DNS and IPv6 (and some IPv4 depletion stats)

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Privately funded, Colorado-based corporation, founded in 2002

Focused on making the DNS trustworthy and secure

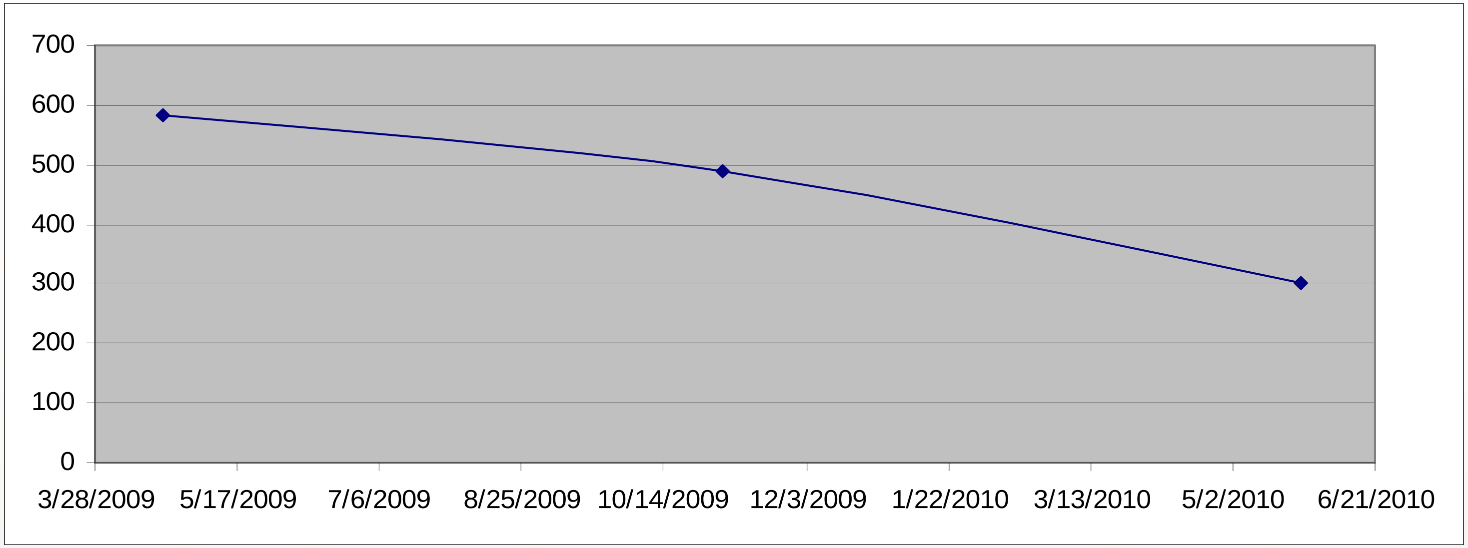
Secure64 products: ‘DNS Authority’, ‘DNS Signer’ & ‘DNS Cache’

All our products are IPv6 ready

Topics For Today

- Some IPv4 depletion statistics
- Quick primer on the DNS and IPv6
- A few real-world DNS operational issues
- A surprise benefit of IPv6 against cache poisoning

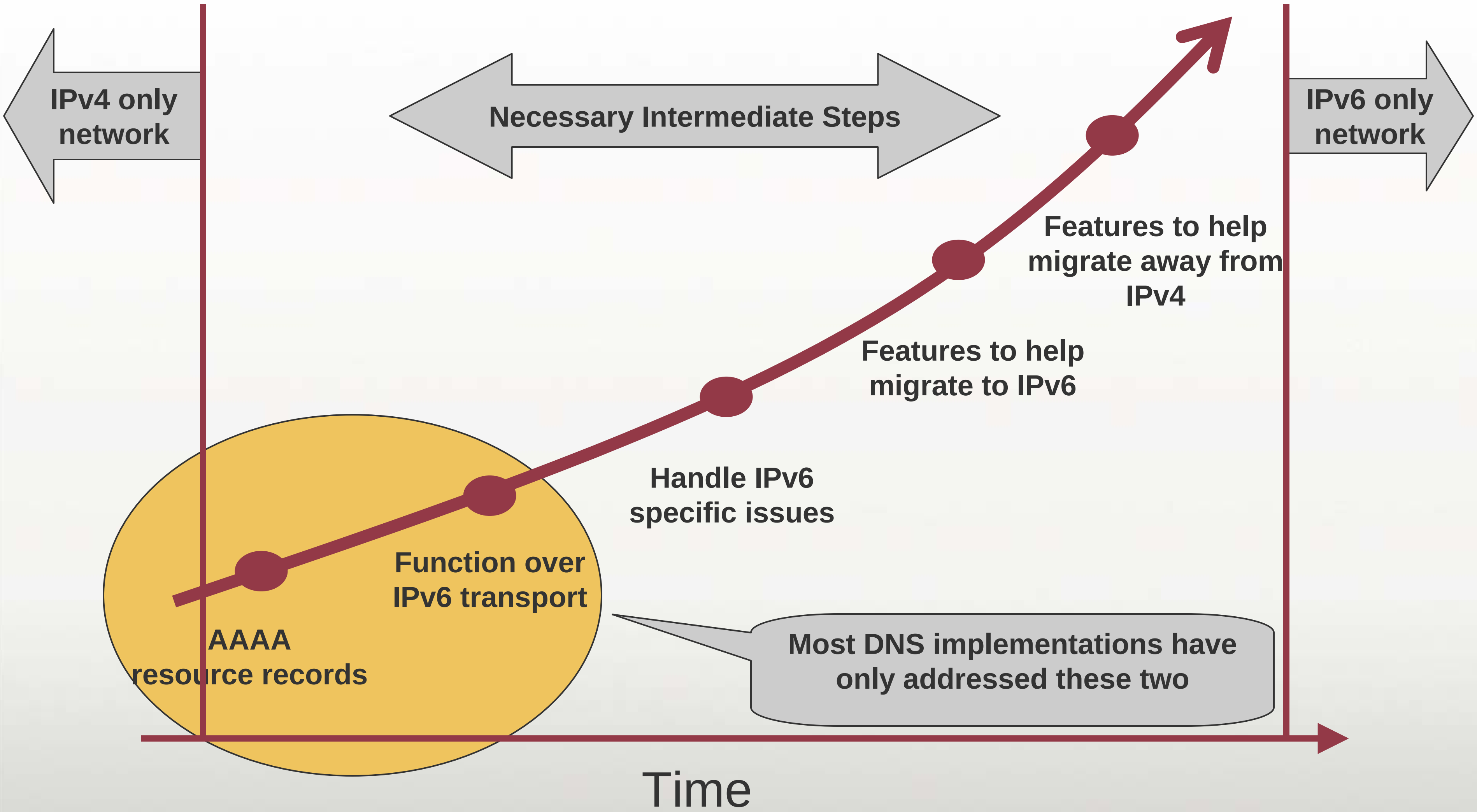
Ipv4 Depletion



- RMv6TF 2010 meeting in Denver, April 21st.
  - Days to IANA depletion: 583 days
- TXv6TF meeting in Houston, November 4th
  - Days to IANA depletion: 488 days
- RMv6TF 2010 meeting in Denver, May 27th.
  - Days to IANA depletion: 300 days

IPv4 addresses will be exhausted by next year's IPv6 conference

Many Steps to IPv6 only DNS



DNS and IPv6 Primer

- DNS is used to:
  - Map a hostname to an IP-address
  - Map an IP-address to a hostname
  - Identify servers for other protocols and systems (mail, AD, etc.)
- DNS “mandatory” in IPv6, even for internal hosts, router, switches, etc.
  - IPv6 addresses are 128 bits, hard to remember
  - Easier to SSH to router-10.secure64.com rather than 2001:12EF:1AB9:3391:4510:100F:8FFE:E63C
- If you put everything in the DNS, the only address you have to remember is the DNS server address
  - Pick an easy to remember address for your DNS server
  - In the simplest form, just add AAAA records for everything else

Reverse Delegation In IPv6

- Reverse delegation in IPv6 is done in the ip6.arpa zone
  - Ip6.int deprecated

address 4321:0:1:2:3:4:567:89ab would be:

b.a.9.8.7.6.5.0.4.0.0.0.3.0.0.0.2.0.0.0.1.0.0.0.0.0.0.0.1.
2.3.4.IP6.ARPA.

Real-World DNS and IPv6 Issues

- Populating reverse DNS
- Transitioning to IPv6
  - Running dual stack to the client
  - Running DNS64/NAT64

Reverse Delegation Issue

- All hosts on internet should have a reverse delegation (RFC)

- In reality, not always as easy as previous slide suggests
  - In IPv4 service providers pre populate the entire reverse tree:
    - adsl-70-250-178-4.dsl.rcsntx.swbell.net.
  - Reverse delegation of just a single /64 would require 4 billion 400 G disks of storage

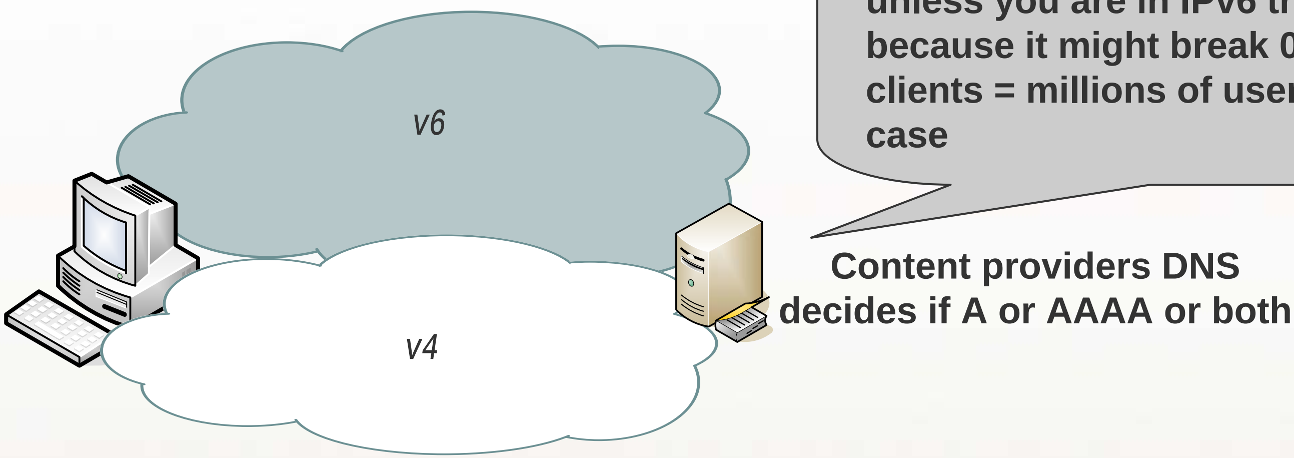
- IETF draft lays out 4 alternatives:
  - Do nothing
  - Use wildcards
  - Use dynamic DNS
  - Synthesize records on the fly

Comparison of IETF Options

	Do Nothing	Wildcards	Dynamic DNS	Synthesize
# new servers	0	0	Hundreds	0
Requires development				✓
Reverse record exists		✓	✓	✓
Reverse record matches forward record			✓	✓
Works with DNSSEC		✓	Difficult	Difficult

DNS solutions need to evolve to simplify reverse IPv6 DNS

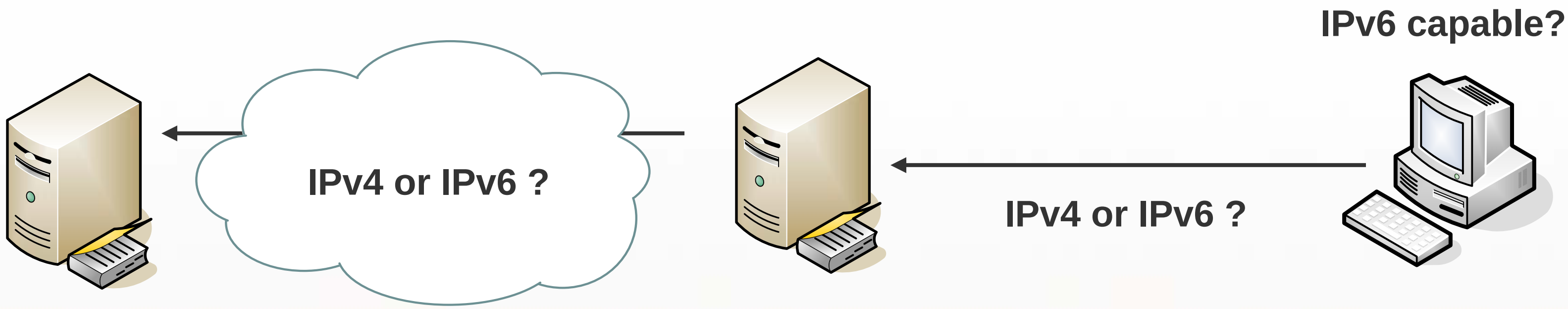
Dual Stack Issue



Today google is not giving out AAAA unless you are in IPv6 trials with them because it might break 0.078% of Ipv4 clients = millions of users in google's case

- Dual stack is the IETF recommended transition mechanism, but
- There are problems when client IPv6 connection is broken
  - Extreme slowdown as client retries AAAA and then A lookups
- Estimated 0.078% of clients have this problem
  - Some older Opera browsers, some older Apple OSes, etc.
  - Amounts to millions of users for some large content providers like Google, Yahoo, etc.
- Dual stack is temporary, IPv6 only is the final goal

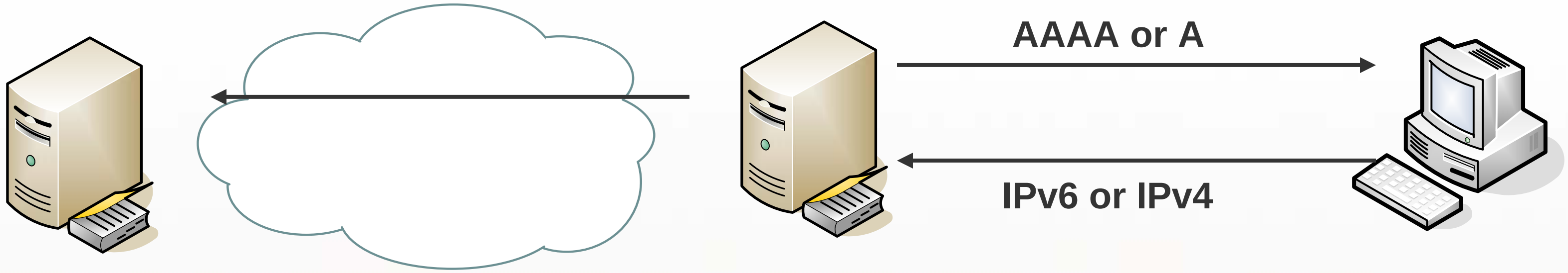
Dual Stack Issue Continued



- The lookup of A versus AAAA records is independent of whether the DNS packets are carried over IPv4 or IPv6
  - Client cannot know IPv4/IPv6 capabilities of the authoritative servers
  - Authoritative server cannot know IPv4/IPv6 capabilities of the client
  - Neither knows the IPv4/IPv6 capabilities of the intermediate network
- Typically an IPv6 enabled client OS will send AAAA then A, but not always
  - Inconsistency across OSes is hard to deal with
  - Combining this behavior with search domains (domain completion) can generate lots of DNS queries!

Increased client latency and DNS server load likely with dual stack!

One Proposed Solution Using DNS

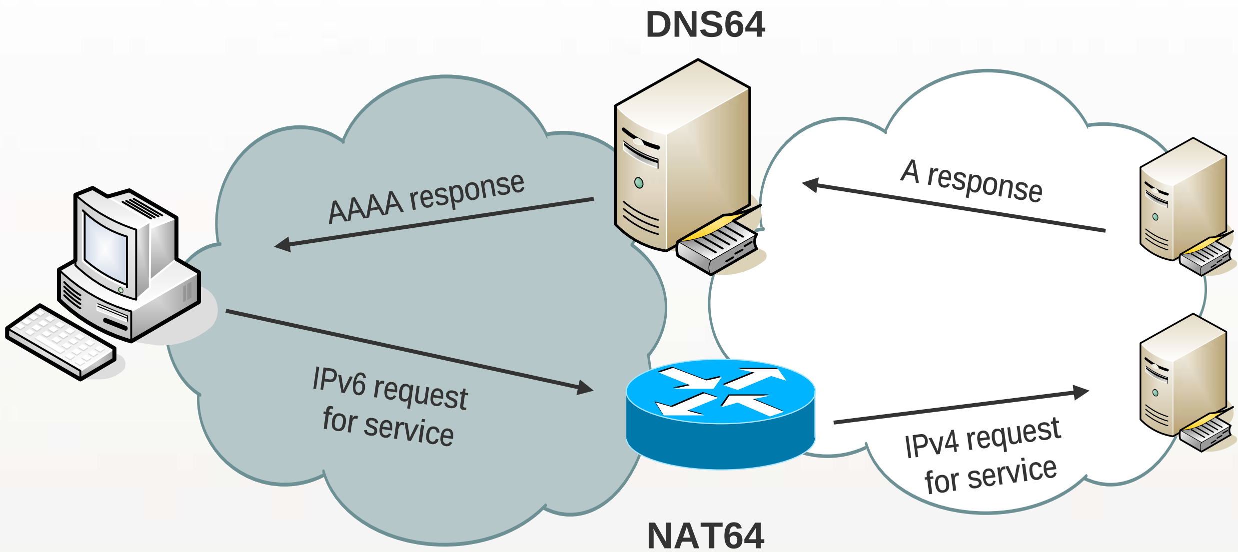


- Caching side (ISP, consumer of content)
  - If query came in over IPv4, respond negatively to the AAAA request and wait for the A request
- Side effects:
  - Breaks DNSSEC
  - Turns off IPv6 for clients that can only do DNS queries over IPv4 (ie Windows XP)

An Alternative Transition Method

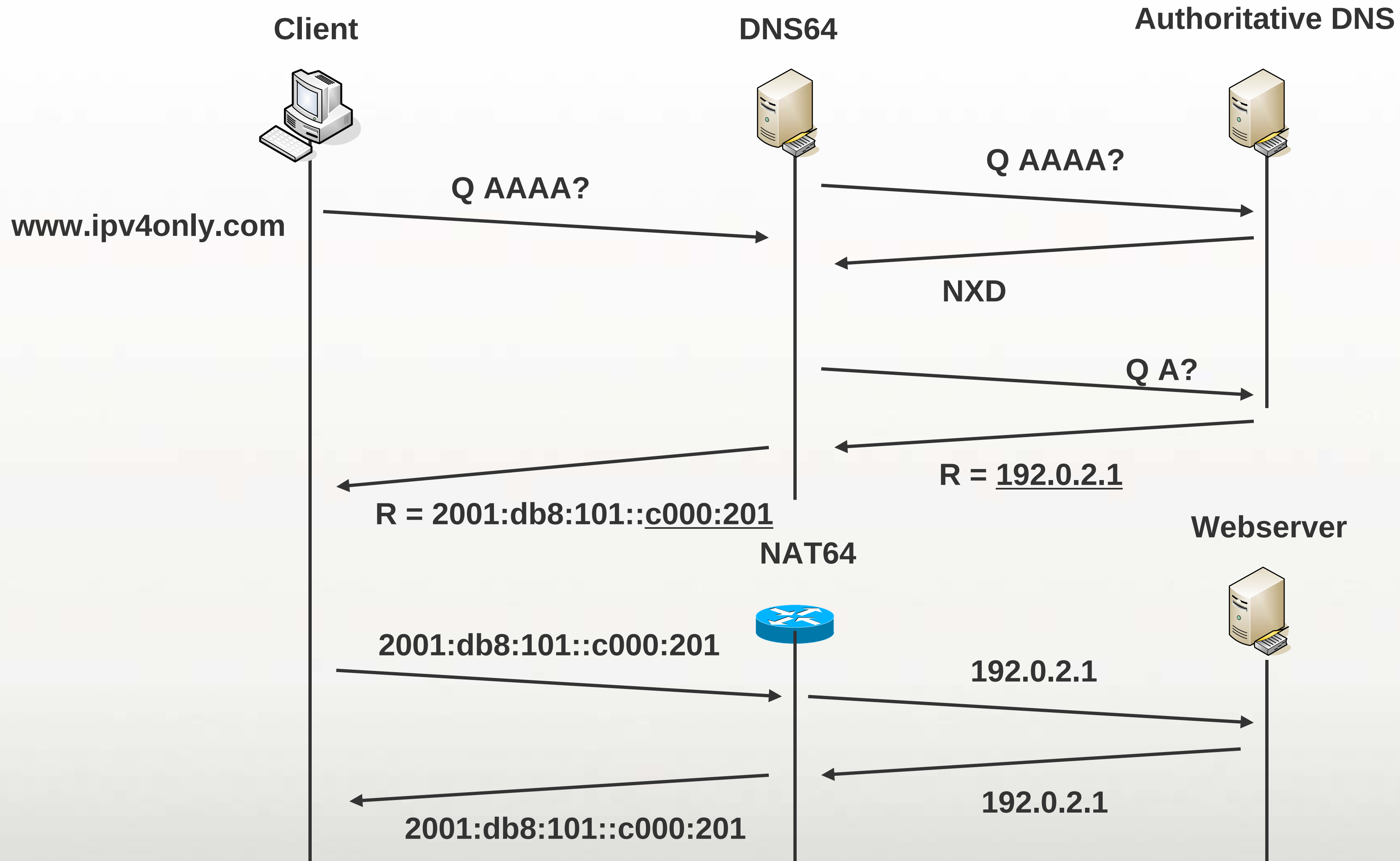
- Run pure IPv6 to client, not dual stack
  - Mandatory approach if you don’t have enough IPv4 addresses for dual stack
  - Only works when you control the client and the caching DNS server (think wireless providers, large internal networks)
- Must still be able to communicate with DNS servers that only support IPv4 and A records
- Use DNS64/NAT64 to bridge the gap

NAT64 / DNS64 Solution



- IETF draft
- IPv6-only network on the client side!
  - DNS rewrites A record responses to AAAA records using prefix
  - NAT64 translates IPv6 addresses to IPv4 and vice-versa
- User experience with NAT64 is (almost) the same as NAT44
- Only one network to maintain

NAT64 / DNS64 Under The Hood



Breaks hardcoded IPv4 addresses in web pages, but still compelling

DNSSEC

- Kaminsky found a problem with DNS that allowed for cache poisoning
- The short term solution was to add a patch to do source port randomization
- The long term solution is DNSSEC
  - Digitally sign zones
  - DNSSEC is a complex standard, ZSK, KSK, rolling keys, signature expiration times, etc.
- In the meantime, IPv6 offers additional protection from cache poisoning attacks

The “Kaminsky Attack”

1. Send a query.
2. Send a lot of responses and guess the TX id (and port).
3. If unsuccessful goto 1

	Bits of Randomness	
Randomness Source	**Unpatched DNS**	**Patched DNS**
Transaction ID	16	16
Source Port		16
Destination IP (avg)		
Capitalization (avg)		
Source IP		
Total Bits	**16**	**32**

The Patch is Not Enough

Attack Volume (pps)	Time to Poison		
	Number of random source ports		
	None	1024	60,000
500	90 seconds	1 day	63 days
5,000	9 seconds	3 hours	6 days
50,000	1 second	16 minutes	15 hours

- Source port randomization makes the attack more difficult, doesn't prevent it
- High attack rates are easily reachable by botnets and compromised PCs
- Patched code has already been compromised in <10 hours (using 80K-100K pps)
- A patient attacker can take more time to remain undetected

The patch is a temporary fix – we need a long term solution

How Can IPv6 Help You Here ?

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Randomness Source	S64
ID	16
Source Port	16
Destination IP (avg)	2
Capitalization (avg)	8
Source IP	5
Total Bits	**47**

Can we configure our DNS with say 32 IPv6 addresses and let the server pick IP-address randomly?

2 = 1 bit
4 = 2 bit
8 = 3 bit
16 = 4 bit
32 = 5 bit
64 = 6 bit
128 = 7 bit
256 = 8 bit

Questions?

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