# ND6 Enhancements

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# Vision

Multi-year project: IPv6 deployment at enterprises.

- Provide training,
- Analysis of security and application conversion,
- Help enterprises plan their IPv6 deployment.

**India Internet Engineering Society (IIESoc) and Industry Network Technology Council (INTC)**

# A few words about me

- President: Industry Network Technology Council
- Founder & CEO: Inside Products, Inc.
- Advisory Board: India Internet Engineering Society
- RFCs: RFC8250 (Embedded performance and diagnostics for IPv6) and others
- Product developer (OEMed by IBM and others)
- Working with IPv6 for 15 years
- Working with network management, diagnostic, performance issues at large brick-and-mortar enterprises for over 30 years

# Thanks to…

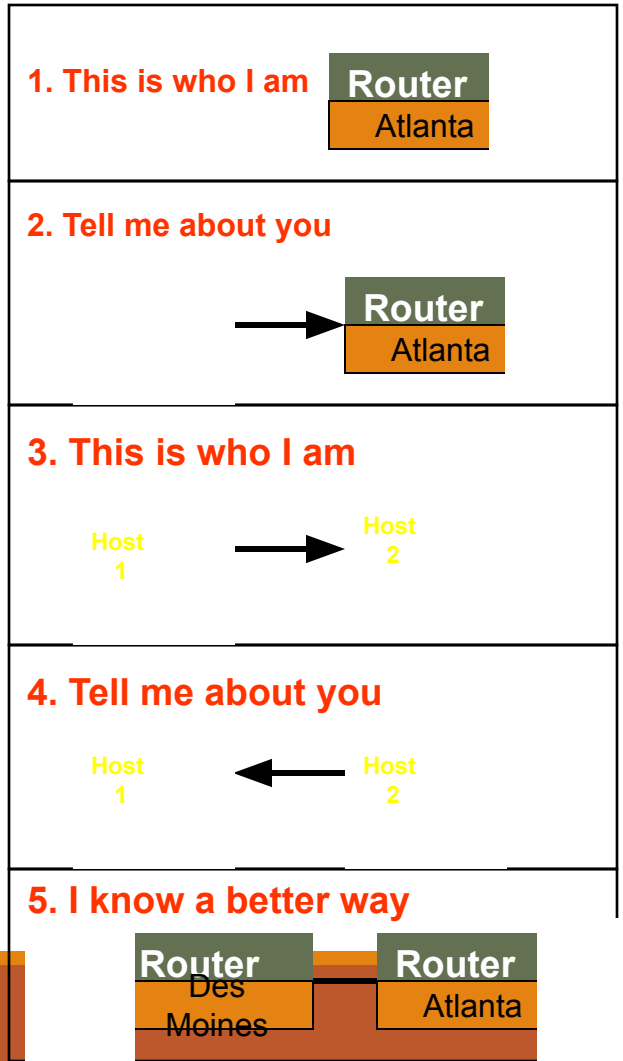


In particular, Dr. Mohit Tahiliani

# Neighbor Discovery

- Neighbor Discovery (ND) replaces ARP
- RFC4861: Neighbor Discovery for IP version 6 (IPv6)
- Used in SLAAC
- Five ICMPv6 message types:

1. *Router Advertisement*
2. *Router Solicitation*
3. *Neighbor Advertisement*
4. *Neighbor Solicitation*
5. *Redirect*



# ND6 Enhancement Project

# Outline

- Team Introduction
- Hypothesis
- Modifications and Benefits
- Implementation
- Demo
- Future work
- Questions

# Team Introduction

- Priyanka
- Advaith
- Kavya
- Sudesh

# Hypothesis

- The number of ND messages will be reduced.  In particular, Neighbor Solicitation messages. This should also reduce power consumption.
- ND messages go out multicast (to entire group) periodically.  Some are only really unicast.
  - Example: NS and DAD
- With our approach, NS will increase in size because we add EARO option.

# Modifications

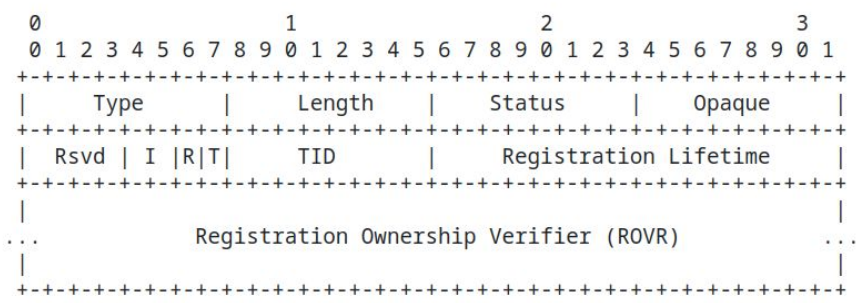
# RFC 6775 and RFC 8505

- **RFC 6775:**
  - Goal: Optimise ND by avoiding multicast flooding.
  - Host initiated interaction.
  - Host address registration feature using a new option(**ARO - Address Registration Option**) in unicast Neighbor Solicitation (NS) and Neighbor Advertisement (NA) messages.
    - Registration lifetime
    - EUI-64 unique identifier
  - **ABRO - Authoritative Border Registration Option**

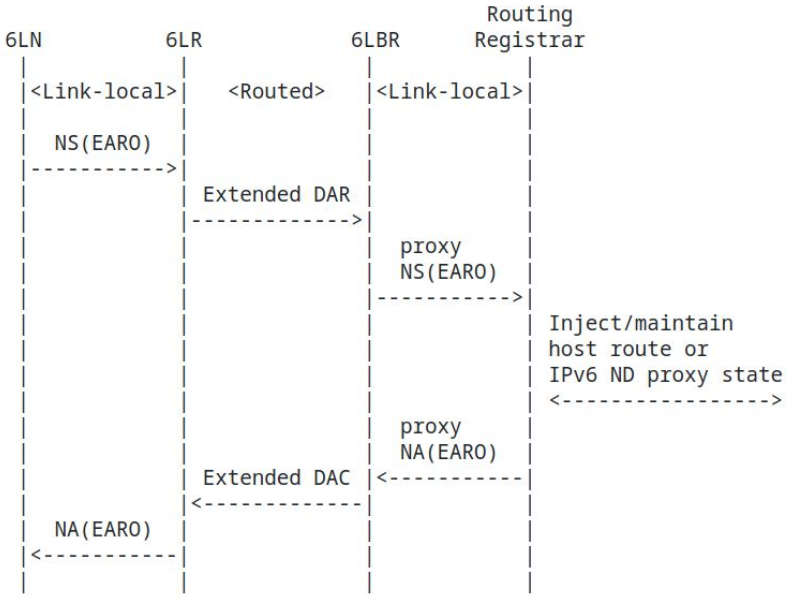
# RFC 6775 and RFC 8505

- **RFC 8505:**
  - Registration extensions on top of RFC 6775.
  - Provision for registration to an IPv6 ND Proxy.
  - **EARO** Option - Extended ARO
    - Registration Lifetime
    - TID - Transaction ID
    - ROVR - Registration Ownership Verifier

# EARO packet for registration




EARO Option Format



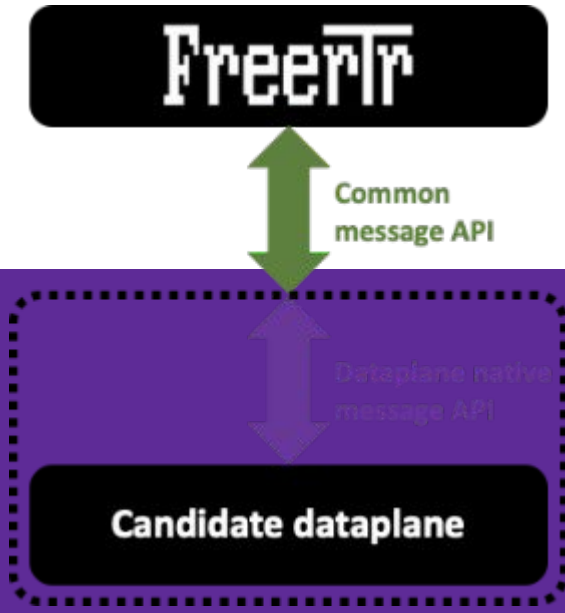

Registration Flow

Source: [RFC 8505]

# Implementation

# Intro to Freertr

- A free, open source, router control plane software.
- Has immense protocol portfolio.
- “One image for all the protocols you'll ever need in routing”
- Currently has been used and developed at RARE (Router for Academia, Research & Education RARE project).
- System independent as it handles packets at the socket level.
- Natively relies on UDP sockets.




Source : Modular Design of Freertr

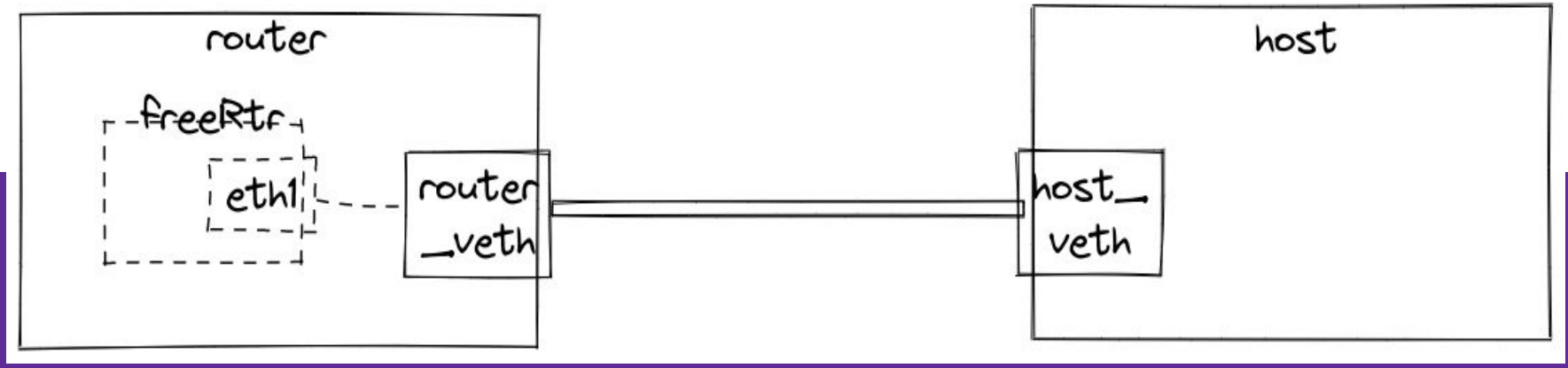
# Testbeds

- FreeRtr on Network namespaces
- FreeRtr on Raspberry Pi
- FreeRtr on Azure
- Testing on actual routers

# Network Namespaces

- Namespaces are like isolated groups inside a system that emulate certain system resources.
- Network namespaces emulate/encapsulate the system resources related to network interfaces(eth0, wlan0), route tables etc.
- By having isolated namespaces within the same system, it helps you try out different configs, like different firewall rules, routing rules etc. which are independent of the underlying host OS.

# FreeRtr setup on network namespaces



# Implementing RFC 8505 in FreeRTR

- Parsing SLLAO, TLLAO and EARO options in ICMPv6 packets.
- Performing neighbor registration and storing it in Router's Neighbor cache according to EARO.
- The neighbor cache entry expiry is set in the registration lifetime field of the EARO option.

# Crafted Packet using Scapy

- Since Kernel changes for RFC 8505 are in progress, we crafted the NS, NA etc. packets in Python using Scapy for testing

```
class ICMPv6NDOptEARO(_ICMPv6NDGuessPayload, Packet):
    name = "ICMPv6 Neighbor Discovery Option - Extended Address Registration Option"
    fields_desc = [ByteField("type", 33),
                   ByteField("len", 2),
                   ByteField("status",0),
                   ByteField("opaque",0),
                   BitField("rsvd",0,4),
                   BitField("I",0,2),
                   BitField("R",0,1),
                   BitField("T",1,1),
                   ByteField("tid",0),
                   NBytesField("registration_lifetime",1,2),
                   EUIField("rovr",b"\x00" * 8)]
```

# Implementation of RFC 8505 in Linux Kernel

- Work in Progress
- Will update you as it happens

# Demo

# Neighbor Table Entries

- On starting the router and checking the Neighbor cache, we find no entries (as expected)

```
r1#show ipv6 neigh eth1
r1#show ipv6 neigh eth1
mac  address  time  registeration_lifetime  static  router

r1#
```

- Now we send a crafted EARO packet to the router from the host to see if the router is able to register the host node.

```
r1#
r1#show ipv6 neigh eth1
r1#show ipv6 neigh eth1
mac             address  time      registeration_lifetime  static  router
0123.4567.89ab  1234::1  00:00:36  65000                   false   false

r1#
```

The node is registered in the router's neighbor cache for 65000 milliseconds. After that time, the cache entry will expire and get deleted.

# Future work

# Future work

- Using transaction ID to re-register the address.
- Border router logic implementation and ABRO parsing.
- Testing on various topologies and testbeds.
- <Kernel chages to be done - @Priyanka>

# Questions

# Thank You!

# Questions?

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