Securing Core Internet Functions – DNSSEC

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Core Internet Functions: Routing & DNS

- The Internet relies on two critical resources
  - DNS: Translates domain names to IP addresses and IP addresses to domain names
  - Routing: Tells us how to get to an IP address
- These critical resources <u>are not secure</u>
- DNSSEC helps secure these critical resources

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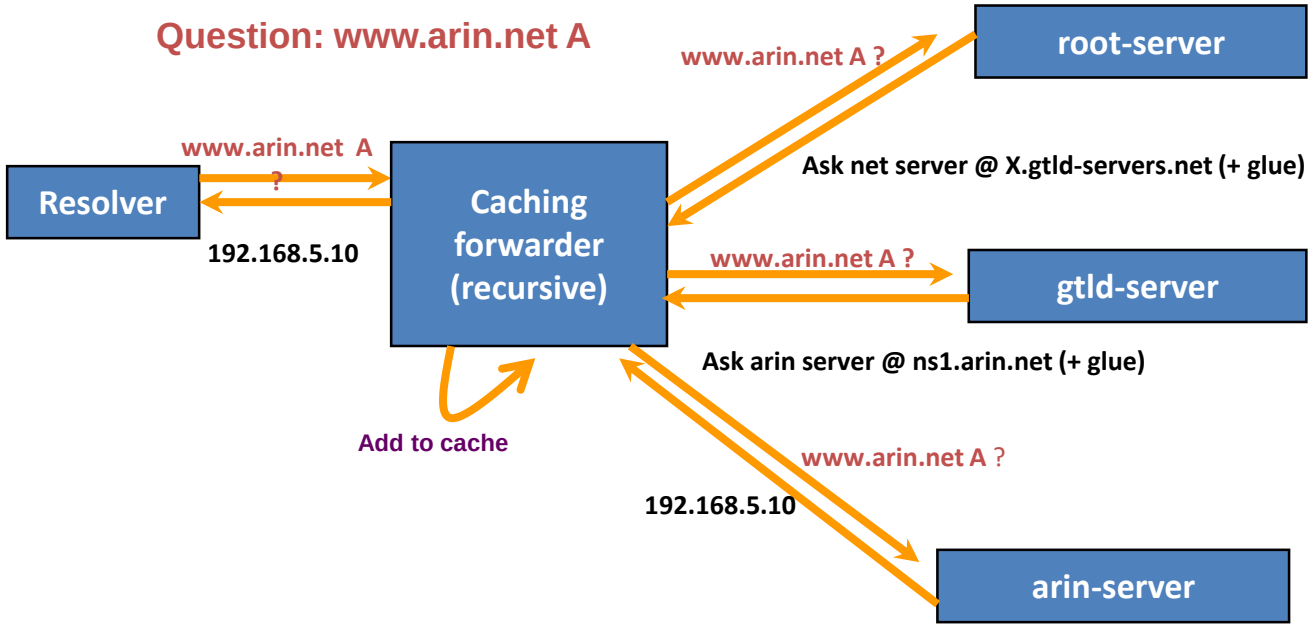
Securing DNS With DNSSEC

How DNS Works



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What is DNSSEC?

- A DNS extension which authenticates responses
  - When you ask how to get to www.arin.net, DNSSEC verifies the answer is from ARIN and not someone pretending to be us
- Doesn't ensure the answer is correct, just that it's coming from the right place

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Why is DNSSEC Important?

- Standard DNS is not secure
  - Trivial to spoof (provide false responses)
  - … so an attacker can redirect people looking for www.arin.net to his own site
  - … and then steal login information.
- DNSSEC is (surprise) secure
  - An attacker can try to redirect traffic, but DNSSEC will show it's not a valid response

DNS Cache Poisoning

- Attacker gives the nameserver a "poisoned" (incorrect) response to www.arin.net
- If accepted, this nameserver will direct people to the fake site, typically for hours
- ... and any nameservers that trust the poisoned one will also become poisoned.

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Case Study: Kashpureff Attack

- Eugene Kashpureff didn't like Internic's control of top level domains
- In 1996, he used DNS cache poisoning to redirect Internic traffic to his own site
- Kashpureff was eventually convicted of computer fraud
- This attack <u>could have been prevented</u> with DNSSEC

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Case Study: Kaminsky Flaw

- 2008: Dan Kaminsky discovered a fundamental flaw in the DNS protocol
  - 65,536 Transaction IDs in DNS makes it easy to guess the right one & spoof
- Updates to DNS software makes this flaw more difficult to exploit, but not impossible
- <u>These attacks can be prevented with DNSSEC</u>

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Case Study: Bradesco

- Bradesco is a bank in Brazil
- DNS cache poisoning attack resulted in 1% of the bank's customers being redirected to a fake site
  - Getting login credentials for 1% of a large bank's customers could be disastrous
- <u>Networks not using DNSSEC are vulnerable to a similar attack</u>

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Other Uses

1. Protect DKIM & SPF
   - Without DNSSEC, an attacker can make use your email addresses for spam.
2. SSH Initial Host Key Exchange
   - Protect SSH Fingerprint (SSHFP) records.
3. PGP Key Distribution
   - Use _pka records to distribute PGP keys easily usable by GnuPG
4. DANE
   - Coming standard from the IETF to use DNS as a global public key infrastructure.

DNSSEC Usage Statistics

	ARIN 39
Number of Orgs with DNSSEC	139
Total Number of Delegations	620,412
DNSSEC Secured Zones	671
Percentage Secured	0.11 %

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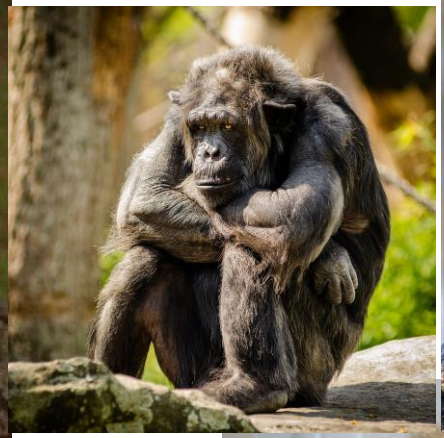

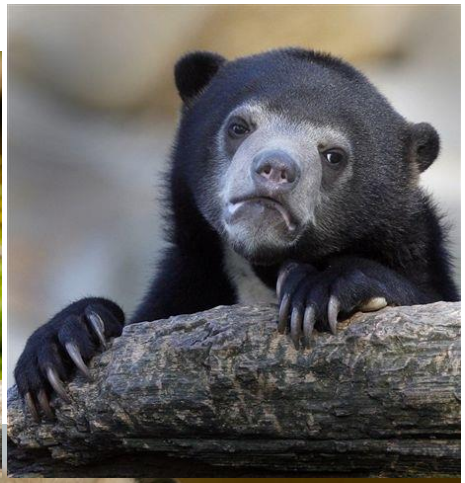

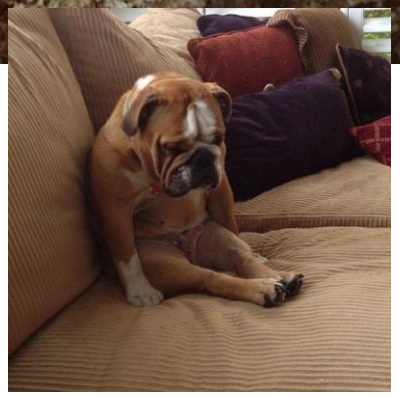

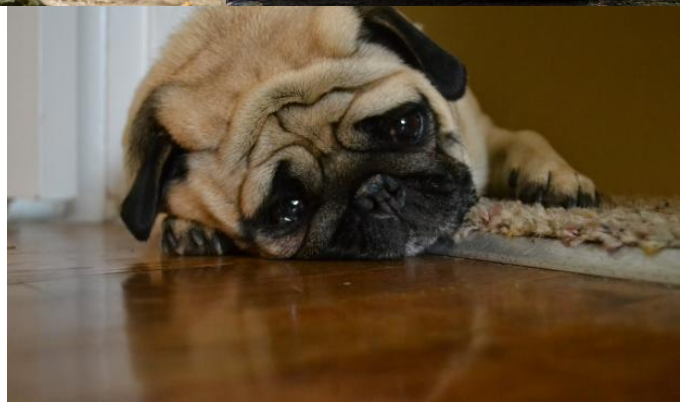

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How Can We Increase Usage?

- Identify Barriers to Adoption
  - Don't know how
  - Don't have time
  - "... but I haven't been attacked"
- Then, knock them down
  - Increased awareness
  - Education/assistance
  - "An ounce of prevention is worth a pound of cure"

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Using DNSSEC with ARIN

- **Remember: this is for reverse DNS, not forward DNS**
- Use your DNS server software to:
  - Generate your key pair
  - Create DS records to upload to ARIN via ARIN Online or Reg-RWS
  - Sign your DNS zones

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Completing DNSSEC Configuration

- Ensure the required DNSKEY, RRSIG, NSEC, and DS records are published in your nameservers
  - Consult your zone file…..
- ARIN provides only reverse DNSSEC
  - Make sure to also secure your forward DNS through your domain registrar

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How It Works

- DNSSEC adds new resource records into your zone file.
- These records are signed off-line.
- Two types of public/private key pairs
  - Zone Signing Key (ZSK) is used to sign records in the zone
  - Key Signing Key (KSK) signs the ZSK. Usually longer lived than the ZSK.

What a Unsigned Zone Looks Like

```
0.43.199.in-addr.arpa.   10800     IN    SOA   ns1.arin.net. dns-
ops.arin.net. 2016072520 10800 3600 604800 3600
0.43.199.in-addr.arpa.   10800     IN    NS    ns1.arin.net.
0.43.199.in-addr.arpa.   10800     IN    NS    ns2.arin.net.
0.43.199.in-addr.arpa.   10800     IN    NS    ns2.lacnic.net.
0.43.199.in-addr.arpa.   10800     IN    NS    sec1.apnic.net.
0.43.199.in-addr.arpa.   10800     IN    NS    sec1.authdns.ripe.net.
1.0.43.199.in-addr.arpa.    10800  IN    PTR   host-199-43-0-1.arin.net.
10.0.43.199.in-addr.arpa.   10800  IN    PTR   host-199-43-0-10.arin.net.
```

What a Signed Zone Looks Like

```
0.43.199.in-addr.arpa. 10800 IN    SOA   ns1.arin.net. dns-ops.arin.net.
2016072520 10800 3600 604800 3600
0.43.199.in-addr.arpa. 3600        IN    RRSIG NSEC 5 5 3600 20170131143127
20170117133127 13093 0.43.199.in-addr.arpa.
p33dgTSLyg/qoDuoN6XGRFUwfRdILdYQtJfl/i077aLZA/usJ0r3furj
3FikILZOodCWez0yiKYwKaUYlGiFgZyWSlDTrbMgnLBG162tQrby8wAQ
Ke1mOYRBdSOT6swRzhJx6rRRSH4C0/3YpQqmKZsplQisyTdbykhy4N3h 38M=
…
0.43.199.in-addr.arpa. 10800 IN    DNSKEY      256 3 5
AwEAAXCN3mUJUntP90L4F4oNxxlzKFos9FYD0wxTqxoWueBjFVAvS9vt
FSAC7sV4yqKF3NbOOgk81Ep8n8BLZ3vvhnL8/y6Gf3K+d/yvK248ZWR6
+r+AAsV6icMEloQhaJzuam/eMrlj4kJ96lVjFvMEwdPNNSYzen30OfpC sswVvamh
…
0.43.199.in-addr.arpa. 3600        IN    NSEC  1.0.43.199.in-addr.arpa. NS
SOA RRSIG NSEC DNSKEY
0.43.199.in-addr.arpa.   10800     IN    NS    ns1.arin.net.
…
1.0.43.199.in-addr.arpa.    10800  IN    PTR   host-199-43-0-1.arin.net.
…
```

A signed zone file will have RRSIG, NSEC, and DNSKEY records.

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DNSSEC Adds New Record Types

DNSKEY – records holding the public zone signing key and key signing key

RRSIG – records holding the cryptographic signatures of the other DNS records

NSEC – records cryptographically stitching the other records together

DS – these point to your zone like an NS record *(needed in the parent zone)*

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How Do I Know It's Working?

Use a DNSSEC validating resolver.

Popular options include:

- www.internetsociety.org/deploy360/dnssec/
- www.isc.org/downloads/bind/dnssec/

How to Test

- DNS Viz gives a good presentation http://dnsviz.net/d/0.43.199.in-addr.arpa/dnssec/
- Give it a shot!

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Initial Takeaways

- If you're not using DNSSEC, you're vulnerable to a DNS cache poisoning attack
- Plenty of readily available documentation regarding implementation details

A Really Easy Way to Use DNSSEC as a User

- Use google public DNS for your resolver
- It's cloud computing!
- It has DNSSEC turned on by default

Thoughts About Cloud Computing in General

- From a user:
  - You may need to provide sensitive data
  - Cloud resources are ephemeral
  - How do you know you are going to the right place?
  - How can you tell afterwards?

Thoughts About Cloud Computing in General…

- From a content provider
  - Given this is a shared system:
  - How do you know you have the right connections for sensitive info (data/payments)?
  - How does the cloud provider ensure isolation between clients?

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Q&A