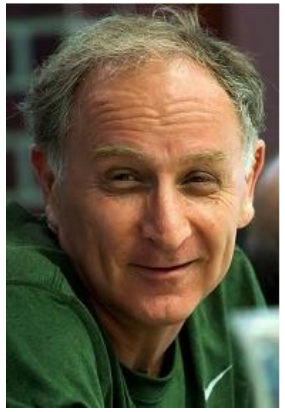
Adaptive DNSSEC



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Supported By:

Motivation (1)

DNSSEC significantly degrades DNS performances

	Max Queries Per Second
Plain DNS	23,524
DNSSEC: NSEC	9,510
DNSSEC: NSEC3	8,989

NXDomain Attack

RANDOM DNS Request Flood

Rxy1xhggsgVCER.sony.com

XVBY$&HGDRxy2.sony.com

FJH*^DHGAKRxy3.sony.com

RxUYQVMNLKAy4.sony.com

Resolvers

RzHW$RE43CBJs$7.sony.com

.com

ns.sony.com

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  - ➔ DDoS amplification

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* All measurements are under NX queries flood attack

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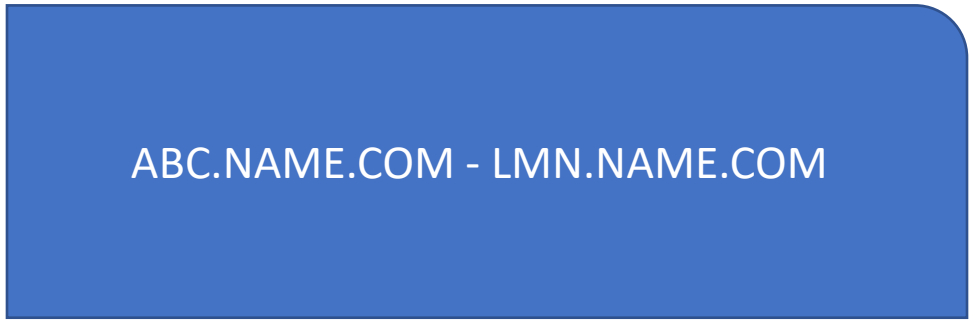

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- NSEC Record:

Motivation (2)

- Aggressive Caching (RFC 8198) – stops NX Attack

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Plain DNS	23,524
DNSSEC: NSEC	9,510
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Aggressive Caching	**Max Queries Per Second**
DNSSEC: NSEC	96,226
DNSSEC: NSEC3	93,756

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Only Knot

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- BUT: Enables Zone Walking

ABC.NAME.COM - LMN.NAME.COM

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- BUT: Enables Zone Walking
  Scalability Issues: Need to quickly find NSEC record

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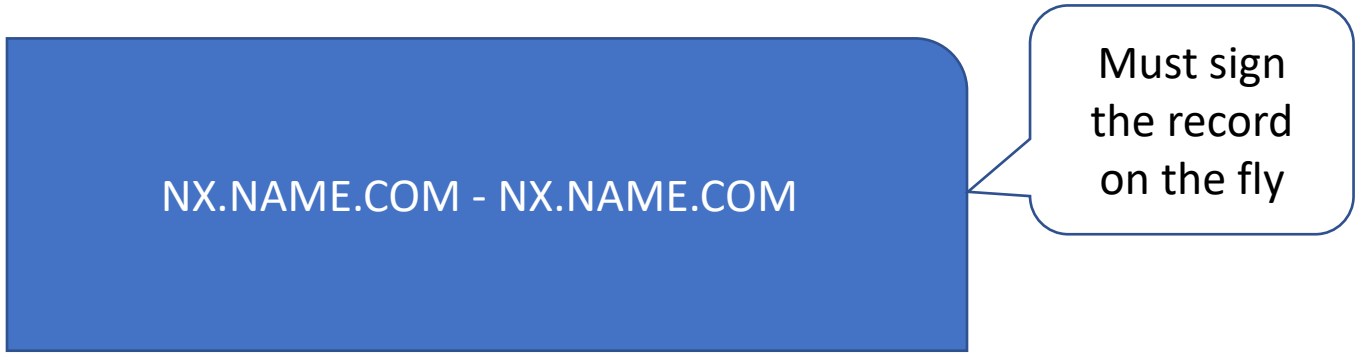

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Motivation (3)

- Online Signing Algorithms – NX Attacks Amplified

	Max Queries Per Second	% of Plain DNS
Plain DNS	23,524	100%
DNSSEC: NSEC	9,510	40%
DNSSEC: NSEC3	8,989	38%
DNSSEC: White Lies	5,863	25%
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DNSSEC: NSEC5	6,324	27%

Motivation (3)

- Online Signing Algorithms – NX Attacks Amplified
- **For security and scalability reasons online signing might be the only option**

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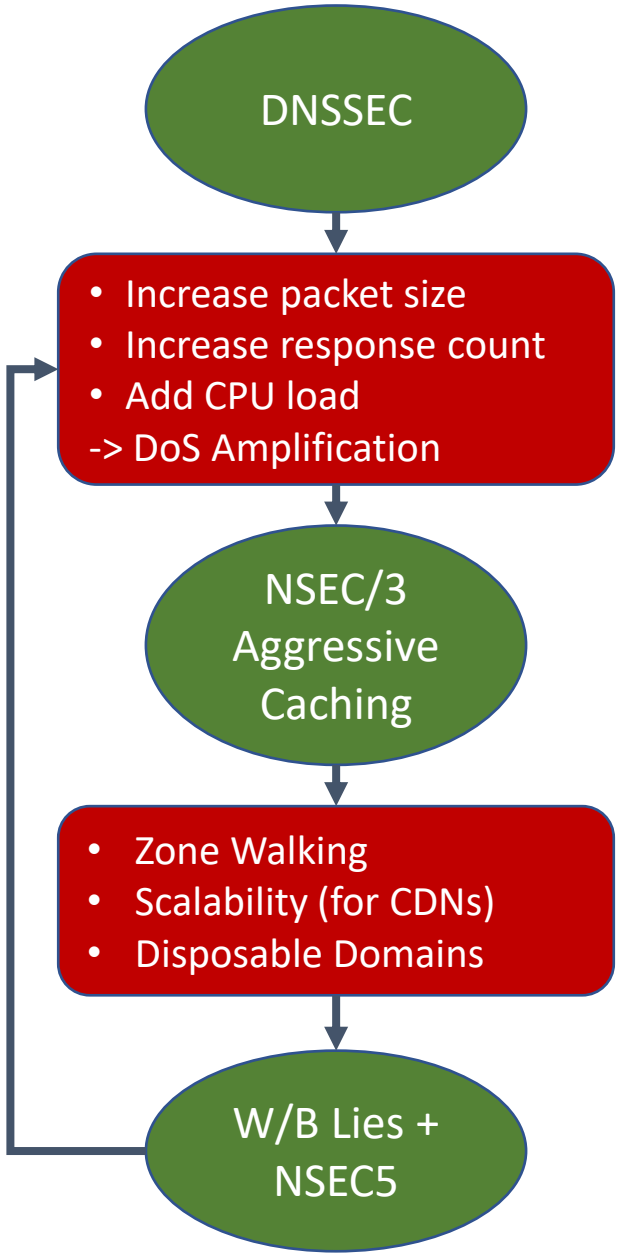
DNSSEC
• Increase packet size
• Increase response count
• Add CPU load
-> DoS Amplification
NSEC/3
Aggressive
Caching
• Zone Walking
• Scalability (for CDNs)
• Disposable Domains
W/B Lies +
NSEC5

Proposed Solution

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  - Packet Size + Count
  - CPU Load

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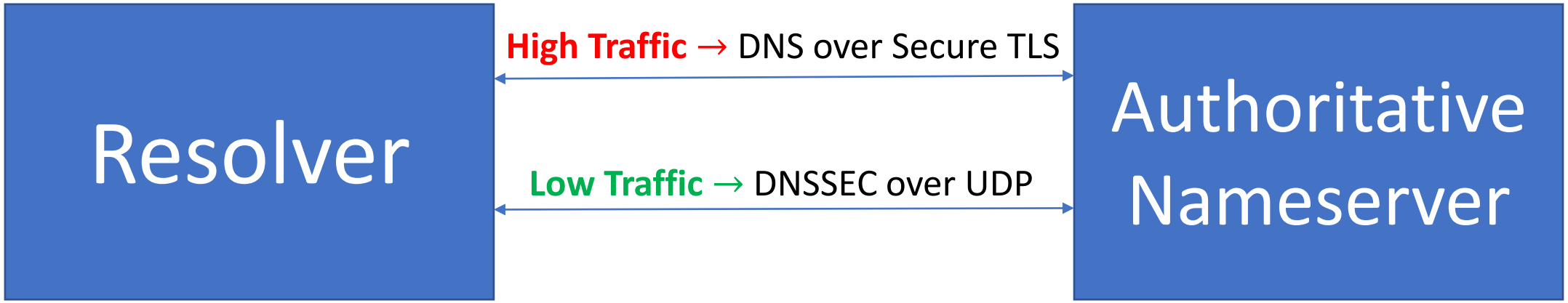
- Use TLS
  - Authoritative identifies once
  - Traffic sent with Plain DNS

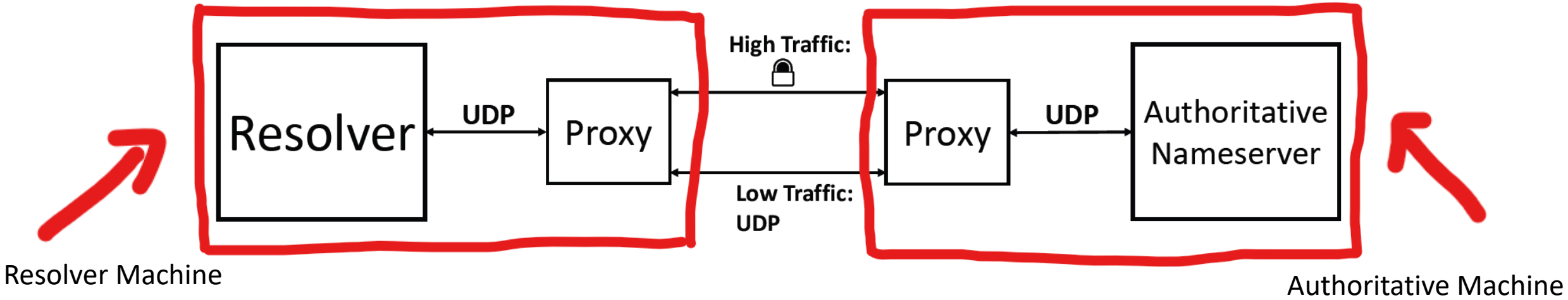
Proposed Solution - Hybrid



Proposed Solution – PoC (1)

- **Problem1:** Can't easily integrate with known resolver/auth implementations (Bind, Unbound, Knot, etc.)

- **Solution: proxy** interface resolver - authoritative servers



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  - TLS overheads are high
  - TLS suffers from Head-of-Line blocking

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  - TLS overheads are high
  - TLS suffers from Head-of-Line blocking
- **Solution:** Use QUIC (similar to HTTP3)
  - UDP Multiplexing (virtual connections)
  - 0-RTT: resume the connection with 0 round trip time
  - No need for TCP integration (firewalls/IPS)

Proposed Solution – PoC (3)

- **Problem3**: Teardown and restart QUIC connections

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- **Solution:** Keep connections alive
  - QUIC has low overhead – long lived connections
  - QUIC can resume quickly

Proposed Solution – PoC (4)

- **Problem4:** Resource limit

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- **Problem4:** Resource limit
- **Solution:** Score connection throughput with

$$F_i = \alpha \cdot F_{i-1} + (1 - \alpha) \cdot f_i$$

Terminate lowest scored connection (LRU)

Measurements

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Measurements

With QUIC, using the same experiment (NX flood), throughput is **87%** of the plain DNS

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AdaDoQ (Our Solution)	**20,558**	**87%**

Conclusions

- DNSSEC degrades DNS performance
  - Make NXDOMAIN attacks worse (DDoS amplification)
- AdaDoQ – Hybrid Solution
  - Light and fast connections
  - One time encryption overheads
  - Close to Plain DNS throughput
  - No Security Compromises
    - Zone Walking
  - No Scalability Issues

Questions?