Messaging Protocols for HF Radio

This white paper looks at different messaging protocols for use over HF Radio. HF Radio has awkward operational characteristics. It is an unreliable and highly variable channel. In order to provide good messaging communications, specialized messaging protocols are necessary. Standard messaging protocols are unsuitable.

HF Radio is often used for formal Military Messaging as well as informal Email, so both types of messaging applications are considered. Message transports described are:

- ACP 142. A modern approach for both Military Messaging and Email that provides multicast support.
- SLEP. A simpler alternative to ACP 142, that gives superior performance to ACP 142 for some types of HF deployment.
- ACP 127. An old Military Messaging protocol, that is still widely used.
- CFTP. An HF protocol for Email.
- HMTP. A predecessor to CFTP.

Military Messaging and Email

General purpose email (referred to as Email in this paper) is very widely used. Although many protocols have been historically used for email, SMTP (Simple Message Transfer Protocol) based email is so widely used that this is the only protocol family considered here.

Military Formal Messaging (referred to as Military Messaging in this paper) was originally provided by the ACP 127 protocol, which is still used. NATO replaced ACP 127 with STANAG 4406, which is based on the X.400 family of protocols. There is now also a family of standards to provide Military Messaging over SMTP, with RFC 6477 "Registration of Military Message Handling System (MMHS) Header Fields for Use in Internet Mail" as the core specification. Further details are given in the Isode whitepaper [Military Messaging (MMHS) over SMTP].

STANAG 5066

To operate applications over HF Radio, a link level service is needed by the application. STANAG 5066 is the only suitable open standard for this, and is used by all of the message protocols described in this white paper. An overview of STANAG 5066 is given in the Isode Whitepaper [STANAG 5066: The Standard for Data Applications over HF Radio].

ACP142

ACP 142 ("P_Mul – A Protocol for Reliable Multicast Messaging in Constrained Bandwidth and Delayed Acknowledgement (EMCON) Environments") is the best general-purpose protocol for supporting both Military Messaging and Email over HF Radio. The core of ACP 142 is a multicast capability, which enable use of HF broadcast. A detailed description of ACP 142 is given in the Isode White Paper [ACP 142: SMTP & STANAG 4406 Messaging for Constrained Networks].

ACP 142 can be used with two messaging families:

- STANAG 4406. STANAG 4406 Annex E defines operation of STANAG 4406 Military Messaging over ACP 142, and is the NATO standard for operation over networks of 20 kbps or slower. Because of

this, STANAG 4406 Annex E is more widely referenced than ACP 142, although it is ACP 142 that provides the majority of the necessary functionality.
- SMTP. SMTP based messaging, both Email and Military Messaging using RFC 6477, can be operated over ACP 142 using MULE ("Multicast Email") specified in RFC 8494.

ACP 142 provides a generic mechanism to multicast blocks of data over an unreliable transport. It fragments the data into small packets, which can be retransmitted if they are lost. ACP 142 primarily uses a negative acknowledgement (NACK) mechanism for retransmissions, coupled with Acknowledgement of completed message transfer.

ACP 142 also defines a mechanism for EMCON (Emission Control) so that messages can be transferred to a system in radio silence.

Compression

STANAG 4406 Annex E defines a flexible compression layer for use with ACP 142. Compression is vital for constrained networks. This compression format provides:

- Ability to carry different content, so that different messaging protocols can be supported. Multiple protocols can be mixed.
- Ability to use different compression protocols, with the compression protocol identified. This enables use of compression appropriate to different applications.
- Option to use the standard DEFLATE compression, which is a good general-purpose compression algorithm suitable for messaging applications.

Use with STANAG 4406 Messaging

STANAG 4406 is the NATO Standard for Military Messaging. STANAG 4406 Annex E defines a file format for use with ACP 142, based on the standard P1 MTA to MTA protocol. This enables use of ACP 142 for communication between STANAG 4406 MTAs.

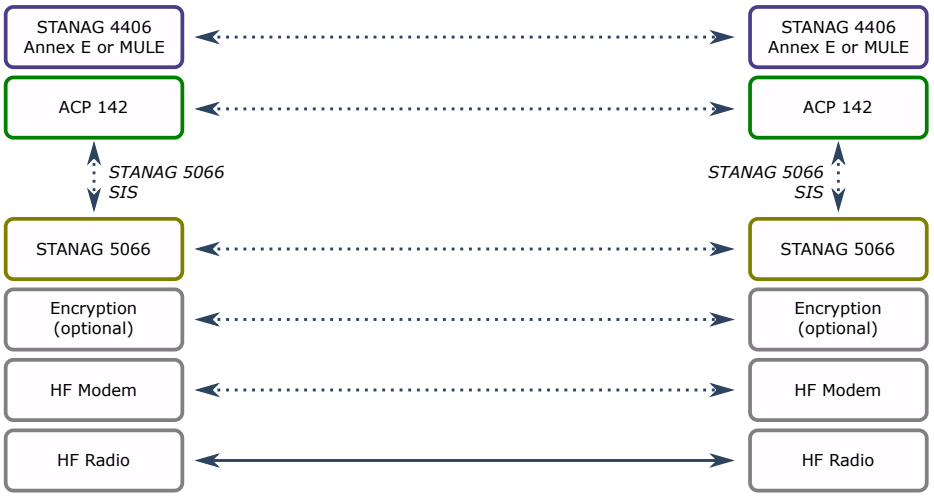
Use with SMTP Messaging

SMTP (Simple Message Transfer Protocol) is widely used for Email. It can also be used with RFC 6477 to support Military Messaging as set out in the Isode whitepaper [Military Messaging (MMHS) over SMTP].

Multicast Email (MULE) is specified in RFC 8494. This defines an SMTP-oriented file format that can transfer messages between SMTP MTAs. MULE also enables key SMTP capabilities, in particular ability to request delivery reports (Delivery Status Notifications) and to transfer 8bit encoded messages.

SMTP messages are widely transferred using 7bit encoding with limited line length, to maximize interoperability. Binary attachments (e.g., Images, Word Documents) are base64 encoded to ensure 7bit. When compression is applied to a base64 encoded attachment, the base64 wrapper compresses reasonably well. However, when the attachment itself is compressible (e.g., a PDF document) the base64 encoding effectively prevents this compression. For this reason, it is recommended to use 8bit (BINARYMIME) message encoding to maximize compression with MULE.

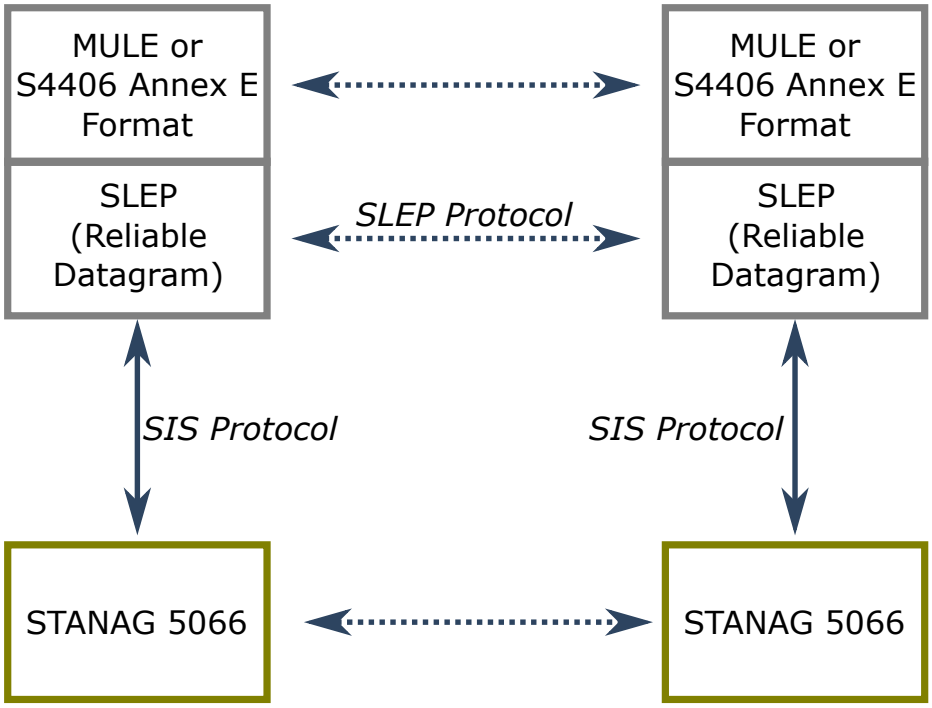
ACP142 over STANAG 5066



The diagram above shows the protocol stack used over HF Radio. STANAG 5066 Annex F standardizes ACP 142 operation over STANAG 5066. This protocol architecture has ACP 142 operating directly over STANAG 5066 using the Unreliable Datagram Oriented Protocol (UDOP). This direct mapping is optimized, and handles priority, as the priority of each ACP 142 packet is mapped on STANAG 5066 priority. This is important if multiple applications are operating over a single modem/radio.

For multi-cast or EMCON operation non-ARQ STANAG 5066 transfer must be used. For unicast non-EMCON operation, STANAG 5066 ARQ may be used. This is strongly recommended, as it gives improved latency and performance due to handling of errors and retransmissions at the STANAG 5066 level.

SLEP (SIS Layer Extension Protocol)



SIS Layer Extension Protocol (SLEP) (S5066-APP3) is an open standard that defines various services over STANAG 5066. The SLEP specification defines how to use SLEP for message transfer using the Reliable Datagram Service to transfer:

- STANAG 4406 Messages using the format defined in STANAG 4406 Annex E.
- MULE (RFC 8494) format messages.

SLEP gives a point to point service operating of STANAG 5066 ARQ. It gives more efficient transfer than ACP 142, but does not provide multicast or EMCON. Where multicast and EMCON are not required, SLEP provides a simpler and more efficient protocol mechanism to transfer messages.

ACP 127

Military Messaging was originally specified in the ACP127 which is essentially a text based message format, with very simple telex-like exchange mechanisms. An example ACP127 message is:

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RR RCWNDB
DE RCCIC 134 02/0009Z
R 012345Z APR 00
FM CANAVHED
TO NAVAL RESERVE DIV WINNIPEG
BT
UNCLAS FOR SHIPPING DEPARTMENT FROM
PROCUREMENT LIAISON SECTION YOUR
291318Z MAR PD ADVISE WHEN MATERIAL
LISTED MY 160322Z MAR WILL BE READY
FOR SHIPMENT
BT
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ACP 127 was originally deployed directly over modems. This is still necessary for some deployments such as BRASS, described in [Isode's Solution for BRASS (Broadcast and Ship to Shore)]. Modern ACP 127 point to point links operate over STANAG 5066 using COSS (Connection Oriented Stream Service) which is specified in STANAG 5066 Annex F.

Further information on ACP127 and on Isode's M-Switch support of ACP127 and related protocols is provided on the M-Switch ACP127 product page. When used with 5bit ITA2 encoding, ACP 127 provides compact transfer for very small messages. For larger messages, lack of compression means it is less efficient that more modern protocols.

ACP 127 does not really have a protocol, and so reliable deployment of ACP 127 is contingent on human operators. Also, ACP 127 has many variants and obscure features that make its use complex. Isode recommends ACP 142 for military messaging deployments.

CFTP

CFTP (Compressed File Transfer Protocol) is defined in STANAG 5066 Annex F, CFTP is a mail transfer protocol, which is is sometimes referred to as Battleforce Email (BFEM). CFTP has an architecture similar to SLEP. It is inferior to SLEP and ACP 142 for a number of reasons:

- No support for message Delivery Reports.
- Restricted to 7bit. This means that compressible attachments do not get compressed as they are base64 encoded. (MULE over ACP 142 or SLEP allows 8bit)
- Messages transferred in order without priority. This makes it unsuitable for military messaging. (SLEP and ACP 142 have priority and allow message overtaking).
- CFTP encoding is not very efficient, so it is less efficient that SLEP for all messages and less efficient than ACP 142 for large messages.
- Not support for multicast.

It does not make sense to choose CFTP, apart from legacy interoperability reasons.

HMTP

HMTP (HF Mail Transfer Protocol) is defined in STANAG 5066 Annex F as mail transfer protocol. It has a similar architecture to CFTP, but does not support compression. It is rarely used, as it has been replaced by CFTP.

Conclusions

This paper has summarized the choice of messaging protocols for use over HF Radio with STANAG 5066. ACP 142 is generally recommended, both for Military Messaging and for Email. Where multicast is not needed, for example in ALE networks where communication is always point to point, SLEP is recommended.