



**RUB**

RUHR-UNIVERSITÄT BOCHUM

# FIRST EXPERIENCES WITH DEPLOYING IPV6-MOSTLY

From the perspective of a University Campus

# Introduction



- Robin Därmann
- Technically responsible for the data network of the Ruhr-University Bochum
- NOC Team with seven members
- Campus network with ~3.000 devices, ~140.000 Ethernet access ports, ~2.600 wireless APs (>1.000 more to come)
- A lot of self-made automation (perl mostly)

# Motivation

- Trying to push IPv6 wherever possible since 2011
- Traditionally, the Dual-Stack approach
- Since 2022 we do some NAT44 because the lack of official IPv4 addresses
- NAT44 with IPv6 in parallel works, but this can be done „better“. Because...

**NOT EVEN A SINGLE IPv4 ADDRESS HAS BEEN SAVED UNTIL NOW!**

# The long way...

- We can't do a hard cut (almost nobody can), so we have to migrate somehow
- „Better“ approach than simply going Dual-Stack would be to force nodes to do IPv6 whenever possible and to avoid NAT44
- NAT64 with DNS64 came to our mind, but it has caveats:
  - Like with NAT44, some protocols need special handling (i.e. IPsec)
  - Communication with IPv4 literals (i.e. `ping 203.0.113.1`) does not work
  - Legacy software wants to use IPv4-only sockets

## ...to IPv6-mostly

- Better approach: 464XLAT (RFC 6877)
  - Uses NAT64 on the provider side (PLAT) and a SIIT translator on the node (CLAT)
  - IPv4 translation to IPv6 directly on the node and back to IPv4 at the provider
  - No manipulated DNS like with DNS64 → no DNSSEC problems
- It also has caveats:
  - Originally designed for Mobile ISPs operating large IPv6-only networks
  - Therefore, some popular operating systems don't support it on WiFi or LAN

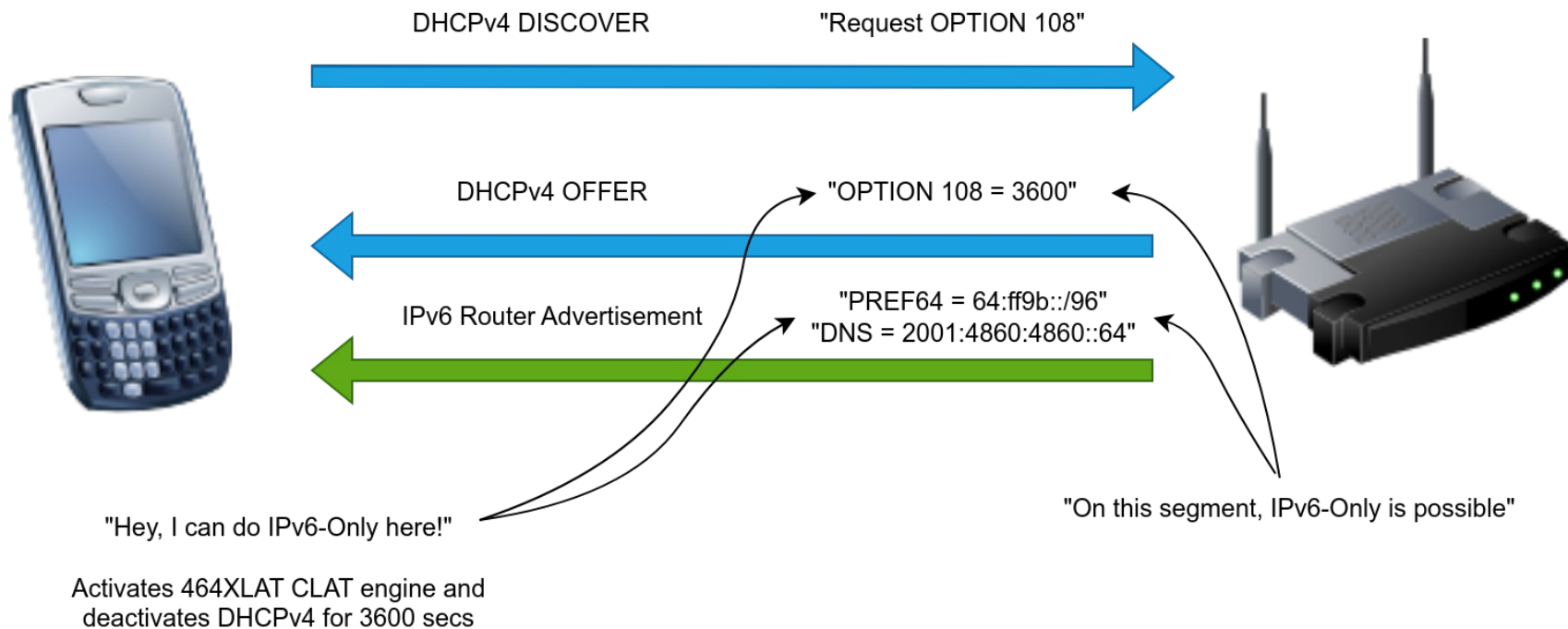
# About IPv6-mostly

- Combination of a DHCPv4 Option, an IPv6 RA Option and NAT64 / 464XLAT
  - RFC 8925: IPv6-Only Preferred Option for DHCPv4
  - RFC 8781: Discovering PREF64 in Router Advertisements
- Saves IPv4 addresses because endpoints can (and will) decide to use only IPv6
- Nodes without support will simply run dual-stack, but with DNS64 most traffic will be IPv6

# How does it work?

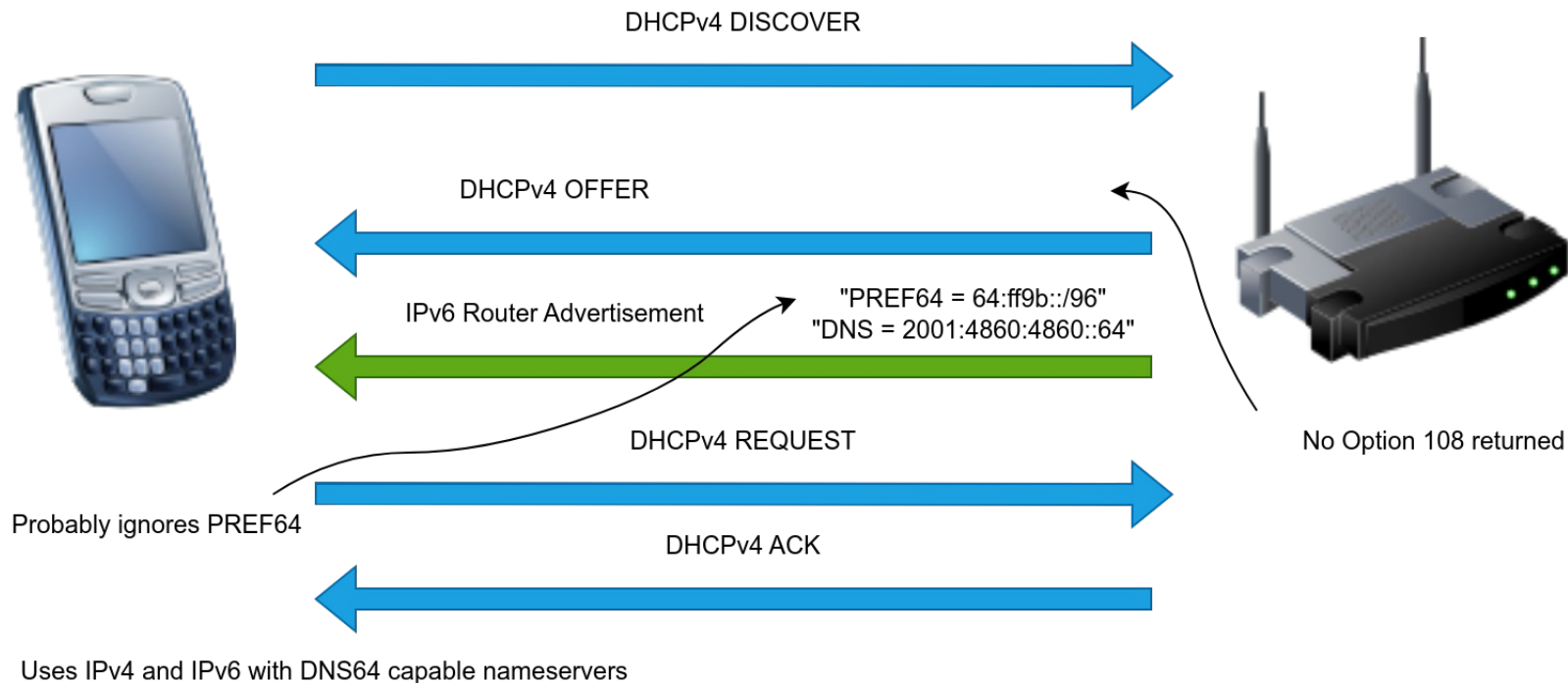
- DHCPv4 option 108 („IPv6-Only Preferred“) is introduced
  - requested in DHCPDISCOVER and DHCPREQUEST by willing DHCPv4 clients
  - sent back in DHCPOFFER by the DHCPv4 server, with a positive integer value
  - → client may disable IPv4 stack for the time specified in the option value (in seconds)
- Router Advertisement Option Type 38 („PREF64“) is introduced
  - sent in Router Advertisements, contains a usable NAT64 prefix
  - Used for local DNS64 and CLAT configuration
  - shares fate with other configuration parameters (i.e. DNS servers)
- Receivment of both option 108 and PREF64 is necessary for IPv6-mostly to work

# Onboarding with support for IPv6-mostly





# Onboarding without support for IPv6-mostly



# Statistics – who requests option 108?

- Campus-wide wireless segment with authentication via Captive Portal
- DHCPDISCOVER captured between and 2023-08-31 and 2023-11-01 (9 weeks)
- 10,794 different MACs / devices in total
  - 7,772 devices requested option 108 in DHCPDISCOVER (72%)
  - 3,022 devices did not request option 108 (28%)

# Statistics – who doesn't want to play along?

- 3,022 devices did not request option 108 (28%)
- Quick check with Fingerbank API showed:
  - 1,932: „Operating System/Windows OS/Microsoft Windows Kernel 10.0“
  - 243: „Operating System/Apple OS“
  - 191: „Operating System/Google OS/Android OS“
  - 128: „Phone, Tablet or Wearable/Generic Android/Samsung Android“
  - 117: „Phone, Tablet or Wearable/Generic Android/Huawei Android“
  - 102: „Operating System/Linux OS“
  - ...
  - 4: „Internet of Things (IoT)/Appliance/iRobot/iRobot Roomba“



# DHCPv4 Server Configuration

- ISC Kea:

```
"subnet4": { "option-data": [ "name": "v6-only-preferred", "data": "3600" ] }
```

- ISC DHCP Server (the older one):

```
option option-108 "3600";
```

- Any other:

- You can send custom option with code 108 and unsigned integer value

# Router Configuration

- Cisco IOS-XE >= 17.11.1:

```
interface Vlan888
  ip address 10.10.10.1 255.255.255.0
  ip helper-address 10.1.1.1
  ipv6 address 2001:db8:1::1/64
  ipv6 nd ra nat64-prefix 64:FF9B::/96
  ipv6 nd ra dns-search-list domain your-domain.tld
  ipv6 nd ra dns server 2001:4860:4860::64
  ipv6 nd ra dns server 2001:4860:4860::6464
```

- Arista EOS >= 4.31.0F:

```
ipv6 nd ra pref64 64:ff9b::/96
```

# Client Configuration / Issues

- Don't set up custom DNS servers
- Don't use multiple IPv6 prefixes as macOS will pick a random one for CLAT, without considering any deprecated or ULA prefix on the interface

# Conclusion

- Next step will be to roll out some wired segments with IPv6-mostly configuration and gather statistics
- Some (all, to be honest) OS vendors should implement the necessary components (464XLAT, CLAT, option 108)
- The numbers are getting better (more than 70% of devices request option 108 already)
- IPv6-mostly is the way to go

# That's it

- Questions?
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