Operational Realities of Running DNSSEC

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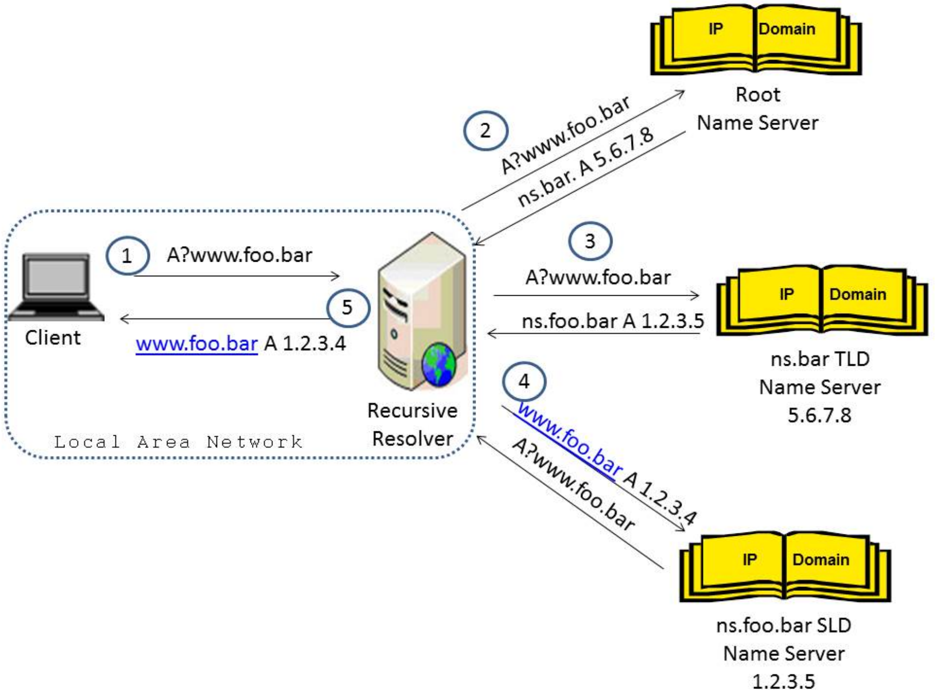
DNSSEC Finally… Slowly Taking Off

- Many resolvers signal ``DNSSEC OK´´
  - Only <5% validate

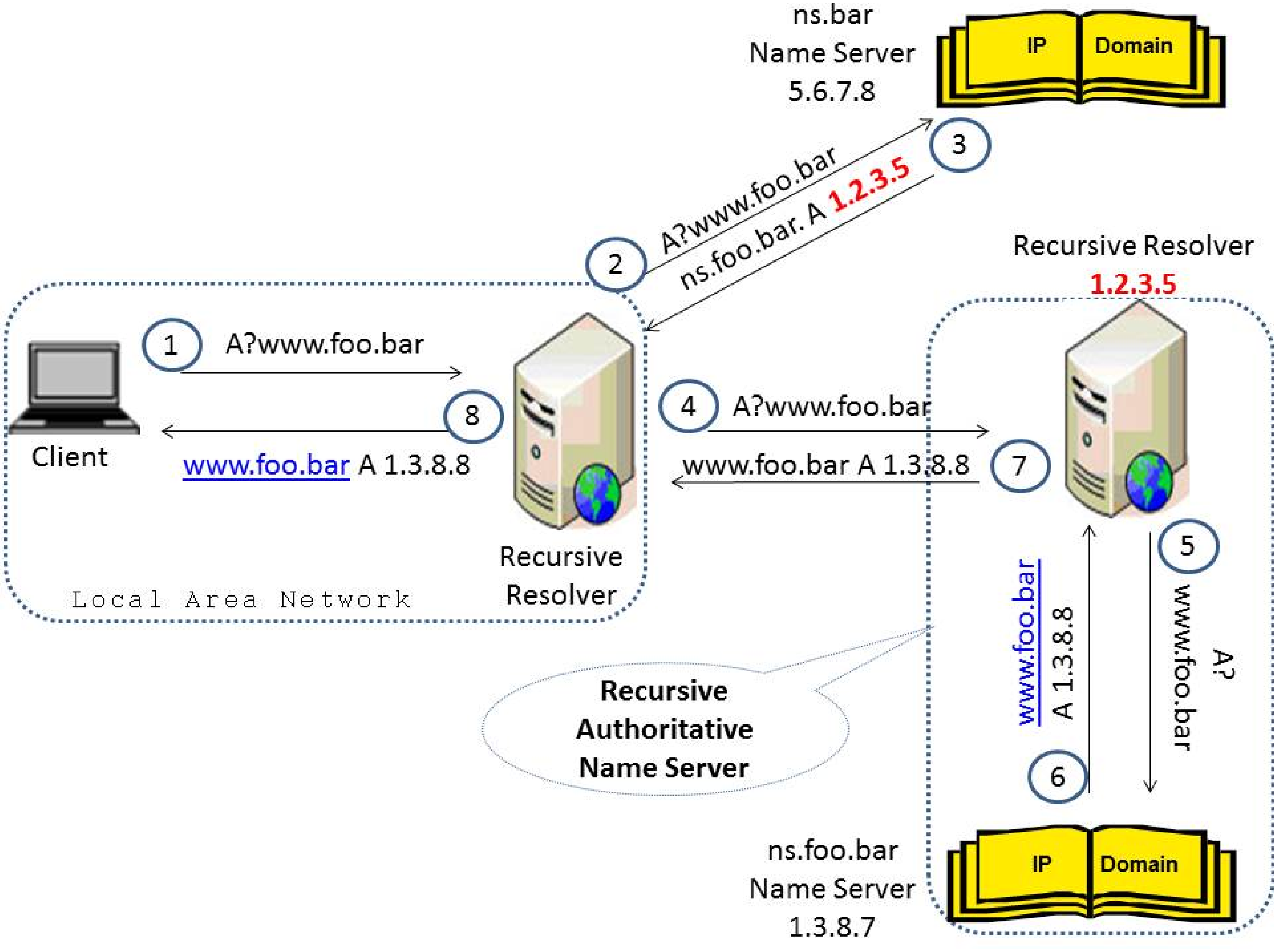
- Many (important) zones got signed
  - Forward DNS: Root, >62% TLDS, but only <1% SLDs
  - Reverse DNS (IPv4): `arpa`, `in-addr.arpa` but only <1% subdomains

Only Lack of Motivation?

- How difficult is it to deploy DNSSEC?
- Many dependencies and … actors
- Our focus: DNS servers



Recursive Auth-Name Server (RANS)

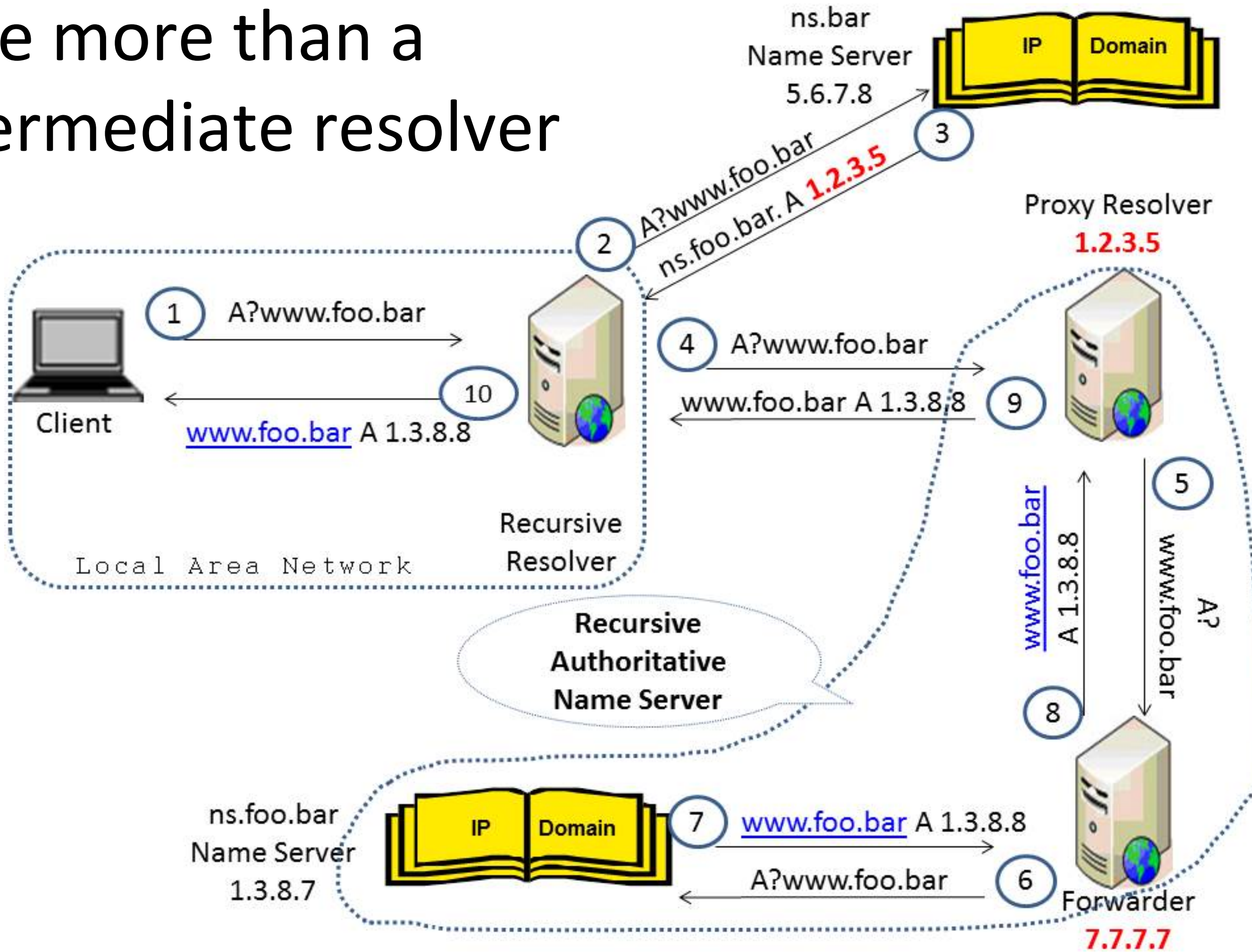


Recursive Auth-Name Server (RANS)

Sometimes a Chain of Intermediate Proxy Resolvers...

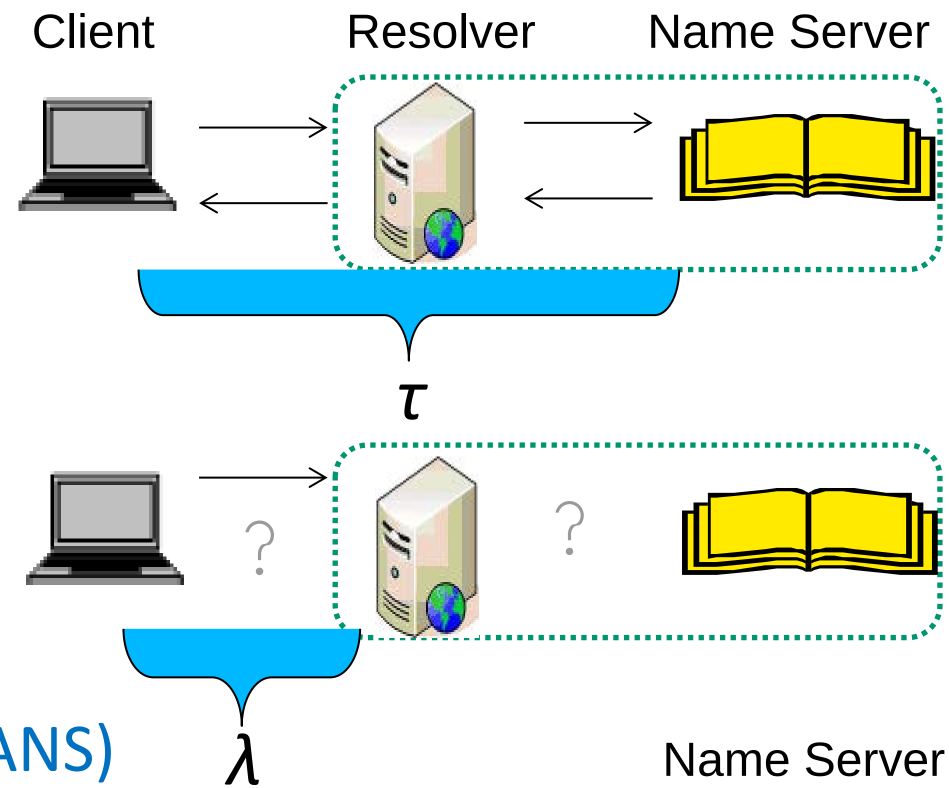
Recursive Auth-Name Server (RANS)

>42% have more than a single intermediate resolver



Detecting RANSes

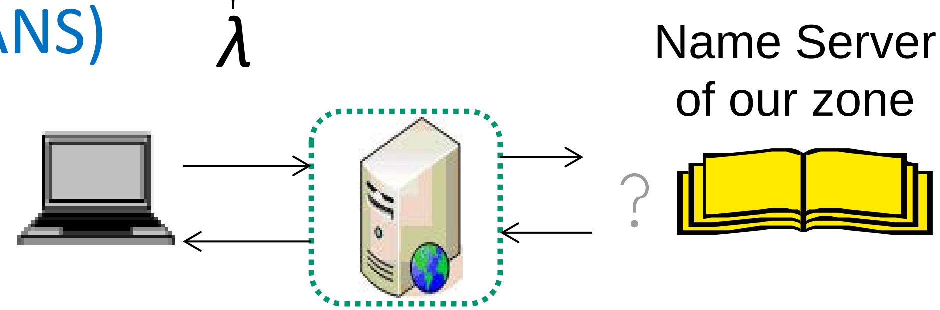
1. Send NXD query
   → Measure latency τ
2. Resend same query
   → Measure latency λ
3. If $\lambda << \tau$ → RANS
   - Typically $|\lambda-\tau| > 30$ms
   - Different ASes



Detecting open recursive (ORANS)

→ Send query to our domain

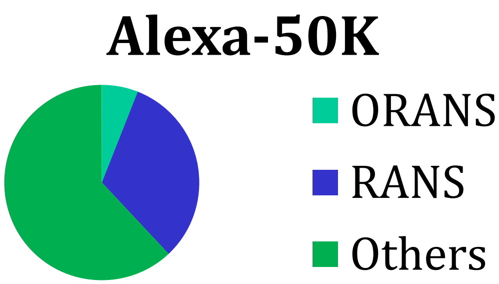
→ Monitor requests on server



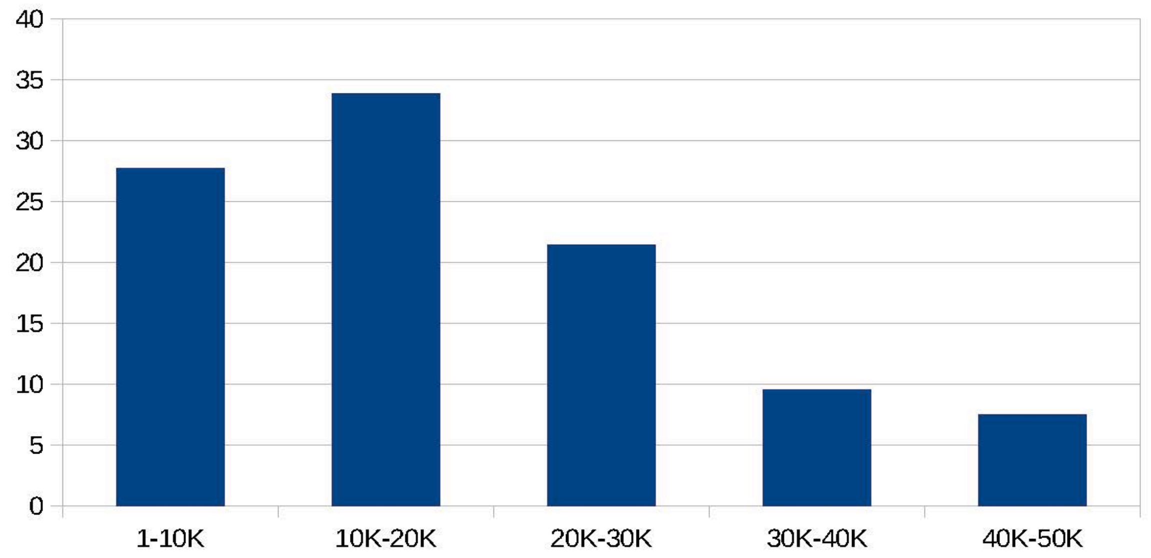
Challenges of DNSSEC Adoption

- How common? Quite common…
  - >38% domains in Alexa-50K
    - >32% RANSes, >6% ORANSes

  → Significant part of DNS infrastructure

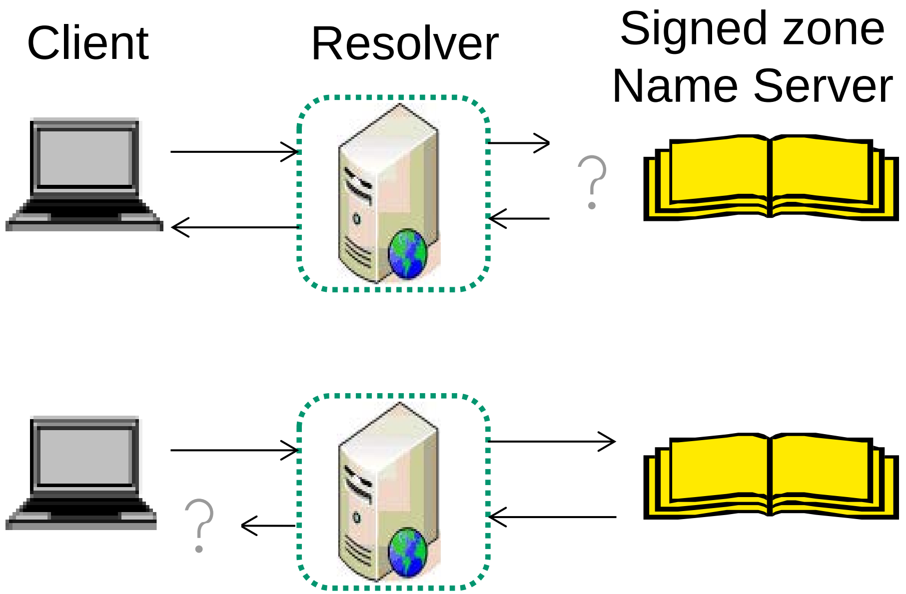


- Distribution of RANSes among Alexa-50K domains



Measure ORANSes Readiness for DNSSEC

1. Send request for a record in our signed zone
   → check if server receives
2. Send signed response
   → check if client receives



Measure non-open (RANSes) with side-channels

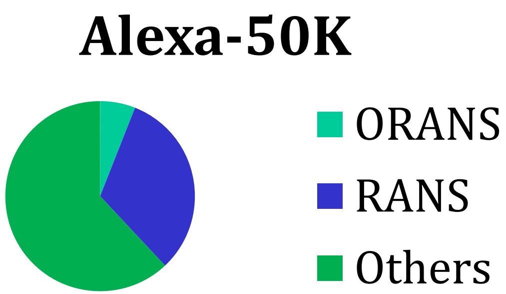
- see paper

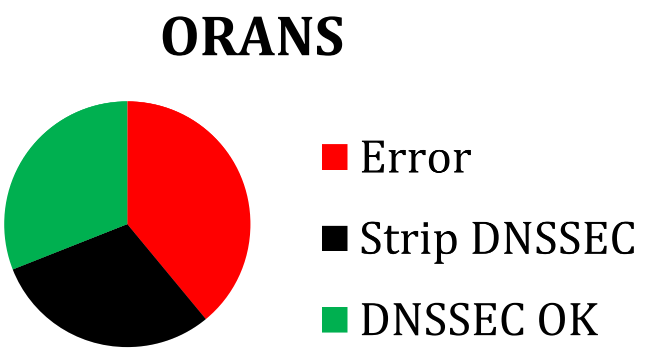
RANSes Measurement Challenges

- Differentiate failure with EDNS vs DNSSEC
  - Support of DO in EDNS ≠ support of DNSSEC
- Differentiate failure with request vs response
- Identify who fails with DNSSEC
  - 1^{st} node? 2^{nd} node? … N^{th} node? the name server?
- See paper for details
  - Also for measurements in TLDs, and in reverse DNS
- So, what is the situation?

Infrastructure Challenges

- Legacy devices = obstacle to DNSSEC adoption!!
- >69% of Alexa-50K open RANSes cannot support DNSSEC
  - > 39% fail with DNSSEC (FRMTERROR/SRVFAIL)
  - > 30% strip DNSSEC
- > 18% do not support EDNS
- Higher % of RANSes
- Similar for reverse DNS





Is it Worth the Effort?

- DNSSEC prevents attacks
  - On-path (MitM) attacks (NSA, GCHQ,…?)
  - Off-path attacks [HS12,HS13a-c,SW14]
  - Vulnerable name servers
- DNSSEC provides evidences
  - Enables forensic analysis, detection of attacks
- DNSSEC would facilitate security protocols
  - ROVER, DANE…
- **Can we do it? → Yes We Can!!**

Cipher-Suite Negotiation for DNSSEC

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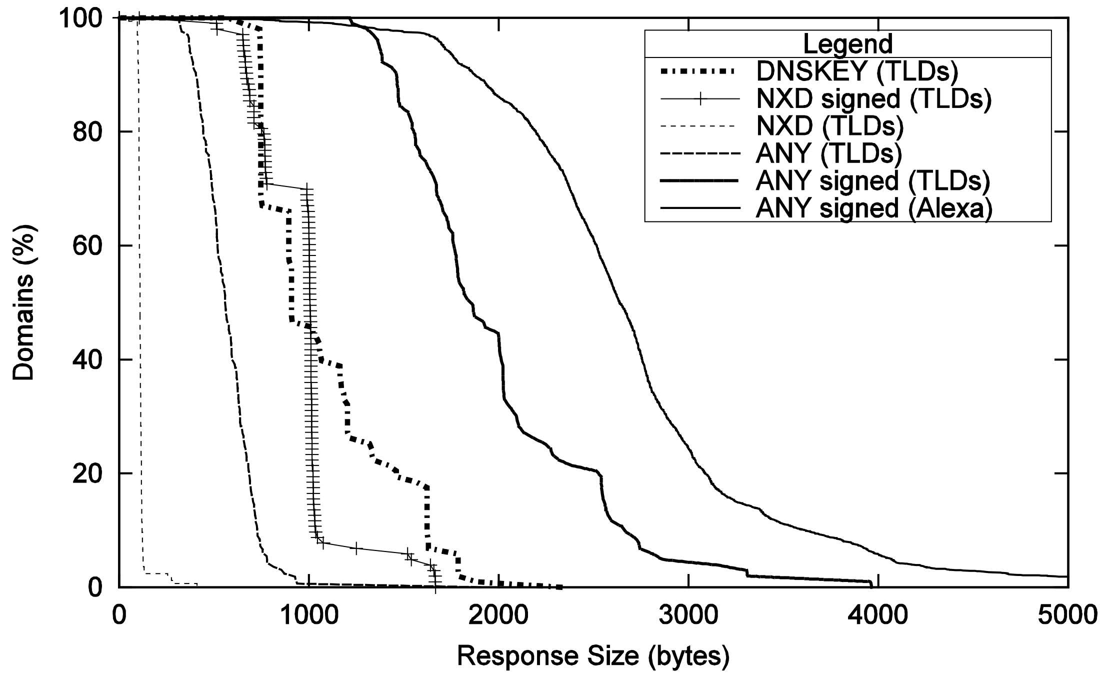
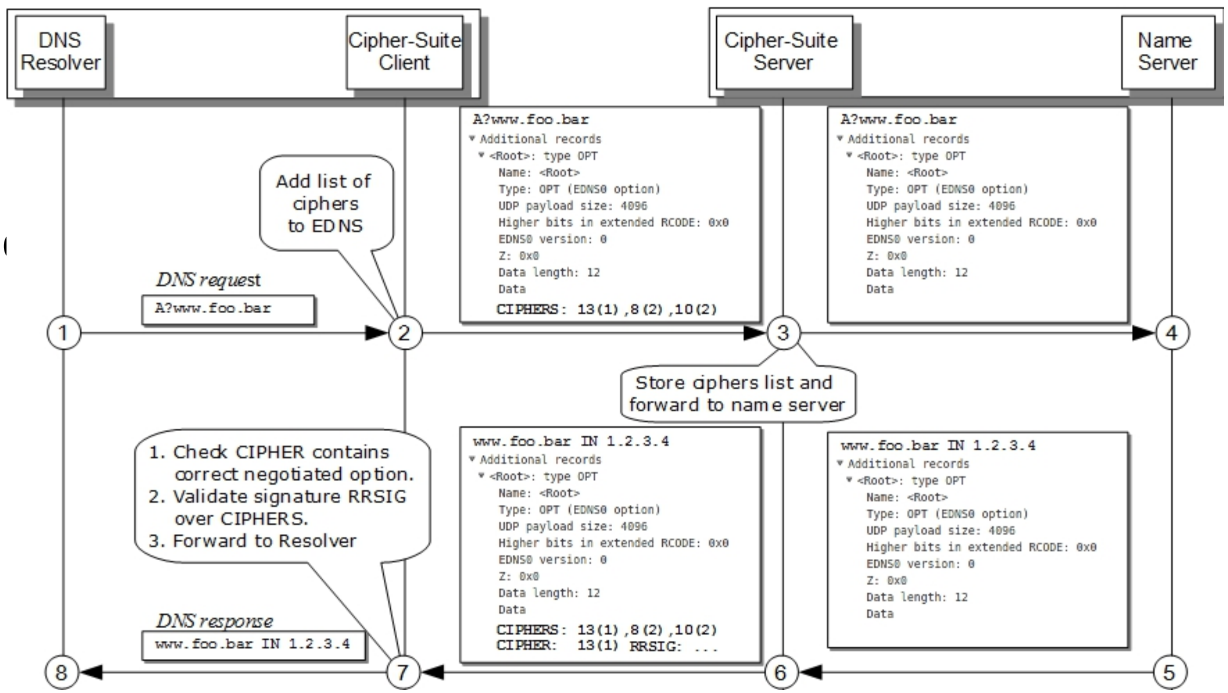
Servers Send Key/SIGs for ALL Supported Algs. → Large Responses!

- Intermediate devices
  - E.g., firewalls
- Transition to TCP?
  - Not all support
  - and overhead
- Low motivation to support shorter algs
  - Mandatory support of RSA
  - More algs - increase responses sizes



Cipher-Suite Negotiation
Signal Ciphers in EDNS

- Resolvers algs and priorities (new options in EDNS)
- Servers compute optimal algorithm
  - Responses signed according to that option
  - To prevent downgra sign the supported ciphers with KSK
- Simple extension to [RFC6975]



Cipher-Suite Negotiation

- But, EDNS is transport layer (hop-by-hop)
- Intermediate caches break end-to-end cipher negotiation
  - Legacy devices cannot process new options
    → break cipher-suite negotiation
  - Supporting devices serve cached signatures
    → may not be the priority/ciphers supported by requesting clients

Cipher-Suite Negotiation

- Idea: signal in application layer
- Client concatenates ciphers as subdomains to query

```
5  - RSA/SHA1
7  - RSA/SHA1-NSEC3-SHA1
13 - ECDSA Curve P-256
     with SHA-256
```

`algs.delimiter.domain: 5.13.7._cs_.foo.bar`

- How can client know server’s algs/priorities?

  → server signals priorities in a DNSKEY record

  - New alg. number for cipher options

Conclusions

- Intermediate devices impede deployment of new mechanisms
  - DNSSEC, cipher-suite negotiation, …
- But, delegation of DNS functionality is common
  - Intermediaries are likely to persist
- More effort is required to speed adoption of DNSSEC!!

Questions ?

Thank you!