

# LINK-11 Tactical Data Link

Advanced Protocols

## LINK-11 Overview

Link-11 is a netted, digital data link employed by NATO and US armed forces for exchanging tactical information between land-based, airborne and seaborne platforms. Its main field of operations is

the exchange of naval radar information. Link-11 is identical with the US armed forces' Tactical Digital Information Link A, TADIL-A .

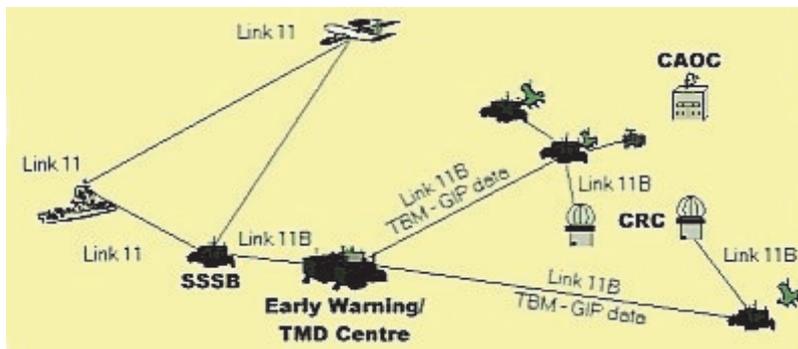


Fig. 1 Tactical data link network

Link-11 comes in two modulation types, the original Conventional Link Eleven Waveform (CLEW) and a more recent Single-tone Link Eleven Waveform (SLEW). Wavecom has implemented CLEW. Hence this document describes the CLEW format. Link-11 communicates both in the HF and UHF bands and is used over satellite links as well. In HF ground wave operation it has a range of up to 300 nautical miles (nm) and may reach a sky wave

range of 1,000 nm. UHF Line-Of-Sight range is 20 to 30 nm for ship-ship connections and 150 nm for ship-air connections. By way of configuration the extended round trip time for satellite links may be mitigated.

Link-11 has been widely employed within NATO and beyond and is expected to continue in service to at least 2015.

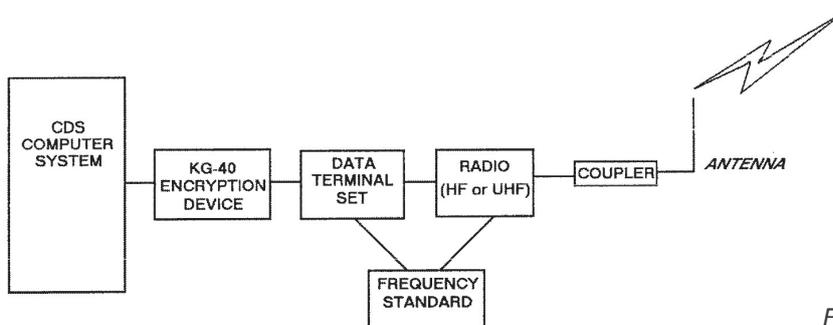


Fig. 2 Onboard system architecture

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## LINK-11 Architecture

A Link-11 network consists of a Data Network Control Station (DNCS or NCS) and a number of Participating Units (PU) or Pickets. Onboard a vessel or other platform the equipment configuration consists of a Tactical Data System (TDS) – a computer - a cryptographic device and a modem or Data Terminal Set (DTS) and HF or UHF transceivers. The TDS is the core of the system and manages a

data base of information on enemy position fixes, tracks, information on own PUs, vessels, aircraft, sonobuoys etc., as well tactical information in the form of splash points, text messages etc. The TDS will correlate data already in the database with data received from the PUs and send it to the display units.



Fig. 3 A AN/USQ130 Link-11 data terminal set

## LINK-11 Protocol and Frame Structure

Link-11 is based on the technologies of the 1960s and this is reflected in the physical structure of the Link-11 format of multi-tone modulation. For both HF and UHF the DTS processes a 16-tone format (from 935 to 2915 Hz) of which 15 tones are differentially encoded, quaternary phase modulated (DQPSK). An unmodulated tone at 605 Hz serves as Doppler correction and the highest data tone at 2915 Hz doubles as a data carrying tone and as frame sync.

The 15 data tones carry data words of each 24 bits to which the DTS adds another 6 bits for Hamming Forward Error Correction able to detect and correct one bit error per data word. Each DQPSK modulated tone thus contains two information bits totaling 30 bits transmitted at a symbol rate of either 75 Baud (2250 bps – normal mode for UHF) or

45.45 Baud (1364 bps – slow mode for HF).

For HF, USB and LSB may be used either individually or combined to provide frequency diversity. For UHF FM with a peak-peak deviation of +/- 20 kHz is used.

A Link-11 messages starts with a preamble and a phase reference followed by an information segment containing control code frames and data message frames. The message format using the Picket Reply Message as an example is shown in Figure 4.

The preamble consists of five frames containing the Doppler tone and the synchronization tone. The phase reference frame is composed of a normal 16-tone composite signal and provides a phase reference for the first data frame of the message.

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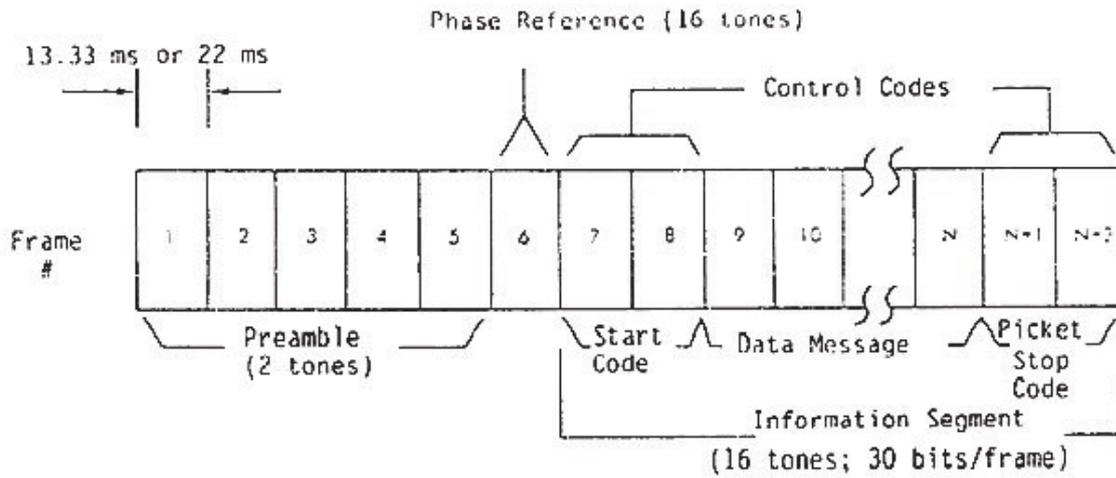


Fig. 4 Link-11 Picket Reply Message

The NCS interrogation (polling) messages have a special structure. If polling is combined with a message an IWM message (Roll Call/DNCS Interrogation with Message) is sent. The format is the same

as the message displayed in Figure 4 but with a two-frame PU address appended (Figure 5).

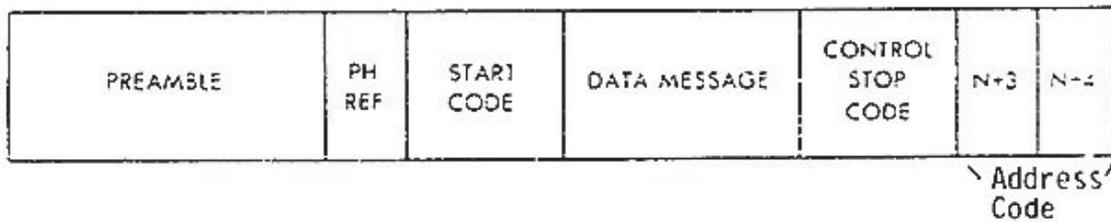


Fig. 5 IWM message

If only polling is sent the format is the one shown in Figure 6 (Roll Call/DNCS Interrogation Message).

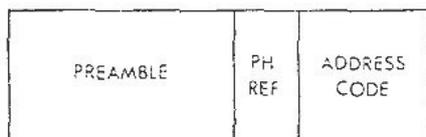


Fig. 6 IM message

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## LINK-11 Implementation

Link-11 offers five modes of DTS operation:

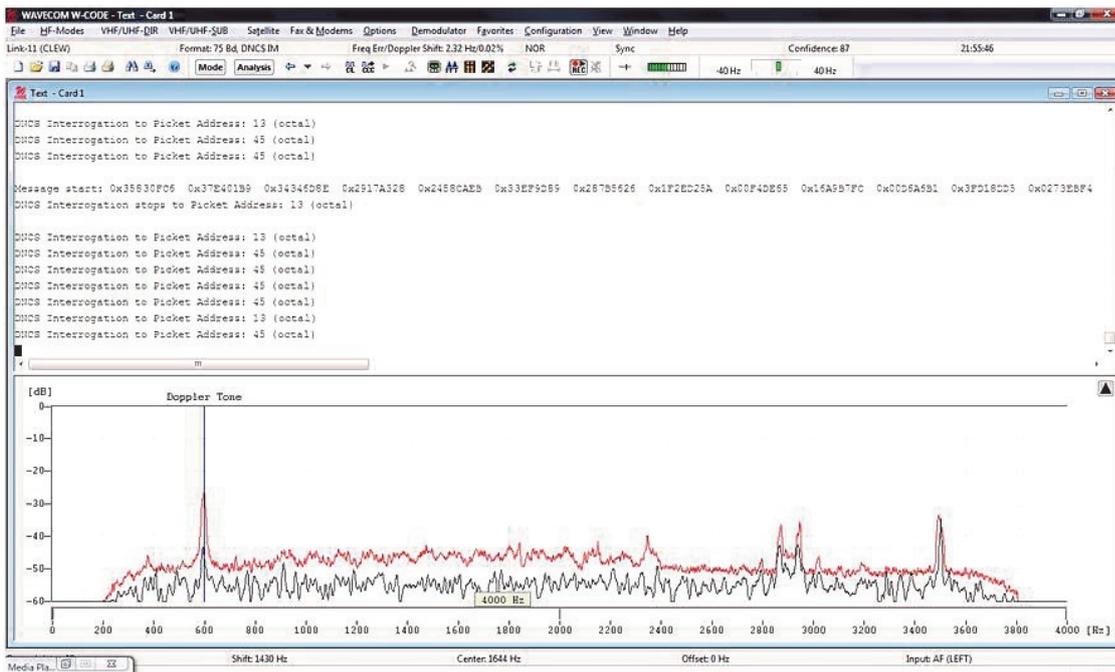
- ◆ Net Synchronization – the NCS sends preamble frames to establish initial communication.
- ◆ Net Test – connectivity checks and line level adjustment with known test patterns.
- ◆ Roll Call – normal operation mode with the NCS interrogating (polling) the PUs for data and the PUs responding with PRM messages.
- ◆ Short Broadcast – broadcast of a single message to all stations.
- ◆ Broadcast – continuous series of short broadcast messages separated by two frames of dead time.

When a Link-11 network is first started, the NCS

will transmit Net Sync followed by Net Test. After Net Test has completed, the pickets report their status to NCS and NCS orders all PUs to switch to Roll Call mode.

After having transmitted a polling message, the NCS will wait for 15 frames (0.2 s) for the PU response. To allow for polling through a satellite the waiting time can be extended to a maximum of 250 frames (3.33 s).

The Link-11 PU address space is 6 bit producing 64 octal addresses (00 and 77 octal are invalid). Message content is encrypted and the message formats are classified.



Wavcom's Link-11 decoder implementation decodes message type, PU address and message contents. The message content is output as 30 bit hexadecimal words. The two baudrates (75 and 45.45)

are detected automatically. Small frequency errors and Doppler shifts are corrected as well as single-bit errors.

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Since more than thirty years Wavecom Elektronik AG has developed, manufactured and distributed high quality devices and software for the decoding and retrieval of information from wireless data communication in all frequency bands. The nature

of the data communication may be arbitrary, but commonly contains text, images and voice. The company is internationally established within this industry and maintains a longstanding, world-wide network of distributors and business partners.

## Product Information

Products	<a href="http://www.wavecom.ch/product-summary.php">http://www.wavecom.ch/product-summary.php</a>
Datasheets	<a href="http://www.wavecom.ch/brochures.php">http://www.wavecom.ch/brochures.php</a>
Specifications	<a href="http://www.wavecom.ch/product-specifications.php">http://www.wavecom.ch/product-specifications.php</a>
Documentation	<a href="http://www.wavecom.ch/manuals.php">http://www.wavecom.ch/manuals.php</a>
Online help	<a href="http://www.wavecom.ch/content/ext/DecoderOnlineHelp/default.htm">http://www.wavecom.ch/content/ext/DecoderOnlineHelp/default.htm</a>
Software warranty	One year free releases and bug fixes, update by DVD
Hardware warranty	Two years hardware warranty
Prices	<a href="http://www.wavecom.ch/contact-us.php">http://www.wavecom.ch/contact-us.php</a>

## System Requirements

	<i>Minimum</i>	<i>Recommended</i>
CPU	Core i5 or Core i7 2.8 GHz	Core i7-6700 3.4 GHz
Memory	4 - 8 GB RAM	16 - 32 GB RAM
OS	Windows 7	Windows 10 32-bit or 64-bit

## Distributors and Regional Contacts

You will find a list of distributors and regional contacts at <http://www.wavecom.ch/distributors.php>

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