TCP/IP over STANAG 5066
HF packet Radio

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Presentation Overview

- STANAG 5066 framework
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- PPP subnet client (Annex F.9)
  - Characteristics
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- IP subnet client (Annex F.10)
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STANAG 5066 Equipment

- HF antenna
- HF transceiver
- HF modem
- STANAG 5066 controller
- Server running Subnet clients
- Local Area Network

STANAG 5066 Equipment diagram
STANAG 5066 Subnet Service Characteristics

• Transmission Modes:
  ▶ • ARQ (requires half/full-duplex transmission)
  ▶ • non-ARQ (uses simplex transmission)
    ▶ – with no detectable errors
    ▶ – with detected errors marked

• Data Delivery Confirmation Modes:
  ▶ • none
  ▶ • Node-to-Node delivery (at subnetwork level)
  ▶ • Client-to-Client delivery

• Delivery Order:
  ▶ • in the order submitted by the sending client
  ▶ • in the order correctly received by the receiving client

• Minimum Number of Retransmissions
  ▶ • (non-ARQ transmission modes only)

Broadcast ▶ Point-to-Point
STANAG 5066 subnet clients

- HMTP (HF Mail Transfer Protocol) → Annex F.4
  - RFC-821 (SMTP)
  - RFC-2197 (Command Pipelining)

- BFTP (Basic File Transfer Protocol) → Annex F.7.3.1

- PPP (Point to Point Protocol) → Annex F.9
  - RFC-1661 (structure)
  - RFC-1662 (HDLC-like framing)

- IP (Internet Protocol) → Annex F.10
  - RFC-1112 (Internet Group Management Protocol)
  - draft-fenner-igmp-proxy-03.txt (IGMP proxy)

- Etc…
PPP subnet client (Annex F.9)

- Supports any protocol that may be carried by PPP (including IPv6). (→ IPCP)

- Authentication (→ CHAP/PAP)

- Compression (→ CCP)

- Multi link PPP (→ MP)

- Limitations … No efficient IP Multicast support
PPP datagram and framing

- **Flag**: 0x7e
- **Addr**: 0xff
- **Control**: 0x03
- **Protocol**: 0x0021
- **Information**: IP datagram

- **Protocol**: 0xc021
  - **Information**: Link Control Protocol (LCP)

- **Protocol**: 0xc023
  - **Information**: Password Authentication Protocol (PAP)

- **Protocol**: 0xc223
  - **Information**: Challenge-Handshake Authentication Protocol (CHAP)

- **Protocol**: 0x8021
  - **Information**: IP Network Control Protocol (NCP)

- **Protocol**: 0x00fb
  - **Information**: Link compressed datagram
Implementation of the PPP subnet client

The PPP daemon forks off a pseudo TTY, PPP frames in HDLC-like framing will be read and written to and from stdin/stdout.

Received S_UNIDATA_INDICATION messages are decapsulated, the FCS on the ppp datagram is recalculated and asynchronous HDLC-like framing is added. The resulting asynchronous HDLC-framed byte stream is written to the stdin of the pseudo TTY.

Add HDLC-like framing and recalculate FCS

TCP port 999
Subnet Interface Sublayer

...lower layers...

Decapsulate S_UNIDATA_INDICATION

PPP daemon

fork

/dev/ppp0

Pseudo TTY

Remove HDLC-like framing

Encapsulate into S_UNIDATA_REQUEST

The ppp5066 program removes the HDLC-like framing from the stdout of the ppp daemon, encapsulates the ppp frame into an S_UNIDATA_DATA_REQUEST and submits it to the subnetwork using the socket subnet interface.
IP subnet client (Annex F.10)

- IP datagram is encapsulated in a S_UNIDATA primitive.

- Point to point IP configuration: using ARQ tx_mode. (although non-ARQ is also allowed).
  - IN-ORDER delivery or AS-THEY ARRIVE

- “One to Many”, or “Many to Many” IP Multicast configuration: using non-ARQ tx_mode.
  - Class D IP addresses (IP Multicast) mapped to STANAG 5066 group addresses.
  - IN-ORDER delivery or AS-THEY ARRIVE
IP client design and implementation

• Use of the TUN/TAP (Ethertap) interface on the Linux operating system.

• No adjustments necessary to user-space configuration tools since it looks just like a normal ethernet device to the operating system.

• The complete system acts as an “HF IP router” where the ‘tap0’ interface is the IP subnet client interface.

• Why did we have to implement the IP client in user-space?

• Support for other Operating Systems
Function: ip_input()
Thread: tapread()

Queue: inQ

Function: ip_output()
Thread: ip_igmp_proxy()

Queue: outQ

Function: ether_output()
Thread: tapwrite()

Thread: s5066_write()

Queue: outQ

User-space

STANAG 5066 stack

Kernel-space

STANAG 5066 stack

User-space
Filtering and address mapping

Transmitting end

tapread()

ip_input()

s5066_write()

Receiving end

s5066_read()

ether_output()

Mapping of IP Multicast to STANAG 5066 group addresses.

Mapping of IP Multicast to Ethernet Multicast

STANAG 5066 stack

Subnet MTU

STANAG 5066 stack

Transmission end

Mapping of IP Multicast to STANAG 5066 group addresses.
IP Multicast forwarding

PIM-SM Multicast IP router forwards received Multicast traffic from tap0 to eth0 (and vice versa).

PCs are running a simple IP Multicast receiver application.
“user-interface” of sending end

[jw-smal@kernelpanic src]$ su -c './hfmcast -b -n fieldworks2 -U 10.0.0.3 -M 17.0.0.1 -B 17.0.0.255'
Password:

SISmcast (c)2000 by NATO C3 Agency, CSD Radio Branch
Using tap device: /dev/tap0, IPv4 address: 10.1.1.69 MAC address: fe:fd:0:0:0:0
S5066 unicast addr: 10.0.0.3
S5066 multicast addr: 1.0.0.1(group)
S5066 broadcast addr: 1.0.0.255(group)
client: Connected to: fieldworks2.csdr.nc3a.nato.int:9999

ETHERNET type: 800 (ip), source: FE:FD:00:00:00:00, dest: 00:00:00:00:00:00
Filtered> IP version: 4, header length: 6, total length: 32, id: 41138, ttl: 1,
    source: 10.1.1.69, destination: 224.1.2.3, protocol: 2 (igmp), tos: 00000000b
IGMP message type: Ver. 2 membership report, routing code: 0, group address: 224.1.2.3

ETHERNET type: 800 (ip), source: FE:FD:00:00:00:00, dest: 00:00:00:00:00:00
Mcast> IP version: 4, header length: 5, total length: 51, id: 41139, ttl: 1,
    source: 10.1.1.69, destination: 224.1.2.3, protocol: 17 (udp), tos: 00000000b
ETHERNET type: 800 (ip), source: FE:FD:00:00:00:00, dest: 00:00:00:00:00:00
Filtered> IP version: 4, header length: 6, total length: 32, id: 41142, ttl: 1,
    source: 10.1.1.69, destination: 224.0.0.2, protocol: 2 (igmp), tos: 00000000b
IGMP message type: Leave-group message, routing code: 0, group address: 224.1.2.3
"user-interface" of receiving end

[jw-smal@penguin1 src]$ su -c './hfmcast -b -a 10.1.1.127 -m 255.255.255.0 -n fieldworks1 -U 10.0.0.3 -M 17.0.0.1 -B 17.0.0.255'
Password:

SISmcast (c)2000 by NATO C3 Agency, CSD Radio Branch
executing: /sbin/ifconfig tap0 10.1.1.127 netmask 255.255.255.0 -arp
Using tap device: /dev/tap0, IPv4 address: 10.1.1.127 MAC address: 0:ff:9b:ea:6a:90
S5066 unicast addr: 10.0.0.3
S5066 multicast addr: 1.0.0.1(group)
S5066 broadcast addr: 1.0.0.255(group)
client: Connected to: fieldworks1.csdr.nc3a.nato.int:9999

s_unidata_indication: len 64, prio 1, dest sap_id 9, dest_node 1.0.0.1, non-ARQ (broadcast) tx_mode, src sap_id 9, src_node 10.0.0.5, sizeof_u_pdu 51

ETHERNET type : 800 (ip), source: 50:66:00:00:00:00, dest: 01:00:5E:01:02:03
IP version: 4, header length: 5, total length: 51, id: 41139, ttl: 1, source: 10.1.1.69, destination: 224.1.2.3, protocol: 17 (udp), tos: 0000000b
Performance

- 4253 bps TCP payload throughput @ 9600 1/2 duplex short interleaver

- ~6 seconds ICMP echo/reply (ping) round trip time.

- Non-ARQ versus ARQ impact on TCP performance being investigated.

- IETF PEP (Performance Enhancing Proxies)

- IETF PILC (Performance Implications of Link Characteristics).
TCP throughput @ 2400 bps 1/2 duplex