Demystifying Tactical Data Links (TDLs)

Why do we need digital tactical communications systems?

Digital tactical communications, their associated technologies and their applications are as deep and complex as they are diverse.

There are very few, if any of us, that understand them in their entirety. This is the first in a series of articles that aims to cast a light over the entire range of technologies and applications, providing an insight into some of those areas that we often 'gloss over'. This, our first article, introduces digital tactical communications systems. Perhaps the question most obvious to ask first is why do we need digital tactical communications systems?

Why?

We have all seen those World War II films where fighters communicate with each other with cut-glass accents over a clear radio circuit. In reality, communications across the HF and VHF bands (see figure below) were often unintelligible.

This could be due to radio propagation effects, or simply down to differences in pronunciation. That is why code words were developed for clarity and why the phonetic alphabet was invented.

WHAT IS MEANT BY DIGITAL?

In the context of the communications systems described in this article, the term digital means that data are expressed as a series of binary digits (0 or 1).

WHAT IS A TRACK?

Search radars are designed to scan systematically a volume of space on a periodic basis. The measured position of a detected object is referred to as a plot. A track is the sequence of plots made during successive scans that are relevant to the same moving target.

WHAT IS A MODEM?

A modem (a contraction of modulator-demodulator) is a hardware device that converts data so that it can be transmitted from computer to computer over some medium.

International Telecommunications Union Frequency Bands

Band Name	Abbrev-iation	Frequency
Extremely Low Frequency	ELF	3-30 Hz
Super Low Frequency	SLF	30-300 Hz
Ultra Low Frequency	ULF	300-3,000 Hz
Very Low Frequency	VLF	3-30 kHz
Low Frequency	LF	30-300 kHz
Medium Frequency	MF	300-3,000 kHz
High Frequency	HF	3-30 MHz
Very High Frequency	VHF	30-300 MHz
Ultra High Frequency	UHF	300-3,000 MHz
Super High Frequency	SHF	3-30 GHz
Extremely High Frequency	EHF	30-300 GHz
Tremendously High Frequency	THF	300-3,000 GHz

The need for code and phonetic pronunciation meant that the speed of exchange of information was very slow – even a good operator struggled to pass more than ten tracks per minute!

As if this wasn't enough, adversaries could tune-in to each other's messages and then jam them by transmitting noises over them or even pass false messages.

All these factors contributed to the information being received by the end user being of variable quality, timeliness and accuracy, leading to a very confused picture. Digital tactical communications systems overcome most of these deficiencies with high data rate, high security, resistance to jamming and timeliness.

Components

All digital tactical communications systems have similar components, consisting of:

a. **A data source.** This could be a sensor system such as a radar, but it could also be a human operator entering command and control directions or manual observations;

b. **A Data Processing and Display System.** When transmitting, this collects coordinate information from the data source(s) and makes sure that it meets criteria for release to the tactical

TECHNICAL ARTICLE

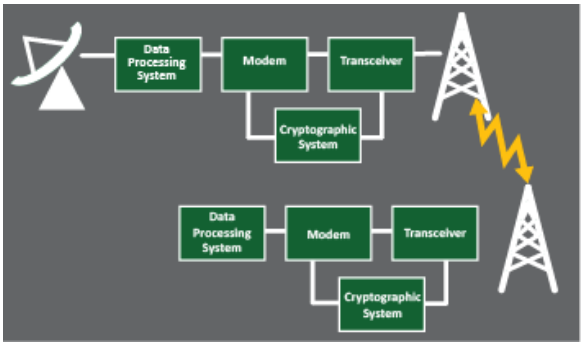
communications network. When receiving, this stores the received information in local databases for use by other integrated systems. It is likely that it will have a user interface from which the parameters of the tactical communications system can be controlled;

c. **Cryptographic system (optional).** The cryptographic system encodes the data that is being transmitted and, in some cases, also introduces pseudo-random transmission characteristics (such as frequency hopping) to improve resistance to jamming;

d. **Communications system.** For radio frequency systems, this typically consists of a modem, a radio transceiver, and an antenna. Land line systems obviously don't need the radio transceiver and the antenna;

e. **Message set.** Current digital tactical communications systems that exchange parametric data utilise a set of messages that have a pre-defined format.

Connectivity



Digital tactical communication systems might support:

- Single direction data transfer (simplex);
- Two-way data transfer, but transfer in only one direction at any time (semi-duplex);
- Simultaneous two-way data exchange (duplex).

Three basic types of connectivity are used:

- **Point-to-point.** A dedicated link between a pair of units, normally only issued between fixed Command and Control (C2) posts, or from C2 posts to a missile command post;
- **Broadcast.** This is where one unit will transmit data to be received simultaneously by several participants. This is also, by definition, a simplex transmission since the data flow is in one direction only from the broadcasting unit to the recovery unit;
- **Networked.** This allows all units in the network to pass data to all other units. Each transmitting unit may transmit information to all other units on the network (that have the correct cryptographic keys), similar to a broadcast, or it might address information to a specific unit, similar to a point-to-point link.

Media

Land lines are used to support data transmissions between fixed ground sites. These can be dedicated copper cables, but more frequently are fibre optic. Most often though, they are part of a multi-route pocket switching network.

Satellite Communications (SATCOM) are being used increasingly to support tactical communications, especially with the introduction of man-portable systems that can find, connect and remain locked in to non-stationary satellites.

Radio is probably the most common medium used for tactical communications. Modern radios are reliable, portable, powerful and easily encrypted. Of the frequency bands defined by the International Telecommunications Union (ITU), military use tactical communications radios tend to operate in the range from HF to SHF, though some very low frequencies are used for submarine communications.

VHF, UHF, and SHF are limited to Line-of-Sight (LOS) and some of the higher frequencies have shorter ranges due to atmospheric water absorption. HF has a Beyond LOS (BLOS) capability, so it is usable over very long ranges or in mountainous terrain but is also susceptible to ionospheric effects.

About SyntheSys

SyntheSys provides defence systems, training, systems and software engineering and technical management services over a spectrum of different industry sectors. Along with distinct support and consultancy services, our innovative product range makes us first choice provider for both large and small organisations. Established in 1988, the company focus is on fusing technical expertise with intuitive software applications to solve common industry challenges.