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DAFTAR ISI

MILITARY AND COMMERCIAL WIRELESS NETWORK

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Abstract

Though we have a general feeling that the military and the commercial wireless networks are providing the same features, in reality it is not so. They are in fact different from each other. Commercial wireless networks such as cellular telephony are dependent on fixed infrastructure of the base stations, which are in turn connected to the lines of high speed. In this paper the researcher will discuss how wireless technology can be applied to military network e.g. by using digitization of voice signals in military radio. Also the researcher will explain how wireless communication is applied to commercial network, by taking an example of cellular telephony. The future application needs of wireless technology to both areas are given later in this paper.

***Keywords:** Military,commercial,wireless.*

Abstrak

Meskipun kita memiliki pandangan umum bahwa jaringan nirkabel militer dan komersil menyediakan layanan yang sama, namun pada kenyataannya berbeda. Jaringan nirkabel komersil seperti telepon seluler sangat bergantung pada infrastruktur menetap sebagai stasiun utama yang kemudian terhubung dengan jaringan berkecepatan tinggi. Dalam tulisan ini penulis akan membahas teknologi nirkabel yang digunakan pada jaringan militer seperti penggunaan digitasi sinyal suara pada radio militer. Selain itu juga akan dibahas bagaimana komunikasi nirkabel digunakan pada jaringan komersil dengan mengambil contoh telepon seluler. Pada bagian akhir dibahas mengenai pemanfaatan teknologi nirkabel dikedua bidang dimasa akan datang.

Kata Kunci: Militer,komersial, tanpa kabel.

1. INTRODUCTION

Wireless technology is a popular technology to use in this century. This wide range of technology contributes to the implementation of military wireless networks ranging from antennas and propagation, digital signal processing, electrochemical, cryptographic and network system control [1]. However these well known technologies have particular lines in some categories e.g. in mobility, connectivity and the energy that could make these technologies become *very* expensive and hard to implement without any risk on wireless systems. There are some solutions to keep these technologies as simple and cheap as possible, but it is still has drawbacks in ability to support complicated techniques.

2. MILITARY WIRELESS NETWORK

Some of the issues of wireless system those remain critical to the development and deployment in military and commercial environments are security, spectrum, interoperability, and product integrity. However in the military world each of these issues means low probability of detection and interception [2]. Commercial needs are more concerned to privacy and prevention of unauthorized access to their hardware and data while some security issues are tolerated. As can be seen in figure 1 is the application required in military environment. The rule is the wireless technology used in the military word can be use in the commercial field as well. However it is difficult to be applied in reverse order.

Generally, land forces combat and service support units rely on voice communications for operations, coordination and control. Units or subunits operating under specific command (such as companies in a battalion) share a common frequency, or – as typical with modern radio systems – a series of frequencies which enable rapid frequency hopping, for improved security, immunity from interference and spectrum utilization. Unlike commercial systems which are based on industry standards, military radios do not have to adhere to standard protocols. Each network can implement the unique technology developed by the manufacturer specifically for its systems, limited only by the distribution of compatible systems. (This can clearly be seen when armies decide to replace their combat net radios they have to do it in a relatively short time, to take advantage of the advanced features provided by those systems.) As these radios become more sophisticated, their interconnectivity with external systems is degraded, causing a severe limitation to coalition and joint operations.

Current combat net radios (CNR) are providing voice and data connectivity and form the basic layer for tactical command and control from division to battalion and company level. Modern systems offer sophisticated communications security (encryption) and frequency hopping for efficient spectrum utilization and electronic counter-countermeasures (ECCM). Modern digital radios are most flexible, as voice and data are transferred digitally. Unlike commercial radios, military wireless systems rely on unique voice coding and decoding systems (codec). Digital software defined radios can be programmed to provide backward compatibility with older systems, by defining appropriate waveforms. Digital radios usually support voice and data communications and offer data transfer rates ranging from 19.2 up to 115 kbps [8].

In current military operations, soldiers typically have voice communication only, which makes it difficult to access needed information and coordinate mission activities. Ideally each soldier would have a portable computing device through which they could query military databases, access maps of the surrounding terrain, view the positions of their fellow soldiers, and send complex observations to the mission planners at headquarters. Providing such computing capabilities to soldiers in the field involves many technical challenges at both the hardware and software levels.

The Active Communications (ActComm) project, which is a Multi-University Research Initiative (MURI) funded under AFOSR Contract F49620-97-1-03821 [9], focuses on two pieces of the software level: (a) wireless-routing systems that route traffic from one soldier to another (and back to headquarters), and (b) mobile-code systems that allow the soldiers to efficiently access databases in the main military network. The underlying assumption in the ActComm work, consistent with military needs, is that all soldiers have short-range, high bandwidth wireless hardware to communicate with each other, while a few soldiers also have long-range, low-bandwidth hardware to serve as gateways to the main network. Due to the short range of the soldier-to-soldier hardware, data going from one soldier to another might need to be routed through several intermediate soldiers. Moreover, the soldiers are continually moving relative to each other, so the available routes change from one moment to the next. The soldiers might even move out of range of each other, requiring the routing system to queue messages until the network disconnection goes away.

Military systems have to be dealt in a special manner for a reason that there should be simulation tools that must predict the performance and behavior of mobile wireless communications under real time performances. The protocols that are currently used tend to concentrate on the lower Physical layer and the middle layers of the OSI model. They do not concentrate on all layers with the same accuracy and hence there is a need for development in this area with respect to military systems. The OSI model is shown below [4]:

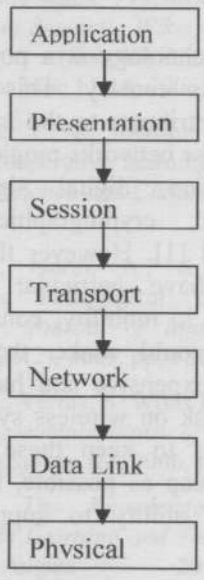

Figure 1. OSI layer

In 1960s, there was wireless technology called vocoder technology used for voice digitization in military voice radios. This technology form is used as a foundation for all digital cellular communication. The analog signal is continuous in nature and it is necessary for it to be shown in appropriate manner in digital system. The process of converting an analog signal to a digital signal is called sampling. The sampling theorem state that for the signal to be reconstructed the sampling frequency should be greater than or equal to twice the modulating frequency. The rate of new values is called the sampling rate or sampling frequency of the converter. However, in this case the conversion accuracy maybe less, due to the presence of quantization error. A practical converter can not make any changes immediately to any output values. Thus the input value must be held constant whenever conversion is performed [3].

First space optic (FSO) is another example that reveal basic wireless technology in defense systems where currently use in the wireless broadband connectivity [6]. SDR (software defined radio) is the very obvious example serves as the military technology that has found in commercial market.

Based on the fact that differing application do not exhibit symmetric two way flow of traffic, modern military wireless systems will require multiple users to share the same bandwidth in order to create a requirement for a protocol that produce efficient, equitable channel access. Voice networks typically exhibit a 40% duty cycle whereas modern internet data flow exhibit 100 – 1000 to 1 ratios to user than from user [3].

3. COMMERCIAL WIRELESS NETWORK

An example of commercial wireless network can be cellular telephony and satellite communication or mobile communication. In this paper the researcher will explain cellular telephony in detail. Cellular systems have some unique properties, which are exhibited during the operation of system. They are:

a. Cell splitting
b. Handoff control
c. Frequency reuse

a. Cell splitting

Cell splitting in cellular system is done to avoid interference between many channels. Instead of a single high power transmitter, transmitting energy to all the areas of the cell, the cells are divided in to many small groups each having a low power transmitter attached to it as can be seen in the figure 2 [7]. By doing this we can be assured that all cellular users get maximum signal strength.

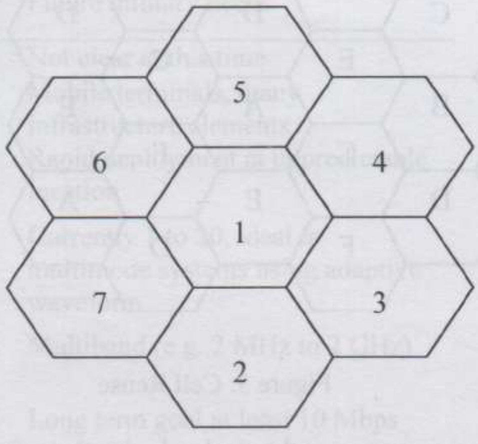

Figure 2. Cell splitting

b. Handoff control

Handoff control is one in which when a user of a cellular system moves from one region to another region having different frequencies should be able to talk over the entire length of the call duration. Figure 3 shows the handoff control system [7].

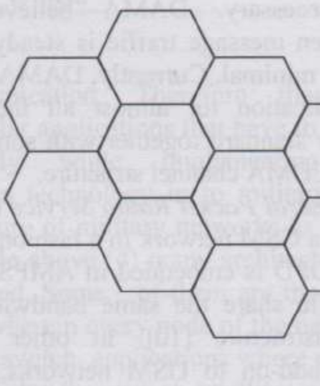

Figure 2. Handoff control

c. Frequency reuse

Based on the calculation done by the experts, it was indicated that because of interference between many channels in adjacent cells, the same frequency could not be reused. It would be necessary to skip many regions before coming into a region having the same frequency as the last one. The picture can be seen in figure 3 [7].

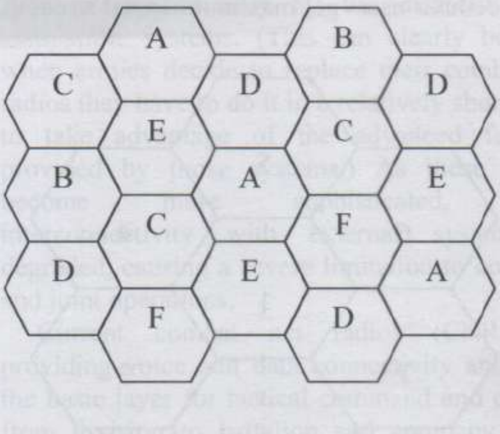

Figure 3. Cell Reuse

There are many other technologies that present in a cellular system which are used regularly. FDMA, TDMA, and CDMA are the techniques that can be used to accomplish this. CDMA believed has higher spectral efficiency than the other two. However these multiple access techniques still have some weaknesses that produce inefficient for many voice and data application such as traffic from single transmitter. DAMA (demand assigned multiple access) occurred as a solution when the military packet switching required a dynamic active terminal and mobile environment whereas flexible multiple access is necessary. DAMA believed has efficiency when message traffic is steady or the traffic itself is minimal. Currently, DAMA is used as voice application for almost all the major digital cellular standard together with some form of TDMA or CDMA channel structure.

The *General Packet Radio Service* (GPRS) is overlaid on a GSM network in a fashion similar to the way CDPD is embedded in AMPS: Voice and data traffic share the same bandwidth and network infrastructure [10]. In other words, GPRS is an add-on to GSM networks, and it requires certain hardware and software upgrades and introduces packet switching to a circuit-switched architecture. GSM voice traffic is oblivious to the presence of GPRS data traffic. Similar to CDPD, GPRS is designed to appear as a regular IP subnetwork both to hosts attached over the air interface and to hosts outside the GPRS network.

The GPRS standard was finalized by the *European Telecommunications Standards Institute* (ETSI) in late 1997 as part of GSM Phase 2+ [11]. It is regarded as a transitional technology toward 3G networks [13], and is commonly referred to as 2.5G. One of its main advantages is that the same device can be used to transmit and receive data, and initiate and accept phone calls. GPRS defines three classes with respect to simultaneous usage of voice and data. Class A mobile hosts can transmit and receive voice and data at the same time. Class B hosts can transmit and receive either voice or data but not both simultaneously. Finally, class C hosts have the user manually select if the host should be attached to the GSM (voice) or GPRS (data) network. When compared to Mobitex, DataTAC, and CDPD, GRPS class A devices can have simultaneous access to a packet-switched and circuit-switched network. Of course, GSM-only devices do not have this capability either, as mentioned earlier.

GSM uses a combination of *Frequency Division Multiple Access* (FDMA) and *Time Division Multiple Access* (TDMA) for channel allocation, as explained in detail in [11]. In short, each frequency channel carries eight TDMA channels. Each of these channels is essentially a time slot in a TDMA frame. Thus, any GSM frequency channel can carry up to eight circuit-switched connections with each slot reserved for a single connection (read *voice call*). In GPRS, each slot is treated as a shared resource and any mobile host can use it to transmit or receive data. In addition, a mobile host can be allocated more than one of the eight available slots in the same TDMA frame. In other words, GPRS can multiplex different traffic sources in one channel and allocate several channels to the same traffic source.

GPRS defines four different channel coding schemes [12], namely CS1, CS2, CS3, and CS4, with radio data rates 8.8 kbps, 13.3 kbps, 15.6 kbps, and 21.4 kbps, respectively. CS1 is the most "conservative" (includes more error correction bits) and is used for signaling packets and when poor channel conditions prevail. CS4 is the most "optimistic" (includes minimal error correction bits), and, assuming excellent channel conditions, allows operators to advertise a maximum radio data rate of 171.2 kbps per 200-kHz frequency channel (or TDMA frame).

Table 1. Comparison of Commercial Wireless Technologies and Future Military Needs

Feature	Commercial System	Future military needs
Architecture	Base-station Oriented	Not clear at this time
Mobility	Mobile terminals, fixed infrastructure	Mobile terminals, many infrastructure elements
Deployment Strategy	Site specific planning & measurement	Rapid deployment at unpredictable location
Modes/ waveforms	Six at most	Currently 1 to 20, ideal is multimode systems using adaptive waveform
Frequency range (per system)	Narrowband (one band per system)	Multiband (e.g. 2 MHz to 2 GHz)
Data rate	384 Kbps to 2 Mbps by 2002	Long term goal at least 10 Mbps
System access	Anyone who can pay	universal
Interoperability of system	Increasingly important	Required for all defence networks & foreign allies
Security	Increasingly important	critical
Anti jam	May become an issue w/ widespread system use	critical
Low probability of detection	Not an issue at this time	critical
Robustness of systems & equipment	Yes, under moderate condition	Yes, under extreme condition
Interference rejection	Somewhat rejection	critical

In practice, CS4 is rarely used because it can lead to frequent retransmissions of lost packets and overall network underperformance. CS3 is commonly used, providing 124.8 kbps per frequency channel. Because a mobile host can be allocated multiple slots, user throughputs can range between 40 and 60 kbps. Mobile hosts typically use an MTU of 1500 bytes. Communication between the base station and any given mobile host is full-duplex but can be *asymmetric*; that is, the downlink and uplink capacities need not be the same. The GSM Association has defined 12 multislot classes for GPRS [14]. Each class is associated with a maximum number of uplink and downlink slots that can be allocated to a single mobile host.

4. CONCLUSION

Military and commercial environment require significant differences of wireless communication. Therefore there are some particular applications that have to be considering carefully while implementing commercial wireless technology in to military systems. For the future of military networks as can be seen in the table above (4) many architectures have been proposed. Some of them are the mobile packet radio wherein every node of the network acts as a packet switch, applications where communication is done by the use of satellites and some other hybrid models where there are developments taking place.

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