HF AUTOMATED SYSTEMS FOR FORCE TRANSFORMATION

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HF THE CONTEXT

HF has been in use for military communications for more than a century, due to the phenomenon of ionospheric refraction, known as "sky wave propagation", which enables radio waves to reach over the horizon and potentially to any point on the earth's surface. However, due to the complexity of the propagation factors in time it has entailed the use of highly skilled radio operators. When all factors are at their optimum, worldwide communication is possible on HF. At many other times it is possible to make contact across and between continents or oceans. At worst, when a band is 'dead', no communication beyond the limited ground wave paths is possible no matter what powers, antennas or other technologies are brought to bear. When a transcontinental or worldwide path is open on a particular frequency, digital, SSB and Morse code communication is possible using surprisingly low transmission powers, often of the order of tens of watts, provided suitable antennas are in use at both ends and that there is little or no man-made or natural interference.
Later improvements led to the ability to support voice and low-rate data services, but HF remains a low bandwidth medium. In the last years, with the increasing importance of satellite communications, stakeholders interest in HF seemed to decrease, mainly for the higher bandwidths allowed by SATCOM.

HF TECHNOLOGY ADVANCEMENTS

Despite the new scenarios proposed by the modern technology, the HF band radio communications maintain a strategic importance due to the capability of global coverage without need of infrastructures. Nowadays, due to a number of technological improvements and to the increasing attention to the cost factor (as the ionosphere is free), HF technology is experimenting a renovated level of interest.
Modern modem waveforms are extremely efficient, and when used in conjunction with systems that support adaptive data rate and adaptive power management, they enable the data to be transferred at the maximum data rate supportable on the link. Automatic Link Establishment (ALE) techniques allow radio systems to quickly establish and adapt to changes in the HF link. The Internet Protocol (IP) is at the heart of today's network-centric operations, and to support IP across an HF network, edge proxy servers can be introduced to reduce the amount of data that user applications need to transfer across the link. Multi-channel systems can seamlessly increase the bandwidth available for a user circuit, either by the use of Independent Side Band (ISB) links or by combining separate channels; in this way, circuits of 19.2kb/s and higher can be supported. Advanced communications management systems can be used in conjunction with techniques such as Dynamic Frequency Selection to optimize use of the available frequency band.

HF AUTOMATED SYSTEMS: INTRODUCTION REASONS WHY AND ADVANTAGES

The present challenge is to provide systems able to integrate a traditionally "difficult" media into a communication context oriented to user friendliness and uninterrupted availability. So, modern military forces need a versatile, fully automatic High Frequency (HF) network solution using advanced technology to deliver low cost and reliable communications. This system should exhibit the following characteristics:

- Rapidly deployable
- Lower cost of ownership than SATCOM systems
- National ownership of whole system
- Automatic, unattended operation
- Reduced operator workload & skill level with consequently reduced training costs
- Optimizes use of the HF spectrum automatically
- Interoperability with and automation of legacy equipment
- Vast range of user services: IP (TCP or UDP), E-mail (SMTP and POP3), Voice Calls, Synchronous and asynchronous data, Encrypted digital voice and IP data
- Full system integration to optimise technology
- Interoperable with other military HF systems
- Operates with legacy subscriber and radio equipment

These achievements facilitate the integration of HF communications systems into wide area networks, where the transmission medium is transparent to the network subscribers. The benefits provided by such an approach are clear. Operation of HF communications links would be de-skilled, availability and reliability would be improved, and higher data rates would be enabled – and the ionosphere is still free!

SELEX AUTOMATED HF2000 INTRODUCTION AND BENEFITS

SELEX ELSAG has developed the HF2000 system answer to the HF simplification need. SELEX ELSAG third generation automatic link establishment (3G ALE) algorithms ensure that links are automatically maintained, managing on the operator's behalf the factors that affect the propagation of HF radio waves. HF2000 continuously monitors link quality and selects the best transmission frequency, reflecting factors such as time of day and sun spot activity. It is also able to learn from past experience to ensure it provides optimal performance under all conditions. Addressing the needs of both military and commercial users; HF2000 is a turnkey radio system capable of carrying a range of voice and data traffic types. Its advanced features empower subscribers with no knowledge of radio communications technology to operate the system.

HF2000 fully automates the complex task of operating a modern HF communication system through the application of a standards-based solution for Automatic Link Establishment (ALE) and traffic protocols.

Advanced propagation prediction algorithms select the optimum frequency for every link. The choice is based on signal feedback, time of day, seasonal variation, sunspot activity, geographic location and the requirements of a pre-determined management plan. In addition, the system learns from past experience to automatically react to the propagation conditions. A Windows-based user interface allows operators to configure and monitor all aspects of the system. This includes the operational states of all system equipment, even at remote sites, simplifying logistics and minimizing station down-time. Inbuilt redundancy within the design architecture enables automated or manual reconfiguration of the system, significantly improving availability over legacy systems.

SYSTEM OPERATION

The system is based on a number of 'nodes', each of which may incorporate up to 32 transmitter/receiver pairs. Messages can be carried across dedicated links set up for the

duration of the message. In other instances, all informed nets are created and held open to permit free use by data applications and to support broadcasts. Nets are constantly monitored for viability and recreated, if necessary, using alternative frequencies or data rates to match propagation conditions.

NODE STRUCTURE

A typical node contains, or is connected to, data traffic sources and telephones. Encryption is applied to signals prior to entry into the system, thus ensuring end to-end security of traffic content.

LINKS AND NETS

Nodes create links, nets and broadcast groups on frequencies drawn from a frequency pool shared by all allocated nodes. Frequency pools provide spectral diversity to ensure reliable communications, managing daily and seasonal variations in HF propagation.
pThey also include spectral redundancy to ensure that sufficient multiple simultaneous links are possible at any time.

RANGE OF SERVICES

HF2000 users benefit from extensive services and compatibility with legacy systems. Traffic types carried include:

- IP datagrams supporting traffic
- Open channel voice calls
- Synchronous and asynchronous data
- E-mail (supported by SMTP and POP3 services)
- Encrypted digital voice and data

Summarizing, HF2000 is designed to fully automate the complex task of operating a modern HF communication system Automatic Link Establishment (ALE) technologies and to be a network enabled communications system allowing connection into an Internet Protocol (IP) based communications architecture.

CASE STUDY: SWEDEN

The Swedish Defense Material Administration is currently procuring one of the world's most advanced automated HF communications systems, supplied by SELEX ELSAG. This system, known as HF2000, forms a key building block in Sweden's Network-Based Defence initiative, which progresses the evolution from a hierarchical platform-centric organization towards a mission-adapted, network-centric approach that delivers integrated C4ISTAR capabilities. The system will support voice, IP traffic, serial data services and e-mail. It is being installed in military headquarters, on a wide variety of platforms – ships, submarines, helicopters and aircraft – and packaged in transit cases for land tactical-deployment. Transmitter and receiver sites are located on the Swedish mainland so as to optimize propagation to platforms in the Baltic Sea and further afield for multinational peacekeeping operations. The radio assets at these sites, which are connected to headquarters' communication centres by IP networks and dial-up telephone lines, form a resource which can be dynamically allocated to meet traffic demand.

Sweden's Multinational Engagement HF2000 complies fully with recognized international standards in order to ensure interoperability. Modem waveforms meet the well-established MIL-STD-188-110B, STANAG 4285 and STANAG 4539 standards; radio link protocols comply with MIL- STD-188-141B Annex A (for asynchronous ALE) and STANAG 4538 FLSU (for synchronous ALE); and message transfer is to the STANAG 5066 protocol. STANAG 4538 defines a (so-called third generation, or 3G) synchronous ALE standard that offers the benefit of reduced on-air time (for reduced probability of detection); rapid link set-up times; and more efficient use of available spectrum. Such interoperability is highly important to the Swedish Armed Forces as they are increasingly engaged in multilateral cooperation with other nations.

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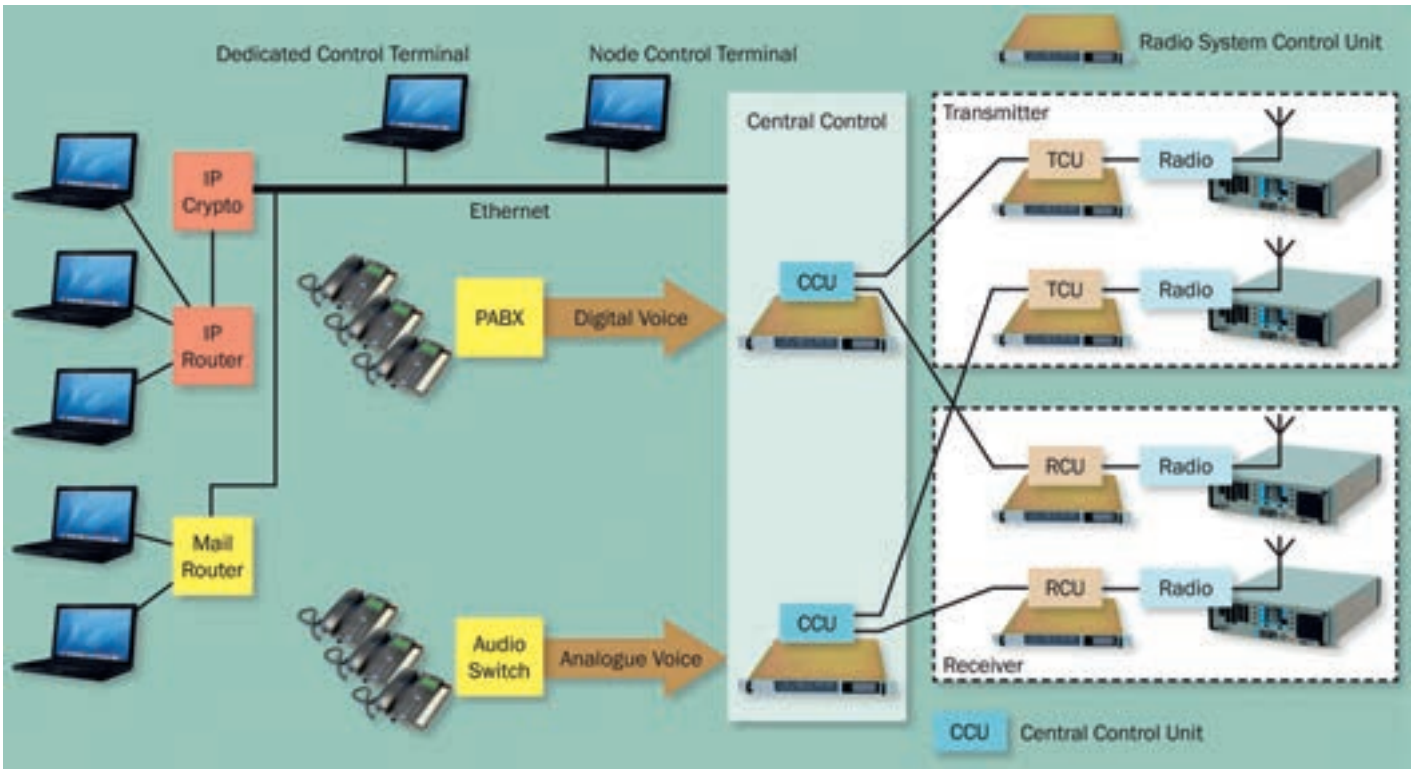

HF2000 network integration and communications architecture