Isode

HF Broadcast Protocol (HFBP) (S5066-APP11)

10th August 2018

Version: 1.0

Status: Experimental

1 Purpose

This document specifies “HF Broadcast Protocol” (HFBP), a protocol to support broadcast operation over STANAG 5066, supporting both EMCON and non-EMCON use. This provides a framework that can be used with different protocols. This specification defines use with selected applications. HFBP is designed to be used in a BRASS (Broadcast and Ship to Shore) architecture.

This document is published in the STANAG 5066 Application (S5066-APP) series.

2 BRASS Requirements

2.1 Current BRASS

BRASS (Broadcast and Ship to Shore) is an approach used by Navies, particularly in NATO countries, to communicate between Ships and Shore using HF Radio. The central part of BRASS is broadcast of messages from transmitters on shore to be received by all ships. This is a continuous stream of data, which will typically be transmitted over multiple HF frequencies at the same time, providing an uninterrupted data flow from ship to shore. The other part of BRASS is Ship to Shore transmission, which will usually operate over STANAG 5066 ARQ

A more detailed description of BRASS is given in Isode's Solution for BRASS (Broadcast and Ship to Shore).

2.2 Deficiencies addressed by HFBP

Current BRASS services have a number of key deficiencies, which HFBP addresses.

1. Single protocol. BRASS is single protocol. HFBP provides a framework that enables multiple protocols to share a single broadcast infrastructure.
2. Cannot use modern messaging protocols. ACP 127 means that BRASS does not make efficient use of the link (no compression), and misses modern messaging features such as delivery reports, read receipts, attachments, and extended character sets. HFBP supports modern messaging protocol.
3. The BRASS recap mechanism which extend ACP 127 is crude and varies between deployments and nations. HFBP provides a compact clean and modern recap mechanism.
4. BRASS broadcast has no error checking, which means receivers get corrupt data and operator message correction is needed. HFBP uses STANAG 5066, so data is validated with checksums

5. The BRASS OTAM mechanism to monitor reception quality needs to compare transmit and receive streams, which is operationally awkward. With HFBP, reception quality can be determined form receive stream alone, using STANAG 5066 checksum information.

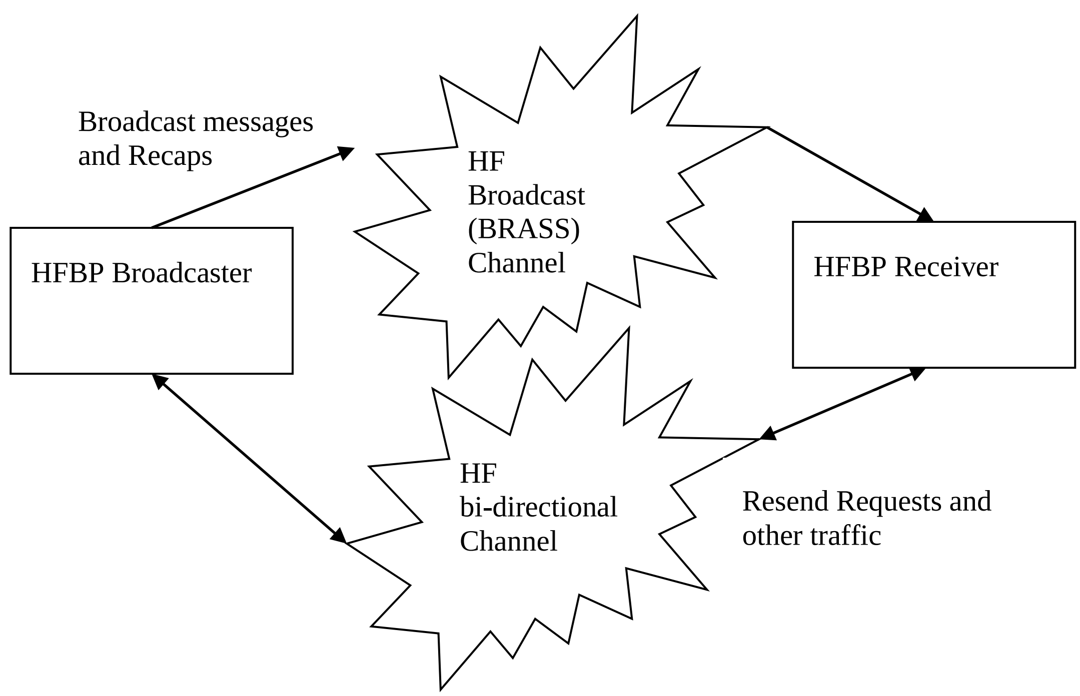
2.3 Why not ACP 142?

ACP 142 provides a multicast service and was designed for this type of environment. In some environments, the ACP 142 service is ideal. For example, in a Naval task group communicating between ships on a single frequency and sharing the link using STANAG 5066 Annex K or Annex L. ACP 142 multicast gives useful performance improvements. In this sort of environment, ACP 142 will give superior performance to HFBP.

ACP 142 is a primarily NACK based protocol, using an ACK at the end of each message transfer. To transfer this ACK, a ship to shore link needs to be established for each message received. A typical use of BRASS is to send many short messages. The broadcast link is always present and using powerful shore transmitters. It is awkward for ships to establish ship to shore links, and smaller ships will need to stop listening to the broadcast while they do this. This “ACK for each message” is problematic in a BRASS environment. HFBP is a fully NACK-based protocol, which means that ship to shore communication is only needed to address missing or corrupted messages.

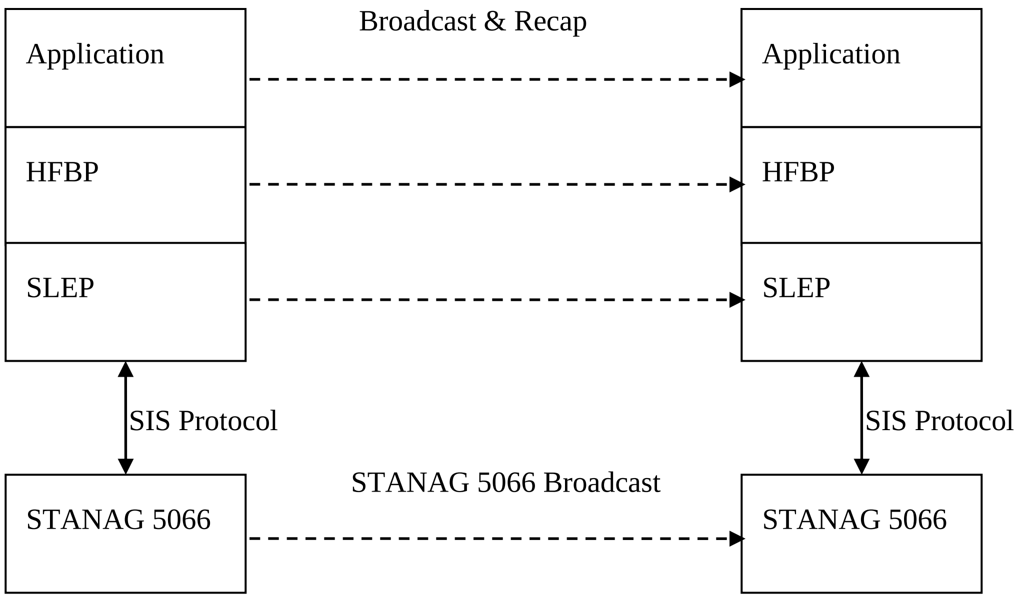
ACP 142 has a complex EMCON mechanism. Optimal operation depends on shore knowledge of EMCON status of all ships. This is often not practical to achieve. HFBP supports EMCON without any sender configuration.

3 Overview

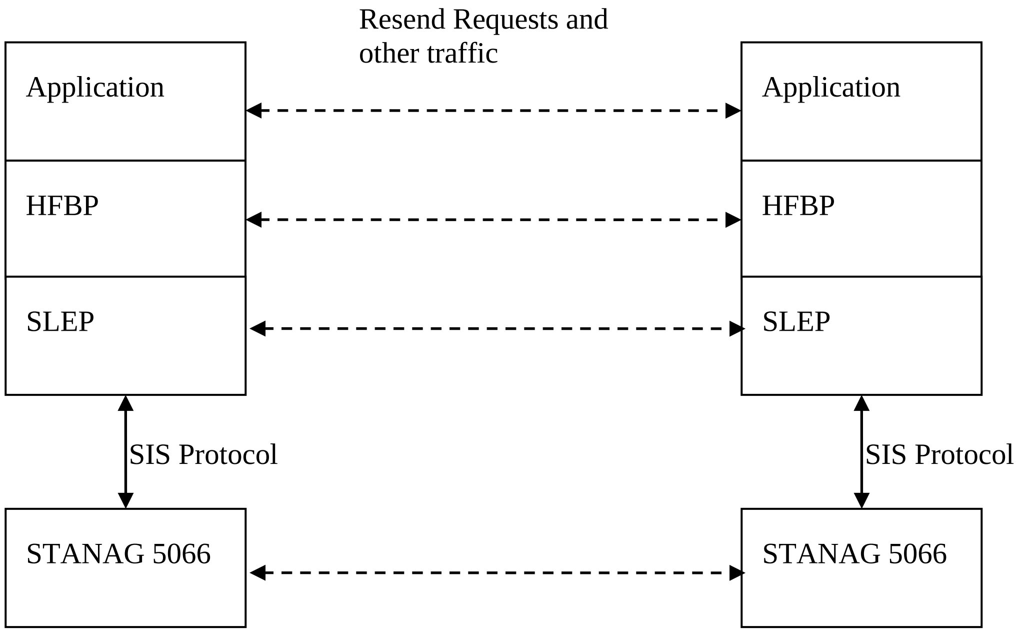


The basic model of HFBP is that there are *two* HF networks involved. Messages and Recaps are broadcast over a broadcast network that is “transmit” only. There is a second HF network that is bi-directional, which is used to transmit Resend Requests to the broadcaster. This link can also be used for other traffic between broadcaster and receiver.

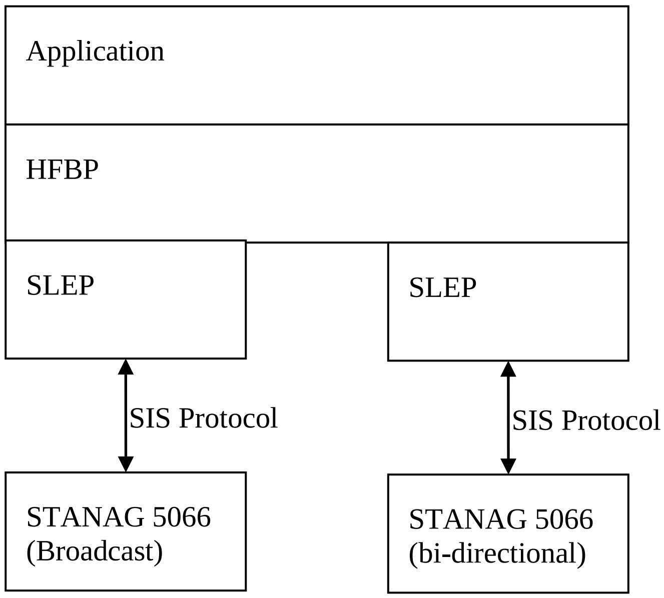
The protocol stack for the broadcast network is shown below.



The similar protocol stack for the bi-directional network is shown below.



In order for HFBP broadcast to work, both sender and receiver will be connected to two STANAG 5066 stacks. This split will be done by the HFBP layer, so that this is transparent to the broadcast application.



Messages are broadcast using SLEP (S5066-APP3 SIS Layer Extension Protocol) unreliable datagrams. These messages may be addressed to:

1. All receivers, using a single broadcast address; or
2. List of receivers, using a list of unicast addresses; or
3. List of receivers represented by a multicast (group) address or list of multicast addresses.

Messages will typically be transmitted a number of times. Reason for this:

- Minimize risk of loss, which is particularly important for recipients in EMCON.
- Minimize need for receivers to request resend.

Receivers can send ARQ requests to the broadcaster to request resend (either over the ARQ link or re-broadcast) of missing messages or message fragments.

The key architectural approach is that request for retransmission and handling EMCON is entirely under receiver control.

This basic approach will work where messages are partially received. However, it does not address handling of messages which are completely lost in transmission. To do this, HFBP includes a Recap mechanism, which enables regular sending of message summaries, covering one or more HFBP broadcasts. This enables a receiver to identify messages intended for them not received (including missing recaps).

For non-EMCON receivers, the HFBP service will request messing messages/message fragment to provide a reliable service for the receiver.

For an EMCON receiver, correctly received message are delivered. Partially received messages are also delivered, as the receiver may be able to extract useful information. This will be most useful for text protocols without compression.

4 HFBP Service Definition

4.1 Bind and Unbind Services

Both broadcast sender and broadcast receiver use the bind services.

4.1.1 HFBP_BIND_REQUEST

Application -> HFBP.

Arguments:

1. SAP. Value of SAP (0-16).
2. Extended Address. Optional. 0-256. 0 is equivalent to no extended address.
3. RANK. As for S5066 S_BIND_REQUEST

4.1.2 HFBP_BIND_ACCEPTED

HFBP -> Application.

No arguments.

4.1.3 HFBP_BIND_REJECTED

HFBP -> Application.

Arguments:

1. Reason. Values as for SLEP

4.1.4 HFBP_UNBIND_REQUEST

Application -> HFBP

No arguments.

4.1.5 HFBP_UNBIND_INDICATION

HFBP -> Application.

Arguments:

1. Reason. Values as for S5066 S_UNBIND_INDICATION

4.2 Broadcast Sender Services

The following services are available to a broadcast sender.

4.2.1 HFBP_MSG_REQUEST

Application -> HFBP

Arguments:

1. Data. Octets to be transferred.
2. ID. Integer provided by the application to correlate responses.
3. Priority. STANAG 5066 Priority.
4. List of Addresses. Zero or more STANAG 5066 Unicast Addresses.
5. Minimum retransmission count.

HFBP messages may be addressed to an explicit list of Unicast addresses. If no address is specified, the message is for all receives (broadcast).

4.2.2 HFBP_MSG_CONFIRM

HFBP -> Application.

Arguments:

1. ID.

Indicates that the message has been accepted for transfer.

4.2.3 HFBP_MSG_REJECT

HFBP -> Application.

Arguments:

1. ID.
2. Reason. The following reject values are defined:
    a. Message too large.
    b. ID already in use.
    c. Priority not currently allowed.

4.3 Broadcast Receiver Services

4.3.1 HFBP_MSG_INDICATION

HFBP -> Application

Arguments:

1. Data. Octets transferred.
2. Priority. STANAG 5066 Priority.
3. Sender Address. STANAG 5066 Address of Sender.
4. Receiver Address. STANAG 5066 Address of Recipient (may be unicast or broadcast).

Message is delivered.

4.3.2 HFBP_PARTIAL_MSG_INDICATION

HFBP -> Application

Arguments:

1. Data.
2. Priority. STANAG 5066 Priority.
3. Sender Address. STANAG 5066 Address of Sender.
4. Receiver Address. STANAG 5066 Address of Recipient (may be unicast or broadcast).

Partial message is delivered to EMCON receiver. The encoding of the data is a local choice. It may be:

1. A structured representation, showing parts of the message correctly received, with alternate unverified information for the gaps; or
2. A text representation of information received, suitable for review/edit by an operator.

5 Providing the HFBP Service

6 HFBP PDU Encoding

6.1.1 Message PDU

Messages are encoded as follows

<table>
<tr><td>MSB</td><td></td><td></td><td></td><td></td><td></td><td></td><td>LSB</td></tr>
<tr><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td colspan="2">Version=0</td><td>Multi Address</td><td colspan="2">Not Used</td><td colspan="3">Type=0</td></tr>
<tr><td colspan="8">Address Count (optional)</td></tr>
<tr><td colspan="8">Addresses (4 bytes per address)</td></tr>
<tr><td colspan="8">Data</td></tr>
</table>

An HFBP message is encoded as follows:

1. The first byte encodes:
    a. Version=0. This reflects this version of HFBP.
    b. Type=0. This value indicates this is a Message PDU.
    c. Multi-Address. If this is set to 0, there is no address information. If this is set to 1, there are additional addresses encoded.
2. If Multi-Address is set, Address Count contains the number of additional addresses.
3. Each additional address is encoded in 4 bytes.
4. The rest of the message is the message.

6.1.2 Recap PDU

The Recap PDU is used to list information on messages sent.

MSB							LSB
7	6	5	4	3	2	1	0
Version=0		Not Used			Type=1		
Previous RECAP							
Listed Messages							

The Recap PDU is encoded as follows:

1. The first byte encodes:
    a. Version=0. This reflects this version of HFBP.
    b. Type=1. This value indicates this is a Recap PDU.
2. The next two bytes encodes the SLEP Transfer ID of the previous Recap.
3. The rest of the message encodes a sequence of references to messages that have been fully sent since the previous message. Each reference is variable length and encoded as shown below.

MSB 7	6	5	4	3	2	1	LSB 0
Reference ID							
Address Count							
Addresses (4 bytes per address)							

Each reference is encoded as follows:

1. Reference ID is the SLEP Transfer ID of the message referenced, encoded in two bytes.
2. Address count is the number of addresses to which the message was sent.
3. This is followed by the addresses, with each address encoded in four bytes.

6.1.3 Resend Request PDU

The HFBP Resend Request PDU is specified below.

MSB 7	6	5	4	3	2	1	LSB 0
Version=0		Whole Msg	Not Used		Type=2		
ID							
Block (optional)							

The Resend Request PDU is encoded as follows:

1. The first byte encodes:
    a. Version=0. This reflects this version of HFBP.

    b. Type=2. This value indicates this is a Resend PDU.
    c. If Whole message is set to 1, the request is to resend the whole message.
2. ID. This is SLEP Transfer ID of the message for which a resend is requested, encoded in two bytes.
3. Block is present and encoded in two bytes if Whole Msg is not set. This specifies the specific SLEP bock that is requested.

6.2 Bind Services

The HFBP Bind Services are mapped directly onto the equivalent SLEP services. An HFBP service will bind to both the broadcast service and the bi-directional service.

6.3 Message Broadcast

When a message is broadcast using the HFBP_MSG_REQUEST service, the first step is to analyze the list of unicast addresses provided.

1. If no addresses are provided, the default STANAG 5066 broadcast address is used.
2. The provided list of unicast addresses is analysed in context of multicast addresses configured for the HF network, to produce the shortest possible list of addresses.

One network address is used to address the SLEP Unreliable Datagram on the broadcast service, along with priority and minimum message count.

An HFBP Message PDU is constructed. The header will be one byte if there is just a single address. Otherwise, multi-address is selected, and a count of the addresses and each address is encoded.

The message is then sent using the SLEP_UDP_REQUEST service. HFBP_MSG_CONFIRM or HFBP_MSG_REJECT is generated from the corresponding SLEP responses.

6.4 Sending Recaps

An HFBP sender will send Recap messages at configurable time intervals. When large numbers of messages are being sent, additional Recaps may be sent to keep the size smaller. If no messages are sent in a period, the previous Recap message is sent again.

Each Recap message references the SLEP Transfer ID of the previous Recap. This enables a recipient to detect missing Recap messages.

Each transferred message is recorded as a block that includes:

- Message identified by SLEP Transfer ID.
- List of STANAG 5066 Addresses of recipients for the message.

Recap messages are sent to the default broadcast address using SLEP_UDP_REQUEST. Because of the importance of Recaps, it is recommended that minimum transmission count is set to at least 2.

6.5 Receiving Messages

A broadcast receiver HFBP will receive a message with SLEP_UDP_INDICATION.

The HFBP receive will determine if the local node is addressed in either the target address or in the explicitly listed addresses. If so the data part of the HFBP Message PDU is used to provide HFBP_MSG_INDICATION.

6.6 Detecting Partial Messages

A partial message may arrive, with the SLEP_UDP_PARTIAL_INDICATION. This is passed to the receiver using HFBP_MSG_PARTIAL_INDICATION.

6.7 EMCON Handling of Partial Messages

When an HFBP broadcast receiver is in EMCON mode, it is not able to request any resends. Therefore, it will pass up the information is has received using the HFBP_PARTIAL_MSG_INDICATION, so that the application may attempt to obtain information.

It is anticipated that this is going to be most useful with text-encoded non-compressed messages.

6.8 Requesting Resend

An HFBP broadcast receiver will be able to detect missing message, including missing recap messages by analyzing a received Recap PDU.

It may also be able to determine that some blocks of a message have not been received.

In non-EMCON, the broadcast receiver will use the bi-directional channel to request resend. A Resend Request PDU can be generated to request resent of each missing message and each block of a message that has been partially received.

The Resend Request PDU is sent using SLEP_RDP_REQUEST.

When an HFBP broadcast sender receives are Resend Request PDU, it will resend the data requested. If the only recipient of the data is the node requesting the resend, it will send the data directly over the bi-directional channel using SLEP_RDP_REQUEST. Otherwise, the message will be re-broadcast on the broadcast channel using SLEP_UDP_REQUEST.

7 Protocol Specifications and Address Assignments

This section recommends default assignments for SAP and Extended Address.

7.1 STANAG 4406 Annex E

This follows the SLEP mapping.

Default address: SAP: 10; Extended Address: 8

7.2 MULE

Using STANAG 4406 Annex E compression.

Default address: SAP: 10; Extended Address: 9

Without STANAG 4406 Annex E compression:

Default address: SAP: 10; Extended Address: 10

It may be desirable to operate in this second mode without compression. This is in contrast to ARQ where compression is always desirable.   The rationale for this is that an EMCON receiver may receive some PDUs with errors and not correct versions.   A text version of the message, while larger, may be useful in this situation.

7.3 XMPP

Encode an XMPP stanza as each HFBP message.

Default address: SAP: 10; Extended Address: 11