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LOW BIT RATE DATA COMMUNICATION IN TACTICAL RADIO

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ABSTRACT: Tactical communication forms the part of Military Communications which only concerns the front end soldiers operating in a theatre environment (formations of division, brigade and below). Mobility is one of the keys to success on the modern battlefield. All communications must be geared to support a combat force that must repeatedly move to survive and fight the enemy. Radio is essential for communications over large bodies of water, territory controlled by enemy forces, and terrain where the construction of wire lines is impossible or impractical. It is also required for air assault operations. As a consequence advance tactical decision support that noe is limited is to advance platforms will become available at much lower level, ranging from different type of vehicles, down to the individual soldier by means of ultra light weight "wearable " equipment. Tactical communication system of today are geared to rather wide area coverage and moderate bandwidth demands providing services like voice communication and low data rate application mainly on point to-point basis. Low-bit-rate speech coding, at rates below 4 kb/s, is needed for both communication and voice storage applications. The basic properties of the speech signal and of human speech perception can explain the principles of parametric speech coding as applied in early vocoders.

I. INTRODUCTION

As digital computers and communication systems continue to spread through our modern society, the use of digitized speech signals is increasingly common. The large number of bits required for accurate reproduction of the speech waveform makes many of these systems complex and expensive, so more efficient encoding of speech signals is desirable. In military tactical communications, a system with a lower speech data rate can use less transmitter power to make detection more difficult, or it can allow higher signal to noise ratios to improve performance in a hostile jamming environment. Also, computer storage of speech, such as in voice mail or voice response systems, becomes cheaper if the number of bits required for speech storage can be reduced. The single-channel radio is the primary means of communication for command, fire control, and exchange of information, administration, and liaison between and within units. Radio is essential for communications over large bodies of water, territory controlled by enemy forces, and terrain where the construction of wire lines is impossible or impractical. Tactical communication should support the operational units in the field, and must therefore reflect the strategy of the forces. The trunk network is today the major tactical communication facility. Its backbone consists of switches mounted in vehicles and interconnected by multichannel radio relays.

II. TECHNIQUE

Amplitude modulation Single-channel communications radio equipment is used primarily to transmit intelligence in the form of speech, data, RATT, or telegraphic code. Although sound can be converted to audio frequency electrical energy, it is not practical to transmit it in this energy form through the Earth's atmosphere by electromagnetic radiation. Great distances can be covered, efficient antennas for radio frequencies are of practical lengths, and antenna power losses are at reasonable levels . At low frequencies (.03 to .3 MHz), the ground wave is very useful for communications over great distances. The ground wave signals are quite stable and show little seasonal variation. In the medium frequency band (.3 to 3.0 MHz), the range of the ground wave varies from about 24 kilometers (15 mi) at 3 MHz to about 640 kilometers (400 mi) at the lowest frequencies of this band. Sky wave reception is possible during the day or night at any of the lower frequencies in this band. At night, the sky wave is receivable at distances up to 12,870 kilometers (8,000 mi). In the high frequency band (3 to 30 MHz), the range of the ground wave decreases as frequency increases and the sky waves are greatly influenced by ionospheric considerations. The direct wave provides communications if the transmitting and receiving antennas are elevated high enough above the surface of the Earth. Communications is limited to a short distance beyond the horizon. Lack of static and fading in these bands makes line-of-sight reception very satisfactory. Amplitude modulation is defined as the variation of the RF power output of a transmitter at an audio rate. When audio frequency signals are superimposed on the radio frequency carrier signal, additional RF signals are generated. . These additional frequencies are equal to the sum and the difference of the audio frequencies and the radio frequency used.). If a complex audio signal is used instead of a single tone, two new frequencies will be set up for each of the audio frequencies involved. The new frequencies resulting from superimposing an AF signal on an RF signal are called sidebands

2.1. Frequency Modulation

Frequency modulation is the process of varying the frequency (rather than the amplitude) of the carrier signal in accordance with the variations of the modulating signals. The amplitude or power of the FM carrier does not vary during modulation. The frequency of the carrier signal when it is not modulated is called the center or rest frequency. The amplitude of the modulating signal determines how far away from the center frequency the carrier will move. This movement of the carrier is called deviation; how far the carrier moves is called the amount of deviation. During reception of the FM signal, the amount of deviation determines the loudness or volume of the signal. The FM signal leaving the transmitting antenna is constant in amplitude, but varying in frequency according to the audio signal. As the signal travels to the receiving antenna, it picks up natural and manmade electrical noises that cause amplitude variations in the signal. All of these undesirable amplitude variations are amplified as the signal passes through successive stages of the receiver until the signal reaches a part of the receiver called the limiter. The limiter is unique to FM receivers as is the discriminator.

2.2. Direct Sequence Spread Spectrum

In direct sequence spread spectrum, we multiply the information-bearing sequence by a much higher-rate pseudorandom sequence, usually generated by some kind of stream cipher. This spreads the spectrum by increasing the bandwidth. The technique was first described by a Swiss engineer, Gustav Guanella, in a 1938 patent application, and developed extensively in the United States in the 1950s. Its first deployment in anger was in Berlin in 1959. Like hopping, DSSS can give substantial jamming margin (the two systems have the same theoretical performance). But it can also make the signal significantly harder to intercept. The trick is to arrange things so that at the intercept location, the signal strength is so low that it is lost in the noise floor unless you know the spreading sequence with which to recover it. Of course, it’s harder to do both at the same time, since an antijam signal should be high power and an LPI/LPPF signal low power; the usual modus operandi is to work in LPI mode until detected by the enemy (for example, when coming within radar range), then boost transmitter power into antijam mode.

2.3.Tran Concept

Tactical Radio Access Network (TRAN) concept which is based on the strategy of using civilian technology and architecture to as large extent as possible. All features specific to tactical wireless communications are encapsulated in a few, well defined modules. In current design strategies of the future civilian wireless communication systems (such as UMTS, ITU-2000), the definition of a Generic Radio Access Network (GRAN) concept has been proposed within ETSI and is the baseline architecture of the ACTS project on future wideband radio access system, FRAMES. This concept is described in figure 1 and includes a • Core Network (CN) and several • Access Networks (AN). The access network comprises all functions that enable a user access his services and telecommunication partners. It additionally hides all access specific functionality from the core network. In case the access network is a radio network we have a GRAN, and all radio interface related functions should be kept within this access network. Therefore, the GRAN can have full control over all radio resources. All GRANs could be realized with existing (e.g. GSM, DECT) as well as with future radio technologies. The core network technology could thus be reused for military applications whereas special purpose access networks, encompassing the needs of military communication applications, have to be designed. In this proposal where our focus is a tactical scenario, our aim is to use the GRAN-concept to design a Tactical Radio Access Network (TRAN). Functions of the TRAN include all those that are associated with a sub-net, i.e. • Distributed sub-network control • Local topology / Mobility management • Support for global mobility management (handover etc.) • Radio resource management • Radio link control • Physical air-interface These functions are designed to make the TRAN indistinguishable from any other radio access network as seen from the outside, i.e. to hide all radio related issues from the Core Network. TRAN has to fulfill the tactical requirements on performance, security, mobility, reliability and resistance to jamming.

2.4. BURST COMMUNICATION

Burst communications, as their name suggests, involve compressing the data and transmitting it in short bursts at times unpredictable by the enemy. They are also known as time-hop. Usually, they are not so jam-resistant, but they can be difficult to intercept; if the duty cycle is low, a sweep receiver can easily miss them. They are often used in radios for Special Forces and intelligence agents. An interesting variant is meteor burst transmission. This relies on the billions of micrometeorites that strike the Earth's atmosphere each day, each leaving a long ionization trail that persists for about a third of a second, and providing a temporary transmission path between a "mother station" and an area that might be a hundred miles long and a few miles wide. The mother station transmits continuously, and whenever one of the "daughters" hears mother, it starts to send packets of data at high speed, to which mother replies. With the low power levels used in covert operations, it is possible to achieve an average data rate of about 50 bps, with an average latency of about 5 minutes and a range of 500–1,500 miles. With higher power levels, and in higher latitudes, average data rates can rise into the tens of kilobits per second.

III. APPLICATIONS

The various applications are as follows:-

1. It is applied to the Army, Navy, Air Force, and Marine Corps.
2. It is used by multiservice and service components of a joint force.
3. Procedures herein may be modified to Fit specific theater command and control (C2) procedures, and allied and foreign national electromagnetic spectrum management requirements.
4. It is used in military for the purpose of secrecy and surprise balanced against the urgency of communications.

IV. MERITS AND DEMERITS

4.1. Merits:

1. Low-rate speech coding can now provide reliable communications-quality speech at bit rates well below 4 kb/s.
2. The goal of toll-quality low-rate coding continues to provide a research challenge.

4.2. Demerits:

1. The main limitation associated with the system is considered to be the range with respect to low bit rate services.

2. This is due to the fact that in a TDMA based operation, the slot duration is, at a minimum, only 1/64th of the frame timing, which results in either very high peak power or a low avg. output power level.

V. CONCLUSION

Future wireless tactical networks providing reliable, wideband communication to low level combat units for sensor data, collection and for supporting efficient local tactical decisions. Investigating the fundamental problems of this communication situation leads us to believe that, despite well documented difficulties, distributed control, short range; multihop store-and forward architectures have definite advantages both with respect to reliability, capacity and power consumption Additional systems, such as semi-mobile cellular communications systems, will continue to find applications as adjuncts to trunk communications systems.

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