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Do we still need IPv6?

11 April 2019

Do we still need IPv6?

Yes

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Questions?

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Thank You

“Do we still need IPv6?”

Agenda

– Living in a v6 world

– IPv6 Crash Course

– Three key v6 points to remember

Do we still need IPv6?

- World IPv6 Day 06 June 2012
  - IPv4 address exhaustion headlines have been and gone
- But we still all use IPv4
- Major tech companies (twitter) don't have IPv6
- "No one cares about IPv6" - a guy in Sweden Oct 2018
- IPv6 discussion group and advocacy has dried up. UK IPv6 council meeting attendance lower than an unofficial quarterly network automation meetup.
- My IPv6 videos were youtube kryptonite – lowest views on the channel

Explain this

– My mum watches youtube over IPv6

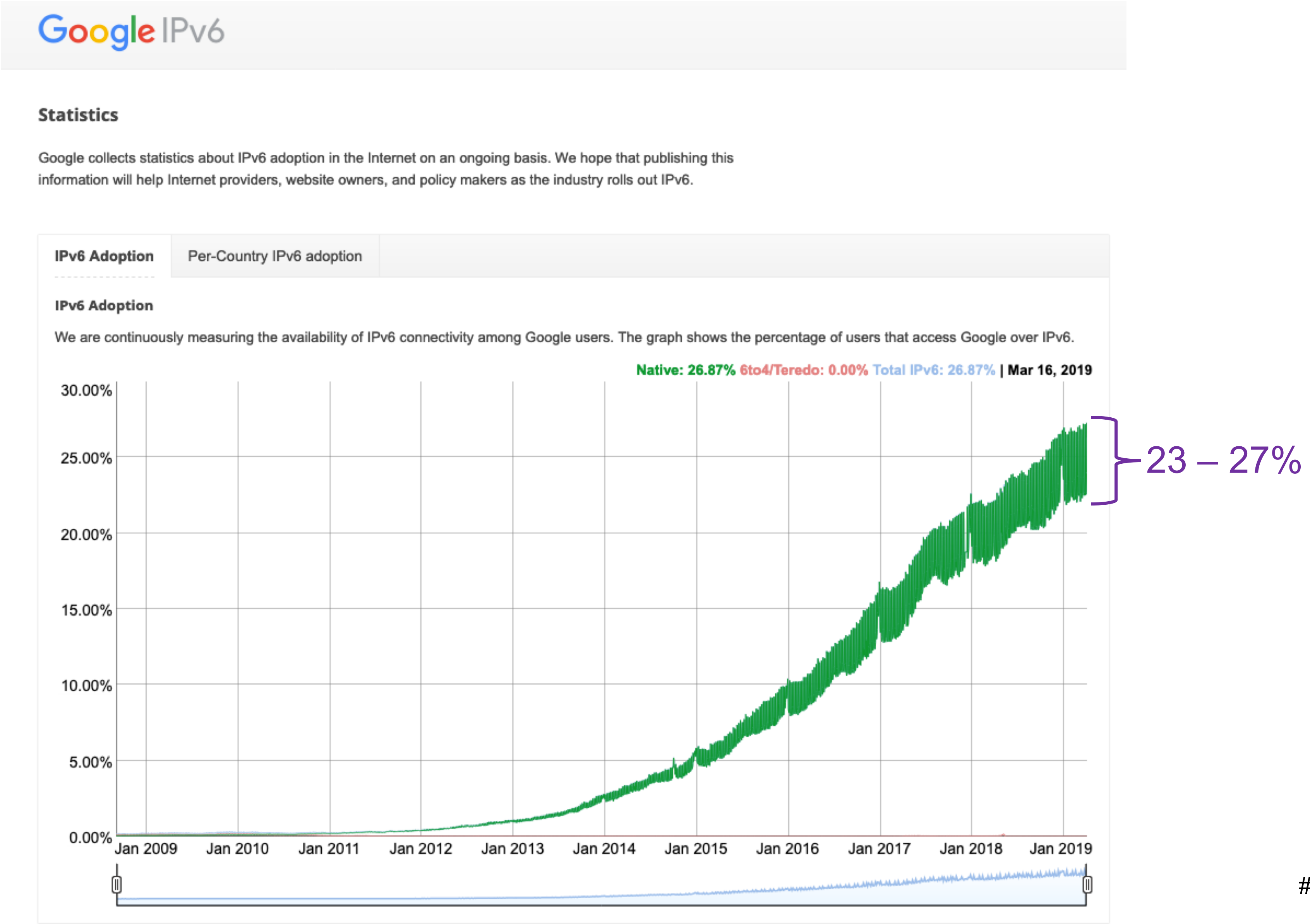
– MSFT tells gamers that IPv6 is preferable over IPv4

What if my Xbox One isn't connected using IPv6?

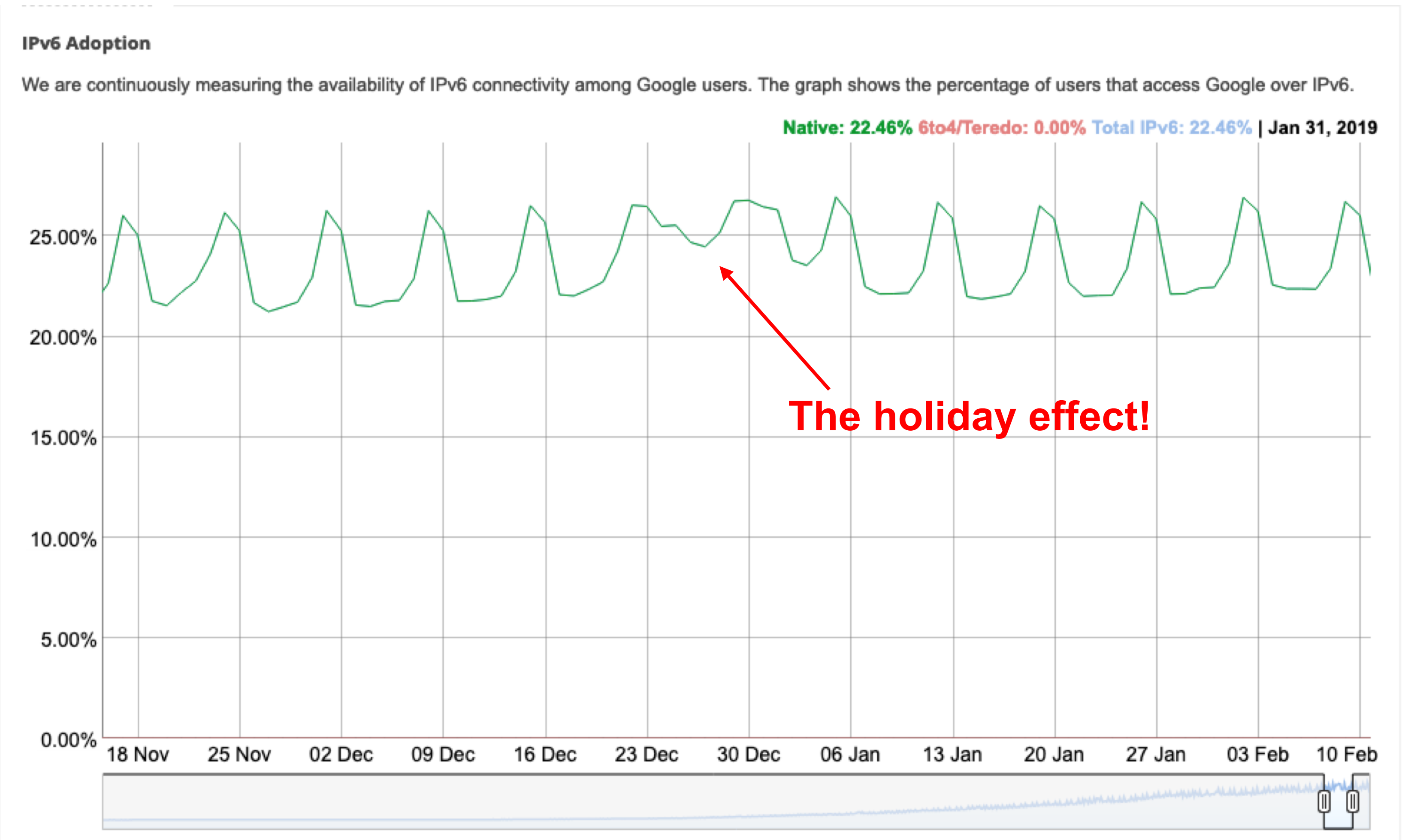
Your Xbox will work normally without IPv6 connectivity. However, for the best possible experience, we recommend enabling IPv6 on your network. Several Xbox One features already make use of IPv6, and we're building more.

– T-Mobile US is IPv6 only

Lies, damn lies, and statistics

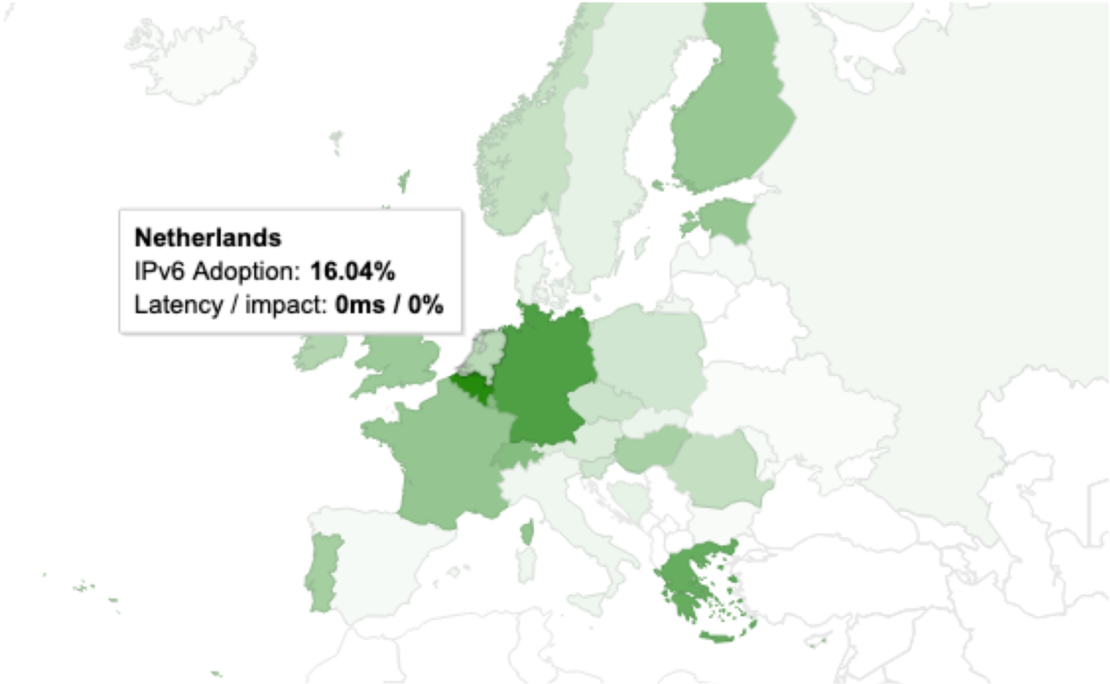


Lies, damn lies, and statistics



Lies, damn lies, and statistics

Per-Country IPv6 adoption



“Livin’ in an IPv6 world”

–IPv6 in the wild:

- Home
- Cloud
- Mobile
- Service Provider
- Content Provider

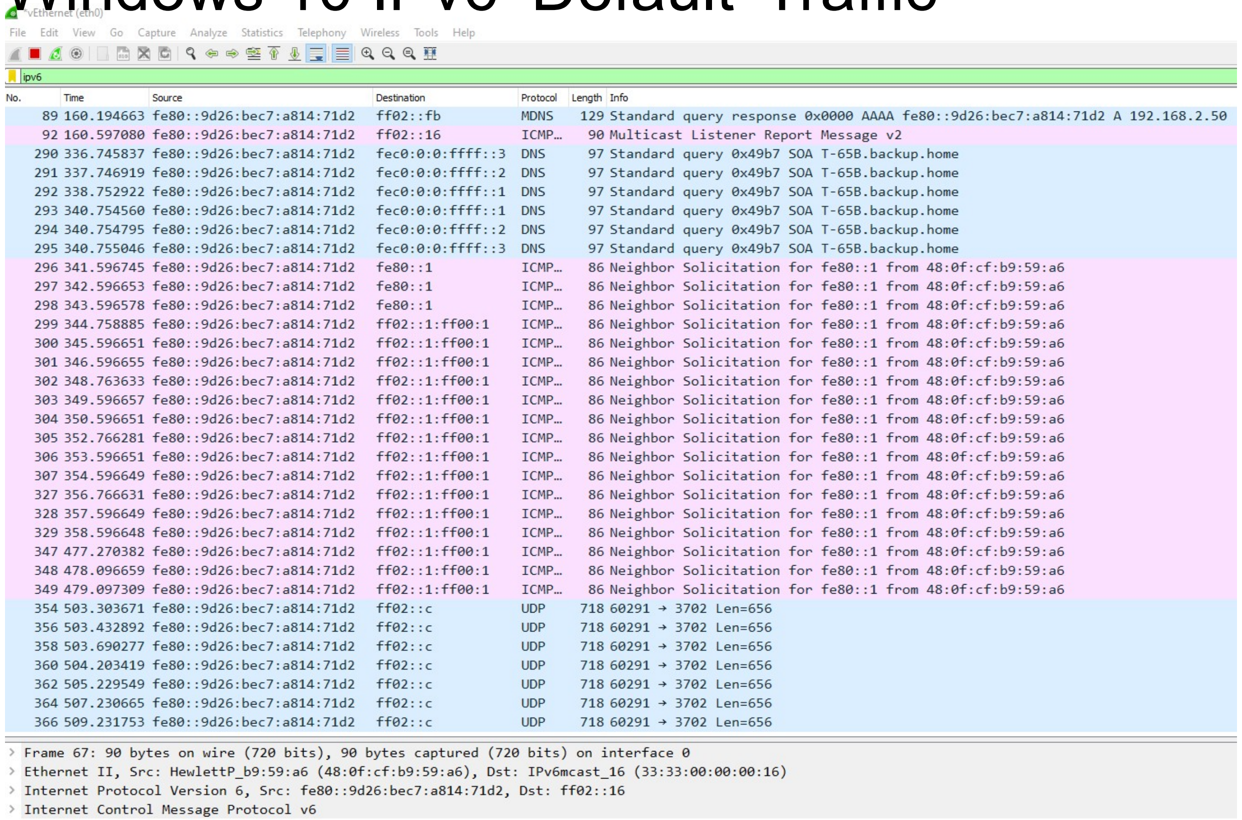
"Yeah, but that's not my network!"

“Yeah but that’s not my network!”

– Don’t be so sure!

- IPv6 has been the preferred protocol in Windows since Vista.
- There are no IPv4 only networks, you have v6 traffic, you just aren't aware.

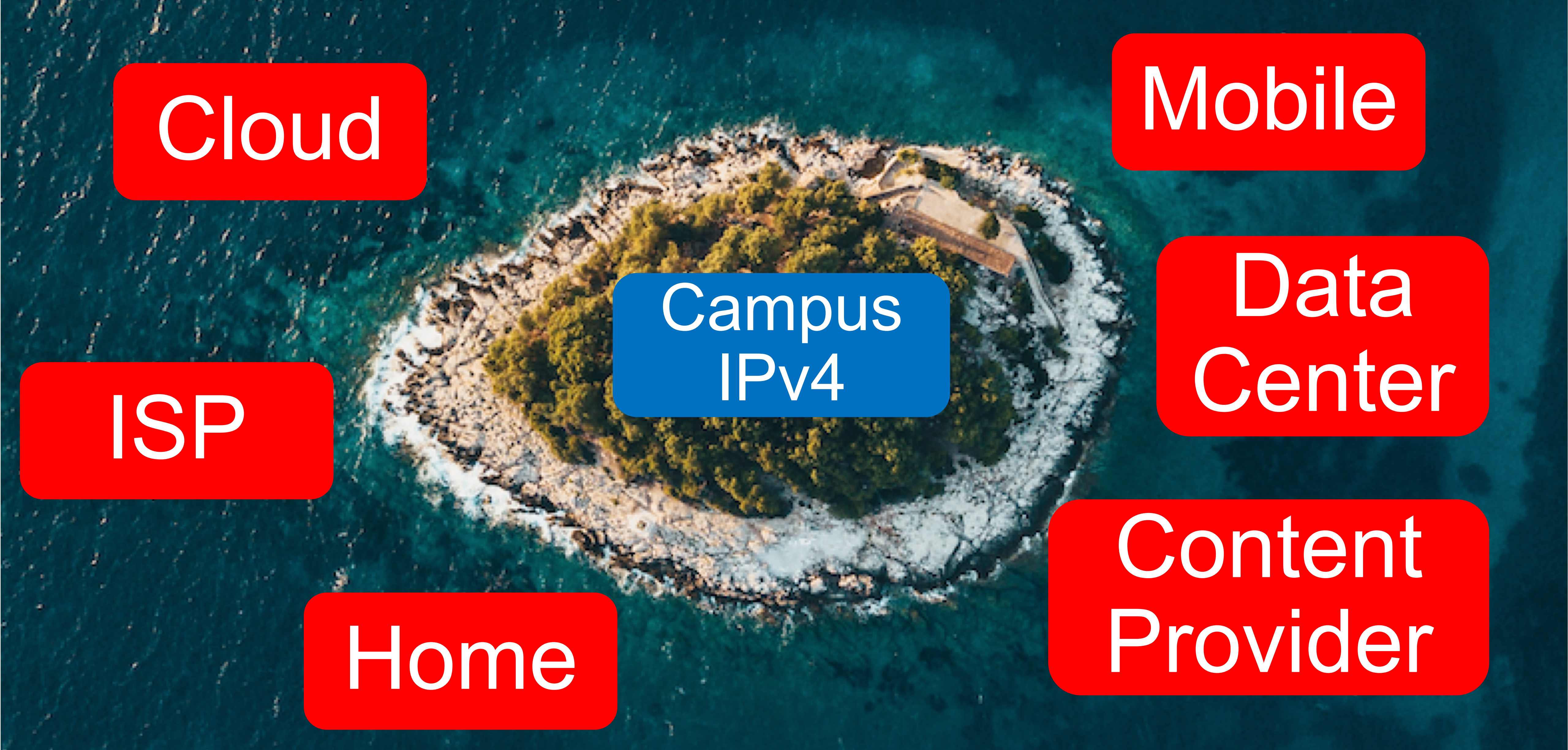
Windows 10 IPv6 ‘Default’ Traffic



No.	Time	Source	Destination	Protocol	Length	Info
89	160.194663	fe80::9d26:bec7:a814:71d2	ff02::fb	MDNS	129	Standard query response 0x0000 AAAA fe80::9d26:bec7:a814:71d2 A 192.168.2.50
92	160.597080	fe80::9d26:bec7:a814:71d2	ff02::16	ICMP…	90	Multicast Listener Report Message v2
290	336.745837	fe80::9d26:bec7:a814:71d2	fec0:0:0:ffff::3	DNS	97	Standard query 0x49b7 SOA T-65B.backup.home
291	337.746919	fe80::9d26:bec7:a814:71d2	fec0:0:0:ffff::2	DNS	97	Standard query 0x49b7 SOA T-65B.backup.home
292	338.752922	fe80::9d26:bec7:a814:71d2	fec0:0:0:ffff::1	DNS	97	Standard query 0x49b7 SOA T-65B.backup.home
293	340.754560	fe80::9d26:bec7:a814:71d2	fec0:0:0:ffff::1	DNS	97	Standard query 0x49b7 SOA T-65B.backup.home
294	340.754795	fe80::9d26:bec7:a814:71d2	fec0:0:0:ffff::2	DNS	97	Standard query 0x49b7 SOA T-65B.backup.home
295	340.755046	fe80::9d26:bec7:a814:71d2	fec0:0:0:ffff::3	DNS	97	Standard query 0x49b7 SOA T-65B.backup.home
296	341.596745	fe80::9d26:bec7:a814:71d2	fe80::1	ICMP…	86	Neighbor Solicitation for fe80::1 from 48:0f:cf:b9:59:a6
297	342.596653	fe80::9d26:bec7:a814:71d2	fe80::1	ICMP…	86	Neighbor Solicitation for fe80::1 from 48:0f:cf:b9:59:a6
298	343.596578	fe80::9d26:bec7:a814:71d2	fe80::1	ICMP…	86	Neighbor Solicitation for fe80::1 from 48:0f:cf:b9:59:a6
299	344.758885	fe80::9d26:bec7:a814:71d2	ff02::1:ff00:1	ICMP…	86	Neighbor Solicitation for fe80::1 from 48:0f:cf:b9:59:a6
300	345.596651	fe80::9d26:bec7:a814:71d2	ff02::1:ff00:1	ICMP…	86	Neighbor Solicitation for fe80::1 from 48:0f:cf:b9:59:a6
301	346.596655	fe80::9d26:bec7:a814:71d2	ff02::1:ff00:1	ICMP…	86	Neighbor Solicitation for fe80::1 from 48:0f:cf:b9:59:a6
302	348.763633	fe80::9d26:bec7:a814:71d2	ff02::1:ff00:1	ICMP…	86	Neighbor Solicitation for fe80::1 from 48:0f:cf:b9:59:a6
303	349.596657	fe80::9d26:bec7:a814:71d2	ff02::1:ff00:1	ICMP…	86	Neighbor Solicitation for fe80::1 from 48:0f:cf:b9:59:a6
304	350.596651	fe80::9d26:bec7:a814:71d2	ff02::1:ff00:1	ICMP…	86	Neighbor Solicitation for fe80::1 from 48:0f:cf:b9:59:a6
305	352.766281	fe80::9d26:bec7:a814:71d2	ff02::1:ff00:1	ICMP…	86	Neighbor Solicitation for fe80::1 from 48:0f:cf:b9:59:a6
306	353.596651	fe80::9d26:bec7:a814:71d2	ff02::1:ff00:1	ICMP…	86	Neighbor Solicitation for fe80::1 from 48:0f:cf:b9:59:a6
307	354.596649	fe80::9d26:bec7:a814:71d2	ff02::1:ff00:1	ICMP…	86	Neighbor Solicitation for fe80::1 from 48:0f:cf:b9:59:a6
327	356.766631	fe80::9d26:bec7:a814:71d2	ff02::1:ff00:1	ICMP…	86	Neighbor Solicitation for fe80::1 from 48:0f:cf:b9:59:a6
328	357.596649	fe80::9d26:bec7:a814:71d2	ff02::1:ff00:1	ICMP…	86	Neighbor Solicitation for fe80::1 from 48:0f:cf:b9:59:a6
329	358.596648	fe80::9d26:bec7:a814:71d2	ff02::1:ff00:1	ICMP…	86	Neighbor Solicitation for fe80::1 from 48:0f:cf:b9:59:a6
347	477.270382	fe80::9d26:bec7:a814:71d2	ff02::1:ff00:1	ICMP…	86	Neighbor Solicitation for fe80::1 from 48:0f:cf:b9:59:a6
348	478.096659	fe80::9d26:bec7:a814:71d2	ff02::1:ff00:1	ICMP…	86	Neighbor Solicitation for fe80::1 from 48:0f:cf:b9:59:a6
349	479.097309	fe80::9d26:bec7:a814:71d2	ff02::1:ff00:1	ICMP…	86	Neighbor Solicitation for fe80::1 from 48:0f:cf:b9:59:a6
354	503.303671	fe80::9d26:bec7:a814:71d2	ff02::c	UDP	718	60291 → 3702 Len=656
356	503.432892	fe80::9d26:bec7:a814:71d2	ff02::c	UDP	718	60291 → 3702 Len=656
358	503.690277	fe80::9d26:bec7:a814:71d2	ff02::c	UDP	718	60291 → 3702 Len=656
360	504.203419	fe80::9d26:bec7:a814:71d2	ff02::c	UDP	718	60291 → 3702 Len=656
362	505.229549	fe80::9d26:bec7:a814:71d2	ff02::c	UDP	718	60291 → 3702 Len=656
364	507.230665	fe80::9d26:bec7:a814:71d2	ff02::c	UDP	718	60291 → 3702 Len=656
366	509.231753	fe80::9d26:bec7:a814:71d2	ff02::c	UDP	718	60291 → 3702 Len=656

> Frame 67: 90 bytes on wire (720 bits), 90 bytes captured (720 bits) on interface 0
> Ethernet II, Src: HewlettP_b9:59:a6 (48:0f:cf:b9:59:a6), Dst: IPv6mcast_16 (33:33:00:00:00:16)
> Internet Protocol Version 6, Src: fe80::9d26:bec7:a814:71d2, Dst: ff02::16
> Internet Control Message Protocol v6

Enterprise Networks – The IPv4 Island



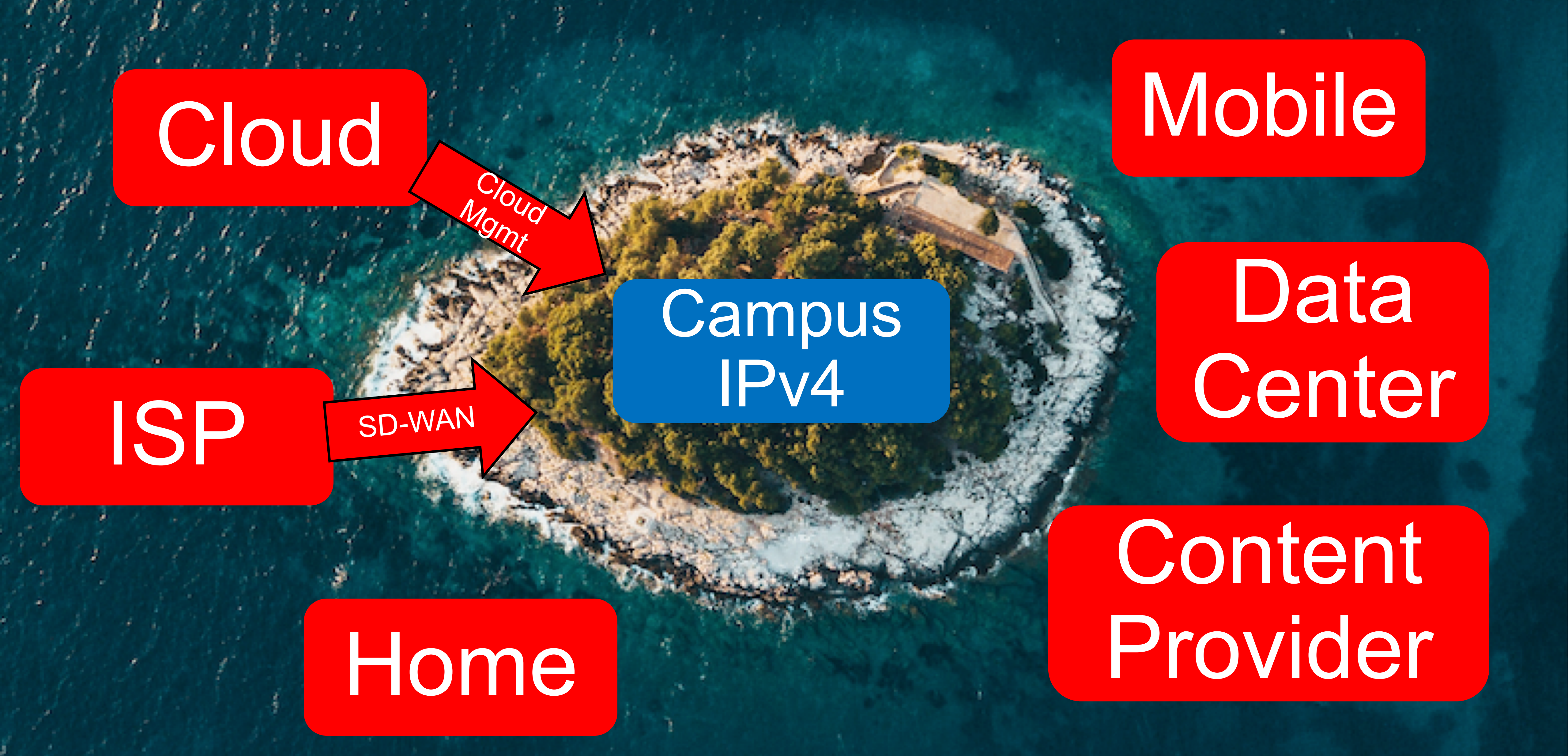
IPv6 Is Unevenly Distributed

–'Early' Adopters:

- – V Large Scale – facing RFC1918 exhaustion
- – Universities – Students need the latest technology in CS Dept, rolls out across campus
- – Industrial – car industry & anyone dealing with IoT at all!

- – This is changing – more requests inbound
- – Some just 'tick box', other genuine.
- – MSFT IPv6 Corp Network project – provides a use case

Networks are changing



Best time to get into IPv6 is yesterday

	Urgent	Not Urgent
Important	Problem	Best to be here
Not Important		

– **Companies**

– Still benefit from being late adopter (let others work out bugs)

– That time is coming to an end

– Certain industries no benefit because must be active (cloud, IoT)

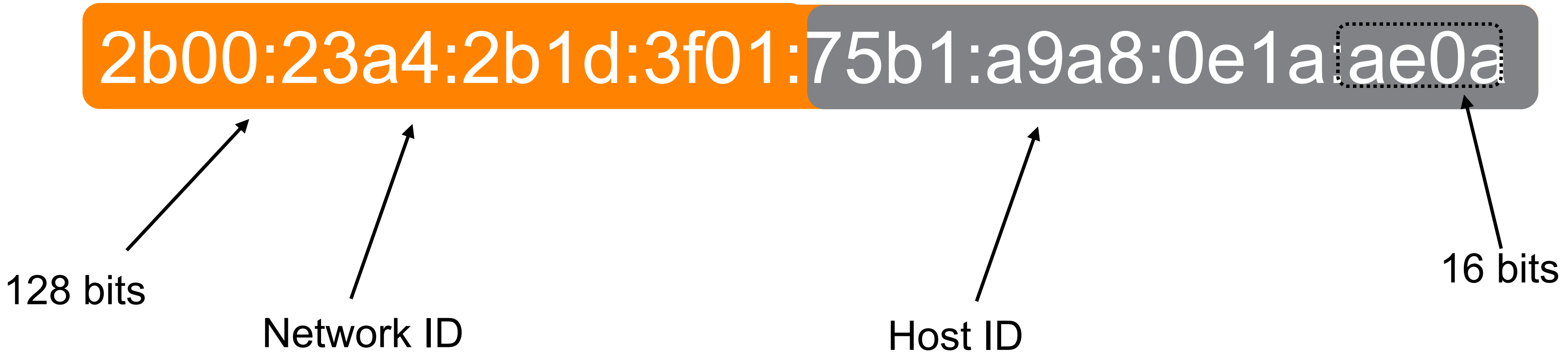
– **Engineers**

– No benefit in waiting

– Increased demand, shortage of skills, higher salary offers (usually).

IPv6 Crash Course

– 128-bits of address space vs. 32 for IPv4



IPv6 Crash Course

– 128-bits of address space vs. 32 for IPv4

Yep, pretty ugly

2b00:23a4:2b1d:3f01:75b1:a9a8:0e1a:ae0a

128 bits

Network ID

Host ID

16 bits

IPv6 Crash Course

– Leading zeros and all zero 16-bits can be abbreviated:

2b00:23a4:2b1d:0001:0000:0000:0000:0001

✂️Snip!

✂️Snip!

IPv6 Crash Course

– Leading zeros and all zero 16-bits can be abbreviated:

2b00:23a4:2b1d:1::1

Not so ugly!

IPv6 Crash Course

- Address planning is very different:
- /64 is the LAN subnet, required for SLAAC
- That’s 18,446,744,073,709,551,616 IPv6 addresses per interface!
- Not need for variable length like v4: /24, /28 etc

- Recommendation: homes assigned /56, allowing 256 LAN segments in every home!
- Typical business: ISP assigns /48. This allows 65,536 LANs!

IPv6 Crash Course

– IPv6 addressing is fundamentally different to IPv4.

– If you see /32 in v4, how many hosts on that subnet can I ping?

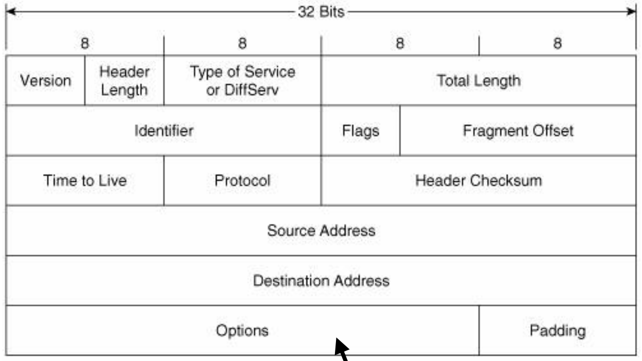
– IPv6 /128 addresses assigned by DHCPv6. Does not indicate number of hosts on subnet to client.

IPv6 Crash Course

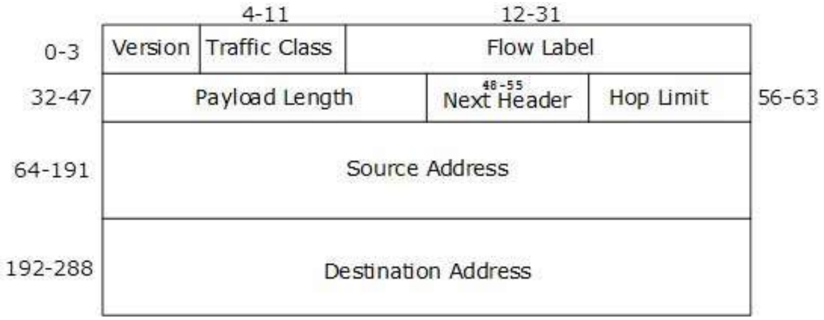
More major differences:

– All-new header

IPv4: 20 – 60 bytes



IPv6 – fixed 40 bytes



What the hell is this anyway?

IPv6 Crash Course

More major differences:

– Extension Headers

Extension Header	Type	Description
Hop-by-Hop Options	0	Options that need to be examined by all devices on the path.
Destination Options (before routing header)	60	Options that need to be examined only by the destination of the packet.
Routing	43	Methods to specify the route for a datagram (used with Mobile IPv6).
Fragment	44	Contains parameters for fragmentation of datagrams.
Authentication Header (AH)	51	Contains information used to verify the authenticity of most parts of the packet.
Encapsulating Security Payload (ESP)	50	Carries encrypted data for secure communication.
Destination Options (before upper-layer header)	60	Options that need to be examined only by the destination of the packet.
Mobility (currently without upper-layer header)	135	Parameters used with Mobile IPv6.
Host Identity Protocol	139	Used for Host Identity Protocol version 2 (HIPv2).[11]
Shim6 Protocol	140	Used for Shim6.[12]
Reserved	253	Used for experimentation and testing.[13][4]
Reserved	254	Used for experimentation and testing.[13][4]

Source: https://en.wikipedia.org/wiki/IPv6_packet

IPv6 Crash Course

More major differences:

– No more ARP!

– Neighbor Discovery Protocol

Router Solicitation (Type 133)

Hosts inquire with Router Solicitation messages to locate routers on an attached link.[3] Routers which forward packets not addressed to them generate Router Advertisements immediately upon receipt of this message rather than at their next scheduled time.

Router Advertisement (Type 134)

Routers advertise their presence together with various link and Internet parameters either periodically, or in response to a Router Solicitation message.

Neighbor Solicitation (Type 135)

Neighbor solicitations are used by nodes to determine the link layer address of a neighbor, or to verify that a neighbor is still reachable via a cached link layer address.

Neighbor Advertisement (Type 136)

Neighbor advertisements are used by nodes to respond to a Neighbor Solicitation message.

Redirect (Type 137)

Routers may inform hosts of a better first hop router for a destination.

Source: https://en.wikipedia.org/wiki/Neighbor_Discovery_Protocol

IPv6 Crash Course

More major differences:

– Forget 1 interface = 1 address

– Multiple addresses per interface are encouraged!

  – Link-local
  – Global Unicast
  – Privacy Extensions
  – ULA (?)

IPv6 - Three to remember

Key points:

1. Address Allocation
2. Dual-stack hardware exhaustion
3. First Hop Security

1. IPv6 Address Allocation – Many Moving Parts

IPv4:

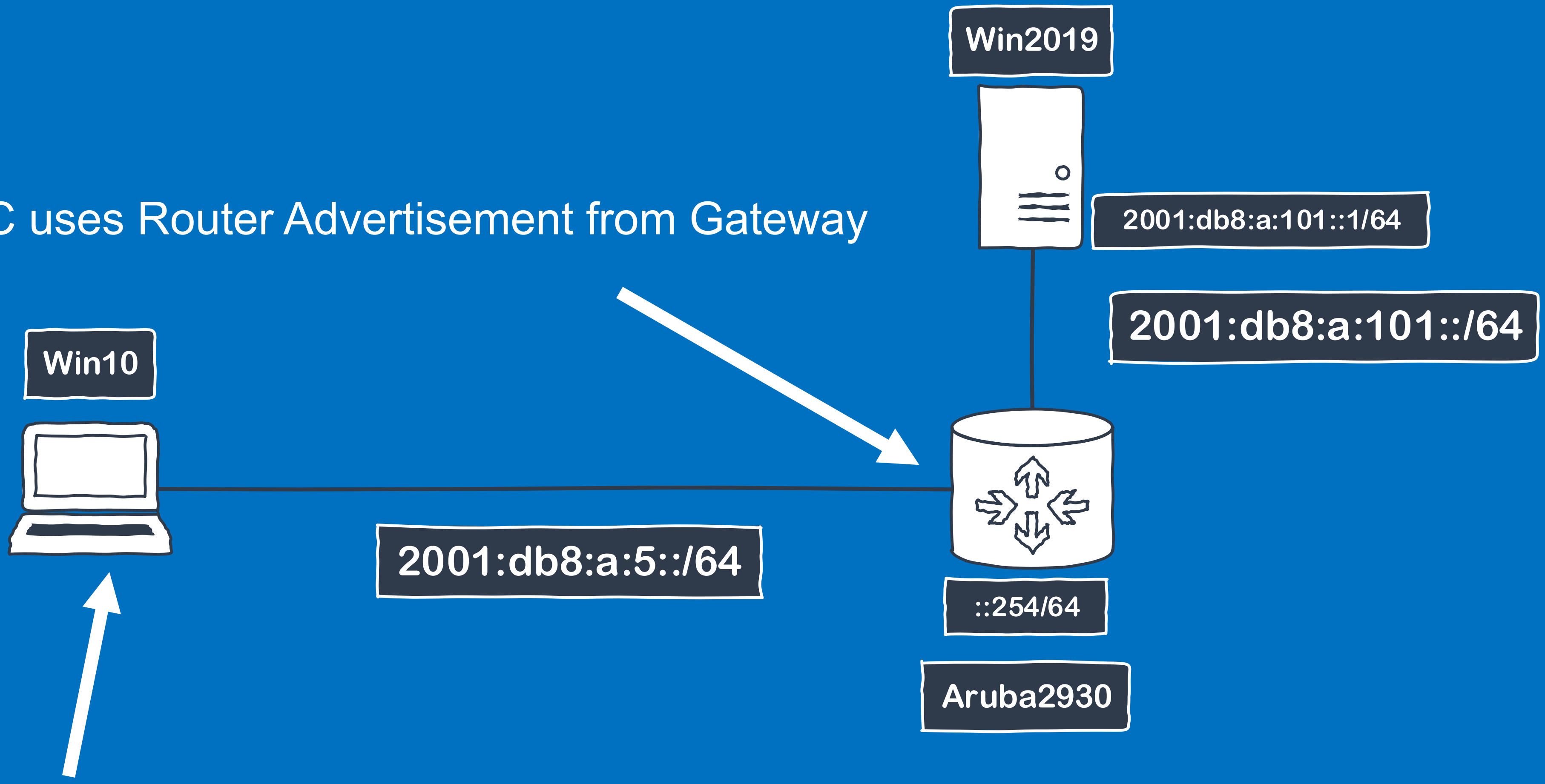
1. Static & DHCPv4
2. DHCPv4 options contain DNS servers and Default Gateway

IPv6:

1. Stateless AutoConfiguration – SLAAC
2. DHCPv6 Stateful – Address and Other info (DNS)
3. DHCPv6 Stateless – Address from SLAAC, other info from DHCPv6 server
4. Static

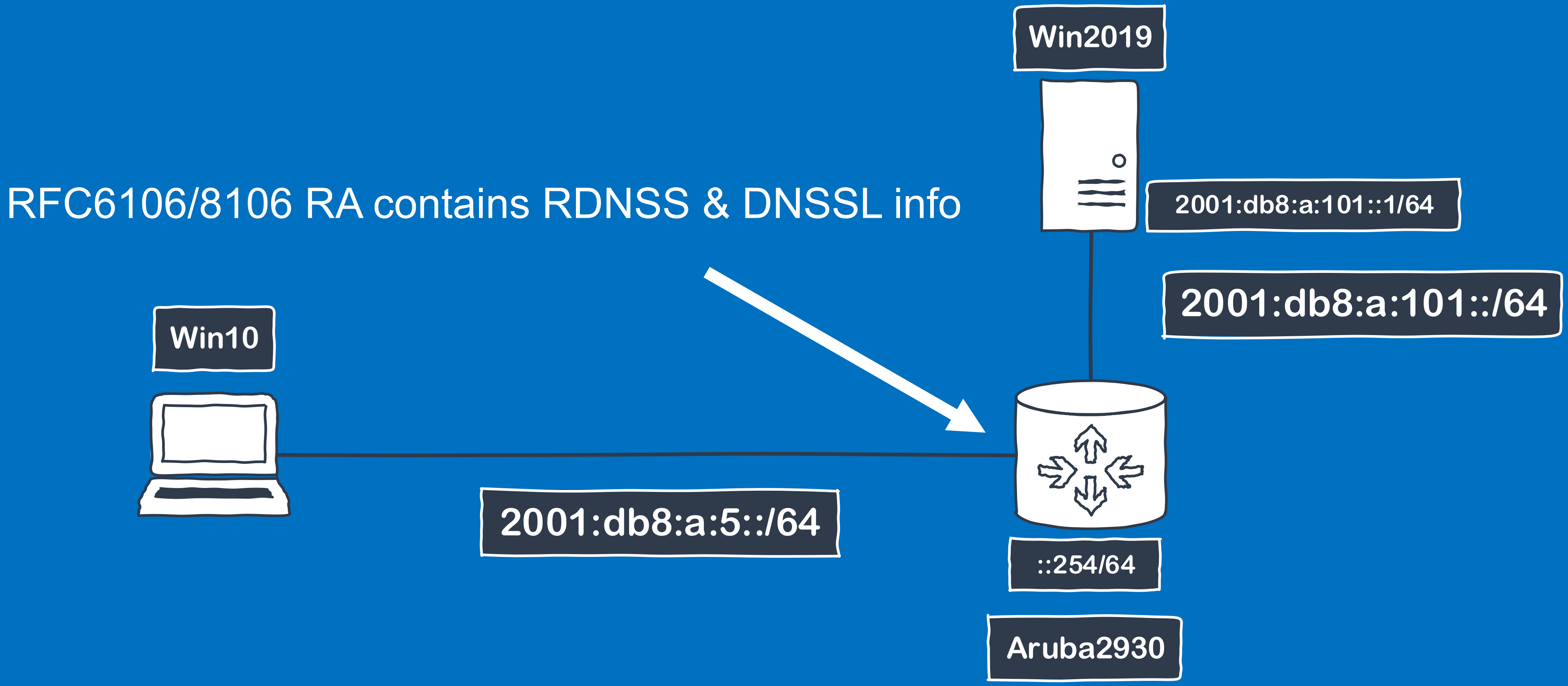
SLAAC

SLAAC uses Router Advertisement from Gateway



Client generates the host ID 64-bits

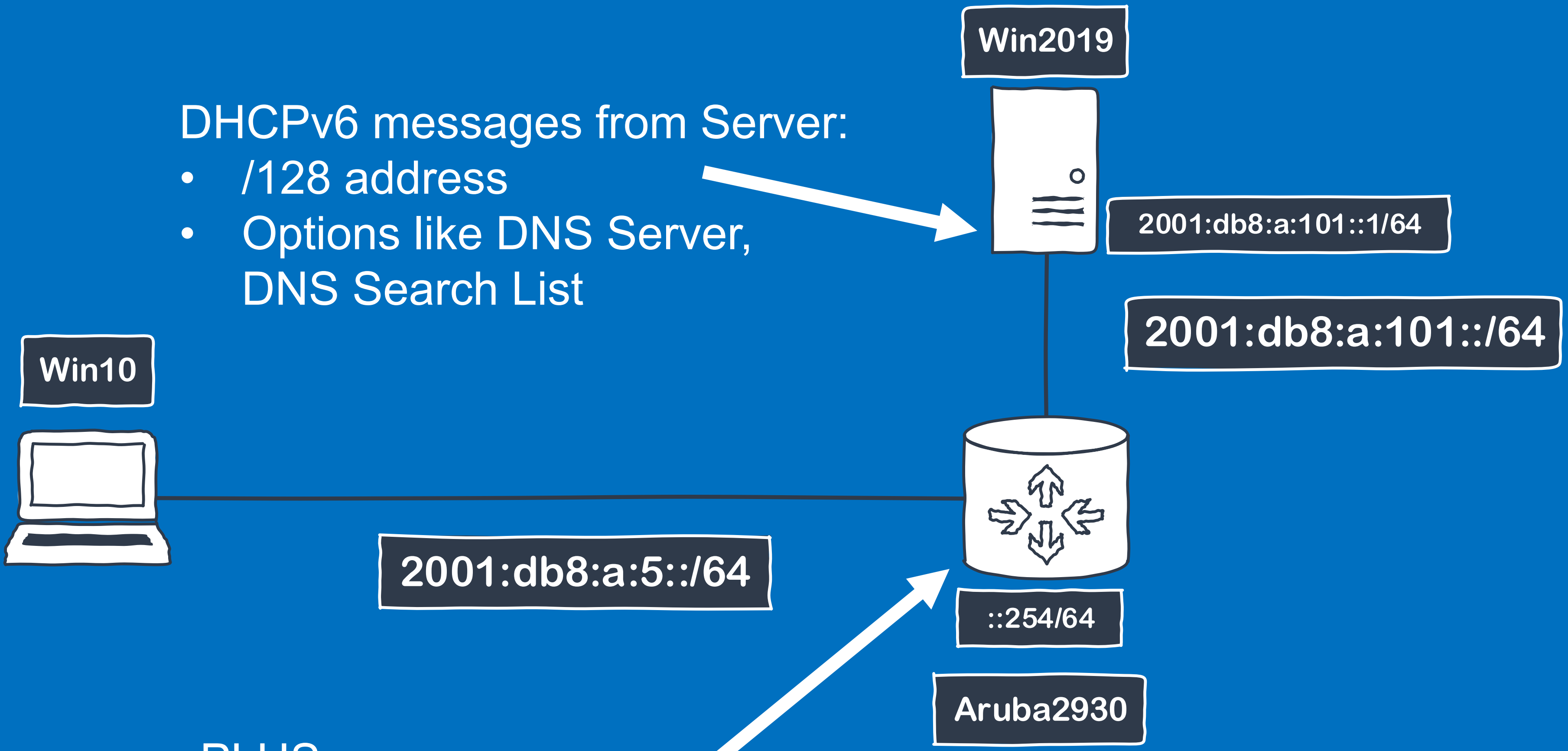
SLAAC


Win2019
2001:db8:a:101::1/64
RFC6106/8106 RA contains RDNSS & DNSSL info
2001:db8:a:101::/64
Win10
2001:db8:a:5::/64
::254/64
Aruba2930

DHCPv6 Stateful

DHCPv6 messages from Server:

- /128 address
- Options like DNS Server, DNS Search List



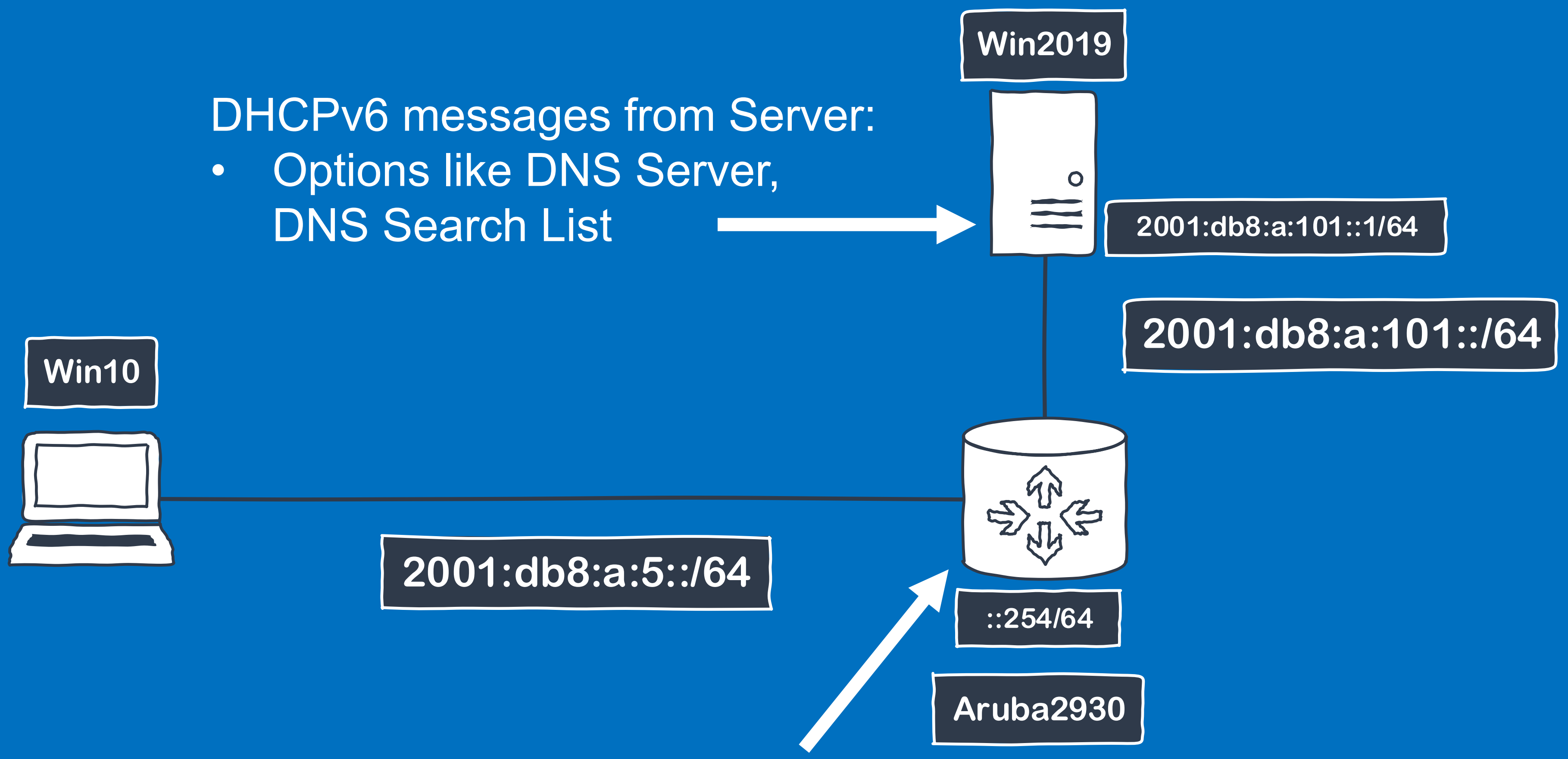
PLUS
RA for default gateway!!

DHCPv6 Stateless

DHCPv6 messages from Server:

- Options like DNS Server, DNS Search List

RA for prefix and default gateway!!




STOP!

IPv6 Address Allocation Issues!

SLAAC Issues:

– RFC6106 support is not universal.

– Windows Creator Update and later (1703).

– Sidenote – 2018 German uni was talking about WinsXP client on their network

IPv6 Address Allocation Issues!

DHCPv6 NOT SUPPORTED ON ANDROID

- This is by design
- Issue tracker opened June 2012: https://issuetracker.google.com/issues/36949085
- 277 comments, no change
- Impacts address allocation – many go with SLAAC & DHCPv6

That leads us on to point 2…

2. Dual-stack hardware exhaustion

IPv4:

1. Usually one address per host

IPv6:

1. Multiple prefixes per interface by design
2. DHCPv6 = 2 prefixes, 1 link-local, 1 GUA
3. SLAAC = 3 prefixes, 1 link-local, 2 GUA
4. Mixed OS environment: 4 prefixes or more!
5. IPv6 addresses take up more resources!

Impacts the networking hardware resources, only have finite routing and IPv6 neighbour tables.

Dual-stack makes this even worse!

3. First Hop Security

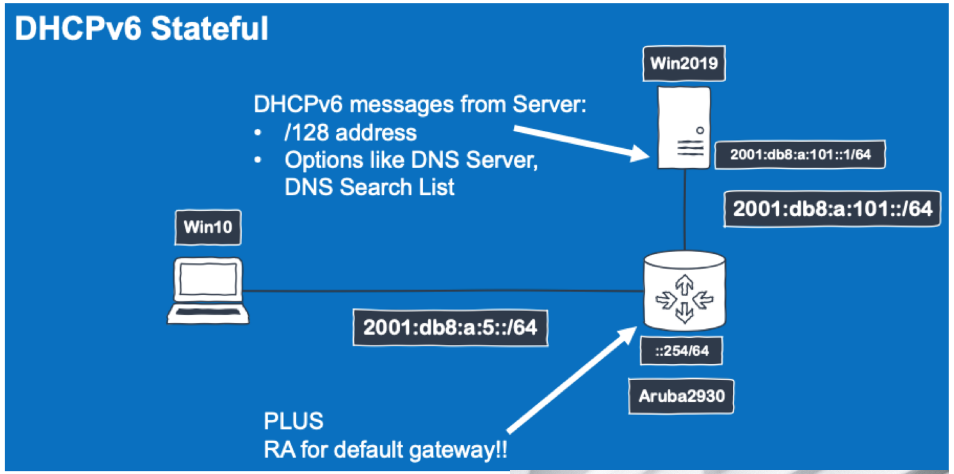
New Attack Vectors

- All those options, packets and the whole new NDP create new opportunities for exploits.
- Spoofing DHCPv6 and NDP pkts for man-in-the-middle & DoS attacks.
- RA is like the crown jewels of the LAN network – crucial because it controls addressing and the default gateway!

Mitigation tools like RA Guard are fundamental requirements.

As is a IPv6 specific security plan.

Understanding IPv6 is vital to understanding how to secure it!



Black hoodie.
Hacker confirmed!

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Aruba & IPv6

IPv6 Open for Business

- IPv6 supported on switching ArubaOS-Switch, CX and AOS8
- Live IPv6 deployments across the globe, airheads ‘pink’ series focused on Wins and v6 wired.
- Campus WLAN installs add the controller & AP provisioning.
- Currently involved in AOS8 IPv6 only POC. Look out for future content.

IPv6

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Questions?

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Thank You