TCP/IP over STANAG 5066 HF packet Radio

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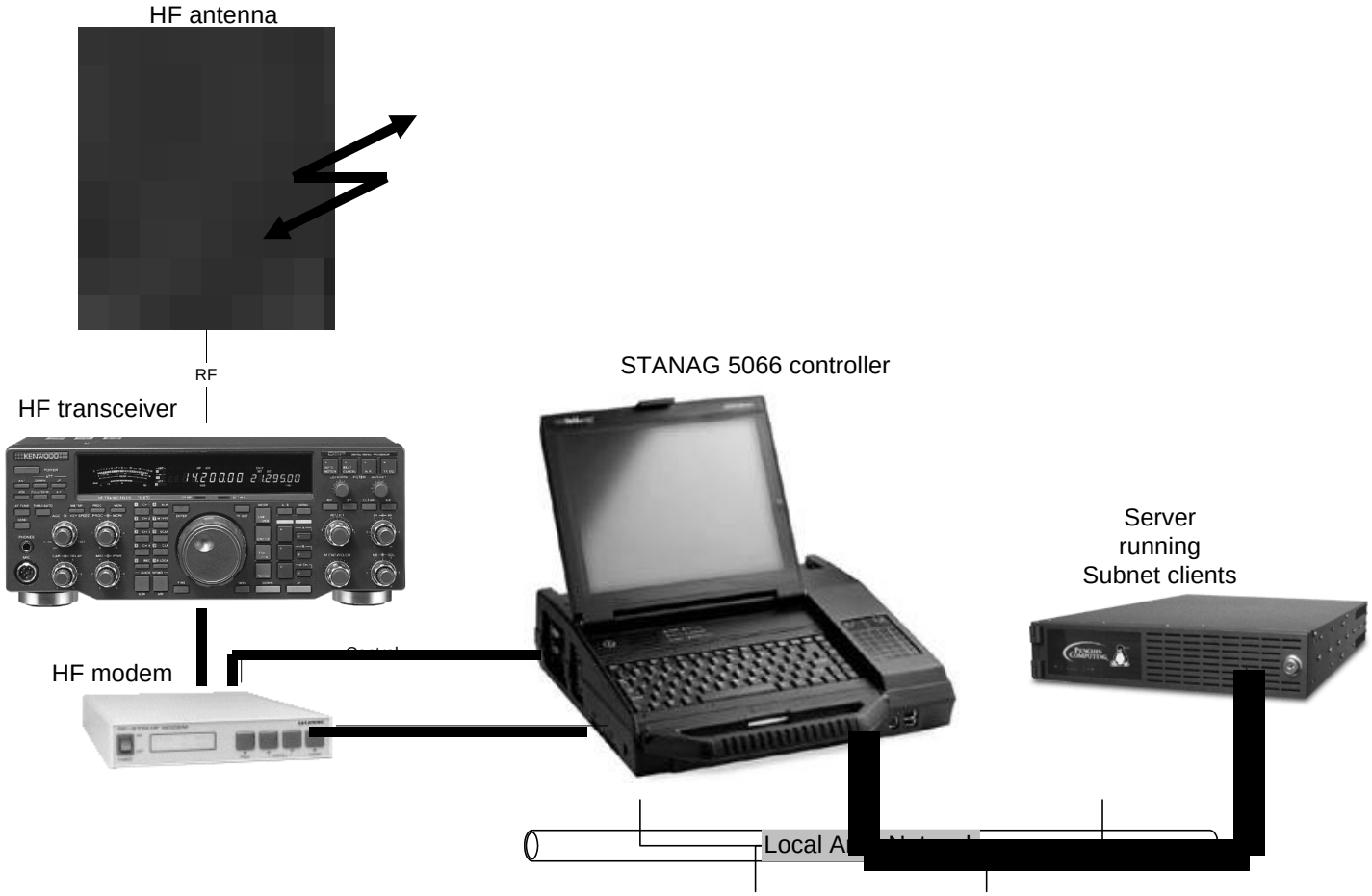
Presentation Overview

- **STANAG 5066 framework**
  - **Equipment**
  - **Characteristics**
  - **Subnet Clients**
- **PPP subnet client (Annex F.9)**
  - **Characteristics**
  - **Implementation**
- **IP subnet client (Annex F.10)**
  - **Implementation**
  - **Efficient IP Multicast support**
  - **Performance**

STANAG 5066 Equipment



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

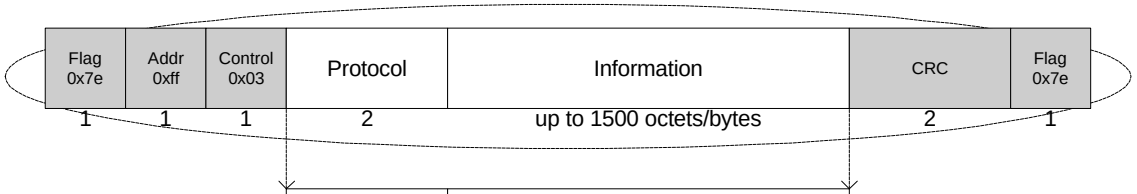
STANAG 5066 subnet clients

- 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)

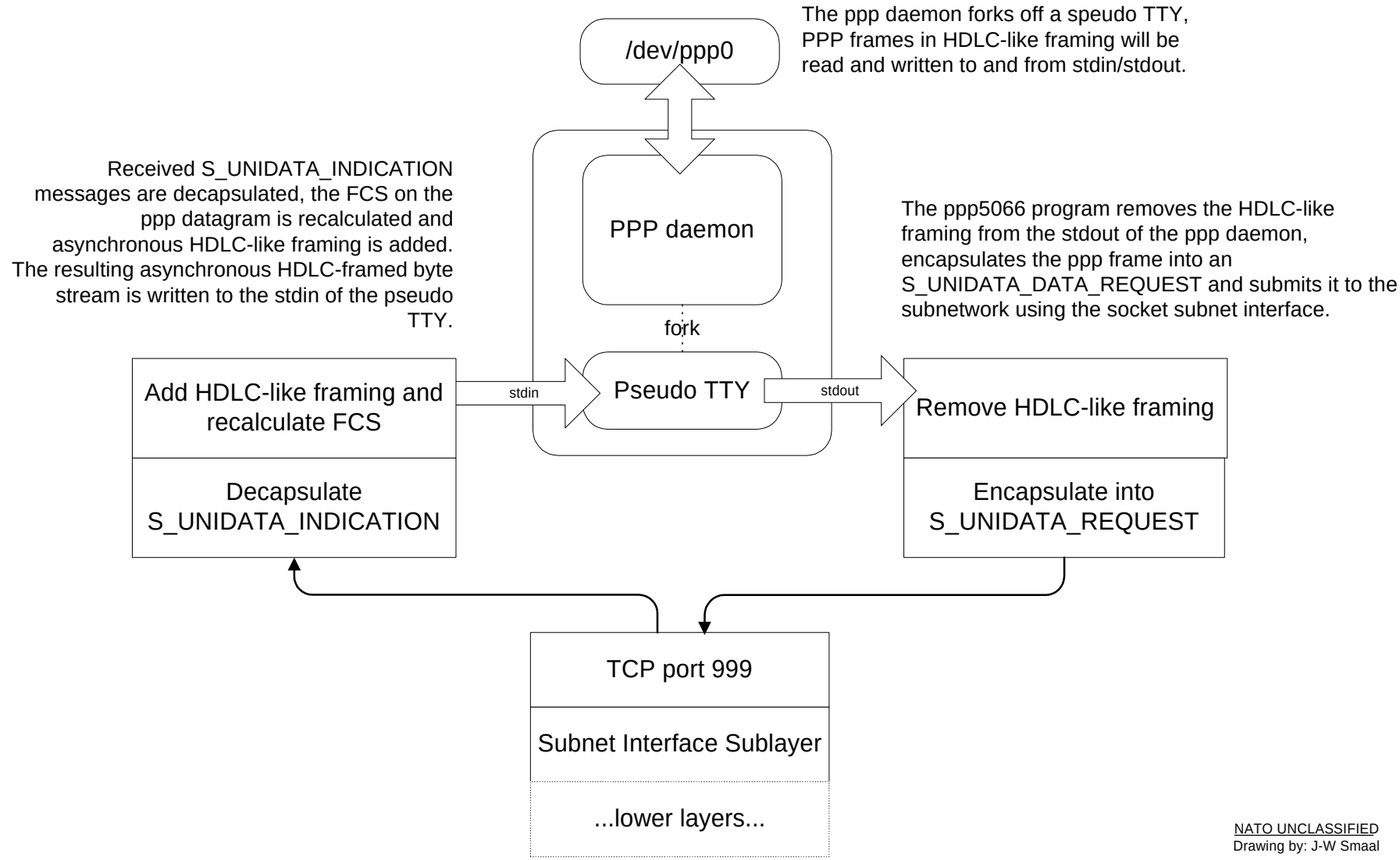
- **Supports any protocol that may be carried by PPP (including IPv6). (→ IPCP)**
- **Authentication (→ CHAP/PAP)**
- **Compression (→ CCP)**
- **Multi link PPP (→ MP)**
- **Limitations … No efficient IP Multicast support**

PPP datagram and framing



Protocol 0x0021	IP datagram
Protocol 0xc021	Link Control Protocol (LCP)
Protocol 0xc023	Password Authentication Protocol (PAP)
Protocol 0xc223	Challenge-Handshake Authentication Protocol (CHAP)
Protocol 0x8021	IP Network Control Protocol (NCP)
Protocol 0x00fb	Link compressed datagram

Implementation of the PPP subnet client



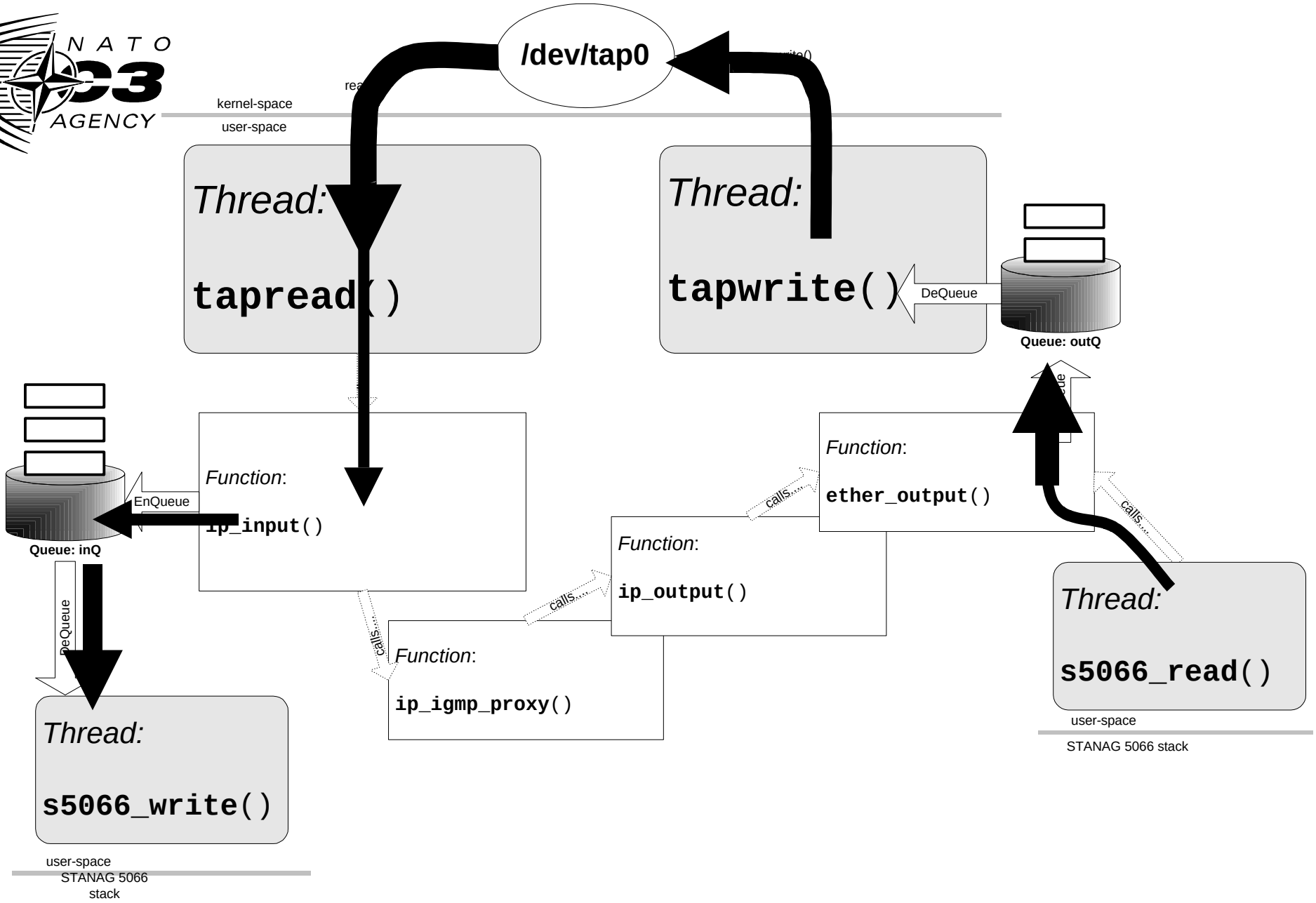
NATO UNCLASSIFIED
Drawing by: J-W Smaal

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**

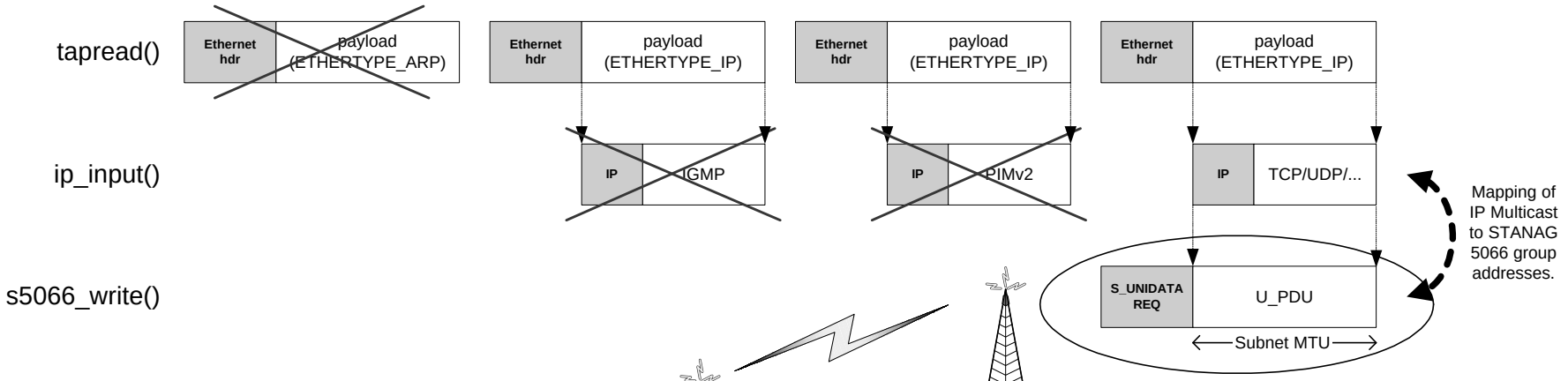
IP client design and implementation

- **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**

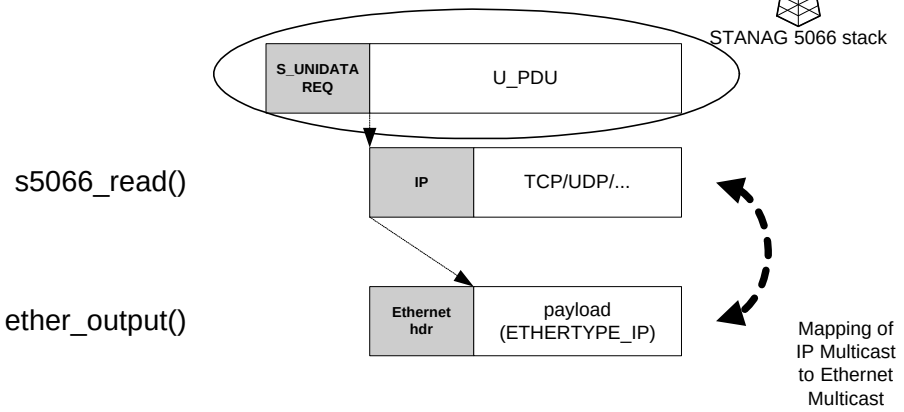

/dev/tap0
kernel-space
user-space
Thread:
tapread()
Thread:
tapwrite()
DeQueue
Queue: outQ
Queue: inQ
EnQueue
Function:
ip_input()
Function:
ether_output()
Function:
ip_output()
Function:
ip_igmp_proxy()
calls...
calls...
calls...
calls...
DeQueue
Thread:
s5066_write()
Thread:
s5066_read()
user-space
STANAG 5066 stack
user-space
STANAG 5066 stack

Filtering and address mapping

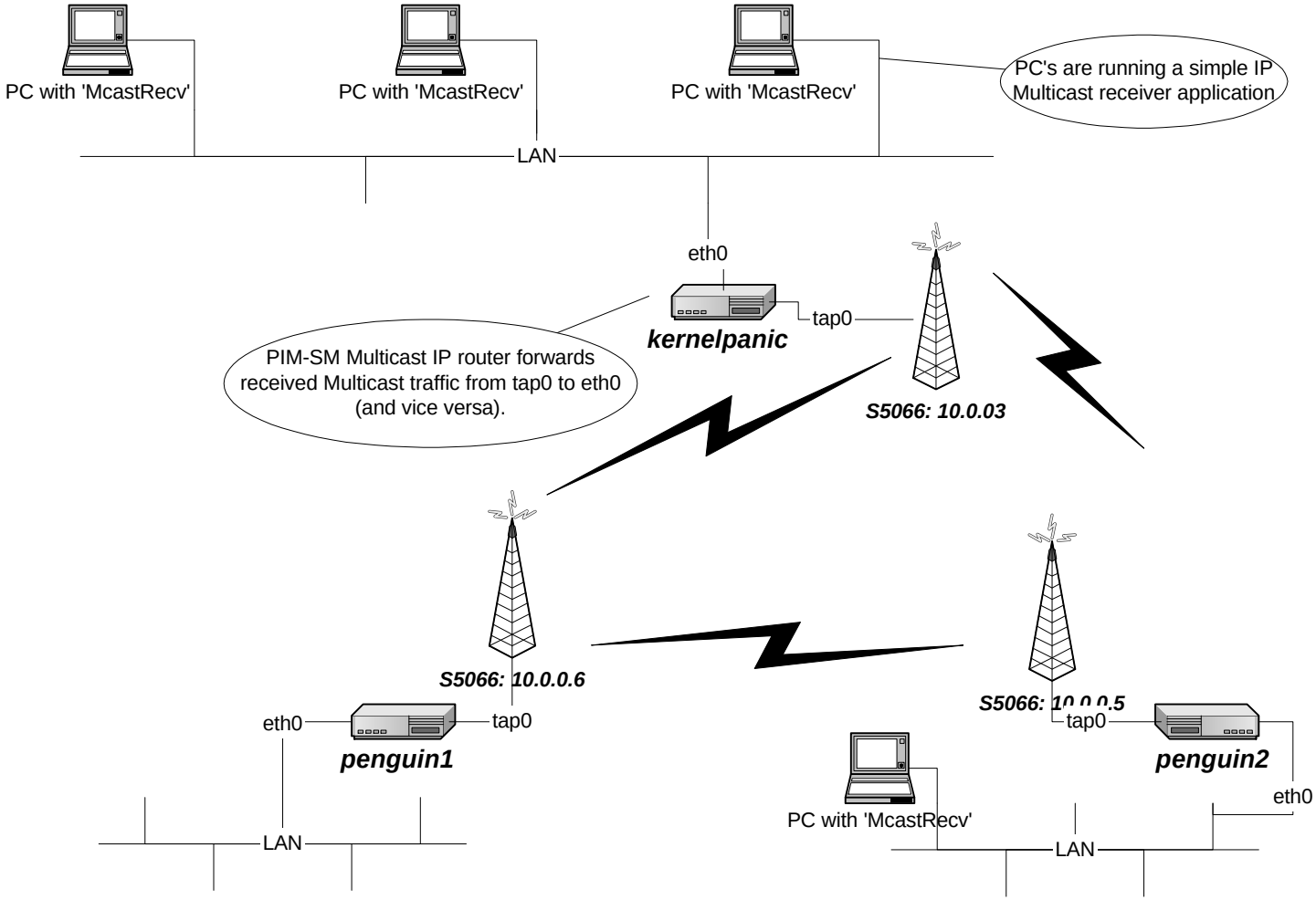
Transmitting end



Receiving end



IP Multicast forwarding



“user-interface” of sending end

```
[jw-smaal@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-smaal@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: 00000000b
```

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 troughput @ 2400 bps 1/2 duplex