ULA in the wild

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ULAs defined

- IANA allocation **`fc00::/7`**
- RFC4193, 2005
  - “approximate counterpart of RFC1918 for IPv6”
  - Not intended to be globally routed
- Two subforms:
  - `fc00::/8` “centrally assigned”
    - No registry currently operating formally
  - `fd00::/8` ‘’locally assigned”
    - Random throw against time, EUI.164 MAC address
  - Goal: unique /48 unlikely to collide with any other consumer (future net mergers, local routing)

Not intended to be globally routed

- Do they leak?
  - Are there places we can see ULA as src address in IPv6 packets on the wire, outside the local context of use?

- Does knowledge of them leak?
  - Are there places we can see ULA referenced as payload in some other transaction?

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  - YES

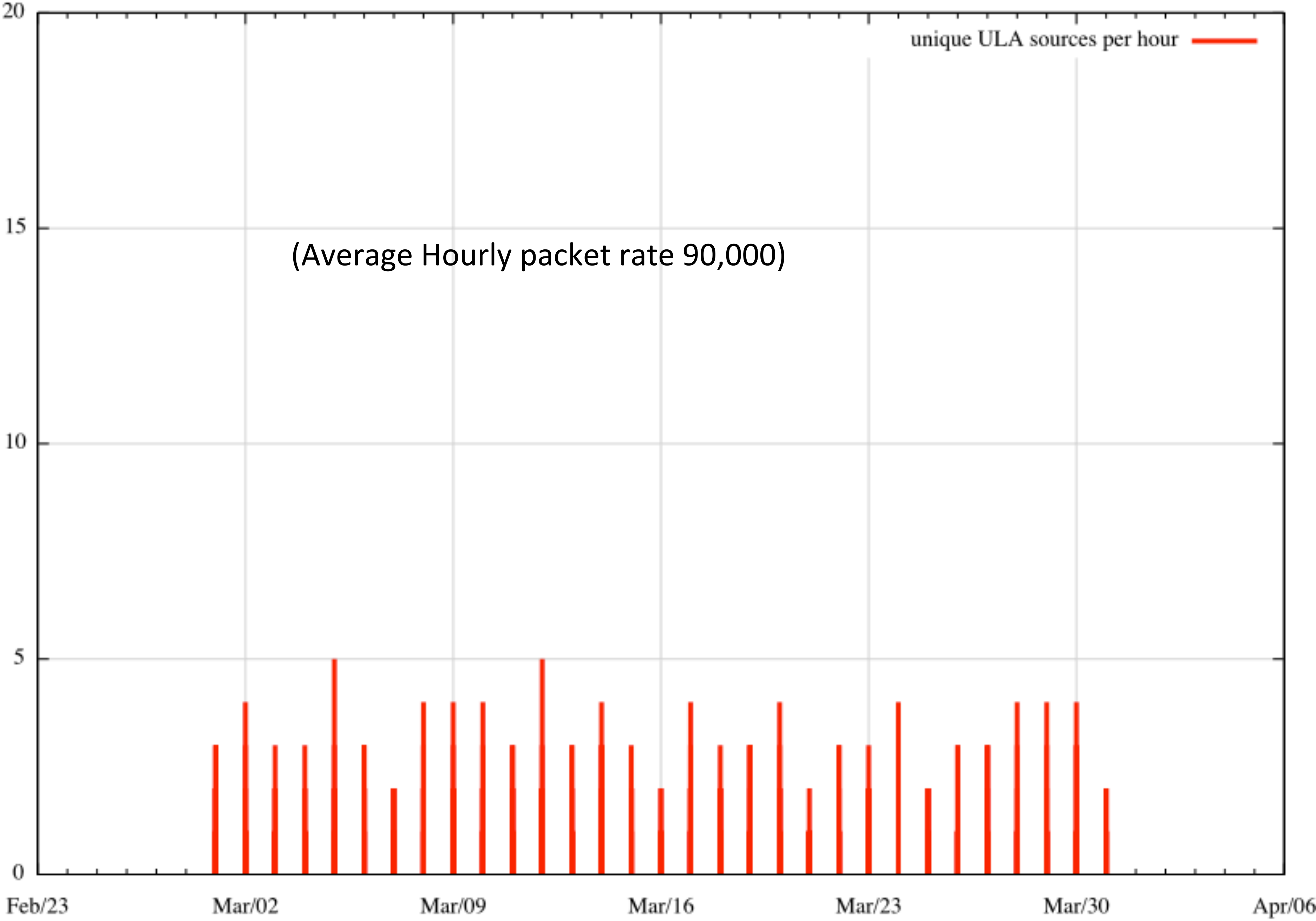
Not intended to be globally routed

- Do they leak?
  - Are there places we can see ULA as src address in IPv6 packets on the wire, outside the local context of use?
  - YES but a very little compared to rfc1918
- Does knowledge of them leak?
  - Are there places we can see ULA referenced as payload in some other transaction?
  - YES quite a lot, and widely distributed

Do they leak?

Do they leak into routing?

- Capture of 2400::/12 prefix via MERIT
  - Comb hourly pcap files for unique ULA instances



(Average Hourly packet rate 90,000)

But…

- That was ‘coerced’ packets with a covering announcement
  - They wouldn’t normally have wound up in the public routing view
- They almost universally relate to one ISP in Indonesia, and are therefore not widespread

Do they leak into routing?

- In-addr.arpa DNS delegation
  - – One of 6 listed NS for in-addr.arpa, ip6.arpa
  - – portspan 24/7 used to feed DiTL, DSC graphs
  - – Count/collect unique src, dst per 24h
  - – 1) do we see any ULA as src addresses?

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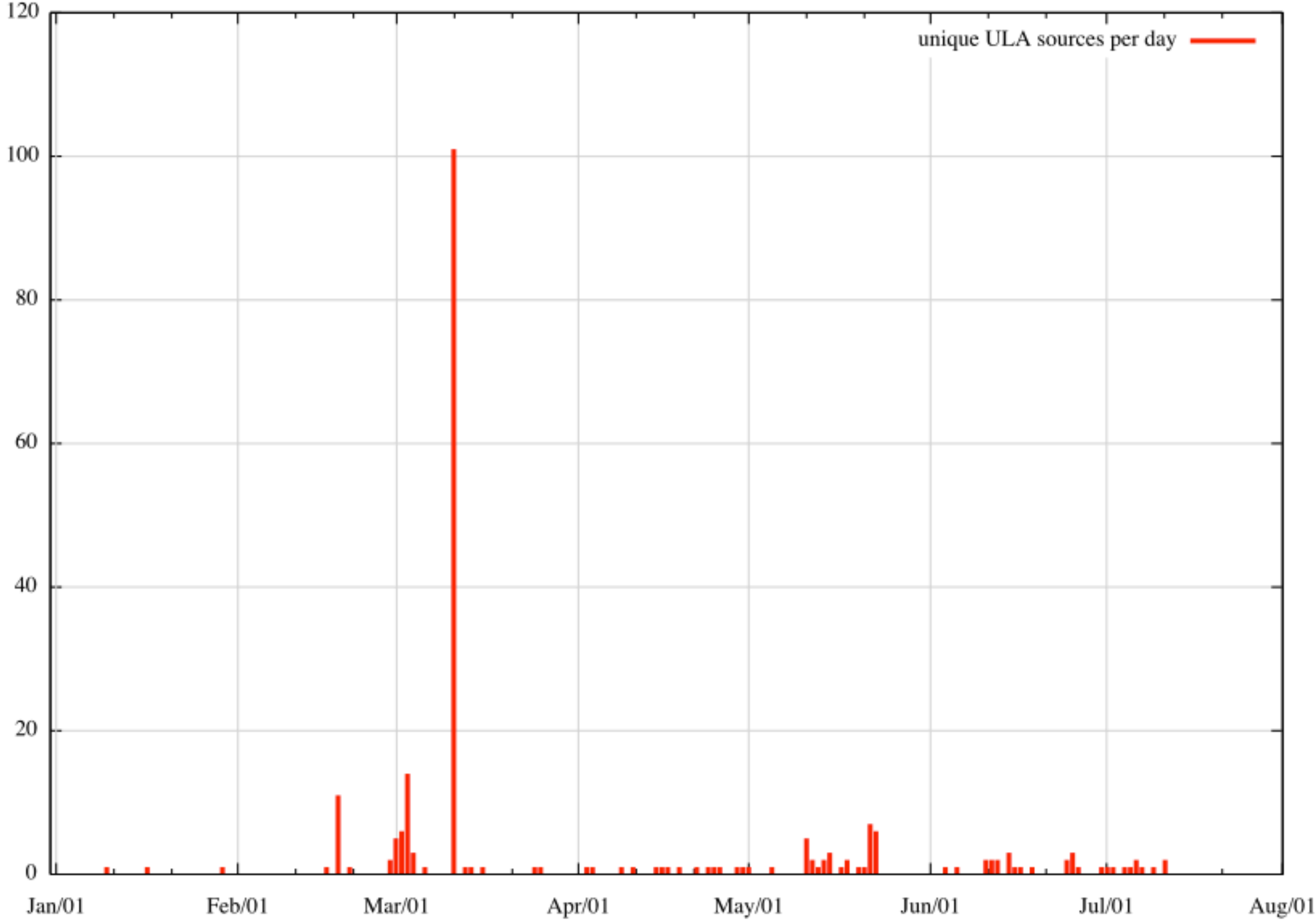
unique ULA sources per day
120
100
80
60
40
20
0
Jan/01
Feb/01
Mar/01
Apr/01
May/01
Jun/01
Jul/01
Aug/01

Low level leakage

- 1-2 ULA prefixes seen per day as source
  - Compared to 50,000 unique IPv6 sources of query
- Occasional peaks
  - Routing slips, acquired default?
- Low level background noise, few DNS questions per src

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- How about the ‘payload’ of DNS reverse questions?
- Hang on
  - Why would anyone do reverse-lookup for IPv6 let alone ULA?

SMTP Received-Via

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```
Received: from ia-mailgw.apnic.net (ia-mailgw.apnic.net. [2001:dd8:a:3::243])
        by mx.google.com with SMTP id wn4si1461945pbc.175.2013.06.20.18.02.16
        for <ggmichaelson@gmail.com>;
        Thu, 20 Jun 2013 18:02:18 -0700 (PDT)
```

- Every email received over IPv6 by an SMTP server appears to add a trace line which depends on gethostbyaddr() call
- If your local SMTP is bound over IPv6 and you are using ULA, its going to do a DNS call.
- If you haven’t delegated ULA locally in DNS, it goes out into the wide blue yonder
- Only a ‘for instance’
  - –SSHD, LPR, other daemons may well log, as may dhcpv6 or ACLs or …

Reverse DNS, one of 6 NS of in-addr.arpa and ip6.arpa

- 350,000,000 queries per day, on the ip6.arpa and in-addr-arpa Nameserver instance we run.
- 500,000 queries into ULA space are currently being seen per day
  - Down from 1,000,000 back in 2011
  - 0.14%
- By contrast global unicast IPv6 query load is now consistently above 1,000,000 queries per day.
- Queries for ULA from > resolvers in 4000 distinct ASN

Top 25 ULA query sources,ip6.arpa

ASN	Name	ASN	Name
174	COGENT Cogent/PSI	4802	ASN-IINET iiNet Limited
209	ASN-QWEST-US NOVARTIS-DMZ-US	6327	SHAW - Shaw Communications Inc.
577	BACOM - Bell Canada	6621	HNS-DIRECPC - Hughes Network Systems
701	UUNET - MCI Communications Services Inc. d/b/a Verizon Business	6830	LGI-UPC Liberty Global Operations B.V.
786	JANET The JNT Association	6939	HURRICANE - Hurricane Electric Inc.
1221	ASN-TELSTRA Telstra Pty Ltd	7018	ATT-INTERNET4 - AT&T Services Inc.
2516	KDDI KDDI CORPORATION	7132	SBIS-AS AS for SBIS-AS
2907	SINET-AS Research Organization of Information and Systems National Institute of Informatics	7922	COMCAST-7922 - Comcast Cable Communications Inc.
3320	DTAG Deutsche Telekom AG	9299	IPG-AS-AP Philippine Long Distance Telephone Company
3356	LEVEL3 Level 3 Communications	15169	GOOGLE - Google Inc.
3462	HINET Data Communication Business Group	17506	UCOM UCOM Corp.
4134	CHINANET-BACKBONE No.31 Jin-rong Street	22773	ASN-CXA-ALL-CCI-22773-RDC - Cox Communications Inc.
4713	OCN NTT Communications Corporation		

Yea but..

- Some of these sources are obviously providing DNS service (8.8.8.8) and its likely they are the visible ‘front’ DNS query for a back-end system.
  - But it still implies quite widespread use of ULA behind these ASN
- Over 4000 ASN seen with some level of ULA query.

Both kinds of ULA

Country and Western

- 870,000 ULA sample

A little bit Country

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  - 8400 in ‘centrally managed’ space (0.96%)

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- How ‘wisely’ do people consume this space?

Centrally managed fc00::/8

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    - There are 2^32 /48 in this /8…

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Centrally managed fc00::/8

- Of 8400 in ‘centrally managed’ space
  - Over 7000 in fc00::
    - There are 2^32 /48 in this /8…
  - Over 2000 in fc00:0000:0000:
    - ‘I didn’t do any random throw. I just took the bottom’
  - When pruned to the /48 equivalent, there appear to be around 250 distinct ULA from this sample.

This is not very wise

- There is no central registry function at this time
- Usage includes fc00:1111 and fc00:1234
- suggests that the choice of /48 is not driven by a strong registry process.
  - more likely is either self-assigned, and so is at risk of colliding
  - or else is a ‘first come first served’ registry service which offers uniqueness within the constraints of how people ask for a ULA at that time.

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Prefix	Count	Prefix	Count
fd00:6587:52d7	198825	fdf1:6dfc:0828	361
fdb2:2c26:f4e4	10867	fdef:7dc7:2e19	337
fd00:0000:0000	8360	fd7f:29be:fce4	334
fd8c:215d:178e	5597	fdef:1729:7999	333
fdbd:0000:0000	4540	fd37:3dd1:7688	330
fd0d:edc3:e12a	948	fde8:e968:28e7	329
fd1e:6d3c:942b	684	fd55:faaf:e1ab	318
fdc2:c837:3301	591	fdb6:4c6e:d6fa	309
fd5e:35a9:696b	470	fd8f:8349:a712	300
fdf1:a35e:8d33	469	fd3d:848e:24be	294
fddb:7f1c:d199	407	fd14:fad0:2c06	289
fd29:41d0:f8c9	375	fdba:1cb5:bb90	285
fd25:81be:cd4f	363		

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fd00:0000:0000	8360	fd7f:29be:fce4	334
fd8c:215d:178e	5597	fdef:1729:7999	333
fdbd:0000:0000	4540	fd37:3dd1:7688	330
fd0d:edc3:e12a	948	fde8:e968:28e7	329
fd1e:6d3c:942b	684	fd55:faaf:e1ab	318
fdc2:c837:3301	591	fdb6:4c6e:d6fa	309
fd5e:35a9:696b	470	fd8f:8349:a712	300
fdf1:a35e:8d33	469	fd3d:848e:24be	294
fddb:7f1c:d199	407	fd14:fad0:2c06	289
fd29:41d0:f8c9	375	fdba:1cb5:bb90	285
fd25:81be:cd4f	363		

Self Assigned fd00::/8

- Two naughty cases, with high levels of usage.
- Majority case is to use the random assignment method
- High levels of usage being seen
- Informal registry service available at sixxs

Seen any from sixxs?

- ‘spin the wheel service’ for your EUI.164
  - http://www.sixxs.net/tools/grh/ula/
- 3000 ULA listed on their ‘whois’ service
  - 20 seen in this capture. Top 3:

ULA prefix	Who	Count from 870,000
fd8c:215d:178e	IBM	5597
fd0d:edc3:e12a	Hughes SE Lab	948
fde9:7537:6abe	Techno hosting	58

Seen any collisions?

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- No

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- No but contextually, hard to prove because the ASN seen asking the question may vary but its no indication it’s a different entity using the same ULA
- Observing the use of the algorithm, it looks unlikely at this level of activity
  - Simple check: 0/1 bias in assigned /48
    - Basically 50:50, slight bias to ones may be from date element in the algorithm.

How do the /128 assign?

- over half the ULA seen appear to be using ff:fe structured MAC addresses for the /128
- By comparison, use of non-privacy mode in global unicast has dropped off significantly
  - Either the processes behind ULA don’t enable temporary/privacy mode
  - Or the time when ULA intrude into gethostbyname() the address selected isn’t privacy mode
  - Or Privacy mode hasn’t spun up yet when ULA is used

Summary

Summary

- ULA usage appears widespread geographically
- ULA usage appears to be stable
- Some ‘unwise’ use of fc00::/8 and fd00::/8 but most assignments honour the unique/random assignment model
- Very little leakage into global routing in this measurement
  - 1-2 instances per DAY seen in 50,000 unique IPv6

ULA here to Stay

- Originally we thought that there was no need for RFC1918 equivalents in IPv6:
  - we would all use provider-based addressing
  - multi-addressing would work
  - and renumbering would be easy

- But as things have turned out folk **do** want a consistent, stable, **internal** address structure independent of external provider prefixes.
- So ULAs have a valued role in the overall IPv6 deployment space, eg in HOMENET