ABSTRACT
This paper presents an interim solution for the development of tactical data networks (TDN) for use by Special Operation Forces (SOF) engaged in Operations Other Than War (OOTW) and similar missions. Missions typified by OOTW generally require messages of greater length than typically handled by SOF communication systems. Additionally, the frequency of these messages may be hourly or less. Often this information requirement can exceed the individual message handling capability of current team-level communications systems. A commercially available packet radio terminal node controller (TNC) was used as part of a digital communications wide area network during Operation Uphold Democracy in Haiti. The experience gained with this system and later research suggests that commercially available TNCs can be easily modified to create tactical packet networks. Such networks could provide an interim solution to the challenge of sending and receiving relatively large amounts of information in unattended operation. This paper describes these networks that would enable deployed teams to communicate more effectively and efficiently with other elements than by using traditional communication methods to contact them. These elements are those within and beyond the current operational area.

INTRODUCTION
Traditionally, Special Forces (SF) team communication equipment has been designed to transmit and receive minimal length messages to avoid detection and interception. Message length was typically less than a few thousand characters. The frequency of these transmissions were weekly or possibly daily. Conversely, OOTW have proven to be information intensive. To stay abreast of developments in the field, commanders require the timely and accurate reporting of information. At the team level this can translate to thousands of characters of information per day. The frequency of these messages may be one every several hours to several in the space of one hour. While this may be only a few pages of text, conveying this information by traditional SOF communication methods severely taxes the capability of the detachment equipment. Additionally, current procedures require verbal "hand-shaking" to transmit, receive and acknowledge all message traffic. This is a time consuming process that significantly reduces data throughput on the communication channel and requires the attention of personnel that can be better used elsewhere. The availability of mobile computers (laptops) at the team level has increased the ability of the teams to collect and process relatively large amounts of information in a timely and rapid manner. However, the "timely" transmission of this material to others via the radio remains a challenge. The military will eventually develop systems that meet this need. However, in the meantime, the organization of tactical data networks at the team level using commercial off-the-shelf (COTS) technology is proposed. Motivation for this work is an outgrowth of the author's experiences during Operation Uphold Democracy. While in Haiti, military high frequency (HF) radios were interfaced with commercially available TNCs. As a result, electronic mail was sent to and from Massachusetts and ultimately the Internet. As a result of the success of this work and the difficulty encountered when attempting to send reports to and from higher units, the idea of using COTS packet equipment was formed.

METHODS
The goal behind the TDN is to use radios to create a local area network. This is not a new concept. Radio local area networks existed in the 1970's [1]. A TDN creates a TCP/IP-based [2],[3] digital radio network between outlying teams and the advanced operations base (AOB), which could serve as the gateway to other nodes in the same or other networks. An example network is shown in Figure 1. A system based on TCP/IP was chosen because of the widespread use of TCP/IP by both the military [4], [5] and civilian organizations. When one station has traffic for another station or for the base, the sending station simply addresses the message to the desired recipient. The message is placed in the mail queue and broadcast. All stations on the frequency hear the message, but it is only processed by the intended station. The transmission is acknowledged by the receiving station. If the receiving station is beyond the transmission range of the sender, the base station, with which all stations should
be able to communicate, will act as the relay point to rebroadcast the message.

The test SOF TDN was based on a two node network. Each node was composed of an FM radio (AN/PRC-126) with antenna, a laptop, a packet terminal node controller (TNC), and associated cables. The TNC functions as a specialized modem for use with a radio. The TNC enables the radio to transmit TCP/IP data to the other node. The software used to control the modem and the operation of the network was the "KA9Q Internet Software Package." It was originally written in an effort to implement the ARPA internet protocol suite (TCP/IP) over amateur radio [6]. The laptops and the radios were connected to the TNC as outlined in Figure 2.

Figure 1. Example of a TDN implemented with four deployed teams and a base station (AOB)

Figure 2. Set up of the test TDN. The names of the nodes are given along with their IP addresses.

The first test was to verify that a link existed between the two nodes. Evaluation of this link was initially performed using the telnet application. This was followed by execution of the file transport protocol (FTP) service and finally, the simple mail transport protocol (SMTP) application, commonly known as "e-mail", was tested. The size of the mail messages that were sent ranged from short (a few characters) to long (a few thousand characters). Also the effects of channel noise, in the form of random speech, on the ability of the nodes to communicate was investigated.

RESULTS

When the telnet session was started on both radios either operator was able to send typed text across the radio link in half-duplex. This is consistent with the expected operation of a telnet application across a radio link. Results of the FTP indicated that an operator at one node could download directory information and files from the other computer across the radio. Data obtained from the SMTP testing demonstrated that e-mail of thousands of characters in length could be successfully transmitted across the radio link. These messages also contained attached data files. Testing in the presence of noise on the channel demonstrated that the radio link could recover and successfully transmit and receive the intended information. In certain cases retransmission of information was required to complete the communication. However, this action was executed automatically by the system without operator intervention. Both the FTP and SMTP operations ran in unattended mode once the original programs were initiated.

CONCLUSION

This work has demonstrated that COTS hardware can be easily interfaced with existing team communications gear to provide reliable and robust communications links. This hardware will support the creation of TDN which will facilitate the transmission and reception of relatively large amounts of information. The TNC enabled information to be more quickly and accurately transmitted than had been possible with current team level communication equipment. COTS technology can be used as an interim solution to provide networked digital communications to deployed teams in an OOTW environment. As a result of the TDN foundation on the TCP/IP model, this system facilitates the transition and integration of team communications into the digital battlefield paradigm.

This technology can be used as an adjunct to other methods of communication that are currently in use with SOF. Use of COTS also enables deployed teams to directly integrate into other agencies such as amateur radio operations using standard protocols such as TCP/IP and AX.25 [7]. This facilitates the further cooperation of the military with other agencies in support of humanitarian aid and disaster relief.
REFERENCES


