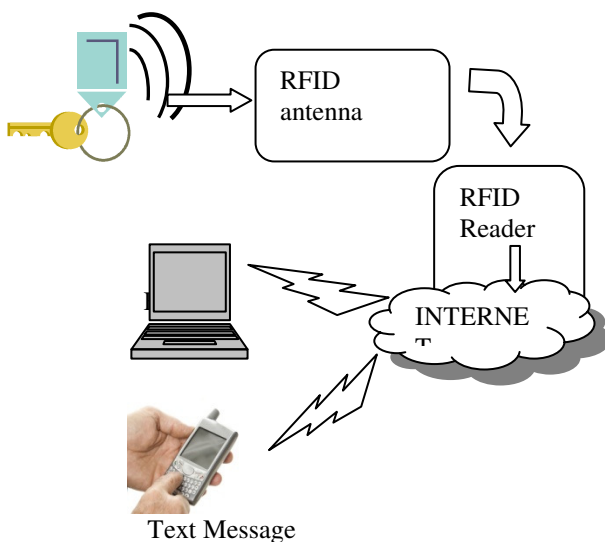


Fig.3. Block Diagram of RFID Smart Home.

**X. CONCLUSION AND FEATURE DEVELOPMENT**  
 By sitting in office also, we can able to find the location of items in the home. And also we can able to find the missing items in our houses by placing tags on each and every item in our house, in feature manufacturers keep the RFID tags on their products so we do not able keep the tag again just we need to install the RFID reader at our homes. If any item is found missing in our home than we will get notify by a text message and also an automated E-mail to us. To find any item location in our house we need to check the item in computer or mobile phone instead of wasting time in searching.

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# Theory and Application of Microstrip Filters

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**Abstract** - There are many kinds of radio frequency (RF) filters such as cavity filters, ceramic filters, tubular filters and microstrip filters. Microstrip filters are essential components in a huge variety of electronic systems, and they have an enormous impact on modern civilization. They are used in many life sectors, in personal computers, satellite stations, to civil and military radar and navigation systems.

Microstrip filters are one of the main types of microstrip circuits and they are widely used in all these systems in order to discriminate between desired and undesired frequencies.

Microstrip filters in fact are printed circuits used for very high frequency electronics and microwaves, made of conducting lines deposited upon a dielectric material, they are sometime called microwave integrated circuits (MICs). Practically, any microstrip is just a thin plate of insulating material, called *the substrate*, covered with metal on one side, called *the ground plane*. They are preferred as waveguides, because they are much cheaper than the other conventional waveguides, such as coplanar as well as their light weight compared with the others and more compact.

This paper will introduce an overview on microstrip different types of filters as well as microstrip filter's classifications, theories and applications, also going to explain the design technique that used to fabricate and build these filters.

**Keyword :** microstrip, filters, microwave, applications

## I. INTRODUCTION

Microstrip circuits are used in general in microwave applications over the ranges of giga hertz of the electromagnetic spectrum. Microstrips first introduced in 1952 as a genius solution for the relatively huge size of transmission lines, and the enormous space they take that were used in microwave circuits as in hollow metallic tubes.

However in comparison with the low frequency circuit applications like those used in power electronics, these microstrip circuits are sensitive to dimensions.

Research in this field is still in progress and it seems that it is never-ending process, yet dealing with microstrip even with the available advanced programmes nowadays yields in many cases unsatisfactorily results, this gives rise to the interaction between strip lines and other complicated parameters represented in the radiation of waves.

Microstrip technology can provide the industry with circuits used to implement the signal detectors, mixers, control devices, etc, by using semiconductor components such as (diodes) .

There are enormous experiments have been devoted to realize and fabricate antennas exploiting the

fundamental characteristic of the physical phenomena of radiation.

Filters which are our subject here are one of the most important circuits that can be realized by microstrip. In the recent years there have been lots of applications and experiments on microstrip filters because of the great advance in the materials used to fabricate the filters, including microelectromechanic systems (MEMS), monolithic microwave integrated circuit (MMIC), and high – temperature superconductor (HTS). In this research the intention is not to include everything about microstrip filters; such a work would take much time and size, but some descriptions of some types of microstrip filters and their applications would be very convenient here. Figure (1) shows a microstrip various structures.

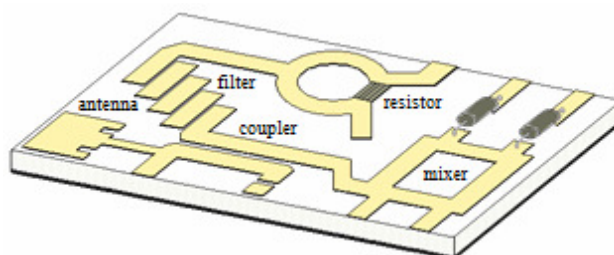


Fig. 1 . Microstrip structure, showing conductor patterns and various inserted components

## II. MICROSTRIP TRANSMISSION LINES

For designing any microstrip filters a look on some useful components are so important as described here. we will not write all of them, but the most important ones and the reason for that is because of the enormous researches that have been written in this field and by many researchers .

### A. Microstrip Structure

The general construction of a microstrip line is shown in figure (2), where there are the width  $W$ , the thickness  $t$ , the permittivity constant  $\epsilon_r$  , the conducting strip and the ground plane [4] .

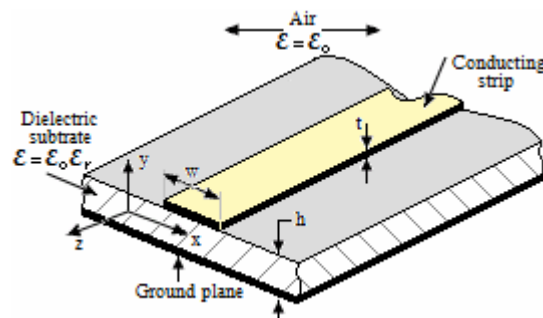


Fig. 2. Microstrip line geometry

### B. Microstrip waves

As it is clear from figure (3), the distribution of the electromagnetic field is asymmetrical, in the lower part the field is between the conducting strip and the ground, and on the upper part the conducting strip radiates the field into the air which is useful in antenna design, but not acceptable in filter design [4].

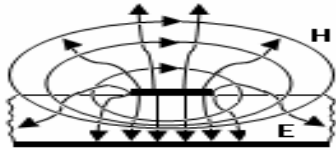


Fig. 3. Field pattern in a microstrip lines

### C. Coupled lines

Coupled microstrip transmission lines are of great importance in filter implementation, figure (4) illustrates them. For the even mode, both lines carry the same voltage, and in the odd mode they are excited by different signs, but these two modes would happen in the same time, in this case the two lines would experience different permittivities and different characteristic impedances [4].

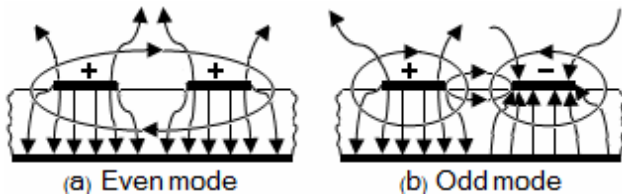


Fig. 4. Field distribution of parallel coupled lines

## III. A STRATEGY FOR MICROSTRIP FILTER DESIGN.

Figure (5) shows the overall design technique that any microstrip filter design follow, begin by selecting the parameters (by using the insertion-loss approach), then step by step until completely find the required lengths and dimensions for a practical layout [1].

### A. Low-pass filters formed with cascaded microstrips

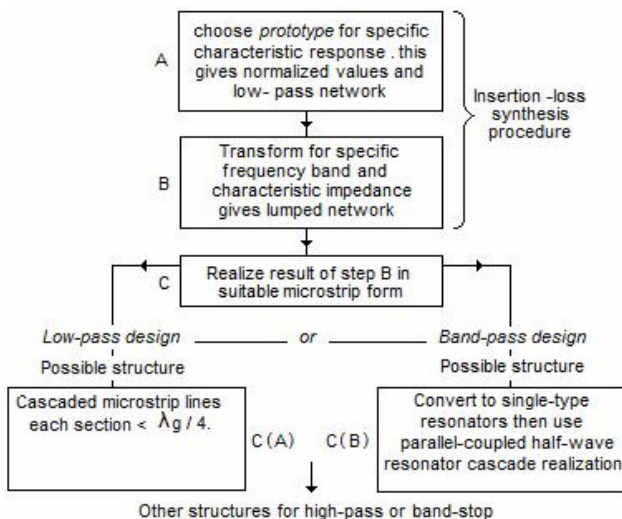
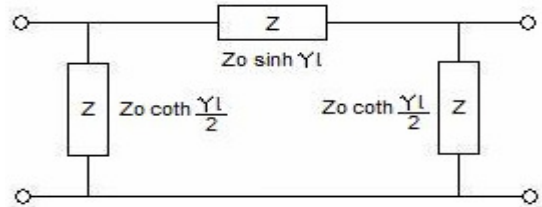


Fig.5. overall design technique for any microstrip filters

The cascaded sections of microstrip technique is only useful at ranges of frequencies of some few giga hertz .to start with, first try to find the required lengths by analysing the lumped elements, which in turn can be

obtained from the direct transform of the specific frequency band and the characteristic impedance. In this case, short lengths ( $< \lambda_g/4$ ) of high impedance line will act as series inductances, and a very short length ( $\ll \lambda_g/4$ ) of low impedance line will become as a shunt capacitance .Figure (6) illustrates the lumped elements of  $\pi$  - network which later can be directly represented by



microstrip lines of low and high impedances .

Fig. 6. Lumped elements of  $\pi$ -network

Figure (7) shows a lumped circuit with its equivalent form of inductive length of microstrip transmission line .This simple line gives the input reactance of the line of length  $l$ :

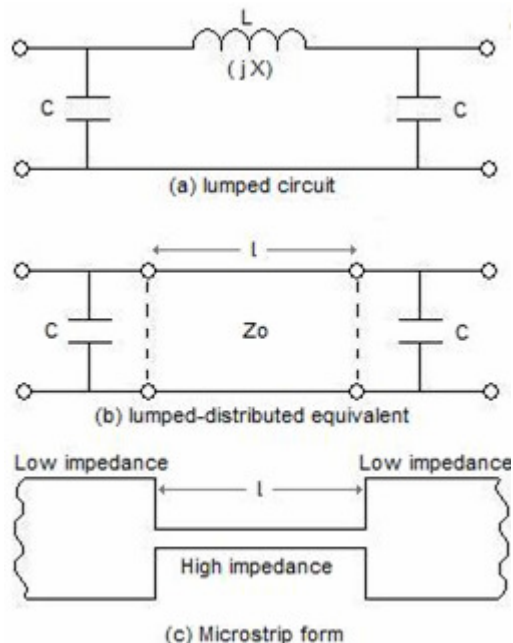


Fig. 7. Inductive length of microstrip transmission line

$$X_{\text{in}} = Z_0 \sin \left( 2\pi l \frac{1}{\lambda_g} \right) \quad (1)$$

(1), so the inductive line length is:

$$l = \frac{\lambda_g}{2\pi} \sin^{-1} \left( \frac{\omega L}{Z_0} \right) \quad (2)$$

the small - angle approximation can be used such

that  $2\pi l / \lambda_g \ll \pi/4$  and equation (2) simplifies to

$$l = \frac{f \lambda_g L}{Z_0} \quad (3)$$

Here the end susceptances  $B_{\text{in}} = \frac{1}{Z_0}$

$$\tan \left( \frac{\pi l}{\lambda_g} \right)$$

then 
$$l = \frac{1}{2fZ_0\lambda(\epsilon_g)} \quad \dots\dots\dots (4)$$

A short length of line with low  $Z_0$  yields a capacitive element as in figure (8). The shunt capacitance can be determined by the following relations:

$$B = \frac{1}{Z_0} \sin \left[ \left( \frac{2\pi l}{\lambda(\epsilon_g)} \right) \right] \quad \dots\dots\dots (5)$$

$$\text{so } l = \frac{\lambda(\epsilon_g)}{2\pi} \sin^{-1}(-1) (\omega(Z_0)) \quad \dots\dots\dots (6)$$

This can be written as:

$$l = f \lambda(\epsilon_g) Z_0 C \quad \dots\dots\dots (7)$$

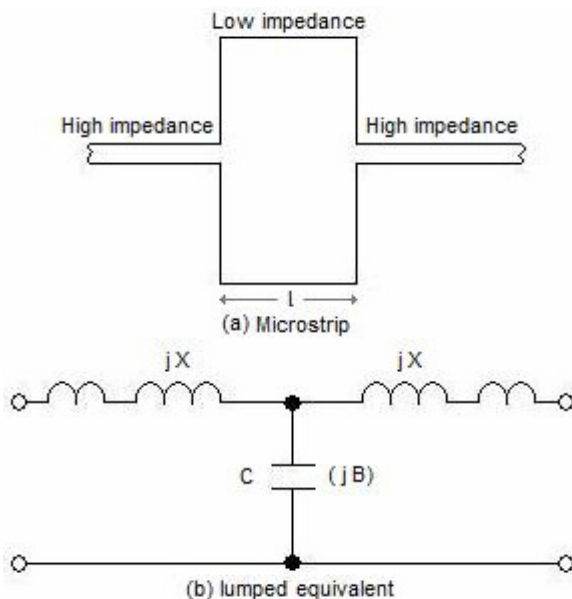


Fig . 8 . Capacitive length of microstrip transmission line

The T-network shown in Fig (8) with equivalent low impedance line has inductances which can be neglected,

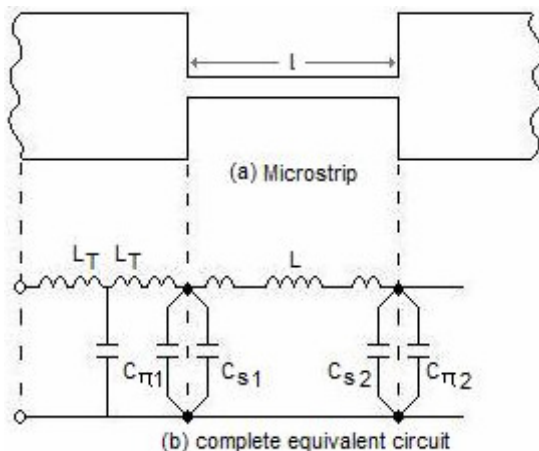


Fig . 9 . A complete capacitive and inductive lines with equivalent lumped elements .

thus

$$X_{L_1} = \left( \pi l Z_0 \frac{1}{\lambda(\epsilon_g)} \right) \quad \dots\dots\dots (8)$$

A more complete equivalent circuit for a capacitive line circuit's portion of a filter is given in fig (9).

A summary for this design is listed here.

- (1) First by choosing the substrate which will be used to fabricate the filter , with suitable permittivity and thickness, and specifying the frequency to be used, as well as the insertion loss and the impedance for the input and the output which is usually selected to be 50  $\Omega$  for most applications .
- (2) Selecting the prototype for the previous specifications can be found in many books which then yield the lumped elements for the equivalent low-pass network.
- (3) Replacing each component of the lumped elements by the equivalent microstrip.
- (4) Calculate the initial values for the lengths  $l_{L_1}$  ,  $l_C$  which is equivalent to the proper inductances, capacitances respectively using eqn (2).
- (5) Using CAD programme simplify the procedure to complete the calculations and plot the final dimensions for the filter [1].

#### B. Band-pass microstrip filter using cascaded half wave resonators

The coupling between the resonators in this kind of filter is parallel. First of all the designer should know how to get to the lumped elements network, this can be done by the direct transformation of the desired frequency and the characteristic impedance of each resonator. The transformed, lumped-elements network will normally consist of both series and parallel resonators of LC circuits as shown in figure (10).

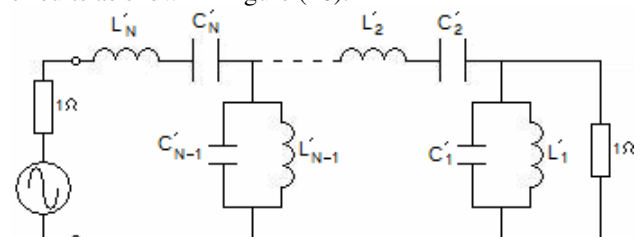


Fig . 10 . Transformed, lumped-element, band-pass filter network

There are two kinds of coupling between the resonators: end coupling and edge (parallel) coupling [1].

#### (1) End coupling band pass filters

As shown from the next figure which represents a general microstrip layout for this filter .The end side would either connect to the load or to the next stage of the filter.

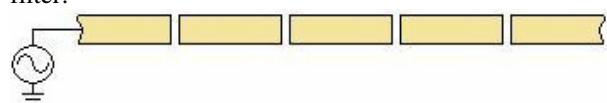


Fig. 11. General layout of end-coupling bandpass filter

The length of the resonators depend on the coupling reactances, the microstrip wavelength and the gaps which

cause shunt capacitances .Cunningham described this length by the following equation:

$$l_{j,j} = \frac{\lambda(\epsilon_g)}{2\pi} (\pi - X_{j-1,j} - X_{j,j+1}) - b_{j-1,j} - b_{j,j+1} \dots\dots\dots(9)$$

Where  $b_{j-1,j}$  are the lengths due to the affect of the gap shunt capacitances and

$$X_{j-1,j} = 0.5[\tan^{-1}(2b_{j-1,j}/Y_0)] \dots\dots\dots(10)$$

This type of filter experimented to use as a front-end filter in a down-converter for a millimetre-wave multipoint multichannel video distribution system.

## (2) Parallel-coupled band pass filters

The general layout is shown in figure (12) where  $l_1, l_2, l_3, l_4 \approx \frac{\lambda(\epsilon_g)}{4}$

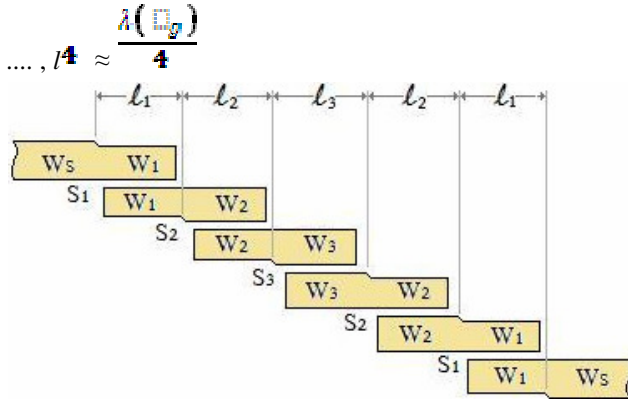


Fig. 12 .General layout of parallel-coupled band-pass filter

In this coupling structure the maximum coupling is

achieved when the length of the coupled region is  $\frac{\lambda(\epsilon_g)}{4}$ , or some odd multiple thereof, and to obtain resonance,

each resonator should be  $\frac{\lambda(\epsilon_g)}{2}$ , or any multiple thereof. The designer should follow the next steps in order to design the filter.

1 – Calculate the specification of each resonator from the original prototype.

2 – Evaluate the even – and odd mode for this network.

3 – transfer these values of  $Z_{e1e}$  and  $Z_{o1o}$  to the equivalent microstrip widths and spaces, there are many techniques for these procedures which involve using some series of equation, for example those described by Akhtarzad, or trying the graphical way used by Bryant and Weiss.

4 – Find the physical length of each resonator separately by:

$$\lambda_{g1e} = \frac{300 Z(\epsilon_g)}{f Z(\epsilon_{o1e})} \dots\dots\dots(11)$$

$$\lambda_{g1o} = \frac{300 Z(\epsilon_g)}{f Z(\epsilon_{o1o})} \dots\dots\dots(12).$$

Where  $Z_{e1e}$ ,  $Z_{o1o}$  are the even and odd modes characteristic impedances with air substrate, then the final length is calculated by

$$l = (\lambda_{g1e} + \lambda_{g1o}) / (8) \dots\dots\dots(13)$$

[1] [4].

## C. High pass and band stop filters

Here are some important microstrip high pass and band stop filters.

### (1) Quasilumped High pass Filters

They are consisting of series capacitors in their simplest form, which is usually found in dc block applications. To improve the performance many other elements can be added [3] .

### (2) Band stop Filters for RF Chokes

This filter used in a bias network the purpose is to choke off RF transmission over its stop band, but getting a direct current transmission [3] .

## V. ADVANCED MATERIALS AND TECHNOLOGY

### A. Superconducting filters

by using superconducting materials , filters can be used in many types of designs including medical instrumentation, military navigation systems and in the next generations of mobile networks .superconductor filters consists of high-temperature superconductors ( HTS) thin films, some of these films are yttrium barium copper oxide (YBCO) and thallium barium calcium copper oxide (TBCCO) used in 900 MHz cellular band with 25 bandwidth and made of coated YBCO films on a 0.5 mm thick lanthanum aluminate ( LAO) substrate, the opposite side is coated covered by silver/gold layer using an ion beam deposition technique at room temperature. These materials are exploited because of the characteristic of superconductivity which is 1000 better than the normal conductors, for example YBCO surface in 10 GHz and 77 K = 0.25 mΩ ,where copper in the same range =8.7 mΩ . HTS filters can be configured as hairpin-comb which is used in personal mobile services and pseudocombine filters. A significant usage is to capture desired signals in high EMI environments, providing enhanced tenability and selectivity to ultra-sensitive receivers [3] [5].

### (1) High-power HTS filters

They are some kinds of microstrip filters used for handling high –power according to the factors of (i) RF arcing when there are small gaps between the couplers of the filters because of the high fields; (ii) heating caused by the dissipation which may reduce the handling capability. A filter of this type was developed for C-band multiplexers [3].

### (2) Ferroelectric tunable filters

These filters depend on the change in electric fields due to the ability of changing the permittivity of the substrate, this idea can be used in dynamic channel allocation, satellite and ground communications. Ferroelectric thin films inserted between the microstrip and the substrate using laser ablation or laser deposition according to the material of the ferroelectric used.

### (3) Micromachined Microstrip Filters

Microelectromechanical systems (MEMS) are a combination of small mechanical and electrical elements

which are fabricated in IC form. Some materials including (Au, Al, etc), ceramics, and special plastics are used in this fabrication by evaporation or electrodeposition.

Recent applications using dielectric layer deposited on top of silicon substrate, then the filter components put on this substrate. One application of this filter is in 8% bandwidth centred on high spectrum of 61.5 GHz.

#### (4) Active Microstrip Filters

In some approaches, they used a coupled negative resistors ( $R < 0$ ) to each resonator of bandpass filters (three-pole hairpin) to achieve very high performance for the filter. The microstrip components used  $L_{a1}$  and  $C_{o3}$  substrate [3].

#### (5) Photonic bandgap (PBG) Microstrip Filters

Microstrip lowpass and band stop filters easily obtained by using modified dielectric substrate which can be integrated with PBG structures that can be obtained by using metallic, ferroelectric implants, the benefit of this is to increase the maximum attenuation [3].

### B. Advanced RF/Microstrip Filters

#### (1) Microstrip CQ Filters

By using a cascaded quadruplet (CQ) sections a bandpass filter can be designed consists of a certain number of resonators. This type of filter has a high selectivity as well as simple tunability as the coupling between each section is independent. This filter is normally implemented in high-speed digital transmission applications like (Software Defined Radio) to reduce linear distortion and to gain channel selectivity.

#### C. Compact Filters and Filter Miniaturization

Where the size of the filter is in great importance for special applications, a small microstrip filters can be used in some applications.

#### (1) Miniature Open-loop And Hairpin Resonator Filters

They are small size filters use meander open-loop resonators and each resonator has a size less than  $\frac{\lambda_g}{8}$ , where  $\lambda_g$  is the midband guided wavelength, this is about 20 mm by 18.7 mm in some applications. A compact filter of this type using (HTS) has been developed to have a passband of 1710 to 1785 MHz, which is the range for digital communications system at the receiving side [3].

#### (2) Multilayer Filters

In this modern technology a multilayer bandpass filter consists of different layers, in each layer there are many coupled line resonators and in this structure there is not a ground plane between the layers. Because of the

strong coupling between the resonators this type of filter is compatible for wide-band applications. Another way uses a ground and aperture coupling and this filter used for narrow-band applications [3].

### VI. FABRICATION TECHNIQUE

All microstrip circuits including filters consist of a substrate, covered completely with a thin plate of metal used as ground from one side and the intended circuit on the other side. Before describing the manufacturing process a clear knowledge of the substrate and the metal is necessary as mentioned below:

#### (A) The substrate

- (1) The dielectric relative permittivity or  $\epsilon_r$  of the material used to design the substrate, table (II) shows some properties of these materials.

Table (II) Properties of some substrate materials

| Material       | Surface roughness | $\tan \delta$ (10 GHz) | $\epsilon_r$ | Dielectric strength Kv/cm |
|----------------|-------------------|------------------------|--------------|---------------------------|
| Air (dry)      |                   | $\approx 0$            | 1            | 30                        |
| Alumina 99.5%  | 0.05 – 0.25       | 1 - 2                  | 10           | $4 \times 10^3$           |
| Quartz         | 0.006 – 0.025     | 1                      | 3.8          | $10 \times 10^3$          |
| Ferrite/garnet | 0.25              | 2                      | 13 - 16      | $4 \times 10^3$           |
| RT-duroid 5880 | 0.75 – 1.0        | 5 - 15                 | 2.16 – 2.24  | $4 \times 10^3$           |

Many filters used a thin substrate with high Permittivity, whereas a thicker one with low permittivity preferred for antenna design because of the sufficient radiation conditions it provide.  $\epsilon_r$  is used to determine the size of the design by the proportional factor of  $\sqrt{2} / \sqrt{1 + \epsilon_r}$ .

- (2) To ensure good performance of the filter, the dielectric loss should be small ( $\tan \delta < 0.001$ ).
- (3) The mechanical property of the substrate should have:
  - (i) enough strength to resist the vibration in some applications.
  - (ii) Uniform thickness  $h$  for the whole batch of the material.
  - (iv) Good stability in moisture and temperature changing.
- (4) Physicochemical parameters can be summarized in:
  - (i) Smooth surface to ensure a good contact to the conductor.
  - (ii) Low ability to saturate with water, since it has a high loss [2].

#### (B) The metallic conductor

Different types of conductors are used, table (1) shows some of them, but all must exhibit the following parameters:

- (1) Good solderability.
- (2) Strong ability to adhere to the substrate when exposed to thermal or mechanical change.
- (3) Oxidation and aging stability, in many cases by using a protective layer of gold.

The filter elements or the conductor on the top side can be obtained by sculpturing a complete metallic substrate to yield the desirable shape, or by directly covering the substrate with these elements, the process used for this is called photography which means exposing a light to a sensitive layer, the later is obtained by depositing a varnish (photoresist) on the top of the metal. Several methods as described below regarding this method:

- (1) *Dipping* the metallic substrate on the varnish completely.
- (2) *Spraying* the photoresist by using a nozzle.
- (3) *Centrifuging* property of the rotated substrate with the photoresist deposited on the top.
- (4) *Pressuring and Heating* the photoresist.

For the previous methods to produce an accurate shape of the filter the photoresist layer should be thin, because it then will expose to an ultraviolet ray through a vacuum-pressured mask. The next step is to remove the UV-exposed part, after that the designer use etching process: **Etching:** by adding acid to the metallized substrate, so the acid will dissolve the metal without affecting the photoresist, this is removed by using a solvent. In all previous steps a drying and rinsing should be done after each step [2].

## VII. CONCLUSION

Filters in general are important devices in any system design, for an example showing the importance of these circuits in the sophisticated revolutionary technology available nowadays the implementation in deep-space probe Voyager 2, which was sent to planet Neptune, at about 4.5 billion km from earth and transmitted a very clear coloured pictures of the planet, so without using a sensitive filters the extremely weak signals could not be detected. Microstrip filters are one of these filters which actually have a special character because in the design we are looking to find lengths, widths, spaces between couplers and another important issue which are electromagnetic considerations; this involves using an extensive math. The paper presented was not attended to write about all kinds of this filter, because this is impossible, but a brief description of some important ones were viewed [2] .

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# An overview and Implementation of Digital down Converter (DDC)

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**Abstract-** This paper describes general overview of the DDC by explaining its individual blocks (NCO, CFIR, PFIR, and CIC) and their implementation in MATLAB SIMULINK and XILINX system generator. Paper also briefs that how Numerical Controlled Oscillator (NCO) provides precision, accuracy and flexibility. What are the main characteristics of CIC (Cascaded Integrated Comb) filter and how it lowers the data rate in DDC. Also how the second stage CFIR (compensation filter) of DDC compensates for the pass band droop caused by the CIC and how programmable filter (PFIR) provides additional decimation and final signal shaping. This article present the full design process of DDC, from a floating point simulation (SIMULINK MATLAB) to fixed point or bit level designing (XILINX SYSTEM GENERATOR).

**Key Words:** - Digital down Converter (DDC), Numerical controlled oscillator (NCO), Mixer, Cascaded Integrated Comb Filter (CIC), Compensation FIR (CFIR), Programmable FIR (PFIR)

## I. INTRODUCTION AND OVERVIEW

Concept of Software Defined Radio was introduced by Joe Mitola in 1991. Channel Modulation of Software Defined Radio is defined in software. That is its waveform is generated as sample digital signal, using wideband DAC it is converted from digital to analogue and up converted from IF to RF. Receiver simply employs wideband ADC for capturing of all channels of software radio node and then down converts and demodulates the channel waveform using software on a general purpose processor. General architecture is [1]:-

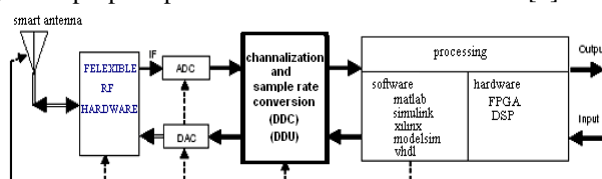
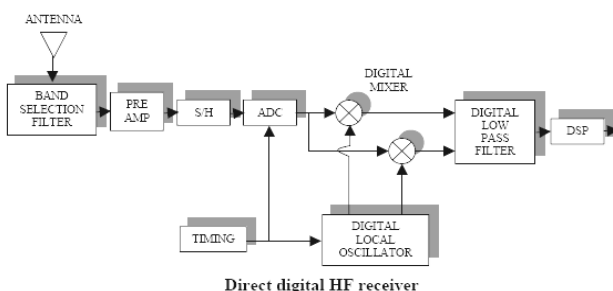


Fig 1:- Architecture of SDR

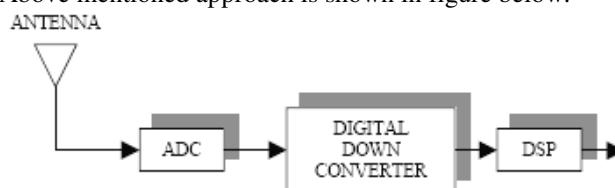


Direct digital HF receiver

In digital receivers analogue filters occur after the antenna. These analogue filters must be highly accurate and should be having high band of rejection to prevent

aliasing. Thus filter should be continually adjusted for the best performance [1]. After the analogue signaling ADC is used to digitize the signal, which confirms that ADC must have enough analogue bandwidth and accurate sample and hold circuitry. Alternate approach to this is use DDC following the ADC can be used for the band selection in digital domain.

Above mentioned approach is shown in figure below.



Digital Receiver

DDC is employed after the ADC and this architecture form the backbone of any digital receiver and used in software defined radios [1, 2]. We can say that whole HF spectrum is digitized using the ADC and DDC is used for the final band selection and data rate lowering for easy signal processing.

This paper describes the DDC (digital down Converter) shown in Fig 1. DDC's are the key components of digital radios that perform the frequency translation to convert higher sample rates into lower one for further and easier processing. Down Converter contains NCO (Numerical Controlled Oscillator), mixer to quadrature down convert to baseband followed by Cascaded Integrated Comb Filter (CIC) and for the isolation of desired signal two stages of decimation and filtering are also included named CFIR and PFIR. A block diagram is shown below.

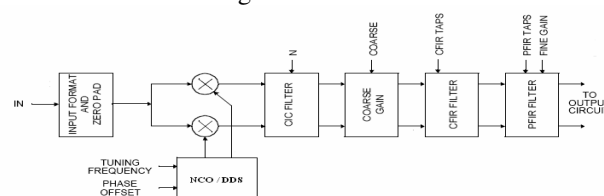


Fig: - DDC block diagram

Input format converts data into bit format. Zero padding enables the user to clock at higher rate than input sample rate. NCO circuit is used to tunes the centred frequency down to DC for the low pass filtering by CIC, CFIR and PFIR. CIC reduces the sample rate to programmable factor. Course gain is used to amplify weak signal up to 42dB in 6dB steps. CFIR filter compensates the droop of CIC filter and further decimate by 2 with user programmable tap weights. PFIR is second stage of filter and user can customize channel spectral response using

PFIR filter. Using split I/Q capability of CIC, CFIR and PFIR, DDC can be used to down convert wideband signals or two 8X over sampled NB-CDMA IS95 signals. Re-sampler in the end is used as final filtering stage.

## II. Numerical Controlled Oscillator (NCO)

In digital signal chain if Phase accumulator is employed then resulting architecture is named as NCO [3].

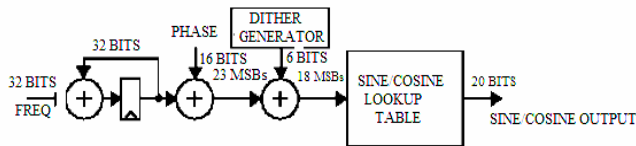


Fig 2:- NCO architecture

Module of NCO comprises of phase accumulator, increment register and sine/cosine lookup table. Increment register stores the incremented value in the phase and this value is continually integrated by phase accumulator. Phase to amplitude or sine/cosine lookup table converts the truncated version of phase accumulator instantaneous output value into the sine wave amplitude information that becomes the input of A/D converter [1, 3]. NCO is used in digital receiver DDC. Digital nature of NCO provides repeatability, precision and flexibility.

Its implementation in MATLAB SIMULINK and XILINX system generator is shown below.

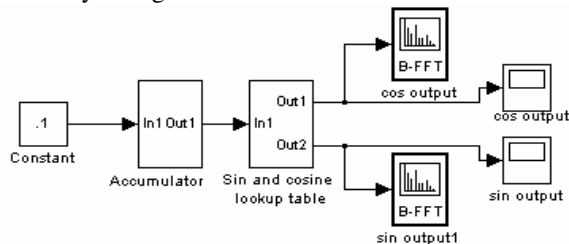
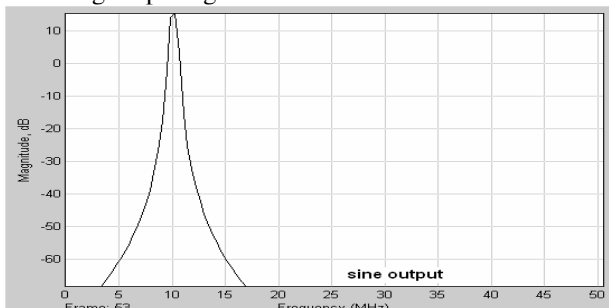


Fig 3:- NCO design in SIMULINK

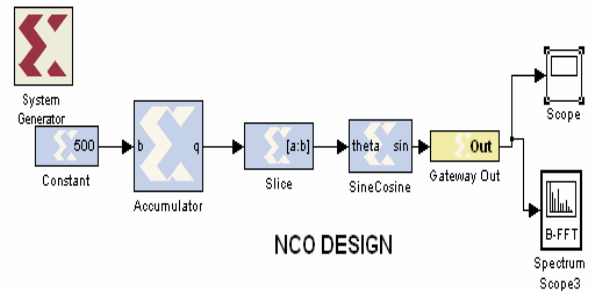
By giving the constant value 1 and sample time 0.0000000099 and output frequency 10MHz we get the following output figures.



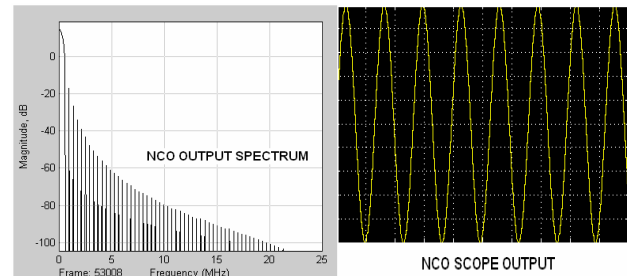
Different tests are performed by changing the constant value and sample time and then concluded that designed NCO can be tuned to any frequency by changing sample time and frequency. Thus NCO provides high accuracy and perfect results. Now NCO is designed in system generator for the hardware implementation and

downloading in FPGA. Shown below NCO is designed in system generator and following formula is used to determine the frequency of NCO [1].

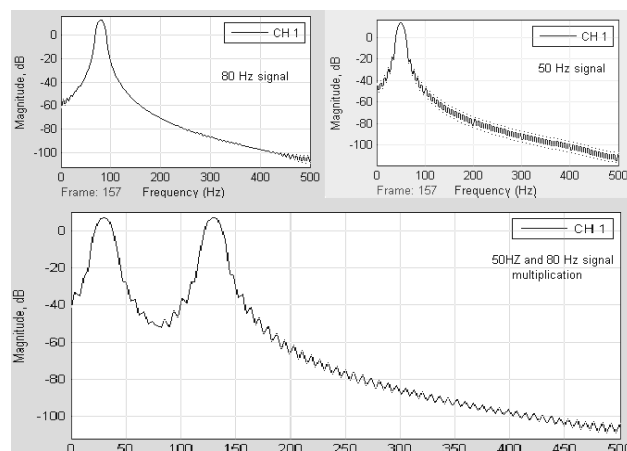
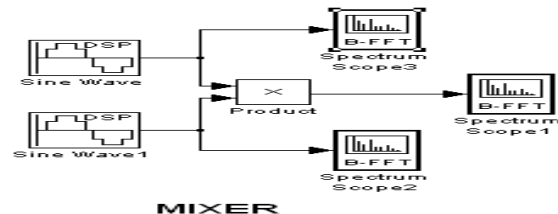
$$F_{out} = (f_{clk} * \text{constant}) / 2^{\text{accumulator width}}$$



For above design if  $f_{clk}$  is 50MHz and constant value is 500 with accumulator width 32 then NCO will be tuned at 5.82Hz.



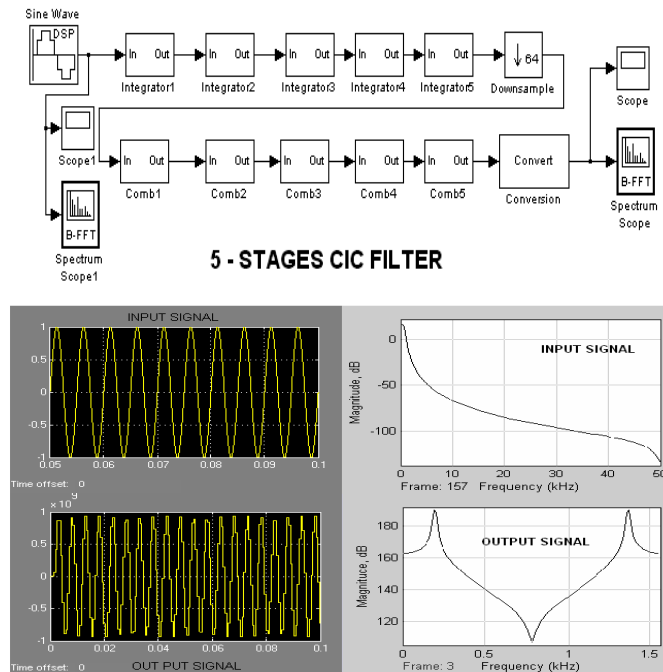
**Mixer Testing:** - Mixer's function is to convert base band signal to band pass signal and vice versa. Its architecture is simply multiplication of signal with carrier signal as shown in fig below with its signal testing example [1].



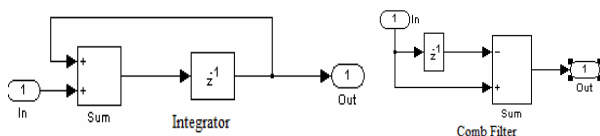
## III. CIC Filter Design

CIC filter are multiplier less and efficient filters use in high decimation and interpolation systems. These are simply BOXCAR filters implemented recursively in

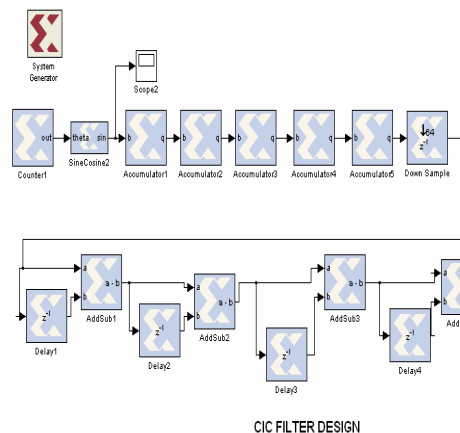
cascaded manner with down sampler. This beauty of CIC is very useful in digital systems operating at high rates especially for the implementation of CIC in FPGAs [4]. Also *CIC* incurs attenuation in the pass band region due to its sinc like response. Because of this reason *CIC* is followed by Compensation FIR [1, 5]. Data rates in DDC are mainly decreased by the *CIC* filter. Shown below is 5-stage *CIC* filter design in SIMULINK.



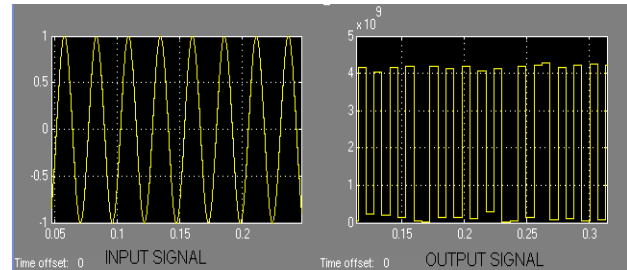
As figures and results show that there is droop at  $F_s/2$  which confirms the theoretical explanation of *CIC* filter [4]. Integrator and comb filters are the building blocks of *CIC* filter [4].



*CIC* filter design in System generator and its results are shown below.

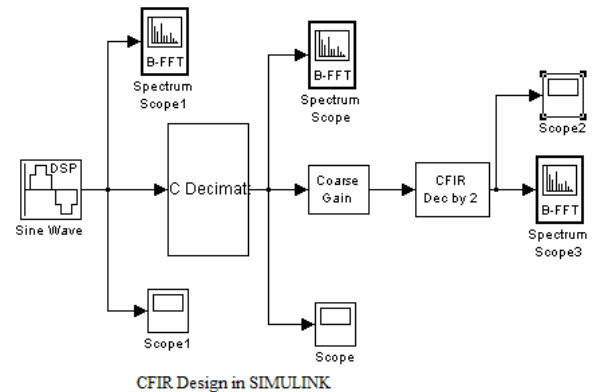


CIC FILTER DESIGN

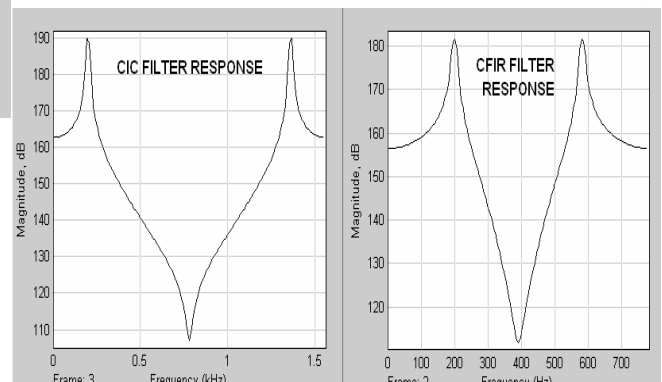


#### IV. CFIR Design

Compensated FIR filter is used for removal of droop and further decimation [5].

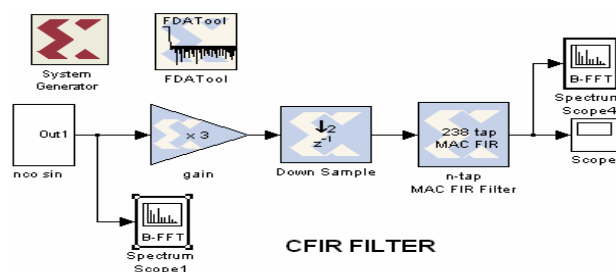


CFIR Design in SIMULINK



Above figure shows the effect of CFIR on the filter response of *CIC* filter.

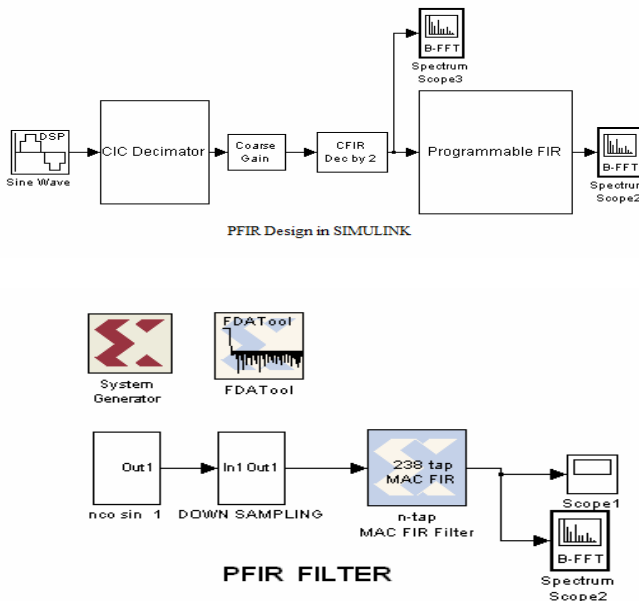
CFIR design in XILINX system generator is shown below.



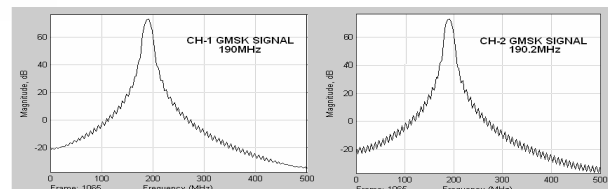
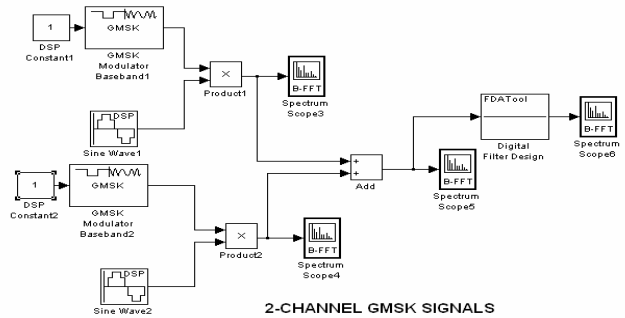
CFIR FILTER

#### V. PFIR Design

Programmable filter in DDC is used for the further decimation of 2 and final extraction of signal to the desired frequency [5]. PFIR design in SIMULINK and system generator shown in figures below

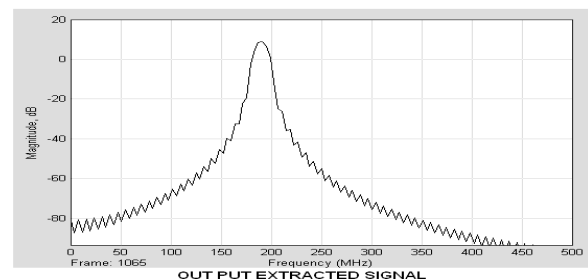


**Example 2:-** GSM signal is used at the input of DDC [6]. For GSM source we use GSM band 900MHz in which each carrier is separated by 200 KHz through channel bandwidth of 200 KHz. Here 2 channels of GSM are used as example and visualized that how DDC down converts the signal into lower data rates.



Above figure shows the spectrum of two channels one at 190 MHz and other channel at 190.2 MHz

Now the output of extracted signal from the 2 channels is shown below.



**VI. DDC final Design in SIMULINK and XILINX**  
After the implementation of individual buildings blocks of DDC, the final design comprising all of its blocks is shown below.

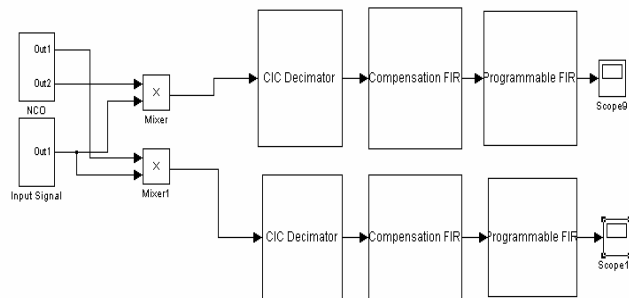
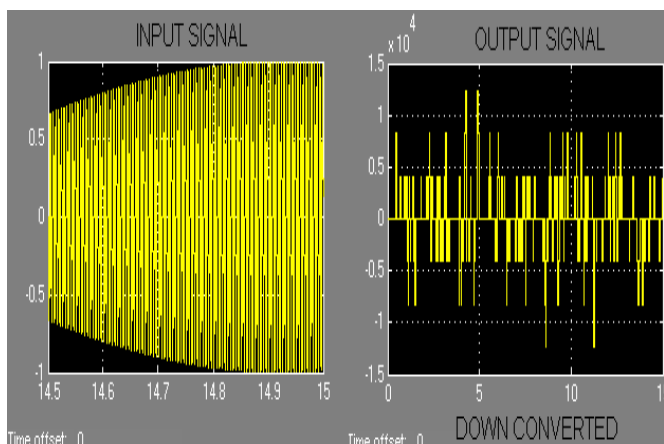


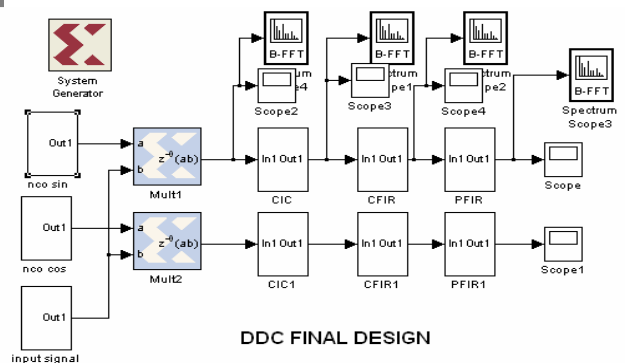
**Fig: - DDC design in SIMULINK**

**Example 1:-** As DDC down convert higher data rates into lower data rates this can be shown if higher data rate signal is input the DDC final design of SIMULINK as shown below.



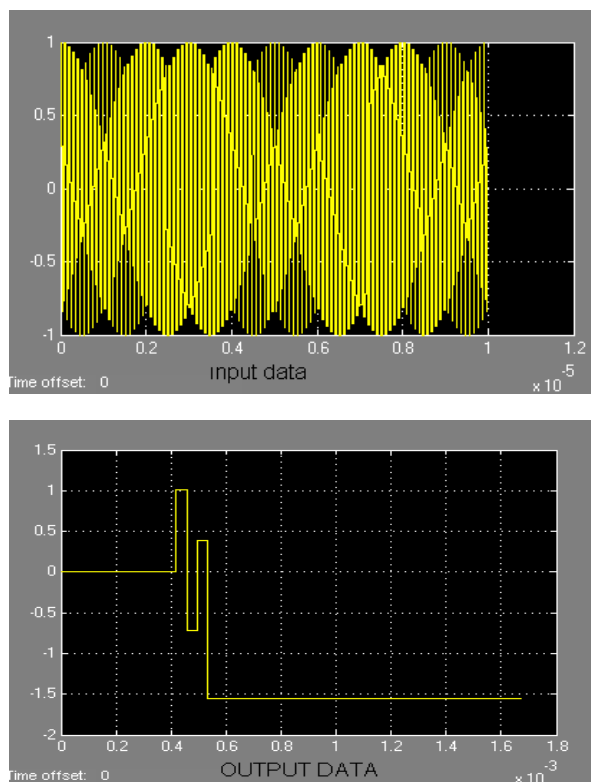
In this example data is down converted by 256 times as that of in input signal.

DDC design in XILINX system generator is shown in fig below.



As discussed earlier that system generator design is used for hardware implementation of DDC in FPGA. Thus

example below shows that input signal of high data rate is down converted to a significant value.



### VII. Conclusion

Because of the high accurate resolution of NCO, DDC can be used to down convert to 0 HZ often using only 32-bit accuracy. DDC is ideal for the application that requires precise change in tuning. Thus DDC takes the form of integrated circuit having flexible functionality in order to meet the requirements of a broad range of receiver designs. Design also great effect the computational complexity of Local oscillator and general receivers. Both the implementation of DDC in SIMULINK and XILINX help in the processing of migrating from floating point model of a system under consideration towards an optimized fixed point model (system generator). Thus this approach allows designers to quickly translate high-level behavioral models to other models [6].

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# Applying an Integrated Wireless LAN with Bluetooth Technology into an Industrial System Control

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**Abstract**—Wireless communications for signal transmission are playing an increasing important role in most working environment thereby reducing the need for wired network. Though, when deploying wireless network facility it is expected that such network meets the required needs for which the wired systems was initially used and also serves the processes in real-time as well.

The paper proposes a way of implementing an integrated application of a wireless LAN access point network incorporating a Bluetooth technology for remotely controlled system for both industrial / home appliances. The wireless LAN access point is an IP-based network system, which allows remote login connection, whereas the Bluetooth technology is a wireless personal area network system (device-to-device) used for connecting short range Bluetooth-enabled devices e.g. control systems, surveillance cameras and various electronic appliance. The wireless LAN access point has high throughput connection technology.

The process involves carrying out the test using a wireless LAN system for devices control, the test result obtained is used to model the integrated wireless LAN and Bluetooth for use in industrial and home appliance control system.

## I. INTRODUCTION

The benefit of wireless network connection is enormous, its provides a comparable cost advantage solution to device connectivity needs, to facilitate device control. Moreover, it has been regarded as a replacement for the cable network technology. The greatest challenge of the cable network is the complicated network configuration requirement in most factory floors and work environment, it also considerable hinders worker movement and thereby reduces productivity hour.

The implementation of the integrated wireless LAN access point with Bluetooth is expected to considerably improve the efficiency of labour, increase process velocity and overall output. The device-to-device attribute of the Bluetooth makes it possible to move and synchronize data in a localized environment. Both the wireless LAN access point IP-based and Bluetooth could be configured to operate in a point-to-point mode or in a point-to-multipoint mode for device connectivity. The project demonstrates a way of applying wireless remotely controlled system for use in the industrial / domestic appliance.

## II. UNDERLYING TECHNOLOGIES

### A. Wireless LAN and Bluetooth

The integrated wireless LAN with Bluetooth technology applied into an industrial control system is an IP based wireless technology control system that permits users to remotely login for network access. The complete system design is in part, made up of the following individual

components working in a seamless manner in an automated form:

- (1) Controller PC.
- (2) Integrated wireless LAN with Bluetooth.
- (3) Bluetooth enable switch setup.
- (4) Selective switch panel.

The system design is setup solely to improve the process velocity in any applied environment where it is been deployed. Though, they're various wireless technology available for use i.e. infrared and radio frequency technology, in the case of the infra red this requires line-of-sight in its path during transmission which makes it not suitable for this application [3, 6]. The wireless LAN (Wi-Fi) and Bluetooth signals posses the ability to travel through solid objects and also allows for mobility within the service area during data exchange between application devices, this is difficult or practically impossible with infrared. The wireless LAN and Bluetooth uses radio frequency operating in the 2.4GHz frequency band and its unlicensed band. The wireless LAN has a 100 meter coverage distance and the Bluetooth posses a 10 meter coverage distance.

### 1) Wireless LAN (Wi-Fi) System Architecture:

The wireless (LAN) local area network is an IEEE 802.11b specification for the transmission of approximately 11Mbps of data with a coverage distance of 30.8 meters over the 2.4 GHz unlicensed band. The 802.11b uses direct sequence spread spectrum (DSSS) for its signalling technique One of the advantages of using spread spectrum codes is that even if one or more of bits in the chip are lost during transmission, statistical techniques embedded in the radio can recover the original data without the need for retransmission[4]. Most spread spectrum products are often interoperable because many are based on the IEEE 802.11 standard for wireless network, which is shown in the figure 1 below, further more the protocol suite is used during data communication process.

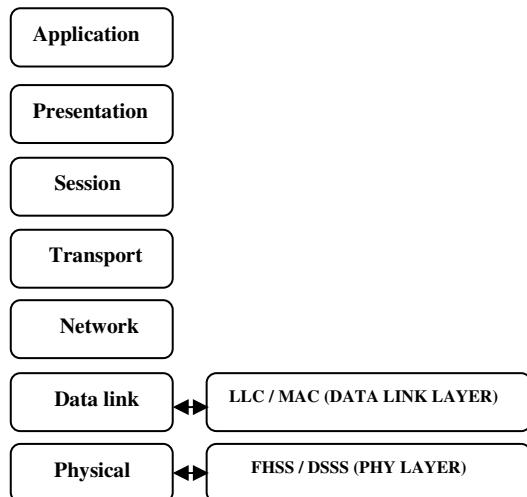


Fig.1. IEEE 802.11 OSI reference model.

## 2) Bluetooth System and Architecture:

Bluetooth is an industrial specification for wireless personal area network (WPAN). Bluetooth is also IEEE 802.15.1 standard. Bluetooth provides a way to connect and exchange information between devices like mobile phones, laptops, personal computers, printers and digital cameras via low-cost, globally available short range radio frequency.

The Bluetooth frequency of operation occurs in the Unlicensed ISM band at 2.4 GHz, same operating frequency as the IEEE 802.11b/g (Wi-Fi). The transceiver utilizes frequency hopping spread spectrum technique to reduce interference and fading. The communication channel is designed to support data and voice within a total bandwidth of 1Mbps. The Bluetooth device is capable of communicating with one or more other Bluetooth enable devices within its service area (piconet). One of the devices act as the master and the other as a slave. A Bluetooth network system with one master, having one or more slaves, the communication topology is referred to as point-to-multipoint. The master is capable of servicing up to seven active slaves whereby the channel bandwidth is shared amongst all the devices in the piconet.

The Bluetooth technology uses time division multiplexing for service delivery amongst multiple Bluetooth devices in a piconet [1]. The underlying architecture of the Bluetooth technology is consist of the hardware and software components of a Bluetooth protocol stack as shown in figure 2, which is used in communication with other peer Bluetooth enable device.

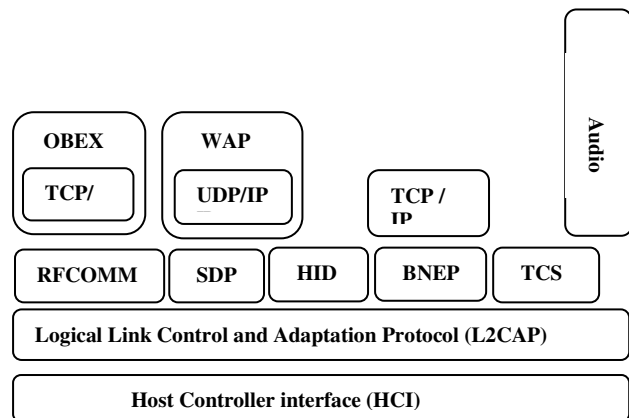


Fig.2. Bluetooth Protocol stacks.

## III. COEXISTENCE OF WIRELESS LAN AND BLUETOOTH

The Wireless LAN and Bluetooth co-existence have been speculated for years by companies and various special interest group (SIG), but because there was the worries that the devices would generated interference with one another. The issue of interference concern was legitimate, but it was technically resolved.

Both the Bluetooth and Wireless LAN are designed to operate in the unlicensed frequency band 2.4 GHz Industrial, Scientific, medical (ISM) band which is 83.5MHz wide from 2400 MHz – 2483 MHz

The Wireless LAN uses wideband direct sequence spread spectrum (DSSS) and Orthogonal frequency division multiplexing (OFDM) signal method, but the Bluetooth uses a frequency-hopping spread spectrum (FHSS) technique for signalling method. Although, the Spectrum bandwidth the Wi-Fi occupies is about one quarter of the 83.5 MHz available bandwidth, since the Bluetooth device is designed to hop through the entire frequency band i.e. 2400 – 2483.5MHz in order to establish connection with a peer, it therefore limit possibility of interference.

Although, in order to achieve coexistence various suggestion were speculated, including Adaptive frequency hopping, Power control during transmission and Time division multiple access. However, with the use of adaptive frequency hopping technique this would prevents the Bluetooth device from hopping across the whole band during peer connection negotiation, so restricting the channel hopping to frequencies not occupied by Wireless LAN network. The Time division multiple access technique allows for both the Bluetooth and Wireless LAN to provide simultaneous operation whereby reducing the issue of interference. Also controlling the Transmission Power during transmission would lessen the degree of Interference generated.

## IV. SIGNAL INTERFERENCE AND PREFERRED

## SOLUTION

Since both the Wireless LAN and Bluetooth are complementary technologies which operates within the same frequency spectrum i.e. 2.4 GHz the tendency of them interfering with one another is high when they are in close proximity. Both IEEE 802.11 and IEEE 802.15 technologies failed in performance test in the presence of interference carried out in the laboratory. Thus, it's observed that when the level of interference is increased this in turn affects the data transmission rate. In order to alleviate the interference problem, various interference reduction or eradication techniques were proposed, which are discussed below:

The experimental results shown below in figure 3 and figure 4, was performed in Texas Instrument Lab to demonstrate the effect of Interference on data throughput during communication between two endnodes (PC). The baseline test indicates when communicating devices were in line-of-sight of each other. An interference source was placed in the vicinity to the communicating devices, here it was discovered there was significant drop in the data throughput, but when both communicating device were brought close to each other there was significant improvement in their throughput [2, 4].

The figure 3 below shows the degradation on the Wi-Fi signal throughput in the presence of the Bluetooth interference and the improvement which occurred when the source of interference was removed i.e. Baseline signal.

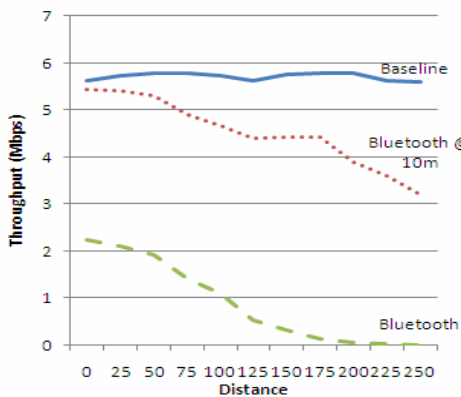


Fig.3. The effect on the Wi-Fi throughput with Bluetooth interference

The figure 4 below shows the degradation on the Bluetooth signal throughput in the presence of the Wi-Fi interference and the improvement which occurred when the source of interference was removed.

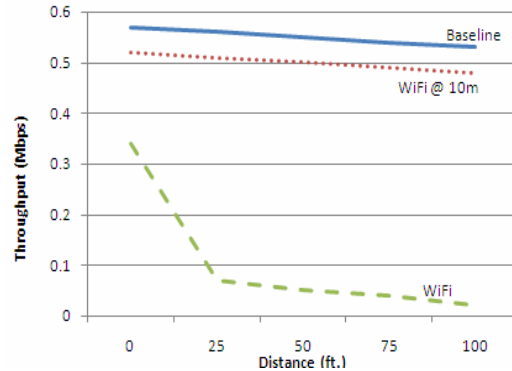


Fig.4. The effect on the Bluetooth throughput with WiFi interference

#### A. Preferred Solution for Limiting Interference

The use of wireless LAN technology may be limited to the IEEE 802.11a where ever possible in the design network, since the IEEE 802.11a has operation frequency which uses 5 GHz band and has throughput of up to 54 Mbps. The IEEE 802.11a frequency band 5 GHz which is amongst the Unlicensed National Information Infrastructure bands, which is 100 MHz wide this would eliminate interference with the Bluetooth which operates at 2.4 GHz frequency.

1) Adaptive frequency hopping: The use of adaptive frequency hopping, since Bluetooth uses frequency hopping spread spectrum whereas the wireless LAN uses direct sequence spread spectrum technique with both technologies operating in the unlicensed frequency band between 2400 – 2483.5 MHz frequency range i.e. having a 83.5 MHz wide band available. But the wireless LAN (802.11b) occupies approximately around one quarter of the allocated frequency bandwidth associated with 2.4 GHz ISM band. The 802.11 b/g occupies channel 1, 6 and 11 as shown in the table 1 [7].

The effective bandwidth for each channel is about 22 MHz with a Centre frequency which is evenly spaced between the lower sideband frequency and the Upper sideband frequency. The Adaptive Frequency hopping signalling method prevents the Bluetooth from operating in frequency channel 1, 6 and 11 respectively, but allowed to operate in all other frequency channels. This method of specific frequency channel frequency avoidance in ISM using the adaptive frequency hopping method reduces the problem of interference.

2) Time division multiplexing: The use of time division multiplexing techniques allows for both the Bluetooth and Wi-Fi to provide simultaneous operation and applying systematic power reduction in radio signal transmission, reduce the effect of signal interference [7].

Table 1.  
IEEE 802.11 b/g used channel frequencies

| Channel | F <sub>C</sub> (MHz) | F <sub>L</sub> (MHz) | F <sub>H</sub> (MHz) |
|---------|----------------------|----------------------|----------------------|
| 1       | 2412                 | 2401                 | 2423                 |
| 2       | 2417                 | 2405                 | 2428                 |
| 3       | 2422                 | 2411                 | 2433                 |
| 4       | 2427                 | 2416                 | 2438                 |
| 5       | 2432                 | 2421                 | 2443                 |
| 6       | 2437                 | 2426                 | 2448                 |
| 7       | 2442                 | 2431                 | 2453                 |
| 8       | 2447                 | 2436                 | 2458                 |
| 9       | 2452                 | 2441                 | 2463                 |
| 10      | 2457                 | 2446                 | 2468                 |
| 11      | 2462                 | 2451                 | 2473                 |

## V. SYSTEM DESIGN AND CONNECTIVITY

The structural system design is expected to convert a manually carried out task into an automated form, thereby reducing the need for man's point of presence in any industry where the system is been deployed. The system is targeted at achieving 100 percent efficiency in performance in order of consideration. Most industrial system is time dependent system which uses circuit driven switches mechanism for device control. The design requirement is expected to provide a close loop control system that is expected to be flexible, reliable and have low power consumption.

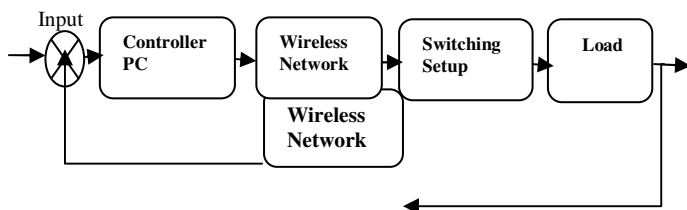


Fig.5. Industrial wireless control system setup

The intended system design layout is shown in figure 5, the system consist of several parts, synchronized in a close loop format. The system setup consist of a PC which serves as a controller, a wireless access point consisting of an Integrated Bluetooth in a wireless LAN (Wi-Fi) setup as shown figure 6, a switching system consisting of programmable switch which is Bluetooth enable and a contact switch and the load ( industrial machines, motors, surveillance cameras and various electronics appliance).

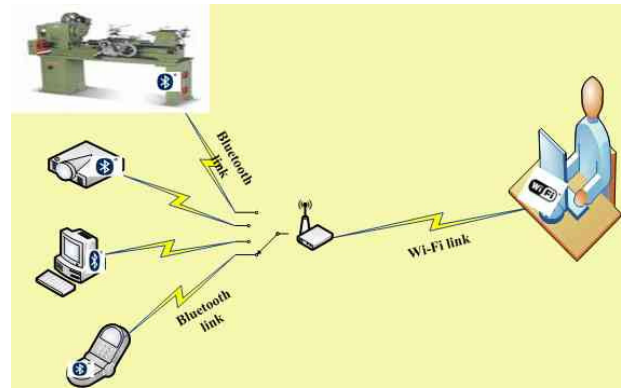


Fig.6. WLAN and Bluetooth wireless control system setup

The system algorithm works by coping a data packet generated from the PC, this is been transmitted through the wireless network to the Integrated wireless LAN / Bluetooth setup which in turn communicates with the required Bluetooth enabled switch circuit. The algorithm collates information such as message sent, message correctly delivered and message delivered in error. The system is design to employ forward error correction mechanism during data transfer. All other programming language would be specified by chip manufacturer.

### A. Controller PC

The controller PC acts as a general purpose computer, it performs different tasks ranging from communication to controlling the integrated wireless LAN and Bluetooth device, running the required suite of protocol (programming) and data storage during / nor feedback response. It is the initial point of contact between the man and the integrated system setup devices.

### B. Wireless Network

The integrated wireless LAN and Bluetooth serves as a wireless router system which provides a cost-effective two way connections. The integrated wireless LAN and Bluetooth setup is an IP based system which allows for remote login for the controller PC. The first connection is established between the controller PC and the integrated wireless LAN and Bluetooth device, while the next connection is between the integrated setup and the Bluetooth enable switch setup.

### C. Switching Setup

This is a Bluetooth enable switch which is consist of two types of switching system, a digital switch and a relay contactor switch. The digital switch is a programmable logic switch that provides software control switches (pre-switch) which in turn setup the relay contactor switch which is a hardware switch use in turning ON/OFF or control the connected load (machine).

### D. Load

This is the final point in the connection process, where the effectiveness and efficiency of the communication and control process is been determined. The propose area of utilization or load type includes machine control,

process control, automotive robot applications, crane control, surveillance camera and various appliances.

#### E. Feedback

The feedback loop is used to deliver information about the status of the link / control process back to the controller PC for onward review. It's a way to ensure that the information transmitted wirelessly was well received at the respective destination.

### VI. WIRELESS SYSTEM SECURITY

The system security process is an important feature of most data networked application process. The integrated wireless LAN / Bluetooth device address security in three different complimentary methods i.e. authentication, authorization and encryption [1]. Each of the process has a peculiar scheme of security.

#### A. Authentication

The access authentication process in the integrated wireless LAN and Bluetooth is designed to allow client / users to provide credentials i.e. username and password during login, the user is who he / she claims to be. This is used to prevent an unauthorized access to the network / control system, thereby reducing any form data interception. Though the Bluetooth end of the integrated system only authenticates devices, which does involves a username and passwords as wireless LAN platform. This involves the use of link connecting key, i.e. a secret number associated with the connection between two devices. The two end devices peering method requires that a personal identification number (PIN) is shared between any two devices willing to communicate on the network before access could be granted. The PIN number is usually a digital binary 128-bit shared link key [1, 5].

#### B. Authorization

Authorization is the second stage after the authentication process is fully completed. The Integrated wireless LAN and Bluetooth allow only a specific user (user's device) to gain access to specific resources on the control system based on the users (device) ID. The authorize individual could be granted full or partially access into the system network functionality.

#### C. Encryption

Encryption is part of the network security system which deals with data translation into secret code upon transmission.

An encryption algorithm (Cipher) is used to scramble the data. All communicating devices in a location must agree on their unique peer-to-peer encryption and decryption key information during data transmission.

### VII. CONCLUSION

This report reveals that by applying an integrated wireless LAN with Bluetooth technology into an industrial (process) control system as a means of controlling machine remotely would save time, increase labor efficiency, improve process velocity and increase overall productivity.

Though, coexistence of the wireless LAN and Bluetooth is a major source of interference this could be resolve by applying adaptive frequency hopping as proposed. As more devices get connected into the system setup the link performance needs to be measured at regular interval in order to maintain high quality of service.

The future work is aimed at collaborating with organization such as ABB (Italy) that has just developed the world first Bluetooth enable circuit Breaker to advance the research and development of the technology.

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## Wireless Communications (WLAN and Bluetooth)

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**Abstract**—In recent years, a high speed wireless communication is strongly required. A wireless local area network (WLAN) may be temporarily operational but it is also easy to be installed and it is preferred to concrete buildings or historical buildings where it is infeasible to retrofit existing structures for wired network structures. Bluetooth or WPAN is a low power wireless model which uses the low range of frequency of 2.4 GHz. This frequency is globally allocated and it can be used from any user without any permission, in order to communicate with another one, sharing the capacity of maximum 720 kbps.

Thus our main aim is to explain these two ideas and their functionalities more detailed. This research paper includes the types of WLAN's, like ILAN (Infrared LAN) and ad hoc netting. Evolution of WLAN's, applications and how it can coexist with the WPAN are also included. On the other side it includes Bluetooth applications and technology, abilities, evolution and defining protocols like TCP/UDP/IP or PPP protocols. To conclude we explain through a logical reference, how WLAN's and Bluetooth can be interconnected and simultaneously we make a comparison between them.

### I. INTRODUCTION

Wireless communications networks have become very popular and their daily use has remarkable growth. The high growth rate has direct effect of dominance on the market by replacing large percentage of wired communications. Thus the evolution wireless networks can only guarantee desirable results. Both WLAN (wireless local area networks) and Bluetooth have made significant progress in recent years. Right so this project is entirely dedicated to WLAN and Bluetooth or WPAN (wireless personal area network). This is because we want to emphasize the significance of these two networks, and how worthy can replace the wired communication. Initially we start with a small reference to what is a wireless local network. We made an in-depth research and analysis different topologies and architectures like ILAN (infrared local area network) and ad hoc netting. We continue with a reference to the abilities, evolution and finally where such networks can be applied. As far as the Bluetooth is concerned we make an analysis for its technology. Thus, the applications and the evolution of Bluetooth cannot be missing. Also, it is very important to pay attention to the basic protocols defining the Bluetooth such as Radio, LMP or TCP/UDP/IP. To come out, the last chapter is devoted to the coexistence between these technologies [1],[3],[6].

### II. WLAN

The wireless local area networks used to connect users within a building or group of adjacent buildings without using cables. Their use is limited to local level and that makes them different from the broadband-coverage

wireless solutions that extend over long distances using cellular or satellite technology [1]. WLANs operate with rules similar to those applied to wireless telephones using at home. The data is free, as is the voice of the terminal device in a wireless phone base station. A WLAN is a communication system used as an alternative or extension of a common wire-based network (Ethernet) and mobile users transmit and receive wireless data.

It is also important to mention the frequency (2.4GHz) in which the WLAN operates. That is the free worldwide frequency when one considers that one of the problems of these networks is the high costs. However below we will see that the frequency determined by what type of wireless local area network technology we talk [9]. With WLAN users can access data without the restrictions of cables and various complex installation procedures. The main advantages of WLANs compared to "traditional" Ethernet that we could mention are the following.



Figure 1. WLAN Environment

#### A. BENEFITS OF WLANS

- 1) The Network may be temporary and operational for short time.
- 2) It is easy to be installed and it is preferred in case of concrete buildings or historical buildings where it is infeasible to retrofit existing wired structures
- 3) Mobility: Wireless networks offer access to real time data from wherever user is in business or where there is coverage of the wireless network. This can dramatically increase productivity as well.

4) Easy adjustment. The wireless technology allows use of the network in areas that cannot be used cables (e.g. building maintenance)

5) Reduced cost of use. While the initial cost for the hardware that will support a wireless local area network is larger than a wire-based network, the total installation cost is significantly smaller.

6) Scalability: Wireless networks can support a wide variety of topologies to meet the needs of specific applications. The topologies can be easily changed from fairly simple networks suitable for a small number of users to large networks with full roaming capabilities that can support thousands of users over long distances [7].

### B. TYPES OF WLANS

The types of WLANs differ from one another, according to their technology:

1) LAN (IR) or ILAN (Infrared Local Area Network): In infrared technology the communication is carried by light in the visible part of the spectrum. It is primarily used for very short distance communications (less than 1m) where there is a line-of-sight connection. The ILAN technology possesses certain characteristics that fit perfectly in indoor wireless networks. The optical transmitters and receivers can be built at relatively low cost, small size and low power consumption requirements. The low power consumption is a particularly important factor in environments where the function of components requires batteries. Moreover, optical modems are much cheaper to be manufactured than the RF (radio frequency) equipment, at a cost near the cost of construction of cable modems. Furthermore, infrared transmissions do not interfere to RF transmission systems (such as the radio reception) and in most cases they operate at ISM (Industrial, Scientific and Medical) licensed bands.

2) Spread spectrum LAN: Spread spectrum technology derives from the transmission method whereby the transmitted signal is spread out among many frequencies, rather than based at only one frequency as the conventional FM and AM transmissions do. This set of frequencies also can be used by multiple devices, simply by hopping to them at different times. There are two transmission schemes for wireless LAN: direct sequence spread spectrum (DSSS) and frequency hopping spread spectrum (FHSS). In FHSS the communicators send narrowband signals on discrete channels. But they do not restrict themselves in one channel. Instead they use a series of channels and they alternate between of channels using the pattern of hopping that is known to both the sender and the receiver. In both DSSS and FHSS the transmitting station uses more than one narrowband channels in order to send information. In DSSS the transmitter sends each bit of the signal in all channels which

means that DSSS provides redundancy (because the transmitter sends each bit to more than one channel).

3) Narrowband Radio LAN: The term of this technique belongs to microwave RF with a relatively narrow bandwidth just enough to host the incoming signal. These LANs operate microwave frequencies but some of these products operate at frequencies that require FCC licensing. It has two-band width they are Licensed Narrowband RF has the advantages is that guarantees interference-free communication and faithful reception of signal. Unlicensed Narrowband RF can be used for narrowband transmission at lower power 0.5 watts or less. In narrowband transmission environments the two host share the same radio frequency. Narrowband channels are quite similar to that used by standard broadcast radio stations.

### C. Ad-Hoc Netting

An ad hoc network is actually a peer to peer network, which means peer without a central server, which usually made temporarily to cover any direct needs. Often, ad hoc networks are comprised of a group of workstations or other wireless devices which communicate directly with each other to exchange information. For example in a company with a group of officials who want to sit a conference anyone with his own laptop in a different conference room. They would be connected to a temporary network only for that meeting. Therefore refer to networks created for a particular reason. There are no access points in order to pass information between participants. Infrastructure networks pass information through a central information hub which can be a hardware device or software on a computer. Office networks, for example, generally use a server to which company workstations connect to receive their information. Ad hoc networks differ, because they do not have to go through a central information hub.

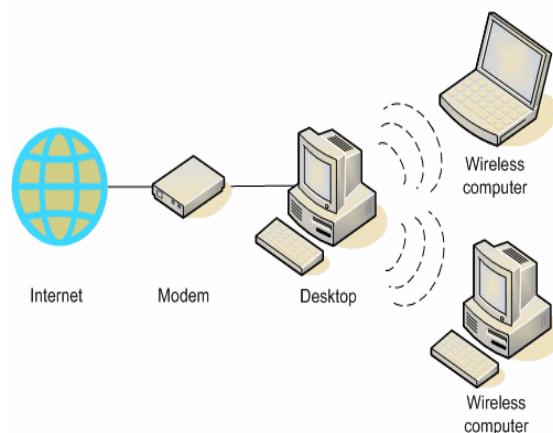


Figure 2. Configuration of an Ad hoc network

### D. APPLICATIONS OF WLAN

The following list describes the multiple/future applications that WLANs can have:

1) They can be very useful in medical domain. Doctors in hospitals having a laptop connected to wireless network will be able to intervene directly in patient [2].

2) Network managers in dynamic environments are able to minimize the overhead of moves, WLANs, which means reducing of total cost for LAN implementation [2].

3) Corporate training sites and students at the universities use wireless connectivity for learning information

4) For some workers who spend extended amounts of time at the same environment, they have to change their minds and make their lives easier by changing quickly the boring environment they used to work.

5) Retail store owners use wireless networks in order to simplify their job's requirements. The wireless point-of-sale device can be easily relocated depending on the place of establishment.

6) Warehouse users use WLANs in order to exchange information with central database and to increase their productivity.

#### E. EVOLUTION OF WLANS

The development of WLANs has become unavoidable, as the wireless communication cannot be left to the levels already reached. The evolution spans the architecture and seamless integration of wire line and wireless services. For example the introduction of real time services such as Voice over WLAN (VoWLAN) and Video over WLAN. This is certainly two very important objectives for the years ahead will monopolize the interest of all telecommunications industry [7]. So the forthcoming WLAN is higher data rates (more than 100 Mbps) and lower power consumption. The following list shows the aspects in which Bluetooth could be evolved:

1) Extending coverage areas and scalability using the multihop/mesh method (self-organizing and self-configuring network)

2) Coexistence of heterogeneous access devices in the same environment

3) Seamless mobility support

4) Indoor location estimation

5) Quality of service assurance including support of real time application

6) Enhanced security features including authentication/authorization and data cipher

#### III. BLUETOOTH

The idea of Bluetooth began in 1994 when Ericsson started a survey to replace the cables by connecting various accessories to mobiles and computers with wireless link. It took its name from the 10<sup>th</sup> century monarch Harald Bluetooth who was managed to unite Norway and Denmark and because the concept had initially started in Scandinavia it made some sense to regard its Viking origins [5]. The Bluetooth is a standard

for wireless communications for small, cheap and low coverage networks. The WPAN technology promises to remove all those components that complicate communication between computers, such as many cables, flanges and many types of communication protocols. With Bluetooth, wireless devices such as mobile phones, tele-informer (pagers), digital cameras and digital assistants (PDAs) become a common communication structure [1]. Bluetooth is a robust, low standard, cheap and safe, suitable for the implementation of wireless computer networks of small coverage. It supports the simultaneous transmission of voice and data, multipoint communication and it is easy to use. The distance range which supports is about 10 meters, but it can be increased by using amplifiers [vi].

#### A. BLUETOOTH TECHNOLOGY (COMPONENTS)

**A system based on the Bluetooth standard, consists of four functional parts [8]:**

1) The **radio transceiver** which is able to transmit and receive voice and data.

2) A **basic unit of area or control channel** (baseband and link control unit), which is able to process the data received and transmitted by radio transceiver.

3) **Software management of the communication channel**, which handles the broadcasts.

#### 4) Application software

The **radio transceiver** is a device with a small coverage and low power consumption requirements, which operates in the frequency of 2.4 GHz ISM. Considered as a virtual reference an antenna, which has the force of transmission of 0 dBm (1 mW), then the coverage is 10 meters. This coverage area can be increased to 100 meters by increasing the power to 20 dBm (100 mW). The maximum data transmission rate is 1 Mbps, but the charges introduced by the communications protocols limit this rate to about 725 kbps [vi].

The **basic unit of area or control channel** is that part of materials that is used to convert incoming radio waves into digital format (bits), to be able to process applications. It transforms digital voice and data in a format suitable for transmission by the antenna. Additionally, the basic area unit is responsible for the transformation of data formats (e.g. conversion of voice from analog to digital form), to compress them, placing them in the outgoing and the export of incoming packets and control errors.

The **software management of the communication channel** is performed in a separate microprocessor and is responsible for managing the communication between devices of Bluetooth. Every Bluetooth computer system has its own channel manager, who is responsible for the identification of other managers of the local network, installation and termination of connections between the stations, the encryption and decryption (if occurring), adapting the data rate dynamically and negotiating communication options between the stations.

The **Application software** consists of all those applications that use the Bluetooth protocol stack which are installed to each of wireless device technology Bluetooth. These applications allow all of a network of Bluetooth devices to perform their work (eg communication, file transfer, etc.).

#### B. BLUETOOTH DEFINING PROTOCOLS

Bluetooth's functionality is based on an architecture protocols consisting of the nuclear protocols, the cable replacement protocol, control protocol telephony and adopted protocols:

The **nuclear protocols** consist of the following components [6],[5]:

**Bluetooth radio** defines the requirements of the transceiver operating in 2.4 GHz ISM band.

**Baseband** deals with the establish connections in a piconet, the addressing, the form of packages and power control.

The **Link Manager Protocol (LMP)** is responsible for link setup and link configurations between Bluetooth devices. It also manages the security responsibilities such as authentication and encryption.

The **Logical Link Control Adaptation Protocol (L2CAP)** which shields the upper layer protocols from the details of the lower layer protocol.

The **Service Discovery Protocol (SDP)** which provides a means for applications to discover which services are available and to determine the characteristics of those available services.

The **cable replacement protocol (RFCOMM)** emulates the serial cable line settings and status of an RS-232 or now EIS-232(is a standard serial port interface) serial port and is used for providing serial data transfer. RFCOMM connects to the lower layers of the Bluetooth protocol stack through the L2CAP layer.

The **Telephony Control Protocol (TCS BIN)** defines the call control signaling for establishment of voice and data calls between Bluetooth devices. In conclusion some of the **Adopted Protocols** are the following:

1) **Point-to-Point Protocol** is responsible for the transportation of the packets through a link from a point to point.

2) The **TCP/UDP/IP (Transmission control protocol/user data protocol/internet protocol)** are the fundamental protocols of IP layer.

3) **OBEX (Object Exchange)** provides similar functionality to HTTP, but in simpler way. It has been exclusively developed for data exchanges.

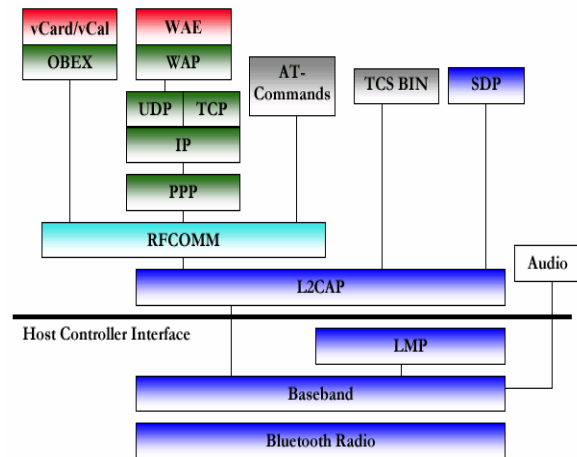


Figure 3. Bluetooth protocol stack

#### C. APPLICATIONS AND EVOLUTION OF BLUETOOTH

Bluetooth is used more and more nowadays, with several applications in our daily lives. It can be applied to [8]:

##### APPLICATIONS:

- 1) Wireless networking between desktop and laptop in a small space where a **minimum** bandwidth is needed.
- 2) Peripherals such as printers, mice and keyboards.
- 3) Transfer files (images, mp3) between mobile phones and PDAs.
- 4) Bluetooth headsets for mobile phones and Smartphone's
- 5) Medical applications
- 6) Some GPS satellites transfer data via Bluetooth networking.

##### EVOLUTION:

There are many reasons to consider Bluetooth for future uses. Bluetooth has widespread adoption which makes it a global phenomenon in business market. There is no limit to what Bluetooth can help the average business with. Low energy Bluetooth is one new idea which is coming to impress all of us. It consumes only a small part of the power of a classic Bluetooth and it has very low standby activity and fast connection setup. It is really impressing to see how this Bluetooth technology can be used. There are some applications below:

**Body machines** (measuring the exercise session i.e. heart rate, duration, speed, distance). They can play significant role in health care (blood pressure monitor, weight scale, heart rate monitor, and thermometer). Also they are useful in diabetic people (these people will be provided some forthcoming machines and they will be

able to check their blood glucose from their mobile phones).

#### D. COMPARING WLAN TO BLUETOOTH/COEXISTENCE BETWEEN THEM

Both technologies have their preferred domain of usage and these areas are more complementary than competitive. WLAN dominates in the area of connectivity and Bluetooth dominates in the Personal Area Networking domain. So co-existence is the most likely scenario in the future. Below is a list which supports the comparison of these two technologies [iv]:

- 1) Bluetooth has lower distance range (10m-efforts to increase it) than WLAN (100m).
- 2) Bluetooth has generally lower speed (1-2Mbps) than WLAN (11-54Mbps).
- 3) Bluetooth components are far cheaper (low cost) than WLAN's.
- 4) Bluetooth is less mature technology but it has huge future.
- 5) Bluetooth has lower power consumption.

#### III. CONCLUSION

In this paper we actually proposed these two technologies by listing as many elements as it could be possible. Wlan and Bluetooth share many common points. They have many advantages and their evolution seems shocking. They have already played significant role in business market as they have attracted the interest of the average consumer. Moreover this evidence has been seriously taken into account from all the huge telecommunication companies, which means, rapid evolutionism in the near future. Thus, the correct utilization of these technologies makes possible that, sooner or later, we will have got rid of the wired communications which make our lives more difficult.

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# WLAN and Bluetooth Technologies for Peer-To-Peer Networks

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**Abstract-** The emergence of wireless networks has changed the way we communicate over the last few years; it is gradually replacing the wired network which requires longer time and high cost to implement. Wireless Local Area Network (WLAN) and Bluetooth are the most widely used form of wireless technology; they both operate in unlicensed 2.4GHz Industrial, Scientific and Medical (ISM) frequency band. WLAN technology is used in public areas where there are no existing infrastructures to connect people to broadband internet access because of its support for mobility and simplicity to deploy while Bluetooth technology falls under the category of Wireless Personal Area Network (WPAN) and its application is usually found on PDA's, Laptop's and Mobile phone's which allows for fast exchange of data and multimedia messages between two devices that are up to 10 meters apart.

This paper presents an architectural overview of IEEE 802.11 standard for WLAN and Bluetooth technology for implementing a mobile peer-to-peer network. A detailed analysis of the Physical layer (PHY) and Medium Access Control (MAC) layer of these technologies are analysed. The paper also reviews the protocol stack, power management and power managed states associated with Bluetooth technology

**Keywords:** WLAN, Peer-to-Peer Network, PHY, MAC, WPAN

## 1. INTRODUCTION

A peer-to-peer network also known as an Ad hoc network is a network which consists of a set of devices communicating with each other without an access point. This type of network is basically implemented on a temporary basis where there is no pre-defined network infrastructure and its applications can be found in military operations (for secure communication), seminars, business conference, video games and even on motion when devices such as laptops and mobile phones are used to quickly exchange data.

The history of peer-to-peer networks dates back to 1972 when it was referred to as Packet Radio Networks (PRNET) and was used in combination with Carrier Sense Medium Access (CSMA) and Area Locations of Hazardous Atmospheres (ALOHA) in military operations. In 1980, it was applied as part of the Survival Adaptive Radio Networks Programs (SURAN) that offered a packet-switched network where there is no pre-defined network infrastructure [2]. With the great success achieved with the early application of mobile ad hoc networks, in the 90's it was rolled out commercially and it was integrated into notebook computers and an IEEE 802.11 standard was adopted.

WLAN an IEEE 802.11 standard and Bluetooth technologies are the most widely used form of wireless technology for implementing a mobile ad hoc network

because of the ease of setup and low cost of implementation.

## 2. WIRELESS LAN

A Wireless Local Area Network is a network that employs the use of radio waves as the medium to enable users communicate and also have access to a core network. Unlike the traditional wired local area network that requires laying of cables and users having to physically connect to an access point in order to gain access to network resources, Wireless LAN allows users to communicate and gain access to network resources without having to be physically connected to an access point. One major advantage of WLAN over the traditional wired network is its support for mobility while in use, faster setup time and lower cost of implementation when compared to the wired network. WLAN application can be categorised into four applications: LAN extension, Cross-building Interconnect, Nomadic Access and Ad hoc networks [3].

WLAN can be implemented in two different modes: Infrastructure mode and Ad hoc mode. The infrastructure mode, as shown in Fig1a, consists of an access point that is usually connected to a backbone wired network to provide access to the internet or other networks. In this mode, mobile stations communicate with each other through the access point. This is referred to as Basic Service Set (BSS), when a station in one Basic Service Set communicate with another station in another Basic Service Set through a distribution system, this kind of infrastructure mode is called Extended Service Set (ESS) [4]. The Extended Service Set seems like an independent BSS to the Logical Link Control (LLC) layer, hence, stations can exchange packets [4]. In Ad hoc mode, as illustrated in fig1b, mobile stations communicate directly with each other without the need for an access point.



Fig1a: Infrastructure mode

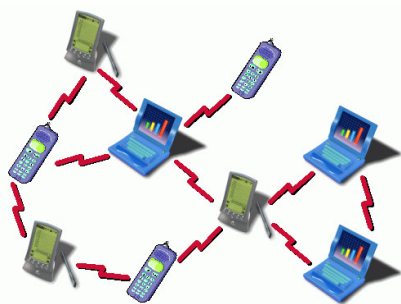


Fig1b: Ad hoc mode

### 3. THE IEEE 802.11 ARCHITECTURE FOR WLAN

The IEEE 802.11 defines the architectural standards for WLAN, this standard specifies two layers: MAC and PHY layers.

#### 3.1 Medium Access Control (MAC) layer

IEEE 802.11 standards specify two types of access schemes for the MAC layer, Distributed Co-ordination function (DCF) and Point Co-ordination function (PCF).

##### 3.1.1 Distributed Co-ordination function

It employs contention access algorithm to grant access to all traffic and it is based on Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) protocol [3]. Collision detection is not achievable in wireless systems due to large dynamic range of signal in the channel, in a DCF access scheme, a station that is intending to transmit checks the channel to see if its idle or if another station is requesting to transmit through the channel [3]. If the channel is idle for an interval of time equal to interframe space (IFS), it transmits the packet. However, if the channel is busy, the station does not transmit and waits until the channel is idle before it transmits. Upon completion of transmission, the interframe space is activated again and if the channel is still idle for the duration of the IFS, it backs off and senses the channels once more and if it is still ideal, the station can transmit [3]. The back off timer reduces as long as the channel is idle, stops when transmission is sensed and resumes again when the channel is ideal [1]. When a collision occurs, a station tends to retransmits over and over again and this increases the traffic on the channel, Binary Exponential Backoff is used to sustain back off constancy when this occurs. This technique doubles the mean value of the random delay when collision occurs.

Three values of IFS are defined for DCF: Short IFS (SIFS), Point Co-ordination Function IFS (PIFS) and Distributed Co-ordination Function IFS (DIFS).

##### 3.1.1(a)

*Short IFS: Shortest amongst the IFS and has the highest priority when compared to other IFS's.*

##### 3.1.1(b)

*Point Co-ordination Function (PIFS):*

A middle length IFS employed by a central controller for issuing polls.

##### 3.1.1(c)

*Distributed Co-ordination Function (DIFS):*

It is used as a medium delay in asynchronous frames competing for access.

However, to ensure a packet transmitted by a Station A has been successfully received by a Station B, the receiving Station B responds with an acknowledgement frame (ACK) indicating the packet has been received successfully. If station B does not respond with an ACK frame, it will be assumed that the packet is lost or corrupted during transmission. When a packet is received in error as a result of error in transmission or collision, the channel must be free for some amount of time before retransmission is resumed. This is as a result of the non-reliance on stations to detect a collision when ever it occurs.

Virtual sensing mechanisms also referred to as Request to Send (RTS) and Clear to Send (CTS) are used to govern transmission. When a station wants to initiate transmission, a short packet known as Request to Send (RTS) is sent to the receiving station informing about an upcoming packet. The receiver responds with a Clear to Send (CTS) packet signifying readiness to accept packet [1].

##### 3.1.2 Point Coordination Function

In PCF, a centralized point coordinator uses PIFS to seize the channel and lock out all asynchronous traffic when polls are issued and response reception [3].

#### 3.2 Physical Layer (PHY)

The IEEE 802.11 defines three physical layer specifications having a data rate of 1 and 2 Mbps. These layers include one infrared and two spread spectrum. The two spread spectrums are Direct Sequence Spread Spectrum (FHSS) and Frequency Hopping Spread Spectrum (FHSS) both operating in unlicensed 2.4GHz ISM band.

### 4. WLAN PEER-TO-PEER NETWORKS

WLAN peer-to-peer network also known as Independent Basic Service Set (IBSS) network consists of a set of stations communicating directly without the need of an access point. An IBSS consists of a unique identification number that is generated initially at setup of the network; this identification number is used to differentiate the network from other peer-to-peer network. In other for a new station to join a peer-to-peer network, a scanning process is initiated in which a station finds control frames on different frequencies. The scanning can be either

active or passive. In passive scanning, the station scans to detect a beacon frame. A beacon consists of IBSSID, data rates that can be supported, IBSS management function and the beacon period used [1]. The active scanning process entails the creation and processing the Probe frames. Synchronization in an ad hoc network is executed through a distributed algorithm that is performed by stations in the IBSS, the algorithm uses nominal rate to transmit beacon frame.

## 5. BLUETOOTH

Bluetooth is an open specification system technology for short-range wireless communication operating in the 2.4 GHz unlicensed band. IEEE 802.15 standard classifies Bluetooth as a Wireless Personal Area Network (WPAN) system. The Bluetooth Special Interest group (SIG) is an organisation which consists of a group of companies that defines the specification for the Bluetooth technology.

Until recently, most form of short-range communication between computing devices involves physical connection between the communicating devices, this physical connection entails using cables and connectors as the medium to transmit data. One of the greatest disadvantages to this approach is the non-support for mobility. However, using Bluetooth technology which supports full mobility between communicating devices, mobile stations can exchange information while mobile up to 10 meters apart.

IEEE 802 standard defines a 48-bit addressing scheme for Bluetooth devices. When a group of eight devices communicate directly with each other using Bluetooth technology to exchange information, this is known as Piconet. In a Piconet, as shown in figure 2, one of the communicating devices assumes the role of the master while others are slaves. The device that assumes the role of the master does not have any unique advantage over other devices in the piconet but only manages the synchronization of the Frequency Hopping Spread Spectrum (FHSS) communication amongst devices. It also makes a decision on which slave to have access to the channel and the frequency hopping pattern based on its Bluetooth device address and the phase for the hopping sequence (based on its clock) [5]. The role of a master between any set of communicating devices in a piconet is based on the station that initiates the transmission. The master-slave relationship is essential in Bluetooth low-level communications but in general devices operates as peers [5]. If a device establishes a point-to-point link with any other device, the master or slave role assumed by each communicating device is insignificant to higher level protocols and users using the devices [5]. In a Piconet, a slave can only transmit only if it receives a polling message from the master.

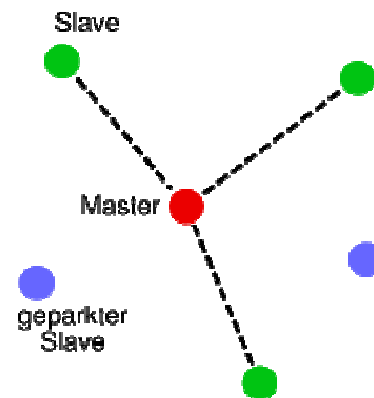


Fig2: Piconet

However, when two or more piconets are linked through a master or slave, a scatternet is formed. In this network, the same principles that applies in a piconet is also applicable in a scatternet. Fig3 shows a scatternet network

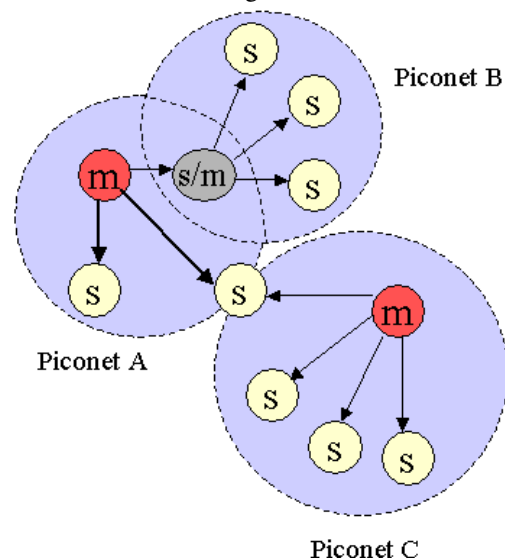


Fig3: Scatternet

## 6 BLUETOOTH PROTOCOL STACK

The main segment of a Bluetooth specification is a protocol stack; this protocol stack allows the location of devices, its connection and exchange of data in order to run smoothly.

### 6.1 Protocol Stack Components

Bluetooth protocol stack consists of three components which are logically partitioned into three groups:

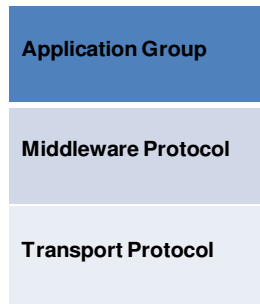


Fig4: Protocol Stack Group

**6.1.1 Transport Protocol Group:** The transport group comprises the protocols that allow devices using Bluetooth technology as a medium to transmit data to find each other in order to configure and manage the physical and logical links. The lists of protocols associated with this group are Baseband, Radio, Link Manager, Logical Link and Adaptation and Host Controller Interface.

**6.1.2 Middleware Protocol Group:** Protocols developed by the special interest group (SIG) distinctively for Bluetooth technology are contained in this group. Also, this protocol group also contains additional transport protocol required by existing and new application in order to function over Bluetooth links [5].

**6.1.3 Application Group:** The applications that make use of Bluetooth technology as a medium to communicate are contained in this group.

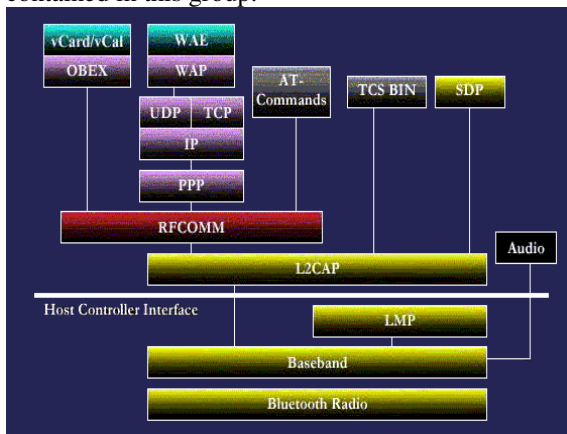


Fig5: Protocol Stack architecture

## 7. BLUETOOTH PROTOCOL STACK COMPONENTS

### 7.1 Bluetooth Radio

The Bluetooth radio specification defines 79 different channels in the 2.4GHz unlicensed band with 1 MHz carrier spacing. Transmitter output powers are based on three classes which are Class 1, Class 2 and Class 3 [3].

**7.1.1 Class 1:** Transmitters in this class have the longest range of transmission with a maximum output power of 100mW and 1mW for minimum range. Power management is compulsory between 4 to 20dBm.

**7.1.2 Class 2:** Transmitters in this class have a maximum output of 2.4mW and 0.25mW as minimum output. Power management in this class is optional.

**7.1.3 Class 3:** Transmitters in this class have the least output power which is typically 1mW.

The type of modulation used by Bluetooth is GFSK (Gaussian Frequency Shift Keying). The modulation modes for Bluetooth are classified into two modes, Basic Rate and Enhanced rate [6]. The Basic Rate mode is mandatory and uses a shaped, binary FM modulation to minimize transceiver complexity [6]. However, the enhanced data rate is optional and employs PSK modulation with two variants:  $\pi/4$ -DQPSK and 8DPSK. Time Division Duplex (TDD) scheme is used for transmission.

### 7.2 Bluetooth Baseband

The Bluetooth Baseband protocol layer defines the procedures for the initiation of connections between the master and slaves. This initiation can take the form of a device scanning the channel for other available devices in order to establish a connection for the purpose of transmitting or exchanging data. The master and slaves roles assumed by devices in a piconet and scatternet are defined in this layer. Frequency hopping schemes used by devices to transmit and receive data serves two purposes: resistance to interference and multipath effects. The baseband layer also states the regulations for dividing the air-interface between various devices using Time Division Duplex (TDD).

### 7.3 Link Manager Protocol

LMP controls and negotiates different aspects of the Bluetooth radio link connection by allowing the exchange of LMP PDU packets amongst communicating devices. Different security mechanisms for handling authentication, key distribution and encryption are implemented in the LMP.

### 7.4 Host Controller Interface

HCI provides a common standard interface to the baseband controller and link manager which enables upper layer of the Bluetooth protocol stack such as application layer to access Bluetooth hardware capabilities.

### 7.5 Logical Link Control Adaptation Protocol

The L2CAP layer enables several protocols to share air-interface by through multiplexing. Large packets used by higher layers are segmented and reassembled before and after transmission. Quality of services parameters are also defined in the L2CAP layer.

## 8. BLUETOOTH PEER-TO-PEER NETWORKS

Bluetooth technology provides one of the most basic ways of implementing a peer-to-peer network; its application can be found in most digital devices. Before

initiating a transmission in a Bluetooth ad hoc network, a Bluetooth device checks if there is any other Bluetooth device operating in its operating space. This is achieved by going into an inquiry state where it sends packets with an access code over the channel. This packet can be a Dedicated Inquiry Access Code (DIAC) meant for only a set of devices that belong to a certain group or a General Inquiry Packet (GIAC) that is not restricted to a specific group. Frequency hopping sequence of 32 frequencies obtained from GIAC is used in the inquiry state during transmission, the 32 frequencies are divided into two equal half's of 16 trains each [1]. In other for a device to respond to an inquiry message, the device's receiver must be in the same frequency as that of the device transmitting the inquiry packets. The response packet from the receiver to the transmitting device contains a special control packet (FHS packet) that includes the receivers address and native clock. The essence of the inquiry packet is to enable Bluetooth devices to know other Bluetooth device's address and clocks before initiating a transmission. The device that initiates transmission takes the role of a master while other participating devices in the network takes the role of slaves.

## 8. BLUETOOTH POWER MANAGEMENT

Most Bluetooth applications are found on portable devices such as laptops, Head phones, mobile phones etc. As a result of this, power management is essential and this can be achieved in three optional power modes: Hold, Sniff and Park modes.

### 8.1 Hold Mode

In this mode, an installmental time interval known as hold time is used by ACL to communicate with slaves. A master uses an LMP\_HOLD packet to force a slave into hold mode.

### 8.2 Parked Mode

In this mode, a slave disengages its self from the piconet but still keeps time synchronization with the piconet. The time synchronization enables the slave to rejoin the piconet rapidly without having to start the initiation process of joining the piconet again.

### 8.3 Sniff Mode

A slave listens at the beginning of each even-numbered to check if the master will transmit to it. When in sniff mode, this requirement is relaxed for ACL links allowing the master to transmit at a reduced rate to the slave.

## 9. CONCLUSION

This paper revealed the architectural overview of WLAN and Bluetooth technology for peer-to-peer network, from the above discussion; it is evident that the performance of these two technologies is based on their protocol stack. The power management incorporated into Bluetooth also makes it suitable for use on battery powered devices.

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# Bluetooth Today and Tomorrow

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**Abstract** - The topic of interest is the Bluetooth technology. The reader will understand and appreciate Bluetooth. This is an ever developing technology as far as applications are concerned. This technology is forecasted as going to eliminate cables for portable and fixed devices. Because it is a standard, a wide range of Bluetooth devices are made to communicate with each other.

This research paper is focused on a detailed explanation of this technology. It looks at the history of Bluetooth, and then looks at the core architecture, security, the specifications and standards that govern it. Bluetooth is then compared with other similar wireless technologies, like Wi-Fi and infrared, outlining the advantages and disadvantages of each technology.

The paper then goes on to look at the wide range of Bluetooth devices and applications that already exist in the market, showing which devices and applications are best suited for Bluetooth. Bluetooth research is ongoing and the paper captures this by outlining possible devices that will use Bluetooth in the future. The paper will conclude by giving the reader an idea of the kind of impact that Bluetooth has now, and the kind of impact it will have in the future.

**Keywords:** Application, devices, architecture, security, technologies

## I. INTRODUCTION

Bluetooth Special Interest group (SIG) is a non profit association. This association does not sell or produce Bluetooth devices; it is responsible for publishing Bluetooth specifications and protecting the trademark. The association is made up of technology leaders in different fields like telecommunications, computing, music and others. It is the association members that produces and market the Bluetooth devices [1].

The word Bluetooth was originally used as a code for association members and the name never changed. The name comes from a 10<sup>th</sup> century king called Harold Blatand or in English Harold Bluetooth. King Harold was known for uniting soldiers from different regions of from what is now known as Norway, Denmark and Sweden. Because Bluetooth was also aimed at uniting different industries the founders saw fit to use that name. It started with five founding members which are Ericsson, Nokia, IBM, Intel and Toshiba in 1998 and by the end of that year had over 400 members in its association. Now Bluetooth SIG has over 9,000 members [1].

Bluetooth is a special wireless standard because it uses low power as compared to other wireless standards such as IEEE 802.11b or Wi-Fi. Bluetooth falls under the 802.15.1 standards which are defined by IEEE as WPAN (Wireless Personal Area Network). This because it transmits over a short distance and is especially designed to eliminate cables for fixed and short range transmissions, so in theory any two devices that

communicate via cables will and can be turned wireless through the use of Bluetooth. Bluetooth is becoming very popular because it is cheaper to incorporate as compared to its rival standards and so it can be easily put on consumer goods without making the goods to expensive [1][2].

## Aims and Objectives

- To give a clear understanding of Bluetooth
- To compare Bluetooth with other wireless rival standards
- To outline the core architecture of Bluetooth
- To outline the kind of security Bluetooth has to offer
- To outline the specifications of the Bluetooth standard
- To outline the kind of devices which should use Bluetooth and those that should not
- Discuss Bluetooth devices now and in the future

## II. LITERATURE REVIEW

Looking at other wireless standards that compete with Bluetooth and how they differ from it. The literature also highlights the use, data rate and ranges of the other standards and how those compare to Bluetooth. Table 1 below summarise the technical specifications of each technology.

### A. Zigbee

This is an IEEE 802.15.4 wireless standard. ZigBee is designed to provide highly efficient connectivity between devices transmitting small packet, for example key fobs, keypads and barcode readers (see figure 1 below). (These packets are small than those transmitted by Bluetooth). Because of small packet transmission zigbee devices need less power to sustain them. This is why zigbee products are relatively cheaper as compared to other wireless standards. The name Zigbee is adopted from the pattern bees make and was compared to a web of wireless connections which the standard can make [3].



Figure 1: Zigbee Barcode Reader [4]

### B. Wi-Fi

This is an IEEE 802.11a/b/g standard for high speed wireless local area networking. These use access points for Wi-Fi enabled devices (i.e. laptops, PDAs) to connect to when they are within range. Wi-Fi is normally located in hot spot areas like stations hotels and airports. This wireless technology allows users to access the internet; it provides higher data rate and transmission range compared to Bluetooth. [5]

### C. Ultra Wide Band

This is a short range wireless transmission scheme which utilises extremely low energy, normally less than 1mW. It operates over a wide range of the frequency spectrum so it has a higher bandwidth as compared to a lot of standards. Because it operates at very low power it causes very little interference to other wireless technologies and so can operate with them. The figure 2 below gives a clear understanding of UWB and its relationship with other technologies. This standard has the same transmission ranges a Bluetooth but higher data rate. Just like Bluetooth this technology can be incorporated into consumer devices like mobile phones.

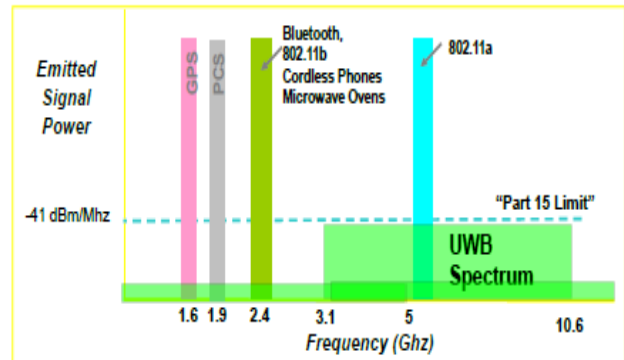


Figure 2: Ultra Wide Band Power and Bandwidth

### D. Infra Red

This is a specification class IRDA (infra red data association). This is a point to point short range wireless connection. This works on line of sight only as IR cannot penetrate solid objects. Infra red has an operating range less than that of Bluetooth and has a higher transmission speed compared to Bluetooth. Infrared is used on sensors and remote control devices. [1]

### E. Technical Comparison of Technologies

Looking at table 1 below it can be seen that each technology has advantages over the others in one or two fields. But in this case it is particularly important to note Cost and Power consumption. These are the two areas that keep Bluetooth competing with the other standards. Zigbee and infrared which generally cost less than Bluetooth can be ruled out because zigbee has lower data rate while infrared needs line of sight and has a low transmission range. Wi-Fi which has higher data rate and better transmission range compared to Bluetooth but on the downside this technology consumes more power as well as costing more compared to Bluetooth. The best idea to pick up from comparing these technologies with Bluetooth is to realise that each has applications that best suit it.

TABLE 1: TECHNICAL COMPARISON OF TECHNOLOGIES

|            |       | Zigbee | Bluetooth | 802.11b        | 802.11g        | 802.11a        | UWB        | Infrared |
|------------|-------|--------|-----------|----------------|----------------|----------------|------------|----------|
| Throughput | Mbps  | 0.03   | 1-3       | 11             | 54             | 54             | 200        | 16       |
| Max range  | Feet  | 75     | 30        | 200            | 200            | 150            | 30         | 3        |
| Power      | mW    | 30     | 100       | 750            | 1000           | 1500           | 400        | 30       |
| Bandwidth  | MHz   | 0.6    | 1         | 22             | 20             | 20             | 500        | 4        |
| Cost       | US-\$ | \$2    | \$3       | \$5            | \$9            | \$12           | \$7        | \$2      |
| Modulation |       | QPSK   | GFSK      | DBPSK<br>DQPSK | DBPSK<br>DQPSK | DBPSK<br>DQPSK | PPM<br>BPM | PPM      |

### III. BLUETOOTH PROTOCOL

Bluetooth works in such a way that it allows devices from different manufacturers to communicate. Bluetooth defines both the radio system and software stack to enable devices to find other devices within range [8].

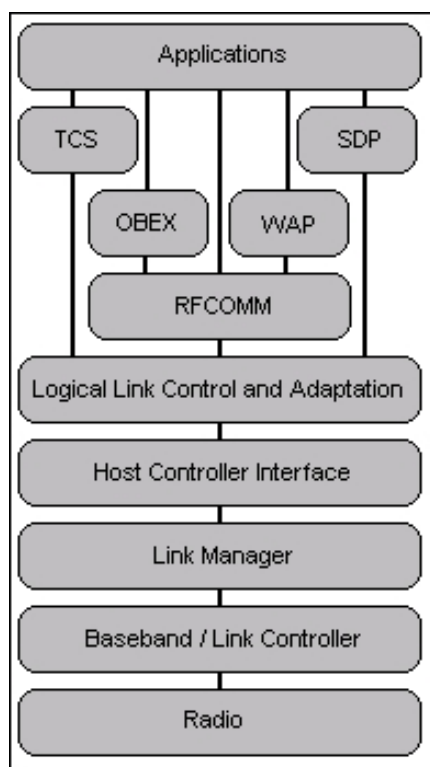


Figure 3: Bluetooth Protocol Stack [7]

Guidelines given by Bluetooth profiles define how application layer functions and should use the protocol stack. It is important to note that the Bluetooth protocol stack can be compared with the Open System Interconnect (OSI) reference model. Even though they are similar a few functions are added to make Bluetooth the unique standard it is [8].

**1. Application layer:** this is responsible for managing communication between user applications. This layer directly matches the application layer on OSI model. [8]

**2. TCS (Telephony Control Protocol Specification):** Provides telephony services, defines call control signalling for setting up speech and data calls between Bluetooth devices. [7][8]

**3. OBEX (Object Exchange Protocol):** this is a specification for data exchange over infrared links. Bluetooth uses this specification to allow applications to function over both short range RF and IR and applications can choose either [7][8].

**4. WAP (Wireless Application Protocol):** Specifies requirements for interoperability for Bluetooth as a WAP user [7] [8].

**5. SDP (Service Discovery Protocol):** Lets Bluetooth devices see services that other Bluetooth devices have and support [7] [8].

**6. RFCOMM:** It defines a transport protocol that provides an RS232 like serial interface. The combination of L2CAP (Logical Link Control and Adaptation Protocol) and lower ends of RFCOMM/SDP provide management and data flow control just like the session layer in the OSI model [7] [8].

**7. Logical Link Control and Adaptation Protocol (L2CAP):** provides connection orientated and connectionless data services. Multiplexes data from higher layers and changes between different packets [7] [8].

**8. Host Controller Interface (HCI):** defines specifications for controlling and managing link manager and baseband. This layer also communicates separate hosts and Bluetooth modules. This provides actual data transportation. Together with the Link manager, HCI perform the same task as the transport layer in the OSI model [7] [8].

**9. Link Manager (LM):** Controls and configures links to other devices [7] [8].

**10. Baseband and link controller:** they control the physical link through the radio waves, by assembling packets and managing frequency hops. The upper part of baseband and the lower part of link controller have similar operation as the data link layer, which is responsible for transmitting, framing and error control over a certain link. If you put the link controller with the lower parts of the Link manager you get a layer that is similar to the network layer which is responsible for data transfer across the network [7] [8].

**11. Radio:** Modulates and demodulates data during transmission and reception. This layer together with lower part of baseband act as the physical layer of the OSI model which is the actual medium that data gets transmitted on, i.e. radio links, cables etc, [7][8].

#### IV. BLUETOOTH OPERATION

##### A. Frequency usage

Bluetooth is made to operate at 2.4 GHz ISM (Industrial, Scientific and Medical) band. This is a frequency band that does not require a licence. Because of this there is high competition on this band which means that Bluetooth has to have means to share the channel without being interfered. Bluetooth uses Gaussian Frequency Shift Keying (GFSK) as its modulation scheme. It uses Frequency Hopping Spread Spectrum (FHSS) transmission technology as means of jumping between channels in the band looking for a free channel; this is a good way of avoiding interference with

other standards that share the band like Wi-Fi (the Wi-Fi uses a 22 MHz wide channel; this allows for 11 overlapping channels and 3 non-overlapping channels in the 83 MHz wide band using DSSS). The 2.4 GHz ISM band is 83 MHz wide and Bluetooth uses 1 MHz channels to divide the band, which gives a total of 79 channels that can be used including guard bands in-between the channels to avoid interference, figure 4 below illustrates the channels and band usage [9].

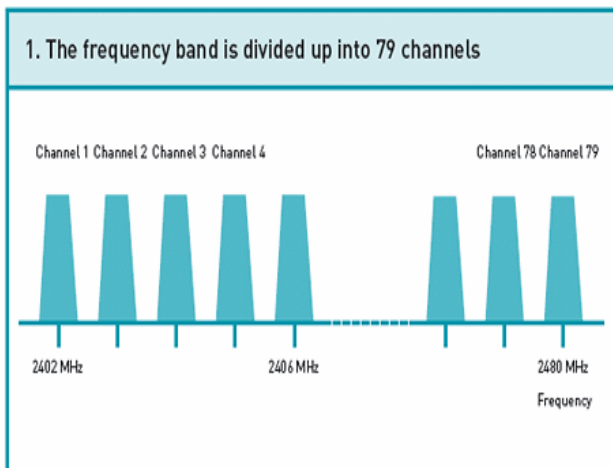


Figure 4: Division of 2.4 Frequency Band to 79 Channels [10]

### B. Piconets and Scatternets

Bluetooth devices can operate in two modes, as a master and as a slave. The master is the device that sets up the frequency hop sequence and the slaves are the devices that follow the master's hop by synchronising to it both in time and frequency. Each Bluetooth device has an address and a Bluetooth clock. When a slave wants to connect to the master, an algorithm tells it the master address and clock, this information is then used to calculate the hop sequence. A Bluetooth master can have more up to 7 slaves [8].

A master also controls when slaves can transmit by allocating them with slots for voice and data traffic. In data traffic, slaves are only allowed to transmit the data if replying to a transmission made to them by the master. In voice traffic slaves can transmit regularly in the reserved time slots, they don't need to be replying the master. The master controls bandwidth to each slave and how often communication with each slave will be made. It divides the time slots (TDM) based on amount of data being transferred [8].

**1. Piconet:** One or more slaves having a common master. All devices on the Piconet follow the frequency hop and timing of the master. See figures below for further illustration.

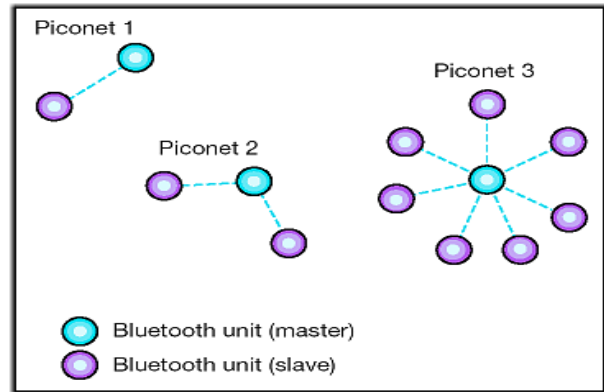


Figure 5: Bluetooth Piconets [11]

**2. Scatternet:** If a device belongs to more than one Piconet then the whole system turns to a Scatternet, which is a collection of two or more piconets. A device can be a slave in two piconets or it can be a slave in one and a master in another, see figure 6 below for pictorial clarity. It is impossible to have a master in two piconets. It is important to note that the more piconets there are in an area the more chances of Bluetooth to Bluetooth interference, where some packets may be lost if a collision occurs on the same frequency.

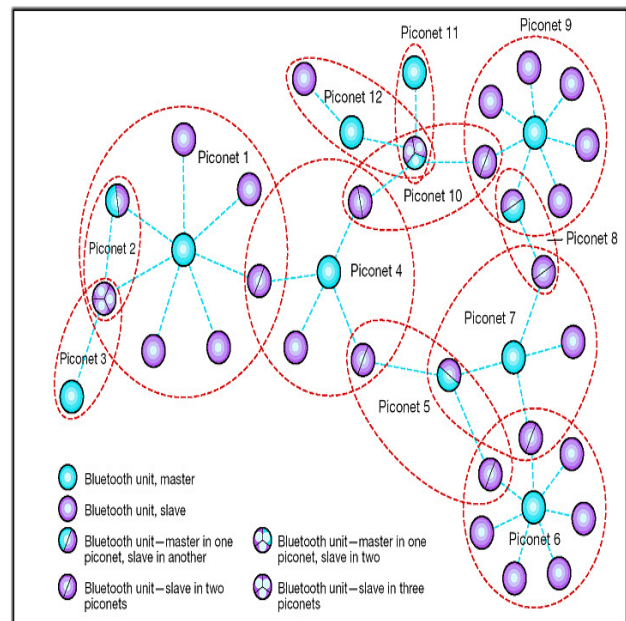


Figure 6: Bluetooth Scatternet [11]

Table 2 shows that the more power a device has the more transmit range it can have. But most of Bluetooth devices are handheld portable devices which cannot have oversized power supplies. That is why the standard range for Bluetooth is 10m. Because microwaves are easily absorbed by things like walls and furniture one should realise that transmitting through a medium might reduce the transmit distance.

### Power classes

| Class | Power  | Range |
|-------|--------|-------|
| 1     | 100 mW | 100m  |
| 2     | 2.5 mW | 20m   |
| 3     | 1 mW   | 10m   |

TABLE 2: POWER CLASSES [12]

## V. BLUETOOTH SECURITY

A cabled environment is inherently secure because you only give connection to only those you want to connect to your network or device. With wireless connections there is a problem that anyone in range of your network or device can listen in or connect. Because of this problem security is a very big issue in wireless transmissions.

Bluetooth uses high speed pseudo-random frequency hopping algorithms to make it difficult for unwanted people to listen in to a connection being made. The use of 79 hopping channels by themselves provides a good level of security. The hop makes it difficult for listeners to know which channels to listen to. But relying on hops alone is not very secure so Bluetooth uses encryption and authentication to set up a connection between devices by using a strong cipher algorithm called SAFER+ which generates 128 bit cipher keys from a 128 bit plain text input [13].

The procedure of encryption needs these inputs:

- Data being passed between devices
- The master device address
- Master device clock
- Secret key to be shared by sending devices (key used to encrypt)

\*The HCI provides authentication and encryption to a connection [13]

## VI. DISCOVERING BLUETOOTH DEVICES

There are a lot of Bluetooth devices out there and any device requiring a particular service will have to find out which devices in range can offer that service. For example if a cell phone wants to connect to hands free device it will have to find out which devices out there have that capability.

*Procedure:*

- Perform an enquiry to look for devices in range. The device transmits a few inquiry packets. (device on figure 7 has performed an enquiry and found speakers)
- Devices within range will reply with a frequency hop synchronisation (FHS) packet which contains all the needed information to create a connection. It also contains the device class.

- The cell phone will have a list of devices within range and their class. Now depending on the manufacturer the cell phone could wait for the user to choose the wanted devices or a device could be chosen automatically based on its class [14].

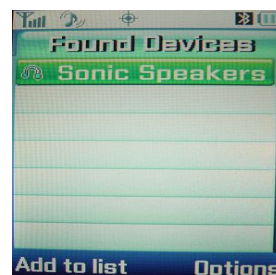


Figure 7: Device Discovery [15]

## VII. BLUETOOTH DEVELOPMENT

Version 1.0 was the first Bluetooth and because it was still new it had a lot of problems, this was in 1998. It was device specific and did not allow interoperability between different Bluetooth devices; it was slow and faced a lot of interference problems. Then we saw version 1.1 which solved most of the problems experienced before; support for non-encrypted channels and received signal strength indicators were introduced as well by this version. Version 1.2 was next; it improved connection and neighbour discovery and transmission speed. The other major improvement that came with this version is the introduction of FHSS that tackled the problem of interference Bluetooth faced. Next came version 2.0, which introduced EDR (Enhanced Data Rate) which improved data transfer from 721 kbps to 2 Mbps. This version also simplified multiple simultaneous connections as well as improving power consumption. The 2.1 version which followed after added more functionality to Bluetooth such as reducing power consumption when device in sniff mode and improving encryption procedures. All these versions are backward compatible [16].

\*In the future we can expect to see Bluetooth version 3.0, which is aimed at increasing data rate by adopting the UWB technology. By transmitting over a wide band Bluetooth will be able to have data rate as high as 400 Mbps.

### *Bluetooth devices*

A device is suitable for Bluetooth technology if:

- Transmits over short distance
- Has limited power supply
- It is not interference sensitive (can cope with retransmissions)
- It needs cheap means of transmitting medium data rate

### Future of Bluetooth

Bluetooth security is constantly improving and we can most definitely expect its data rate to improve as well. If these were to go happen than the only restriction that Bluetooth will have is transmission range. Even that is not a problem because Bluetooth was never meant for long distance transmissions. So we can expect to see any two devices communicating within a short range, whether it's a fixed devices or mobile device to use Bluetooth. If you use your imagination it is clear to see that this is almost all your devices at home or office that can be fitted with a processor, transmitter and receiver.



Figure 8: Smart Home Idea [17]

The above figure shows an idea which is already happening where the whole house can be controlled by one single device wirelessly. This idea can be adopted by Bluetooth in the future. Since Bluetooth also connects devices without wires, all the devices in the house will be connected wirelessly, i.e. you home theatre system can be connected to the television wirelessly via Bluetooth, the surveillance cameras will also connect wirelessly and there will be no need for the long unpleasant cables that run around the house.

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# Ray-tracing Technique for Propagation Prediction for Indoor Wireless Communication

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**Abstract**-Propagation of radio waves can be either in indoor environment or outdoor environment. The mechanism of radio waves propagation depends upon three physical phenomena: reflection, refraction and diffraction. Indoor wireless communication such as wireless local area networks and personal communications (PCs) are developing rapidly. The need for a typical way to evaluate radio propagation in buildings is increasing. However, transmitted signal reach the receiver through more than one path with different times, due to its reflection and diffraction across balks, so the signal will contain from multi signals which differ from each other in magnitude and phase, that leads to a phenomenon known as multipath fading. Ray-tracing technique used to predict the radio propagation in the (UHF) band in an indoor environment to find out the efficient formula for transmitters and receivers which is more suitable for indoor communication channels, as well as reducing the multipath fading which is sometimes leads to path loss. In this research two-dimensional (2D) and three dimensional (3D) ray-tracing methods used to compute the path loss to any point in the building, furthermore patched-wall model is used to improve the accuracy of prediction in the method. Finally, comparison between simulation and measurement shows a good agreement.

**Keywords:** indoor wireless communications, ray-tracing, 2D model;3D model.

## I. INTRODUCTION

In the last few years wireless communication has a great revolution, in terms of personal communication services (PCS) and its fast spreading, An indoor wireless communications one of its successful implementations. However, transmission of voice and data inside buildings depends upon their layout, thus Indoor radio propagation is not influenced by weather conditions like rain, snow or clouds as outdoor propagation, that is why doors, windows, walls and furniture are taken to account. It is very significant to understand that there are more than one ray from the transmitter to the receiver which is resulting a multi-path fading. Figure (1) illustrates how the transmitted signal reach its destination in indoor environment including direct, reflected and diffracted rays. To predict radio propagation inside buildings such as supermarkets, houses, shopping malls or offices, a ray-tracing techniques has been used, rays are traced in both 2D and 3D models with less computation time [1].

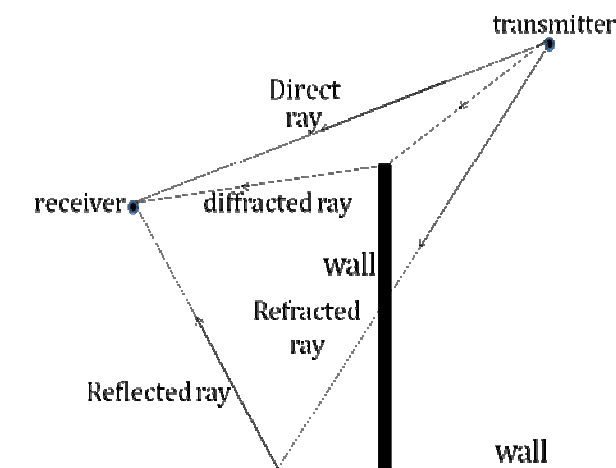


Fig.1.Four main types of rays in indoor environment.

## II. PROPAGATION IN FREE SPACE.

Waves can be transmitted from transmitters to receivers by several ways, the simple aspect is a propagation in free space. In vacuum waves travel by the speed of light which is equal ( $3 \times 10^8$  m/s), this propagation known as a direct propagation or line of sight (LOS). Surface-waves is the second aspect of wave propagation, in this kind of propagation three different waves can reach the receiver, direct wave, reflected wave and parallel wave from the ground surface. The third kind of propagation happen according to troposphere and ionosphere layers. troposphere layer covers the earth from its surface and extend until (16km) height, and the ionosphere spread from (60km to 600km) from the ground, both play a significant role in radio propagation, and they are models with changeable attributes with time and abscissas. Refraction in those layers decrease steadily with the steady increase in height away from the earth surface

## III. INDOOR RADIO PROPAGATION

The important need of studying the indoor radio propagation comes with the rapid development in (PCS). In fact there are several differences between indoor and outdoor radio channels, indoor radio channel covers a small distance comparing with outdoor channel, moreover there are huge mutations in transmission medium which is happened with a small change in distance between the transmitter and the receiver in indoor radio channel without ignoring propagation mechanisms (Reflection, Diffraction and Refraction). Indoor radio propagation channel has some characteristics:

- It has a multipath dispersion because of the large number of barks[2].
- There is not fast movement inside buildings, so Doppler shifting can be ignored[2].
- Indoor radio channel is not stable with time in free space, because people are walking around receiver antenna[6].

#### IV . OUTDOOR RADIO PROPAGATION

The propagation between transmitters and receivers of radio waves in outdoor environment happened in various medium, such as streets, roads and so on. Generally signal goes in direct line between transmitter and receiver unless it cavils by balk as mountain or building. Briefly there are some outdoor propagation channel characteristics:

- It has a multipath dispersion[10].
- It is stable with time in free space[6].
- Doppler phenomenon is taken to account due to the fast movement of objects[6].

#### V . PROPAGATION MECHANISMS FOR RADIO CHANNELS.

There are several propagation phenomena affecting the radio channel in direct way, which is going to make the arrival signal to the receiver comes via different paths. Those physical phenomena are:

1) *reflection and refraction*: The result of falling a radio wave on surface is reflected and refracted rays. In the reflected ray the angle of incidence equal the angle of reflection as shown in figure2.

$$\theta_i = \theta_r \quad (1)$$

While in refracted ray, the rate between the sinusoidal of an incident angle and the sinusoidal of the refracted angle is constant as shown in the equation below.

$$N_1 \sin \theta_i = N_2 \sin \theta_t \quad (2)$$

where

$\theta_i$  = incident angle.  
 $\theta_r$  = reflected angle.  
 $\theta_t$  = refracted angle.

$N_1$  is a refraction coefficient of the first medium.

$N_2$  is a refraction coefficient of the second medium. That shown in figure2 as well.

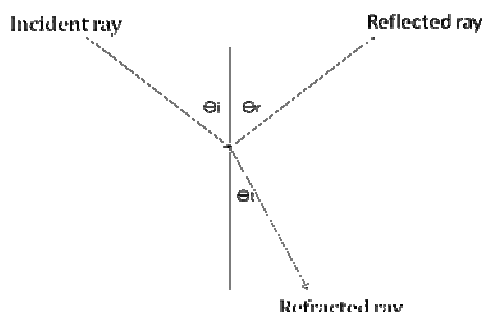


Fig.2. General situation of reflection and refraction rays.

2) *diffraction*: diffraction means bending an incident waves around small barks and the spreading waves past small opening[3].

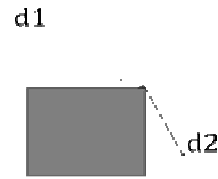


Fig.3. General situation of diffraction.

3) *Absorption*: physically, it is a process in which incident radiated energy is retained without reflection or transmission on passing through a medium[4].

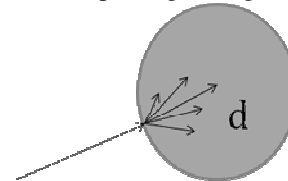


Fig.4. General situation of absorption.

4) *Scattering*: is a general physical phenomenon where some forms of radiation are forced to diverge from a straight trajectory by one or more localized non-uniformities in the medium through which they pass[5].

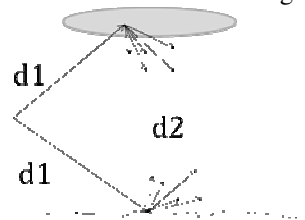


Fig.5. General situation of scattering.

#### VI. MULTIPATH FADING

Transmitted signal reach the receiver via multipath resulting of its reflection, refraction, diffraction from barks. So received signal is the sum of many signals differ from each other in phase, amplitude and arrival time producing fading[9]. In fact there are different distributions of fading, in this research those distributions presented in brief way, and they are:

1) *Rayleigh distribution*: this kind of distribution found when the direct path(LOS) is not exist, thus the received signal found as the sum of the multipath signal components with non-LOS(NLOS).

2) *Rician distribution*: line of sight(LOS) is exist in this kind of fade distribution.

3) *Lognormal distribution*: this type of fading found to demonstrate the big changeable in signal amplitudes and wideband rate in multipath environment[6].

Generally there are two types of fading, fast fading (short-term fading) or slow fading (long-term fading).

##### A. Fast fading

- The fade become very strong in points that the distance between them are nearly  $(\lambda/2)$ .
- Short-term fading happen due to the high speed of bodies.

- Fast fading follow Rayleigh distribution.
- Fast fading causes Doppler shifting and time delay in multi-ray channel[7].
- where  $f_d(\alpha) = (v/\lambda) \cdot \cos \alpha$  (3)

$f_d$  = Doppler frequency.  
 $v$  = the receiver velocity.  
 $\lambda$  = wavelength of the transmitted signal.  
 $\alpha$  = the angle between the arrival multipath signal and the motion of the receiver.

#### B. Slow fading

- Can be caused by many events such as shadowing[7].
- Slow fading increase in urban areas where large buildings and fast movement are found, whereas it decrease in rural and suburb areas, therefore the strength of the received signal depends upon the geographic area.
- Lognormal distribution can be used to model the amplitude change which is happened due to shadowing.

#### C. Delay spread

- Define as the different in time between the first arrival of the signal component to the receiver (usually LOS) and the last strong one from other path.
- Delay spread varies according to the geographic area, it is about (0.2  $\mu$ s) in open areas and around (0.5  $\mu$ s) in suburbs, while it is equal (3.5  $\mu$ s) in urban areas.
- Delay spread causes a signal attenuation, that is why it is classified as a type of distortion.

#### D. Coherence bandwidth

Coherence bandwidth is inversely proportional to the time delay as we can see in the equation given below.

$$B_c = 1/2\Delta\tau$$

where,

$B_c$  = coherence bandwidth.

$\Delta\tau$  = time delay[8].

Coherence bandwidth varies between 30KHz in cities to 1MHz in suburbs[8].

#### E. Interference

According to superposition theorem rays with different amplitudes and phases are added vectorially.

- Interference occurs when two or more waves come from the same source or they have the same frequency.

- Any sinusoidal signal can be presented exponentially (in complex numbers).  
 $\text{Exp}(j\omega t) = \cos(\omega t) + j \sin(\omega t)$  (5)
- A brief explanation is shown below to make it more obvious about what I mentioned before, where the figures show how the incoming rays in different time and phases are added vectorially in a phase plane.

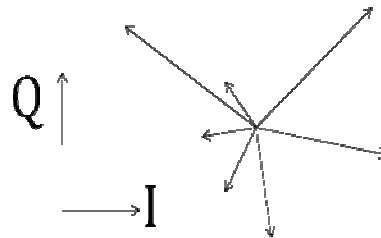


Fig.6. Arrival rays with various amplitudes & phases[7].

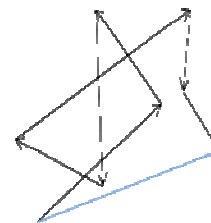


Fig.7. Rays are added vectorially to produce the resultant[7].

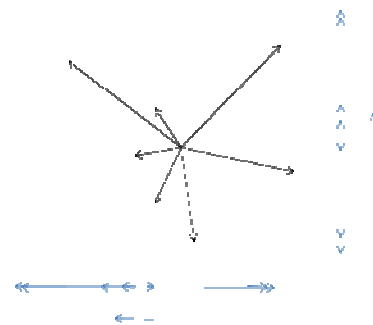


Fig.8. Rays resolved into their in-phase(I) & quadrature(Q) components[7].

#### F. Constructive & destructive interference

If the phase differences between any two waves is  $(n\pi)$ , where  $(n)$  is an even number ( $n=0, 2, 4, \dots$  etc), that means the interference is constructive as we can see in the figure below.

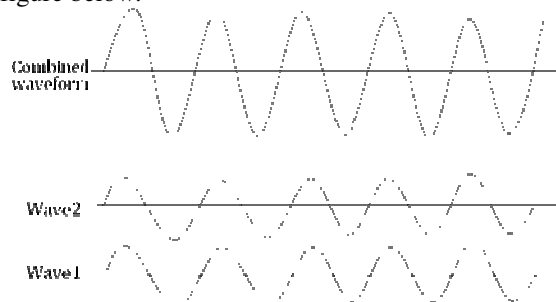


Fig.9. Wave1 & wave2 are in phase.

Consider  $\text{wave1} = A \exp[j\omega t_1]$  (6)

where  $t_1 = T$

and  $\omega = 2\pi f = 2\pi/T$ .

$\text{wave2} = A \exp[j\omega t_2]$  (7)

where  $t_2 = 2T$ .

in constructive interference wave1 and wave2 are added together

$\text{Wave1} = A \exp[j2\pi f t_1] = A \cos(2\pi) + j \sin(2\pi)$  (8)

$\text{Wave2} = A \exp[j2\pi f t_2] = A \cos(4\pi) + j \sin(4\pi)$  (9)

$\text{Wave1} + \text{Wave2} = A + A = 2A$  (10)

On the other hand if the phase differences between any two waves is  $(n\pi)$ , where  $(n)$  is an odd number ( $n=1, 3, 5, \dots$  etc), that means the interference is destructive and that shown in the below in figure 10.

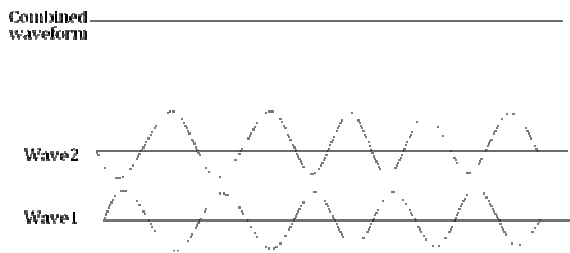


Fig.10. Wave1 & wave2 are  $180^\circ$  out of phase.

Consider  $t_1 = T/2$  and  $t_2 = T$

so,  $\text{wave1} = A \exp[j2\pi f t_1] = A \cos(\pi) + j \sin(\pi)$

(11)  $\text{Wave2} = A \exp[j2\pi f t_2] = A \cos(2\pi) + j \sin(2\pi)$

(12)  $\text{Wave1} + \text{Wave2} = A - A = \text{zero}$

(13)

#### G. Path loss

- Path loss known as path attenuation.
- It is a reduction in power density of radio waves as it propagate in free space [10].
- Path loss means obtain a weak received signal, but in the worst case this signal disappeared.
- Path loss is caused due to many reasons, such as:
  - ❖ Free space loss which is equal:  $(4\pi R/\lambda)^2$  (14) where  $(R)$  is the path distance in meter and  $(\lambda)$  is the wavelength.
- Free space loss it is expressed in (dB) by this equation:
 
$$\text{FSL} = 20 \log f - 20 \log R - 27.56 \quad [10]$$
 (15)
  - ❖ Reflection, refraction, diffraction, scattering and absorption.
- There are several factors influence the path loss for instance:
  - ❖ Environment (urban, rural, suburban, industrial, .....etc).
  - ❖ The medium where the waves should propagate (dry or humid air).
  - ❖ Character and density of buildings.
  - ❖ Antennas locations and heights.

❖ The distance between transmitter and receiver [7].

#### H. Doppler shift

- The phase of the received signal changes in time and with distance [7].
- Changes of phase in time is given by  $(\omega)$ , where  $(\omega = 2\pi f)$ .
- Change of phase with distance is given by  $(k)$  where  $(k = 2\pi/\lambda)$  and  $k$  is the propagation constant.
- Doppler shift is the change in frequency and wavelength and that given by this equation:  $f_d = (v/\lambda) \cos \alpha$  as mentioned before.

- Doppler frequency depends on direction of arrival distribution.

- The large shift occurs when a signal heads towards or away from rays [7].

- Doppler effect is might be the result of receiver motion, source motion or medium motion.

Doppler shift can be heard when a vehicle heads towards or away from the source [7].

#### VII. RAY-TRACING TECHNIQUE

Ray-tracing technique is a method utilized to track the transmitted signal to the receiver, the attenuation in transmitted signal comes as a result of some circumstances such as, reflection, refraction, absorption and scattering, therefore the received signal comes as a sum of reflected, scattered, and direct signals, so it reaches the receiver during multipath.

The same main principles which is used in a ray-tracing technique, known in electromagnetic. Line of sight (LOS) known as a ray truckles to path loss, reflected rays known as flush waves incident on an unlimited dielectric surface. We can calculate the reflected and refracted electric fields as the following:

$$E_{r\perp} = \Gamma_{\perp} E_{i\perp} \quad (16)$$

$$E_{r\parallel} = \Gamma_{\parallel} E_{i\parallel} \quad (17)$$

$$E_{t\perp} = \Gamma_{\perp} E_{i\perp} \quad (18)$$

$$E_{t\parallel} = \Gamma_{\parallel} E_{i\parallel} \quad (19)$$

Where  $\Gamma$  = reflection coefficient  
 $\parallel$  and  $\perp$  refer to parallel and perpendicular polarization respectively.

$E_r$  = reflected field.

$E_t$  = refracted field.

$E_i$  = incident field.

Reflection and refraction coefficients depends upon medium characteristics, polarization, frequency and incident angle as given below [7]:

$$\Gamma_{\perp} = (\eta_2 \cos \theta_i - \eta_1 \cos \theta_t) / (\eta_2 \cos \theta_i + \eta_1 \cos \theta_t) \quad (20)$$

$$T_{\perp} = (2\eta_2 \cos \theta_i) / (\eta_2 \cos \theta_i + \eta_1 \cos \theta_t) \quad (21)$$

$$\Gamma_{||} = (\eta_2 \cos \theta_t - \eta_1 \cos \theta_i) / (\eta_2 \cos \theta_t + \eta_1 \cos \theta_i) \quad (22)$$

$$T_{||} = (2\eta_2 \cos \theta_i) / (\eta_1 \cos \theta_i + \eta_2 \cos \theta_t) \quad (23)$$

Where (T) is a refraction coefficient and ( $\eta$ ) is the medium impedance.

the relationship between (T) and ( $\Gamma$ ) is given below:

$$1 + \Gamma_{\perp} = T_{\perp}$$

$$(24) \quad 1 + \Gamma_{||} = (\cos \theta_t / \cos \theta_i) T_{||}$$

(25)

Using ray-tracing principles for indoor propagation can be achieved by doing a calculation in two stages, 2D and 3D. In 2D ray-tracing method rays are sent sequentially in horizontal level with different angles from the transmitter, in order to deal with differences in dielectric properties of building materials[1], such as glass windows, wooden doors, concrete walls and some furniture, a researcher assumes that the loss due reflection is about (6dB) and the loss due to absorption is about (12dB) [8]. When a ray is traced in 2D, first of all, computing the intersection rays during the direct path length is done, then computing reflected and refracted rays over balks comes as the next step, finally, those rays must be traced in reiterative way to obtain the received power in the system.

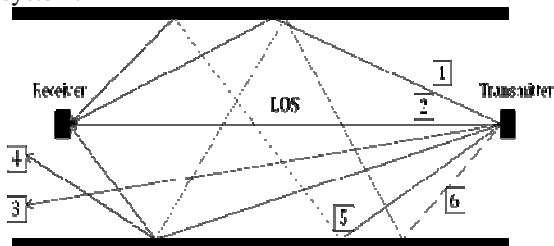


Fig.11.Ray-tracing in 2D model

The previous figure illustrate briefly how rays can reach the receiver in two-dimensional prototype, as we can see rays (1,2,5 and 6) can reach a receiver, while rays (3 and 4) die to infant path, so they will be ignored because they cannot reach the receiver. Through the two-dimensional ray-tracing, all paths between the transmitter and the receiver are calculated and recorded(save their paths), then utilized them in 3D method, where all rays may reach the receiver need to be traced corresponding to each 2D path[1], thus intersection rays with the receiver are computed, this limitation in the number of rays save much time because unneeded computation are cancelled.

By using a computer software to trace rays in this model , we can calculate the following:

The number of received rays including (reflected, refracted, diffracted and direct rays).

- The length of each ray.
- Path loss of each ray.

Finally, the received power can obtained by summing all rays vectorially.

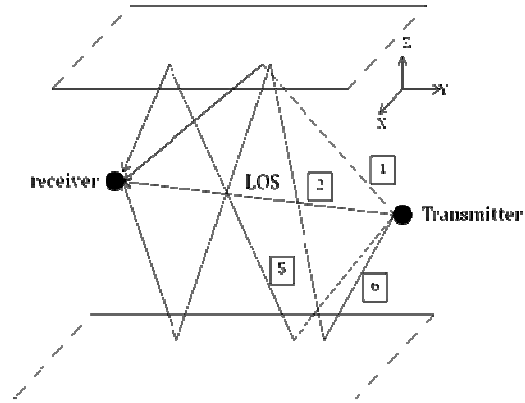


Fig.12.Ray-tracing in 3D model.

#### VIII. CONCLUSION

The transmitted signal inside buildings is influenced by propagation mechanisms, because it is reflected, refracted and diffracted across balks, and that leads to change in the signal behavior, since that various ways of evaluating the propagation in indoor environment have been established, in this research 2D and 3D models have been discussed, ray-tracing prediction is a technique used to decrease the multipath fading by using 2D and 3D methods in ray-launching approach. When rays are traced by using 2D ray-tracing algorithm, a reduction in a computation time comes as a result of that, the non intersection rays with the receiver are ignored, so when a 3D ray-tracing algorithm is proposed for indoor propagation, only the rays which are known from the 2D model, and they were intersects the receiver are computed, therefore, the number of non active rays which cannot reach the receiver decrease to a minimum value, thus the prediction comes with more accuracy and much computation time can be saved. In fact the main aim of studying and researching on a ray-tracing technique in indoor environment, that to obtain an efficient formula of transmitters and receivers which is more active and practical for indoor communication channels, this kind of formula is going to decrease the multipath fading, which plays a significant effects on indoor propagation channels. However, the final received power is the sum of signal components arriving from many paths in different times, each differ in phase, amplitude, direction and polarization[7]. In this paper patched-wall model is not covered because of the lack of references and time.

#### IX. ACKNOWLEDGMENT

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# Wireless Sensor Networks: Energy Efficiency Mac Protocols

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**ABSTRACT:** It is a fast growing research area in the recent past. By the technological advances the development of the low-cost sensor devices are been equipped with the wireless sensor networks. This wireless sensor network has been moved to the availability of the sensor networks. There are some of the key challenges deals with the network protocols, different network operation data mining, data querying, data fusion and the exciting new application that exploit potential of wireless sensor networks. It can address the issue of observing the environment from a close range, densely in space and frequent in time. The sensor network should be adaptive to dynamic changes in the environment. These basic challenges in the wireless sensor network have a sparked number of research themes. The sensor nodes operate for a long period of time with small battery. It has some problems like self configuration, network security, media access control and multi hop routing. The sensor network faces energy efficiency problems due to MAC layer which consumes most energy. MAC layer protocols plays a major role in the network. It is associated with energy problems such as collision, overhearing, protocol overhead and idle listening. Various protocols are proposed to reduce power consumption but Contention based protocol and schedule based protocol are some of the methods to minimize the power consumption. The power consumption plays a vital role in wireless sensor networks.

**Key words:** Wireless sensor networks, MAC protocols, Contention-based protocols, Schedule-bases protocols.

## 1. INTRODUCTION

The network consists of different layers which is open systems interconnection (OSI) model. Wireless sensor networks was developed for military application such as battlefield surveillance[3]. It is a combination of various sensors connected with out wire to each other for achieving different tasks. It merges the sensing, computation and communication into a tiny device[1]. Due to the improvement in the technology have lead to low cost sensor nodes. They are responsible for sensing and first stage of processing. A communication network is composed of nodes and it can broadcast the data packets[2]. Sensor nodes are battery-powered and it is difficult to recharge or recharging them may not be cost effective. These nodes automatically adopts network changes [4]. The MAC layer protocols plays vital role in the network. It is a sub-layer of data link layer which is next to physical layer. Most of the power is consumed at this layer. MAC protocols solve the energy efficiency problems of sensor network[9]. The major sources of power wastes are identified as collision, idle listening, overhearing and protocol overhead[13]. Various MAC protocols are proposed to reduce the power consumption, for example the contention based and schedule based protocols are used to minimise power consumption. To enhance the network life time energy efficiency protocols are required[11].

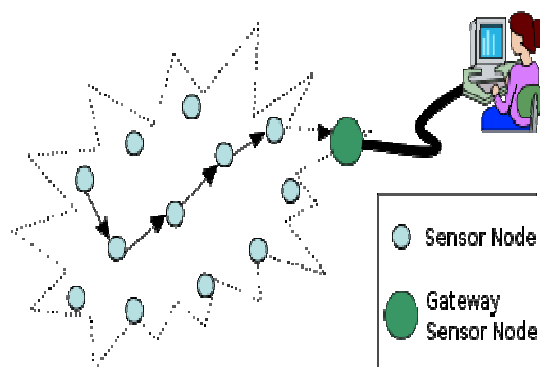


Figure.1 Typical Multihop Wireless Sensor Network Architecture[3]

## 2. MAC LAYER ENERGY PROBLEMS

Collisions, overhearing, protocol overhead and idle listening are major sources of energy wastes caused in MAC layer.

### A. Collisions

In wireless networks collisions plays a major source to enhance latency and retransmission.

Retransmission result in useless cost at destination and source. Due collision in the network results in more energy consumption[6].

### B. Overhearing

The neighbours of source node can overhear the packet transmitted from source even though the packets are not meant for them. Overhearing consumes lot of energy[5].

### C. Protocol overhead

Overheads are control related frames like Request- To-Send (RTS) and Clear- To-Send(CTS) or request packets. It also includes per-packets overheads like headers and trailers which are attached to starting and ending of the frames[5].

### D. Idle listening

In this state some parts of the receive circuitry are active and others may switch off. Transceiver is ready to receive but currently not receiving any thing.

## 2. METHODES TO MINIMISE POWER CONSUMPTION

### I. Contention based protocols

The power of the sensors nodes may turn off and on in order to conserve energy. Contention occurs when two nodes attempt to access the channel at a time. It causes message collisions due which occur when traffic is

frequent and correlated, and they reduce the lifespan of the sensor network[7]. Contention based protocols are carrier sense multiple access (CSMA) protocols and power aware multi-access with signalling (PAMAS).

#### A. Carrier Sense Multiple Access (CSMA) Protocols

A sensor node desires to transmit, sense the medium first. If the medium is busy then the node withdraws its transmission to later. If the channel is sensed free then the node transmits packets. These kind of protocols are very effective when the channel is not heavily loaded, since it produces minimum delay to stations to transmit, but there is a chance of stations transmitting at the same time which can cause a collision. Virtual carrier sense mechanism is employed[8].

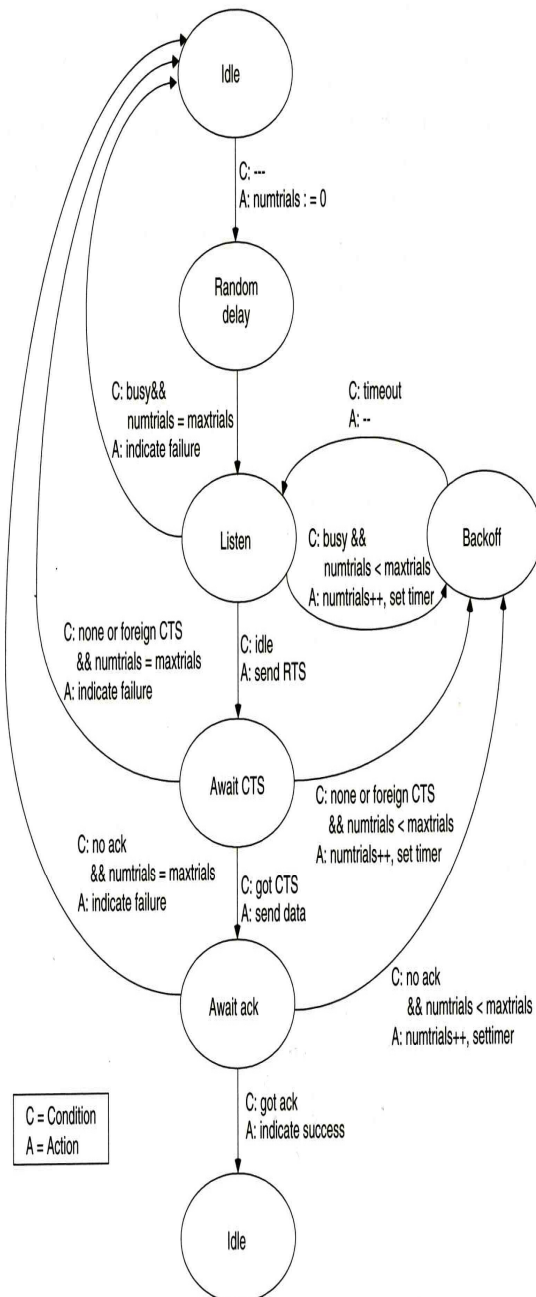


Figure 2 schematic of the CSMA protocol[5]

The above figure shows the various steps a node passes through transmission. A node gets a new packet for transmission, it starts with random delay and initializes its trail counter `num_retries` with zero. The random delay is to desynchronize nodes that are initially synchronized by the external event. At the time of random delay, the node's transceiver is kept in sleep mode. During the following listen period, the node performs carrier sensing. If the medium is found to be busy and the number of trails so far is smaller than the maximum number, then the node goes into backoff mode. At backoff mode, the node waits a random amount of time, which can depend on the number of trails and during the node can sleep. Application layer uses the backoff mode to initiate a "phase change". This phase change aims to desynchronize correlated or periodic traffic of different nodes. After the backoff mode finishes, the node listens again. If the medium is busy and the node has exhausted its maximum number of trails, the packet is dropped. If the medium is idle, the node transmits an RTS packet and enters the "Await CTS" state, where it waits for the corresponding CTS packet. In case no CTS packet arrives or a CTS packet for another transaction is received, the node either enters the backoff mode or drops the packet, depending on the value of `num_retries`. If the CTS packet arrives, the node sends its data packet and waits for an acknowledgment. If acknowledgment arrives it goes to idle state otherwise goes to backoff mode. This protocol is good for adaptive change in the network topology, it does not require synchronization[5].

#### B. Power Aware Multiaccess with Signaling (PAM)

PAMAS uses two channels one is data channel and the other is control channel. The data channel is used to transmit data packets and control signals make use of control channel. It employs busy-tone solution and RTS/CTS handshake. The operation of protocol as follows. If a node A decides to send a packet to neighbouring node B. Without sensing the carrier the node A sends an RTS packet on control channel. This packet carries MAC addresses of both A's and B's. If B receives the RTS packet, it sends CTS packet. If it does not know of any ongoing transmission in its range. After receiving the CTS packet, A starts sending the packet to B on data channel. Node B sends out the busy-tone packet on control channel while receiving data. If node A fails to receive CTS packet within certain time span, it enters the backoff mode, where it uses binary backoff scheme. Now let nodes receiving A's RTS packets. There is receiver B and other nodes, let C be one node of them. If a node C is currently receiving packet, it sends a busy-tone packet, which overlaps with B's CTS packet at node A and effectively destroys the CTS. Therefore, node A cannot transmit and C's packet reception is not disturbed. If the busy-tone packet is more longer than the CTS, that can be sure the CTS is destroyed. Now, we consider the receiver B. If B knows about the ongoing transmission in its vicinity, it suppresses the CTS and

cause A to backoff mode. If node B knows this either by sensing the data channel or by the control channel whether there was some noise, immediately after receiving the RTS. This noise may either RTS or CTS of the another node colliding at B. In the other hand, B answers with CTS packet and starts to transmit busy-tone as soon as A's transmission has started. Furthermore, B sends busy-tone each time it receives some noise or a valid packet on the control channel, to stop its neighbourhood activities.

Node that receives RTS while being in the backoff state starts its packet reception procedure, after checking the conditions for sending a CTS. The node enters in to sleep mode when the node stops transmitting and receiving packets because some other node in its range is already doing so. On the other hand node wakes up if node A knows about the duration of ongoing transmission. However, if the length is unknown to A, for example, because these packets are corrupted or foreign data transmission cycle starts when A is sleeping. To resolve the additional procedures. It runs probing protocol on the control channel which is similar to binary search algorithm[5].

## II. Schedule-based protocols

Schedule-based protocols employs the TDMA scheme. TDMA divides the time into small slots, the transmitter and receiver has to agree slot boundaries which are meant for them and to avoid the overlaps with other slots, it lead to collisions. Resynchronization is required for some sensor nodes. The neighbour node cannot use time slots which are unused by the other nodes[5]. By scheduling listen period and transmit, the protocol can avoid collisions, idle listening and overhearing[9].

### A. Low- energy adaptive clustering hierarchy (LEACH)

For wireless sensor network LEACH is cluster based routing protocol and it is self organized protocol[10]. LEACH separates the nodes into clusters, each cluster is a dedicated node. The cluster head is responsible for creating and maintaining TDMA schedules. The other nodes under the cluster are member nodes[5]. All other nodes which are non-cluster heads has to transmit to cluster head[10]. To exchange the data between the clusterhead and members TDMA slots are assigned to all members nodes. The member nodes are active when the slot is meant for then otherwise enter in to sleep mode. The cluster head aggregates the data of its members and sends it to the sink node or to the others. The cluster has to spend more energy for this transmission because the sink is far away. The member of nodes can easily access the cluster head than sink. Clusterheads consumes more energy because it is always switched on and it performs long-range transmission. This leads to quick waste of energy, and after it died, all its members are useless[5].

This protocol is round based, all nodes decides to become a clusterhead at the same time and the nonclusterhead nodes related to clusterhead subsequently. Based on received signal strength nonclusterheads choose

clusterhead. Each cluster picks a random CDMA code for its cluster. The rounds are subdivided into a setup phase and a steady-state phase. According to the cluster's TDMA schedules, clusterhead switch, during hole round and during setup phase and occasionally in steady-state phase[5].

This protocol cannot cover long geographical areas, they do not have sufficient energy because clusterhead far away from sink[5].

### B. Traffic-adaptive medium access protocol(TRAMA)

TRAMA employs TDMA –based algorithm, which is similar to Node Activation Multiple Access(NAMA). It creates schedules allowing nodes to access a channel in a collision manner. Distributed election algorithm is used to select one transmitter with in two-hop neighbourhood for each time slot. It eliminates hidden terminal problem and hence one-hop neighbourhood nodes of the transmitter will receive the data without collision. This protocol divides time into random-access periods and scheduled-access periods. Two-hop topology is established by random-access period where channel access is contention-based[11]. For each time slot of the scheduled-access period, distributed scheduling algorithm is executed by the nodes. This protocol has three different components, the neighbourhood protocol, schedule exchange protocol and adaptive election algorithm. Neighbourhood protocol is executed in the random access period, where it is subdivided into small time slots. Randomly a number of time slots are picked by a node and transmit small control packets without carrier sense. During the random access phase all node's transceivers must be active. In schedule exchange protocol a node transmits its current schedule and also picks up its neighbour's schedule. It uses the global hash function. The adaptive election algorithm allows nodes to reuse their neighbour unused slots[5]. High channel utilization is achieved by TRAMA[12]. Delay is found due to high percentage of sleep times[11]. This protocol has natural advantage of collision avoidance[13].

## 3. CONCLUSION

Table 1 Comparison of MAC protocols

|                      | Contention based protocols | Schedule based protocols |
|----------------------|----------------------------|--------------------------|
| Time synchronization | NO                         | Yes                      |
| Collision            | High                       | Very Less                |
| Idle listening       | High                       | No                       |
| Overhearing          | High                       | No                       |
| Type                 | CSMA                       | TDMA                     |

Table.1 gives the information about MAC protocols which are used to minimize the power consumption of wireless sensor networks. The time synchronization column indicates about whether the protocols are using synchronization techniques. Collision, idle listening and overhearing column's gives the idea about the protocols are suffering with these are not.

Although there are various protocols proposed for wireless sensor networks to minimize the power consumption. These protocols have better performance than others. By investigating these two protocols use of schedule based protocols can give good energy efficiency characteristics.

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# Intelligent Transportation System

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**Abstract-**Transportation is the movement of people and goods safely and efficiently from one place to another. Intelligent Transportation System (ITS) employs modern technology to keep transportation systems performing as efficiently and safely as possible for operating agencies and private users. ITS deployment becomes imperative, with traffic congestion problems on the rise worldwide, resulting from increasing population, urbanization and motorization. This system eliminates traffic congestion, increases efficiency of transportation infrastructure, reduces travel time and improves safety, cuts down air pollution and fuel consumption. They vary in form based on the system into which they are integrated, typical examples are: Closed Circuit Television (CCTV), speed cameras, traffic signal control, navigation systems, automatic number plate recognition, parking guidance and information systems. Various Intelligent sensor technologies are adopted, these are: embedded technologies, wireless communications technology, inductive loop detection, computational technologies, video vehicle detection and floating car/cellular data. ITS can be installed in different modes as standalone units, incorporated as elements within a new infrastructure or deployed to manage traffic impacts created by other projects. This paper reviews various ITS technologies and the deployment modes adopted in various scenarios. Furthermore, a reflection on the global impacts of ITS and future application areas are also discussed.

**Keywords:** ITS (Intelligent Transportation System), Intelligent sensors, Deployment modes.

## 1. INTRODUCTION

Intelligent Transportation System is the incorporation of information and communications technology into transportation infrastructure. Advanced communication has improved the dissemination of information to the traveling public; resulting to improved access, saved lives and time with increased productivity. The use of multimodal means of transportation in these big cities such as walking, bicycles, motorcycles and tricycles coupled with vehicular movements create a lot of congestion problems. Automobiles produce significant amount of air pollution, safety risk, and exacerbate feelings of inequality inequalities in the society. Various technologies are deployed for ITS implementation; some of these technologies are also incorporated into automobiles to reduce the level of fuel emissions and to improve safety for the driver, passengers on board as well as the multimodal users. Urban infrastructures therefore, are being rapidly developed, providing an opportunity to build new systems that incorporate ITS at the early stages. Deployment modes can be intrusive or non-intrusive.

## 2. ITS TECHNOLOGIES

Various types of technologies are adopted for the design, deployment and implementation of ITS. Some of these

technologies employ the use of sensors, wired and wireless media with an on-board computational facility to process and relay real time data feedback for control, monitoring and regulation purposes. The technologies vary from control systems, management systems, monitoring systems, to more advanced applications that relay real time live signals and feedback from a couple of other sources[1]. Typical examples of these type of systems are: weather information systems, parking guidance and information systems, traffic signal control systems, container management systems, surveillance systems.

### A. Computational Technologies

These are computer processors, micro controllers and programmable logic controllers with high processing capabilities. These processors are embedded in vehicular systems and work together with high precision sensors [2]. The current trend of this technology is towards fewer but more costly microprocessor modules with hardware memory management and real time operating systems which creates allowance for the integration of significant software applications. Most automobile systems come with increased interoperability with other ITS technologies [2]. Video vehicle detection employs computational technology in a non intrusive manner for traffic detection. Video images are fed into processors which analyze the changing characteristics of the video image as the vehicle passes. The processors of this detection system is configured to reflect a certain baseline bar ground image or threshold [3]. The cameras are usually mounted on structures above or adjacent the roadway. The output information contains details such as: lane-by-lane vehicle speeds, counts and lane occupancy readings, wrong way vehicle alarms, stopped vehicle detection and a couple of other vehicle specific data [4].

### B. Sensor Technologies

Sensors are devices which measures and converts a physical variable into a signal which can be read by an observer or a computer. They are made of silicon micro-machined components operating in conjunction with computer controlled devices and radio transceivers to provide precision and repeatability functions[6]. Sensors form a major part of intelligent vehicle technologies, usually called 'Intelli Drive'[3]; performing major functions of sensing, computing and communication of conditioned signals. Sensing systems for ITS are vehicle and infrastructure based networked elements. They are deployed mostly in an embedded form (intrusive) and form an important basic part of ITS wireless communications infrastructure. A typical example of sensing technology is as seen in the inductive loop detection, where loops are placed on the road bed, to

enable vehicular movement detection by measurements of magnetic field of vehicles as they pass over the loop. Estimates of vehicular speed, length, weight, and consecutive distances between vehicles can also be obtained by this technology which also works well with various vehicular speeds [4].



Fig 1. Electronic Toll Systems

### C. Wireless Technologies

This involves wireless transmission of signals through air waves. Various wireless technology techniques adopted in ITS are based in the transmission environment and the operating distance required [3]. Examples of some of these technologies are: Bluetooth, WIMAX, WIFI. The communication range of these technologies can be extended using mobile adhoc or mesh networking [5]. This is seen in the floating cellular data services adopted for traffic management. Most cars have on board one or more mobile phones which transmit location information intermittently to the network. By measuring and analyzing triangulation network data, the data is converted into accurate traffic flow information. With high congestion, the more the number of cars, more phones and more probes for effective and accurate traffic estimation. Floating car data technology has great advantages over existing methods of traffic estimation. This is because, they are faster to set up, require less maintenance, their performance is not deterred by weather conditions, have an unbeatable coverage and are generally less expensive[3].



Fig 2. Wireless Technology with ITS [6].

## 3. ITS APPLICATIONS

ITS plays important roles in transportation services. Some of these application areas are as highlighted

**A. Arterial Management:** these are systems that manage traffic along arterial roadways; information is communicated to travelers through signal detectors. This information is used to smoothen the flow of traffic along

travel corridors, travel condition information is also disseminated to the travelers via technologies such as Dynamic Message Signs (DMS) or Highway Advisory Radio(HAR). This system collects information describing arterial operating conditions and transfers this information to a travel management system[3]. The freeway management system implements appropriate management strategies e.g. changing ramp metering timing in response to excessive queue length of vehicles waiting to enter the freeway or in response to traffic conditions along the freeway. Arterial systems adjust traffic signal timing as appropriate to provide priority to transit vehicles, especially for those equipped with technology to establish traffic signal priority along congested corridors [8]. Incident management systems use arterial traffic information to identify incidents and manage incident response on the arterial system by implementing appropriate strategies. Emergency response vehicles can be equipped with technology to establish traffic signal pre-emption, as soon as the arterial system receives this request; it adjusts signal timing as appropriate. Electronic toll collection systems also provide probe information on traffic conditions to Arterial Management Agencies (AMA) as vehicles pass toll collection sites. Arterial management sensors are used to establish intersection status and provide intersection collision warning to approaching vehicles. Environmental Sensor Systems (ESS) deployed by AMA share weather data with road weather management systems, this information on weather and traffic condition is provided to driver assistance systems for use in adjusting route guidance. Three levels of Integration are possible with Arterial Management Systems (AMS), these are: Data sharing, co-ordination of control activities, and joint control of traffic signals of multiple agencies [3]. These are as seen in surveillance systems, lane management, parking management. Speed and traffic signal enforcement systems

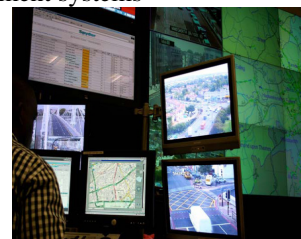


Fig3. Real time traffic Management system

**B. Freeway Management:** Surveillance systems use detectors and video equipment to support the most advanced freeway applications; ramp meters and sensor data are used to optimize freeway travel speeds and ramp meter wait times. These sensors are used to establish vehicle speeds for purpose of issuing speed warnings along curves, downhill segments and ramps. Large changeable destination signs or other lane control equipment are installed in areas with frequent events, while portable equipment which can help to smooth traffic flow are installed in areas with occasional or one-time events[7].



Fig 4. Congestion Pricing for cordon zones



Fig 5. Automatic Speed enforcement system.

**C. Crash Prevention and Safety:** This system detects unsafe conditions and sends warning signals to travelers to take caution to avoid crashes. Alerts are provided for traffic approaching at dangerous curves, off ramps, restricted overpasses, high way rail crossings, high volume intersections and also provide warnings on the presence of pedestrians and bicycles and even animals on the roadway. Sensors monitor the speed and characteristics of approaching vehicles; this is compared with information from environmental sensors which monitor roadway conditions and visibility. These systems are deployed either temporarily or permanently providing general warning of the recommended speed for prevailing roadway conditions or specific warnings by taking into account, the particular vehicles characteristics (Bus, Truck or car). Manual systems are also employed where multimodal users provide warnings of their presence by manually sensitizing the system. Information on roadway closures (using automatic or remotely controlled gates) due to severe weather or other conditions to traveler information systems for dissemination to travelers.

**D. Roadway Operations and Maintenance:** ITS applications in this area focuses on Integrated Management and maintenance of fleets, specialized service vehicles, hazardous road conditions remediation and work zone mobility and safety. Deployment of ITS in work zones helps in securing the safety of workers and travelers while facilitating traffic flow through and around the construction area by efficient deployment of other elements of traffic and incident management programs. Information is channeled in from all the other transportation systems on the need to inspect for and repair any damage to infrastructure from incidents. This system also co-ordinates the use of resources to meet regional needs

**E. Transit Management:** This involves the use of surveillance and communications technology in order to help transit agencies improve operational efficiency and guaranty the safety and security of the nation's public transportation systems. The use of Automated Vehicle Location (AVL) systems, Computer Aided Dispatch (CAD) systems and remote vehicle and facility surveillance has tremendously impacted on the success of the transit management system.



Fig 6. Automated Vehicle Location System

**F. Traffic Incident management:** The application of ITS in this area has tremendously helped in reducing the effects of incident-related congestion. This is achieved by effective management of detection time of incidents and the response time of arriving vehicles as well as the time required for normalization of traffic created as a result of the incident. A variety of freeway and Arterial Management Systems shared with surveillance technologies as well as enhanced communications and other technologies which facilitate co-ordinate response to incidents. Cordon zones have been implemented in some countries where a fee is charged using electronic toll collection or automatic number plate recognition for vehicles entering a congested city centre. This is done in order to reduce traffic congestion within the cordon area.

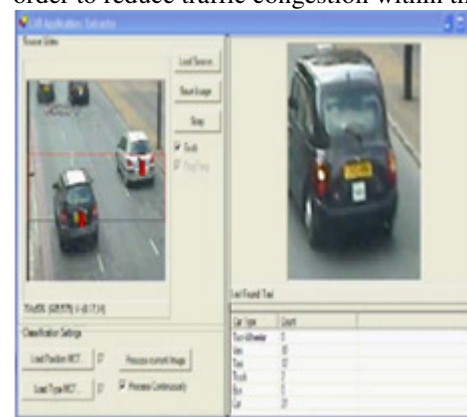


Fig 7. Automatic Number plate Recognition

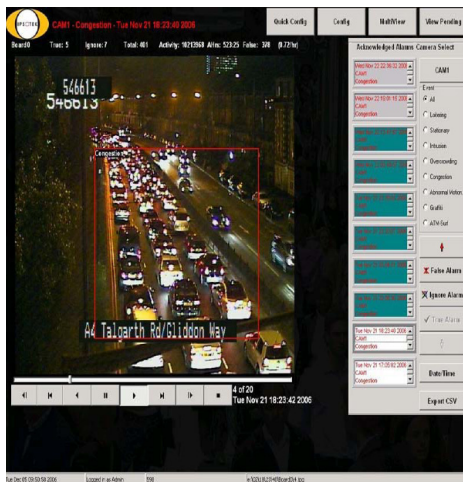


Fig 8. Traffic Management system

**G. Information Management:** Archiving and retrieval of data generated by other ITS applications is the major role of this system. It also helps other ITS applications that use archived information. This system assists in transportation planning, research and development, forecasting and management activities. Decision support systems, predictive information and performance monitoring are some ITS applications enabled by ITS information management.

**H. Collision Avoidance:** this application helps the driver to avoid accidents. Embedded vehicular laser and optical sensors are used to monitor vehicle surroundings and then alerting the driver on the conditions that could lead to collision. Vehicle mounted Collision Warning Systems (CWS) are being continuously tested and deployed with added functionalities capable on alerting the driver on intersection collision warning, obstacle detection, lane change assistance, lane departure warning, rollover warning, road departure warning, forward collision warning, and rear impact warning. Some countries like Japan already have these systems installed.

**I. Driver Assistance:** This involves navigation, route guidance, driver-to-driver and driver-to-carrier or dispatch communication, vision enhancement, object detection, adaptive cruise control, intelligent speed control, lane keeping assistance, roll stability control, drowsy driver warning systems, precision docking, coupling/decoupling, on-board monitoring involving cargo detection, safety and security, vehicle diagnostics, event data recorders etc. These automated systems work together to improve driver safety.

**J. Collision Notification:** The location and severity of collisions are detected and reported to the agencies responsible for coordinating appropriate emergency response actions. These systems are manually or automatically activated with Automatic Collision Notification (ACN) other advanced systems then transmit information on the type of crash, severity and number of passengers and the likelihood of injuries, improving response time and saving lives in the process.

#### 4. DEPLOYMENT STATISTICS

This shows recent national survey results indicating deployment rates and successes of the various ITS technologies.

- Over 63% of signalized intersections are under computer control.
- Over 59% of freeways are instrumented
- 61% of the transit buses are equipped with AVL.
- Excess journey time reduced to 3.4%
- Percentage of scheduled service operated-93%
- Scheduled kilometers operated before traffic congestion-98.8%
- Overall commuters satisfaction-90%

#### 5. IMPACTS OF ITS

The following are some of the the major impacts of ITS recorded over various regions.

- Congestion charging in London has resulted in further pollutant reductions: 8% for oxides of Nitrogen, 7 percent for airborne particulate matter and 16% for carbon monoxide.
- Congestion mitigating benefits of cordon charging in London enabled taxi drivers to cover more miles per hour, service more riders and decrease operating expenses per passenger, inner city traffic was also reduced by about 20% and more than £97 Million has been generated each year for transit improvements.
- In Great Britain, automated speed and red-light enforcement systems has reduced the percentage of vehicles exceeding the speed limit by 58%, the number of persons killed or seriously injured by 4-65% and the personal injury rate by 6%
- In Southampton, a transit signal priority system reduced bus fuel consumption by 19%, reduced emissions by 15-30% and reduced bus delay by 9 seconds
- In London an automatic fog detection system that used free way dynamic message signs to warn drivers of fog, reduced traffic speeds by an average of 1.8mi/h
- Freeway lane reversal improved traffic volumes by 44% following south Carolina hurricane
- A survey in London indicated that 30% of travelers who used computerized route planning system and completed a trip, changed routes based on information provided, another 10% decided to use public transport.
- In European cities, advanced parking information systems has reduced traffic volumes related to parking space searches up to 25%
- It was estimated that variable speed limit signs and lane control signals installed on the autobahn in Germany would generate cost savings due to crash reductions that will be equal to the cost of the system within two to three years of deployment.

- World wide it was found that speed cameras reduce crashes by 9-51%[3]
- 

## 6. FUTURE ITS TECHNOLOGIES

A lot of improvements is expected on the current ITS infrastructure for the future. Some Agencies have embarked on some initiatives in this area.

*A. The Artificial passenger:* This is a telematic device developed by IBM to provide an interactive environment to prevent the driver on transit from sleeping on the wheels. It is equipped to engage the the vehicle operator by carrying o conversations, playing verbal games, controlling the vehicle's sound system etc.It also monitors the drivers speech pattern to detect fatigue and responds by suggesting that the driver take a break. Its integration into wireless services to provide weather, and traffic routing information is being investigated.

*B. Intelli Drive:* research in this area is based on the prevention of crashes by enabling active safety application relying on interoperable wireless communication among vehicles and with infrastructure elements via an open communications platform. Numerous mobility, environment and convenience applications are supported by intelli drive. Its full deployment is awaited by the ITS world.

*C. Clarus:* The activities of the nationwide surface transportation weather observing and forecasting system-clarus initiative will develop and demonstrate an integrated weather information system for comprehensive suface weather reporting [3].

*D. Driverless Car:* this is an autonomous vehicle that can drive itself from one place to another. Michael E. Arth its designer said driverless cars together with the increased use of virtual reality for work, travel and pleasure could reduce the worlds population of cars within a few decades if only unused private cars requiring drivers and which are not used 90% of the time would be traded for public self driving cars.

*E. Cooperative Intersection Collision avoidance system:* Through this initiative USDOT is working in partnership with various auto manufacturers and both state and local transport agencies to achieve an optimized combination of autonomous- vehicle infrastructure and cooperative communication systems that potentially address the full set of intersection crash problems.

Other initiatives are in the area of urbotics, vehicular communication systems, integrated vehicle based safety systems, traffic optimization, estimation and prediction systems, intelligent speed adaptation, intelligent roads and on intelligent vehicles.

## 7. CONCLUSION

The impacts of ITS on the society and transportation infrastructure cannot be overemphasized. Advanced communications technology as well as effective deployment modes adopted for each application scenario has tremendously contributed to successes recorded in ITS implementation. Artificial intelligence forms a strong spring board for emerging future ITS technologies which is anticipated to curb world wide congestion problems significantly.

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# An Introduction to STANAG 4406

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**Abstract-**STANAG 4406 is the implementation of a military message standard based on the civil X.400 standard. With the technologies available in all fields like communication, war, software and so on. Countries are going toward having systems like Command and Control and Network Centric Warfare (NCW) and they depend on how fast the information can be exchanged and transmitted in order to be aware of any situation around and to make the right decision in split of a second. It will be necessary to Increase the interoperability between the strategic and tactical systems. Military Message Handling System (MMHS) Represented in STANAG 4406 is the newest NATO standard for military strategic and tactical messaging, where high data rate are used for a strategic direct information exchange and low data rate is for tactical users. STANAG 4406 can be used for Surface Fleet Communication, Submarine Communication, Army Deployment, and Special Forces. The X.400 standard is used because it offers more capabilities than SMTP does. MMHS need to be transferred over low bandwidth network using HF Radio and Satellite Networks. This paper presents an explanation on how does STANAG 4406 work, its architecture, and different scenarios in which STANAG 4406 can be used in.

**Keywords:** STANAG 4406, MMHS, NATO, SMTP.

## I. INTRODUCTION

Military communications are part of the Command and Control, Network Centric Warfare, Communications, and Intelligence (C3I) Model. Military communications is a military activity, tactic, and equipment fields dealing with communications. Military communications are communications combat, including intercommunication within the command or country's hierarchy. Sending and Receiving simple signals is the first military communications form and they usually hidden or encrypted so the enemy will not recognize it. A signal is what the first distinctive tactics of military communications was called, while Signal corps was the name of the units which was specializing in those tactics. Using advance and modern high-tech telecommunications and computing methods on a daily basis is how Present-day militaries conduct their very intense and complicated communicating activities. In command and control and network-centric warfare the swap or exchange of information within and between forces at sea, on ground and in air must be automated, reliable, and secure. STANAG 4406 is the state-of-the-art information management systems in which this requirement is met. It is going to be necessary to Increase the interoperability between the strategic and tactical systems. Military Message Handling System (MMHS) Represented in STANAG 4406 is the newest NATO standard for military strategic and tactical messaging, where high data rate are used for a strategic direct information exchange and low

data rate is for tactical users [3]. Communications over leased lines are increasingly giving way to state-of-the-art wide area networks (WANs) based on TCP/IP. STANAG 4406 standard describes the exchange of military messages in various strategic way like IP-based, local and wide area networks (LAN/WAN). The interface to radio communications networks is defined by Annex E of the standard and it is also covered the support of future IP radios [5].

## II. WHAT IS STANAG?

Standardization Agreement (STANAG) developed and promulgated by the North Atlantic Treaty Organization (NATO) in conjunction with the Conference of National Armaments Directors and other authorities concerned, which set up processes, procedures, conditions, and terms for common military technical procedures and equipment between the member countries of the alliance. The NATO Standardization Agency in Brussels published the STANAGs in the two official languages of NATO English and French. Each NATO country can ratify and implement any STANAG to use it in their military. The main purpose of STANAGs is to provide a common operational and administrative procedure and logistic, so countries military can support each other. Countries that do not belong to the NATO can use any of the STANAGs but in order to talk to any NATO country they should use the same cryptography [1]. The main purpose is to provide the communication for forces at sea, on the ground and in the air in the way it's shown in the following figures.



Figure 1 MMHS - Naval Scenario [7]

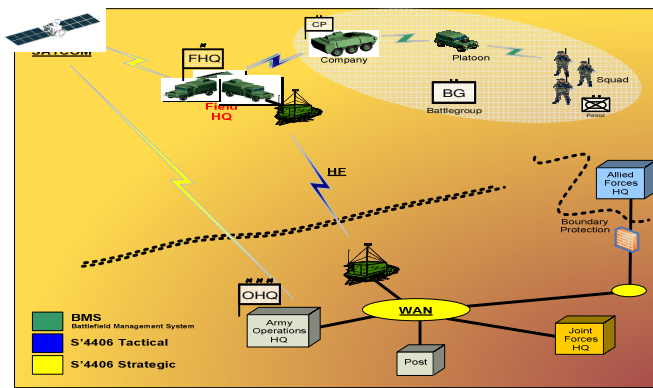


Figure 2 MMHS – Army Scenario [7]

### III. STANAG 4406

Based on the International Telecommunications Union (ITU) X.400 Standards STANAG 4406 derive its protocols that support military messaging. The X.400 standard is used because it offers more capabilities than Simple Mail Transfer Protocol (SMTP) does. Message Transfer Agents (MTA) is store and forward message switch that STANAG 4406 use to switch its messages. MTAs use the X.400 P1 Protocol, which has a mapping onto TCP/IP when communicating over a high speed network. The diagram below shows two of the MTAs communicating using X.400 P1. A User Agents (UA) uses X.400 P3 for communicating directly with an MTA, or uses X.400 P7 for communicating indirectly by a Message Store (MS). Both options are shown in figure 3 below.

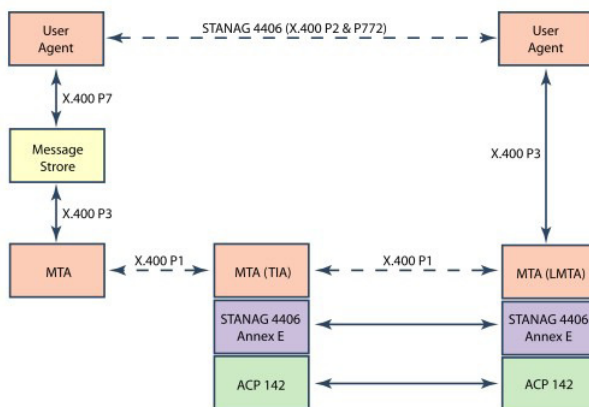


Figure 3 STANAG 4406 and ACP 142 Protocol Architecture [2]

Military Message Handling System MMHS need to be transferred over low bandwidth network using HF Radio and Satellite Networks. The NATO's STANAG 4406 Annex E and ACP 142 are the two military specified for this type of messaging. To integrate the X.400 MTA with ACP 142 the procedures and protocols are defined by Annex E. There are two configurations of MTA defined by Annex E. The Tactical Interface Agent (TIA) and Lightweight MTA (LMTA) and they are considered as special types of MTA, and they are explained as follow:

1. Lightweight MTA (LMTA), which is appropriate for a ship where all internal communication goes direct to the LMTA. LMTA is an MTA where the P1/Annex E is used by external communication only.

2. Tactical Interface Agent (TIA), which allows LMTAs to be interconnected to a general X.400 network by communicating with full stack P1 to other MTAs. TIA is an MTA where P1/Annex E are used to communicate with LMTAs (or other TIAs).

Figure 4 below explain the idea of LMTA and TIA. [2]

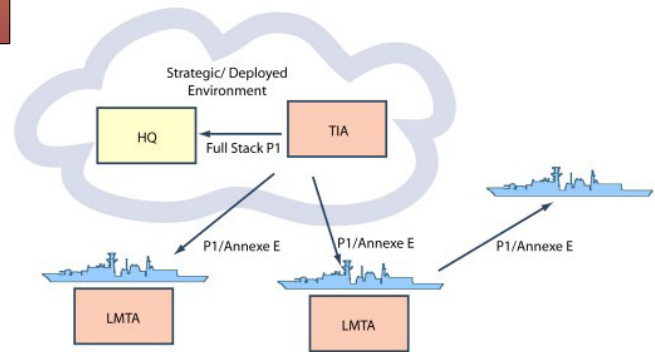


Figure 4 LMTA and TIA [2]

### IV. STANAG 4406 ARCHITECTURE

In STANAG 4406 the strategic high data rate is foreseen and developed in annex C of the standard and it's not fitted for low data rates. In the other hand the tactical communication is developed and foreseen in annex E of the standard. The figure below illustrates the Seamless interconnection of MMHS between the strategic and tactical domains.

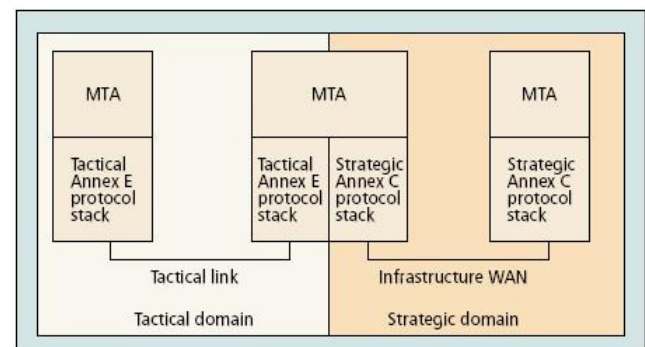


Figure 5 Seamless interconnection of MMHS between the strategic and tactical domains [5]

The tactical protocol profile of STANAG 4406 Annex E has adopted the following characteristics of a tactical radio link:

|                                                                                                                         |
|-------------------------------------------------------------------------------------------------------------------------|
| A connectionless protocol stack, which gives less overhead and reduces the effect of large turnaround times of the link |
| A choice of full-duplex, half-duplex, or simplex (broadcast) operation                                                  |
| Compression to reduce the amount of data transmitted                                                                    |
| Usable for both unicast and multicast, the latter providing efficient use of radio resources                            |
| Procedures for handling EMCON recipients                                                                                |

Table 1 Characteristics of tactical radio link.

Compared to the connection-oriented Annex C protocols Annex E increase the messaging throughput significantly for tactical communication channels with low data rates with the mentioned features.

The Annex E protocol profile is divided into a transport layer and an application layer on top of the potential bearer systems. Furthermore the application layer is divided into more specific sublayers. In order to reuse the messaging applications the messaging sublayer remains the same in Annexes E and C. A common service interface (TA-SAP) for the different protocol stacks is kept by the required adaptation which is done by the tactical adaptation. Furthermore, this sublayer performs compression and decompression of both envelope and content of the message. Figure 6 below shows the layered architecture of the STANAG 4406 Annex E protocol profile.

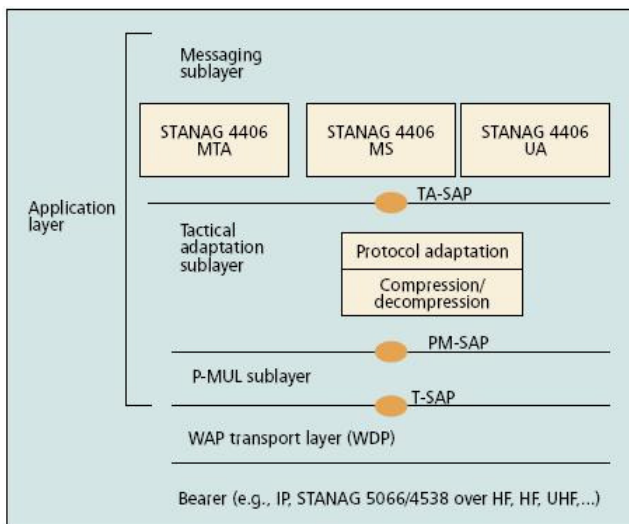


Figure 6 The protocol structure of STANAG 4406 Annex E [5]

#### V. STANAG 4406 SCENARIOS

The naval communication is a major target for communication specialise in communication. Normally and using radio broadcast communication signals could flow from the strategic environment directly to the task force ships. The case is when ships are arranged in a task force, communication will usually go to the chosen command ship and then relayed to the other ships in the task force using the same communications technology as in ship to shore. From the COMCEN (Communications Centre) at shore the message come directly from originators in the strategic environment [4]. Every and each company has its own technology that might be used in these cases some of them allow the user to send the messages to all ships at once some to use the case of master and slaves ships. Multicast, is the case when a message can be broadcast and transmitted to multiple parties simultaneously. Multicast allows optimum usage of radio channel capacity in case of large attachments. One of the most important features that not all company

have, but they are looking forward to meet since it's very important to the user is to have an automatic rebroadcasting for recipients operating in the EMCON mode so the probability of correct Reception will be increased [7]. The below mentioned scenarios are some examples in which companies are trying to meet the customer requirements and needs. The scenarios will be explained, but we have to realise that is up to the company to develop the features for the need of the user and they are Surface Fleet Communication, Submarine Communication, Army Deployment, and Special Forces.

#### A. Surface Fleet Communication

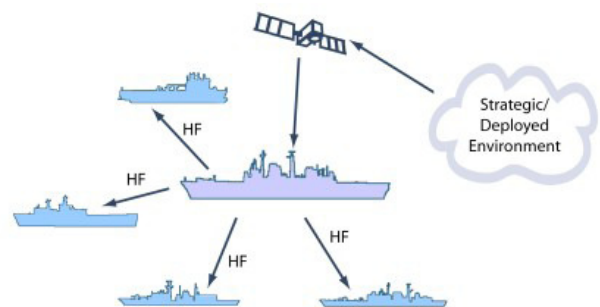


Figure 7 Surface Fleet Communication [4]

In this scenario the satellite is used to reach the command ship and to communicate with the other ships and units in the task force the high frequency HF radio broadcast is used. For communication between the command ship and the other ships in the task force the multicast is used. A ship would have quite a number of possible internal message recipients, and the external message communication needs to be connected with the internal messaging infrastructure, and it need to be managed by planned communication scenarios and status.

#### B. Submarine Communication.

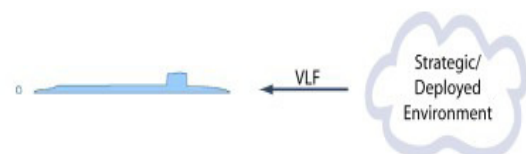


Figure 8 Submarine Communication [4]

Submarine Communication requires several of special requirements. On the surface Submarines uses a higher bandwidth channels, and they might use a data rate of around 300 bits per second Represented by the VLF (very low frequency) radio. The main advantage of the VLF radio is that it will penetrate below the surface for a reasonable distance, so submarine uses it without surfacing. Submarines will be out of communication when diving below the When submarines dive below VLF penetration level. So from the above we can conclude that there are three states of a submarines communication: full communication; EMCON; no communication. As we mentioned on the previous

scenario these states need to be controlled by planned time schedule for the communication status.

### C. Army Deployment

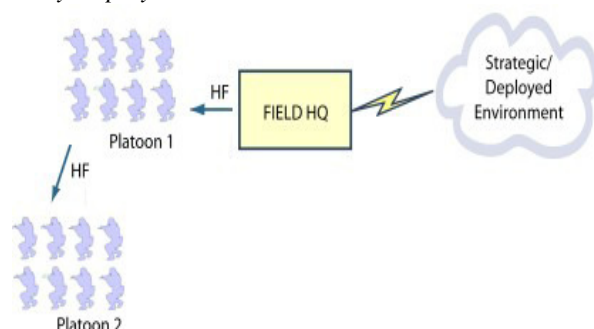


Figure 9 Army Deployment [4]

In the scenario shown in figure 7 above, there is no direct communication between field HQ and the second field unit, messages can be passed on ( relayed ) by use of the messaging system in the first field unit. This relay should not require a manual involvement by the first field unit and needs to be fully automated also. The communication to the field HQ will be in a high bandwidth. Communication to field units may be bandwidth inhibited, and there might require for EMCON, because the army has similar requirements as the navy. In some situations, to send a formal message in inclination to voice communication a store and forward messaging is used.

### D. Special Forces

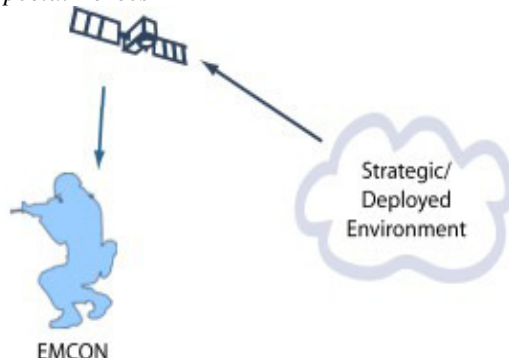


Figure 10 Special Forces [4]

Supporting the Special Forces operations consider as another important requirement. Having radio silence is frequently desirable, but it's used to retain the ability to listen and to receive messages.

### E. Handling Multiple Communication Channels

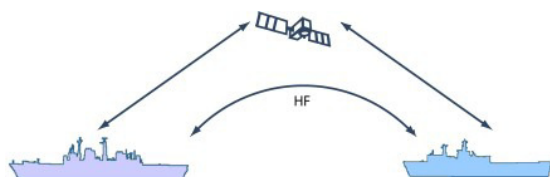


Figure 11 Multiple Communication Channels [4]

This scenario shows that many real deployments have multiple communication channels.

Normally A ship might have two or more communication channels: HF Radio and Satellite. To use them in combinations will depend on intimidation and threat:

- Both channels in EMCON.
- Both channels active.
- One channel in EMCON. In this case Satellite channel will be in EMCON, because it is more visible and has a stronger signal. However, the satellite and location of threat may guide to HF channel in EMCON and satellite active.

When both channels are open and depended on the complexity of the messages load, for the higher bandwidth the Satellite may be preferred and for the lower the HF radio is used. With a headquarters unit case, the channel would never be in EMCON status, but to support multiple satellites with more than one ship reached through different satellite services more channels will be needed. The Special Operations systems might be in EMCON status, which considered as a shore based system. It is noticeable that these scenarios of multi-channel offer some significant complexity [4].

### VI. IP OVER HF

HF link can form an essential part of a military IP network with the new arrival of fully automated and adaptive HF system. Due to the extraordinary and amazing radio coverage of HF, such a solution could offer IP services can be offered to the users with such a solution even if they are positioned beyond line of sight, and it is believed that it is the range limit of many communications systems at higher frequencies. IP over HF is an interesting substitute, for instance, for:

- Future shore-ship/ship-ship communications.
- Communications to Special Forces in hostile territory area.
- Last-ditch communications when the normal communications grid has broken down

The latency of the typical HF link will be very high and the throughput very low compared to most other links used in an IP network despite the fact of the improvements offered by the HF modem technology.

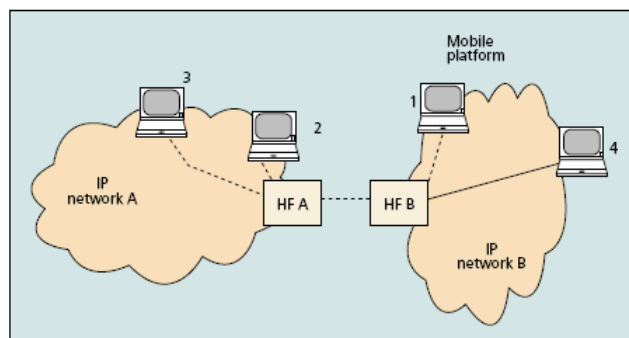


Figure 12 A model of IP networks connected by HF [5]

The HF link with no doubt will be represent as the bottleneck in the IP network in most of the cases, and

with a great impact on the Qos ( quality of service ) offered to the user. An HF link is used to connect IP network A and IP network B together in the IP networks connected by HF in figure 12 illustrated above. From figure 12 we can clearly see that the IP connectivity may exists between data terminals (2, 3) in the main network and terminals (1, 4) existed on the ship which is the mobile platform using 2G or 3G HF protocols. Above the network layer the protocols must be able to tolerate the high latency forced by the HF link protocols, in order to take the full advantage of the IP service. Parameter alteration may be necessary for the HF link protocols as well as the transport protocols, in order to reach pleasing and satisfactory performance in an IP networking situation. In figure 12 above each one of the nodes HF A node and HF B node comprise the HF radio/modem functionality, an optional link crypto functionality, an IP routing functionality, and the HF link protocols. All the mentioned functionalities are implemented in the available 3G HF system present in the markets. Accordingly a dedicated HF radio, which is what the 3G HF node is simply composed of, and also acts as IP networking component. In Figure 12 above, terminals 1–4 are data terminals, two of which host a STANAG 4406 MTA for provision of flawless MMHS service to the ship which is the mobile platform [5].

#### VII. SATELLITE NETWORK

The figure below illustrates a satellite connection between two routers. This shows a usual configuration, as in general the MTA will not be connected to a satellite router directly. To operate directly over IP the ACP 142 makes use of UDP (User Datagram Protocol).The below arrangement can work over any IP network, with the help of IP multicast. In all of the used routers Multicast support is required. [2]

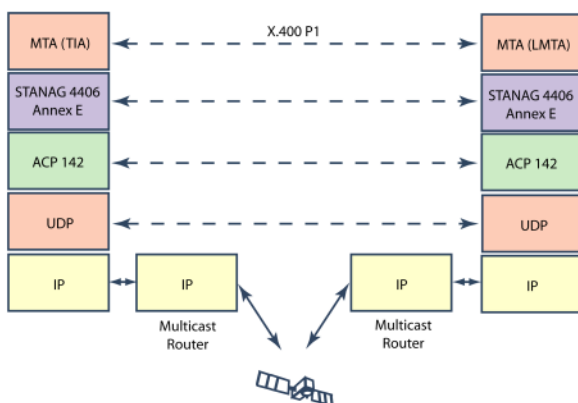


Figure 13 using STANAG 4406 Annex E and ACP 142 Over IP [2]

#### VIII. ADVANTAGE

The following are the advantages to using STANAG 4406 Annex E and ACP 142:

| # | Advantages                                                                                                                                                            |
|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | With protocols operating over TCP the recipients in EMCON is not possible while ACP 142 support it.                                                                   |
| 2 | ACP 142 is improved to work with and for high latency networks because Satellites have high latency.                                                                  |
| 3 | In order to optimize the overall network use for messages, which have been sent to multiple destinations, the ACP 142 permits the broadcast ability of the satellite. |
| 4 | Annex E can reduce data volumes because satellite networks are usually rather slow, and this can be useful.                                                           |

Table 2 Advantages of using STANAG 4406 Annex E and ACP 142.

#### IX. CONCLUSION

To conclude, STANAG 4406 is the NATO Standard that identifies the services and protocols required for interoperability between military systems implementation. The interface is between Military Message Handling System (MMHS), and the legacy ACP127 systems is the main focus. There are companies all over the world working in this field of communication. The reason that lies behind this interest in investing their money toward STANAG 4406 is because that it's the future of communication. Most of the militaries are heading toward having the best way to communicate and exchange information within and between their forces at sea, on the ground and in the air. The answer to a reliable, automatic and secure communication is STANAG 4406. In this paper it was explained how does STANAG 4406 provides enhancements for military services, even though communications in radio networks are still dominated by ACP127 radio systems, and the current plans are calling for the replacement of ACP127 by STANAG 4406 within NATO countries as soon as 2012.

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## Advanced Portable Projectors and Applications

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**Abstract-** The first projection was made during 1420 using a lantern as the light source and a small translucent window glass, through which light was passed on to a thin scaly image of a monk holding a lantern, which is now advanced to a potential where it can interact with us in our day to day life. This paper shows how a complete new novel class of emerging applications. The dimensions of the projector would be one of the main evolutionary changes, rather than its functionalities. The new generation of miniature or “Pico”-Projector Technologies is going to pay the inevitable price of portability. Some of the topics discussed are Portable Projector Technologies, their issues and applications in RFIG, Projector Interactions and Projective Geometry. Projectors could be the next emerging piece of hardware to be incorporated into mobile phones or any other hand held devices. They can also function as a smart light, which not only projects out images, but also provides with the required Optical Information.

**Key words:** Projector, Projection, Portability.

### I. INTRODUCTION

Portability is the key factor of the upcoming technologies. So when it comes to displaying, it had always been limited to the size of the screen, for example a mobile phone or a computer screen. However not in the case of a projector, in which it goes down when it comes to the portability. As we see in our daily life, Projectors are usually fixed to the ceiling of the roof or on the table. This paper describes about the portable, hand held projectors and their applications. A huge interest in industry is taken for the handheld projectors (which are defined as accessory projectors [1], a small sized battery powered projector which can be connected to mobile devices) and projector phones (mobile phones with Pico sized projectors embedded in them), which permit projection of high-resolution information, anywhere and potentially any size solving the trouble of the small mobile phone screen. Texas Instruments [2], Microvision in association with Motorola [3] and 3M [4] are some of them, who are currently working on small sized projectors and their incorporation into mobile devices [5]. A presentation of a full working prototype of a mock mobile phone with a built-in projector was unveiled at CES 2008 [6]. It is expected that these products will emerge in the market place in mid of 2010 if not before [3]. Pico projector applications are divided into three segments: (1) Embedded, (2) companion, and (3) stand-alone. In the embedded segment, the device resides inside the mobile device. So the power consumption and device size will be the most significant featuring criteria. On the other hand companion projectors, having their own batteries connected to the mobile platforms, will have intermediate size and light output [7]. This paper also describes about how the physical world can be

instrumented for objects, becoming self-describable and communicating their identity, geometry and other information, using radio frequency identity and geometry (RFIG) transponder, which shows the usage of a photo sensor attached to a wireless tag and a projector to the tag reader which can bring out excellent functionalities to allow geometric operations, such as locating the 3D position of a tag and detecting the changes in the shape of the tagged objects. This information is brought to the user through interactive projection using a handheld mobile projector which can update the projected information. [8]

### II. PROJECTORS

Just by mentioning the word “Projector”, our memories start flashing up many people with dull lectures in darkened rooms, boring business presentations or unending holiday picture’s slideshows. It is very hard even to imagine about someone getting excited regarding the technology. Some people think that projectors could be the next piece of hardware that could be integrated into mobile phones and other portable devices. As pocket-sized gadgets have become both smaller and more capable in recent years, the inevitable price that must be paid for portability is the new generation of miniature or “picot”-projector technologies that can display photos, videos, web pages and maps by beaming them onto a nearby wall or table. [9]

### III. CLASSIFICATION OF TECHNOLOGIES USED IN PICO PROJECTORS

*1..DLP (Digital light Processing) chip by Texas instruments.*

The semiconductor manufacturer, TEXAS INSTRUMENT showing a prototype digital projector, based on its digital light processors (DLPs), which could fit into a cell phone. The projector consists of three lasers, a DLP chip, and a power supply and is about 1.5 inches in length. This projector, which is fitted into the cell phone, can produce a DVD-quality video onto a screen, which therefore allows it to

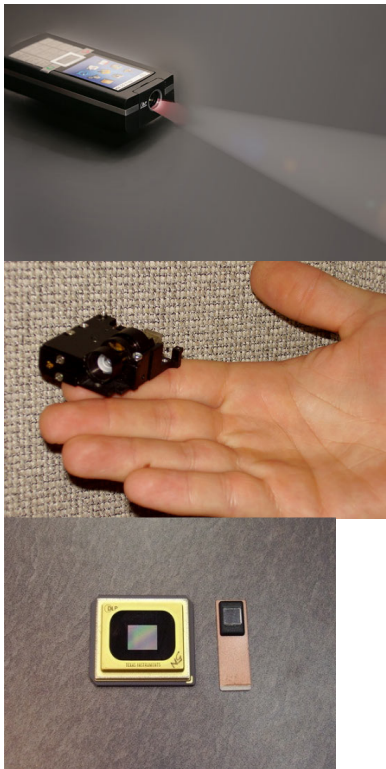


Fig. 1. A mock-up of TI's (Texas Instruments) functioning projector in a phone. 2. A completed pico projector which can be fit into a projector. 3. On the left is the DLP chip for a large screen TV and on the right is the small DLP chip for pico projectors[10]

serves the purpose of a video player. But in these projectors, the original size of the screen can be drawn to a much bigger size than what a person would get by using the LCD panel embedded into the phone. The chip inside the phone, would in fact, steer images for a widescreen television.

For several years the DLP chip was used in Projection TVs. In these Projection TVs, the images are projected onto the DLP, which is a chip that houses thousands of moving, small micro-mirrors, which in turn magnify the images and then project them on[10]. Though small, the chip can still project large images. Texas Instruments hopes that by using these chips, it can make more videos viewable on phones. By putting these chips into phones, TI hopes to make video watching on phones more enjoyable and therefore sell more chips[11].

## 2. Light Blue Optics

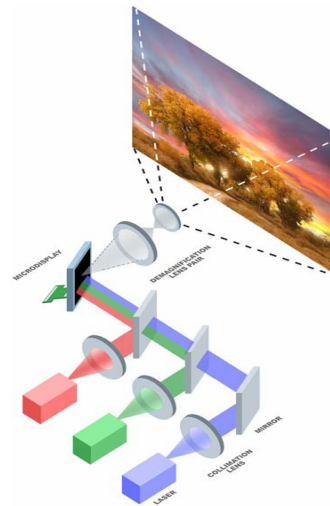


Fig. 2 A schematic diagram of LBO's projection technology[11].

Light blue optics (LBO) is a privately owned company which develops holographic laser projection technology registered in England and Wales. LBO has a fresh approach towards the range of differentiating qualities and benefits. The term "holographic" refers to the technique of projection, but not to the projected image. A required 2D image's diffraction pattern is calculated using LBO's patented holographic algorithms, which is then produced onto a custom-designed phase-modulating Liquid Crystal on Silicon (LCOS) microdisplay which is then lit up by a coherent laser light, which in turn projects the 2D image. The compatibility is very ideal for miniaturisation. The technology route is very consistent with the production of light engines as small as 5cc. This technology is capable of negotiating the optical aberrations by improvising the diffraction patterns, making the overall technology of low cost equipments and high-volume manufactures. In contrast to the conventional projection systems, which create dark areas by blocking light, Holographic laser projection technology drives all the light to the precise location where it is needed the most. The total system energy efficiency is low for video and photo content, delivering the highest lumens per watt, producing a very bright efficient display. It makes use of the laser light to produce high quality WVGA video images, replacing any need of viewing screens or surfaces. Its embedded speckle-reduction technique ends in producing considerable laser speckle reduction without compensating for either the high quality image or the system focus free operations.

In LBO's technology, there is no need of any manual focusing controls required as when compared to the conventional projectors. This technology uses a laser light as the source. Projection onto curved surfaces or any angled surfaces can be done without any distortion enabling the clear view of the image projected.[11] The limitation of this method is that the LCoS array uses more space than a single mirror, LBO's current prototype

projects a 1,600-by-1,024-pixel image using an 864-by-480-pixel array[12].

### 3. Microvision

About Micro vision, it is an innovative display and imaging solution company which was established in 1993, its headquarters is in Redmond, WA, USA[13].

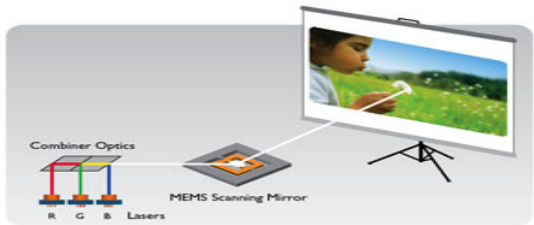


Fig.5. showing the process of projection in microvision using mems scanning mirror[13].

Microvision's ultra-miniature full-colour digital projection produces an image of approximately the size of a Thin Mint candy, the engine is designed to be embedded into small handheld electronic devices such as cell phones, PDAs, (January 2007 Consumer Electronic Show). The projectors developed at Microvision consist mainly of two parts, the first one is a laser set of red, blue, and green which are of semiconductor material, such as gallium indium arsenide, and the second part is a mirror of one millimetre which tilts on two axis. The simple technique is that the lasers are focused onto the mirrors, and which in turn reflects onto the pixel of light onto a screen or any surface. The colours produced from the varying intensities of the lasers, and at the end when the light is blasted out in full, it beams out a white pixel, which in turn goes to a black pixel when all the three go off. The other colours are produced from the various combination of the three sets of lasers. And now the projection is done by beaming the laser towards the mirrors which gimbals on the two axis, flickering to generate over 30 million pixels for a single second which in turn illuminate the surface for 20 nanoseconds. Implementing this single mirror setup, the projector paints the image onto the screen at the rate of one pixel at a time. Due to the speed at which the images are painted, our eyes perceive a static image or a continuous movie. The challenge is to design a fast gyrating mirror which should coordinate along the lasers that turn on and off 100 million times a second. Embedded into the Microvision mirror's are silicon mechanical structures that can compute strain on the mirror, detecting the positioning of the mirror. The laser modulator is fed back with the data from the position of the mirror, which determines if a laser is emitting light or not, allowing the system to continuously correct accordingly to the requirements of the projected image. All the equipment that is the mount, mirror and the other mechanical components are made up of silicon sectioning out the projector to a class of devices called MEMS (microelectromechanical systems)[12]

### IV. HANDHELD PROJECTORS AND APPLICATIONS

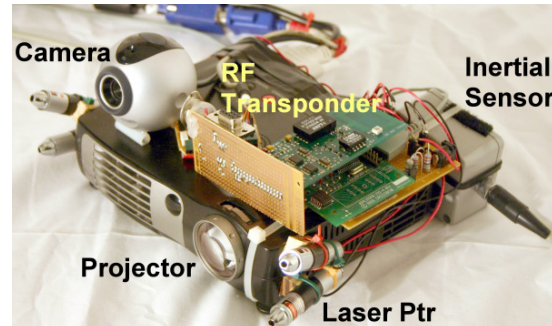


Figure 4: Handheld projector system [8].

#### Components

The components of the prototype handheld projector system in Figure 4 are

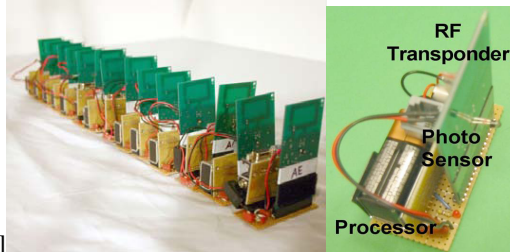
- a Plus V-1080 projector with 1024x768 resolution, 60Hz frame-rate, dimensions 7\_5\_1.5 inches and weight 1kg,
- a rigidly attached 640x480 pixel webcam is used to compute the position and orientation of the device, and also for the handling the user interaction that confine surface texture.
- a rigidly attached AC&C VS123 6DOF inertial sensor (accelerometer and gyroscope), this is for handling the computation of pose by giving out the high-frequency estimate (160Hz) of changes in the pose.
- four rigidly attached laser pens invisible IR, these are used for the display out the unique points on the screen or the projection surface to carry out the computation of pose
- a Parallax board for RF communication at 433.92 MHz with data transfer rate of 2400 baud,
- two click buttons for simple input and output,
- a computer[8].

### V. RADIO FREQUENCY IDENTITY & GEOMETRY (RFID)

There has been significant research in modifying and interfacing projectors for novel

The work was motivated by the advent of RFID tags. RFID has antenna attached to a microchip which in turn stores its identification and has some computing power. Passive RFID requires no batteries, they are very small in size equal to the size of a rice grain and of low cost. RFID is used in variety of applications like warehousing, inventory, live stock tracking, routing, baggage handling and many more. The RFID reader broadcasts a request and all the tags in the RF range capture the energy and responds back with the data. In most cases the data is identity number typically a 96 bit IDno, which acts as index to an online database. However the reader actually doesn't know where the tags are located geometrically. For example, by using the reader, it is very easy to find out the tagged books in a library, which are present in the range, but without a precise information it is very difficult to find out if the books are in the correct alphabetical order and without orientation it is difficult

to locate if the books are upside down .Taking another, example if an operator in a warehouse wants to find out as to which objects or boxes are close to the expiry date , he will have to go through the manual procedure of scanning and checking each and every one of them, as it is difficult to give a visual feedback. The solution to this problem is to enable geometric interaction



[8]  
Fig. 5 .(a)Fourteen of the tags and (b) Details in a RF tag and photosensor [8].

The solution is simple by adding a photosensor to the RF tag so that it can sense the light when incident on that tag and in this way the photosensor can communicate with the RF reader. The Spatial temporal light modulator (projector) can be used as the light emitting device as it beams information in a very directional manner as shown below in figure 6the conventional RF tag system and the photosensor RF tag [8].

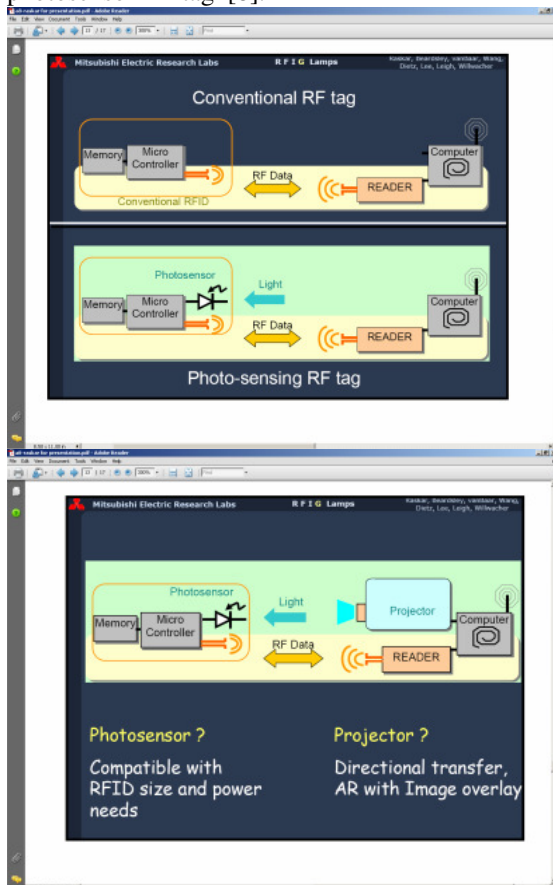


Figure6. (a)architecture of a conventional RF tag and a photosensing RF tag (b)Communication between the photo sensing tag (left) and handheld projector system (right)[14].

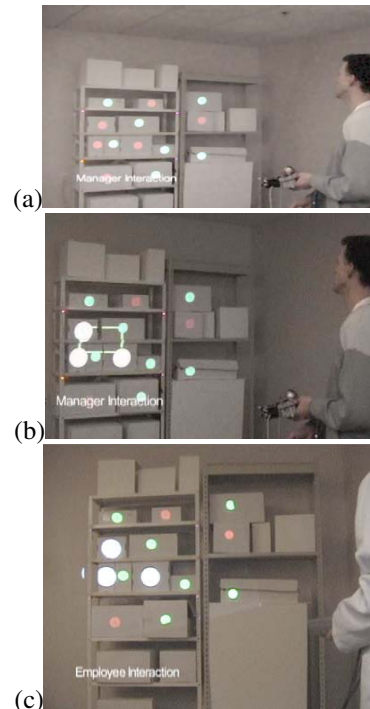


Figure 7. Warehouse scenario implementation. (a) Manager locates items about to expire (marked in red circles) and (b) annotates some of those items (marked in larger white circles) (c) Employee retrieves and views the same annotations from a different projector view.[8]

#### Inventory control

Now say if a manager wants to check the products in a store, whether if they are about to expire or not, he does it by aiming the handheld projector onto the shelf, does the Structured Light Projection and finds out that the boxes with the red colour are about to expire and the ones in the blue are not. He then selects a subset of red-circled objects by Region Selection and then the illumination of the circle changes to white in colour, whereas the other spots remain stable without any change. The manager then selects and transmits the RF request to remove the selected objects, so the RF tags record these internally, and now the employer comes in and selects and transmits the RF query from a different projector view and gets the annotation of his manager as to where they are stored internally and thereby replaces those products successfully. as shown in the above figure 7(c)[8]. To locate a photo sensor tag, beams of binary coded structured light are projected on to the desired area .The main idea is only to send a temporally unique code per pixel ,so that each tag can compute parallel, of which the x and y coordinates of the pixel illuminate the photo sensor attached to the tag, In this case lets us say we have a 5-bit code ,which can distinguish 32 columns of a projector and can indicate the photo sensor dot on the box . Out of the 5 frames which is formed in the binary code structured light, a code of 01100 is formed as the

dot is in the black region which makes it zero and one when it is in the white region, forming a total it is in the 12<sup>th</sup> column as shown in the figure. , similarly the horizontal pattern is also projected to find out the y coordinates, after which the value is send. And when the reader receives the X,Y positions it tells the projector to illuminate those pixels ,so that the corresponding tag location are visually marked which gives back a feedback regarding the position of the tag .as shown below in figure 8(b) [8].

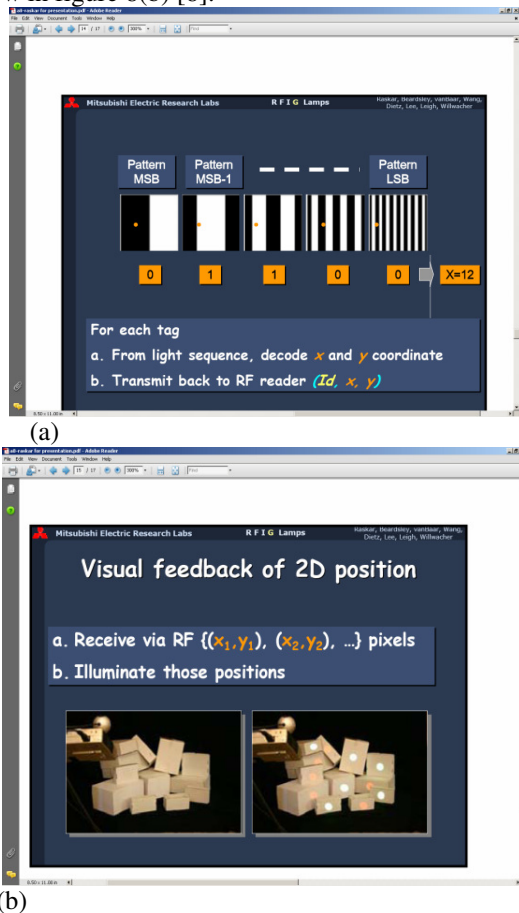


Fig 8. (a) The projected sequential frames from the handheld projector (b) the visual feedback of the 2D position of the illuminated RF photosensor tags [14].

#### VI. ARRANGEMENT 3D COORDINATE FRAME FOR TAGS

The present tag systems are not functional for creating a 3D coordinate frame. For a handheld use there are no appropriate devices that could provide direction between RF-reader and tag. There are a few who require meter-wide antenna, or more than one RF readers to distribute. The main objective is the course of small, indiscernible tags. The proposed way is the following approach

The handheld projector device is casually aimed toward the direction of a tagged surface like that in Figure 9(a).

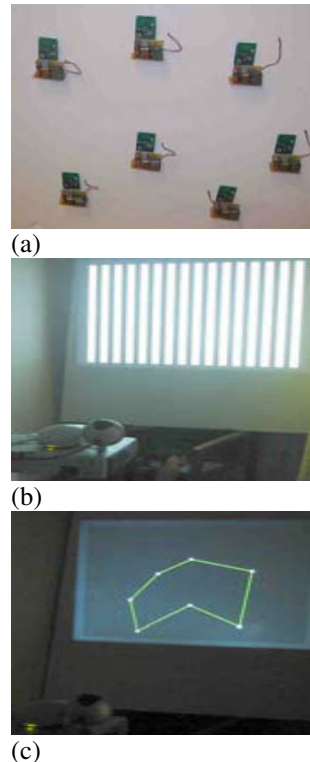


Figure 9. (a) A tagged surface, (b) One frame during Gray-code projection, (c) Correctly-placed projected augmentation [8].

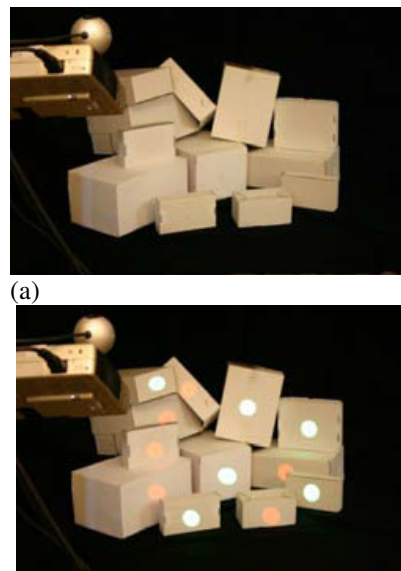


Figure 10. The projector beam reveals the presence of tagged objects [8].

For synchronizing the tags a RF signal is send from handheld device is followed by illumination in a continuous binary pattern .For example the frame in. see one example frame in Figure 9(b) describes about the unique temporal gray-code which is emitted by each projector pixel. Gray-code which is incident on the photo-sensor is records by the tag and then transmits it to the RF

of its identity in addition to the recorded gray code is fed back to RF-reader.

The camera that is installed on the handheld device also observes the projected light and determines where each Gray-code appears in the camera's view of the surface. Therefore, through the Gray-code, we can know the following information for the tag.

Which pixel **p** projector is illuminating it, and which pixel **c** camera is viewing it. Hence this is a measured projector-camera system; this decreases to a triangulation problem in which we intersect the 3D rays associated with pixel **p** for the projector and pixel **c** for camera to explore out the 3D position of the tag. It is then a clear-cut to create precisely positioned augmentation on the tagged surface as shown in Figure 9(c) and Figure 10. [8]

## VII.CONCLUSIONS

Portable projectors are opening up newer areas of applications; the rising need for building smaller things is a key factor. These kind of portable projectors are very flexible and have loads of applications in our daily life. And the basic thing is a light source (laser), sensor calculations and grouping capability. The embedding of pico projectors into mobile phones has made it clear that an advancement of the present applications will change drastically, in which the user will network in a great amount of information which direct towards a whole new way of interacting [5]. This paper is a brief study of the portable projectors, and the classification of different technologies in this emerging research field of pico projectors and its significantly endless applications, also about how the wireless RFIG tag system brings in geometric operations. These projectors technology is building up the gap between the physical world and the digital worlds by creating the day to day activities to be more self describing and a medium of interaction. [8]

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## WiMedia Applications and Challenges

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**Abstract:-** Traditional business models of mobile communications will be challenged in the near future because of current demands of high speed personal area networking. Internet-based streaming, video services and high definition wireless video connections within the home are an essential feature of the next phase of digital revolution. Ultra Wideband (UWB) radio technology will play a prominent role in enabling these services and products with its very high speed, low cost and low power consumption.

This paper presents an insight into the WiMedia: its origins, current status, applications and standardization. WiMedia® is the regular radio platform for ultra-wideband (UWB) wireless networking. The standard incorporates Medium Access Control (MAC) and physical (PHY) layer specifications based on Multi Band – Orthogonal Frequency Division Multiplexing (MBOFDM) technique. It offers solution to enable data rates up to 480 Mbps with lower power consumption.

**Keywords:** WiMedia, UWB, OFDM, WPAN

### I. INTRODUCTION

WiMedia is the standard radio platform for Ultra Wide Band (UWB) wireless networking. The standard incorporates Medium Access Control (MAC) and physical (PHY) layer specifications based on Multi Band – Orthogonal Frequency Division Multiplexing (MBOFDM) technique. The platform is also optimized for Wireless Personal Area Network (WPAN) technology such as Protocol Adaptation Layer (PAL), Bluetooth 3.0 and Wireless Universal Serial Bus (USB).

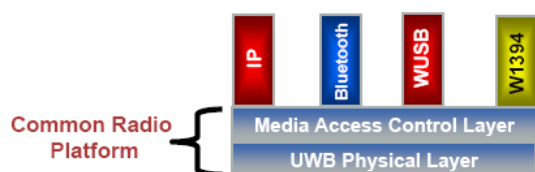


FIGURE 1: COMMON RADIO PLATFORM

Figure 1 refers to the WiMedia UWB common radio platform that enables high-speed (480Mbps and beyond), low power consumption multimedia data transfers in a wireless personal area network (WPAN). The common radio platform enables the different systems like Bluetooth 3.0, WUSB and Wireless 1394 to work co existing without any problem. [3]

WiMedia UWB has been selected by the Bluetooth and WUSB Implementers Forum as the foundation radio of

their high-speed wireless specifications for use in next generation consumer electronics, mobile and computer applications. There are over 200 international member corporations and research institutions which support the non-profit WiMedia Alliance, developing specifications, certification tests, and educational programs.

### II. REGULATORY EFFORT

IEEE 802.15 is the specialized group in [Wireless PAN](#) (Personal Area Network) standards. The IEEE 802.15 includes six task groups. The task group 3 works on 802.15.3 High Rate Wireless Personal Area Network (WPANS). The task group is working to define a universal standard of ultra wideband radios capable of high data rate over a distance of 10 meters using the 3.1GHz to 10.6GHz band for TVs, cell phones and PCs. Besides a high data rate, the new standard will provide low power, low cost solutions addressing the needs of portable consumer digital imaging and multimedia applications. When it is combined with the 802.15.3 PAN standard, UWB will provide a very compelling wireless multimedia network for the home. Thus the IEEE 802.15.3 standard enables the wireless multimedia applications for portable consumer electronic devices within the home coverage area. This standard supports the wireless connectivity for gaming, printers, cordless phones and other consumer devices. Thus it can be used to develop wireless multimedia applications including wireless surround sound speakers, portable video displays and digital video cameras. So, it addresses the need for mobility, quality of service and fast connectivity for the broad range of consumer electronic devices. [4]

#### A. WiMedia Alliance

The WiMedia Alliance in association with the International Standards Organization (ISO), published radio platform specifications for high-speed ultra wideband (UWB) that will be the catalyst for enabling a new era of connectivity — particularly for battery-operated devices. WiMedia's UWB radio operates in the unlicensed spectrum between 3.1GHz and 10.6GHz which in 2002 the FCC had allocated in the U.S.A for the enterprise and the more general consumer use. Subsequently, regulatory agencies in all major markets worldwide have adopted similar regulations to enable UWB use in their respective regions.

WiMedia Alliance which is led by Intel has approximately 214 members. These members belong to many different technologies from different countries. Famous participant companies are Hewlett-Packard, Hitachi, Microsoft, Nokia, Panasonic, Sony and Texas Instruments. The focusing point of all these participants is to adopt UWB technology to provide the best services using their products. ECMA International (European Computer Manufacturer's Association) has already adopted WiMedia as a standard, and the International Organization for Standardization (ISO) and the European Telecommunications Standards Institute (ETSI) are in the process of doing the same.

### B. UWB Spectrum

WiMedia UWB spectrum is divided into five band channels each channel have three sub groups, except the group number five which have only two groups. Each subgroup has 528 MHz of band, so in total the spectrum has fourteen sub bands.[2]

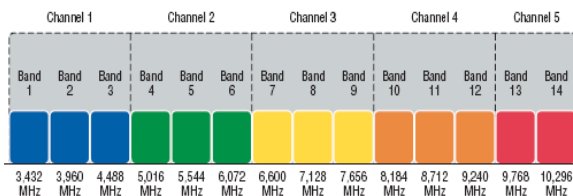


FIGURE 2: UWB SPECTRUM

Each of the 528 MHz band is further divided into 128 frequency channels. All these channels are orthogonal so they do not interfere with each other.

### III. UWB WORKING

UWB allows new transmission techniques to coexist with other RF systems with minimal or no interference at all. It transmits low-power, short-range signals by using extremely short low-power pulses which lasts only about 1 nanosecond. It transmits over a band that is at least 500 MHz wide so very high data rates are achieved.

UWB uses Frequency Hopping Spread Spectrum (FHSS) or Direct Sequence Spread Spectrum (DSSS) in order to spread the signal over a wide band. In FHSS the signal covers full bandwidth of a device's transmitting frequency.

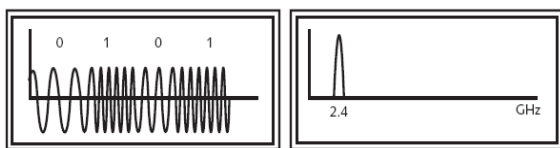


FIGURE 3: NARROWBAND FREQUENCY MODULATION

UWB does not use the traditional modulation methods, one of which is shown in Figure 3. Instead it uses a technique called Impulse modulation shown in Figure 4.

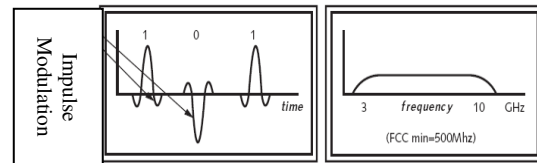


FIGURE 4: UWB IMPULSE MODULATION

The WiMedia works on the principle of Multi-Band Orthogonal Frequency Division Multiplexing (MB-OFDM). The current OFDM modulators are limited only to approximately a 500 MHz bandwidth. In order to gain more of the advantages of UWB, multiband OFDM uses a frequency hopping technique which makes it more efficient. This allows further spreading of the conventional OFDM signal and thus more attractive for indoor environments, where interference and multipath are common. The WiMedia OFDM modulation is basically the frequency hopping over a band group which is composed of 528 MHz wide bands. A Time Frequency Code (TFC) controls hopping of OFDM signal across the band group. Comparative to the most common Frequency Hop Spread Spectrum (FHSS) signals, the MB-OFDM with an uncomplicated hopping pattern very quickly sends one symbol during each hop.

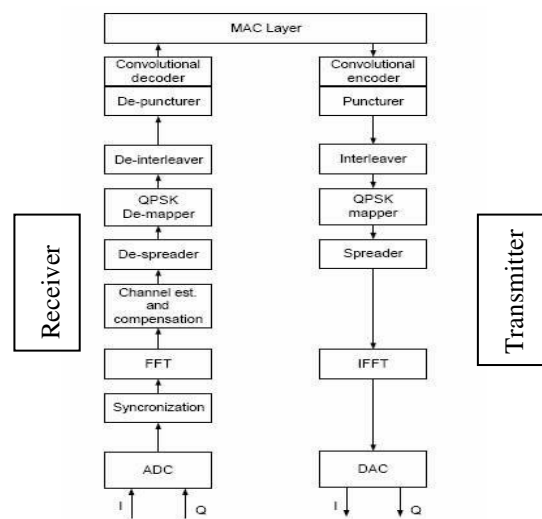


FIGURE 5: MB OFDM TRANSCIVER BLOCK DIAGRAM [9]

The combination of short pulse duration with an OFDM signal structure provides scalable data rates, excellent propagation characteristics and the spectral flexibility to coexist with other complementary wireless systems. The MB-OFDM approach offers other advantages including high data rates of hundreds of Mbps at short ranges of about 10 meters and very low power consumption. Future evolution of WiMedia will push the maximum data rate to multiple Gbps. The WiMedia standard has specified a Detect and Avoid (DAA) scheme where transceivers listen to the band and see

if any other signals are there before transmitting, and avoid transmissions in busy bands to help mitigate interference to other users. This addresses a persistent concern about using UWB signals even at low power levels and even in some countries it is a regulatory requirement.

#### A. UWB Comparison

WiMedia will dominate the home networking market and will provide an inexpensive LAN alternative in the near future. UWB provides 50 to 500 times the data speeds of Bluetooth solution, allowing transmission of large amounts of data i.e. transmission of video files between TVs or PCs as well as enabling high quality video applications for portable devices. Table 1 shows the comparisons of Bluetooth, Wi-Fi and UWB for frequency, distance and data rates. UWB seems to be mostly getting the most out of the frequency spectrum in terms of the data rates provided by it.

TABLE 1: COMPARISON OF DIFFERENT TECHNOLOGIES

|                | Bluetooth | Wi-Fi          | UWB            |
|----------------|-----------|----------------|----------------|
| Frequency      | 2.4 GHz   | 2.5 GHz , 5GHz | 3.1 - 10.6 GHz |
| Range (meters) | 10        | 15-30          | 10-15          |
| Data Rate      | 50 KBPS   | 5 MBPS         | 200-300 MPBS   |

For the purpose of comparison, Figure 6 shows the time taken and power consumption for the transfer of a 4GB data by Bluetooth, Wi-Fi and UWB respectively. [1]

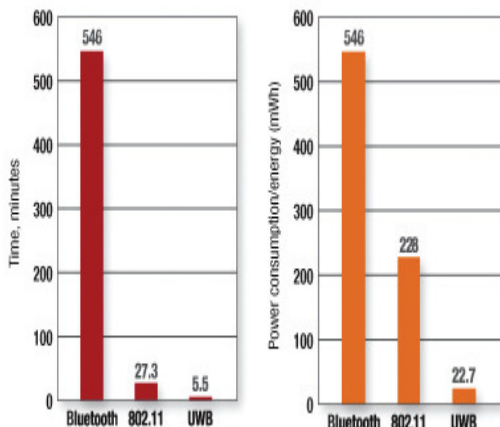


FIGURE 6: THE COMPARISON OF DATA RATES FOR DIFFERENT TECHNOLOGIES

We assume a 300Mbps transfer rate for WiMedia UWB and average power consumption of 750 mW during active mode, this 4 GB transfer would take about a minute and a half and consume 22.7 mWh.

Then, for implementation of a 802.11g, assuming a 20Mbps transfer rate and an average 500mW active-mode power consumption, the transfer of a 4 Gbytes of data would take about 27 minutes and consume 228mWh.

While for a Bluetooth implementation, assuming a 1Mbps transfers rate and an average of 60mW active-mode power consumption, transmitting 4 Gbytes of data with Bluetooth would take about nine hours and consume 546mWh.

#### B. Characteristics of UWB

WiMedia brings some characteristics to wireless multimedia networking that makes it the ultra-platform:

1) *Ultra-popular*: The WiMedia Alliance is commonly known as an open industry association has its members all over the world from all the technologies. Those include mobile industry, computer industry, short range devices industry and defense departments etc. The members are located in all geographical areas such as Asia, Europe and North America.

2) *Ultra-friendly*: The WiMedia Alliance views ease-of-use as the key to consumer acceptance. Wi-Media Alliance is working with other organizations to make sure that the wireless networking is transparent to average users. The Alliance is achieving this by helping to establish a uniform industry approach that is simplifying the installation process and also the operation for consumers. WiMedia is addressing this urgent need for clear co-existence guidelines when multiple devices share the same wireless spectrum for communication on the same network.

3) *Ultra-trustworthy*: WiMedia is committed to define and certify specifications that build trust for consumers by making trust devices to be secure and private. Only then it will be able to deliver glitch-free High Definition video and the trust that future products will remain compatible. Ensuring the interoperability, quality of service and security are the key goals of the WiMedia Alliance.

4) *Ultra-smart*: Smart new technologies recognize their place in the real world. WiMedia recognize the fact that it lives in the era of the well established wired protocols that want to extend into the wireless applications, where batteries have limited lives, and where wired "backbone" technologies will continue to exist for a good reason. Since WPANs are designed for a very limited area, WiMedia is complementary with existing and the emerging wired "backbone" approaches.

5) *Ultra-powerful*: Ultra wideband wireless technology offers fantastic potential for bandwidth intensive multimedia applications. WiMedia will continue to develop the Multi-Band OFDM physical layer radio (PHY) and a sophisticated medium access control layer (MAC) optimized for mobile multimedia applications. This will ensure that the WiMedia-enabled devices offer a very powerful and high-performance connectivity for both fixed and mobile applications. Furthermore, the fast

device discovery and association makes sure that the devices can quickly and easily join and leave an ad-hoc network.

### C. UWB Technology General Applications

1) *Wireless HDTV*: The Wireless HDTV will simplify the home theater systems and get rid of costly HDMI cables and routing. With the advancements in the flat panel displays and popularity, hiding cables is user friendly and visually pleasing as well.



FIGURE 7: UWB TECHNOLOGY APPLICATIONS 1

2) *Wireless Speakers*: Wireless Speakers remove the most expensive cables in the home theater. The speakers typically require hard work in the installation and long speaker wires automatically degrade performance and quality.

3) *Printers*: Printers enabled with Wireless USB can be moved off the home desk and dwelled where they are most convenient. Furthermore, a wireless USB enabled printer can be connected wirelessly to a USB camera for direct printing.

4) *Cameras*: Cameras benefit from high bandwidth short range wireless so they may quickly and easily be synchronized with a PC. By using streaming services, cameras can share photos and videos with each other more simply and quickly.

5) *Mass Storage Devices*: Mass Storage Wireless Devices can be used to back up a notebook when present, thus removing the hassle of connecting USB wires to your backup drives.

6) *Wireless Docking*: Wireless Docking actually means that a notebook can seamlessly connect to all the peripherals in a home. Using WiMedia protocols like WUSB and Streaming Services, the docking station will apparently disappear and all devices are set free, including your display and pc speakers.

7) *Wireless Projectors*: Conference projectors normally have very long expensive VGA cables to connect the output of a laptop to a projector mounted in the ceiling. By the use of Wireless USB, notebooks can be directly connected to the projector and thus content can be shared without any need of cables layout.



FIGURE 8: UWB TECHNOLOGY APPLICATIONS 2

8) *Web cams*: WiMedia enabled Web cams can now be located anywhere in the room providing more interesting camera angles without the need of long USB cables.

9) *Digital Picture Frames*: Now we can hang Digital Picture Frame on the wall and do not need to attach to the PC to synchronize with it. A WUSB enabled Digital Picture Frame can be mounted which can automatically synchronize whenever the host PC is available with new pictures. [7]

## IV. LIMITATIONS IN WIMEDIA TECHNOLOGY

### A. Power Management

All wireless devices have limitations in battery power. Especially Bluetooth is a device which has the main concern for power. Bluetooth is also used to connect the handset and a Bluetooth earpiece. On the other hand, Wi-Fi connects laptops, PCs and some other devices to internet via access point. But WiMedia applications are expected to be much more in range and capabilities. So the engineers have main concern to also power management.

Although UWB devices are becoming mature but power management especially for battery enabled devices is still a problem. It is creating the challenges for engineers that how manage the power because their battery backup is not for long time.

Bluetooth and some Wi-Fi devices have advantage over UWB devices in sleep or standby mode, because these devices consume very low power in standby mode than UWB devices. In digital circuitry, clock gating and Power gating are the techniques those are used to achieve low power consumption. These techniques are discussed below:

1) *Clock Gating*: In clock gating there is power leakage because you turn off the clock driving the circuitry. Although this leakage is minor but what happened if there are millions of transistors used then for sure it will become significant loss.

2) *Power Gating*: Power gating is the technique in which the power supply to some certain areas of a chip is powered off. In this way, even a minor leakage will not happen because no power is used which will result in a significant reduction in power when millions transistors

are in use and half of them are off. It is clear that power gating is fine, but, power gating is not too mature at this time. But as this technology will be so mature that it can be used in market for commercial purpose, then it will ideal for spectrums of UWB.

### B. Security Issues

WiMedia radio is largely a digital process so it is secured with the digital encryption. Today the AES-128 standard for encryption is widely used and believed to be secure. Given that the WiMedia radio is a digital design, adding AES-128 encryption is relatively straightforward and does not slow down the transmission process as it is an integral part of the radio transmitter.

Older wireless communication schemes like Bluetooth and Wi-Fi have been criticized for weak security, and the latest versions now include AES-128 encryption, but interoperation with older devices is problematic. Since WiMedia is a new technology, so it is free to exploit encryption in new ways without concern for backward compatibility. Following methods can be used to enhance the security:

1) *Unique IDs*: All the devices can have unique device IDs, so they can generate cryptographic checksums that can guarantee that a message is originated from a specific device ID. This is a guard against spoofing from a third party attempting to represent themselves as somebody else.

2) *Sequence Numbers*: The messages that are sent can include a cryptographic sequence number. This can make the system safe against any 'replay attack'. An attacker can't capture messages and replay them later as the sequence numbers will not be correct, and the messages will be rejected.

3) *Cost of Components*: WiMedia will have a very tough competition with the other existing technologies regarding the cost of the chips. Experts believe that in order for this technology like other WPANs the cost should be reduced. The cost of the cables is almost half the price to that of a Wireless device connecting two equipments.

4) *Spectrum Conflict*: Bluetooth, Wi-Fi and WiMedia can have issues of frequency interference with each other. In order to minimize the interference, algorithms should be developed in order to reduce serious problems.

## V. CONCLUSION

WiMAX and Wi-Fi networking technologies truly support data transmissions over longer distance with good speeds efficiency in WANs and LANs respectively but in the end only WiMedia can provide the best speeds and great efficiency in the 10 meter range of connectivity through a high-speed WPAN.

The world's leading consumer electronics (CE), personal computer (PC) and mobile device companies actively support the WiMedia Radio platform exemplifying its importance and position in the industry. Indeed, WiMedia UWB has been selected by both the Wireless USB Promoters Group and the Bluetooth SIG as the foundation radio for their high-speed wireless specifications. CE device manufacturers now want to provide the connectivity solution to develop faster, cheaper, more efficient smart phones, cameras, portable media players and new gadgets that are being invented to exploit the latest advances in technology and connectivity speeds. If the challenges like speed, security, cost, industry support, interference, and protocol limitations are worked upon in time, the WiMedia will be able to replace the old and traditional systems quickly.

In today's information-based society, the compelling need to instantaneously transfer large amounts of data and rich media will drive the integration of WiMedia Radio technology into a wide array of devices used in both the home and business environments. In addition to the laptops shipping today, InStat has projected that over 400 million UWB enabled devices will ship in 2011. [8]

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## Control System for Modern House

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**Abstract:** A modern home potentially has a great number of sophisticated electrical systems, including security systems, audio/video systems, telephone systems, intercom systems, etc. The Control system for Modern house is designed to provide an efficient control and security system for the modern house. Here the house is assumed as a individual, which has separate gate. The system is designed with IR, human, fire, temperature, and with the password protection for the door. Also automatic gate opening is provided when the owner's car reaches to the gate. An IR transmitter is attached to the vehicle, and a IR receiver is attached to the gate. When the car comes near to the gate the IR rays are detected by the IR receiver at the gate; the controller identifies this and gives a signal to open the gate. An electronic door locking/unlocking system is attached to the door. A keypad was provided in that system to enter the security password. If the password matches the door opens otherwise, if any unauthorized person tries to open the door by entering the wrong password more than 3 times, the controller gives the signal to the security alarm (buzzer). The power system for the home appliances is deactivated when we lock the door automatically except for some necessary appliances like refrigerator and the security sensors. The total power system for the home is activated upon opening the door. Also a light is switched on automatically in the hall when you first enter into the hall.

**Keywords:** Control system, sensors. Security, automation.

### I. INTRODUCTION

*Aim:* The main aim to design the project is to provide a control environment to the home or the area where the security and the control takes a important place.

*Objective of the Control System for Modern House:*

Home automation systems enable control of lighting, heating and air conditioning, window shades or curtains, pool heaters and filtration systems, lawn sprinklers, ornamental fountains, audio/visual equipment, and other appliances. Home automation systems will be integrated with a home security system so that when a fire alarm is raised, for example, internal and external lights will be turned on.

### II. OVERVIEW OF THE CONTROL SYSTEM FOR MODERN HOUSE

The "control system for modern house" is designed to provide security system for the modern house. Here the house is assumed as an individual, which has separate gate. The system is designed with IR, human, fire, temperature, and with the password protection for the door. Also automatic gate opening is provided when the owner's car reaches to the gate.

An IR transmitter is attached to the vehicle, and a IR receiver is attached to the gate[1]. When the car comes near to the gate the IR rays are detected by the IR receiver

at the gate; the controller identifies this and gives a signal to open the gate.

An electronic door locking/unlocking system is attached to the door. A keypad was provided to enter the security password. If the password matches the door opens otherwise, if any unauthorized person tries to open the door by entering the wrong password more than 3 times, the controller gives the signal to the security alarm (buzzer). The power system for the home appliances is deactivated when we lock the door automatically except for some necessary appliances like refrigerator and the security sensors. The total power system for the home is activated upon opening the door. Also a light is switched on automatically in the hall when you first enter into the hall. This is designed with the smoke sensor to detect any fire. If any fire is detected the controller identifies this with the sensor, and it gives a security alarm with the buzzer connected to the controller. The system is provided with the automatic power off feature when there is any fire is detected. This is provided with automatic control of the lights attached to the compound wall. This is possible by interfacing the LDRs with the controller [1]. All the controlled devices are connected to the controller via the relays. The IR remote is provided with this system to control the home appliances remotely. From this we can control pool heaters, sprinklers etc. This is designed with the smoke sensor to detect any fire. If any fire is detected the controller identifies this with the sensor, and it gives a security alarm with the buzzer connected to the controller. The system is provided with the automatic power off feature when there is any fire is detected.

This is provided with automatic control of the lights attached to the compound wall. This is possible by interfacing the LDRs with the controller. All the controlled devices are connected to the controller via the relay.

### III. MICRO CONTROLLER

In this system work the micro-controller is plays major role. Micro-controllers are originally used as components in complicated process-control systems. Of course, because of their small size and low price, Micro-controllers are now also being used in regulators for individual control loops. In many areas Micro-controllers are now outperforming their analog counterparts and are cheaper as well. All the Industrial parameters will be controlled by the Microcontroller.

*Power Supply:* In this system we are using 12 volts and 5 volts power supply 5 volts for Microcontroller [3] and DC motor & Relays will be operated on 12 volts Keypad is a switch used to provide the condition for the operation of the microcontroller.

**LCD Display:** The status of the Input & output parameters will be displayed on LCD.

**Smoke Sensor:** Smoke sensor is used to detect any leakage of smoke and any hazardous gases.

**PIR Sensor:** The PIR Sensor is used to detect the movement of the object or the thing.

**IR Receiver:** The IR Receiver is used to detect the IR signals transmitted.

**Relays:** In this system Relays are used to the Trip the parameters. A relay is works like an electrical switch, which opens and closes under the control of another electrical circuit. In the actual form, the switch is always operated by an electromagnet, to open or close one or many sets of contacts.

- A. **Buzzer:** Buzzer is used to sound when ever certain condition which is undesirable
- B. **Dc Motor:** The DC Motor is used for the demonstration purpose we are identifying it as a home appliance.

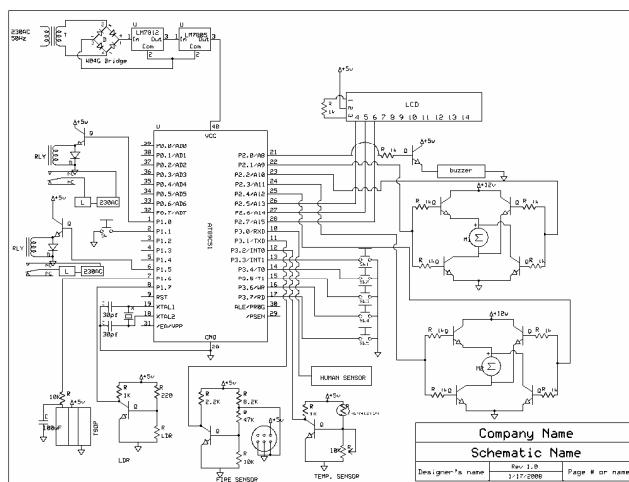


Fig.1 Schematic diagram.

#### IV. SCHEMATIC EXPLANATION

In “control system for modern house” we are using different type of sensors to detect and control the appliances Here the detailed explanation about micro controller pins to which these sensors are connected.

**PORT ‘0’:** This port pins (complete 8-pins) are dedicated to the data pins of LCD pins. Through this pins only the data will be send to the LCD and that will be displayed on screen [4].

**PORT‘2’:** Out of 8-pins last three pins (p2.5, p2.6 and p2.7) are connected to the control pins of the LCD. RS pin is to select the register i.e. command register or data register of the LCD, R/W pin is for read or write operation in to the LCD and last one EN is to enable the LCD. First pin i.e.p2.0 pin is connected to the buzzer which is a indication for the smoke sensor and also for the door security purpose i.e. if anyone enter wrong password more than three times this buzzer will ‘ON’

P2.1 and p2.2 pins are connected to the motor1s, p2.1 to rotate the motor in forward direction and p2.2 is to rotate in reverse direction. This motor will be connected to the

door such that based on the entered password motor will rotate in corresponding direction (door open or close).

P2.3 and p2.4 pins are connected to the motor2, p2.1 to rotate the motor in forward direction and p2.2 is to rotate in reverse direction. This motor will be connected to the gate based on the IR sensor.

**PORT ‘1’:**Out of 8-pin p1.0 and p1.5 pins are connected to the bulbs (B1andB2) through relays, when the PIR sensor, Temperatures sensor and LDR sensor detects moment, change of temperature and change of light respectively these devises are going to be “ON”.

P1.6 and p1.7 pins are connected to IR sensor and LDR sensor respectively. If IR sensor detects any obstacle it will send the information to the controller and the controller will control the corresponding device. LDR sensor detects any change in light this one also sends the information to the controller and the corresponding device will be controlled.

**PORT ‘3’:** P3.0, p3.1 and p3.2 pins are connected to the human sensor (PIR), fire (smoke) sensor and temperature sensor respectively.P3.3 to p3.7 pins are connected with switches to enter the password to open the door for security.

For the past three decades have seen the introduction of a technology that has radically changed the way in which we analyze and control the world around us. Born of parallel developments in computer architecture and integrated circuit fabrication, the Microprocessor and the Microcontrollers became a commercial reality [5].

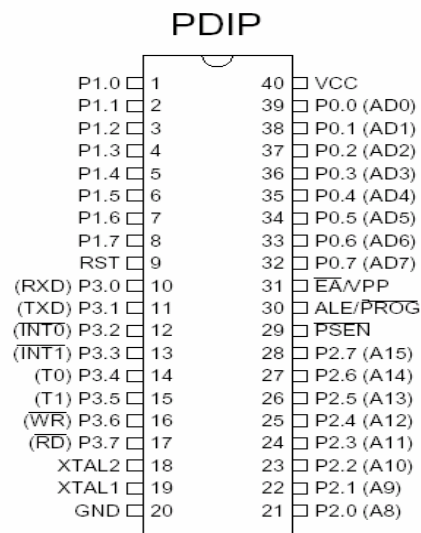


Fig.2 Pin Configuration of AT89C51

#### V. PIN DESCRIPTION OF AT89C51

##### VCC:

Supply voltage.

**Port 0:** 8-bit bi-directional input-output port.

**Port 1:** 8-bit bi-directional input-output port with internal pull-ups. The output buffers of port 1 can sink four TTL(transistor-transistor logic) inputs.

**Port 2:** 8-bit bi-directional input-output port with internal pull-ups. During the accesses to external data

memories that use 8-bit addresses (MOVX @ RI), Port 2 can emit the contents of the P2 Special Function Register.

**Port 3:** The Port 3 output buffers can sink/source four TTL inputs. When 1 is written to Port 3 pins they are pulled high by the internal pull-ups and can be used as inputs.

**RST:** Reset input. A high (1) on this pin for two cycles while the oscillator is running resets the device.

**ALE/PROG:** ALE (Address Latch Enable) is the output pulse for latching the low byte of the address, during accesses to external memory. If desired, Address Latch Enable operation can be disabled by setting bit 0(low) of SFR location 8EH. With the help of bit set, ALE is active during a MOVX or MOV C instruction only.

**PSEN:** Program Store Enable is the external program memory's read strobe. When the AT89C51 is executing code from external program memory, PSEN is activated two times each machine cycle, except that two PSEN activations are skipped during each access to external data memory.

**EA/VPP:** EA must be strapped to GND in order to enable the device to fetch code from external program memory locations starting at 0000H up to FFFFH.

**XTAL1:** It is the Input to inverting oscillator amplifier and to the internal clock operating circuit.

**XTAL2:** It is the output get from the inverting oscillator amplifier.

**Oscillators:** XTAL1 is the input, XTAL2 is the output, respectively, of an inverting amplifier which can be used also as an on-chip oscillator. Ceramic resonator used or Quartz crystal may also be used. For driving the device from an external clock source, XTAL2 always should be left as unconnected while XTAL1 is driven.

## VI. DC MOTOR

There are several applications with dc motors in our daily life. We require different speeds at different instants depending on the applications. There are some concepts to control the speed of dc motor. In this system we are using 12v DC Motor. The working principle of an dc motor is given below. DC motors are configured in many types and sizes, including brushless, servo, and gear motor types. A motor is consisting of both rotor and permanent magnetic field stator. The magnetic field was maintained using permanent magnets or electromagnetic windings. DC motors most commonly used in variable speed and torque. Let's start by looking at a simple 2-pole DC electric motor (here red represents a magnet or winding with a "North" polarization, while green represents a magnet or winding with a "South" polarization).

**Pwm Technique:** A pulse width modulator (PWM) is a device that may be used as an efficient light dimmer or DC motor speed controller. A PWM works by making a square wave with a variable on-to-off ratio; the average on time may be varied from 0 to 100 percent

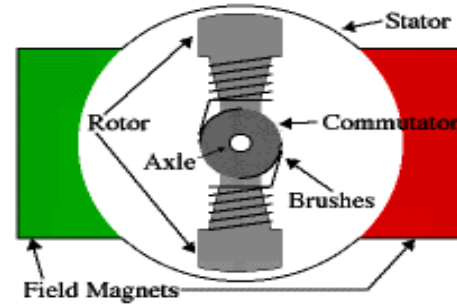


Fig.3 DC Motor

**Power Supply:** There are many types of power supplies. Most of them are designed to convert high voltage AC mains electricity into a suitable low voltage supply for electronic circuits and other devices. A power supply may be broken down into a series of blocks, in that each of which performs a particular function. To make power supply on, we use a LM7805 voltage regulator IC (Integrated Circuit).

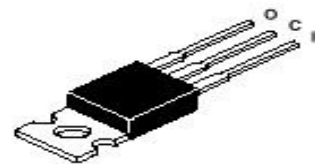
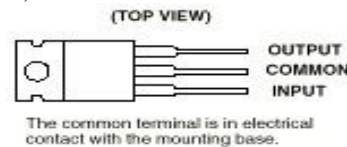


Fig.4 Power supply

The LM7805 is simple to use. We simply connect the positive lead of our unregulated DC power supply (anything from 9VDC to 24VDC) to the Input pin, connect the negative lead to the Common pin and then when we turn on the power, you get a 5 volt supply from the Output pin.

## Keypad

Figure shows a 4x4 matrix connected to two ports. The rows are connected to an output port and the columns are connected to an input port. If no key has been pressed, reading the input port will yield 1's for all columns since they are all connected to high (Vcc). If all the rows are grounded and a key is pressed, one of the columns of the microcontroller to scan the keypad continuously to detect and identify the key pressed.

## VII. RELAYS

A relay is the switch which is electrically operated. Current flows through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil's current can be on or off so relays have two switch positions and they are double throw (changeover) switches.

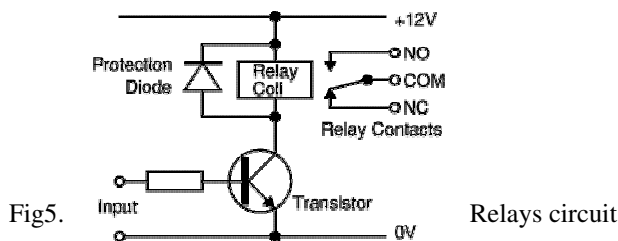


Fig5.

### Advantages of

*relays:*

Relays can switch DC and AC, transistors can only switch DC.

Relays can switch from high voltages, transistors cannot.

*Disadvantages of relays:*

Relays are may be bulkier than transistors for switching small currents.

Relays do not switch rapidly (except reed relays), transistors can switch

## VIII. IR SENSOR

The IR sensors play a major role in the present project to count the number of persons entering in to the house and the no. of persons who are leaving out of the house. These are also used to identify the authorized persons car to open the entry gate.

*Technical specification:*

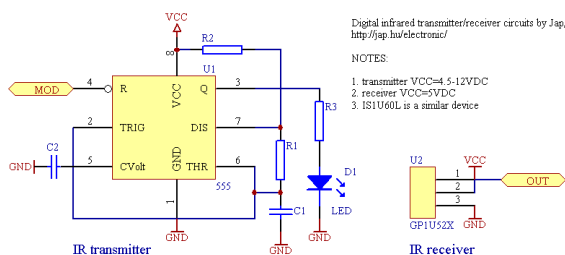


**Fig.6 Digital infrared transmitter/receiver circuits**

## Decoding IR Remote Controls:

The origin of this posting was the question what to do with an old TV. I suggested to use the infrared remote control as an input keyboard for a micro controller board and mentioned a piece of code I had written for the 89S51 micro controller.

IR Receiver :

These receivers are for infrared remote control systems. PIN diode, preamplifier are assembled on lead frame, the epoxy package is designed as IR filter. The demodulated output signal is directly decoded by a microprocessor. this was the standard IR remote controller receiver series, supporting all major transmission codes.

### Passive IR Motion Sensor:

Many More advanced security systems include motion detectors. The feature motion sensing on most lights (and security systems) is a passive system that detects infrared energy.

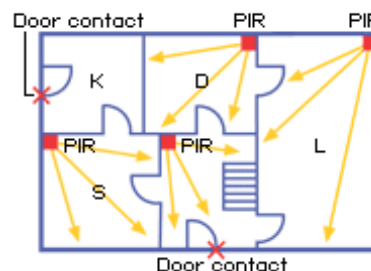


Fig.7 Passive IR motion sensor

The above figure (top view) illustrates how the Passive IR sensors can be used in the home security system. A PIR sensor can be placed at a corner of the desired room so that it can sense the motion of the intruder.

## IX. FUTURE ENHANCEMENT:

Wireless RF communication is finding a huge development in Satellite Communications. The RF signals are sensed and reflected back to the earth stations. These signals contain information about weather forecasting, geological surveys and other cosmic developments.

## X. CONCLUSION

This paper discusses in detail about the concept “CONTROL SYSTEM FOR MODERN HOUSE”.

It has been developed by integrating features of all the hardware components used. Presence of every module has been reasoned out and placed carefully thus contributing to the best working of the unit.

Secondly, using highly advanced IC's and with the help of growing technology, we will get better outputs .

Wireless communication industry is blossoming at a great pace. As wireless communication technology systems evolve, service quality and capacity are of primary importance. To ensure reliable communication over a mobile radio channel, a system must overcome multi path fading, polarization mismatch, and interference. The current trend requires low power hand held transceivers increases all of these challenges. Keeping all the above parameters in view we have designed a low cost integrated system for monitoring the different types of parameters between two systems. Finally we conclude that CONTROL SYSTEM FOR MODERN HOUSE is an emerging field and there is a huge scope for research and development

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# Global Positioning System (GPS) and Applications

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**Abstract-**Global Positioning System (GPS) is a satellite-based navigation system. GPS provides continuous positioning and timing information around the world. GPS was developed for military purposes by US Department of Defense, but later it was commercialized. Since then GPS has revolutionized the navigation industry and is being used in almost every field of life today. By integrating GPS system with terrestrial communication systems its use has been extended over the years.

In this paper GPS has been discussed along with its application from its very basic applications for the purpose of knowing the location and time to the modern security applications, where with the help of GPS surveillance is done and in case of emergency medical aid is provided.

## I. INTRODUCTION

Navigation has been the need of human kind since the very beginning. When people started travelling either on lands or via sea they devised the different methods to find the right way towards the destination and back [1]. Sun compasses were used by Vikings, North Star method and some people even used the direction of the winds or waves to find the direction. Many other methods were devised until the time of Captain James Crook who gave a very useful method to find the courses [2]. In today's world we have Global Positioning System that has revolutionized the world of navigation.

Global Positioning System (GPS) provides positioning and timing information around the globe under any weather conditions [3]. In the start GPS was used for military purposes but later it was made available to civilians in 1996 realizing its effectiveness. Since then GPS is being used for so many applications that its receiver has become one of the most used equipments on the earth today. It is used in much diversified fields today that in almost every field it is being used. From military use to Geocaching [4], from telecommunication to agriculture, from aviation to public safety [5] and many more.

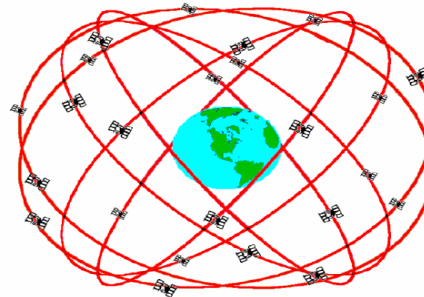
In the start GPS history and architecture will be discussed. Later on applications of the GPS in today's world will be elaborated.

## II. OVERVIEW OF GPS

GPS consists of 24 satellites, 21 operational and 3 spare satellites. To ensure efficient worldwide coverage satellites are arranged in a way that in each of six orbital planes there are four satellites placed. With this constellation four satellites are visible anywhere in the world. Four satellites are necessary to provide accurate positioning information [6].

GPS satellite orbits are elliptical, with an inclination of about 55 degree to the equator. Semi-major axis of a GPS

orbit is around 26,560 km. Orbital period is almost 12 hours (~11 hours, 58 minutes).



GPS Nominal Constellation  
24 Satellites in 6 Orbital Planes  
4 Satellites in each Plane  
20,200 km Altitudes, 55 Degree Inclination

### A. GPS Segments

GPS has three segments and they are:

- 1) *Space segment*: This segment contains 24 satellites in 6 orbital planes. Each of them travel at the speed of 7,000 miles per hour and completes the orbit twice a day. These satellites continuously send pseudorandom codes towards the earth. These messages contains:
  - Satellite that is sending the information
  - Location of that satellite at that time
  - health of that particular satellite
  - Date and time

Each satellite is powered by the solar energy with backup batteries. Satellites are built to last for 10 years [7].



- 2) *Control Segment*: This segment is on earth and is responsible for monitoring satellite's health, signal integrity and orbital configuration. It has got one Master Control Station located in the United States at Colorado Springs, Colorado. This Master control station with the help of 6 Monitoring stations around the world receives the signals from the satellite describing satellite's orbital and clock information. Master Control Station makes precise correction to the

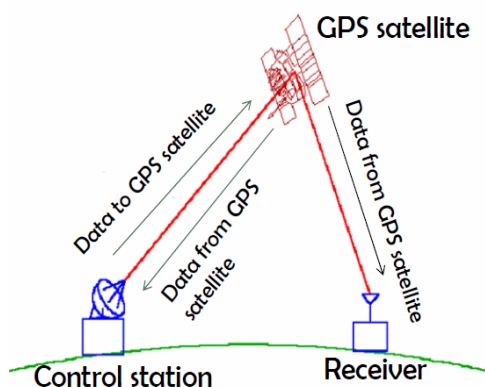
data and sends back to appropriate satellite via Ground Antenna [8].

- 3) *User Segment*: This segment contains a GPS receiver connected to GPS antenna. User receives GPS signals which are used to determine the position of the user around the world.

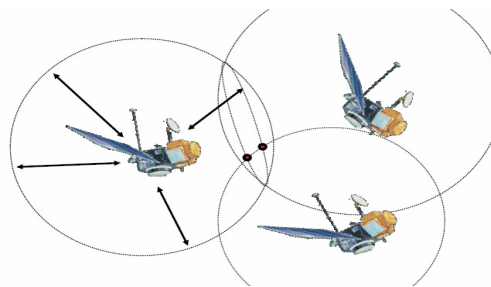


### B. Working of GPS

GPS receiver receives the signal from satellite and calculates the difference between signal sent time and the time signal is received. This is done with the help of software installed in GPS receiver. Time difference tells how far the receiver from the satellite is. Multiplying the travel time with the speed of light gives the distance between satellite and the receiver.

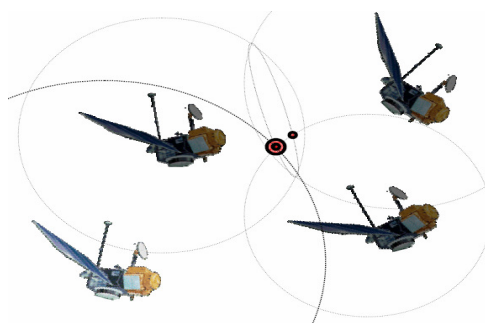


GPS receiver receives the signal from satellite and calculates the difference from the time signal is sent and the time signal is received. This is done with the help of software installed in GPS receiver. Time difference tells how far the receiver from the satellite is. Multiplying the travel time with the speed of light gives the distance between satellite and the receiver. Receiver receives signals from other two satellites and calculates the distances from them too. This gives two possible locations out of which one is discarded on the basis of two facts that are 1) velocity is very high 2) point is far from the earth.



With the help of fourth satellite we get

- Confirmed location
- Altitude
- Improved accuracy [7]



### III. Applications of GPS

GPS system has many applications. And with the addition of two other signals it has been improved its quality as well and its use has been increased as well. There are limitless applications of GPS. A few of them are discussed here.

#### A. Timing

For operational efficiency and synchronization communication networks, electric power grids and financial networks need precise timing. With the free availability of GPS time not only that companies are able to get precise timing but also they are saving cost.

For example, in wireless communication and data networks it is very important to keep the base stations perfectly synchronized. To achieve this companies use GPS time to keep them in perfect synchronization. Due to this mobile handsets are able to share limited radio spectrum efficiently.

Likewise, digital broadcast radio services use GPS time to ensure that bits received from all radio stations arrive at the receiver in a lockstep. This allows listeners to tune between stations with least delay.

Another very interesting application of GPS time is recently being implemented in Hollywood studios. Hollywood Studios are integrating GPS in their movie slates to allow unparallel control of audio and video data. It is also used for multi-camera sequencing [5]. The ultimate applications for GPS, like the time it measures, are limitless.

#### B. Traffic Management

GPS provides precise location and time for most of Intelligent Traffic Systems and traffic control systems worldwide. Problems associated with the routing and dispatch of commercial vehicle has significantly reduced with the help of GPS. By integrating GPS with

geographical information system (GIS) it has become easier to monitor vehicle location, keep transit vehicles on schedule and inform passengers of precise arrival times [5,6].

GPS has also revolutionized the logistics by forecasting and keeping the track of the movement of freight. Trucking companies use application called time-definite delivery to guarantee delivery and pick-up at the given time. Time-definite delivery application tells the dispatcher a list of trucks and full detailed information on the status of them. If a truck is being late an alert is sent to dispatcher.



Research is going on in the field of intelligent traffic system (ITS), where GPS is playing yet another vital role. With the help of intelligent traffic system it is going to be possible for the drivers to avoid emergency situations like red light violations, lane change collision, traffic jam and will also be provided with the alternative options as well accordingly [5,10].

#### C. Space

GPS is revolutionizing and revitalizing by providing tracking and control of communication satellite constellations.



*Jason-1 Ocean Surface Topography Mission*

Benefits of using GPS for space include:

- Providing high precision orbit determination
- Replacing high cost on-board attitude sensors with low-cost multiple GPS antennae and specialized algorithms
- Provides low-cost precise time GPS receivers
- Constellation control
- Minimal intervention from ground

#### D. Aviation

In aviation GPS is used to increase the safety and efficiency of flight. As GPS provides three-dimensional position that is suitable for all phases of flight from departure, en route and arrival to airport surface navigation.



With the help of GPS new and more efficient air routes are made. Reduction in time and cost has been realized because of this technology. GPS has made aircrafts fly according to the routes that are more favorable to aircrafts. It has reduced the fuel consumption, saved time and provided more security to aircrafts.

GPS based navigation is being implemented in those remote areas where traditional ground-based operational and security services are not available. With the improved signal quality and addition of new satellite it is now possible to use it special applications like landing planes even in poor visibility conditions.

Two new signals have been introduced in GPS. These two signals are going to complement the existing signals for civilian service. The first signal is for general use in non-safety critical applications and the second signal will be for aviation navigation purposes. This safety-of-life signal will make GPS more efficient for navigation applications for aviators. This signal will benefit avionics beyond the capabilities of current GPS services. By using dual-frequency the future service will improve the instrument approach opportunity. That means that error that occurred in the past due to disturbances in the ionosphere will be reduced through the simultaneous use of two signals. This will increase the accuracy of the overall system [5].

#### E. Agriculture

Availability of Differential Global positioning system (DGPS) provides decimeter level accuracy. This has revolutionized the agricultural industry [14, 15]. Soil sample collection, chemical application control, and harvest yield monitoring are the applications of GPS in farming.



While collecting a soil sample GPS can locate the sample point precisely. After testing the soil samples farmers can efficiently and economically treat the soil problems.

Other application is to use GPS while spraying in the field with the guidance of moving map display. By this sprayer will spray the chemicals on the particular spots with least overlap [6].

#### *F. Marine*

GPS has without doubt changed the world for the mariners. It had never been as easy for the mariners in the past as it is today to move around the world and that is because of GPS. Not only that they know their direction, they know speed, precise time as well. Almost every boat has its on-board GPS device. Many firms deployed Chart plotter, a device having a map and GPS receiver on it, for use on boats.

GPS is also used for marine seismic surveying. There are different methods for seismic surveying depending on the depth of water. In order to achieve useful results, the position of the energy source and the hydrophones must be known accurately. To achieve this GPS is used that also saves the cost.

Seafloor mapping is done to maximize the cargo capabilities. This is very important at the places where water is shallow. New technology for seafloor mapping has evolved that combines GPS, INS and multi beam echo sounders. By integrating GPS and INS purpose is achieved very easily. And accurate 3-D seafloor mapping is done with the help of Laser bathymetry system (LBS) and GPS/inertial-based position.

#### *G. Rail*

Rail systems in many parts of the world use the Global Positioning System (GPS) in combination with various modern devices to improve safety, security, and operational effectiveness. These technologies help to reduce accidents, delays, operating costs, and dangerous emissions, while increasing track capacity, customer satisfaction, and cost effectiveness [5].



GPS also helps to schedule depending on the location of the train. Passengers are informed accordingly if there is any change in the schedule of train's arrival or departure accordingly [16].

Differential GPS can also help for surveying, maintenance and system planning for the future.

#### *H. Environment*

GPS technology is used for aerial studies in world's most impenetrable forests. This is done to study wildlife, terrain and human infrastructure. This is done by tagging imagery with the help of GPS to assist in strategy planning.

Environmental changes are predicted with the help of GPS technology. Meteorologists use GPS measurements and integrate it with the operational methods to find the water contents in atmosphere.

To fight fire in the forests an efficient resource-management system is developed. In this system GPS plays an important role that enables the operator to monitor the location of resources. With the help of GPS/GIS and efficient communication system appropriate decisions can be made [6].

#### *I. Safety & Emergency Aid*

GPS is playing a vital role in earthquake prone areas where scientists are trying to study how strain builds up over the time. With the help of precise position information that GPS provides them they are able to anticipate earthquakes.



In Case of Emergency (ICE) is one of the applications that mobile manufacturing companies have started embedding in the mobile phones. This is another very effective and efficient application of GPS. In case of emergency all that a user has to do is to press an ICE button and a message will be sent to local emergency service providers along with the geographical coordinates of the user. Emergency service providers with the help of that information will be able to provide aid to the victim as quickly as possible.

#### *J. Recreation*

GPS is being used for recreation purposes as well. Outdoor adventurers use GPS for technology increasingly. It has minimized the danger of losing the course. GPS enabled devices also provide recording the path for the use of returning back to the point where traveler starts from.

One other advantage is that a user can transfer GPS data into computer. This data can be downloaded by other adventurers to enjoy their outdoor tours with excitement and safety.



GPS is used as a hobby as well. There is a famous game known as Geocaching that is played with the help of GPS [4].

#### K. Vehicle Navigation

GPS based navigation systems are widely deployed are used for surveillance and monitoring the vehicles. Integrating GPS with other wireless technologies like GSM/GPRS/UMTS makes it a very efficient navigation system that can work from very rural areas to urban areas. This application also helps service providers to help find theft vehicles easily. Integrated GPS/GSM technology is also being used in some of the countries for boat navigation purpose.

Retail industries use GPS technology for keeping the track of their vehicles for enhancing the efficiency.

#### L. Telecommunication

GPS is widely used in telecommunication for many applications from timing synchronization to surveying. Timing has already been discussed in the start now I'll be writing a few of other applications.

Surveying teams for BTS deployment use GPS technology. When a BTS is installed its co-ordinates are saved on the maps or on systems. For the purpose of future enhancement or maintenance these maps are used for reaching the particular BTS.

To check the performance of BTS coverage area drive tests are done. These are also done with the help of GPS technology by integrating it with computer based maps.

Femto cells are being deployed to provide better data services. GPS is playing a very important role for this purpose. GPS will be used for monitoring and synchronization of the network.

#### M. Military

GPS is playing very important role in military as well. Initially GPS was used for strategy planning and surveillance. As the technology is getting matured its usage has been rapidly increased. Now we can see GPS guided Unmanned Air Vehicles (UAV) are playing the

same role for identifying and detecting enemy's positions in war fields. More over it is extensively used for guided missiles for accurate target detection.

GPS is playing a key role in Satellite Based Remote Sensing for tracking and profiling. GPS is also used in the areas where mines are expected. Surveys are done using many technologies and methods and then areas are plotted on the maps with the help of GPS.

#### IV. CONCLUSION

GPS has revolutionized the world of navigation and surveying since its early stage. It has grown so faster that we find its applicability in almost every field. It has replaced old methods of navigation and surveying and has reduced the cost as well. One of the most important reasons of its popularity is that it is easy to integrate GPS with any available technology to make better surveying and navigation systems.

GPS has many applications in land, marine and air navigation systems. In future automatic machine guidance and control are the applications of GPS. Remote vehicles will be controlled efficiently in hazardous areas for security.

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## Digital Signal Processing/Processor Applications

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**Abstract-** Digital signal processing (DSP) applications are a field that is constantly evolving with engineers continually coming up with innovations. DSP applications have come in and are replacing analogue systems because of their speed of computation (MIPS-million instructions per second) and ability to compress and decompress large amounts of data.

Traditional areas in which DSP applications have been used include; audio processing software which is used to improve speech audibility in auditoriums by shaping up the frequency, processing of optical communication system data, sonar and radar signal processing, spectral estimations, statistical signal processing and digital image processing.

DSP has also most recently been extended to audio advertisements where the user uploads real time audio marketing, vocoder systems, optical laser communications for deep space, building test and diagnostic systems, data conversion software and ASTI's digital communications and radio simulation systems for avionic, military purposes and also in biometrics.

The main aims of this paper are to elaborate the uses of DSP chips and techniques in all the above mentioned areas and to also show the future areas in which there are to expand into. The paper will also endeavour to highlight the areas in which their use may be expanded into in the future. The paper will also critically evaluate all these application areas.

**Key words:** DSP applications; real time processing; DSP chips.

### I. INTRODUCTION

Digital Signal Processing has evolved over the years. It has had a far reaching impact on a wide range of areas and the areas in which it has taken over are far ranging areas and the break through that has been made has made giant steps. The introduction of the DSP has been lead by Texas Instruments (ti) who have been in the forefront of these developments.

Texas Instruments have been the corner stone in these developments which have been present across the different areas of engineering. They have not been the only ones that have looked into this area of expansion, other companies that have looked into the development of FPGA's which have been suggested that they could replace some standalone DSP systems. [1]. Although there have been some developments into FPGA systems DSP systems still have the greatest advantage.

The areas that this paper is going to focus on will be the application areas in Audio processing, Automotive, Medical, Biometrics, Video-imaging, Wireless communications, optical laser communication systems, Avionic and military purposes.

All these are areas in which the DSP has been applied, and it has been growing and will continue to expand as shown by the graph below:

**PROGRAMMABLE DSP MARKET**  
(WORLDWIDE: 12% CAGR)

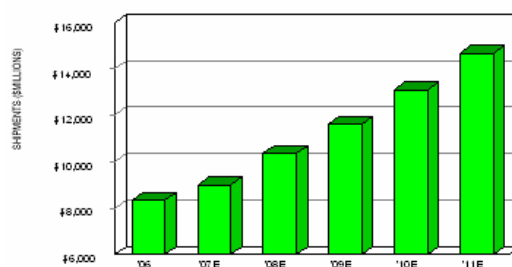


Figure 2- Uses of DSP [2]

This development has been due to the advances that have been made by the DSP chip which has been made smaller and at the same time faster. It now has capabilities of processing millions of instructions per second (MIP) and some of these chips are even 32-64 bit processors. The speed and processing capabilities of the chip has enhanced its functions and now it expanded to the video and imaging.

The rest of the paper will focus on the areas that DSP has been applied and the explanation of how it is being used.

### II. Audio Processing

Traditionally audio processing has been an area that analogue circuits and systems have been used to process the information. Digital methods have now been adapted and this has an added disadvantage to the system designer, in that he/she has to convert the analogue signal to digital signal, because sound is naturally analogue. This is easily done by using analogue to digital convertors (ADC) and DAC. DSP's are being used to smoothe out the quality of sound that is outputted and it also gives the system the ability to connect using USB ports. A typical example of how the DSP chip is used is in the Audio Portable dock:

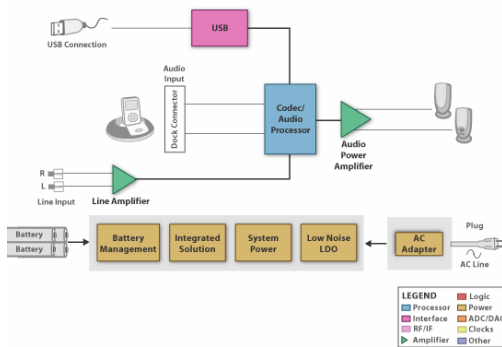


Figure 3-DSP Audio Block Diagram [11]

The audio dock is powered by batteries or from the mains supply. The mains supply operates the dock and powers the speakers enabling them to connect to the USB port. The TMS320C550x DSP chip provides 12s, SPI high speed quality that enables audio inputs to be processed. This provides more options for the connection of more docks. The dock is also connected with the latest ultra low power C550x DSP architecture that enables battery life to be extended. [3]

Another area in audio processing that has taken off is real-time marketing audio uploads that are done over the internet or on billboards. These have been able to take place due to the high-speed processing speeds of proprietary DSP/data acquisition boards that have been developed. This type of technology has been used in competitive analysis, detection of the advisement techniques, counting of ads that are being put out there and also the demography that is being reached by the ads that are being used. [4]

On the hardware side of audio analysis there typical example of hardware such as the Audio Processor:

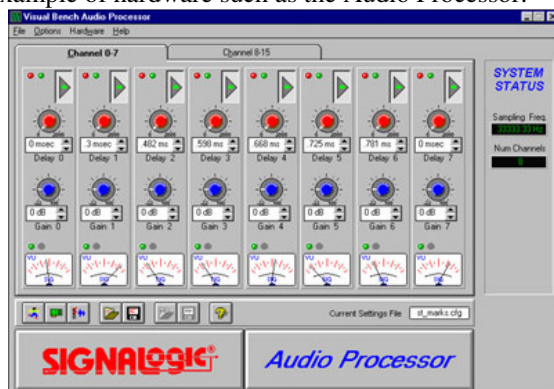


Figure 4-Audio Processor [4]

This is software that has been implemented with DSP so that it can shape out the audio in cinemas and auditoriums. This is done by dynamically shaping the frequency response of the sound and then by applying the DSP algorithms altering the path taken by the sound.

These are just a few of the areas that DSP has taken over in the audio section. These are areas where this has been done to great success. It is also going to continue growing. This is an area where DSP will have the most

impact due to the fact that most of the circuitry in the audio industry was conventionally analogue.

### III. Biometrics

This is an area that is of importance because of the perpetual need for a system that is secure and safeguarded. A system that will be running this biometric service will have to be able to read/scan the fingerprint or the iris of the user trying to log onto the system. After having scanned that information, it should then be compared to that on the database to see if they are the same. The speed at which this is done is important. That is why it is necessary to have a DSP for processing all that information. [5]

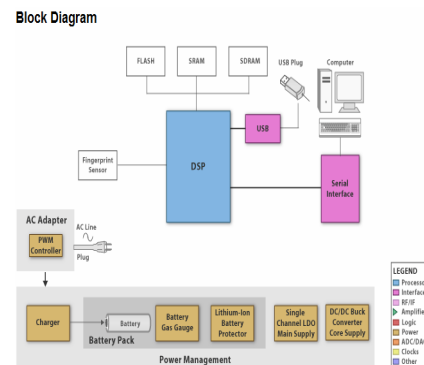


Figure 5-Biometric System Block Diagram [5]

Block diagram above shows the constituent components of the system. These include the power management system which is rechargeable, that is then connected to the overall system. There is the fingerprint sensor which reads the prints and transfers that to the memory which could either be flash, Sram or Sdram. This is all controlled by the DSP which also provides an interface with the computer which acts like a user interface.

In biometrics DSP's are also used in more complex reads such as face recognition system that will detect the facial features of the user trying to access the system. These are then compared with those that will already be stored in the memory. If these are then the same this will mean that the user will gain access. The slight differences that occur to people's facial features as they grow older should also be put into consideration. The system should hence be able to scale the changes and compare them to the image that will be provided. This is all being done by the use of faster DSP processors.

### IV. Automotive

This is an area where there is a wide range of fields in which DSP applications could be used, these vary from the control of the braking system to the processing of traction control. The area that will be focused on will be the control of the central body. This entails the control of the things such as the windows, door locks, light and seat belt control. It works as the interface to other systems.

The control of this can either be done straight from the DBM or via CAN/LIN communication by the use of ECU's. This function can also be incorporated by the use of RFID functions like remote keyless entry. [14]

The power supply to this system will be coming from the on board 12 or 24V supply, this is then regulated down to the DSP and Micro-processor required voltages. The system shown below also provides communication interfaces to allow data exchange between independent electronic sub modules of the Central Body Controller. The high speed controller runs at speed of up to 1Mbps through the link of the CAN which has a two wire fault tolerant differential bus. This serves as the main connection link between the various components. The load drivers in Central body Controller are the lights and these are generally put onto the controller directly. The relays are then used to power other electronic modules that are being run by the central control body.[14]

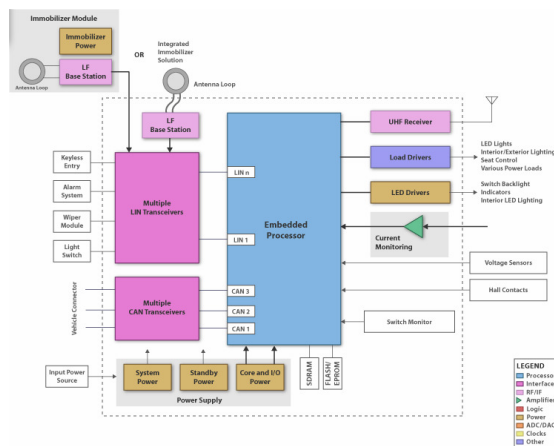


Figure 6-Central Body Controller System [14]

## V. Video and Imaging

Video imaging has progressed from the traditional few application areas such as camcorders and security to more expansive areas. The biggest problem that was hindering the development of the video and imaging industry was the complexity of the coding required to expand the application areas. The coding would require engineers that were very familiar with assembly language for high performance signal processing platforms. This has now been overcome by the introduction of design environments that will enable the use of integrated processors, development environments and software environments. This has enabled the designers to focus on the development of the applications rather than focusing on the coding of the hardware through the use of AIP's which allow the developed audio, video and image technology to be glued onto the software rather than being coded on. [6]

As the cost of developing video systems has continued to spiral down embedded programmers have now incorporated home surveillance cameras onto Set-top TV boxes that will enable homeowners to view who is at the door through their TV's so that they don't even have to

get up. This has also enabled there to be capabilities of not only showing that the person being videoed is the person you want to see but can also compare with the image of the person that you would have stored in the database. A typical example of this system is shown below: [6]

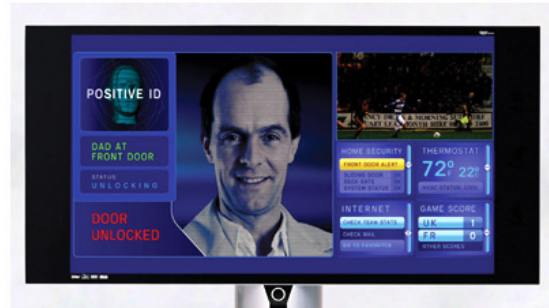


Figure 7-Video/Security System [6]

This will be posted onto the TV screen. The implementation of such a system has been an area of great research so that the traditional need for compression and decompressions of the video stream be reduced so that it can reduce bandwidth consumption.[6]

## Hardware Implementations:

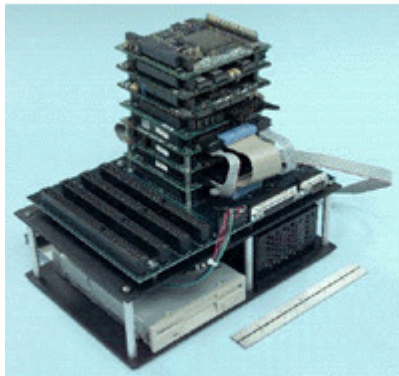
The codec will run on a digital signal processor (DSP). The processor has full software programmability and it also has functions of being able to upgrade the software to MPEG2 products and even in later versions to H.264 video codec. The DSP provides the ability to be able to run and have multiple codecs' on one chip. This will also allow the user of the system to be able to switch from one function to the next. The DSP may also be incorporated into a system on chip (SoC). This will make it more compact. [6]

## VI. Optical Laser Wireless Communication Systems

Optical communications is now being researched into and it has yielded some good results. This is because of the need to increase the bandwidth in which communications can take place. It is mainly because humans are exploring further and further into space, hence they need more accurate, higher bandwidth and efficient communication channels. As a solution to this laser has been put forward by the Optical Communication Group (OCG). Using laser systems is far much better than using traditional radio frequency systems in that laser systems tend to be less heavy. The less weight that they have tends to reduce the volume that it would take on the space craft. The weight means that they would be less battery consumptions.[11]

Current top of the range optical systems tend to exhibit up to 20times more bandwidth than ordinary radio frequency systems. The down side to all this is the fact that for laser systems they are highly dependent on the direction of the transmitting laser and the receiver. So this means if the direction is off by a few degrees it means that the system will not receive any information from the spacecraft. This

will mean that the focusing and directionality has to be of the greatest accuracy. Although this exhibits this type of limitation it has a higher resolution that comes with it and hence this means that the clearer pictures can be transmitted back to the base.



*Optical Comm Prototype System*

**Figure 8-Optical Communication System [11]**

The DSP use comes into recognition in that the prototype uses a SigC44-PC/104 DSP-based board as part of the laser communication system. The C44 DSP device reads CCD images at 2000 times/ sec. It will then determine the location of the incoming and outgoing laser. The code on the DSP has a very fast control system loop which also has IIR filters and gain adaptive algorithm.

The SigC44 board is then mounted onto another Pentium processor that will then control and run all the other functions that the system would need to support.[11]

## VII. Avionics and military systems

In the military there are areas that DSP has been integrated and these vary from image processing, digitalisation of data, system control, system communications to system displays. The best way to show how all these are being used in the military will be by the incorporating example of Sonar/Radar system.

The sonar system is the part that will detect the presence of obstacles and their positioning, whilst the radar system will determine the velocities of objects with respect to the radar unit.

Integrated GPS guidance, image processing for target recognition and also so flight guidance is provided by high speed DSP's. These processors have performances of up to 1GFLOPS (billion of floating-point operations per second) and they also have 1600 MIPS processing capabilities. The system is broken down to various constituent components which are shown in the block

diagram

below:

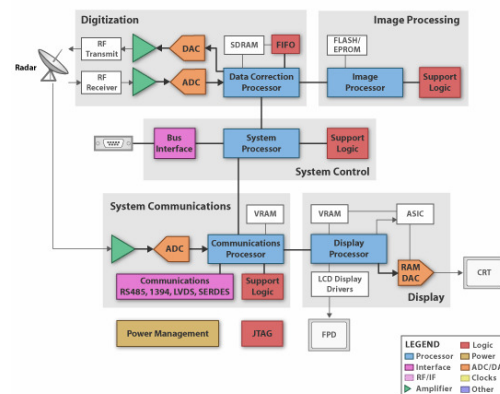


**Figure 9-Sonar/Radar System[ ]**

The digitalisation block of the system converts signals from analogue to digital and communicates with the radar satellite it is run by a DSP processor that also has an SDRAM on it, it is then connected to the system control block also to the image processor, and the image processor will then compare the image detected to that in its memory. This will help to identify the object and then the information is then passed onto the control block.

The other half of the system is made up of the system communication and display blocks. The communication block in one that runs all the communications that take place between the base and the satellite and this is done by the communications DSP. This is connected to the display block which will show the analysis of the communications. The communication block is connected to the system control.

This is one typical example of the area in which DSP has been applied in the military, it is also used for missile control and in Jet fighters that need instant control.

## VIII. CRITICAL EVALUATION OF APPLICATION AREAS

The areas in which Digital signal processing has been introduced into have been improved form the audio industry, to the military who instead of just being able to detect an object and have a delay in knowing what exactly it to being able to get results of the process instantly.

Although there has been improvement into the areas of application, there still are downsides to the DSP in that there could be over reliance to the processor and it would fail, if this would take place it could have a greater impact that it would have had in a lesser complicated system.

## IX. CONCLUSION

In this paper the application areas of DSP where discussed and also shown how it is being put into use. The developments are being done due to the higher rates of processing that are of the order of MIPS. These speeds in tell faster data output and multitasking can also be

done with the greatest of ease. DSP circuits are slowly but surely taking over all the areas that analogue circuits used to have a strong hold on. The processors are continually getting smaller and this means the areas of application are also increasing.

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# WiMAX – Challenges and Opportunities in a Wireless World

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**Abstract-** WiMAX (Worldwide Interoperability for Microwave Access) is a trademark given to a cluster of wireless technologies based on the IEEE 802.16 standards. Due to a lot of expectations from WiMAX and especially the mobility and radio resource management it could also compete with or even replace the traditional 3G architecture. WiMAX is a plausible solution to a lot of problems that have weighed down the predetermined wireless network since its commencement. WiMAX could be a cost effective and feasible solution in remote regions where normal text/data/voice or broadband access using fixed network is not feasible. WiMAX also developing 'Mobile' standard which means it can provide broadband wireless in nomadic and suburban environments.

In this paper, I will explain WiMAX – mainly its architecture and how it could compete the 3G architecture – then moving on to exploring some technical barriers which should be prevailed prior to its commercialization. I will also explain the emerging needs of both fixed and mobile services. I will conclude my paper by establishing a relationship between WiMAX and other wireless services and the ongoing trend towards 4G.

## I. WiMAX

WiMAX – Worldwide Inter-operability for Microwave Access is a technology which provides wireless data communication [1] [2]. The communication depends on transmission modes which mainly includes point-to-multipoint and cellular WiMAX [2] [3]. It can provide data communication up to 72 Mbit/s [1] and it based on an IEEE 802.16 standard which also known as Broadband Wireless Access (BWA) [1] [10] [4]. WiMAX provides BWA up to 30 miles for fixed stations and a maximum of 10 miles for mobile stations [10]. It promises to provide long distance broadband access for a number of different applications [8]. WiMAX name was emerged by 'WiMAX Forum' [8] [9]. The forum so far has provided two documented released including Release 1.0 and Release 1.5 [9] which contains the technical information regarding the network architecture of WiMAX and the process for its development and deployment [2] [9]. The WiMAX forum also responsible to carryout various future researches, case studies and analyst reports [9]. The WiMAX got popular when the International Telecommunications Union (ITU) gave approval for a non-cellular telecommunications technology as part of 3G's union standard [2]. Although WiMAX which originally labeled as a 3G technology but most of the International companies like Sprint Nextel is calling it futuristic 4G [2]. 3G is the 3<sup>rd</sup> generation of mobile, wireless and telecommunication hardware standards, software protocols and in general the technology behind mobile networking [1] [2].

## II. WiMAX ARCHITECTURE

The WiMAX architecture as standardized by WiMAX Forum in the early release i.e. Release 1.5 is shown in Figure 1 below.

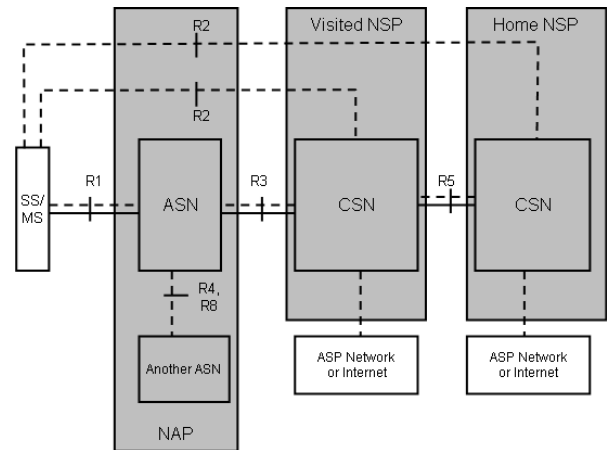


Figure 1: WiMAX Network Reference Model [1] [10] [11] [12]

The architecture as described by WiMAX forum defines many aspects including WiMAX network connectivity with other networks, Interface allocations and authentication. It is generally regarded as the logical representation of network architecture. The figure illustrates number of various components along with interconnections of the logical entities or reference points which are labeled R1 to R5 and R8 [9] [10]. The Interface R4 is used to inter-connect various ASN (Access Service Network) or NAP (Network Access Providers) [12]. While, the interface R5 is used to inter-connect various CSN (Core Service Networks) or NSP (Network Service Providers). The various components which are illustrated in the figure are summarized in the following table.

Table 1

### Summarized Network Components

| Component |                                      |
|-----------|--------------------------------------|
| SS/MS     | Subscriber Station or Mobile Station |
| ASN       | Access Service Network               |
| CSN       | Connectivity Service Network         |
| NAP       | Network Access Provider              |
| NSP       | Network Service Provider             |
| ASP       | Application Service Provider         |

The core individual entities including MS/SS, ASN and CSN can be realized in a single physical device or they can be distributed amongst multiple physical devices [14]. However, the distributions of functions into physical device in ASN are left for ease for the manufacturer [14].

The ASN or Access Service Network defines logical

boundaries and it represents a way to describe aggregation of functional entities and conventional message flows associated with the access services or NAS (Network Access Server) [14].

The CSN or Connectivity Service Network defines a group of functions which provides IP connectivity services to the WiMAX Service Subscriber or more in general to the end User Terminal Equipments [14].

WiMAX Forum Network Working Group (NWG) has redefined the Network Reference Model or NRM in to more generalized IP based Network Architecture which promises the followings;

- The Network Architecture or NA shall be decomposed into modules and defined reference points between functional entities for multiple vendor interoperability [14, [15].
- The NA shall support modularity and flexibility both in development as well in deployment. This will ease the manufacturer to develop and deploy according to their own needs and requirements [14, [15].
- The NA shall support both kinds of transmission modes i.e. Point-to-multipoint as well as Cellular and it shall support fixed, nomadic/portable and mobile operations [14, [15].
- The NA shall support inter-connectivity of WiMAX network with variety of business models e.g. Network Access Provider or NAP owns the network and operations, Network Service Provider or NSP owns the subscriber relevant services and Application Service Provider or ASP provides all application services [14, [15].
- The NA shall also support internetworking with 3GPP, 3GPP2, Wi-Fi as well wired networks using IETF protocols. [14, [15].

From the table 1 and figure 1, it can be found out that WiMAX builds on architecture which has three core blocks, which are;

- User Terminal Equipments
- Access Service Networks
- Connectivity Service Networks

All of the blocks can be grouped together and an IP-based architecture is formed, which is shown in figure 2 as below;

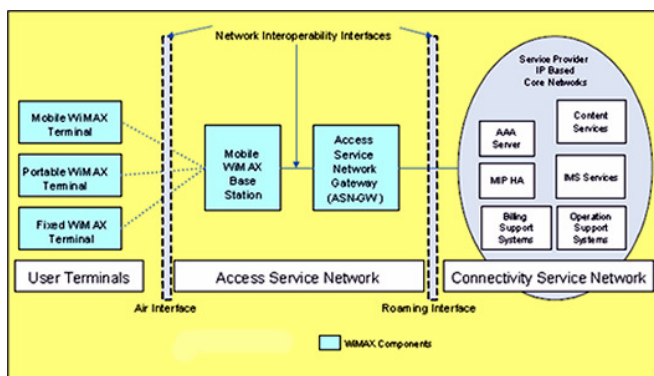


Figure 2: WiMAX IP Based Architecture [1] [10] [11] [12] [14]

#### A. User Terminal Equipments (UE)

A terminal that provides connectivity to the WiMAX base stations via an air interface. In WiMAX, there are three types of UE, these are;

##### a) Mobile WiMAX Terminals

These are the radio terminals used for communicating over R1 or air interface for example Mobile Handset supporting WiMAX.

##### b) Portable WiMAX Terminals

Portable or nomadic terminals are similar to Mobile Terminals except for the access of special applications utilized by them, for example laptop or PDA.

##### c) Fixed WiMAX Terminals

They have fixed connection rather than wireless or air. They are connected with the Customer Premises Equipment or CPE which has got an air interface with the WiMAX base station.

##### d) Customer Premises Equipment

CPE is special user equipment that performs various end users' functions e.g. stores subscriber's identity and encryption keys, performs authentication with the AAA (Authentication / Authorization / Accounting) Server. This equipment is responsible for establishing a connection with either Network Access Provider via an air interface (R1) and with Network Service Provider via Network Interoperability Interface (R2).

#### B. Access Service Networks (ASN)

Access Service Network in a broader sense or in general Network Access Server (NAS) or with a more suitable name Network Access Provider (NAP) is a complete set of network which are responsible for providing Radio Services to the User Terminal Equipments. It should be noted that all Layer 2 or Data Link specific services are handled by ASN [11] [13]. In general, ASN makes up the WiMAX network.

ASN provides a means to connect WiMAX Terminals to IP network without losing the session. ASN composed of two important nodes i.e. WiMAX Base Station(s) and ASN-GW(s) [15]. In general, ASN provides a set of functions which includes;

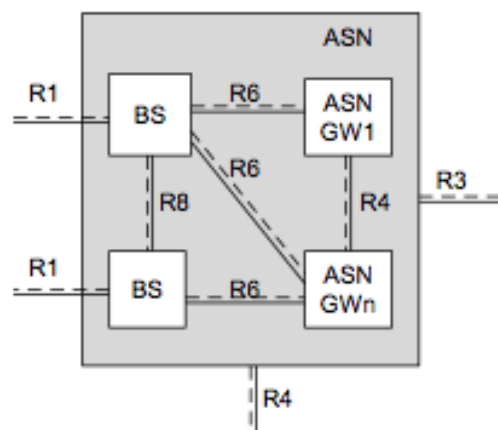


Figure 3: ASN Reference Model [14] [15]

- Network Identification
- Network detection
- Network (CSN/NSP) Selection

- Network Authentication (CPE with AAA Server)
- IP Connectivity
- Radio Resource Management
- IP Casting (Multi/Broad) Control
- Intra ASN Mobility
- Location Management
- Data Management
- Service Flow Authorization
- Quality of Service
- Call Admission Control
- Policing and Role Management

However, it should be noted that an ASN could be composed of many WiMAX BTS and many ASN-GW depending on the circumstances, number of users and efficient services.

A more detailed picture having multiple ASN-GW and multiple WiMAX Base Stations is illustrated in Figure 3 below with the respected interfaces;

From figure 1 and figure 3, some reference points or interfaces are observed which are ranging from R1 to R6 and R8. These reference points are conceptual or logical links that connects two functional entities. The reference points are as follows;

- R1: Logical Interface between MS/SS and BS or BTS [15].
- R2: Logical Interface between MS/SS and ASN-GW or CSN in general. The interface R2 is used for authentication, authorization, IP management and mobility management [15].
- R3: Logical Interface between ASN and CSN. The logical interface supports AAA (Authentication, Authorization and Accounting), Policy Management and Mobility Management [15].
- R4: Logical Interface between ASN and ASN. The logical interface is responsible for mobility of MS between two ASNs [15].
- R5: Logical Interface between CSN and CSN. This interface is responsible for internetworking between local and foreign networks [15].
- R6: It is a logical interface between BS and ASN-GW. It is commonly known as Intra-ASN Tunnel. The main purpose of this tunnel is to send control signals between BS and ASN-GW [15].
- R7: It is an internal logical interface which resides inside of ASN-GW. It is used for coordinating data and control plane in ASN-GW [15].
- R8: The logical Interface is also known as Intra-BS and it is used between two Mobile WiMAX Base Stations. This interface is responsible for fast and efficient handovers between BTS [15].

ASN comprises of two important nodes which are;

a) Mobile WiMAX Base Stations

Like other Base Stations or BTS, WiMAX Base Station acts as a network controller. It acts as a barrier between all sorts of WiMAX Terminals and the terrestrial network using the ASN-GW node. In one ASN there could be more than one WiMAX BTS depends on the needs and requirements of the region.

b) Access Service Network Gateway (ASN-GW)

ASN Gateways holds a major infrastructure position in

mobile WiMAX networks [16]. The WiMAX forum defines the basic requirements for the ASN-GW, which are as follows;

- ASN-GW is responsible for providing Layer 2 (Data Link Layer) connectivity with User Terminal Equipments [16].
- ASN-GW performs signaling between UTE/MS/SS and CSN subcomponent AAA Server for providing Authentication and Authorization and also to employ Accounting to the customer [16].
- ASN-GW is responsible for detecting available WiMAX networks [16].
- ASN-GW is responsible for connecting UTE with the IP Network [16].

Which means clearly that ASN-GW plays a key-role in the WiMAX architecture because it has not only job to provide interfacing with base stations but it also communicates with other nodes like AAA Server, DHCP (Dynamic Host Configuration Protocol), Home Agent and other ASN-GW.

The WiMAX architecture as a whole can be seen in one complete form in the following figure 4.

As can be seen from figure 4 that the most important node in the architecture is no other than the ASN-GW, so, the efficiency of the WiMAX Infrastructure lies in a fact of reliable Access Service Network design and good/high quality product should be chosen for WiMAX BTS and WiMAX ASN-GW.

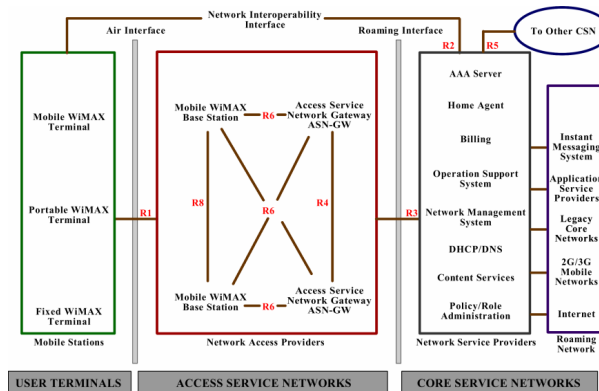


Figure 4: WiMAX Complete Architecture [1][10][11][12][14][15]

### III. LONG TERM EVOLUTION (LTE) AND WIMAX

#### A. 3G LTE and path towards 4G

Long Term Evolution or LTE is perhaps a new radio standard which is being defined in 3GPP (3<sup>rd</sup> Generation Partnership Project) and which is based upon the same technology as WiMAX currently is i.e. OFDMA-MIMO [18]. The LTE network just like the traditional UMTS (Universal Mobile Telecommunication System) is one of the 3G (3<sup>rd</sup> Generation) Radio Architecture but they require new and state of the art devices and service providers needs to purchase Radio Access Network (RAN) equipments in order to handle the IP-based traffic [14][16][18]. It is necessary to discuss some important issues regarding both the LTE and WiMAX.

#### a) Timeline:

The radio or air interface as described by the LTE is still in the standard development process and it is expected to be completed no later than the end of this year i.e. 2009 [16]. Also, the LTE Access Network are designed to connect to a new IP Core Network whose standardization also is due till in the mid of 2009 [16].

b) Spectrum Segmentation and Deployment Issues:

In order for LTE to be deployed fully functional the spectrum should also be available, so, either a new spectrum or it would be necessary to free up the 2G Band Segmentation in order to make useful high speed broadband LTE architecture [16]. In USA, network operators are hoping to deploy LTE but in 700 MHz or even in 1.7/2.1 GHz bands, whereas in Europe LTE would be deployed in popular 2.5 GHz band. China is under process of finalizing some of the standardizations of deploying LTE in the available band [16].

c) Approved Devices:

So far, there are no devices available to be used within the LTE Network Architecture and it is also because of the standardization issues faced by the LTE.

d) Services:

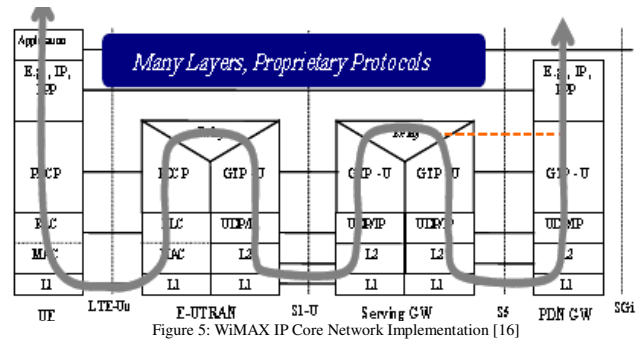
For Long Term Evolution there are no services available by the Network Providers. Yet there are only few operators who are looking to provide the LTE under the umbrella of fixed LTE Business Models but this would lower down the flexibility and the scale of technology [16].

e) Performance

As far as the performance is concerned, the LTE would be offering peak data rates up to 144 Mbps for Downlink if 2x2 MIMO (Multiple Input Multiple Output) Antenna used with 5/6 Convolution Encoder, 20 MHz Channel and with 64 QAM (Quadrature Amplitude Modulation) Scheme. LTE is expected to see these performances by the end of 2009 [16].

f) IP Core Network

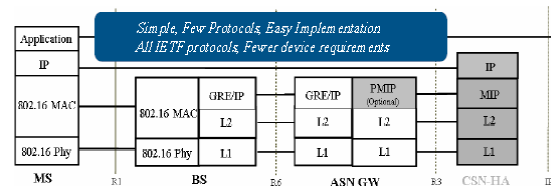
The end-to-end network of LTE is encumbered by 3G legacy network protocols which have resulted in a network with many layers and proprietary protocols [16].



WiMAX is an open standard technology just like its predecessor Wi-Fi. It has foundation upon IEEE 802.16X standard. The standard has already been ratified by a large community of engineers. The latest standard of WiMAX with its standardization 802.16m is about to be implemented in the industry which promises further higher data rates which LTE is promising now to implement later at the end of 2009 [18][19].

Due to its open standard feature, all WiMAX equipments are standardized and therefore cheaper to buy [19].

WiMAX is functional in terms of everything. It is



implemented in the bands ranging between 1.5 GHz to 3.5 GHz in every region. Globally, WiMAX is deployed in the frequency band of 2.5 GHz [18]. WiMAX is already supporting a data rate of 145 Mbps with the same specifications which LTE is promising to commence later by the end of 2009 [18]. The same data rates remained operational under the mobility of 350 Km/hr [18] [19].

#### IV. WiMAX CHALLENGES

According to a deep analysis, WiMAX is facing some problems which if rectified than WiMAX is an ideal solution to Broadband in terms of both Voice and Data. These challenges are highlighted from time to time. Following are the challenges which should be overcome before WiMAX completely commercialized. Following are some of the challenges;

- The deployment cost for WiMAX Radio Access Network or RAN or more precisely Network Access Provider (NAP) or Access Service Network (ASN) as mentioned in figure 2 and figure 3 is more than the typical Wi-Fi network [20].
- By the end of 2009, LTE would be finished in standardizing the equipments, IP Core Network and architecture and 85% of the work and technology for WiMAX would be reused by LTE equipment designs [19].
- Even if the WiMAX is a standard today but its market

opportunities will take time to develop [20].

- The Mobile Transmission mode is not backward compatible with the point to multipoint or fixed network [20].
- Most of the developed countries like USA, and China cellular operators or Network Providers are considering the fixed mode transmission of WiMAX and they have not yet given consideration to the Cellular Transmission Mode [19][20].
- According to a consideration took place in 2006, WiMAX could have become effective if Smart Antennas used in a cell site with a frequency band of 3.5 GHz so as to reduce the effect of RF Propagation, but Smart Antennas are more expensive as well they react slower to a mobile user. By the time, it developed and today at a least cost of design MIMO is used with OFDMA (Orthogonal Frequency Division Multiple Access) as a multiple access scheme which has considerably reduced all legacy issues. The only thing which has not been looked carefully is the development and deployment cost [19][20].
- Most of the work remained unfinished in the network architecture till 2006 but later on WiMAX Forum and WiMAX NWG contributed towards finalizing standard and general network architecture for WiMAX in the Release 1.5.
- As far as the deployment is concerned, WiMAX is as equal as a 3G to deploy.

#### V.CONCLUSION

Despite many challenges addressed in this research paper, there are many challenges which WiMAX is facing and contributing towards its solutions. Due to which there is an opportunity for WiMAX to expand for a non-traditional operators given that the implementation of network architecture is upon the Operator-Driven Business Model.

The WiMAX address a particular market need which is the availability of a low-cost and open standard based which could provide basic voice and broadband access throughout the world.

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## Electrical Machines and Adjustable Speed Drives

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**Abstract:** Electrical machine, nowadays have become one of the most important parts of a human life. Electrical machines are of different types used for different applications. Today, most of the electrical machines are motor driven, so for better efficiency, it is very important to control the speed of the motor. Most of the research focuses on the optimal design approach and also on the design for a wide constant power speed rates. Certain drives are used to control the speed of the motor. Better control on the speed of the motor is gained with the help of adjustable speed drivers.

**Keywords—** ASD, PWM, VSI.

### INTRODUCTION

The two basic types of electric motor are AC motors and DC motors. Both AC motors and DC motors comes in different shapes and sizes. Some of them are known as standardized motors used for general purpose applications and other are used for specific purpose or task. For both cases, selected motor must satisfy the requirement of the machines on which these motors will be fitted without exceeding rated motor temperature. Therefore first and foremost step in motor selection is to determine the characteristics of load, torque and speed with respect to time. Selection of motor is also based on availability of power, cost and mission goals. The first parameter which is to be considered is starting and running torque when sizing of electric motor is required. Variation in starting torque can be from small percentage of full load torque to many times of it. This variation in torque is because of load conditions or due to nature of the machine on which motor is installed.

An adjustable speed drive is used to control the torque, speed, acceleration and direction of rotation of a machine. This adjustable speed drives allow selection of speed within the operating range.

### ELECTRIC MOTOR

Electric machine is a link between electrical system and mechanical system. If conversion from mechanical to electrical is required, electric generators will be used and if from electrical to mechanical is required then electrical motors have to play their part to do this task. Machines are of many types like DC machine, induction machine and synchronous machine. Machines are called AC machine (motor or generator) if the electrical system is AC. And machines are called DC machine (motor or generator) if the electrical system is DC. Basically two electromagnetic phenomena are present in the motor

- Induced voltage – when a conductor moves in a

magnetic field, voltage will be induced in the conductor.

- Mechanical force – when a current carrying conductor is placed inside a magnetic field, a mechanical force will act on it.

The structure of the electric motor has two main components, stator and rotor. Stator and rotor are separated by air gap. Stator does not move and it is usually the outer body or frame of the machine. It consists of individual electro-magnet arrangements in a way that they form a cylinder which is hollow from inside. The term “stator” is derived from the word stationary. Rotor is free to move inside the motor and it is normally the inner part of the machine. Rotor is mounted on the shaft of the motor. The term “Rotor” is derived from the word rotation. Both stator and rotor are made up of ferromagnetic material.

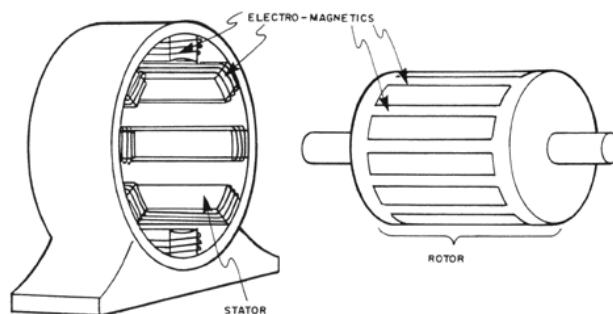


Figure 1 - Basic electrical components of a motor.

### A. DC MOTOR

The DC machine, induction machine and the synchronous machine are the major devices in industry. Some of the advantages of induction motors are that they are light weight, more simple and have less initial cost. But with respect to DC motors their speed cannot be controlled over wide range of conditions. When alternating current is supplied to the stator of the induction motor, induced alternating is produced in the rotor.

The DC machines are widely used for speed control. This is because of the fact that torque and speed are independent identities for DC machines. Because torque is related to armature current and speed is related to voltage applied to the motor. Due to this special feature of DC machines they are widely used in such systems in which speed control is required. Working principle of these machines is very simple, when current is supplied in a field coil, it produces magnetic flux in the air gap between the pole and the armature, the direct current in

the armature interact with the magnetic flux which in result produces a torque.

Some of the disadvantages of DC motors are electrical noise, audible noise, physical size, wear of brushes which leads to maintenance cost, sparks in brushes, load current in rotor and removal of heat.

Permanent magnet DC motor is another type of a DC motor in which a very straightforward approach is used to create motion or force. Figure 2 shows a cut-away view of this type of motor. Stator is made up of a powerful permanent magnet that generates a static magnetic field. Rotor carries armature and commutator, rotor is supported by bearings.



Figure 2: Cutaway view of PMDC motor.

To generate torque, stator and armature are the two sources of interacting magnetic fields. The magnetic flux lines runs from one end of stator to other. Figure 3 will show magnetic flux lines.

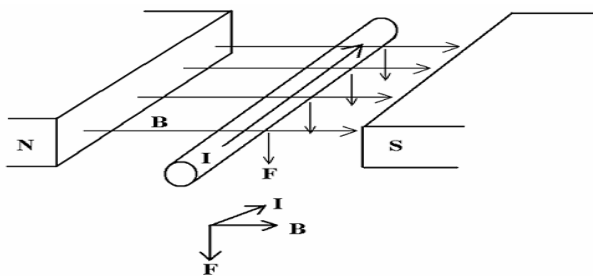


Figure 3: PMDC motor stator and armature details.

## B. INDUCTION MOTOR

Most induction motors are used for three-phase sources. Three phase set of windings is slots in the stator. They are

connected either in wye or delta configuration. Rotor is a cylindrical iron core on which conductors are placed around the surface. Figure 4 will show cut-away sketch of a three phase induction motor.

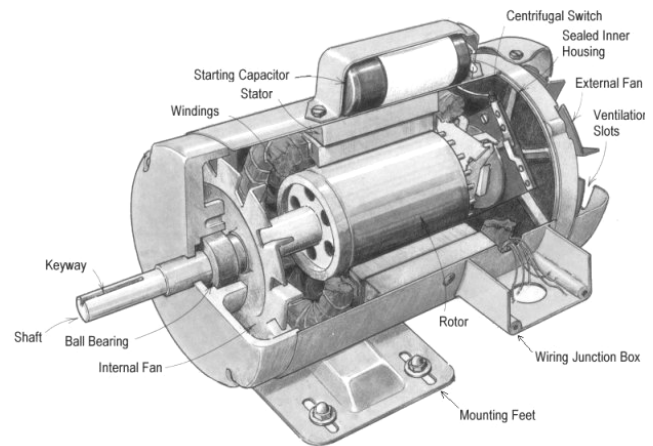


Figure 4: Induction motor.

In three phase windings, the turns in each winding are distributed in such a way that current in the windings produces a sinusoidally distributed flux. When three time varying currents passes through windings, air-gap flux density is produced this is rotating at an angular velocity exactly equal to angular frequency of the stator current. Figure 5 will show all three currents which produces the magnetic field across the air gap of the machine. Following is the relation between mechanical angular velocity of rotor and poles of the machine.

$$\omega_m = (2/p)\omega_s$$

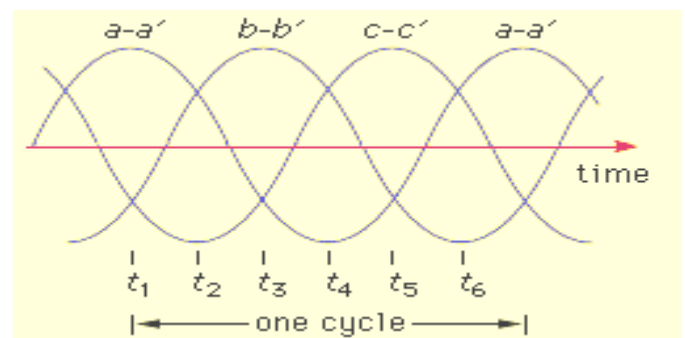


Figure 5: Three phase current across windings

The main advantage of induction motor is that because of the absence of commutator, it is light weight. Brushes are not required in induction motor. Maintenance is very easy and cost for manufacture is low. Speed can be control by using frequency. But to control the speed complex power electronics is required.

## C. SYNCHRONOUS MOTOR

Synchronous motor is the motor in which rotor normally rotates with the same speed as revolving field inside the motor. The stator is almost the same as that of induction

motor. The only difference is that the rotor is connected with the direct current source through slip rings. Figure 6 will show the cross sectional view of synchronous motor.

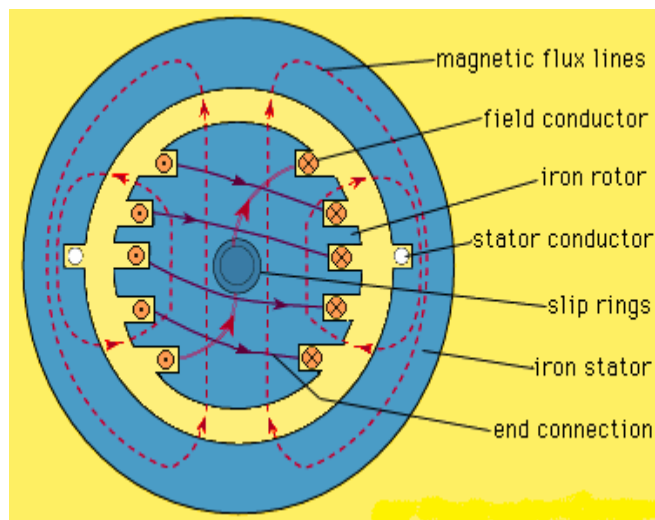


Figure 6: Synchronous motor

To understand the principle of operation, consider stator winding is connected to three-phase supply. This stator current will establish a rotating magnetic field for a frequency of  $f$  Hertz for  $P$  poles. A direct current on the rotor will also produce a magnetic field rotating at a rotor speed. If speed of rotor is made equal to the stator speed if there is no load torque, then these fields will align with each other. That is why they are known as synchronous motors.

Due to small difference in structure synchronous motors are divided into two categories, permanent magnet and switched or trapezoidal permanent magnet motors. PM motors are constructed with totally enclosed rotors. Due to this protection the magnet is safe from iron dust from cooling air. The trapezoidal PM motor is also known as brushless DC motor. One thing which distinguishes this motor from others is that stator winding is supplied by a sequence of rectangular pulses of current. Stator winding are almost similar to those of induction motor.

Advantage of synchronous motor is that magnetic field can be produced by direct current through field windings. So all it needs is current in stator winding in phase with applied stator voltage. Another advantage is that the variable speed control can be achieved by the variation of voltage or frequency. Due to permanent magnet high efficiency can be achieved. Disadvantage of using synchronous motor is that it requires slip rings to supply current to the rotor.

## ADJUSTABLE SPEED DRIVES (ASD)

For a rotational mechanical load, range of operating speeds may be required. This is known as “adjustable speed drive”. The two basic parameters which must be kept under consideration are load torque and speed. The basic components for such drives are motor which gives torque to the load and control speed and a controller

which must be a power controller which will drive power to the motor.

For better control of the speed and torque we use a feedback loop system which always gives feedback to the controller from the motor with the help of sensors. Sensors are very critical components of any feedback loop system. Sensors are used to determine current, position, speed and direction of the rotating motor. In most control systems, several sensors are used to provide feedback information to the motor. These sensors are used in the control loop and they improve the reliability of the motor by detecting fault conditions which may damage the motor. Figure 7 will show a very basic closed loop system using a sensor to control the speed of the motor.

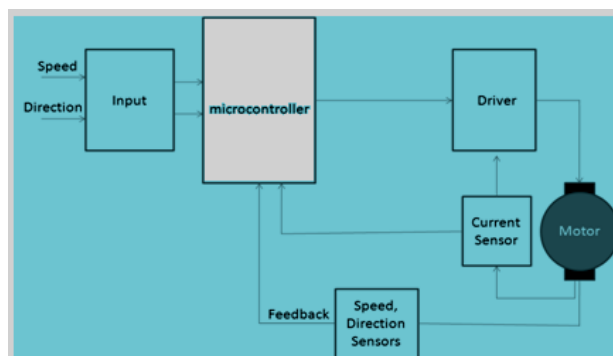


Figure 7: Close loop system for speed control

The output power delivered by motor is directly proportional to the product of torque and speed of shaft. The value of this torque varies automatically to satisfy the load torque and torque due to friction and windage. When load torque increases it will also increase the shaft power and as a result of all this development more current will be drawn from the supply. But any change in the speed of the motor must be obtained in a controlled manner through some adjustment to the motor or in electrical supply. The basic variable in an electric motor to be controlled is the shaft speed. The ASD does these kinds of jobs more efficiently, significantly reduces the energy consumption. It also offers a more precise method and more equipment reliability than conventional controls.

Figure 7 shows a typical ASD system, which has four basic components: controller, motor drive, motor, and sensors. Different techniques can be used instead of a microcontroller; PID can replace this microcontroller. And for motor drives, different methods can be used to control speed like pulse width modulation, H Bridge or any suitable drives depending upon what kind of motor is used here to drive the load. Control circuits include brushless DC controller, chopper circuit, variable voltage inverter, current source inverter, and flux vector drives. Figure 8 will show another simple ASD.

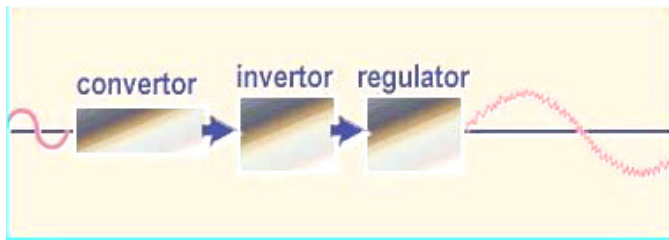
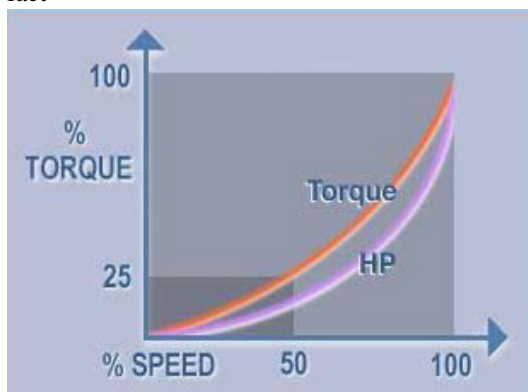


Figure 8: speed control system

Figure 8 shows a type of ASD in which speed of the motor is controlled by changing the frequency at the input of the motor.

### A. ADVANTAGES OF ASD

- Energy saving is possible due to machine controlling. It depends upon load properties and nature of application as well.
- Life Span of motor can be improved because of speed control and because of reduction of revolutions and the stress on the motor.
- ASD has wide range of application starting from a single motor to high sophisticated complex machines.
- AC voltage supplied to the motor can be varied by using solid state electronic devices.
- They allow very precise control of induction motors as a result saves energy and improves control.
- They are suitable not only for new applications but for existing motors as well.
- A single ASD can control more than one motor at once, so ASD can be known as multi-motor control.
- Variable torque will require very low torque at low speed as compared to higher speed. Figure 9 will show this fact



### B. DISADVANTAGES OF ASD

- Initial cost is more than normal controller.
- Motor heating is another issue at low speeds.
- Sometimes it creates electrical interference which can harm electrical equipment.
- It requires more maintenance because of additional electronics.
- Output harmonics is also sometimes problematic.

When specific torque is not main issue, then fixed frequency voltage control is the simplest way of controlling motor. This is termed as voltage controlled drive. When a controller requires current feedback information, current controlled drives will provide fast motor response.

### CONCLUSION

A wide variety of electrical motors is now available with variable frequency, variable speed. This paper has presented a brief overview about electrical motors and adjustable speed drives. No single type is ideal for all applications. The choice for particular drive and motor depends upon the assessment of system design. Assessment of system design is of critical importance which involves initial cost, maintenance, performance, life-cycle, weight. It is hoped that the paper will provide some useful information about the motor choice and drives to control them and providing references to enable further study.

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## Electrical Machines and Adjustable Speed Drives

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**Abstract:** Electrical machine is a device which converts electrical energy into mechanical energy or vice versa. It is also used to change AC voltage from one level to another. Electrical machines are divided into three parts; Motor, Generator and Transformer. This paper will provide an overview of different types of motors. There are motors which run at constant speed. But it is not always necessary that the devices run by these motors, always require a constant speed. The speed requirement can be less, high or variable. So in such cases we use a device called as Adjustable Speed Drives (ASD). The main types of ASD are Variable Voltage Inverter (VVI), Current Source Inverter (CSI) and Pulse Width Modulator (PWM).

### 1. Introduction:

Electrical motors are used in almost every industrial and manufacturing process. There are two main types of motors; AC and DC motor. The selection of these motors depends upon some factors like cost of machine, efficiency, speed, braking requirement, reliability and controllability etc. In twentieth century, most of the electrical machines were designed to operate at a constant speed. In most of the industrial and domestic applications, we don't require constant speed. It has been well known that in most of the applications adjustable speed drive (ASD) would provide improved energy efficiency and performance. ASDs may be referred to by a variety of names, such as variable speed drives, adjustable frequency drives or variable frequency inverters. This paper will provide an overview of electric motors and ADSs.

### 2. Electric Motors:-

There are three main types of electric motors;

- (a) DC motor
- (b) AC Synchronous motor
- (c) AC Induction motor

**(a) DC Motor:** DC motor consists of two parts stator and rotor. Stator and rotor are the stationary and rotating parts of motor, respectively. The stator acts as a frame for motor and field poles are located on it. Field winding is mounted on stator and armature winding on rotor. Poles are projected inward from the inside surface of the stator yoke. Stator serves as a closed path for magnetic flux. The rotor has an axial shaft which is carried on bearings at each end located in the end covers bolted to stator. The shaft extends out of the end cover usually at one end and is coupled to the load. The space between the rotor and pole is called the air gap. Both the windings are connected with the DC electrical sources to provide the required current to the motor. Field poles are always even in number. The current is supplied to both windings. The interaction of the axially directed armature currents and

the radially directed magnetic flux produces torque on the shaft. DC motor has very desirable output characteristics but the torque of dc motor is limited due to the limit of current entering through commutator. In DC motors the main drawback is the maintenance cost of commutator.

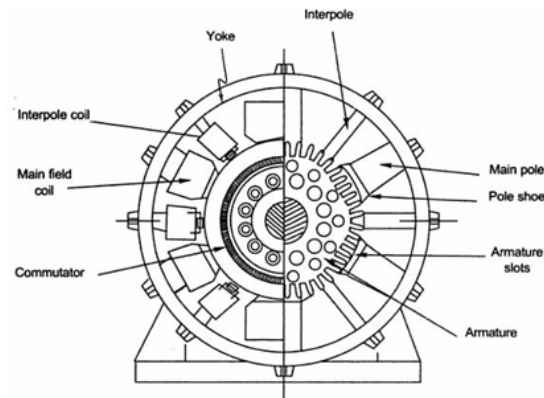


Fig:1:- DC Motor

**(b) AC Synchronous Motor:** In AC synchronous motor field poles are excited by dc current. The stator forms the armature which carries three phase winding. The distance between two consecutive poles is called as angular displacement. The angular displacement between all the poles will be same and the three phase winding is also identical. The speed of synchronous motor is directly proportional to the frequency of the ac supply and inversely proportional to the number of pole pairs.  $N = \frac{60f}{P}$

Where 'f' is the frequency of ac supply, 'P' is the number of pole pair and 'N' is the synchronous speed. When balanced three phase currents are allowed to flow in the armature winding, these produce a synchronously rotating field, stationary with respect to the rotor field as a result of which the machine produces torque. There are many different types of synchronous motors such as wound field motors, permanent magnet motors, synchronous reluctance motor, self controller brushless motor, stepper motor and switched reluctance motor. Voltage and current in the armature winding determines the power handling capacity of synchronous motor. Synchronous motor does not have commutators so the maximum speed is not limited due to it. As compared to DC motor, the synchronous motor has lower weight and volume for the similar power ratings due to the absence of commutator. Synchronous PM motors are much more efficient than induction motors.

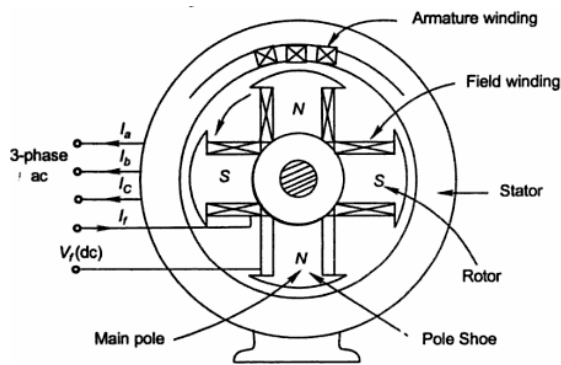


Fig:2:- AC Synchronous Motor

**(c) Induction Motors:** The three phase induction motor is widely used in industry due to its rugged construction. The stator winding is three phase similar to the armature winding of synchronous motor. When balanced 3-phase currents are allowed to flow in stator winding, rotating magnetic field is produced. Power is supplied to the rotor by electromagnetic induction thus it is a type of asynchronous AC motor. There are two types of Induction motors; Squirrel cage motor and Slip ring (wound rotor) motor. Both motors have the same stator but there is just a small difference between the constructions of rotor. In squirrel cage motor the rotor has copper or aluminium bars embedded in slots and they are made short circuited from their both ends. In slip ring motor, the rotor has three phase winding with three leads brought out through slip rings and brushes.

When current is supplied to three phase system, a rotating magnetic field is produced. As rotor is in short circuited position so current will be induced in the rotor due to the change in magnetic field. The emf induced in the rotor will produce magnetic field which will interact with the rotating magnetic field and hence torque is produced.

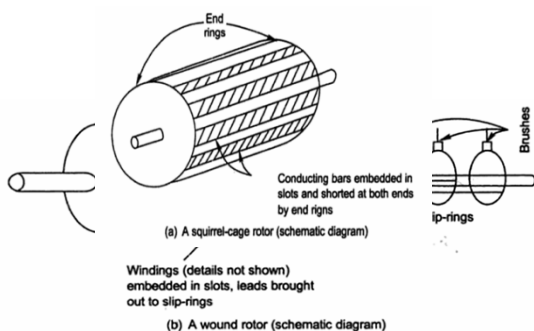


Fig:3:- AC Induction Motor

### 3. Adjustable Speed Drives:-

Most of the motors run at a constant speed but it is not essential that the devices which these motors are running always require a constant speed. In most of the industrial applications, variable speed is the requirement for any process. We may consider an example of driving a car. Let us suppose we are drive to work on a car with its maximum speed, then there is a lot of chance for accident but contrary to this, if we drive too slow we can get late.

So the best approach is to vary the speed of a car according to the traffic and road conditions.

Similarly, ASD allows motors to operate at the most efficient speed depending on the requirements. They include a continuous speed range from zero to full speed. An adjustable speed drive is a device used to provide continuous range process speed control.

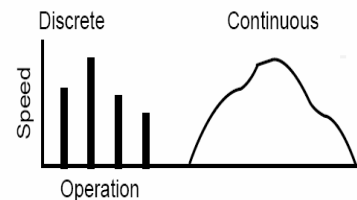


Fig:4:- Speed vs Operation graph

It is capable of adjusting both speed and torque. The primary function of any adjustable speed drive is to control the speed, acceleration, torque, deceleration, regenerative braking and direction of rotation of a machine. ASDs are not only used to vary the speed of motor but are also used to maintain the speed of a motor regardless of load. Unlike constant speed systems, the adjustable speed drive allows us to select an infinite number of speeds within its operating range. Adjustable speed drives can also be known as variable speed drives, adjustable frequency drives or variable frequency inverters. Adjustable speed drives are the most efficient drives and their full load efficiency is up to 97 or 98%. ASDs can be hydraulic, mechanical or electrical. Electrical AC or DC adjustable speed drives have a number of advantages over other speed drives in terms of its low cost, low maintenance requirement, high efficiency and excellent performance. Physical appearance of an ASD system is shown in Fig: 5.

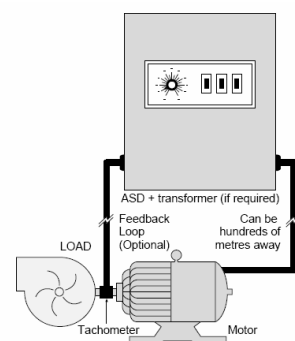


Fig:5:- ASD Model

ASD mainly consists of three parts;

- Operator control station
- Drive controller
- Drive motor.

Operator control station allows the operator to start and stop the drive controller by push buttons or switches, and set the motor speed by turning a potentiometer to the desired dial setting. Operator controls may be integrated

into the controller or mounted remotely from the drive controller.

Drive controller converts fixed electrical power to a variable or adjustable power which allows it to drive the motor over a broad speed range. The controller includes monitoring systems and the capability of adjusting the speed of motor. The output is established by the speed control potentiometer. The controller can maintain or regulate the speed of motor with the variation in load or input source voltage. The controller also includes protection circuitry which can prevent the system from overloads, power source transients and output power faults.

Drive motor could be AC or DC motor. The speed of motor depends upon the output of the drive controller. Fig: 6 shows the block diagram of the whole ASD system.

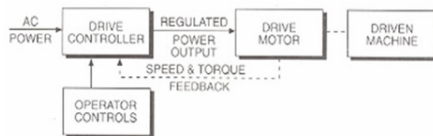


Fig:6:- ASD Block diagram

#### 4. Types of ASDs:-

Both ac and dc ASDs receive ac plant power and convert it to an adjustable output for controlling motor operation. DC drives control dc motors and ac drives control ac motors. Both usually use solid-state conversion systems. ASDs are becoming more famous because of its availability and low cost of variable frequency electric supplies. Recent advances in inverter technology have reduced controller cost and improved performance and reliability. AC drives operate by adjusting the frequency and voltage to ac motors. The speed of a motor is determined by the frequency. It is necessary to keep voltage and frequency in a constant relationship to maintain constant torque. This relationship between voltage and frequency is called Volts per Hertz. The main types of ASDs are Variable Voltage Inverter (VVI), Current Source Inverter (CSI) and Pulse Width Modulator (PWM).

**(a) Variable Voltage Inverter (VVI):** A variable voltage inverter is one of the types of ac adjustable speed drives. In a VVI, the DC voltage is controlled whereas DC current is free to respond to the requirement of motor. The VVI uses a converter, a DC link and an inverter to vary the frequency of the applied AC voltage. A converter is the part of VVI which converts AC supply to DC. The converter is simply a rectifier circuit that produces an un filtered pulsating DC. The converter can be either single phase or three phase. The selection of single phase or three phase converter depends upon the type of power that the AC motor requires. A DC link is simply a LC filter circuit. The purpose of the DC link is to filter or smooth the AC ripple from the output of

converter. DC link is connected to the inverter via DC bus as shown in Fig:7.

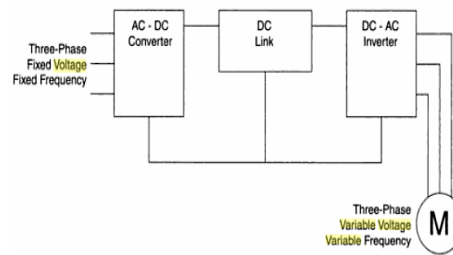


Fig:7:- VVI model

Last stage of the VVI is inverter stage. An inverter converts the applied DC voltage to a pulsating DC voltage. We can vary the magnitude and frequency of this pulsating DC, therefore control of the speed of an induction motor. VVI are used for low to medium power applications, generally up to a few hundred horsepower. VVI has the ability to control several motors. One of its disadvantages is the lack of regenerative braking capability.

**(b)Current Source Inverter (CSI):-** The current source inverter is a type of inverter in which the current is controlled while the voltage is varied according to the requirement of the motor. A large inductor is used in DC link for this purpose. Large value of inductor is used to keep the DC current constant. There are two ways to control CSI. One is by means of phase controlled bridge rectifier circuit and the other is controlled by diode bridge rectifier circuit. Typical current source inverter is shown in Fig:8.

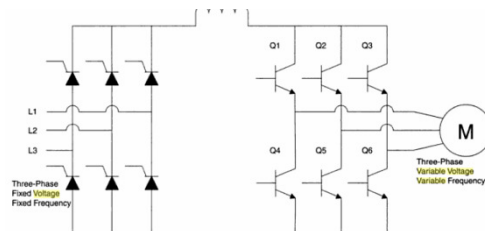


Fig:8:- CSI model

In figure the bridge rectifier is constructed with SCRs. We can change the amount of current through the DC link by controlling the firing angle of these SCRs. The controller is capable to control this firing angle. If low average output current is required then the controller will fire the SCR later in the cycle thus low average output current through DC link. Conversely, if high average current is required then the SCR is fired early in the cycle.

Current source inverters have several advantages over variable voltage inverters. They provide protection against short circuits in the output stage. CSI has good efficiency and its control circuit is simple. CSIs are suitable for medium and large motors. It has regenerative braking capability. CSI has a disadvantage that it produces torque pulsations at low speed. CSI are large

and heavy. Its performance is poor below the 50 percent speed.

**(c) PWM:-** Pulse width modulation (PWM) adjustable speed drives use complex computer software to control the voltage and frequency. These types of ASDs are most commonly chosen and are available for all sizes of motors. It receives DC power from a fixed voltage source and adjusts the frequency and voltage. They have high power factor and fast response characteristics. It has the ability to control several motors from a single drive. It also has some drawbacks. It lacks regenerative braking capability and increases motor heating.

### 5. Advantages of ASDs:-

Electronic AC or DC adjustable speed drives have a number of advantages over mechanical, hydraulic and fixed speed drives. They include a continuous speed range from 0 to full speed, improved process control, improved efficiency, short response time, soft starting, wider speed, torque and power ranges, regenerative braking, equipment life improvement, multiple motor capability (except CSI), increased productivity, re-acceleration capability, reduced maintenance and downtime and operation above full load speeds.

- Speed control is used to control the production by controlling the conveyor systems in the food, paper, automotive, and consumer goods industries.
- ASDs are used for position and torque control.
- It saves energy by controlling the machine and not providing it any extra power.
- It provides soft starting capability which reduces stress on motor and hence increases the durability of machine. When the motor is started, the initial input current is about six times higher than the ordinary current, thus producing much stress on the motor especially on winding. With adjustable frequency drives, acceleration times can be adjusted from instantaneous up to several minutes, thus providing soft starting capabilities.
- PWM adjustable speed drives can improve power factor.
- VVI and PWM adjustable speed drives have the capability to operate multiple motors at the same time at the same speed.
- Some of the ASDs also provide regenerative braking. Regenerative braking is used when the rapid reduction of motor speed in a controlled manner is needed for production or safety reasons.

### 6. Disadvantages of ASDs:-

- ASDs can increase motor heating.
- ASD will increase energy consumption when motor is operating at full speed.
- Some ASDs can produce electrical interference.

### 7. Conclusion:

Adjustable speed drives can be used with a wide variety of electrical machines. Optimum choice of a certain ASD depends upon the detailed assessment of the system design, initial cost, speed range, reliability, running cost, ease of maintenance and power factor. Such an optimization is well beyond the scope of this paper. This paper has provided the general overview of Electrical machines and various types of adjustable speed drives along with their advantages and disadvantages.

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# Robotic Manipulation

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**Abstract** - The success with which a robot interacts with its environment is based on how easily and accurately it can move around and manipulate objects. This paper examines current technologies used in robotic manipulation and discusses and compares various examples of robotic manipulators, actuators and end effectors.

Traditional robotics is based around use of pneumatics or electric motors to move parts rotationally or linearly along a single axis, in order to achieve more complex movement additional degrees of freedom are added by increasing the number of motors and rotation points.

The trend towards emulating organic movement in order to allow robots to function in less contained and controlled and more natural environments has led to the development of many new technologies. Technologies such as air muscles, elastic nanotubes and electro static polymers have been developed to actuate robots in a similar way to muscles. Snake arms, tentacle manipulators and robotic hands are developed in order to allow robots to move in natural environments and manipulate organic objects more effectively.

In order to expand the usage of robots, efficient and effective manipulation of the environment is necessary, for use in real world environments more organic based solutions are required.

**Keywords:** Robotics, Manipulators, End effectors, Actuators

## I. INTRODUCTION

Robotic manipulation describes how a robot can interact with its surroundings, with advances in technology people are investigating more complex ways for robots to interact with their environment. Traditional methods of robotics have gone a long way into exhausting techniques for making more dexterous robots, a great deal of modern research into robotic manipulation centers on emulating the natural world.

Biologically inspired manipulator, actuator and end effector designs are becoming realities and are finding usage in industrial and commercial settings due to their ability to effectively interact with the natural world and all of its irregularities.

## II. ACTUATORS

Actuators are how a robot effects its environment, just as sensors take in information from the robots surroundings, actuators create an effect whether it is to move part of the robot or to directly effect the robots environment. Some actuators are common such as

electric motors, pneumatics and hydraulics, whereas some are less well known and are in the early stages of their use such as air muscles, electroactive polymers, air motors and piezo and ultrasonic motors.

Research into new actuators goes on, elastic nanotubes are still some time away from being a usable form of actuation as they are still in an early stage of research.

### A. Electric Motors

Electric motors are probably the most common and well known form of actuator, certainly in robotics the many different types of electric motors are used extensively. In general, electric motors comprise of AC induction motors, DC motors, and synchronous motors[1], within these general types there are many variations although their main principles of operation remain the same.

DC motors have armature windings mounted on the rotor through which current is passed and field windings or permanent magnets mounted on the stator, the current through the armature interacts with the magnetic field from the stator to cause the rotor to rotate. The current through the armature is reversed every half rotation to keep the rotational force in the same direction.

AC induction motors generally use a multiphase AC current to create a rotating magnetic field, a three phase induction motor will have different parts of the stator energized at different points due to the three phases of current passing through the windings, this causes the rotor to be attracted to the energized point and rotate.

Synchronous motors are generally AC, however the most well known of them is the stepper motor which uses digital pulse trains to excite different "teeth" of the stator at different times in order to rotate a toothed rotor.

Another commonly used motor in robotics is the servo motor, this is usually a DC motor which is controlled using feedback from sensors that give information on the motors position, this allows the motor to be sent pulses indicating desired velocity or position which the motor can then assume.

### B. Fluid Power: Pneumatics, Hydraulics, Air Muscles and Air Motors

Both pneumatics and hydraulics are commonly used in industry, as both come under the area of fluid power they can be thought of as two variations on the same principle.

Fluid power is the use of pressurized fluids or gases to create a mechanical effect, the most common use of fluid power is in pneumatic or hydraulic cylinders in which a chamber is filled with a pressurized medium which then forces a piston out creating linear motion. In robotics this type of actuator is generally used where accuracy is not of great importance, this is because pistons are normally on/off devices which are either fully extended or fully retracted. In order to get accurate movement complicated control systems are needed to regulate the amount of pressure and therefore the amount of movement of the piston.

Another application of fluid power is for rotational actuation, an example of this is an air motor [2], the air motor described in [2] uses low pressure air passed over blades of a pair of impellers to rotate the impellers in a similar way to a water wheel. A major problem with this type of motor is the speed control, as it tends to oscillate especially at high speeds.

Air muscles[3,4] are a form of fluid power linear actuator developed by the “Shadow Robot Company”, they are in some ways the opposite of pistons in that they retract when pressurized air is supplied to them. Air muscles consist of a rubber core surrounded by “a tough plastic weave”, when the rubber core is supplied with air it expands, this causes the length of the core to decrease in the same way as a contracting muscle.

### C. Electroactive Polymers

Electroactive polymers (EAP)[5,6,7] are a group of polymers whose shape changes when a voltage is applied to them, they can be made into various shapes in order to deform in different ways, examples of bending and contracting have been developed for research and have been used in actuation of a simple robotic arm[5].

EAPs come in several types, the type most commonly used in robotic actuator research are ionic polymer–metal composites (IPMCs), these EAPs deform due to movement of ions within the material. A bending EAP actuator works by having a layer of EAP that reduces in volume attached to a layer of a non changing substance, when the volume of one layer reduces it will bend the non changing layer towards the side it is attached to. IPMCs have major disadvantages, they permanently deform when subjected to DC voltage and they degrade due to drying caused naturally or by electrolysis as there performance is based on the moisture content of the material.

### D. Piezo and Ultrasonic Motors

Piezo motors [8,9,10] use the change in shape of piezoelectric material to move a rotor. One method of motion uses three groups of crystals, one crystal is sandwiched between the other two, one of the outer two crystals extends so it contacts/locks with the stator or rotor (depending on which the crystals are attached to),

the center crystal then extends sideways pushing the locked crystal away. This causes the rotor to rotate, the locked crystal then retracts followed by the center crystal, this is done at high frequency which allows rotational speed comparable to some electric motors [10]. It is important to note that these motors are small scale of the order of a few centimeters.

Ultrasonic motors are a variation of piezo motors that use resonance to amplify the vibrations of the piezoelectric crystals.

Piezo motors have the advantages that they can work in vacuums and are nonmagnetic as well as being accurate, however as they are small scale there uses are limited.

TABLE I  
SUMMARY OF ACTUATOR ADVANTAGES AND  
DISADVANTAGES

|                             | Advantages                                                                                                                                                                                   | Disadvantages                                                                                                                                                                                                                          |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Electric Motors             | Wide variety available – suitable for many tasks<br><br>Some motors can run off batteries – allows autonomy<br><br>Extremely scalable<br><br>Can be low cost and very commercially available | Most motors need power to maintain position                                                                                                                                                                                            |
| Fluid Power Solutions       | Can exert very high power<br><br>For on/off applications, very simple to control<br><br>Can hold position without additional power                                                           | Can have complex control issues<br><br>Needs supply of air/liquid<br><br>Fairly limited availability<br><br>Interruption of supply can cause catastrophic failure<br><br>Difficult to make autonomous units due to supply requirements |
| Piezo and Ultrasonic Motors | Very small scale<br><br>Highly accurate                                                                                                                                                      | Very small scale<br><br>Only suitable for very specific applications                                                                                                                                                                   |
| Electroactive Polymers      | Many types available                                                                                                                                                                         | Some polymers performance degrades easily due to drying<br><br>Still fairly experimental                                                                                                                                               |
| Elastic Nanotubes           | Potentially huge amounts of energy                                                                                                                                                           | Early experimental – will not be available for years                                                                                                                                                                                   |

### E. Elastic Nanotubes

Elastic or carbon nanotubes are still in a very early stage of research and development, as yet no applications of this type of actuator exist. Elastic nanotubes exist in small scale research and as their name would suggest nanotubes are a single nanometer in diameter, however

multiple strings can be used in a material allowing for larger constructs. In terms of actuation, the properties of elastic nanotubes allow them to be deformed elastically at which point they hold a large amount of energy relative to their size, this could then be used as an actuator.

### III. MANIPULATORS

A robotic manipulator is the arm of a robot, it is what positions the end effector at the required point for the robots operation. The most obvious type of manipulator are robotic arms, however manipulators are not limited to emulating human arms or simply trying to achieve all 6 physical DoF (degrees of freedom). In the search for ever more dexterous manipulators, engineers are more often taking inspiration from the natural world, the results of such inspirations can be seen in both snake arms and tentacle arms.

#### A. Holonomic and Redundant DoF Robotic Arms

Degrees of Freedom (DoF) in robotic arms is the number of translations and/or rotations that the arm can make, for example a robotic arm with a wrist capable of rotation, an elbow joint capable of movement on a single plane and a shoulder joint capable of rotation and movement on a single plane would have 4 DoF.

Holonomic robotic arms are arms that have the capability to move in all 6 DoF in the physical plain (x, y and z on a Cartesian co-ordinate systems plus rotation about these 3 axis), above the 6 physical DoF arms are said to have redundant DoF. The human arm has 7 DoF, 3 at the shoulder, 1 at the elbow and 3 at the wrist as such the human arm has a redundant DoF although this allows for more dexterous movement.

Although many different types of holonomic and non-holonomic (less than the 6 physical DoF) robotic arms exist, most operate on the same principles of multiple rotational and/or hinged joints to achieve their operational movement. It can be said that the more DoF a robotic arm has, the more dexterous the arm is, there are examples of robotic arms in industry that have as many as 34 DoF [11] (32 DoF in one plane, 1 DoF in a second plane and 1 rotational DoF). With such a large number of DoF in a single plane the arm becomes more like a controllable rope in this plane, this allows for extremely dexterous movement at the expense of mechanical complexity as well as requiring an extremely complicated control system.

#### B. Snake and Tentacle Arms

Both snake and tentacle arm robots are examples of biologically inspired robotics. The most advanced examples of snake arms are designed and built by OC Robotics ([www.ocrobotics.com](http://www.ocrobotics.com)), these snake arms have multiple segments spaced by springs and controlled by sets of three motor actuated wires [12]. The segments form a continuous tube with each segment being kept

straight from the others with springs, the wires are then used to bend the arm by compressing the springs. Examples of snake arms have 23 [13] and 27 [14] DoF and are between 610mm [15] and 4m [13] long, with diameters ranging from 12.5mm [15] to 100mm [16]. These arms have been put into use in the nuclear industry and have been commissioned by the aerospace industry as well as the UK and US MoD, these snake arms are entirely motor actuated in contrast to tentacle arms.

A tentacle arm is both a manipulator and to some extent an end effector, the best way to describe it would be as a robotic elephant trunk or tentacle. As such it is capable of both positioning of its end point (manipulator style) or actively picking things up without the use of an additional end effector.

The Air-Octor [17,18,19] researched and designed at Clemson University, South Carolina, as the name suggests uses a pneumatic approach to a flexible arm, however what makes the Air-Octor more significant is its combination of a pneumatic approach and motorized wire actuators for positioning control. The Air-Octor consists of multiple sections that each have an inner and outer tube, in between the two tubes are 3 wires for controlling the movement in a similar way to the OC Robotics snake arm, the inner tube is filled with air of varying pressure depending on the required movement. This construction allows the arm to retract by compacting the sections, this allows the proto-type in [18] to contract each section from 45cm to 13cm, with a diameter of 9cm this is a significant contraction/extension range. The large range of movement that the flexible tubing combined with the control of the motor driven wires allows for an impressive range of movement closely emulating an elephants trunk, this is what allows the Air-Octor to pick up and manipulate objects which makes it more than just a manipulator style arm.

TABLE II  
SUMMARY OF MANIPULATOR ADVANTAGES AND DISADVANTAGES

|                         | Advantages                                        | Disadvantages                                |
|-------------------------|---------------------------------------------------|----------------------------------------------|
| Robotic Arms            | High power                                        | Limited movement                             |
|                         | Well documented                                   | Cannot handle real world environments well   |
|                         | Wide variety of configurations                    |                                              |
|                         | New redundant DoF arms achieving high flexibility |                                              |
|                         | Accurate                                          |                                              |
| Snake and Tentacle Arms | Flexible                                          | Complicated control                          |
|                         | Copes with organic objects well                   | Movement not entirely accurate on some types |
|                         | Copes with real world environments well           | Limited availability                         |
|                         |                                                   | Supply required for some types               |

#### IV. END EFFECTORS

End effectors are the tools or hands of a robot, there are a variety of types focused on grasping and picking up objects that use various methods of gripping such as pneumatics or electronic motors, other grasping/picking up type end effectors include vacuum and electromagnetic type grippers. Other end effectors are generally specialist tool types that are suitable for single functions such as router ends, drills, cutting tools etc.

##### A. Mechanical Grippers (Pneumatic and Electronic)

Mechanical grippers are general purpose grasping and picking up type end effectors, they usually consist of two or more “fingers” that are moved together by either pneumatics or a motor arrangement. The closing of the gripper is what creates the force to hold onto an object, as such the power of the system closing the gripper dictates to a large extent the size, shape, material and mass of the objects the gripper can hold. Due to the large variety of these type of grippers their abilities vary massively from small scale grippers that can delicately pick up test tubes to large scale grippers used in industry.

##### B. The Shadow Robot Hand

Despite essentially being a pneumatic gripper, the complexity of this particular end effector warrants a closer inspection [20,21,22], the Shadow Robot Hand is “Considered to be the most advanced Dexterous Hand in the world!”[20]. The hand is an attempt at replicating a human hand with robotics, it consists of 40 compliant air muscles which allow the manipulation of soft organic objects, demonstration videos show the hand picking up and manipulating eggs, peppers and soft fruits without any damage to them. The air muscles are mostly located in the wrist of the hand and use wires in place of tendons to move the different joints of the fingers and thumb. The natural compliance of the air muscles “significantly reduces control issues”[22], as such the control of the hand is less complex than may be expected.

##### C. Vacuum Grippers (Passive and Active)

Vacuum technology is similar to and in some cases a form of pneumatics in that it uses pressurized (in this case negatively pressurized) air to create a force or movement.

Passive vacuum grippers are simple vacuum cups that have little in common with pneumatics other than the before mentioned use of pressurized air, they produce a gripping force on the object due to the difference in pressure between the atmospheric air and the air inside the vacuum cup. When a passive vacuum cup is pressed against an object the air in the cup is evacuated, providing there is sufficient sealing between the object and the cup the evacuated air cannot re-enter the cup, as such the cup contains lower pressure air than the atmospheric pressure

and is pressed against the object by the pressure of the external air. As may be expected, the gripping force of a passive vacuum cup is limited, this is due to the level of vacuum in the cup being limited.



Fig. 1. The Shadow Robot Hand [20,21,22]

Active vacuum grippers use an external method of evacuating the air from the cup, motor driven pumps and venturi type compressed air fueled pumps are both used for this purpose, the vacuum in the cup is then limited to the amount of vacuum pressure the attached pump can provide (assuming the seal between cup and object is good).

Important factors in vacuum cup lifting include the coefficient of friction of the material being lifted, the seal between cup and object, the diameter and volume of the cup, the level of vacuum the evacuator can achieve and the pressure external to the cup[23]. In general heavy lifting can be achieved with large diameter cups at high vacuum with a good seal lifting high friction (appropriate for lifting horizontal to the cups attachment) materials in conditions with high external pressure.

These factors highlight some of the disadvantages of vacuum gripping: irregular shaped objects will not produce a good seal, low friction surfaces will slip when lifted horizontally to the cups attachment and most importantly for some applications, vacuum cups will not work in very low pressure environments and as pressure decreases their reliability will decrease. As such vacuum

technology is not very appropriate for planes due to the changes of pressure and totally useless for external atmosphere usage.

#### D. Electromagnetic

Electromagnetics are not generally used for small scale robotics end effectors, this is due to the potential for them interfering with electronic circuits. In large scale applications where the end effector is sufficiently far away from the control circuitry that the electromagnetic field can no longer interfere, they have found use due to their potentially high power and the fact that they can lift large objects without damaging them unlike high power mechanical grippers. The most obvious disadvantage is that electromagnetic grippers are only suitable for lifting ferromagnetic materials and as such have severely limited uses almost to the point of them becoming specialist tool end effectors.

#### E. Microspine Arrays

Microspine arrays are another attempt at emulating nature in order to achieve better performing robotics, researchers at Stanford, Utah and Pisa Universities have been researching and developing a method of scaling vertical surfaces based on the way geckos and some insects grip surfaces[24]. Geckos and insects can scale walls due to large numbers of tiny hairs or spines that catch onto tiny protuberances on the walls surface, the principle revolves around increasing the surface area in contact with the surface which allows adhesion via friction.

Although in early stages of development a robot using an array of tiny spines to grip onto walls has been prototyped and tested, although the robot was successful in climbing walls made of various rough stone such as bricks it has a tendency to slip without control. This makes the control itself difficult as the adhesion is somewhat unreliable, additionally the prototype is small and therefore further work needs to be done in order to research upscaled applications. Another problem is the gripping ability is based on the relationship between the size of the microspines and the roughness of the material to be gripped as such spines would need to be changed for different surfaces. This method of adhesion could see use in gripping mechanisms as an addition to mechanical gripping systems or as a system in its own right.

TABLE III  
SUMMARY OF END EFFECTOR ADVANTAGES AND DISADVANTAGES

|                     | Advantages                                 | Disadvantages                                                                                 |
|---------------------|--------------------------------------------|-----------------------------------------------------------------------------------------------|
| Mechanical Grippers | Widely available                           | Relies on friction – potential for slippage                                                   |
|                     | Large variety                              | Can damage objects being lifted without precise control                                       |
|                     | Pneumatic and electrical systems available | Can damage fragile objects                                                                    |
|                     | Simple control                             | Loss of power/supply can result in loss of grip                                               |
| Vacuum Technology   | Can have high strength                     | Requires air supply – limited autonomy                                                        |
|                     | Can maintain grip after power/supply loss  | Dirty/dusty surfaces or objects will damage system                                            |
|                     |                                            | Cannot grip irregular surfaces                                                                |
| Electromagnetics    | Can be very high power                     | Only works on ferromagnetic materials                                                         |
|                     | Cannot usually damage lifted object        | Loss of power will result in loss of grip<br>Rust/dirt on surfaces can result in loss of grip |
| Microspine Arrays   | No supply needed                           | Not adapted to pick up objects as yet                                                         |

#### V. CONCLUSION

Although biologically inspired designs have produced impressive results, their applications are limited just as more traditional designs are. Their ability to interact with the natural world is without doubt better than most traditional designs, however there are still problems that have to be overcome. Complexity of control, cost and accuracy are still points that need to be addressed, most importantly it should always be considered whether a more traditional, less complex design can complete the required task to a competitive level. It remains that the use of robots is always application based, where some robotics excel in certain areas there are yet more areas in which they are uneconomic, inappropriate or would simply fail.

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## Cloud Computing: Software as a Service (SaaS)

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**Abstract-** Cloud computing has become one of the key buzzwords of the web 2.0 revolution. However the term has no universally agreed definition. Some define the term to meaning just a modern version of utility computing. While others have a much broader definition of cloud computing meaning anything outside a user's network could be considered part of the "cloud".

The focus of this report is on just one aspect of cloud computing - Software as a Service (SaaS). SaaS is a method of providing software to businesses and individuals. Examples of SaaS include Google Apps and Zoho Office. SaaS is an "on-demand" model, where consumers only pay when using the software. Making software a variable cost for consumers. Some see SaaS as a possible threat to traditional licensing model, such as software packages like Microsoft office.

This report aims to investigate SaaS development and affect on businesses. This report will have brief overview of the technology behind cloud computing and SaaS, but the main focus will be on how SaaS is developing for service providers and their consumers and whether SaaS is a threat to tradition methods of providing software.

**Keywords:** Cloud computing, SaaS, Software

### I. INTRODUCTION

#### A. Cloud Computing

Due to the wide spread use of computers that are connected to the internet there is now new opportunities of supplying resources using Cloud Computing. Cloud Computing is a style of computing which provides users with services through the internet. The term cloud is used as a metaphor for a large network of computers. It was first used to describe the telephone network but now it mainly refers to the Internet but Cloud could refer any large network.

The services are resources which have been commoditized into virtual products that which can be bought and sold via the internet.

These services are virtual commodities and include resources such as data storage, information processing, web hosting and software (SaaS). Any service which is accessed through the internet is considered Cloud Computing including web-based e-mail service like Hotmail, Yahoo! Mail or GMail. Cloud Computing is an umbrella term which includes concepts such as Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS).

Over the past ten years Cloud Computing has become big business and according to Jonathan Schwartz the CEO of Sun Microsystems, Cloud Computing is currently worth anywhere from a \$20 billion to \$80 billion per year industry

[1]. It is expected to keep growing for years to come by becoming the preferred method for supplying services.

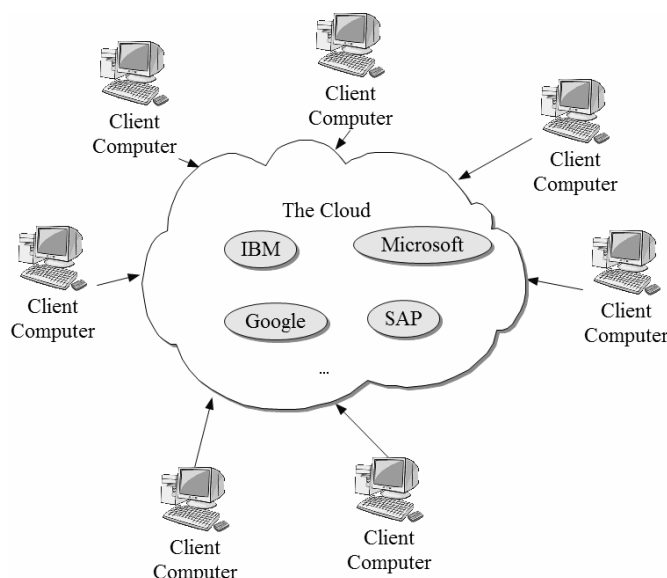


Fig 1. The Cloud Computing overview

#### B. Software as a Service (SaaS)

SaaS is a concept which refers to the providing software using Cloud Computing. It is one of the largest and fastest growing parts of Cloud Computing. The idea is to provide software on the internet. The software is paid for by the user with a subscription or a pay as you go model. This is more flexible than the most common method of supplying software today which is End User License Agreement (EULA). These licences are permanent and usually restricted to one computer per licence. This can be a huge cost for businesses with a large number of computers and is very costly for a user who only wishes to use the software for a limited time. So SaaS is being used to provide software on more flexible terms. [2]

### II. TECHNOLOGY

#### A. Front end Vs. Back end

Cloud Computing can often be split in to two sections. The front end this is what the end user can see. The front end accesses the cloud through the use of middleware. Middleware is interface software and can be a generic web browser or a specialist program. When using the middleware users can access the services in an easy to use format. The middleware hides the other side which is the back end. The back end is where all the heavy processing of the software takes place. This means a user can use a program that might be distributed in the data centres around the globe without even knowing its workings.

#### B. Architecture

The majority of services are currently provided through large data centres. These data centres act as servers on which Web Services can operate. Web Services are small

programs that are specialised in one task. Web Services communicate with each other using Extensible Mark-up Language (XML) messages transported using either Simple Object Access Protocol (SOAP) or Hypertext Transfer Protocol (HTTP) to create larger software programs. These clouds of Web Services are a form of distributed computing called service-oriented architecture (SOA). Using this method programs can work and data can be stored over multiple data centres. For the transport of sensitive data Secure Sockets Layer (SSL) encryption is commonly used.

### C. Redundancy

The data centres build in to their computer systems at least double redundancy. This means that the all data can be stored twice, the net result being that all data is backed up in case one copy of the data is lost. This and other procuress have made Data centres reliable enough to use as a platform to provide SaaS applications.

### D. Accessibility

Using SaaS there is a shift in processing power from the local computer to the cloud. This means that local computers no longer do all the heavy processing to run software applications. Instead, all the complex calculations are done by a network of computers which make up part of the cloud. Using this system smaller businesses can rent the processing power from the cloud rather than purchase the expensive hardware themselves. The client's local computers still need to run the cloud's interface software.

## III. SERVICE PROVIDERS

### A. SaaS Businesses Model

There are three key aspects which makes SaaS business model attractive to Service providers. The first two are multitenancy and configurability. If they develop their software using Web Services then they can reuse the Web Services in other programs. Because each Web Service can perform a single function which may be useful again, so they are added to a library of other Web Services. With this library of Web Services developers can mix and match these Web Services quickly to build software which is configured to the client's needs. Since they are reusing Web Services it is also able to serve a growing customer base which is multitenancy.

The final key is scalability which is provided by the use of data centres which can process large amounts of data reliably, so when the Service Providers need more capacity they just buy more from the data centres. [11] Also since the software is kept on the server side (back end) it should reduce software piracy because the end user streams the program to their computer and it is not stored on their machine.

### B. SWOT Analysis

| STRENGTHS                             | WEAKNESSES                                                                         |
|---------------------------------------|------------------------------------------------------------------------------------|
| Cost saving<br>Flexible payment model | Requires internet connection<br>Limited by internet bandwidth<br>Issues over trust |
| OPPORTUNITIES                         | THREATS                                                                            |
| Expanding Market                      | Hackers<br>Government regulation                                                   |

Fig 2. SWOT Analysis of the SAAS market

## IV. INVESTMENT

Currently there is a large amount of investment into Cloud Computing [12]. Many large firms such as IBM, Microsoft, Sun Microsystems, Google and Amazon are currently developing their products in an attempt to a secure market share and insure their business's future. IBM and Sun Microsystems are developing private and hybrid clouds. This is because they likely believe that because of government regulation and organisation's fears over data breaches of sensitive data. Businesses will need Cloud Computing which can be kept private. [1] [3] Microsoft have approach Cloud Computing differently by developing a software package called Windows Azure which allows developers to start making their own program and run them on in the cloud. [4]

Google and Amazon have already developed and released their own SaaS applications. Amazon is running subscription base Web Services called Amazon Web Services [5] and have over half a million users. [1] Google now offers a range of applications called Google Apps which is currently free to use.

## V. APPLICATIONS

### A. eLearning

According to Bob Little SaaS is being used to developing eLearning technologies [6]. The concept of eLearning lends itself to SaaS methodology, since if it is provided in the Cloud then it can be distributed quickly throughout an organisation and just as importantly it a can be updated instantly because it is stored centrally. The NHS is currently providing eLearning software to its employees which can be accessed over the internet. [10]

### B. Web analytics

Web analytics is a common SaaS application provided by many Web hosting businesses. Web analytics allows businesses to track traffic on their web site and can give much more detailed and accurate then pervious methods such as hit tracking. Google have developed Google analytics which allows web developers to access outside of a web hosting company [7].

### C. SAP Business ByDesign

SAP Business ByDesign is Enterprise Resource Planning (ERP) which is accessed through the Cloud. It is a subscription based service based in Germany which provides on demand software to its users from any location with internet access. The ERP software is targeted at small to medium businesses and provides them with real time knowledge management resource access,

such as updating databases. It is currently being used by Leeds City Council. [8]

#### *D. Word processing*

Part of Google Apps is providing Word processing software called Google Docs. Google Docs can be accessed through a web browser and provides the user with the main features of traditional word processing software packages such as Microsoft Word. The feature that Google Docs provides which are different to traditional word processing software packages is that the documents can be stored in the Cloud; this means that files can be accessed from any location with internet access. Google Docs uses user personal accounts which may make it unsuitable for businesses, because of concern over data security. [9]

### VI. SMALL TO MEDIUM SIZE BUSINESSES (SMB)

#### *A. Drivers for Adoption*

SaaS's main attraction is that by using Cloud Computing it can deliver better, more flexible and cheaper software than a business can with a local computers system.

Flexibility of access is one of the main drivers; suddenly data and software can be accessed from any computer with an internet connection. This allows a business to become very flexible in their work practices. An employee could work on a project from an office or at home or conceivably they do the same work in another country, all working with the same data and software which is updated instantly. This gives a business more options and increased speed of service. They could even move to a virtual business model with no fixed offices.

Since in SaaS the processing power can be done by the cloud. A business could lower the cost of hardware and IT support costs by streamlining their computer systems. The computers would only need to be powerful enough to run the middleware to access the cloud. By streamlining their computer systems there is also reduced physical space requirements, because servers and digital storage devices take up physical space. However, the cloud services such as Amazon S3 [5] could be used to store the data and their own servers will be less needed because everything is stored off site. Also Cloud Computing could give the business greater processing power with access to grid computing.

The service provider is providing software to many clients (Amazon Web Services has over 500,000 paying customers [1]). The clients are also able to make requests for new features. These features are often created and released quickly with no extra cost to the client, because the entire community of users can benefit from the new features which spread the cost. [2]

#### *B. Barriers to entry*

If a business is to implement Cloud Computing effectively then their internet bandwidth is key. Whereas before software would be run locally, now they have to access it through the internet. The clients will need to plan for sporadic outages and slow-downs. Bandwidth

and reliability of internet access could be a limiting factor on the business.

Possibly the biggest issue stopping businesses taking up cloud computing and SaaS is that the business will have to give up its data to outside contractors. With the move to a knowledge base economy a business's data assets could be seen as valuable as money assets. That is why in the opinion of the author the service provider has to be as trusted as banks before a business can move onto Cloud Computing and SaaS.

There are still issues of legal rights to data stored on the cloud. One issue is that it is not clear who owns the data, since the data is being stored on the service provider's hardware it could be argued that the service provider owns the data. In the opinion of the author this is an issue because it is important to know who is responsible when things go wrong. For example, if there is data breach where people's private information is accidentally released, similar to the 2007 UK child benefit data scandal [13] but over a cloud network, then who is responsible? But until it has been resolved where the law stands on this it remains a significant risk to both client and the service provider. Another issue is the whether it is legal or not for the service provider to deny a client access to their data. This issue becomes important when interacting with regulatory bodies. It is an unknown whether it is legal for a government to freeze a business's data in the same way that they have the legal power to freeze a business's other assets such as bank accounts.

Government regulations such as the Data Protection Act 1998 can often restrict the types of data that can be shared over a public system like the internet. The response from some of the service providers such as IBM and Sun Microsystems is to develop a private cloud for each business. These private clouds will run on internal internets which are closed to the public. This solves the problem but limits the benefits since the client now has to own and manage the cloud themselves. [1]

When a firm is looking to SaaS for their software needs there is a concern of being locked in to one service provider. This is a huge risk as no matter how well relationship is between the client and the service provider it could break down in the future. This should drive clients to demand a right to access of their data and prepare a plan to be able to switch service providers. The concern about being locked in isn't just a matter about being able to switch, but also how much it will cost the client to re-organise their business without the service provider. It is possible for a business to become incredibly dependant on their service provider. This marks a shift in power to the service provider, and making the client vulnerable to the service provider's decisions.

In theory there shouldn't be a conflict of interests between the client business and the service provider over the updating and maintaining of the software. But in practise there might be a fear on the part of the client that the service provider will try to increase profits by reducing expenditure on the quality of the software. This shouldn't be an issue because service provider currently

relies on the reputation of their service for business, but this could change over time.

As with many of the other problems discussed here it is a result of the reliance on an outside contractor.

#### VII. CONCLUSION

In conclusion Cloud Computing is a quickly changing area of technology.

There remain only a few technology problems and due to the backing and investment from the world's largest IT firms such as IBM, Google and Microsoft these technical problems are very likely to be resolved in the near future. However, it still remains to be seen if these firms can apply their pressure politically to resolve the outstanding legal issues, which make Cloud Computing a gray area in terms of user rights and responsibility for major problems such as data breaches. Fears over data security have lead Cloud Computing to develop in unexpected ways with the introduction of the private Cloud.

Trust seems to be a major issue as businesses have to hand over their data to a third party, in a knowledge base economy this data is of vital importance to their survival as a business. Businesses have to be able to trust both the technology and the service providers behind it for Cloud Computing to be a success.

It will be interesting to see whether Cloud Computing and SaaS has a wider uptake and become a serious challenge the most common method of supplying technology which is EULAs. There has been some early success such as Amazons Web Services and web-based email.

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# E-commerce And Types of Relationships between Customer and Merchant

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**Abstract** - The meaning of electronic commerce has been introduced in the late 1970s. There is no existing definition of e-commerce before 70s. Basically E-commerce is business through Internet and this is concerning any kind transaction.

Nowadays everything can be bought and sold through the Internet. And the implementation of this tool is important for us. Because E-Commerce is very powerful tool of on-line trading in the Internet, and the understanding of how to use this tool is a way to increase the customers' interest and profit.

Technically "E-commerce" includes a lot of different technologies and protocols. The main technologies are EDI (Electronic Data Interchange), e-mail protocols, Internet (TCP/IP, HTTP), payment systems (such as Visa or PayPal).

The main aim of this work is to define principles and relationships between costumer, merchant, supplier and payment systems.

**Keywords:** Internet, E-commerce, Customer, Merchant, Supplier, Payment Systems

## I. INTRODUCTION

Electronic commerce (e-commerce) - the term used to describe the commercial activity in the Internet. It provides the possibility of purchases, sales, service, and marketing activities through the computer networks.

The global network of Internet has made e-commerce accessible to companies of all sizes. Previously it was required from the organization a significant investment in communications infrastructure, and only large companies was able to start such business. The World Wide Web enables any company to attract customers from all over the world. This on-line business forms is a channel for marketing - «virtual», almost doesn't require physical or real office. If the main product of the company is software so it may be delivered through the Web, then the whole process of the sale (including payment) can occur in on-line.

Nowadays, the dominated types of payment in the Internet purchases are credit cards. The other payment instruments: smart cards, digital cash, micropayments and electronic checks.

Electronic commerce includes not only the on-line transaction. It is necessary to include such activities as market researches, identification of opportunities and partners, the support relations with suppliers and customers, the documents management and etc. E-commerce is a complex concept and includes an electronic data exchange as one of the it's components.

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## II. CATEGORIES OF E-COMMERCE

There are different types of relationships in E-commerce: B2B (Business - Business), B2G (business - Government), B2C (business - the customer), C2C (customer- customer), G2B (Government - Business). There are more varieties: B2A (Business - Administration), A2B (Administration - Business) - is respectively equal to B2G, and G2B.

B2B - this term identifies the type of transactions between two or more companies.

B2C - this term for the commercial relationship between the organization (Business) and private, so-called "end" consumers. /D.Chaffey, "E-Business and E-Commerce Management", 2007/. Example is online store.

B2G - the relationship between business and government. Usually the term is used for classification of electronic commerce. Examples of B2G-systems can be an electronic system of government procurements.

C2C - this term describe relationships between two consumers and is very popular type of E-commerce in Internet. The example is Ebay.com.

## III. DROP SHIPPING

Drop shipping is a supply chain management technique which enables you to sell goods directly from manufacturer or a wholesaler, who will ships the goods directly to the customer. The main idea is that costumer doesn't know your secret supplier, and all shipping is made from your name.

Figure 1 showd the main conception of relationships between seller, buyer and drop shipping supplier. The buyer purchases the item from your online store, and seller receives payment for it, then seller is forwarding this order to the drop shipping supplier. The drop shipper company charges seller a wholesale price and making delivery of purchased items directly to the buyer. The profit of this transaction is a difference between the wholesale price and retail price. The big benefit of such business is that seller do not need big amount of money to start this business on-line.

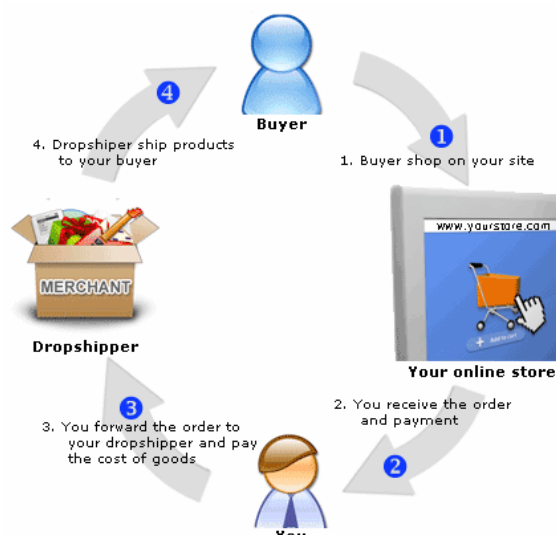


Figure 1 relationships between seller, buyer and drop shipping supplier.

The success of this business strongly depends of the price and quality of the product and costumer service which is provided by seller and drop shipping company. Seller should be sure that he has the lowest price on the market, so this will gave him an advantage from competitors. Simple example, the profit from one item is 1.5 pound. The total amount of sold items is 100, so he will get approximately 150 pounds. But if he will increase the price, to double his profit, he probably will get problems with selling. For example seller will sell 30 items, so the profit will be 45pounds only.

However, to start selling on line it is necessary to have a supplier. There are two different types of supplies:

- Manufacturers or master distributors
- Aggregators

There are many of manufacturers or distributors who will drop ship items. Some distributors do direct shipping to the costumer and other are using the services of a master distributor. So, if seller ordering directly from manufacture, then he is getting the lowest price available on the market.

And other types of drop shippers are Aggregators. This is specific web sites which are collecting information about different drop shipping companies and their range of products. This information may content prices, images, delivery time and product specification. Also these web sites provide price comparing of different products. This option is give to seller a good opportunity to select a lowest price on the market. And other important option of these web sites that they are giving to seller opportunity to left feedbacks about responsibility of a drop shipping companies, so the other sellers can avoid untrusted or unresponsible drop shipping companies. However, such web sites may ask for a small fee, this can be one time payment or monthly membership. There are also some free web sites such as [www.dhgate.com](http://www.dhgate.com) or

[www.alibaba.com](http://www.alibaba.com) which provide information about drop shipping companies from China.

Next step to is to find how to sell items. There are many solutions to create online store. Some of them is free and other is not. There are many different software solutions to create e-shop and some of them is: Interchange, Magento, NetSuite ERP, OsCommerce and Joomla.

The most easy and simple solution to create on line store is Joomla!Market. Based on CMS Joomla, you can create your own online store relatively quickly and without much cost.

Advantages are:

- Works as a shop and as catalog
- Full integration with Joomla CMS
- The opportunity to sell electronic products (templates, software)
- Great potential product (types, attributes, properties)
- Loading of goods through CSV
- The set of modules for payment and delivery
- The set of modules for Joomla.CMS such as galleries, SEO optimisations and etc.
- The set of documentation and forums
- A lot of third party assemblies and shop "hacks"(modules).
- Multilanguage

Disadvantages of this store solution:

- In most cases requires good development skills such as PHP and etc.
- Luck work with tax and currency

Not every one is able to open his own online store because of the different reasons. One is luck of money, to develop online store and other is small experience in web development.

The other solution is to use Internet auctions. The different from normal auction is that they take place through the Internet. Unlike traditional auctions, online auctions are work remotely. After wining the online auction buyer must transfer money to the seller by wire transfer (rarely - in cash, for example - when buyer is collecting item by person), and the seller is obliged to send goods to the buyer by post mail, this could be any country in the world. Seller also can specify the boundaries of the possible transfer.

The largest online auction in the world is eBay, founded in 1995 and has a turnover of several million transactions a day. In Russia, is very popular auction Molotok.ru, Ukraine - AUCTION.ua and Japan - Yahoo action.

The huge contribution in development of drop shipping as business was made by EBay.com. People all over the

world may sell and buy goods and open their own online store. But EBay will ask for a small fee from you monthly salary.

The simple way to trend on EBay using drop shipping is to create auction with fixed price for the product (typically 50-100% higher than that for which he is working with the supplier) or open bidding with start price 0.99p and reserve price equal supplier price. When a customer is winning the auction, the transaction is concluded and prepayment received, the seller send shipping information about customer to supplier and pays the wholesale price. The difference between wholesale and retail price and makes his profit. The drop shipping supplier receive the order, takes all care in packing and shipping the goods the customer. This shipment may be carried out on behalf of the seller, if as previously agreed with supplier.

According to Ebay.com it is very easy to create Online Store. You just need to create a new account. And follow instructions to complete registration and publish on-line store. Ebay.com gives to users possibility to add a domain name to their on-line store, something like www.your-online-store.co.uk. So, every one can access to this store over this domain.

Next step is to decide what to sell. This is one of the most important steps. The reason is that customer may not be satisfied of quality or price of the products. Some products may have some legal issues or can be banned to import to different countries. This may happen if the buyer is located in different country. Seller should consider fact that the price of item plus shipping is not higher than in local store. This reason makes product not interesting to the customer. Also seller should consider the import tax of products. So, this tax may change the end price of product. The most relevant products to sell online is some electronic gadgets. This can be MP3 players, webcams, headphones, cases for ipod or other electrical devices, photo gadgets like soft boxes of flashes and etc.

To create a successful business, seller should use a comfortable payment method for buyer. This task should be solved by using payment systems. Payment system is the system of payments between financial institutions, business organizations and Internet users in the buying and selling of goods and services via the Internet.

There are many different payment systems.

Russian payment systems:

- Yandex.Money - Russian Ruble
- WebMoney, currency - the Russian Ruble, Euro, U.S. Dollar, hryvnia
- Ediniy Kashelec, currency - the Russian Ruble, South African Rand
- MoneyMail
- RBK Money (formerly RUpay)
- ICQMoney
- CyberPlat

International payment system:

- Gate2Shop
- Elios Gold
- PayPal
- E-gold
- Moneybookers
- Liberty Reserve, currency - the euro, U.S. dollar
- Pecunix
- E-Bullion
- PayCashEuro, currency - the euro
- CypherMint, currency - U.S. Dollar

Russian processing center:

- ChronoPay
- Assist
- CyberPlat

International Processing Center:

- 2checkout
- Google Checkout

Organization for receiving payment:

- Checkout gateway
- E-pass

Choosing the payment system, seller should consider the following facts:

- Privacy. In carrying out payments over the Internet buyer wants to be sure that his data (such as credit card number) have been known only to organizations having the legal right to do so.
- Maintaining the integrity of the information. Information about the purchasing can not be changed.
- Authentication. Buyers and sellers should be sure that all parties involved in the transaction are those for whom they themselves are.
- Means of payment. Ability to pay any buyer tender.
- Authorization. The process by which the requirement for the transaction was approved or rejected by the payment system. This procedure allows to determine the availability of funds from the buyer.
- Guarantees of vendor risk. Through online sales, the seller is subject to numerous risks associated with the surrender of the goods and the buyer's bad faith. The amount of risk should be agreed with the provider payment system and other organizations included in the trading chain, by means of special agreements.
- Minimize fees per transaction. The fee for processing the transaction ordering and payment of goods, of course, is their cost, thus lowering prices increases the competitiveness of the transaction. It is important to note that the transaction must be paid in any event.

#### IV. BENEFIT OF DROP SHIPPING

The main benefits of drop shipping are:

- This type of business requires practically no start-up capital. Seller does not care any risks. . The seller usually pays only after he has received the payment from the buyer.
- The seller is not required to have storage space for stock. All that he needs to do business - is a computer with Internet.
- The supplier is caring of sending the goods by itself. Seller is not involved in this process.
- The Seller has the opportunity to collaborate with several supplies at the same time and increasing the range of products and number of clients.
- The supplier sends the goods on behalf of the seller, so he could create a recognizable trademark and advertise it.
- The item descriptions and pictures, can be copied from supplier.

#### V. POSSIBLE RISKS OF DROP SHIPPING

As in any other business, a certain percentage of risk is existing. The main risks are:

- A supplier may not be able to send goods which the customer has ordered. For example back order may happen, it means that items which was ordered by buyer is out of stock. And the result is delays, disruptions date of delivery and client dissatisfaction with the seller.
- Some problems can occur during the delivery of the product by delivery service. And seller is responsible for this.
- The quality of the goods can not satisfy the customer because of objective or subjective reasons. And seller may ask for refund or replacement.

But all these risks can be avoided with competent and responsible work of the seller, the availability of reliable suppliers and good sales schemes.

#### VI. CONCLUSION

The development of the Internet has changed many of the principles of trade in the Internet. Implementation of drop shipping in Internet makes sense only with certain types of goods. This type of business can not be applied to all industries. Before beginning this business future seller must have good negotiating skills in negotiation with customers and suppliers. And also to carry out market research on the demand for certain types of goods. Also, this kind of business has some kind of risks. Because of that the seller will need to pay for a fee for posting his items on eBay, as well as possibility of the returning items to the seller. But all these risks can be avoided with competent and responsible work of the seller, the availability of reliable suppliers and good distributions schemes.

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# Web Based Software for IT Project Management

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**Abstract-** Using web based solutions in many software development and management areas is now very popular. The scope of this work is to find out if it is possible to replace desktop solutions for management of small and medium IT projects, with web based solutions.

In my research I used different sources of information. First of all I used a client's list of some popular web based and desktop solutions to get information about the experience of using these tools from client's web sites, publications and other open sources. Also I have sent e-mails to some IT companies and asked about their tools for project management. Finally I have two years experience of ruling and managing small software projects.

After analysis of all available information I found out that a couple of web based project management tools can replace desktop solutions in small projects and even provide a few of important advantages, such as very simple deployment, support and ease of cooperation through internet or Intranet.

But it is very difficult to find a proper web based tool for management of medium or big projects.

## I. INTRODUCTION

Project management (PM) is the discipline of planning, organising and managing resources to bring the successful completion of specific project goals and objectives [1]. Nowadays it is impossible effectively manage the project without using special project management software. Many projects are too complicated and people from different departments are involved in development process. Project management software is a set of tools for scheduling, budget tracking, resource allocation, effective communication centre, tools for collaboration, risk management, knowledge management and so on [2].

All project management tools can be divided on web-based and desktop applications. The main objective of this research is too find out the best web-based solutions for PM in IT, review them and find out is it possible effectively use web-based solutions for PM and in what types of projects.

## II REVIEW OF WEB-BASED PM TOOLS

### Basecamp

It is one of the most famous web-based PM tools among web studios and small software developer

companies. Basecamp developed by 37signals. The main goal of this tool is to give IT (and others) teams a simple utility that can help to decide the common problems and project management task that can appear during the development of software or creating web sites.

Basecamp offers a list of tool which designer's/developer's team can use for managing project [3]:

#### I. to-do tool

To-do is a list of little tasks that should be done before the finishing of project. It can be some additional features that should be added to the software (website) or something else. It is possible to make to-do list private, so only your team (but not client) will see this to-do list

#### II. milestones

Milestones are similar to to-do list but milestones have dates. The project manager can set person who is responsible for achieving tasks in milestones

#### III. wiki-documents

Provide a very powerful tool for creating and simple sharing document with information about project. It is possible for team members simultaneously work under the same document. For example it can be technical requirements or documentation for website

#### IV. file hosting

Allow team members to upload files to FTP server and share these files with other clients or customers

#### V. time tracking

This utility gathering information about how much time each developer spend during working under each task

#### VI. centralised messaging system

All information and communication are taking part through centralised messaging system. It helps all team members be well informed about current situation in project and well understand all problems that are appearing.

#### VII. Basecamp API

Provide API for developing plug-gins that helps any company to develop its own add-on for Basecamp

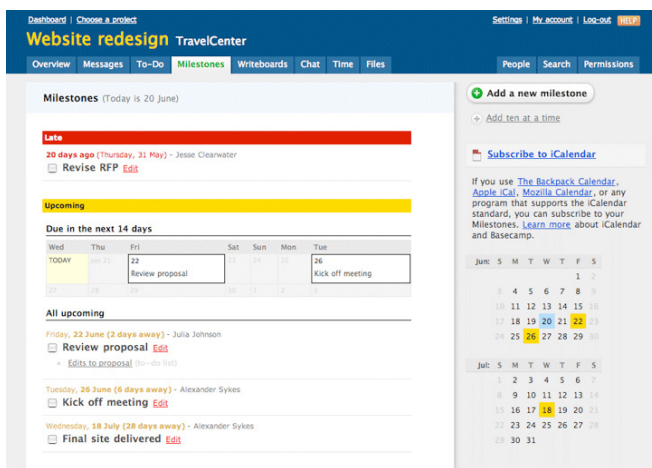
## VIII. support rss

This feature helps team members and clients to receive news about current changes in project using RSS feed format

The main advantage of Basecamp is its simplicity. It is very easy to start using Basecamp. You don't need to have special knowledge in PM management. This software product has a very user-friendly interface. Using Basecamp you don't need to change your way of PM. You don't need to spend time and efforts to study how Basecamp works and what is the most effective way of using this tool.

But it has a couple of disadvantages:

- I. it is too simple
- II. it is not free; you can't install it on your own server in your intranet network
- III. don't have utilities which can illustrate a project schedule (only for very simple projects)
- IV. no WYSIWYG editor for documents and messages
- V. no invoicing system



Pic 1. Milestones in Basecamp

Discuss some of the main disadvantages. Simplicity is an advantage of Basecamp but at the same time it is the main disadvantage of this tool and source of criticism. It is impossible to make any changes in Basecamp (to add new function or turn off function that you don't need). For example, Basecamp has very simple tools for time tracking and time-planning. Many users ask 37signals to add some additional functions, for example Gantt charts. But 37signals has officially announced that this is impossible, because it is contrary to simplicity principles [4]. Plug-ins system reduces this disadvantage but most of plug-ins are too simple because of poor Basecamp API. Another disadvantage of Basecamp is the way of managing tasks. A project in Basecamp system looks like a blog. The main problem of this approach is that

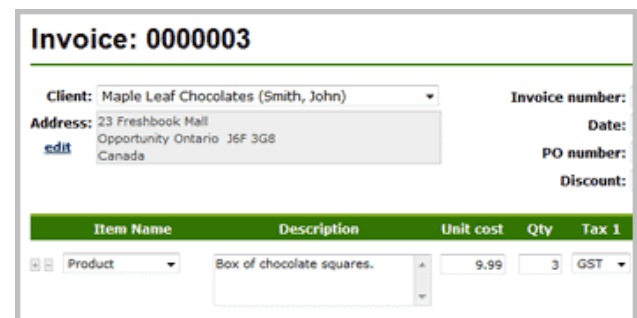
this solution destroys natural way of managing project: task → draft version → discuss of draft version → new draft version → discuss... → final version. So the only way to do this with blog-like tool is to create new blog message for each version. But it is too hard to navigate between different messages if there are a couple of simultaneous tasks. Another way is to add new drafts to the same message. But in this case the user should go through all old messages before he will find the new one draft. Anyway it is too difficult to get result from all messages that have been created especially if project has a dozen of different tasks with long review history [5]. Another issue of Basecamp is that it doesn't have any WYSIWYG editor. So if you want to post messaging system you need to study simple but a little bit strange text mark-up language [5]. Basecamp doesn't have utilities that are important for a developer team. It doesn't have any utility for version control, no bug tracking utility. So Basecamp is a perfect solution for most common tasks and allows team to start using this system as soon as possible. But it is not the best tool for developer team or for complicated projects.

## Freshbooks

Freshbooks is a tool developed by 2ndSite Inc. This tool has not been developed as a PM one, but as the tool for online invoicing. Nowadays Freshbooks have a lot of different tools that can be used for PM [6].

## I. Online Invoicing

Flashbooks provide utility for creating and managing invoices. Clients can view invoices and pay online. This tool provides all invoices history for clients. If client doesn't pay before the deadline, he will receive reminder e-mails, so developer company doesn't need spend time for writing those mails.



Pic 2. Invoices in Freshbooks

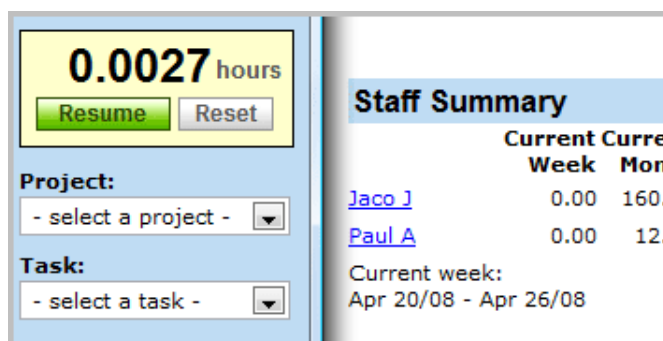
## II. Estimates

Flashbooks provide utility for creating well-looking estimates. This utility is connected with time tracking and invoices utility. So if technical requirements change it will be very simple to change estimate and create new invoice. You can

use estimate templates or re-use already created estimates.

### III. Time tracking

Time tracking utility helps to make project in time and in budget. Also the additional purpose of this utility is to collect statistical information of spending time for each task for using this information in future projects. It is possible to provide full or limited access to this information for clients and customers. It is possible to use couple third part desktop add-ons for time tracking (Windows and Mac versions available).



Pic. 3. Time tracking in Freshbooks

### IV. Expense Tracking

Freshbooks provide a simple way for managing project and company expenses and helps company to increase its profit. This tool provides additional reports that show company where it spends its money and project budget.

### V. Manage Clients and Your Team

This utility helps you to manage staff, employees and your client's contacts. Monitoring timesheets of company's employees the manager will know how company business is doing. The different chart helps the manager to identify keys clients and employees

### VI. Branding

### VII. Integrate with Basecamp and tick

### VIII. Api for developers

Api provide clients ability to develop their own plug-gins for meet their own requirements for PM tool

Freshbooks is a very good chooses for team that likes Basecamp but what more advantage functions and online invoices.

## Trac

Trac is open source web-based PM system that distributed under modified BSD license [7].



Pic. 4 Trac tool

Trac consist of a couple modules such as [7] [8]:

- I. wiki component
- II. issue tracking system
- III. integration with version control systems like Subversion, Git and so on
- IV. Ticket system for client support, for creating to-do lists. Integration with milestones and roadmaps
- V. milestone management
- VI. file sharing
- VII. Browse source code from version control systems with revision support. Highlight code for list of programming languages
- VIII. open source and absolutely free
- IX. it is possible to install it on local server at intranet
- X. very light interface(even minimalist)
- XI. very little impose on development process
- XII. roadmap board for controlling development process
- XIII. support rss for fast broadcasting information about the project for all team members
- XIV. very good organised user management rights system(for example it is possible to use LDAP as identification server)
- XV. very high flexibility. A lot of different plug-gins(examples: web administration plug-gin, code documentation, code covering, testing and so on)

Trac is a perfect PM system for team of developers, but not the best choose for management whole project. Trac is very wide spread system. More than 450 developer teams all over the world use this tool for PM [7]. This tool uses such IT giants as NASA, Apple, and Adobe.

Disadvantages of trac:

- I. no design tools
- II. too simple time tracking tools and no Gantt chart support

## FogBugz

FogBugz is a PM web based bug tracking system

developed by Fogcreek Company. It is high cost (comparing with others), but very high quality utility for bug tracking and PM. It is very popular utility among developers. It has more than 15000 customers all over the world. FogBugz is using by eBay, Nokia, NASA, Intel, Siemens and so on [9]. The main advantages of this PM system are:

I. list of work items(something like to-do list)

It is very simple to create list of tasks that should be done during development process. The main advantage of this function in FogBugz is that every task can be very simple connected with already existed code. It is possible to mentioned developer or group of developers that are responsible for this task. There are a lot of different hints that can help project manager to describe task as clear as possible. So this feature helps developer's team and project manager to organise a well controlled development process. But developers should be well disciplined and add current information about project and project process into FogBugz each day during development process. For example to use all features this tool developers should choose estimate time for each task and hold this information in relevant stage [9].

II. well organised wiki document system (with spell checking) for sharing information about project between team members

III. evidence-based scheduling

FogBugz can help you to calculate the probability of delivery your project on any date that you choose (using Evidence-Based Scheduling EBS techniques).

EBS helps to look at the probability of delivery product in any day changing the list of parameters (for example realise only couple of planned features). This tool helps developers to choose what functionality they should realise for finish project in time

Gantt charts helps to control the progress in development product.

EBS identify the prediction of task duration for each developer(for example the statistic show that one of your developer need twice more time that he planned). This information helps project manager to plan working time more carefully to finish project on time and in budget.

Every time when task is completed, FogBugz records the estimated time and the actual time.

EBS system helps project manager to find out well organised developers.

It is too important for developers to fill time-sheets with information about current state of each task. It is very simple procedure but project manager should control that each developer do

this procedure each day and putting right information to those sheets.

EBS tools delivery project manager a dozen different statistical chars that can help him to identify problem in early stage and helps to make a right decision how solve this problem

IV. bug tracking

FogBugz has a special tool that can help customers and testing team to add bugs to the bug tracking system as easy as it possible. If customer or member of testing tool finds out the new bug he can send a bug report with his comments to the developer teams by 3 mouse clicks. It is possible to add new bug to bug tracking system using e-mail, web interface or using special API.

FogBugz helps developer team to store information about all bugs that has been appeared during the project and find out how each bug has been solved. This information can help developer team to analyse their mistakes at the end of the project.

FogBugz provide project manager a tool that can set the responsible developer for each bug, so every morning each developer receiving the letter from FogBugz about bugs that has been appointed to him. This tool helps team to avoid situation when project has "homeless" bugs.

The FoxBugz's team developed a special search engine that can effectively find out each bug among others using key words, words from bug description or person who posted this bug to the bug tracking system. It is possible to install a special plug-gin for Firefox and MS Internet Explorer so project manager can find information that he need as soon as possible.

V. email tools

FogBugz has a very powerful tool named AutoSort that lets your team members to use a special public e-mail address to add information to the FogBugz system without using web interface. So every person can add important information even from his mobile phone. AutoSort tool has a high quality spam filter that avoiding spam and sorting messages by categories. Also each member can view (if he has rights for this) correspondence between on member of team and for example customer to know the last information about the project.

During customers support process it is easy to find out that many customers ask the same information. So it is possible to create special snippets. So at the next time when the member of supporting team see the question on which he already have answered he can use this snippets.

VI. discussion groups

FogBugz has a discussion board for team members and clients. When customer send new

bug through discussion group you can add this bug to bug tracking system in one click.

Disadvantages of FogBugz tool:

- I. It is a little bit hard to start using this software because of too many features that it has. Another problem is that your team should modify their development process to meet the all requirement for this tool to use it fully (for example to use evidence tool every developer need carefully adds information about each stage of project to FogBugz database).
- II. This utility is not very useful for managing group of designer or architectures.
- III. High cost

### III RESULT OF RESEARCH

The common advantages of web-based PM tools are:

1. All project information are storing at the remote computer so employees and clients can get access to project information from all over the world
2. Company don't need to spend money to install and support server and PM software.
3. Saas (Software as a Service) cost less than buying most common desktop solutions for all staff or employees.

The main disadvantages of most web-based PM tools:

1. The response is of web tools is longer than in desktop base analogue
2. If internet or net connection is not connected, there is no service
3. It is too difficult to find out web-based tool that can decide all project manager tasks, so most teams need a couple of web-based utilities to effectively role the project. Some services have integration with other, but most of them don't.
4. For most tools it is impossible to self-hosted tool or it cost too expensive. But this feature is too critical for some companies, so this disadvantage can be the one of the biggest problem that can appear during transfer from desktop to web-based solution.

During research I try a dozen of different PM tools, but most of that are very similar. For review the most popular tools have been chosen.

So the result of this research is that it is possible to use web-based tools for PM of development small and medium software projects.

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## The Emergence of M-Commerce

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**Abstract-**M-commerce (mobile commerce) is now widely recognised not as a variation of e-commerce, but, as a natural variation. The increasing pervasiveness of sophisticated mobile devices, with ever increasing features and connectivity options, has lead to much speculation with regard to the application of current m-commerce technologies as well as the future of m-commerce. Current examples of m-commerce include location based services (such as a 'nearest cinema' locating service) and traditional e-commerce applications that are carried out on a mobile device (such as purchasing goods from an e-commerce website). The latter has only recently become possible due to improvements in mobile device technology and the increase in bandwidth rates available.

This paper discusses issues concerned with m-commerce technologies and their various applications. The uses of m-commerce technologies are highlighted and the related security and privacy needs are examined. Also, limiting factors of m-commerce applications are investigated with an emphasis on the key issue of the acceptability of a new technology and its uses. Finally, some emerging markets for m-commerce are identified with the conclusion that m-commerce will become indistinguishable from e-commerce except in specific instances; such as m-commerce applications for micropayments.

**Keywords:** M-Commerce, Privacy, Financial Applications, Consumer Acceptance

### I. INTRODUCTION

The 21st Century has bought with it many new and increasingly sophisticated technologies, some of these technologies were already in use and others have become more pervasive with the coming of the new century. New methods of communications such as the Internet, mobile phones and SMS (Short Message Service) are now commonplace in most of the countries around the world. General communication via computer generated networks has now become very visible. This has enabled any individual to communicate with another person that cannot be seen on a face-to-face basis, to purchase something and have it delivered without having to leave the house, to research for any information from vast areas of knowledge, or to meet people with similar interests.

Because of these advances in technology, a range of businesses have found a new and easier way to reach their target customers via the Internet. The old means of market research can now very easily be done through Internet. In the same manner, reaching out to one's target market has been made much easier by the pervasiveness of the Internet.

However, another emerging form of reaching your customer and your customer reaching you has now being introduced and this is through mobile commerce (m-commerce). M-commerce is now widely recognized not as a variation of e-commerce, but, as a natural variation. The increasing pervasiveness of sophisticated mobile

devices, with ever increasing features and connectivity options, has lead to much speculation with regard to the application of current m-commerce technologies as well as the future of m-commerce. Current examples of m-commerce include location based services (such as a 'nearest cinema' locating service) and traditional e-commerce applications that are carried out on a mobile device (such as purchasing goods from an e-commerce website). The latter has only recently become possible due to improvements in mobile device technology and the increase in bandwidth rates available.

### II. M-COMMERCE: DEFINED

A definition of M-Commerce as given in [1] is "Mobile commerce (m-commerce) is the term that refers to the impending financial revolution, and can be defined as the use of mobile telephony infrastructure to obtain or deliver data related to a commercial transaction between two or more parties. It includes the buying and selling of goods over the Internet from a mobile phone."

As stated in [1] M-Commerce is a method of doing business through the use of a mobile telephone type device, this can be a simple device which has just the traditional call and SMS functions, or it could be a more complex device which these days means it could have all the functions of a personal computer but in a portable and pocket-sized gadget. M-Commerce, in a broad sense, has a wholly different structure from traditional E-Commerce and despite it being a relatively young area of commerce it already seems to have captured a large part of the virtual shopping marketplace. In Europe alone, it was estimated that 23 million people used some type of M-Commerce technology in 2003. Mobile phones have become popular for calls and SMS messages but now these devices are also being used to access the internet. In return, the big mobile phone manufacturers such as Nokia, Ericsson and Motorola have been leading the charge to release and further upgrade the phones they are developing into multi function devices; which can accommodate internet browsing, aside from the normal call and text messaging functions [1].

Reference [1] also states that "The forecasted growth of m-commerce hinges heavily on the availability of these mobile devices. Much like their development, m-commerce is in its infancy but is at its most developed in Europe and Japan, where mobile telephony standardization has given an 18-month head start over the USA."

Mobile phone manufacturers all over the world have been trying their utmost to create phones that will incorporate the function of web browsing. In Europe, mobile phones presented to the public can already carry out come payments and other transactions through

advanced mobile phones. In France, some mobile phones are already outfitted to carry out credit card transactions as the phone has a slot into which a credit card can be swiped. In the UK on the other hand, mobile customers are already able to browse many of the large online retailers websites and purchase a range of goods like household appliances, bottles of wine, CDs, etc.

### III. MOBILE PHONES AND INTERNET USERS

The Internet and mobile phones are two of the most highly used means of communications nowadays. Furthermore, both these means are also the highest priority in doing business to some of the major investors, consumers or businesses worldwide.

There is high and frequent usage of mobile phones anywhere in the world. In Asia, mobile penetration is 110% in Hong Kong with a population of 6.8 million; Japan has 70% of 127 million and South Korea with 75% of 48 million. These mobile phones are being used for a variety of different purposes from business calls to arranging a social occasion.

Meanwhile, the Internet has gone from near-invisibility to near-ubiquity in little more than a year [2]. Most of the higher earning business establishments today are those

| Continent     | Hosts     |
|---------------|-----------|
| North America | 4,540,703 |
| South America | 25,577    |
| Europe        | 3,111,048 |
| Asia          | 292,370   |
| Australia     | 252,426   |

Fig. 1.

Number of Hosts per continent in 1996

related to computer, telecommunications and Internet industries.

Reference [3] states that "... The global, public access network, or the Internet, is the sum of all such networks that are in communication with one another. The significant thing about the Internet as a carrier of information is that it has no centre and has no controlling authority. It grows in an organic way as more networks are added. The early Internet had a primarily military function in the USA, and its distributed structure, both in terms of communication routes and information input, make it resistant to military attack or control..."

The Internet has become part of people's everyday lives all around the world. From merely buying the basic necessities in life to having to book airplane tickets. It has been broadly useful to the students through the ability to continuously access faster, easier and reliable sources of different information. It has also been very significant to business-oriented people because of its wide range of marketing and sales strategies being offered by diverse web owners. It has been very useful even to the simplest member of the society as a person can even sell and buy items from the Internet or get information on the subject of a certain product which has been added by many other users. Yes, Internet is very useful to everybody, and we can safely say that one is losing a big opportunity if they have not yet used the internet in one form or another.

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Reference [4] shows that a study conducted in July 1996, the estimated numbers of Internet hosts for each continent are shown in Fig.1.

Meanwhile, a recent survey done by Survey.Net has disclosed that out of 2974 total respondents (taken in May 23, 2004), the majority of the people who accessed with the Internet are those ages ranging from 22 – 25 years old. Also, the majority of the respondents (26.2%) were currently enrolled in college (as to their highest degree attained) (Survey, 2003). The details are shown in Fig. 2.

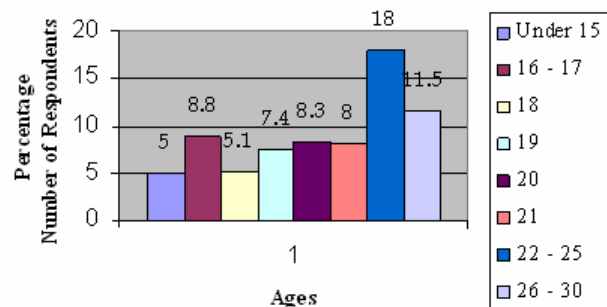


Fig. 2. Age ranges of Internet users

### IV. SECURITY ISSUES

Security is by far the biggest concern surrounding online transactions, with consumers worrying that hackers will get into their account and spend their money (The Pros and the cons, 2004). Credit cards are prone to security issues, especially when it comes to online transactions. The details found in credit cards aren't really rooted in secure channels. Anyone who manages to intercept the data found on your credit card can easily use your line of credit for their own needs. As a result, this makes you suffer for the mistakes that you never carried out (The Pros and Cons of Using a Credit Card, 2006).

Since both the Internet and the mobile phone is a public network, it is necessary for the businesses offering m-commerce business transactions to safeguard the company's and the consumers banking information, credit card numbers, Social Security numbers and other information (What you should know about internet banking, 2007).

Criminals don't always need to have guns and masks to threat and rob money; these days it only takes a social security number, or a pre-approved credit card application from trash to make things according to their wicked way (ID Theft, 2004). Some consumers have had credit card numbers and Social Security numbers stolen and used fraudulently or identity theft. By taking reasonable steps to protect central personal information, this can mitigate the chances that it may be stolen (What you should know about internet banking, 2007) by identity thieves.

Credit card numbers, driver's license numbers, social security numbers, date of birth, and other personal ID can net criminals thousands of dollars in a very small period of time. Most often, identity thieves will obtain your personal identification numbers and obtain credit in your name by having credit cards, goods or services delivered to their address or via a mail drop. Since the bills for costs incurred are sent to the thief's address, the consumers will be unaware that debt is mounting up in

their name until the collections department tracks them down (McGoey, 2007).

With all these concerns with m-commerce security there are several approaches and steps to consider while starting up an m-commerce business dealing.

First is creating a catalogue. In the e-catalogue, goods are offered as images with text descriptions, prices and product options. Any m-commerce definition would have to include an understanding of databases. Instead of "printing" each product web page uniquely, only one page is made, and filled in by a database. This means that instead of a thousand pages for a thousand products, one page only is used - called a template. The template has empty places in it (like a picture space, a price space, a description space etc.) that are filled in from the database. The information needed to call the right data into the placeholders is contained in the link to the product (McGoey, 2007).

It is also essential to create a navigation system. Typically the first set of links will be product categories and will build a list of discrete items in that category, as links. These links in turn will call the exact product within the template page. This system is called drilling down (McGoey, 2007).

When a guest clicks the buy button, the product id number is placed in her shopping basket. This is a space in the computer's memory created especially for this user. Extra commands can add or delete numbers in this space until the visitor is ready to purchase. When the visitor proceeds to the checkout, her details are moved from the temporary memory space into an empty part of the database, along with a list of what she is buying, the prices, options etc. (McGoey, 2007). And, of course, there are the terms of payment. There are several methods of taking online payments; all involve a secure socket layer (SSL). Once obtained, the credit card number is stored for retrieval later to be processed through ordinary PDQ facilities (swiping machine or telephone), or cleared via the Internet by a specialist-clearing house who contacts the visitors' bank (McGoey, 2007).

After the payment is actually cleared online, the clearing house will send your website confirmation so that a receipt and/or order confirmation can be automatically produced for the customer. This can be done by writing an online program that runs on the web server (McGoey, 2007).

The final part deals with alerting the website owner that an order has been placed. This can be done by providing a control panel on the website where new entries in the database are displayed, or simply by sending an e-mail with the information on it to a regular inbox. If the information is going to include a credit card number, then a control panel page on a secure socket layer (SSL) must be used, as e-mail is not secure (McGoey, 2007).

The website owner may want to provide his customer with order tracking facilities. This is done by simply adding a message to the database record and sending the client a unique id number that allows her access to only her record set (McGoey, 2007).

There really are bigger responsibilities for the business owners when the m-commerce approach is used primarily because the mode of doing the business can become very public, thus presenting high risk for identity thefts.

But what is appalling with these methods to ensure security is the fact that e-commerce does the same. E-commerce is done through the internet and is facing the same form of issues when regards to trust and security of the consumers.

## V. CONCLUSION

Indeed, M-Commerce as a business method has a very good market and is therefore presented with a very productive future. As people become more technologically aware and somewhat more dependent on Information Technology, the chances that people will be using M-Commerce and its related technologies will increase greatly and will provide new and lucrative opportunities for many existing businesses and may also open up new markets for new businesses. However, the fact still remains that M-Commerce is and will always be interconnected, related or even compared to E-Commerce. The means of conducting the transaction is almost the same (M-Commerce is through the use of mobile phone while E-Commerce is through a personal computer type device) and can even be interchanged. In the same manner that the issues of security and/or threats of identity theft is an issue with E-Commerce, it is as big, or possibly a bigger issue with M-Commerce.

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- [3] Sturges, P. "Freedom of Expression and the Communication Networks," 1998, [http://www.ifla.org/faife/papers/sturges/sturge\\_e.htm](http://www.ifla.org/faife/papers/sturges/sturge_e.htm) (accessed March 2009)
- [4] Doyle, M. "Women in the Internet." February 1, 1996, <http://www.cwrl.utexas.edu/~tonya/309m/class/internet.html> (accessed February 2009)
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- What you should know about internet banking. (2007). Retrieved from [http://www.chicagofed.org/consumer\\_information/what\\_you\\_should\\_know\\_about\\_internet\\_banking.cfm](http://www.chicagofed.org/consumer_information/what_you_should_know_about_internet_banking.cfm)

## HOW TO CREATE A REFERENCE

References (taken from: URL: <http://computer.org/author/style/refer.htm> )

This special section consists of two subsections: sample formats and general style. The first presents examples of most of the reference types that arise in Computer Society publications. The second delineates the policies and style principles underlying the formats. For Transactions, see the section, "Transactions Department References" (compiled January 2000, URL: <http://computer.org/author/style/transref.htm> ).

### Sample formats

#### Article in a collection

A.J. Albrecht, "Measuring Application-Development Productivity," Programmer Productivity Issues for the Eighties, 2nd ed., C. Jones, ed., IEEE CS Press, Los Alamitos, Calif., 1981, pp. 34-43.

#### Article in a conference proceedings

In general, delete prepositions where the meaning is clear without them. Use the ordinal symbol (2nd, 14th, 23rd) for annual conferences. If available, include the conference initialism in parentheses--for example, (ICDE 98)--following the abbreviated name of the conference.

M. Weiser, "Program Slicing," Proc. 14th Int'l Conf. Data Eng. (ICDE 98), IEEE CS Press, Los Alamitos, Calif., 1981, pp. 439-449.

#### Article in a journal or magazine

Use lowercase for vol. and no. Page numbers through 9999 do not require a comma.

I.E. Sutherland, R.F. Sproull, and R.A. Schumaker, "A Characterization Of 10 Hidden-Surface Algorithms," ACM Computing Surveys, vol. 6, no. 1, Mar. 1974, pp. 1-55.

#### Book

W.M. Newman and R.F. Sproull, Principles of Interactive Computer Graphics, McGraw-Hill, Hightstown, N.J., 1979, p. 402.

M.A. Arbib, ed., The Handbook of Brain Theory and Neural Networks, MIT Press, Cambridge, Mass., 1998.

#### CD-ROM

Place the term "CD-ROM" following the publication's title and

Preceding the publisher's name. For example, the format for a book that is available on CD-ROM is

W.M. Newman and R.F. Sproull, Principles of Interactive Computer Graphics, CD-ROM, McGraw-Hill, Hightstown, N.J., 1979.

#### Dissertation or thesis

B. Fagin, A Parallel Execution Model for Prolog, doctoral dissertation, Dept. Computer Sciences, Univ. of California, Berkeley, 1987.

M. Nichols, The Graphical Kernel System in Prolog, master's thesis, Dept. Computer Science and Eng., Rensselaer Polytechnic Inst., Troy, N.Y., 1985.

#### Electronic publication

L.P. Burka, "A Hypertext History of Multiuser Dimensions," MUD History, <http://www.ccs.neu.edu/home/home/lpb/mud-history.html> (current December 2000).

When formatting URLs, use the exact address supplied by the author. For example, if the author uses the `http://`, you should include it; if the author does not include the `http://`, or a `www`, and so on, do not add these yourself. Not all addresses start with `http://` (there are other protocols that are also legitimate, for example, `ftp://`), and not all addresses need, nor indeed do all work with, a `www`; since we are not familiar with the addresses we must avoid incorrectly "fixing" the author's info. If you recognize something as a URL without the `http://`, the reader probably will, too.

Be sure to include all punctuation exactly as supplied (hyphens and tildes, in particular, are very common in Web addresses).

Verify addresses you tag as URLs by copying and pasting them into your browser and seeing if the string of text that is in your Word doc actually goes where it should.

If the address must run across more than one line, follow these guidelines:

- Break only after a forward slash or a "dot" (period).

- Do not split the double slash.

- Do not split at hyphens, tildes, and so on, that are part of the address.

- Do not introduce hyphens to break words (be very careful about this as Word may try to hyphenate automatically).

- Separating the extension (for example, the `html` at the end) is discouraged.

Some examples using <http://www.web-pac.com/mall/pacific/start.html>:

Acceptable:

[http://  
www.web-pac.com/mall/pacific/start.html](http://www.web-pac.com/mall/pacific/start.html)

[http://www.web-pac.  
com/mall/pacific/start.html](http://www.web-pac.com/mall/pacific/start.html)

[http://www.web-pac.com/mall/  
pacific/start.html](http://www.web-pac.com/mall/pacific/start.html)

Not acceptable:

[http:/  
/www.web-pac.com/mall/pacific/start.html](http://www.web-pac.com/mall/pacific/start.html)

[http://www.web-  
pac.com/mall/pacific/start.html](http://www.web-pac.com/mall/pacific/start.html)

[http://www.web-pac  
.com/mall/pacific/start.html](http://www.web-pac.com/mall/pacific/start.html)

[http://www.web-pac.com/mall/paci-  
fic/start.html](http://www.web-pac.com/mall/pacific/start.html)

Discouraged:

[http://www.web-pac.com/mall/pacific/start.  
html](http://www.web-pac.com/mall/pacific/start.html)

#### Newsletter

J. Butler, "CASE Outlook," System Development Newsletter, Nov. 1987, Applied Computer Research, Phoenix, Ariz., p. 3.

#### Non-English source

Including original title:

A.N. Zhirabok and A.E. Shumskii, *Electronnoe modelirovanie* [Electronic Modeling], Energoatomizdat, Leningrad, 1984 (in Russian).

Original title unprintable:

T. Nakayama et al., "NEC Corporation Develops 32-Bit RISC Microprocessor," *Nikkei Electronics*, vol. 6, no. 12, Dec. 1995, pp. 111-121 (in Japanese).

## Patent

With information about patentee:

M. Hoff, S. Mazor, and F. Faggin, Memory System for Multi-Chip Digital Computer, US patent 3,821,715, to Intel Corp., Patent and Trademark Office, Washington, D.C., 1974.

Without patentee information:

Digital-to-Analog Converting Unit With Improved Linearity, US patent 5,162,800, Patent and Trademark Office, Washington, D.C., 1992.

## Pending publication

Include as much information as possible about the article or paper, including the name of the publication and date if known. If the author does not know where the article will be published, use the phrase "submitted for publication."

R. Lee, "New-Media Processing," to be published in IEEE Micro, vol. 16, no. 4, July/Aug. 2000.

G. Stein, "Implementing Cubist Structures," submitted for publication.

## Personal communication and unpublished materials

These are usually not referenced because they are not available to the reader. Authors who insist on attributing material obtained through personal communication should identify the source of the information in the main text (as Maria Youngblood stated during a conference panel,...).

## Standard

Recommendation ITU-R BT.601, Encoding Parameters of Digital Television for Studios, Int'l Telecommunications Union, Geneva, 1992.

IEEE Std. 1596-1992, Scalable Coherent Interface (SCI), IEEE, Piscataway, N.J., 1992.

## Technical memo

"Requirements for Software-Engineering Databases," tech. memo, Imperial Software Technology, London, 1983.

## Technical report

With report number:

C. Hoffman and J. Hopcroft, Quadratic Blending Surfaces, tech. report TR-85-674, Computer Science Dept., Cornell Univ., Ithaca, N.Y., 1985.

Without report number:

E. Yarwood, Toward Program Illustration, tech. report, Computer Systems Research Group, Univ. of Toronto, 1977.

#### Technical or user manual

Unix System V Interface Definition, no. 2, vol. 2, AT&T, Murray Hill, N.J., 1986.

### General Style

#### Author names

Use each author's initials and last name. Leave no space between initials, but do leave a space between the period following the last initial and the first letter of the last name: E.F. Codd.

If there are more than three authors for an entry, use the first author's name and follow it with "et al." T.G. Lewis et al.

#### Titles

Capitalize the first and last words, and all nouns, pronouns, adjectives, verbs, adverbs, and subordinating conjunctions. Lowercase articles, coordinating conjunctions, and prepositions, regardless of length. Example: Toward Better Real-Time Programming through Dataflow.

To make a source easy for researchers to find, use the title as it originally appears. Do not add or remove hyphens, change words to preferred spellings, or lowercase internal capitals.

For foreign-language references, provide the original title first, followed by its English translation (if available) in brackets: Zur experimentalen Aesthetic [Toward an Experimental Aesthetic].

For a complete treatment of titles, see Chicago 7.126-160.

#### Publications

Italicize names of books (including collections), magazines, journals, newsletters, theses, dissertations, proceedings, manuals, and technical reports. Use quotation marks to enclose names of articles, papers, and technical memos.

Use an en dash to indicate multiple issue numbers, for example, vol. 5, nos. 1-4. Use a slash to denote the issue for bimonthly publications, for

example, Aug./Sept. For quarterly publications, use an en dash to denote the issue, for example, Jan.-Mar. If the name of a column is cited in the reference, use initial caps without quotation marks, for example, Binary Critic.

After the name of a book, thesis, proceedings, or other book-like material, list the publisher, the publisher's location, year of publication, and inclusive page numbers if applicable. Delete Co., & Co., Ltd., S.A., Publisher, and Publishing Co.; retain Press. Where the publisher is a university, add its location if needed for clarity, for example, Stanford Univ., Palo Alto, Calif.

Do not include the editor's name for a conference proceedings unless it is a carefully edited volume published as a regular book.

### Electronic references

References to electronic repositories are acceptable in IEEE Computer Society Publications, but are not the references of choice for formal archival use. Wherever possible, replace such references with references to printed material. However, when this is not possible, cite the electronic address along with as much additional information as possible. If the address itself becomes invalid in the future, the other information may help researchers find the same document elsewhere on the Internet. At the very least, a reference to an electronic source must include the Internet URL and the most recent date the information was accessed by the author citing the reference, for example, (current Oct. 2000).

When an electronic reference is being referred to simply to give the reader a place to go for more information, instead of including it in a formal reference list, it can be noted, perhaps within parentheses, in running text. Because such references break the flow of the text, use them sparingly and do not set them off in italic, boldface, or typewriter font. If an article includes many electronic references, consider placing them in a sidebar or a broken-out list.

When referring to various portions of a WWW page in text, use an initial cap for the designated item. Do not set it off with quotes, parentheses, or italics. Thus, a sample reference could be, The proper way to search the page is to click on the Go button, or The text can be found in the Publications section of the company's Web site.

When referring to hypertext links found on a Web page (the highlighted underlined words), put the entire text of the link in quotes. For example, Click on the "go here" link to reach the table.

When referring to URLs in a string of text, don't apply extra formatting.

### Abbreviations

Use the following abbreviations in the titles of periodicals and when naming publishing institutions:

|        |                           |
|--------|---------------------------|
| Am.    | American                  |
| Ann.   | Annual                    |
| Assoc. | Association               |
| Bull.  | Bulletin                  |
| Comm.  | Communications (of)       |
| Conf.  | Conference (on)           |
| CS     | Computer Society          |
| Dept.  | Department (of)           |
| ed.    | edition, editor           |
| Eng.   | Engineering               |
| Fed.   | Federal                   |
| Govt.  | Government                |
| Inst.  | Institute                 |
| Int'l  | International             |
| J.     | Journal (of)              |
| Math.  | Mathematics, Mathematical |
| Nat'l  | National                  |
| no.    | Number                    |
| Proc.  | Proceedings (of)          |
| Rev.   | Review                    |
| Soc.   | Society                   |
| Symp.  | Symposium (of or on)      |
| Trans. | Transactions (on)         |
| Univ.  | University                |
| vol.   | Volume                    |

Drop the "on" from "Workshop on" constructions. When abbreviating institution names, drop "of" except in "University of" constructions, for example, Inst. Systems Research, Univ. of Wisconsin.

## Locations

After names of cities, use the standard state abbreviations rather than postal codes when identifying publisher locations. See the "Postal information" section for a list of standard state abbreviations. Do not list province or state names for cities outside the US and Canada.

Include the state abbreviation (see the "Postal information" section) for all US cities except the following: Atlanta, Baltimore, Boston, Chicago, Dallas, Denver, Detroit, Honolulu, Los Angeles, Miami, New Orleans, New York, Philadelphia, Pittsburgh, St. Louis, Salt Lake City, San Francisco, and Seattle.

For publishers located outside the US, list the nation after the city. Do not include the nation for the following cities: Amsterdam, Athens, Beijing, Berlin, Brussels, Budapest, Cairo, Copenhagen, Geneva, Helsinki, Hong Kong, Jerusalem, Kyoto, London, Madrid, Mexico

City, Montreal, Moscow, Munich, Paris, Rome, Seoul, Shanghai, Stockholm, St. Petersburg, Sydney, Taipei, Tokyo, Toronto, Vienna, and Warsaw.

References for proceedings should tell where an interested reader can find the source, not where the conference took place. However, including the conference location (in parentheses following the conference name), often helps publishers distinguish among many similarly-named conferences. If a proceedings did not use a traditional publisher, provide the sponsoring organization and its location.

Include the department name for technical reports, technical memos, and other material that may not be indexed in a company-wide or university-wide library or by an abstracting service.

## Dates

Include just the year of publication for books. Include the month and year of publication for periodicals. If a periodical appears more frequently than monthly, include the date with the month: 15 Mar. 1983. If a periodical appears quarterly, use the season or issue number, depending on the periodical's usage. If a periodical appears irregularly (several journals do), do not use the month: vol. 16, no. 5, 1997.

Spell out May, June, and July; abbreviate the other months: Jan., Feb., Mar., Apr., Aug., Sept., Oct., Nov., and Dec. Use a slash for bimonthly issues (Aug./Sept. 2000) and a hyphen or en dash for quarterly (July.-Sept. 2000). Capitalize the names of seasons: Winter, Spring, Summer, and Fall.

## **TIPS FOR MAKING PRESENTATIONS**

### **PRESENTATION STRUCTURE**

An effective oral presentation should be structured accordingly:

#### **1) Opening**

Arouse your audience's interest

Demonstrate why the topic is important (ie: why they should listen to you)

#### **2) Outline of Main Points**

Provide one slide at the beginning of your presentation in the form of a table of contents/agenda to show the topics you will be covering and the order in which you will cover them.

#### **3) Detail of Main Points**

Follow the order of your outline

Limit the number of points you make, since listeners cannot process as much information as readers can

Be clear when you are switching to a new point, since listeners cannot follow as easily as readers can

#### **4) Conclusion**

Give a summary of your main points

#### **5) Question Period (3 minutes at the end of each presentation)**

Prepare yourself by thinking of possible questions and rehearsing answers ahead of time.

Paraphrase or repeat all questions to be sure that you understand what is being asked and that the audience has heard the question.

Keep everyone involved by speaking to the entire audience instead of just the person who asked the question.

Answer the questions clearly and concisely without going off on rambling tangents.

### **VISUAL AIDS**

In order to help your audience concentrate on your presentation and understand what you are saying, it is advisable to use visual aids. Such aids also add variety and interest to your lecture, and help your audience to remember your presentation longer than they would with words alone.

#### **General Information for Slides**

Use 1-2 slides per minute of your presentation, and 4-5 points per slide.

Use effective titles. Someone should be able to look at the slide and understand its meaning without any explanation from you.

Be consistent with your headings and subheadings. Use the same font, size, and colour throughout. Also use the same wording in your table of contents slide as in your detailed slides. This makes your presentation easier to follow.

Use graphs rather than just figures and words. This makes data easier to comprehend and retain.

Proof your visual aids for spelling mistakes!

Avoid wordiness. Use keywords and phrases only.

**Font**

Use large font. The minimum font size you should use is 18-point type, and 24-point font is even better.

Except for very short titles, capitalise only the first letter of a sentence or phrase. Choose a readable font. Serif fonts (those with extenders on the ends of more letters) are easier to read from a distance than sans serif fonts. Times New Roman is a serif font. Arial is a sans serif font.

**Colour and Background**

Use colour to serve a function, not merely to decorate. For example, colour can be used to reinforce the logic of your structure (ex: title in one colour and text in a different colour) or for emphasis.

The colour of titles and text should contrast sharply with the background colour. Otherwise, your audience will not be able to read your slides.

**Graphs and Charts**

Avoid overly complex graphs and charts that will have your audience members trying to understand the slides rather than listening to you.

Do not use unnecessary shading, borders, 3D effects or legends.

**Preparation**

The effort required to make quality slides will be wasted if they are not used properly. Please take the time to practice your presentation with the visual aids so that you use them effectively.

Learn to use the hardware. If you bring your own laptop to the conference, you should know how to connect it to the LCD projector. If you are using the conference computer, you should know how to load your presentation onto the hard drive. If you are using an overhead projector, you should know which way to place the transparencies onto the projector. You should also have your slides in the correct order and ready to use.

Learn to use the software. If you are doing a PowerPoint presentation, you should know how to change your slides forwards and backwards, use the pointer function, etc.

Show only the chart/slide that you are discussing. Otherwise, your audience will become confused.

Meter out the information on each chart. Your audience will always read whatever is in front of them, regardless of what you are saying. Therefore, use a metering technique to control what they see at one time. If using an overhead projector, use a piece of paper to cover up the bottom information until you want it to show. If using a PowerPoint presentation, program the slide to show one line at a time. Practice your presentation so that you feel comfortable talking and changing slides.

Again, if English is not your first language, please take the time to write your presentation and have the grammar proofed by someone.

**GENERAL POINTS**

Practice your presentation so that you feel comfortable talking to your audience and looking at your audience, not at a piece of paper. Notes are very important to help you remember points and to keep yourself organised. However, you should not be reading 100% of the time.

Out of respect for those who are listening to your presentation, please dress

appropriately. Business dress is expected (suit, shirt and tie, or dress shirt/sweater are acceptable). T-shirts, sandals and shorts are not acceptable.

**ADDITIONAL INFORMATION**

1) This guide comes from the INSTRUCTIONS AND INFORMATION FOR PRESENTERS provided by IASTED Conference Organisers.

2) Please view the [sample PowerPoint presentation](#) at the Research Seminar Series Web Site for more information.

3) Much of the information in this document comes from:  
Munter, Mary. Guide to Managerial Communication. Effective Business Writing and Speaking. 4th Edition. New Jersey: Prentice Hall, 1997.

