Less is More
Cipher-Suite Negotiation for DNSSEC

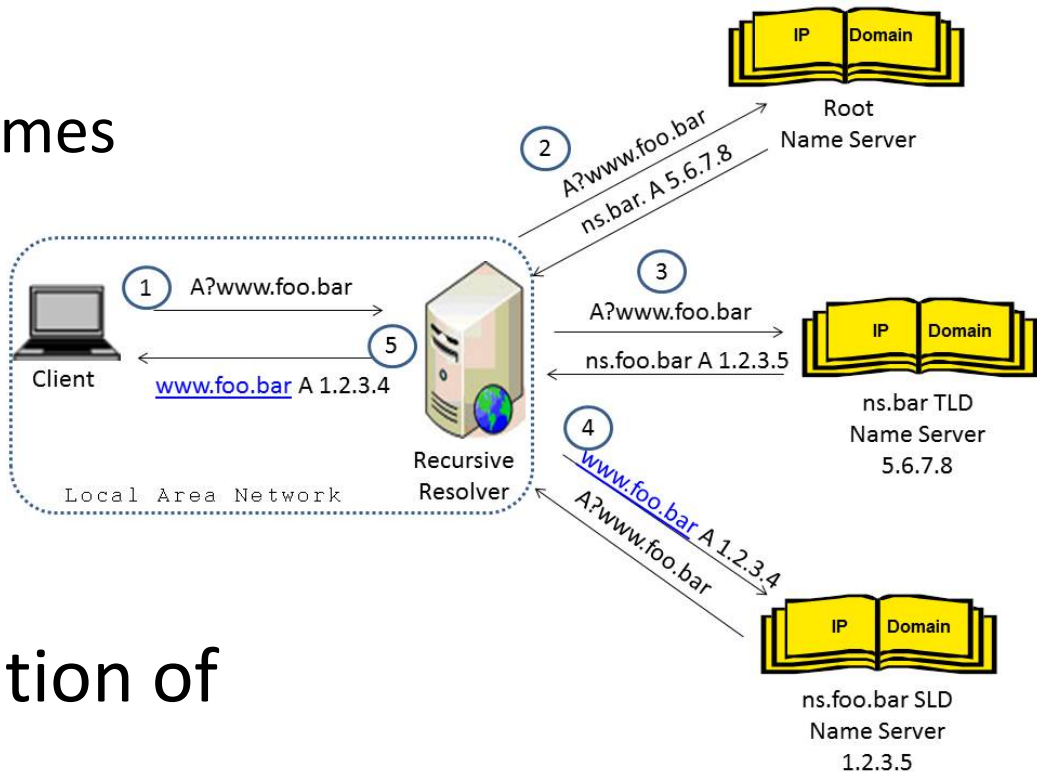
Amir Herzberg
Bar-Ilan University

Haya Shulman
Technische Universität Darmstadt

Bruno Crispo
Trento University

Domain Name System (DNS)

- Lookup services
  - Locate resources: via names
  - Authentication: black lists, policies, security mechanisms (SPF, ROVER, …)



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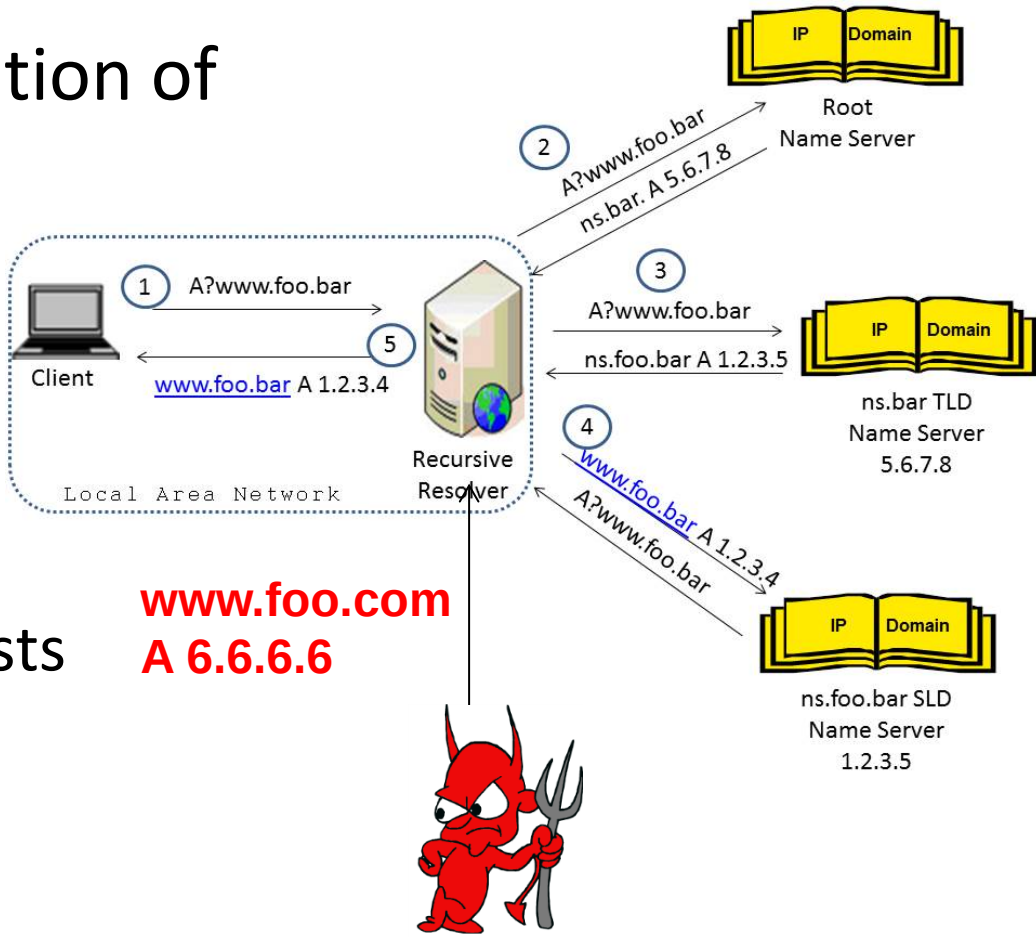
  - Attacker can provide spoofed records
  - Resolver caches
  - Clients redirected to incorrect (malicious) hosts



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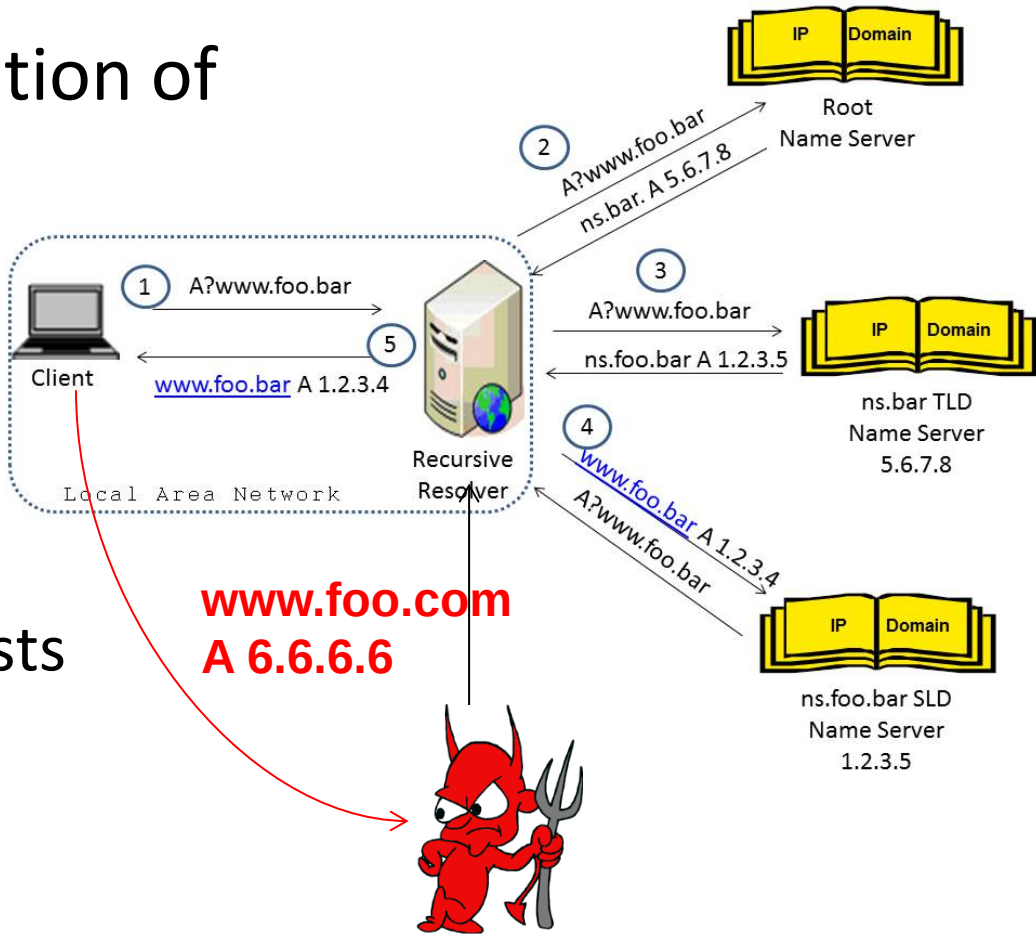
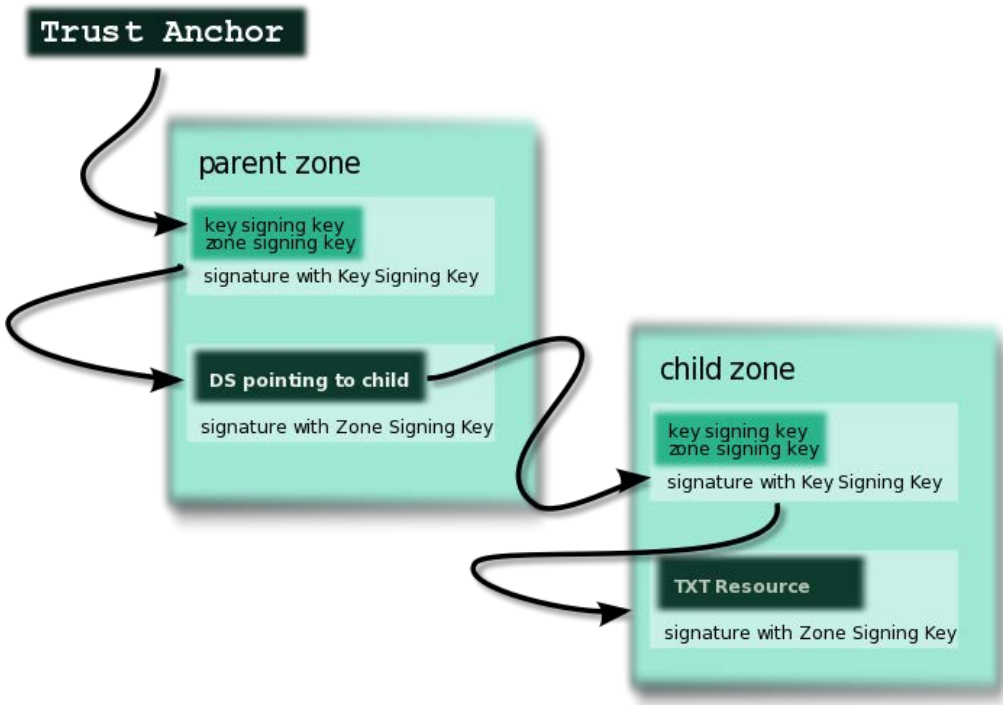


DNS Security (DNSSEC)

- DNSSEC prevents attacks
  - On-path (MitM) attacks (NSA, China, GCHQ,…?)
  - Off-path attacks [HS12,HS13a-c,SW14]
  - Vulnerable name servers
- DNSSEC provides evidences
  - Enables forensic analysis, detection of attacks see [SW14]
- DNSSEC would facilitate security protocols
  - ROVER, DANE…

DNS Security (DNSSEC)

- Zone file is signed
- Name server sends keys and signatures over DNS records
- Resolver validates signatures
- Enables detection of spoofed responses



DNS Security (DNSSEC)

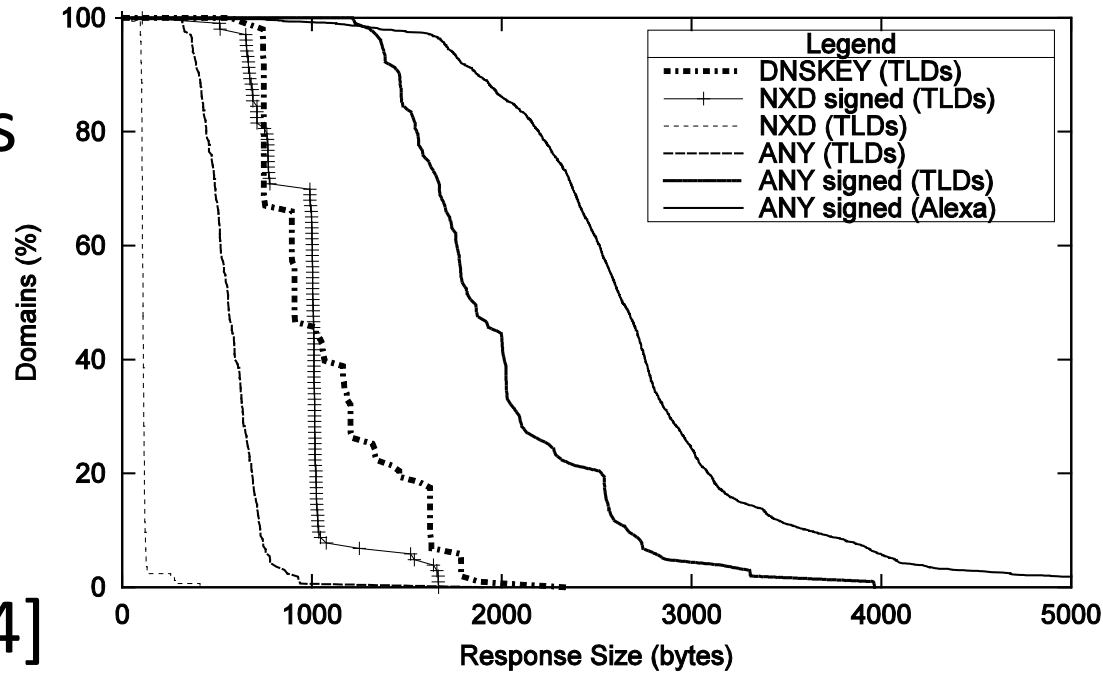
- Only few support it
- Many resolvers signal ``DNSSEC OK´´
  - Only <5% validate
- Many (important) zones got signed
  - Forward DNS: Root, >62% TLDS, but only <1% SLDs
  - Reverse DNS (IPv4): `arpa`, `in-addr.arpa` but only <1% subdomains

Obstacles to DNSSEC Adoption

- Zone file is signed with *all* supported ciphers
- Name server sends *all* keys and signatures over DNS records
- Resolver validates *all* signatures
- Overhead!!

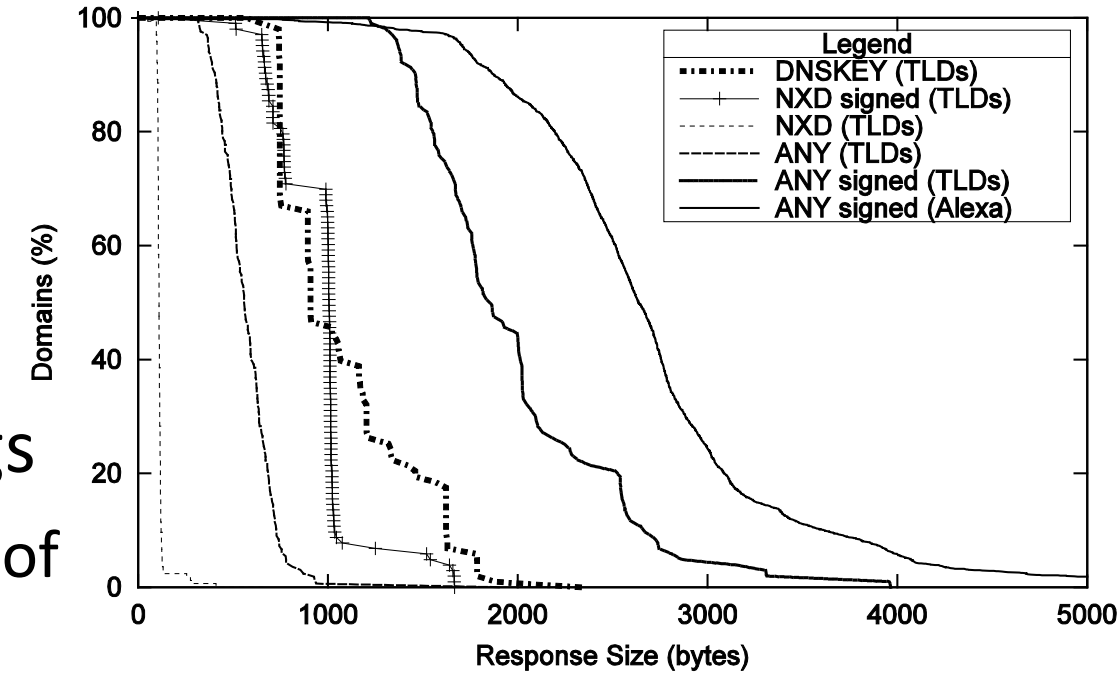
Servers Send Key/SIGs for ALL Supported Algs. → Large Responses!

- Blocked at intermediate devices e.g., firewalls
- Off-path attacks DoS and poisoning [HS12,HS13a-c,SW14]



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

- Transition to TCP?
  - Not all support
  - Overhead
- Low motivation to adopt ``shorter´´ algs
  - Mandatory support of RSA 1024
  - More algs. increase responses sizes

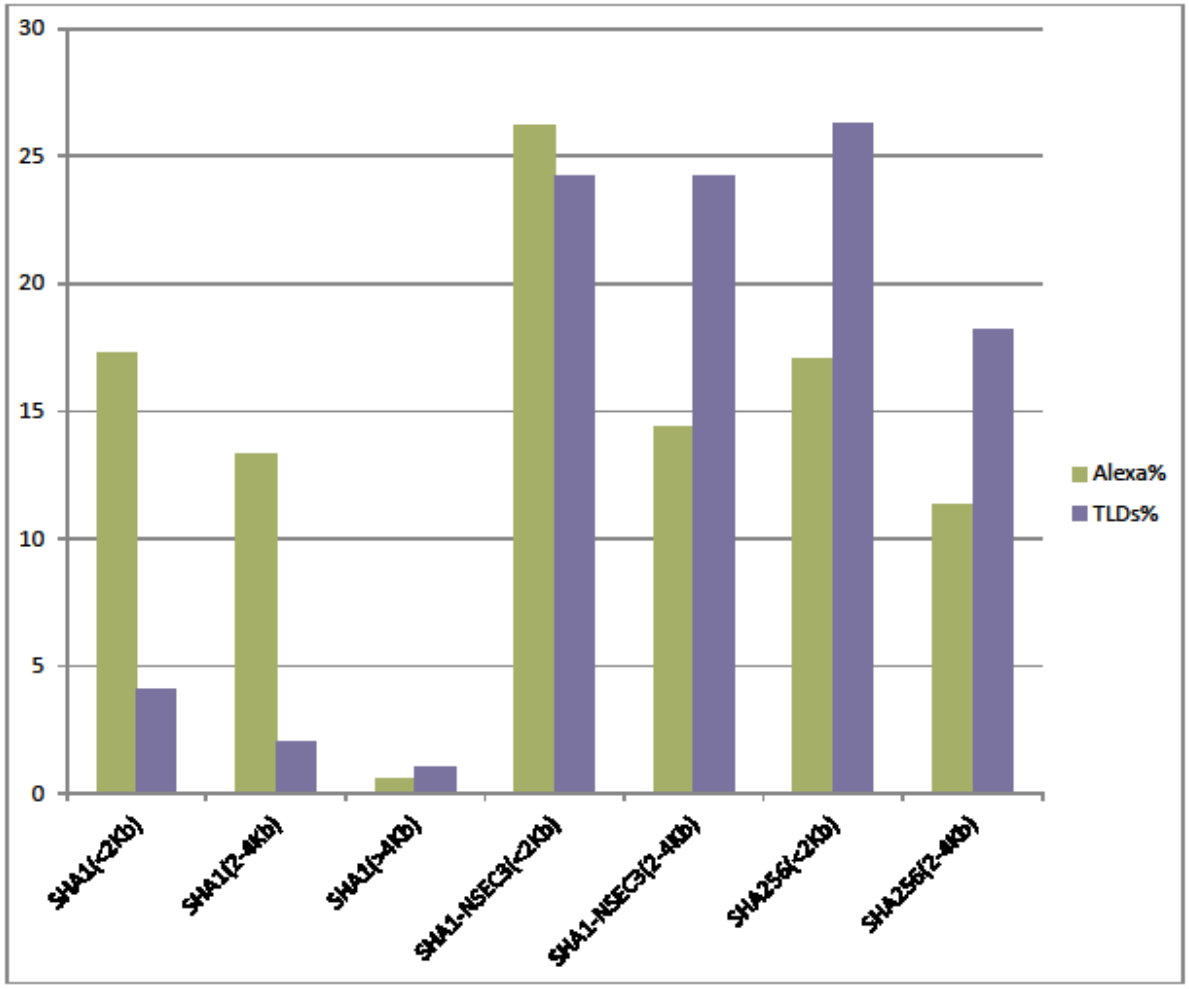


Supported DNSSEC Algorithms

- Weak ciphers

  Mandatory support of RSA1024

- No motivation to adopt better ciphers
  - Shorter signatures
  - More secure



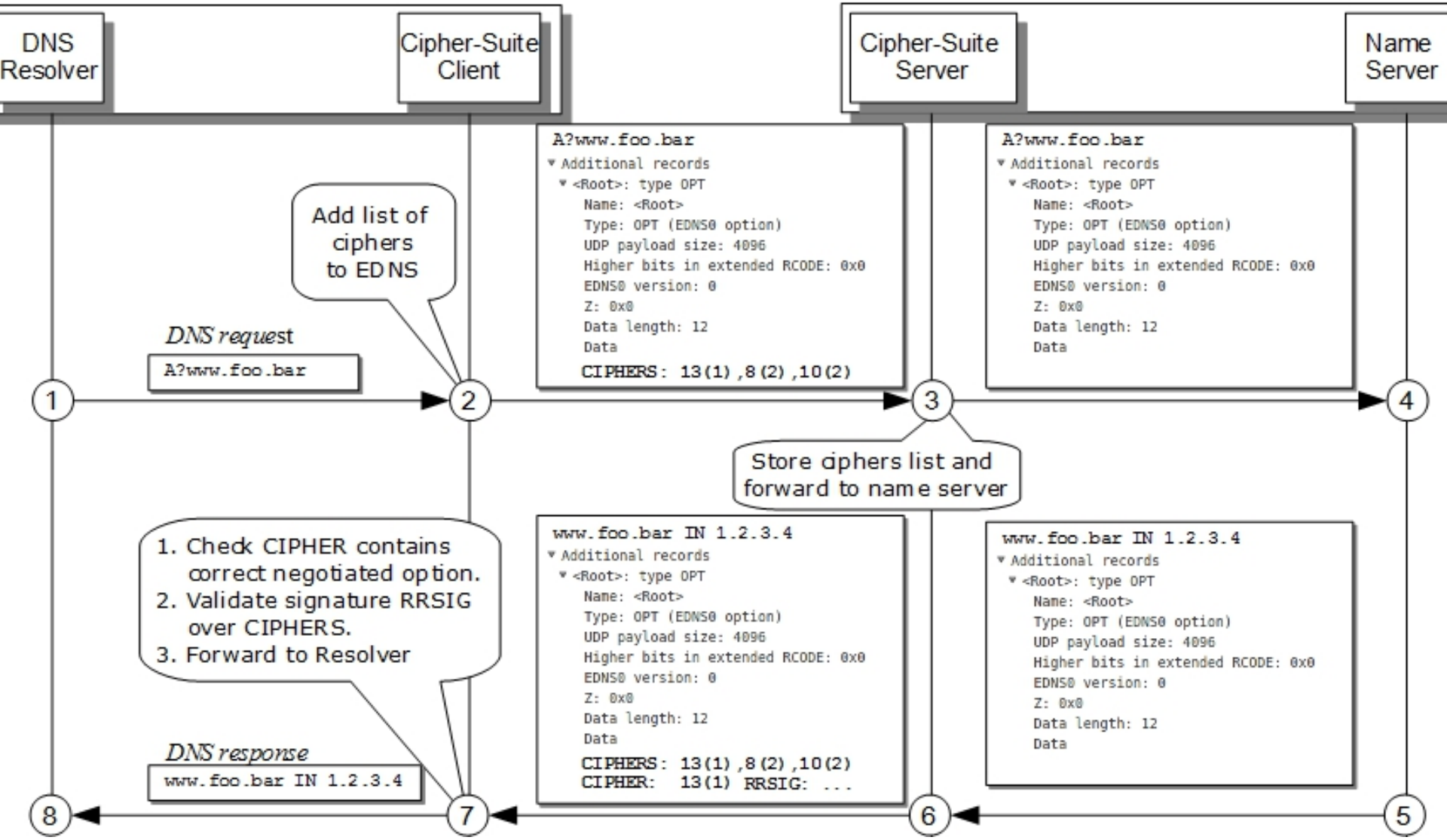
Cipher-Suite Negotiation for DNSSEC

- Goals:
  - Protect DNS transaction with optimal cipher
    - Reduce responses size and latency
  - Robust to downgrade
  - Interoperability with legacy proxies
- Hop-by-hop or end-to-end?

Hop-by-Hop Cipher-Suite Negotiation

- EDNS allows to introduce new options to DNS
- Resolver signals its ciphers and priorities in EDNS in DNS request
- Server sends records protected with the optimal cipher
  - Prevent downgrade → attach a signed list of supported ciphers in response

Hop-by-Hop Cipher-Suite Negotiation



Hop-by-Hop Cipher-Suite Negotiation

- But: intermediate proxies
  - Respond with cached signatures
    → may not be the priority/ciphers supported by requesting resolvers
  - Legacy proxies fall back to traditional DNSSEC

End-to-End Cipher-Suite Negotiation

- Server signals its ciphers in a special DNSKEY record (with new code)
  - DNSKEY encodes the public verification key of the zone

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

```
foo.bar.        3379 IN    DNSKEY 257 3 42
(RSA/SHA1(3), RSA/SHA1-NSEC3-SHA1(2), ECDSA
Curve P-256 with SHA-256(1)= ) ; key id = 12319
```

End-to-End Cipher-Suite Negotiation

- Server signals its ciphers in a special DNSKEY record
  - Key is cached by the resolvers

```
5  - RSA/SHA1
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42  - CIPHERS
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```

- Resolver concatenates cipher to query
  `cipher.delimiter.domain: 13._csn_.foo.bar`
- Name server returns requested record protected with the optimal cipher

End-to-End Cipher-Suite Negotiation

- Resolver identifies supporting name servers in advance
  - Via the special DNSKEY record
  - DNSKEY is requested once and cached according to TTL
- No redundant queries
- Optimal utilisation of intermediate caches

Conclusions

- DNSSEC-adopters use all supported ciphers
- Overhead is obstacle to DNSSEC adoption
- Mitigation: cipher suite negotiation
- Challenge: intermediate proxies
  - Hop-by-hop cipher suite negotiation is non-interoperable
  - End-to-end cipher suite negotiation
    - Resolver identifies supporting name servers in advance
    - No redundant queries and optimal utilisation of intermediate caches

Questions ?

Thank you!