Demystifying Tactical Data Links (TDLs)

Focus on Link 22

Link 22 – the 'New Kid on the Block'

This article will aim to give a general overview of Link 22 and also focus on what this relatively new system provides, that we don't get from the other systems. Note that this article is very much at an introductory level; we would be pleased to provide more information on request.

Introduction

Due to the lack of Electronic Counter Measures (ECM) resistance provided by Link 11 using an easily jammable single frequency system, and a lack of Beyond Line-Of-Sight (BLOS) capability when using Multifunctional Information Distribution System (MIDS)/Link 16 (without relay), North Atlantic Treaty Organisation (NATO) recognised the need for a new system which could overcome both of these issues. This was particularly important for naval platforms, as MIDS/Link 16 using Ultra High Frequency (UHF) would only provide connectivity for around 20 miles. To achieve Link 16 connectivity over greater distances airborne relay platforms would be desirable, however, not always available. Hence Link 22 was born to overcome these problems, while also providing several other improvements over Link 11. The aims of Link 22 may be described as: to replace Link 11, thereby removing its inherent limitations; to improve allied interoperability; to complement Link 16; and to enhance the commanders' war fighting capability.

Link 22 History

Canada, France, Germany, Italy, Spain, United Kingdom and the United States of America signed a Memorandum of Understanding (MOU) to develop and sustain the core products necessary to meet the NATO requirements for Link 22. These seven nations are referred to as the NILE Nations. The core element of the Link 22 system, the System Network Controller (SNC) has been jointly developed by the NILE nations. The SNC software is only available through the NILE programme office; the aim being to ensure Interoperability (IO) between users who will all be using the same software. The other elements of a complete Link 22 system: the Tactical Data System (TDS); the Data Link Processor (DLP); the SNC; and the radios, are procured as a national responsibility. The final element, the Link Level Communications Security (COMSEC) (LLC) unit, has been developed in the United States (US) and is available via US Foreign Military Sales (FMS) procedures.

What does Link 22 Provide for Us?

In the introduction above we have touched on Link 22's ability to provide a jam resistant capability, and to overcome BLOS issues, but what else is provided?

The major improvements are summarised below:

- High Frequency (HF) and UHF Line-Of-Sight (LOS);
- When using UHF, two operational modes are available: Fixed Frequency (FF), or frequency hopping in the Electronic Protection Measures (EPM) mode, which provides anti-jamming;
- Various waveforms that allow selection of resilience versus throughput to adapt to every propagation condition;
- Automatic relay between all NILE Units (NUs) using available networks without the need of an airborne relay;
- Network Management is highly automated, relatively simple and includes features such as dynamic bandwidth allocation;
- No requirement for a Net Control Station (NCS). Designed with no single point of failure.

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- Link 22 messages are part of the J-Series family (specifically F and FJ messages). Link 22 uses the same data dictionary as Link 16 and thus makes translation and forwarding relatively easy compared to Link 11.
- Time Division Multiple Access (TDMA), without the need for a Network Time Reference (NTR);
- Late Network Entry (LNE) capability to allow units to join the network seamlessly after initiation;
- Flexible Addressing techniques, allowing more efficient delivery of data.

To better understand the improvements in the above list, we will now take a more detailed look at each element.

HF and UHF Line-Of-Sight

Link 22 has been designed to use the same HF and UHF frequency bands as Link 11 (UHF 225-400 MHz, HF 2-30 MHz). Therefore Link 11 radios may be re-used for Link 22 fixed frequency operations. UHF radios will provide short range LOS communications, whereas HF provides for BLOS communications. See also the paragraph on Automatic Relay.

UHF EPM

An anti-jamming capability can be achieved when using UHF by utilising frequency hopping radios. This capability was also originally planned for HF, but the development of frequency hopping HF radios for Link 22 appears to have been shelved. UHF EPM radios will hop within the same band as utilised by the fixed frequency system. EPM radios will require a Time Of Day (TOD) input to achieve synchronisation with their peer systems.

Waveforms

The selection of differing waveforms allows Link 22 to provide reliable data exchange in poor conditions, and also to optimise the media for operations in good conditions. However, optimisation of the media to achieve best reliability, will generally result in a reduction of throughput.

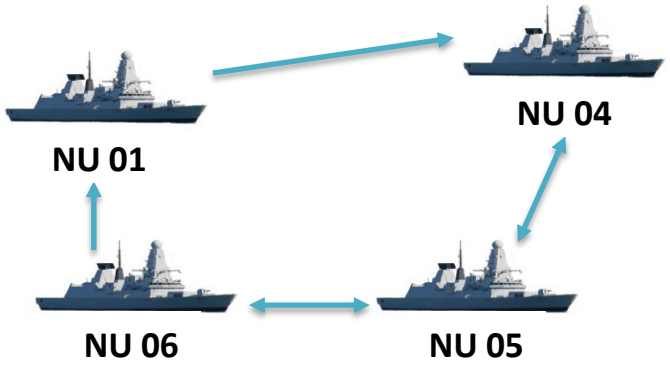
When using HF, or UHF EPM, a parameter known as the Media Setting Number (MSN) will determine the reliability versus throughput selection. When initialising a Link 22 network, it is possible to utilise a function known as Probing, which allows the selected frequency to be tested using various MSNs before selecting the preferred option. A further function known as Fragmentation Rate, which determines how data is fragmented before transmission is also available, and will further affect the throughput and robustness of transmissions.

Automatic Relay

To overcome the UHF LOS issue, and to assist where HF propagation does not achieve the desired connectivity, automatic relay may be employed. Units carrying out the relay function do not require specific transmission capacity for relay (like Link 16), they will simply utilise their existing capacity to relay appropriate messages. The SNC will determine the most efficient relay path based on connectivity information shared between active units. In the diagram over the page, if NU01 needs to send data to NU05, 2 relay paths are available (via NU04 or NU06). The SNC will determine the most efficient path to use.

Network Management

Network Management (NM) is a mainly automated function, vastly decreasing the requirement for operator interaction. This is achieved through the use of system generated NM messages. The management of the Link 22 network is designated through 2 duties, the Super Network Management Unit (SNMU) who is responsible for the whole architecture, (which may comprise up to 8 individual networks), and a Network Management Unit (NMU) who is responsible for their own network, reporting upwards to the SNMU. (See diagram over the page.)



Net Control Station

Link 22 has been designed to operate as a non-nodal system without any single point of failure. Time synchronisation for frequency hopping radios, and transmission opportunities is provided by the TOD input. The NM duties of SNMU and NMU may be handed over to a standby unit automatically if no transmission is received from those units after a specified period of time. Where automatic relay is being used, the system will recognise units leaving the network, and will automatically route data via other available paths.

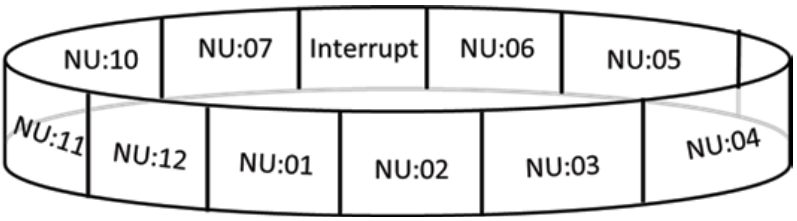
Link 22 Messages

Link 22 utilises a combination of F and FJ-Series messages to pass tactical data. These messages are part of the J-Series message family, and as such are planned for development for the foreseeable future. FJ messages are replicas of their Link 16 J-Series counterparts, whereas F messages are unique to Link 22. Due to their transmission characteristics these messages provide for a more efficient use of the available bandwidth.

For example, in Link 22 the Identification Friend or Foe (IFF) message can be sent without the associated track update message, however, in Link 16 to achieve the same update, both initial and continuation words of a track message would need to be sent. Link 22 also uses a separate set of variable format technical messages for NM and other network maintenance functions.

Time Division Multiple Access

Link 22 transmission capacity is divided amongst users based on their requirements. Each transmitting unit is allocated an Assignment Slot, the size of which will be based on their required transmission capacity. Time synchronisation for the assignment slots is provided by the TOD. Once the network is established, Dynamic TDMA may be used to reallocate capacity between users. This dynamic reallocation is carried out automatically between units; its use will be enabled and disabled by the NMU using a technical message. An Interrupt Slot may also be provided, allowing units to transmit high priority messages outside their Assignment Slot.



Link 22 TDMA Example

Late Network Entry

Link 22 provides this facility which allows units who were not able to join the network at start-up, to join an established network. The LNE protocol will be operator initiated, but will generally then be automatic. The joining unit will be provided with all the parameters required and will be instructed which network(s) it may then join. Transmission capacity will also be allocated via this protocol.

Flexible Addressing

Link 22 provides various addressing capabilities designed to make best use of the available bandwidth.

The capabilities are:

- **Totalcast** Where all units in a Super Network are addressed;
- **Neighbourcast** Where all units within RF range are addressed;
- **Mission Area Sub Network (MASN)** Messages will be addressed to a specified group of units with a shared operational interest (e.g. Electronic Warfare), who may or may not be in the same Network. MASNs may be predefined, or created / altered during operations, on order of SNMU.
- **Dynamic List** A non pre-defined list of between 2 and 5 units to which messages will be sent;
- **Point-to-Point** A single unit is addressed.

Summary

This article has been created with the aim of providing a high-level overview of some of the functionality provided by Link 22, and how it has been designed to make the most efficient use of the system. We will welcome any observations or questions.

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