Zero-Configuration Multicast Address Assignment

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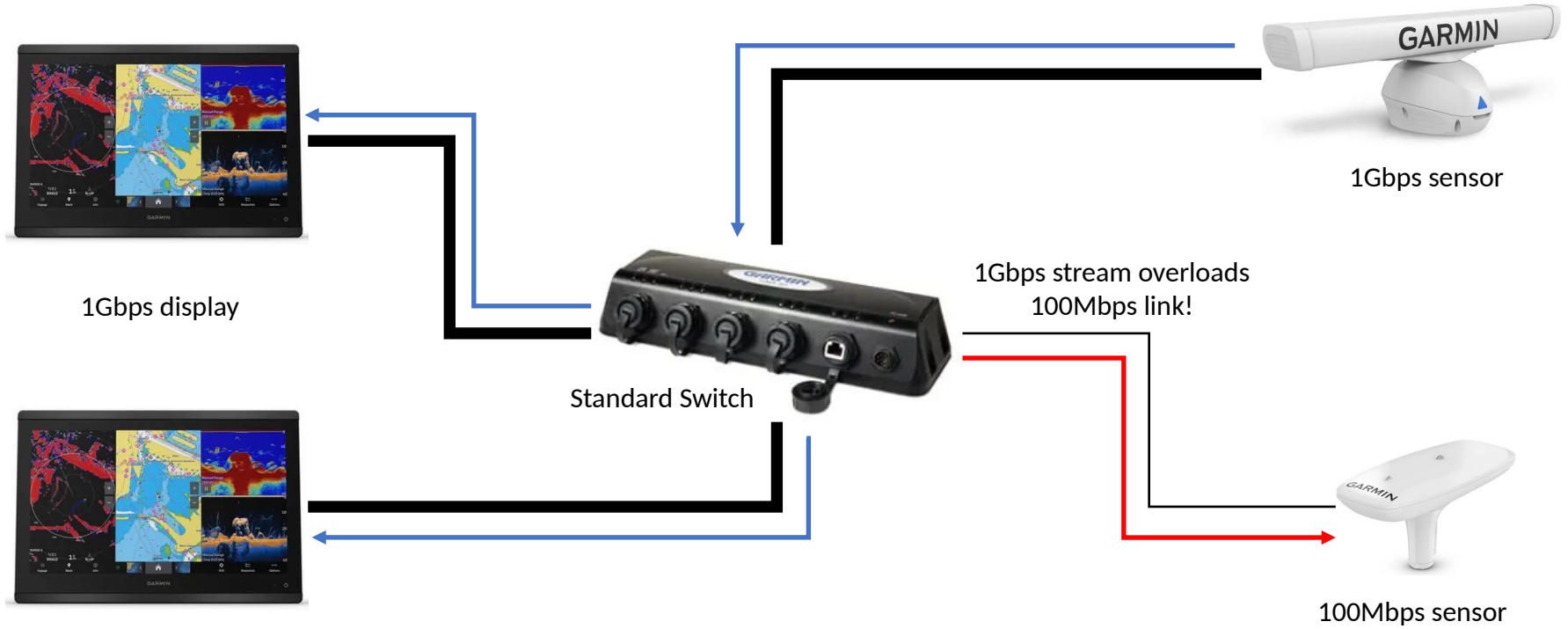
https://datatracker.ietf.org/doc/draft-karstens-pim-ipv6-zeroconf-assignment/

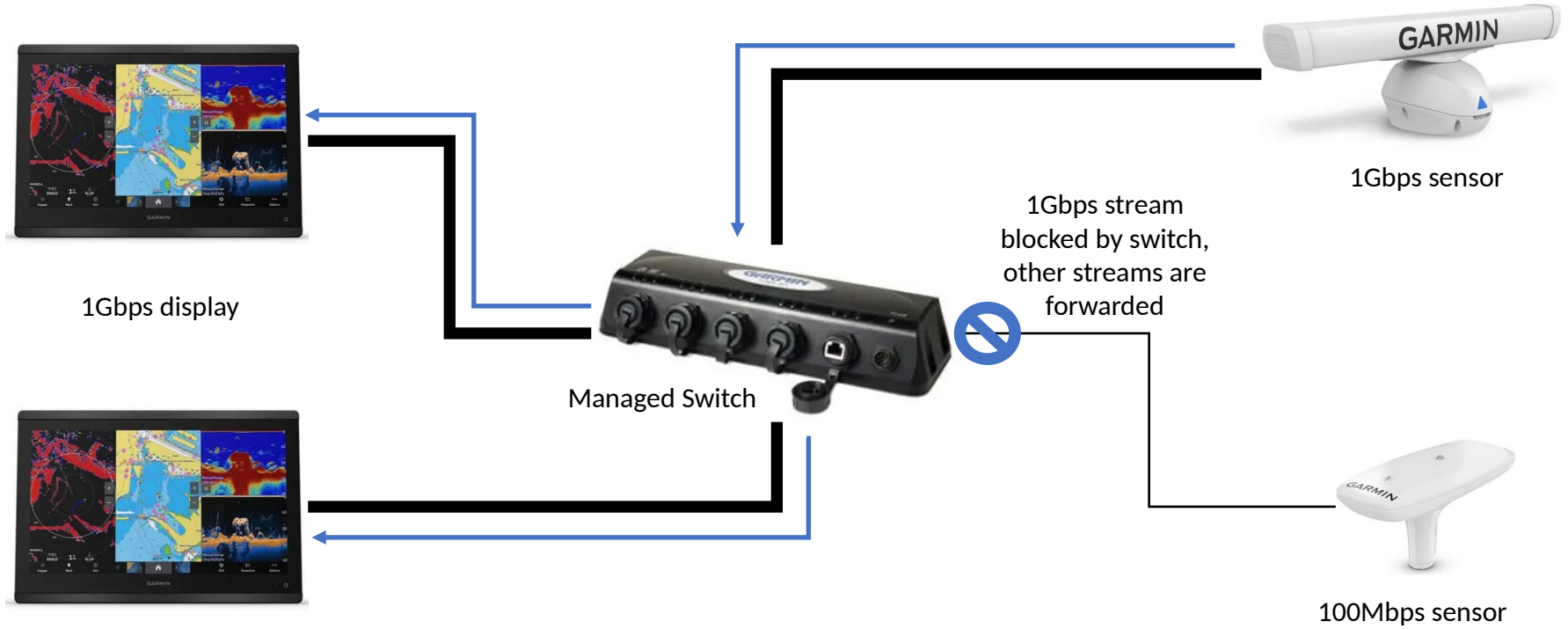
First Problem

- Coexistence of devices with varying link speeds



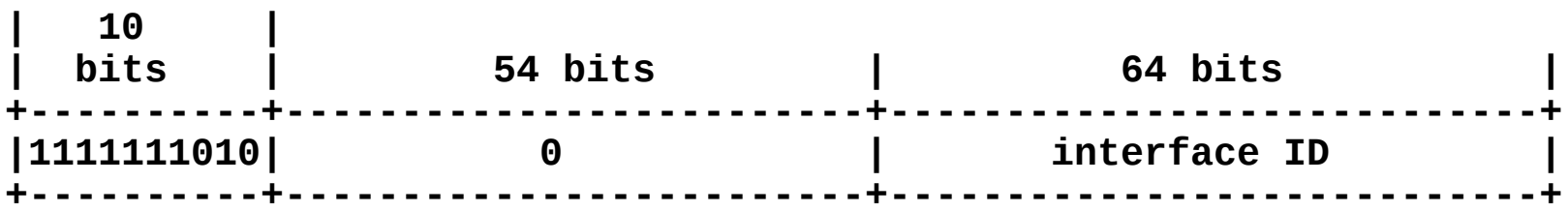
The Solution

- Each data stream assigned a different multicast address
- Devices only request streams they are interested in or can handle
- Multicast snooping forwards packets only to interested ports



Link-Local IPv6 Unicast Address

- RFC 4291



Multicast Addresses

flgs are **0RPT** where:

- 0 = reserved
- R = 0 -> does not embed Rendezvous Point address
  R = 1 -> embeds Rendezvous Point address
- P = 0 -> address not assigned based on network prefix
  P = 1 -> address is assigned based on the network prefix
- T = 0 -> permanently assigned multicast address
  T = 1 -> dynamically assigned

- RFC 1884 (RFC 4291): Multicast Address

```
|   8    |  4 |  4 |                   112 bits                    |
+--------+----+----+-----------------------------------------------+
|11111111|flgs|scop|                   group ID                    |
+--------+----+----+-----------------------------------------------+
```

- RFC 3306: Unicast-Prefix-based IPv6 Multicast Address

```
|   8    |  4 |  4 |   8    |    8   |       64       |    32    |
+--------+----+----+--------+--------+----------------+----------+
|11111111|flgs|scop|reserved|  plen  | network prefix | group ID |
+--------+----+----+--------+--------+----------------+----------+
```

- RFC 4489: Link-Scoped IPv6 Multicast Address

```
|   8    |  4 |  4 |   8    |    8   |       64       |    32    |
+--------+----+----+--------+--------+----------------+----------+
|11111111|flgs|scop|reserved|  plen  |       IID      | group ID |
+--------+----+----+--------+--------+----------------+----------+
```

flgs are 0011
(R = 0, P = 1, T = 1)

scop <= 2

reserved = 0

plen = 0xff

IID = IPv6LL IID

Allocated as per
RFC 3307

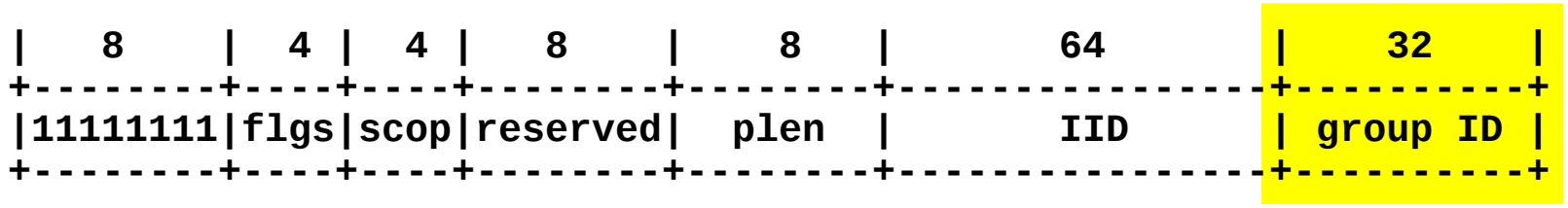
RFC 3307: IPv6 Multicast Address Guidelines

Group ID is:

- 4.1 Permanent IPv6 Multicast Addresses
  Allocated by IANA (IPv6 registry)
  T = 0, P = 0
  0x00000001 to 0x3FFFFFFF
- 4.2 Permanent IPv6 Multicast Group Identifiers
  Allocated by IANA
  0x40000000 to 0x7FFFFFFF
- 4.3 Dynamic IPv6 Multicast Addresses
  T = 1
  0x80000000 to 0xFFFFFFFF

The Problem: Transmitting on Ethernet

- RFC 2464 (Transmission of IPv6 Packets over Ethernet Networks) Section 7 specifies destination multicast MAC address mapping:
  - First two octets are 33:33
  - Last four octets are last four octets of IPv6 multicast address
- Link-Scoped IPv6 Multicast Address



Different nodes can generate different IPv6LL addresses with the same MAC address!

Solution Requirements

- Zero-configuration
  - Most customers do not have expertise on network configuration
- No Internet connection
  - Networks are typically single-subnet
- Unique Ethernet destination address
  - RFC 4541 indicates most switch vendors do not support looking at IPv6 destination address
  - Switch parts at the desired price point do not support Source-Specific Multicast
- Decentralized (avoid single-point of failure)
  - Existing solution for dynamic assignment, MADCAP (RFC 2730), relies on a server
- Multiple streams from same host

Overview of Proposed Solution

- https://datatracker.ietf.org/doc/draft-karstens-pim-ipv6-zeroconf-assignment/
- Update RFC 3307 section 4.3 to designate a range for zero-configuration allocations
- Application generates random group ID in zero-configuration range
- Application uses mDNS (RFC 6762) to ensure group ID is unique
  - mDNS is a zero-configuration technology
  - Both probing before initial use and continuous monitoring
- Application uses group ID to generate Link-Scoped IPv6 Multicast Address

Update RFC 3307 Section 4.3

- RFC 3307 specifies range of 0x80000000-0xFFFFFFFF for both:
  - Server-based allocation (section 4.3.1)
  - Host-based allocation (section 4.3.2)
- Proposed change:

0x80000000-0xBFFFFFFF	MADCAP [RFC2730]
0xC0000000-0xCFFFFFFF	mDNS-based zero-configuration algorithm described above
0xD0000000-0xFEFFFFFF	Reserved for future zero-configuration algorithms
0xFF000000-0xFFFFFFFF	Solicited-node multicast addresses [RFC4291], Section 2.7.1

Uses mDNS to Ensure Group ID Is Unique (1/2)

- DNS uses PTR records to perform reverse lookups. Examples from RFC 8501 (Reverse DNS in IPv6 for Internet Service Providers):
  192.0.2.1 => 1.2.0.192.in-addr.arpa.
  2001:0db8:0f00:0000:0012:34ff:fe56:789a =>
  a.9.8.7.6.5.e.f.f.f.4.3.2.1.0.0.0.0.0.0.0.f.0.8.b.d.0.1.0.0.2.ip6.arpa.
- Proposal uses a PTR record for layer 2 address:
  33:33:CF:ED:24:68 =>
  8.6.4.2.d.e.f.c.3.3.3.3.eth-addr.arpa
- The application uses the mDNS probing algorithm described in RFC6762 section 8.1 to continuously query for a PTR record with the generated string for the name.

Uses mDNS to Ensure Group ID Is Unique (2/2)

- If the probing algorithm completes without any conflict, then the application begins advertising its own PTR record using that name.
- The PTRDNAME field is the concatenation of the device's host name, the colon character (:), and the source port of the multicast stream.
  - Example PTRDNAME: “myhost.local.:56296”
  - Integrating the source port in this manner allows for multiple applications to be on the same host.
- The application should retain the group ID value in long-term storage and use it the next time the multicast stream is transmitted.
  - Conflicts should not be repeated each power cycle.

Thank You!