Technical Challenges Hindering Development of Robust Wireless Network Platforms to Support Emerging Applications.

[1] Imiere E.E., [2] Okonta O.E., [3] Anujeonye N.C, [4] Nwanze M. N, [5] Wemembu U.R

[1] Department of Physics Federal College of Education (T), Asaba
[2,3,4] Department of Computer Science Federal College of Education (T), Asaba,
[5] Department of Mathematics, Federal College of Education (T), Asaba,
emmaedekinimiere@gmail.com, okeyokonta@yahoo.com, Anujeonyechristhy@yahoo.com, maureenrock@rocketmail.com.

Abstract

Wireless communications is the fastest growing sector of the communications industry and as such, it has captured the attention of the media and the imagination of the public. Cellular phones have experienced exponential growth over the last two decades, and this growth has continued unabated worldwide, with more than a billion worldwide cell phone users projected in the nearest future. Indeed, cellular phones have become a critical business tool and part of everyday life in most developed countries, and are rapidly replacing antiquated wireline systems in many developing countries. In addition, wireless local area networks are currently poised to supplement or replace wired networks in many businesses and campuses. Many new applications, including wireless sensor networks, automated highways and factories, smart homes and appliances, and remote telemedicine, are emerging from research ideas to real systems. The explosive growth of wireless systems coupled with the proliferation of laptop and palmtop computers indicate a bright future for wireless networks, both as stand-alone systems and as part of the larger networking set-up. However, many technical challenges remain to be resolved, in designing robust wireless networks that can deliver the performance necessary to buoy emerging applications and make the wireless vision a reality.

Key words: *wireless communications, technical challenges,wireless networks, packet radio network, cellular telephone.*

1.0 Introduction

The first wireless networks were developed in the Pre-industrial age. These systems transmitted information over line-of-sight distances (later extended by telescopes) using smoke signals, torch signalling, flashing mirrors, signal flares, or semaphore flags. An elaborate set of signal combinations was developed to convey complex messages with these rudimentary signals. Observation stations were built on hilltops and along roads to relay these messages over large distances. These early communication networks were replaced first by the telegraph network (invented by Samuel Morse in 1838) and later by the telephone.

In 1895, a few decades after the telephone was invented, Marconi demonstrated the first radio transmission from the Isle of Wight to a tugboat 18 miles away, and radio communications was born. Radio technology advanced rapidly to enable transmissions over larger distances with better quality, less power, and smaller, cheaper devices, thereby enabling public and private radio communications, television, and wireless networking.

Early radio systems transmitted analogue signals. Today most radio systems transmit digital signals composed of binary bits, where the bits are obtained directly from a data signal or by digitizing an analogue voice or music signal. A digital radio can transmit a continuous bit stream or it can group the bits into packets. The latter type of radio is called a packet radio and is characterized by burst of transmissions: the radio is idle except when it transmits a packet. The first network based on packet radio, ALOHANET, was developed at the University of Hawaii in 1971. This network enabled computer sites at seven campuses spread out over four islands to communicate with a central computer on Oahu via radio transmission. The network architecture used a star topology with the central computer at its hub. Any two computers could establish a bi-directional communications link between them by going through the central hub. ALOHANET incorporated the first set of protocols for channel access and routing in packet radio systems, and many of the underlying principles in these protocols are still in use today. The U.S. military was extremely interested in the combination of packet data and broadcast radio inherent to ALOHANET. Throughout the 70's and early 80's the Defence Advanced Research Projects Agency (DARPA) invested significant resources to develop networks using packet radios for tactical communications in the battlefield. The nodes in these ad hoc wireless networks had the ability to self-configure (or reconfigure) into a network without the aid of any established infrastructure. DARPA's investment in ad hoc networks peaked in the mid 1980's, but the resulting networks fell far short of expectations in terms of speed and performance. DARPA has continued work on ad hoc wireless network research for military use, but many technical challenges in terms of performance and robustness remain.

Packet radio networks have also found commercial application in supporting wide-area wireless data services. These services, first introduced in the early 1990's, enable wireless data access (including email, file transfer, and web browsing) at fairly low speeds, on the order of 20 Kbps. The market for these wide-area wireless data services is relatively flat, due mainly to their low data rates, high cost, and lack of "real applications". Next-generation cellular services are slated to provide wireless data in addition to voice, which will provide stiff competition to these data-only services.

Introduction of LAN

The introduction of wired Ethernet technology in the 1970's steered many commercial companies away from radio-based networking. Ethernet's 10 Mbps data rate far exceeded anything available using radio, and companies did not mind running cables within and between their facilities to take advantage of these high rates. In 1985 the Federal Communications Commission (FCC) enabled the commercial development of wireless LANs by authorizing the public use of the Industrial, Scientific, and Medical (ISM) frequency bands for wireless LAN products. The ISM band was very attractive to wireless LAN vendors since they did not need to obtain an FCC license to operate in this band.

Nevertheless, the wireless LAN systems could not interfere with the primary ISM band users, which forced them to use a low power profile and an inefficient signalling scheme. Moreover, the interference from primary users within this frequency band was quite high. As a result these initial LAN systems had very poor performance in terms of data rates and coverage. This poor performance, coupled with concerns about security, lack of standardization, and high cost resulted in weak sales for these initial LAN systems. Few of these systems were actually used for data networking: they were relegated to low-tech applications like inventory control. The current generation of wireless LANS, based on the IEEE 802.11b and 802.11a standards, have better performance, although the data rates are still relatively low (effective data rates on the order of 2 Mbps for 802.11b and around 10 Mbps for 802.11a) and the coverage area is still small (100-500 feet). Wired Ethernets today offer data rates of 100 Mbps, and the performance gap between wired and wireless LANs is likely to increase over time without additional spectrum allocation. Despite the big data rate differences, wireless LANs are becoming the preferred Internet access method in many homes, offices, and campus environments due to their convenience and freedom from wires. However, most wireless LANs support applications that are not bandwidth-intensive (email, file transfer, web browsing) and typically have only one user at a time accessing the system. The challenge for widespread wireless LAN acceptance and use will be for the wireless technology to support many users simultaneously, especially if bandwidth-intensive applications become more prevalent.

Cellular Telephone

By far the most successful application of wireless networking has been the cellular telephone system. Cellular telephones are projected to have a billion subscribers worldwide within the next few years. The convergence of radio and telephony began in 1915, when wireless voice transmission between New York and San Francisco was first established. In 1946 public mobile telephone service was introduced in 25 cities across the United States. These initial systems used a central transmitter to cover an entire metropolitan area. This inefficient use of the radio spectrum coupled with the state of radio technology at that time severely limited the system capacity: thirty years after the introduction of mobile telephone service the New York system could only support 543 users.

A solution to this capacity problem emerged during the 50's and 60's when researchers at AT&T Bell Laboratories developed the cellular concept [10]. Cellular systems exploit the fact that the power of a transmitted signal falls off with distance. Thus, the same frequency channel can be allocated to users at spatially-separate locations with minimal interference between the users. Using this premise, a cellular system divides a geographical area into adjacent, non-overlapping, "cells". Different channel sets are assigned to each cell and cells that are assigned the same channel set are spaced far enough apart so that interference between the mobiles in these cells is small. Each cell has a centralized transmitter and receiver (called a base station) that communicates with the mobile units in that cell, both for control purposes and as a call relay. All base stations have high-bandwidth connections to a mobile telephone switching office (MTSO), which is connected to the public-switched telephone network (PSTN). The handoff of mobile units crossing cell boundaries is typically handled by the MTSO, although in current systems some of this functionality is handled by the base stations and/or mobile units.

The original cellular system design was finalized in the late 60's. However, due to regulatory delays from the FCC, the system was not deployed until the early 80's, by which time much of the original technology was out-of-date. The explosive growth of the cellular industry took most everyone by surprise, especially the original inventors at AT&T, since AT&T basically abandoned the cellular business by the early 80's to focus on fibre optic networks. The first analogue cellular system deployed in Chicago in 1983 was already saturated by 1984, at which point the FCC increased the cellular spectral allocation from 40 MHz to 50 MHz. As more and more cities became saturated with demand, the development of digital cellular technology for increased capacity and better performance became essential.

Enter the Second Generation

The second generation of cellular systems are digital. In addition to voice communication, these systems provide email, voice mail, and paging services.

Unfortunately, the great market potential for cellular phones led to a proliferation of digital cellular standards. Today there are three different digital cellular phone standards in the U.S. alone, and other standards in Europe and Japan, none of which are compatible. The fact that different cities have different incompatible standards makes roaming throughout the U.S. using one digital cellular phone impossible. Most cellular phones today are dual-mode: they incorporate one of the digital standards along with the old analogue standard, since only the analogue standard provides universal coverage throughout most countries.

Paging Concept

Radio paging systems are another example of an extremely successful wireless data network, with 50 million subscribers in the U.S. alone. However, their popularity is starting to wane with the widespread penetration and competitive cost of cellular telephone systems. Paging systems allow coverage over very wide areas by simultaneously broadcasting the pager message at high power from multiple base stations or satellites. These systems have been around for many years. Early radio paging systems were analogue 1 bit messages signalling a user that someone was trying to reach him or her. These systems required call-back over the regular telephone system to obtain the phone number of the paging party. Recent advances now allow a short digital message, including a phone number and brief text, to be sent to the pagee as well. In paging systems most of the complexity is built into the transmitters, so that pager receivers are small, lightweight, and have a long battery life. The network protocols are also very simple since broadcasting a message over all base stations requires no routing or handoff. The spectral inefficiency of these simultaneous broadcasts is compensated by limiting each message to be very short. Paging systems continue to evolve to expand their capabilities beyond very low-rate one-way communication. Current systems are attempting to implement "answer-back" capability, i.e. two-way communication. And this requires a major change in the pager design, since it must now transmit signals in addition to receiving them, and the transmission distances can be quite large. Recently many of the major paging companies have teamed up with the palmtop computer makers to incorporate paging functions into these devices [13]. Paging allies focus strategy on the Internet]. This development indicates that short messaging without additional functionality is no longer competitive given other wireless communication options.

Enter the Satellite services

Commercial satellite communication systems are now emerging as another major component of the wireless communications infrastructure. Satellite systems can provide broadcast services over very wide areas, and are also necessary to fill the coverage gap between high-density user locations. Satellite mobile communication systems follow the same basic principle as cellular systems, except that the cell base stations are now satellites orbiting the earth. Satellite systems are typically characterized by the height of the satellite orbit, low-earth orbit (LEOs at roughly 2000 Km. altitude), medium-earth orbit (MEOs at roughly 9000 Km. altitude), or geosynchronous orbit (GEOs at roughly 40,000 Km. altitude). The geosynchronous orbits are seen as stationary from the earth, whereas the satellites with other orbits have their coverage area change over time. The disadvantage of high altitude orbits is that it takes a great deal of power to reach the satellite, and the propagation delay is typically too large for delay-constrained applications like voice. However, satellites at these orbits tend to have larger coverage areas, so fewer satellites are necessary to provide wide-area or global coverage.

The concept of using geosynchronous satellites for communications was first suggested by the science fiction writer Arthur C. Clarke in 1945. However, the first deployed satellites, the Soviet Union's Sputnik in 1957 and the NASA/Bell Laboratories' Echo-1 in 1960, were not geosynchronous due to the difficulty of lifting a satellite into such a high orbit. The first GEO satellite was launched by Hughes and NASA in 1963 and from then until recently GEOs dominated both commercial and government satellite systems.

The trend in current satellite systems is to use lower orbits so that lightweight handheld devices can communicate with the satellite [1]. Inmarsat is the most well-known GEO satellite system today, but most new systems use LEO orbits. These LEOs provide global coverage but the link rates remain low due to power and bandwidth constraints. These systems allow calls anytime and anywhere using a single communications device. The services provided by satellite systems include voice, paging, and messaging services, all at fairly low data rates [1], [13], [2]. The LEO satellite systems that have been deployed are not experiencing the growth they had anticipated, and one of the first systems (Iridium) was forced into bankruptcy and went out of business. A natural area for satellite systems is broadcast entertainment. Direct broadcast satellites operate in the 12 GHz frequency band. These systems offer hundreds of TV channels and are major competitors to cable. Satellite-delivered digital radio is an emerging application in the 2.3 GHz frequency band. These systems offer digital audio broadcasts nationwide at HD quality. Digital audio broadcasting is also quite popular everywhere.

Wireless communications

Network operators have made significant investments in building IP core networks based on internet system architectures. Further efforts are needed to optimise these and ease the integration of fixed and wireless networks. Frequency spectrum and bandwidth allocation will be important considerations. Radio spectrum is scarce, and therefore expensive and hence future systems will have to be very efficient in how they use the limited spectrum available. Alternative methods of spectral allocation and use could also be considered. The system must be able to dynamically change the allocated resources as users' requirements and available capacities change. Particular attention should be paid to how the air interface might affect terminal, base station and other infrastructure costs. Also regulatory authorities are specifying mandatory limits for the maximum power consumption and radiation for both the base station and the mobile terminal [11].

Wired and Wireless Network

The basic difference between a wired and a wireless network is self-explanatory. A wired network uses wires to communicate whereas a wireless network uses radio waves. Let us look at what are the other differences and how one technology gets an edge over the other.

- Wired networks are easy to set up and troubleshoot while wireless networks are comparatively difficult to set up, maintain, and troubleshoot.
- Wired networks make you immobile while wireless ones provide you with convenience of movement.
- Wired networks prove expensive when covering a large area because of the wiring and cabling while wireless networks do not involve this cost.
- Wired networks have better transmission speeds than wireless ones.
- In a wired network, a user does not have to share space with other users and thus gets dedicated speeds while in wireless networks, the same connection may be shared by multiple users.

Understanding the Wireless Vision

The vision of wireless communications supporting information exchange between people or devices is the communications frontier of the next century. This vision will allow people to operate a virtual office anywhere in the world using a small handheld device - with seamless telephone, modem, fax, and computer communications. Wireless networks will also be used to connect together palmtop, laptop, and desktop computers anywhere within an office building or campus, as well as from the corner cafe. In the home these networks will enable a new class of intelligent home electronics that can interact with each other and with the Internet in addition to providing connectivity between computers, phones, and security/monitoring systems. Such smart homes can also help the elderly and disabled with assisted living, patient monitoring, and emergency response. Video teleconferencing will take place between buildings that are blocks or continents apart, and these conferences can include travellers as well. Wireless video will be used to create remote classrooms, remote training facilities, and remote hospitals anywhere in the world. Wireless sensors have an enormous range of both commercial and military applications.

Commercial applications include monitoring of fire hazards, hazardous waste sites, stress and strain in buildings and bridges, or carbon dioxide movement and the spread of chemicals and gasses at a disaster site. These wireless sensors will self-configure into a network to process and interpret sensor measurements and then convey this information to a centralized control location. Military applications include identification and tracking of enemy targets, detection of chemical and biological attacks, and the support of unmanned robotic vehicles. Finally, wireless networks enable distributed control systems, with remote devices, sensors, and actuators linked together via wireless communication channels. Such networks are imperative for coordinating unmanned mobile units and greatly reduce maintenance and reconfiguration costs over distributed control systems with wired communication links, for example in factory automation.

Tackling the underlying Technical Issues

The technical problems that must be solved to make the wireless vision a reality extend across all levels of the system design. At the hardware level the terminal must have multiple modes of operation to support the different applications and media. Desktop computers currently have the capability to process voice, image, text, and video data, but breakthroughs in circuit design are required to implement multimode operation in a small, lightweight, handheld device. Since most people don't want to carry around a twenty pound battery, the signal processing and communications hardware of the portable terminal must consume very little power, which will impact higher levels of the system design.

Many of the signal processing techniques required for efficient spectral utilization and networking, demand much processing power, precluding the use of low power devices. Hardware advances for low power circuits with high processing ability will relieve some of these limitations. However, placing the processing burden on fixed sites with large power resources has and will continue to dominate wireless system designs. The associated bottlenecks and single points-of-failure are clearly undesirable for the overall system. Moreover, in some applications (e.g. sensors) network nodes will not be able to recharge their batteries. In this case the finite battery energy must be allocated efficiently across all layers of the network protocol stack [7],[6]. The finite bandwidth and random variations of the communication channel will also require robust compression schemes which degrade gracefully as the channel degrades.

The wireless communication channel is an unpredictable and difficult communications medium. First of all, the radio spectrum is a scarce resource that must be allocated to, many different applications and systems. For this reason spectrum is controlled by regulatory bodies both regionally and globally. In the U.S. spectrum is allocated by the FCC, in Europe the equivalent body is the European Telecommunications Standards Institute (ETSI), and globally spectrum is controlled by the International Telecommunications Union (ITU). A regional or global system operating in a given frequency band must obey the restrictions for that band set forth by the corresponding regulatory body as well as any standards adopted for that spectrum.

Spectrum can also be very expensive since in most countries, including the U.S., spectral licenses is now auctioned to the highest bidder. In the 2 GHz spectral auctions of the early 90s, companies spent over nine billion dollars for licenses, and the recent auctions in Europe for 3G spectrum garnered over 100 billion dollars. The spectrum obtained through these auctions must be used extremely efficiently to get a reasonable return on its investment, and it must also be reused over and over in the same geographical area, thus requiring cellular system designs with high capacity and good performance. At frequencies around several Gigahertz wireless radio components with reasonable size, power consumption, and cost are available. However, the spectrum in this frequency range is extremely crowded. Thus, technological breakthroughs to enable higher frequency systems with the same cost and performance would greatly reduce the spectrum shortage, although path loss at these higher frequencies increases, thereby limiting range.

As a signal propagates through a wireless channel, it experiences random fluctuations in time if the transmitter or receiver is moving, due to changing reflections and attenuation. Thus, the characteristics of the channel appear to change randomly with time, which makes it difficult to design reliable systems with guaranteed performance. Security is also more difficult to implement in wireless systems, since the airwaves are susceptible to snooping from anyone with an RF antenna. The analogue cellular systems have no security, and you can easily listen in on conversations by scanning the analogue cellular frequency band. All digital cellular systems implement some level of encryption. However, with enough knowledge, time and determination most of these encryption methods can be cracked and, indeed, several have been compromised. To support applications like electronic commerce and credit card transactions, the wireless network must be secure against such listeners.

Wireless networking is also a significant challenge [4], [12] , [3]. The network must be able to locate a given user wherever it is amongst millions of globally-distributed mobile terminals It must then route a call to that user as it moves at speeds of up to 100 mph. The finite resources of the network must be allocated in a fair and efficient manner relative to changing user demands and locations. Moreover, there currently exists a tremendous infrastructure of wired networks: the telephone system, the Internet, and fibre optic cable, which should be used to connect wireless systems together into a global network.

However, wireless systems with mobile users will never be able to compete with wired systems in terms of data rate and reliability. The design of protocols to interface between wireless and wired networks with vastly different performance capabilities remains a challenging topic of research. Perhaps the most significant technical challenge in wireless network design is an overhaul of the design process itself. Wired networks are mostly designed according to the layers of the OSI model: each layer is designed independent from the other layers with baseline mechanisms to interface between layers. This approach greatly simplifies network design, although it leads to some inefficiency and performance loss due to the lack of a global design optimization.

Sincerely speaking, the large capacity and good reliability of wired network links make it easier to buffer high-level network protocols from the lower level protocols for link transmission and access, and the performance loss resulting from this isolated protocol design is fairly low. Nevertheless, the situation is very different in a wireless network. Wireless links can exhibit very poor performance, and this performance along with user connectivity and network topology changes over time. In fact, the very notion of a wireless link is somewhat fuzzy due to the nature of radio propagation. The dynamic nature and poor performance of the underlying wireless communication channel indicates that high-performance wireless networks must be optimized for this channel and must adapt to its variations as well as to user mobility. Thus, these networks will require an integrated and adaptive protocol stack across all layers of the OSI model, from the link layer to the application layer [9].

In a nutshell, technological advances in the following areas are needed to implement the wireless vision we just outlined:

- Measurements and models for wireless indoor and outdoor channels.
- Hardware for low-power handheld computer and communication terminals.
- Techniques to mitigate wireless channel impairments and to improve the quality and spectral efficiency of communication over wireless channels.
- Better means of sharing the limited spectrum to accommodate the different wireless applications.
- Protocols for routing and mobility management which support users on the move.
- Architecture to connect the various wireless subnetworks together and to the backbone wireline network.
- An integrated and adaptive protocol stack for wireless networks that extends across all layers of the OSI model.

Given these requirements, the field of wireless communications draws from many areas of expertise, including physics, communications; signal processing, network theory and design, software design, and hardware design. Moreover, given the fundamental limitations of the wireless channels and the explosive demand for its utilization, communication between these interdisciplinary groups is necessary to implement the most rudimentary shell of the wireless vision depicted above. Looking at the wireless systems in operation today, it is quite clear that the wireless vision remains a distant goal, with many challenges remaining before it will be realized. Many of these challenges will be further re- examined

What is Wireless-Fidelity?

How many times have you needed network or Internet access at home and wished you could work in a different room, or even outside, without having to run a long Ethernet cable? Wireless Fidelity is a relatively new technology which enables people to connect to IP networks (such as the Internet) without any network wires connected to their computer. Wireless digital communication is not new; other wireless technologies such as HAM-radio and Aloha have been around for a long period. There were several reasons why these technologies didn't become popular: they were expensive, they were not easy to use (mainly used by specialized individuals and enthusiasts) and they offered a much lower bandwidth compared to wired networks. All this changed with the introduction of Wireless Fidelity (or Wi-Fi) [5].

Wi-Fi can operate in two modes: infrastructure mode and ad hoc mode. Ad hoc mode (referred to as IBSS, or Independent Basic Service Set) refers to direct connections between exactly two computers, with the same possibilities as a serial cable. Infrastructure mode is the more interesting mode of Wi-Fi: it basically works the same as an Ethernet, without using network wires. This mode is what the name WLAN (Wireless Local Area Network) refers to.

Wi-Fi is defined in one of IEEE's standards: 802.11. "802.11 refers to a family of specifications developed by the IEEE for wireless LAN technology. 802.11 specify an over-the-air interface between a wireless client and a base station or between two wireless clients. The IEEE accepted the specification in 1997." [8] Wi-Fi is known by many different names. Each of the following names refer to the same base technology, without referring to any particular implementation or specification: Wireless-Fidelity, Wi- Fi, 802.11, WLAN. Further, there are specifications under 802.11 whose names are usually used in order to denote any implementation of such a specification. At this moment there are the following specifications:

- 802.11: The original specification of 1997. This specification defines a transmission speed of 1 or 2 MBPS and an operation frequency of 2.4 GHz. In most cases, when 802.11 is referred to nowadays, any of the specifications discussed below is meant instead of this original specification.
- 802.11b: This specification was approved by the IEEE in 1999 and defines a transmission speed of 11 MBPS and the same operation frequency as 802.11, 2.4 GHz. originally, the term Wireless- Fidelity (or Wi-Fi) denoted this specification, but with the introduction of even newer specifications, this changed. Wi-Fi now refers to the implementation of any of the specifications of the 802.11 standard.
- 802.11a: This specification was added in order to achieve a much higher speed than 802.11b: 54 MBPS. But in order to achieve this speed, it was chosen to use another frequency band: 5 GHz. This decision meant that existing hardware would be incompatible, and couldn't be used to achieve this speed.
- 802.11g: Finally, this specification was added as it was realized that 802.11a wasn't gaining popularity, mainly due to the fact that new hardware was needed. Especially access points offering public access was equipped with hardware implementing the 802.11b standard and as such weren't able to handle client hardware that implemented the 802.11a standard. To overcome this, the 802.11g standard was devised. This specification defined a speed of 54 MBPS in the 2.4 GHz band, which made this standard backward compatible with 802.11b. With hardware implementing this specification people were able to both connect to newer access points implementing the 802.11g standards (supporting the 54 MBPS transmission speed) and to older access points which only supported 802.11b.

Relevance to the society

To use wireless technologies now is becoming more popular every day, as more and more people are using wireless technologies on daily basis. Wireless technologies are becoming a part of our everyday lives, either personally or professionally or both. People are counting on wireless technologies to be able to do their work more efficiently, resulting in a great dependence on these technologies. The fact that the society is becoming wireless connected makes it socially relevant. But it is also scientifically relevant in the same realization as man makes great improvement to the use of technology to conquer its surroundings and improve his well-being in a way never anticipated before now as more and more people are being connected using wireless technologies. A scientific approach (as opposed to the economic approaches taken by the various telecom providers) is needed in order to create a well-structured architecture. The structured approach using academic techniques, the use of

Object oriented service and the new way of approaching the problem (top-down: from a general abstract overview to a detailed implementation; as opposed to the bottom-up approach applied by telecom providers: functionality is needed somewhere and later on at other places, eventually leading to an integrated, though not well designed whole and the need for further research and more improvement) is what makes this project scientifically relevant.

Standardisation

Communication systems that interact with each other require standardization. Standards are typically decided on by national or international committees: in Nigeria, the Nigerian Communications Commission plays this role. These committees adopt standards that are developed by other organizations. The IEEE is the major player for standards development in the United States, while ETSI plays this role in Europe [8]. Both groups follow a lengthy process for standards development which entails input from companies and other interested parties, and a long and detailed review process. The standards process is a large time investment, but companies participate since if they can incorporate their ideas into the standard, this gives them an advantage in developing the resulting system. In general standards do not include all the details on all aspects of the system design. This allows companies to innovate and differentiate their products from other standardized systems. The main goal of standardization is for systems to interoperate with other systems following the same standard.

In addition to insuring interoperability, standards also enable economies of scale and pressure prices lower. For example, wireless LANs typically operate in the unlicensed spectral bands, so they are not required to follow a specific standard. The first generation of wireless LANs were not standardized, so specialized components were needed for many systems, leading to excessively high cost which, coupled with poor performance, led to very limited adoption. This experience led to a strong push to standardize the next wireless LAN generation, which resulted in the highly successful IEEE 802.11b standard widely used today. Future generations of wireless LANs are expected to be more standardized, including the now emerging IEEE 802.11a standard in the 5 GHz band.

Limitations to Standardisation

There are, of course, disadvantages to standardization. The standards process is not perfect, as company participants often have their own agenda which does not always coincide with the best technology or best interests of the consumers. In addition, the standards process must be completed at some point, after which time it becomes more difficult to add new innovations and improvements to an existing standard. Finally, the standards process can become much politicized. This happened with the second generation of cellular phones in the U.S., which ultimately led to the adoption of two different standards, a bit of an oxymoron. The resulting delays and technology split put the U.S. well behind Europe in the development of second generation cellular systems. Despite its flaws, standardization is clearly a necessary and often beneficial component of wireless system design and operation. However, it would benefit everyone in the wireless technology industry if some of the disadvantages in the standardization process could be mitigated.

Challenges facing new Architectures

As technology develops, users are faced with an ever broadening range of ICT devices and network-based services, along with a bewildering array of configuration procedures, access technologies and protocols. Excessive complexity places an enormous burden on users, service providers and network operators and risks slowing down the deployment of new technologies. In these circumstances, there is a danger that Beyond 4G applications will not exploit the full potential of ambient intelligence, context-aware services and novel access technologies.

One solution is to make wireless devices and systems smarter and more flexible, that is what Network Engineers called "re-configurability approach" and smart engineers had adopted such an approach for a number of years. It is now recognised that this re-configurability needs to extent throughout mobile communications systems, from the user device right through to the network infrastructure. This so-called "end-to-end re-configurability" is seen by many in the wireless industry as a key enabling technology for systems beyond 4G. It has the potential to revolutionise wireless just as the PC revolutionised computing.

Reconfigurable equipment and systems will generally provide much higher flexibility, scalability, configurability and interoperability. Reconfiguration will stretch over all network layers and be implemented on open platforms but we have at least three major challenges to tackle therein and these are:

- *Transforming embedded flexibility into end-to-end re-configurability*

The protocol stacks used to run the system should be partly or fully defined in software so that they can be downloaded, reconfigured and executed. These protocols are on the terminal, access network entities and associated procedures/protocols, and may cover one or more air interfaces so needed to be fully defined and specified software wise.

- *Capturing the newly enabled re-configurability functionalities*

The corresponding optimisation of resources (spectrum, radio systems and equipment), and reconfiguration functions (discovery, negotiations, control and triggering) needed to fully known and properly utilized

- *Finding right balance between integrated versus distributed approaches*

The re-configurability functions, architectures and intelligence may either be integrated - logically or physically - in any equipment, or distributed depending on the requirements, constraints and availability of enabling technologies. These axes drive the definition of an architecture and design of reconfigurable and flexible system concepts that enable seamless and transparent communication across heterogeneous environments. An active cooperation between end users, operators, service providers and new comers is needed to firm up the definition of the most appropriate distribution of intelligence between reconfigurable terminals and networks.

Benefits of Reconfigurable Architectures

The advent of end-to-end re-configurability will influence the structure of the industry, creating new markets and new employment opportunities, notably in the area of content creation, new services and service/content creation tools but also in wireless information technology administration. Industry, end-users and standards will benefit through these ends:

- *Efficient, Advanced and Flexible End-User Service Provision*

The re-configurability management of the network and systems will serve the optimal provision of end-user services and applications. This aspect of end-to-end re-configurability encompasses the tailoring of application and service provision to user preferences and profile, taking into consideration the network/terminal capabilities, configuration and profile, as well as service/charging/security profiles and related context.

➢ *Efficient Spectrum, Radio and Equipment Resources*

Utilisation: In collaboration with the regulatory authorities and local regulators, the resulting technologies will offer flexible use of spectrum resources and associated security issues. Such an approach would simplify the process of optimizing resource usage

Satellites Deployment

Satellites today provide both direct access to, and the backbone of European and Worldwide digital information broadcast networks, as well as interactive and subscription TV services, mobile services to ships, aircrafts and land-based users, and data distribution within business networks. Satellites are also a key element in the Internet backbone, and enable both broad and narrowband Internet access services from remote and rural locations. Satellite services provide an essential component of disaster relief activities worldwide, offering reliability, instant and long-term availability, over very wide areas. In addition to civil applications, the unique coverage advantages of satellite systems position them as key players for risk and crisis management for institutional, government and defence applications.[2]

Satellite-delivered broadcast, broadband and mobile services are converging. The moves towards location based services stimulated by Galileo and the increasing interest in environmental monitoring and security means that future satellite systems and technologies are fully capable of delivering a broad mix of features, as and when required. Telecommunication satellite services may be seen as the supporting infrastructures to other applications such as Earth Observation satellite services, Navigation satellite services.

Conclusion

Sadly, third world countries and their governmental agencies are doing nothing to support the development of robust wireless network platforms to buoy emerging applications and the academic institutions are not doing well enough and serious research are discarded for more frivolous ones but the steps will put emphasis on developing solutions that further ease the integration and convergence between satellite communications systems and terrestrial systems, thus making it far more appealing and ubiquitous for the user. Hybrid networks, in which satellite complements terrestrial technologies, rather than compete, must be developed. Satellite can then be seamlessly integrated into hybrid systems, and its contribution will evolve in line with the progress of technology during the lifetime of the satellite. Ultimately, satellite should have the capability to serve as a universal overlay of any terrestrial network, fixed or mobile, as well as being able to deliver service where satellite has clear advantages mostly in remote and rural areas found in third world countries.

References

[1] Abrishamkar F. and Siveski Z., “PCS global mobile satellites,” IEEE Communication Magazine, pp. 132-136, Sep. 1996.

[2] Ananasso R.and Priscoli F. D., “The role of satellites in personal communication services,” Issue on Mobile Satellite Communications for Seamless PCS, IEEE J. Sel. Areas Communication Magazine, pp. 180-196, Feb. 1995.

[3] Ayanoglu E., Eng K. Y., and Karol M. J., “Wireless ATM: limits, challenges, and proposals,” IEEE Pers. Communication Magazine, pp. 18-34, Aug. 1996.

[4] Bhagwat P., Perkins C., and. Tripathi S, “Network layer mobility: an architecture and survey,” IEEE Pers. Communication Magazine., pp. 54-64, June 1996.

[5] Cox D. C., “Wireless personal communications: what is it?,” IEEE Pers. Communication Magazine., pp. 20-35, April 1995.

[6] Goldsmith A. J. and Greenstein L.J.. A measurement-based model for predicting coverage

areas of urban microcells. IEEE Journal on Selected Areas in Communication, pages 1013–1023, September 1993.
[7] Goldsmith A. J. and Wicker S. B., "Design challenges for energy-constrained ad hoc wireless networks," IEEE Wireless Communications Magazine, Aug. 2002.
[8] IEEE Personal Communications Magazine: Special Issue on Wireless ATM, August 1996.
[9] IT Intel White Paper, "Building a Mobile Application Development Framework", August 2012.
[10] McDonald V.H., "The Cellular Concept," Bell System Tech. J, pp. 15-49, Jan. 1979.
[11] Rappaport T. S., Wireless Communications: Principles and Practice, 2nd ed. Prentice Hall, 2002.
[12] Raychaudhuri D., "Wireless ATM networks: architecture, system design and prototyping," IEEE Pers. Communication Magazine., pp. 42-49, August 1996.
[13] Schiesel S.. Paging allies focus strategy on the Internet. New York Times, April 19, 1999.

`