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Enhanced high frequency digital radiocommunication systems capable of providing enhanced applications

(2005)

1 Introduction

Digital radio communications in the HF band have specific attributes that make HF a viable solution for many requirements. There are three digital applications that are typical for HF digital systems; messaging, also known as e-mail, interactive Internet applications, and large file transfer. Software defined radios are also used for data transmissions over applications of enhanced HF systems.

In the event of the collapse or overload of normal telecommunication operation due to natural disasters (e.g. earthquakes) and other emergencies, such HF digital systems using fixed transportable and mobile stations can be established in a very short period of time to provide the emergency links required, in the first phase of the alarm or during the coordination of the relief operation.

2 Electronic messaging

HF electronic message systems and networks provide a highly versatile means of radiocommunication to a broad base of users engaged in public protection and humanitarian efforts. Such systems can also bring inexpensive and reliable radiocommunication equipment to remote and sparsely populated areas.

2.1 Operational characteristics

Beyond the salient features of HF systems, electronic messaging systems are:

– *Easy to use:* A laptop computer and an HF radio transceiver using adaptive techniques alleviate the requirement for trained radio personnel. Once the equipment is configured, non-technical personnel can send electronic messages without the assistance of trained radio personnel.

– *Flexible:* An HF electronic messaging system can provide robust and reliable Internet electronic mail connectivity to meet modern communications requirements.

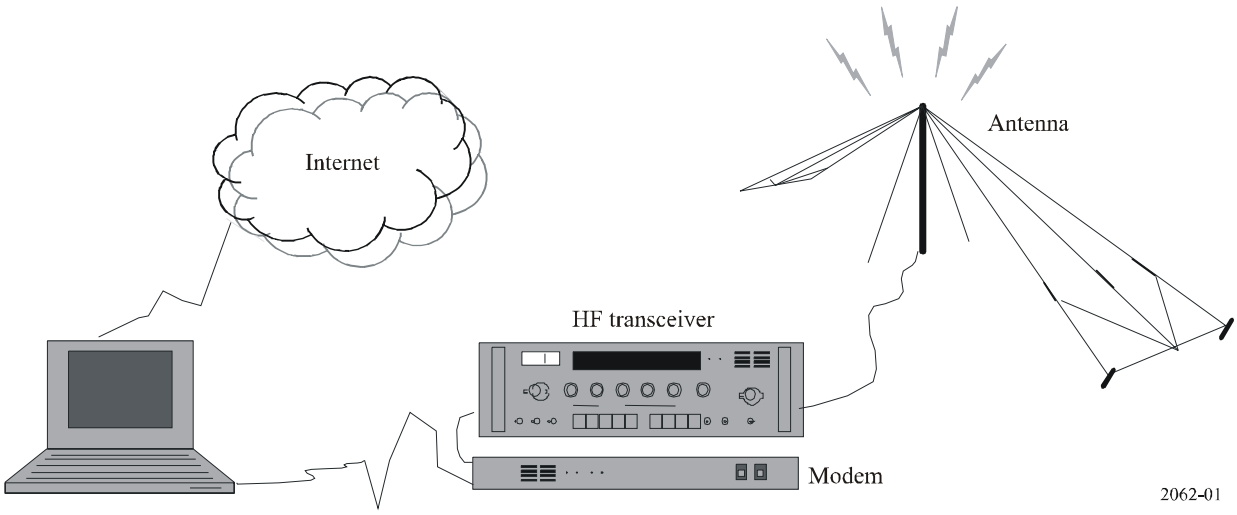
Electronic messaging systems usually operate in store-and-forward mode; that is, the system is expected to deliver messages eventually, but users do not expect instantaneous delivery. This store and forward possibility of electronic messaging makes it especially suitable for use over HF radio, because of the occasional link outages that occur due to ionospheric variability.

2.2 General description

The following describes a common set-up for a typical HF electronic messaging system. The ground entry point (Fig. 1) is a gateway to the Internet (connection to the Internet may be of a variety of means, from local area network to dial-up to cable, satellite, or digital subscriber line). The remote site (Fig. 2) can be an exact duplicate of the ground entry point, with the exception that no connection to the Internet exists.

FIGURE 1

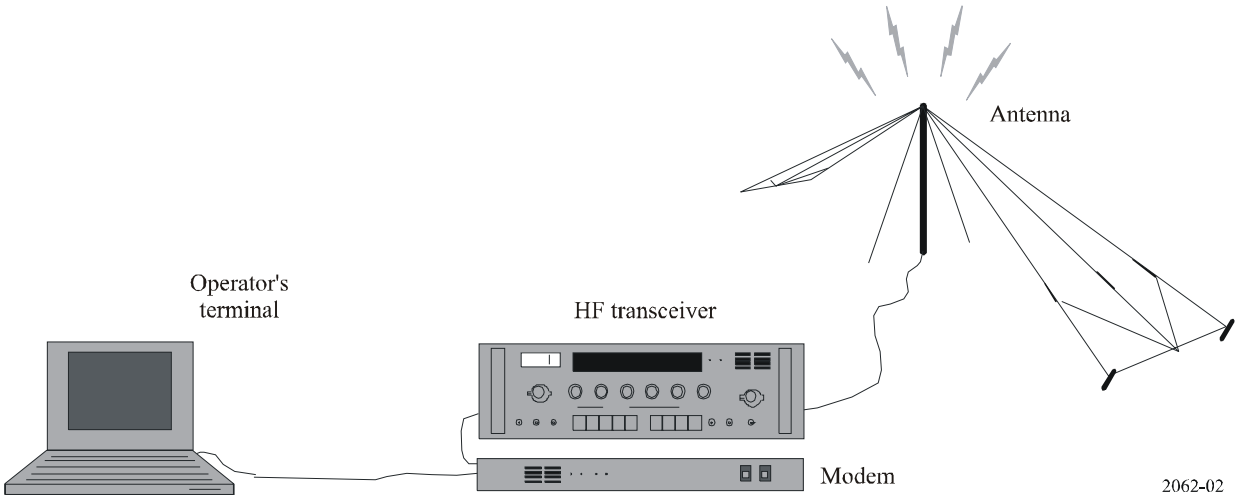
Gateway set-up



The main function of a gateway is direct connectivity to the Internet and to serve as a bridge between the wired network and the wireless network. Otherwise, both the ground entry site and the remote site may have similar components.

FIGURE 2

Remote site set-up



HF electronic messaging networks often provide numerous ground entry points throughout a region or even around the globe. These ground entry points are all interconnected by the Internet to central message servers. Remote users establish an HF link to any suitable entry point to send and receive their messages. HF electronic messaging systems often use specialized protocols over the air.

3 Interactive Internet and Intranet applications

In contrast to electronic messaging, other Internet and Intranet applications are interactive: Users expect quick responses to their input (typing or mouse clicks). Such applications include web browsing, remote login, and instant messaging (sometimes called “HF chat”).

3.1 Operational characteristics

Both the interface protocols used and the network architectures that support Internet applications vary. In some cases, HF provides a wireless last hop from the wired Internet to fixed or mobile remote users. In other cases, multi-node HF networks implement wireless local- or wide-area networks (WLANs and HF-WANs) that sometimes connect through router(s) to the wired Internet, but may exist as stand-alone networks.

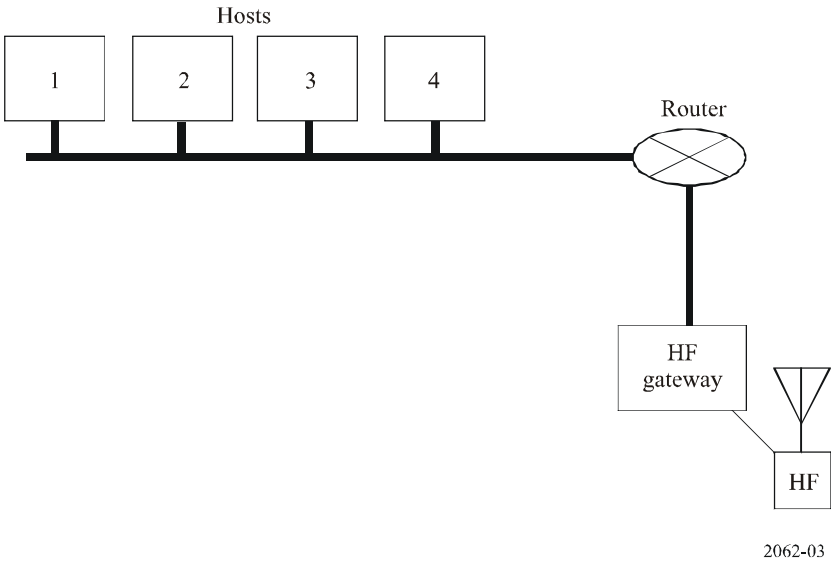
HF radio is commonly used to extend wireless communications beyond the line-of-sight range. Despite such long-range coverage, however, indirect routing is sometimes required even in HF networks. In addition, HF radio can provided an interconnectto wired subnetworks in various contingency applications.

3.2 General description

Figure 3 illustrates a notional LAN, router and HF node.

FIGURE 3

Notional HF LAN

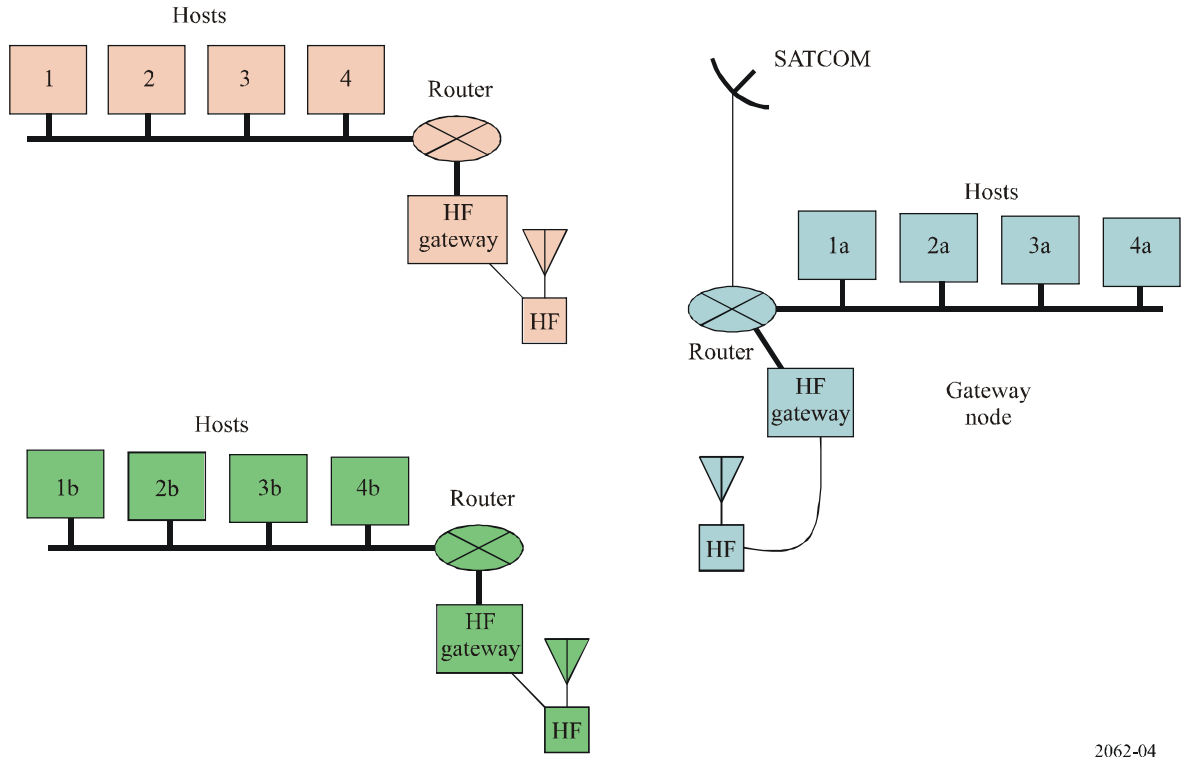


HF LAN – High frequency local area network

Figure 4 shows three nodes interconnected by HF radio, forming an HF WAN. IP subnets have been set at each node. Subnet addresses may have been assigned independently, and there is no guarantee that a common prefix exists among those addresses. Note that the node with 6.x subnets also has a satellite (SATCOM) connection to the Internet; the router port in the SATCOM subnet has IP address 12.23.

FIGURE 4

Notional HF WAN



4 File transfer

Due to the limited bandwidth of HF radio links, operational limitations must be taken into account when conducting file transfers that occupy a link for extended periods. Files of hundreds of kilobytes are sent via HF easily and often, but multi-megabyte files are rarely sent via HF due to bandwidth limitations.

4.1 Operational characteristics

As is the case elsewhere in the Internet, the most common mechanism use for transferring files (hundreds of kilobytes) via HF radio is as attachments to e-mail messages. Some applications also exchange large files directly over HF links; such applications include near-real-time imagery and database updates.

4.2 General description

The transfer of files (hundreds of kilobytes) demands the highest throughput possible, so high-speed HF data modems are normally employed.

– Non-adaptive networks will often select a fixed data rate that can be supported throughout the day without adjustment. This is often 6 400 bit/s per 3 kHz channel in ground-wave applications. When dual independent-sideband radios are used, this offers 12 800 bit/s in the resulting 6 kHz channel.

– Adaptive systems, on the other hand, continually adjust the channel data rate to match the capacity of the channel. For long-haul skywave channels, the achievable data rate in a 3 kHz channel is usually 2 400 to 4 800 bit/s. In less challenging channels, data rates up to 9 600 bit/s per 3 kHz channel are used.

5 Digital voice

Digital voice technology offers two key features: improved intelligibility compared to analogue voice in the presence of moderate channel impairments, and the ability to encrypt the voice stream for privacy.

5.1 Operational characteristics

Digital voice differs from the data applications discussed in the preceding paragraphs in that it is error tolerant but delay intolerant. Thus, errors are not corrected by retransmission but through the use of robust forward error correction coding.

5.2 General description

Digital voice technology for example, multiple-excitation linear prediction (MELP) offers a trade-off in voice quality versus data rate. State-of-the-art voice systems provide excellent voice quality when operating at 2 400 bps, but can operate with reduced voice quality at 1 200 and even 600 bit/s.

6 Software defined radio

The migration of interface protocols away from the physical layer and toward the transport and session layers has proved to be a complementary trend toward interfacing with the network, data-link and physical layer functions of software defined radios (SDRs). In fact, the high speed HF modem and other physical/datalink layer devices are already planned as intended capabilities in some future SDRs.

To effectively manage a design migration strategy, it is prudent to carefully consider the design requirements for an open standards environment as they fit into SDR. The design should assure the appropriate level of capability to the user is maximized, while establishing link layer activity and network decision hierarchies.

6.1 Operational characteristics

In servicing the data packet traffic between LAN and WLAN enterprises, SDR equipment plays the part of an effective transportation device, but has little or no interaction at the session or presentation layer in assuring flow control and IT address correlation.

6.2 General description

The industry's method for developing applications of enhanced HF waveforms is normally done with modem firmware or software upgrades available for legacy users. SDR software changes can make provision for these waveform upgrades.

Some SDR developers are standardizing application program interfaces developed during the production of hardware sets and the development of waveform applications. The ultimate goal of this standardization is to optimize a waveform application's portability and maintainability across various SDR sets. To achieve this goal, waveform functionality should be separated from common non-waveform services. A waveform application should concentrate on waveform-specific needs, and service implementations should provide a software infrastructure that abstracts an SDR set's underlying software and hardware functionality. If this separation is maintained, a waveform application developer can use predefined interfaces to access the functionality of any SDR. Because the services that a waveform application requires are implemented on the SDR set, the portability potential of the waveform application is greater.