



NAVAL
POSTGRADUATE
SCHOOL

IPv6 Customer Prefix Rotation in a Residential ISP

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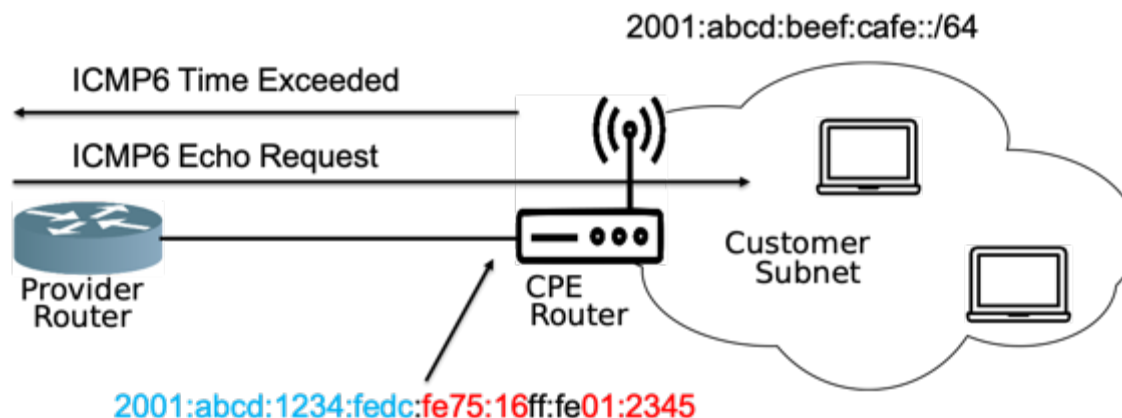
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NPS/CAIDA IPv6 Measurements Workshop

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Common Residential Deployment

- IPv4: Internal network *private*, single public external address
- IPv6:
 - Internal network *routable*, P2P link from provider to CPE
 - CPE is a routed hop
 - P2P subnet may be entirely different than internal subnet!



CPE Addresses

- Our prior CPE discovery work [PAM20]:
 - Found >16M CPE interfaces numbered w/ EUI64
- What's EUI64?
 - RFC 2373: form an IPv6 address using a /64 prefix and host's MAC addresses for lower /64
 - E.g.: MAC 00:11:22:33:44:55 becomes
`2601:c001:d00d:0:0211:22ff:fe33:4455`
- Why are EUI64 CPE interesting?
 - Uniquely identifies CPE
 - We can identify a CPE that has moved to a new prefix
 - E.g., `2601:c001:d00d:42:0211:22ff:fe33:4455`

[PAM20]: Rye & Beverly, “Discovering the IPv6 Network Periphery”

Prefix Rotation

- Our PAM 2020 work provided evidence that providers were *rotating* (in time) P2P subnet
- Have focused on Versatel (.de) where effect is pronounced
- For 106 days, *yarrp*¹ to random target in 45M /64s daily
 - *yarrp* – next-generation active topology mapping tool
- Goal: Hit random target in each /64 daily to track CPE as issued prefixes change over time

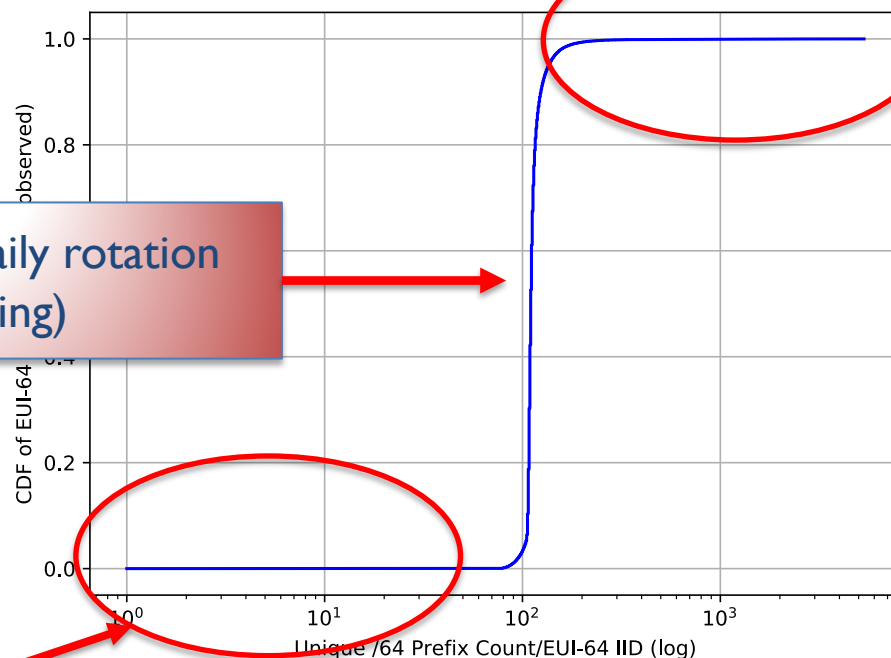
¹ <https://www.cmand.org/yarrp/>

Unique /64 prefixes per EUI-64

- Malfunctioning equipment?
- Unstable power?

- Expected w/ daily rotation (106 days probing)

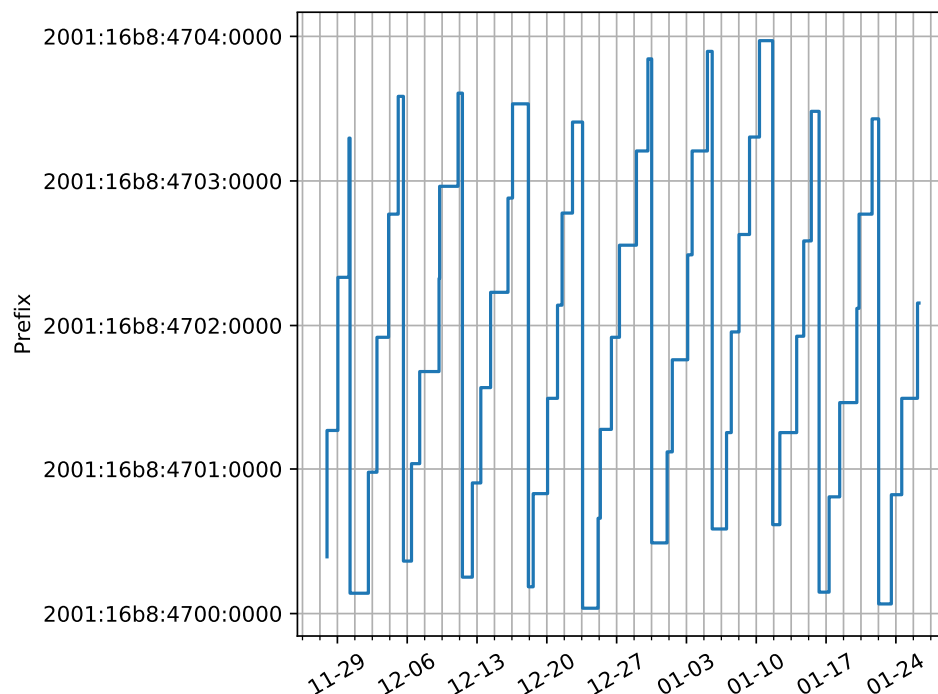
- Device taken offline?
- Cancel service?



Prefix rotation for an EUI-64 IID

Micro-level dynamics:

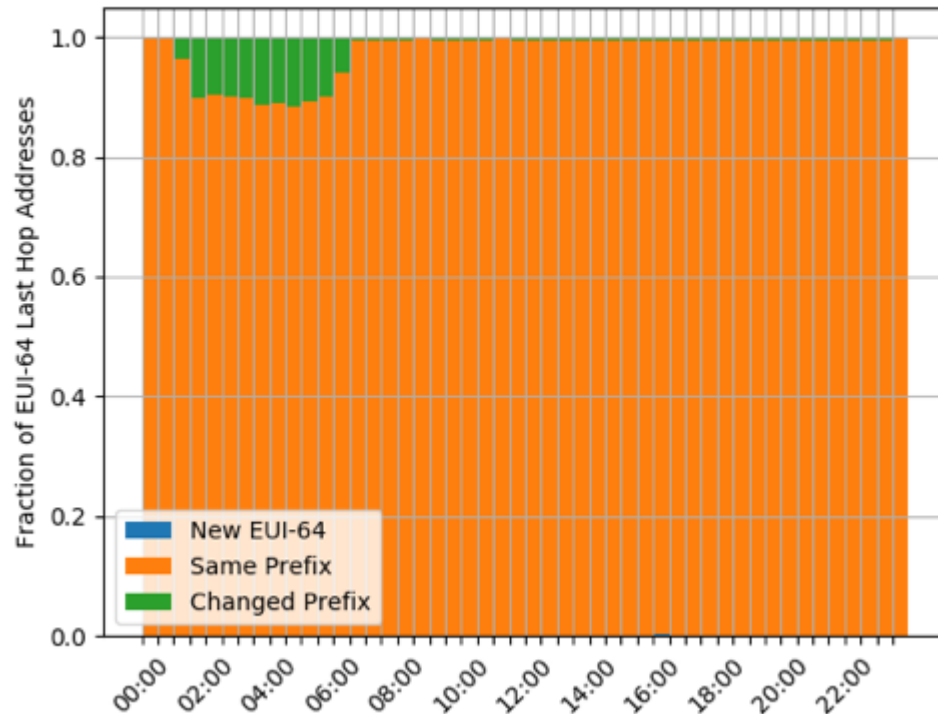
- Plot a single EUI-64's prefixes over time
 - Fritz!Box device
 - 106 days observed
 - 106 distinct /64s, all from single /46
- Observe cyclical pattern in /48s over time
 - Unclear whether pattern in /64s



When do prefixes change?

Macro-level dynamics:

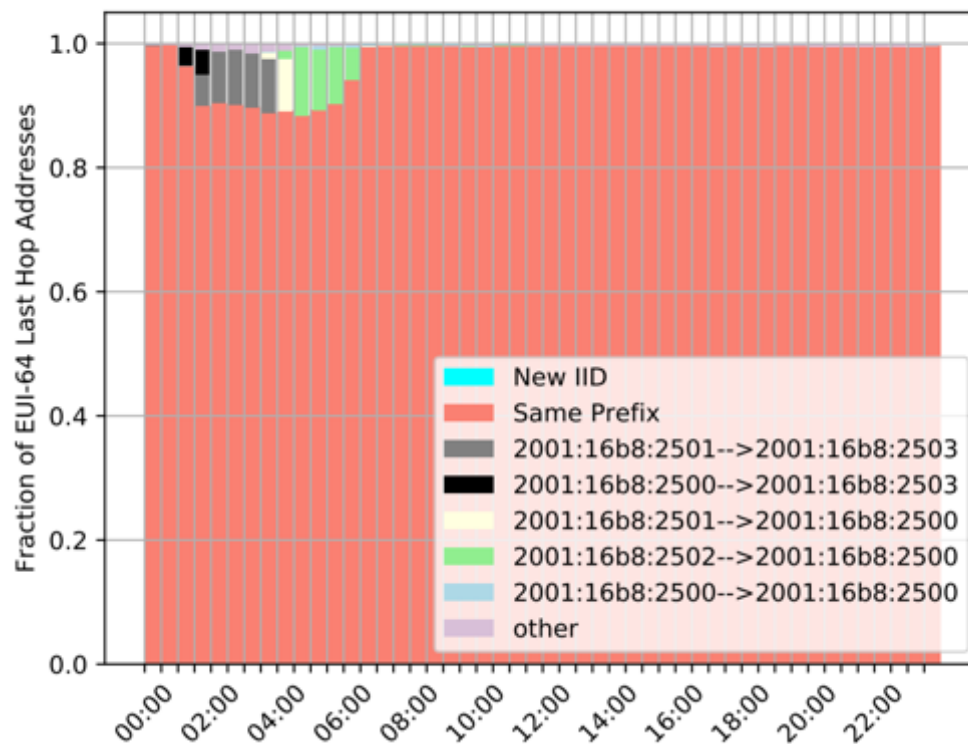
- Empirical data show prefixes drawn from /46, so
 - Probe each /64 in /46
 - Every 30 min
- EUI-64 IID change prefixes between 1 and 6 AM (DE)
- Few (but some) prefix changes happen at other hours
 - Power outage?
 - Reboot?



What prefixes change?

2 June 2020

- Same data, but disaggregate by (to, from) prefixes
- Clear “blocks” of prefixes
 - All addresses in one prefix rotate to same new prefix
 - Blocks rotate at staggered intervals





Questions?

- Is v6 provider->CPE prefix rotation common?
- Why do some CPE and networks use EUI64?
- How do providers implement prefix rotation?

Thanks!

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