A Simple Approach to DNS DoS Mitigation

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DoS attacks on DNS

Attack: Flood the nameservers of a DNS zone

Goal: Disrupt the resolution of

- The zone's resource records
- And the records for any of the sub-zones

Attacks aplenty (some successful, other not!)

- Microsoft attacked (2001)
- DNS Root Servers attacked (2002)
- SCO attacked (2003)
- Akamai attacked (2004)
- Root Servers, TLDs and UltraDNS (2006)

Networking community to the rescue

- Kangasharaju et. al. [INFOCOM'00]
- Cox et. al. [IPTPS'02]
- Theimer et. al [ICDCS'02]
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Decouple data distribution from authority hierarchy

Ensure **availability** of data distribution mechanism

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Decouple data distribution from authority hierarchy

Ensure **availability** of data distribution mechanism

- Centralized approaches
- Peer-to-peer approaches

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Decouple data distribution from authority hierarchy

Ensure **availability** of data distribution mechanism

- Centralized approaches
- Peer-to-peer approaches

A complementary tact to handle DoS attacks

Do away with the need for 100% availability

Clients are able to resolve a zone's records even when the zone's nameservers are not available

In this paper

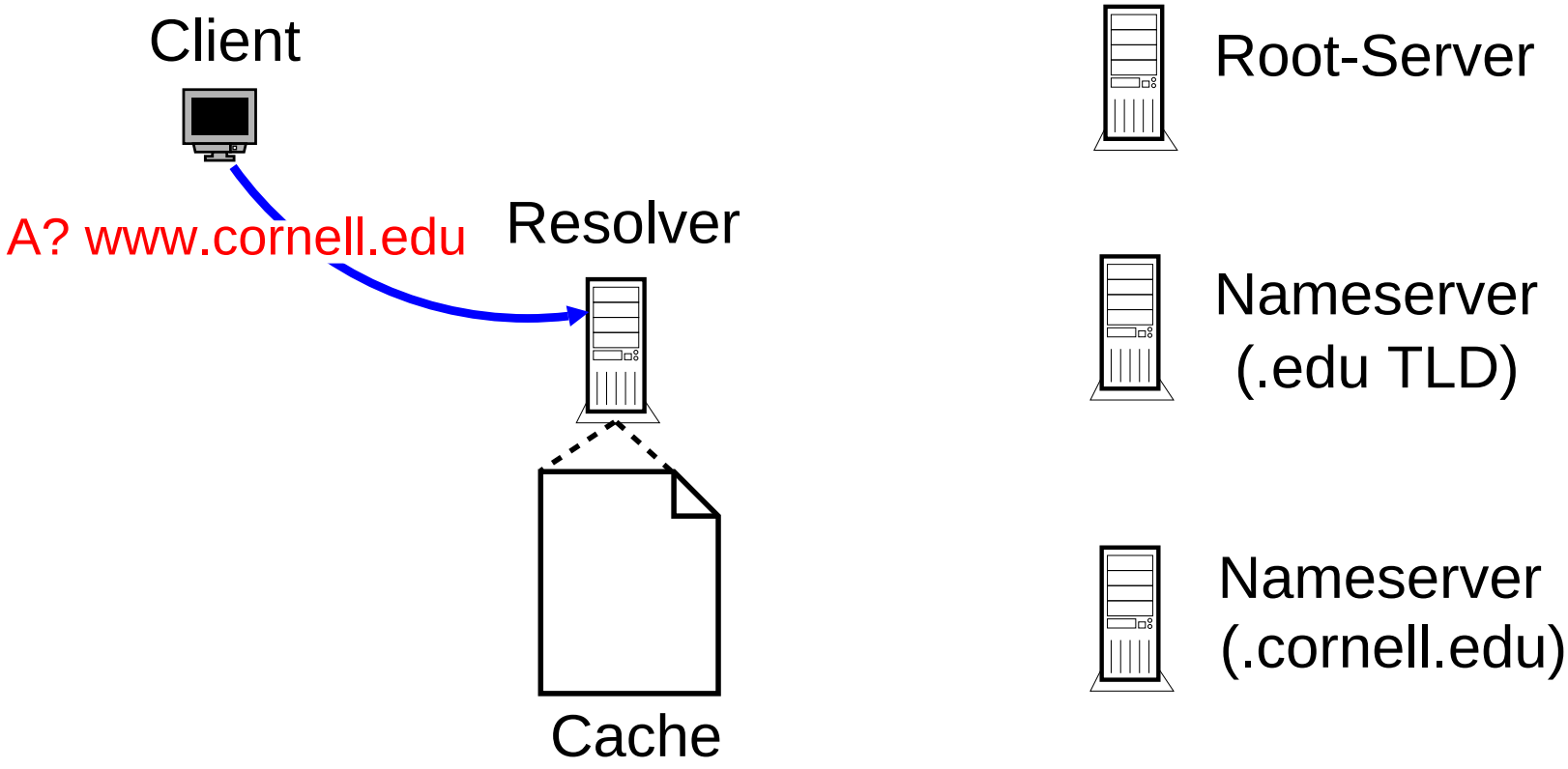
A minor modification in the caching behavior of DNS resolvers

- Reduces the need for nameserver availability in the **existing DNS framework**
- Mitigates the impact of DoS attacks on DNS

Talk Outline

- Introduction
- DNS Resolvers Today
- Proposed Modification
- The Good
- The Bad and the Ugly

DNS Resolvers Today



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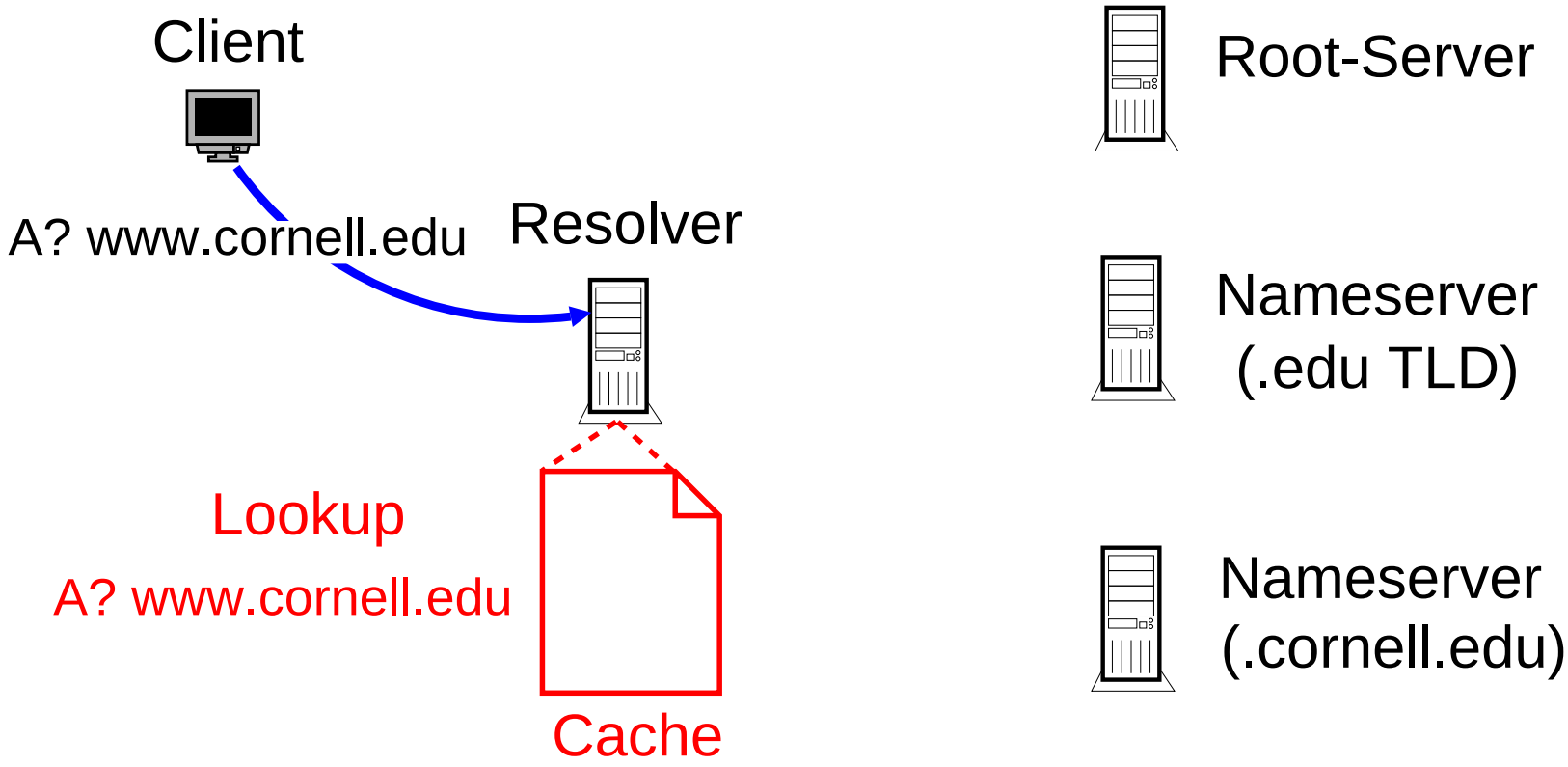

Resolution Process

1. Lookup the resolver cache
2. Traverse down the DNS hierarchy
3. Traversal fails $\Rightarrow$ Resolution fails

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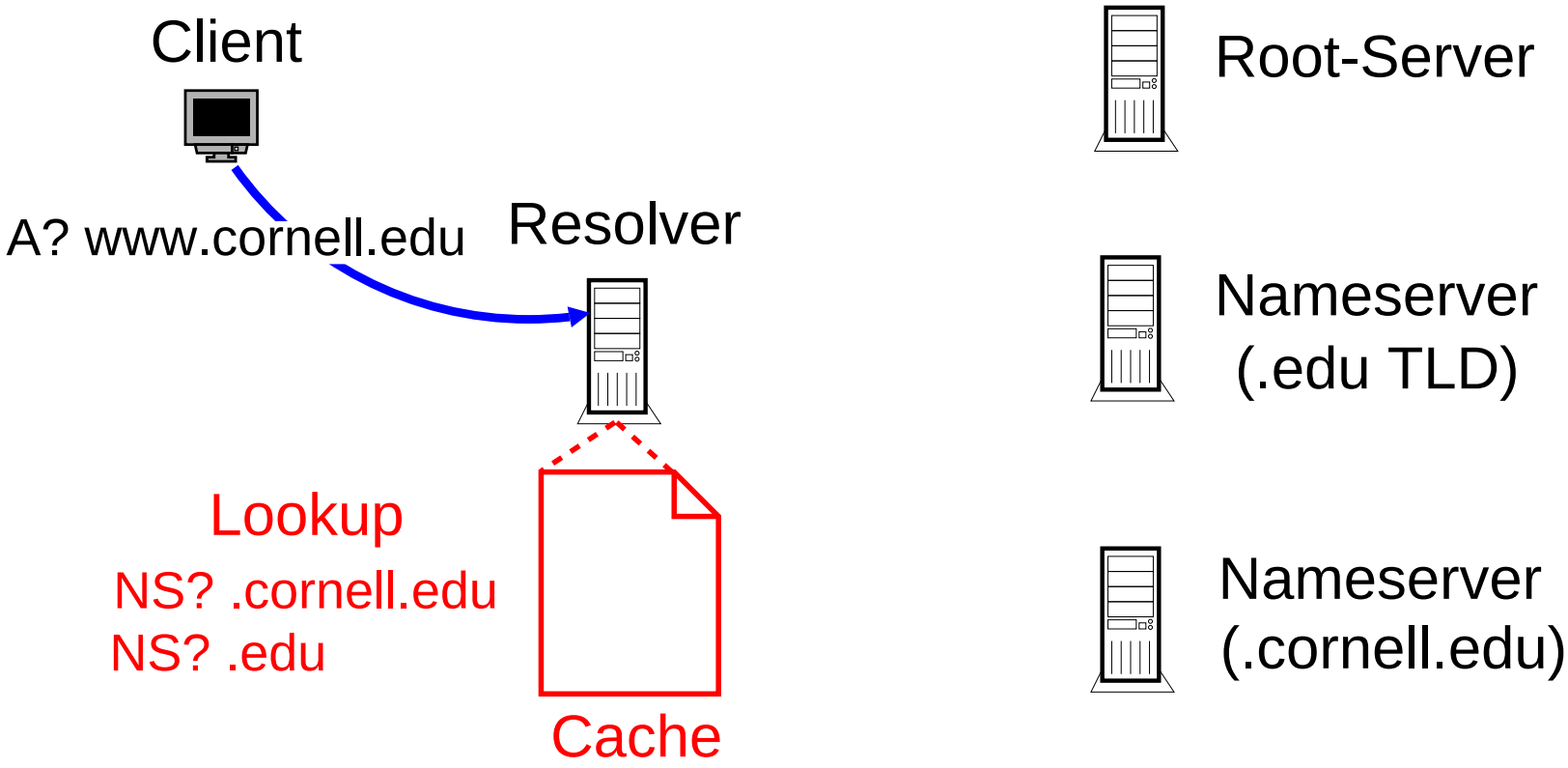

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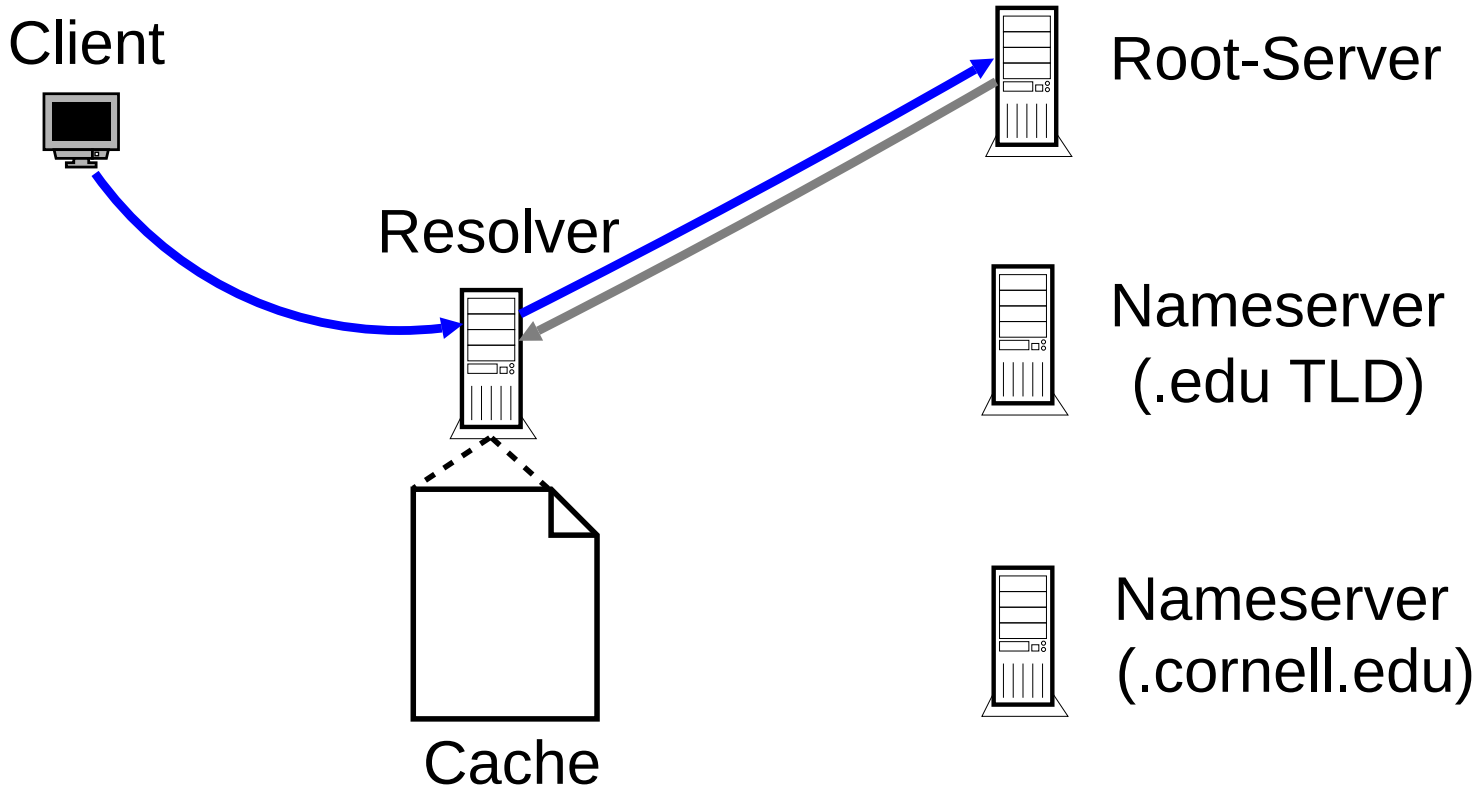

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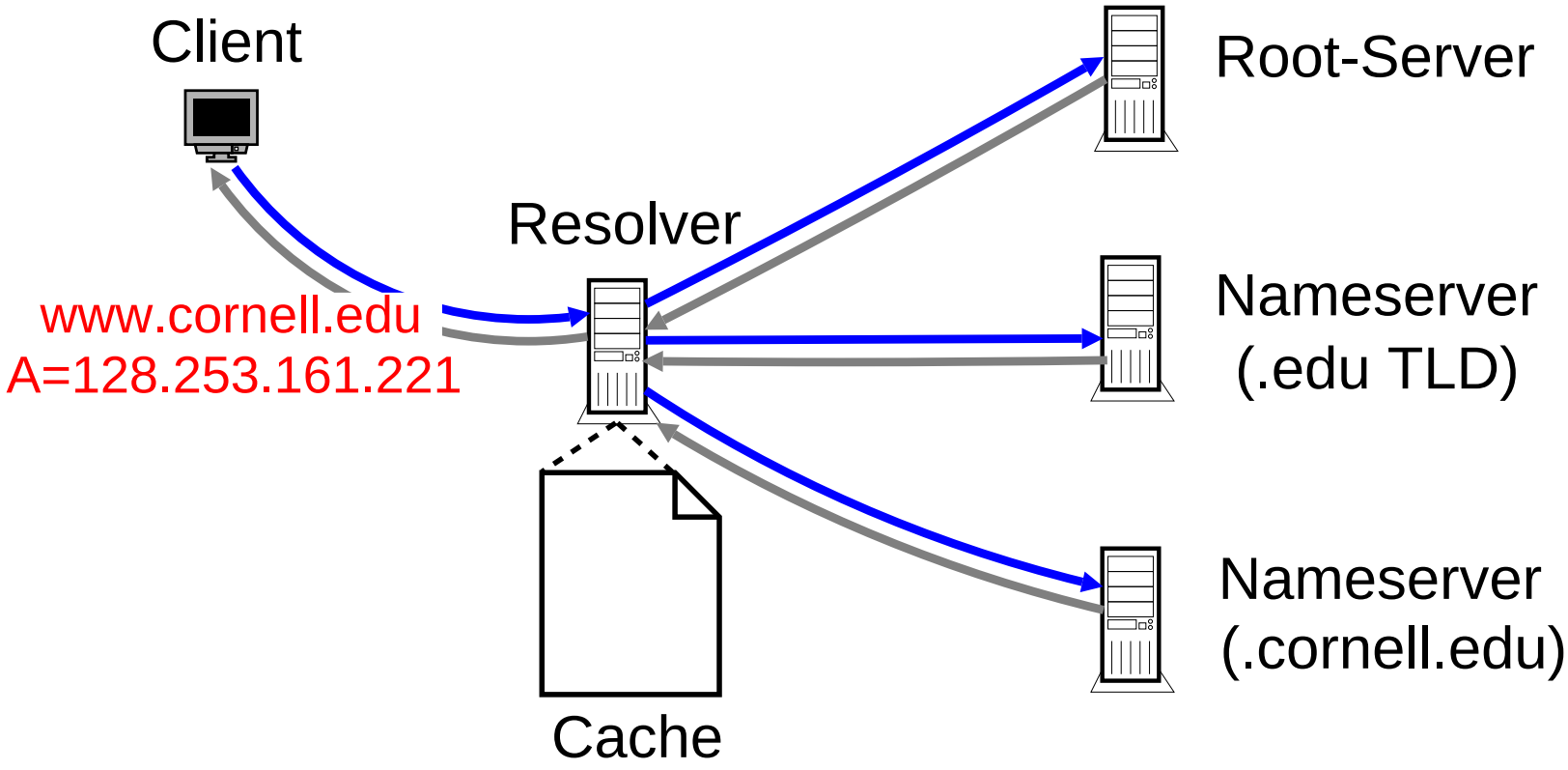

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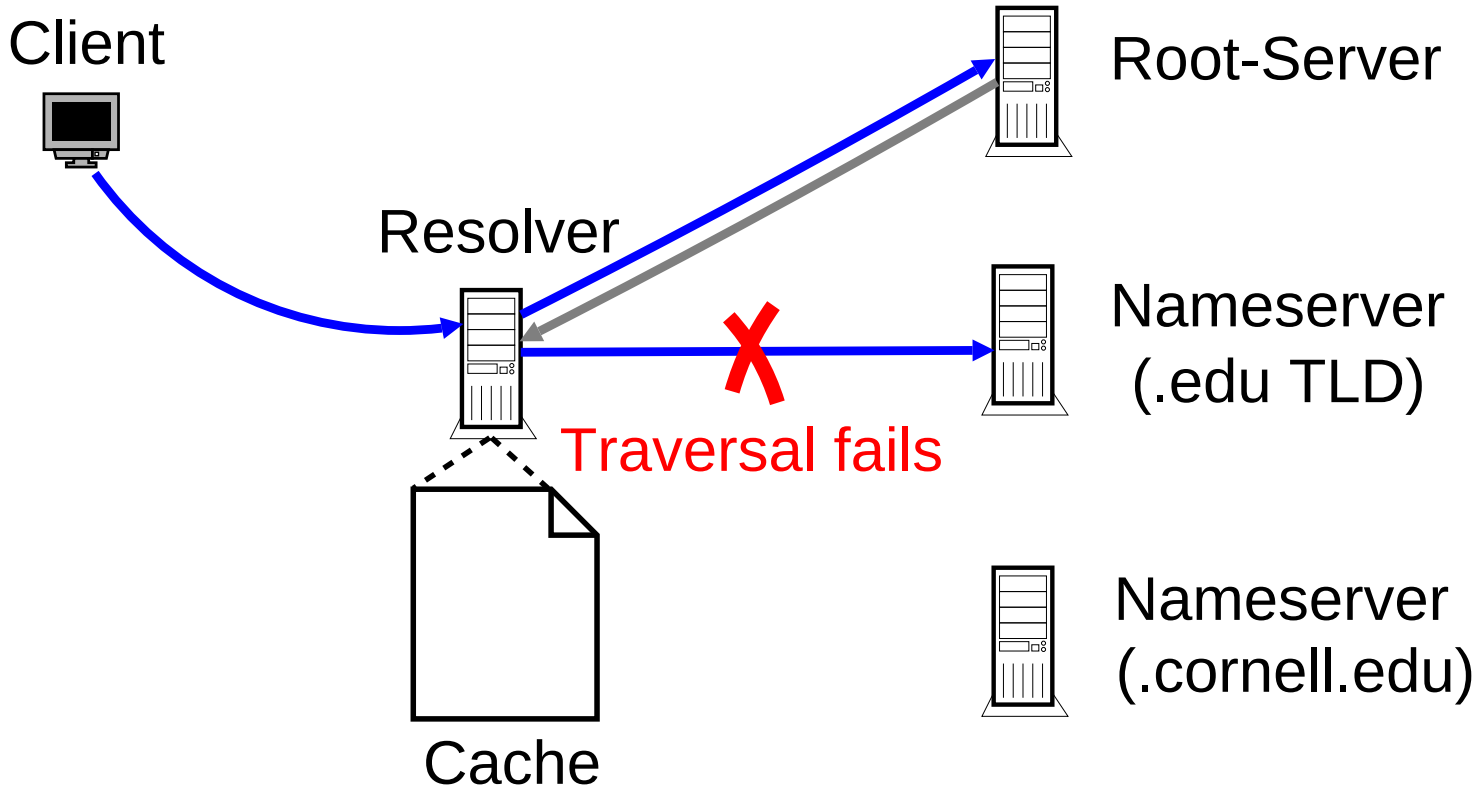

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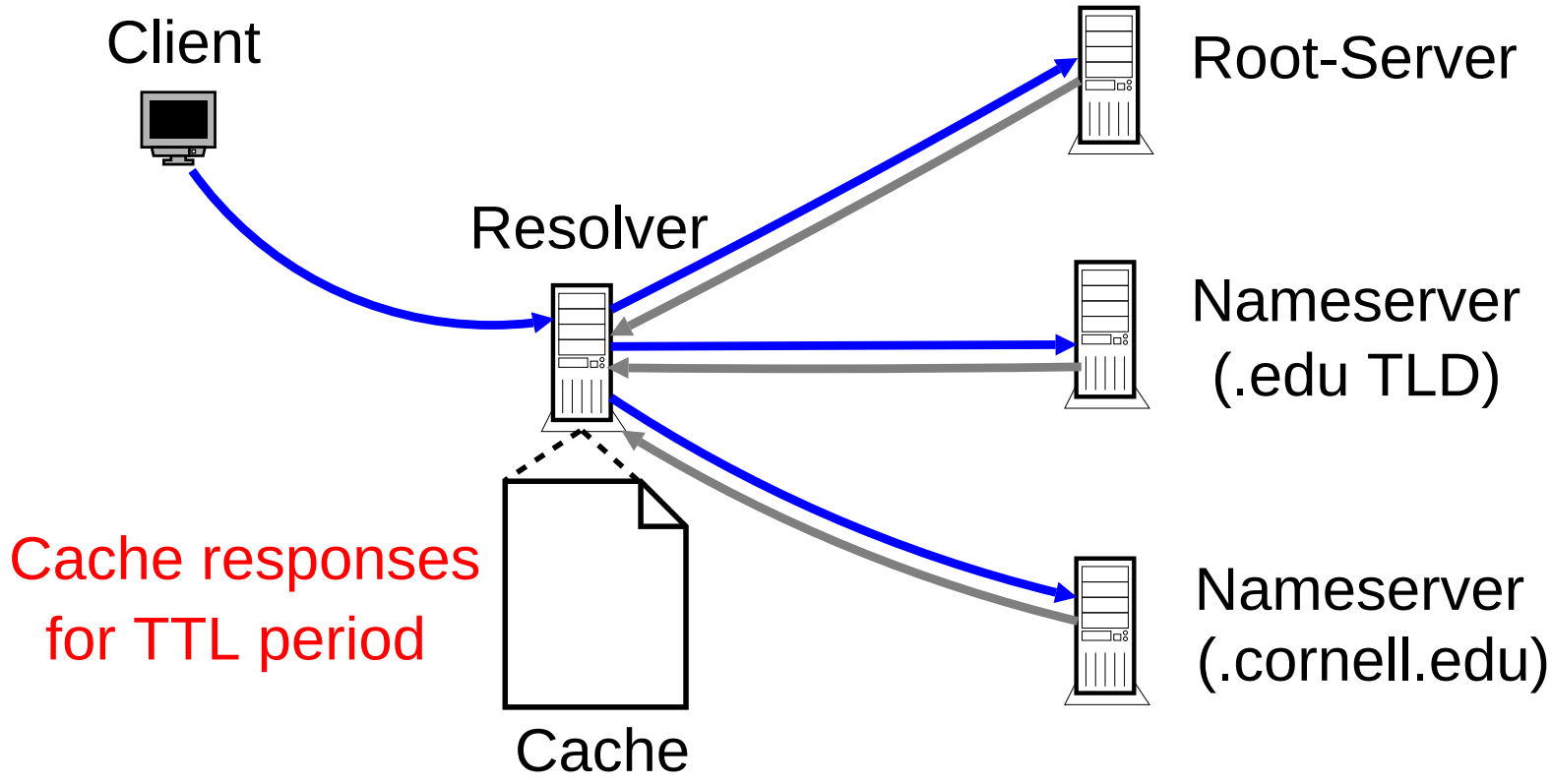
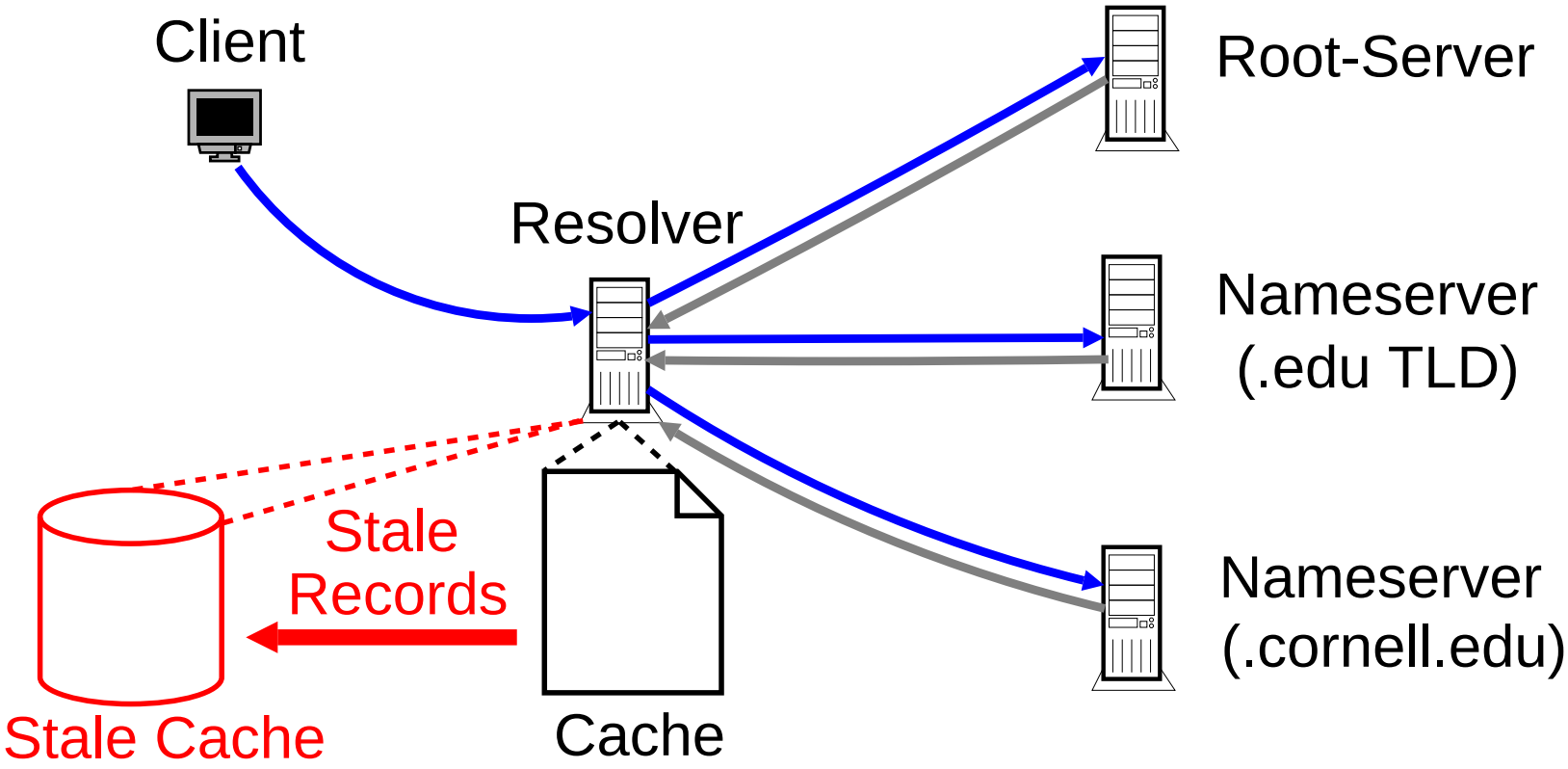


Resolver caching behavior

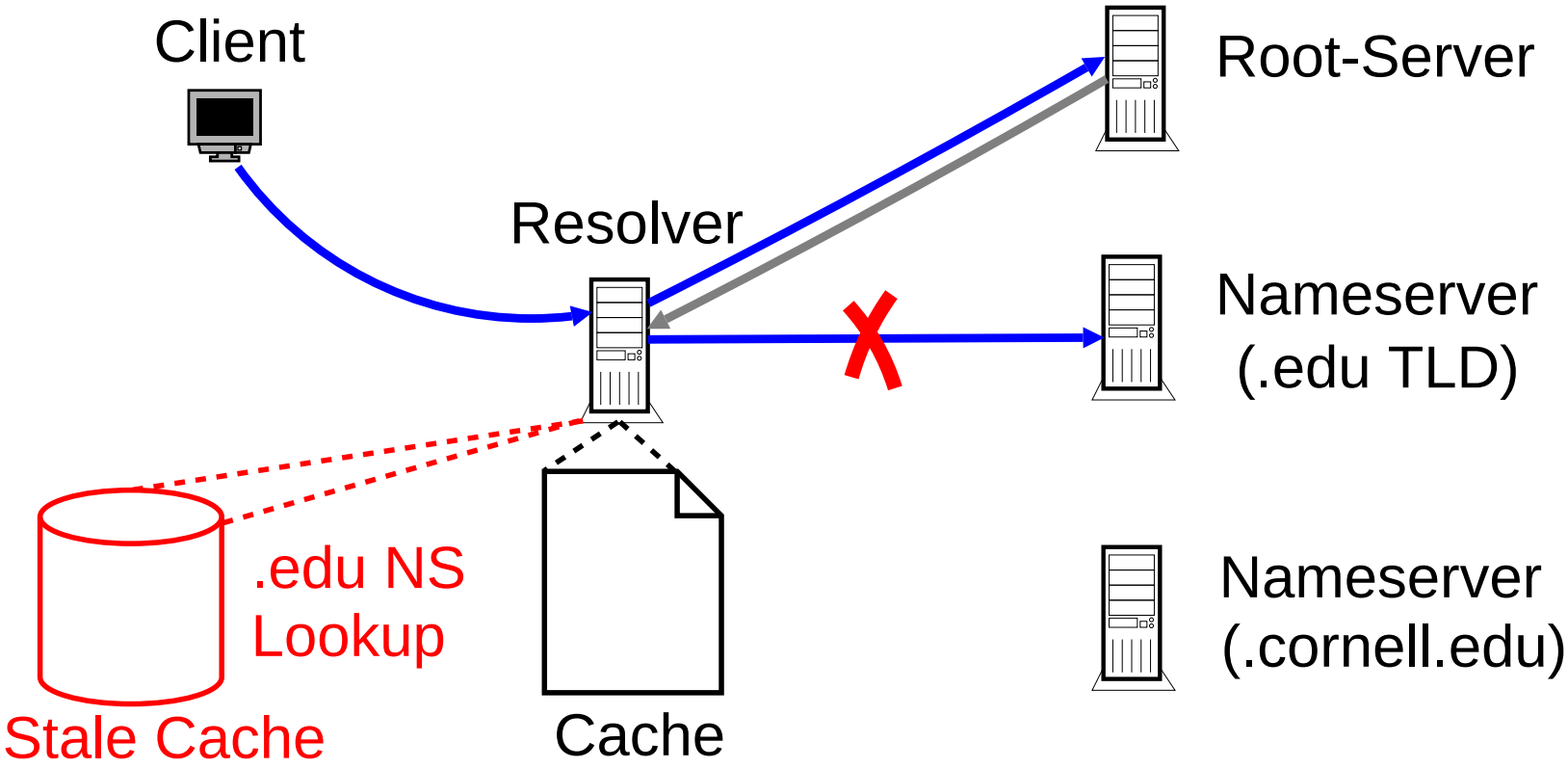
Cached records expunged after their TTL expires

Proposed Modification



Cached records expunged to a **Stale Cache**

Proposed Modification



Modified Resolution Process

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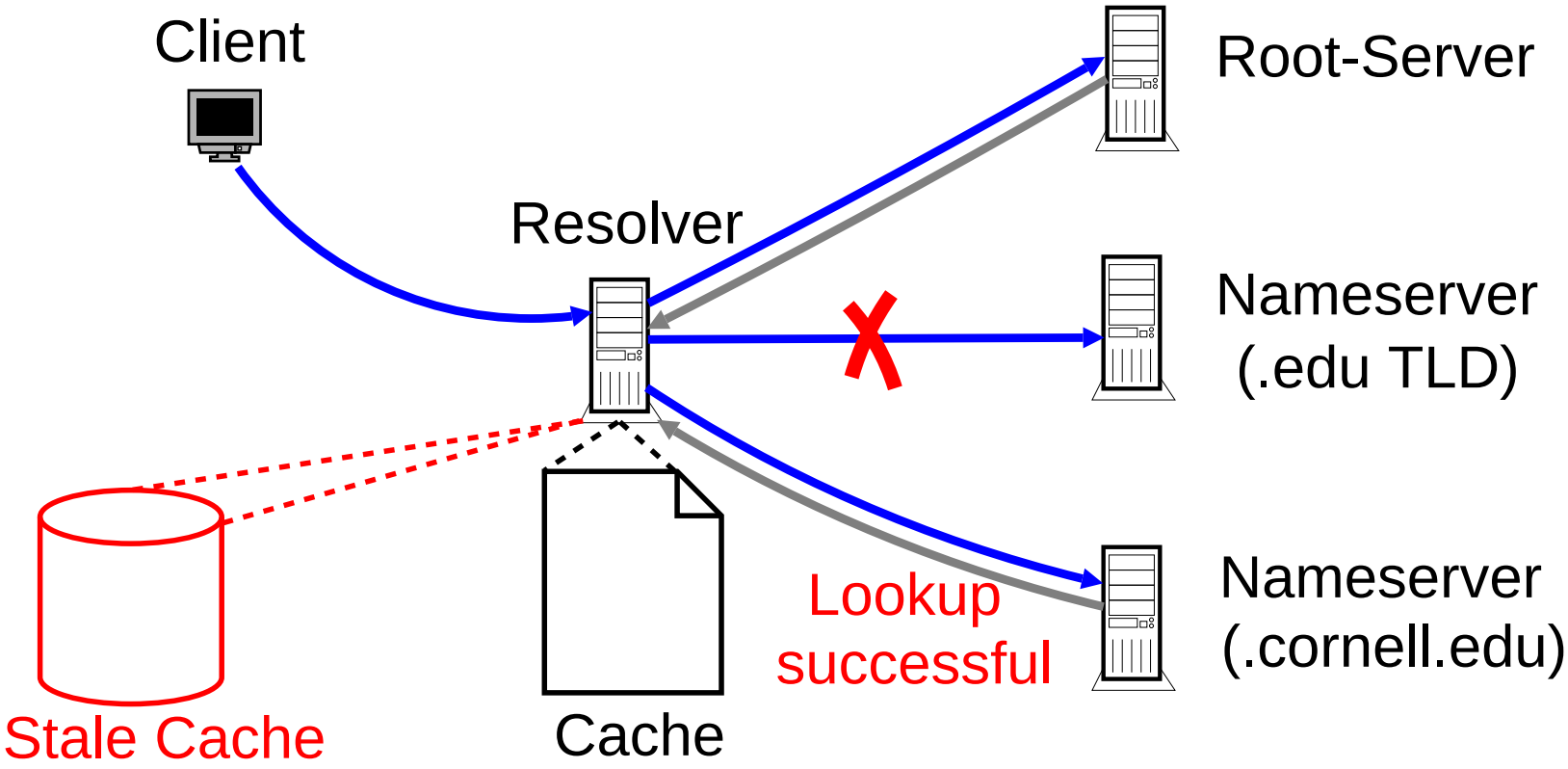
Proposed Modification



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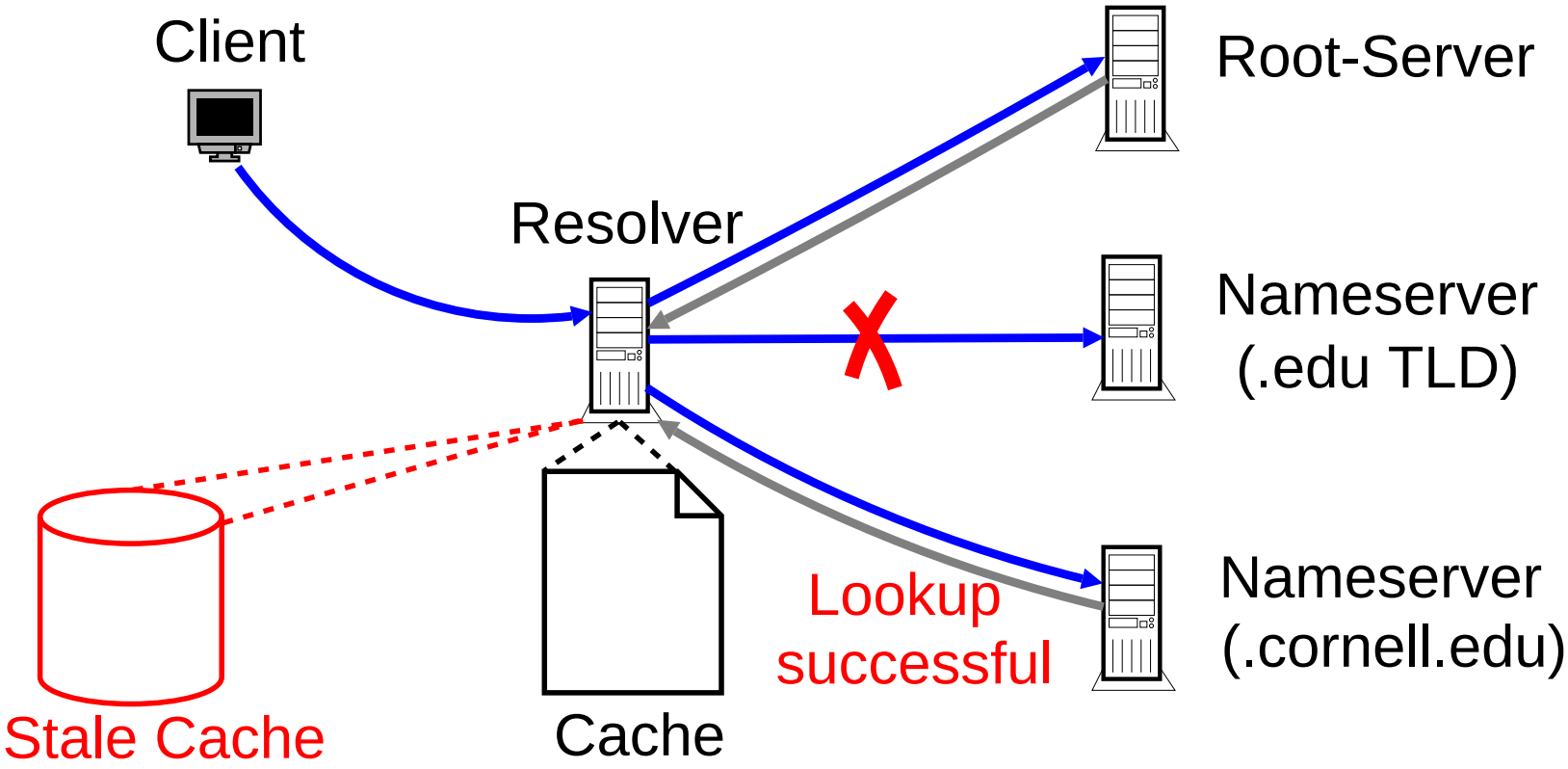

Stale records for a zone used **only** when the nameservers for the zone are unavailable

Stale Cache Details

Expunging records from the Stale Cache

Responses from nameservers used to clean up the stale cache

Disk-based Stale Cache

Stale Cache lookups can be done while querying the nameservers

Proposed Modification: Pros

Increased DNS Robustness

- Nameserver availability less crucial
- Mitigates the impact of DoS attacks

Simplicity

- Does not change the basic protocol operation
- Does not impose any load on DNS
- Does not impact the query resolution latency

Incremental Deployment

- Motivation for deployment

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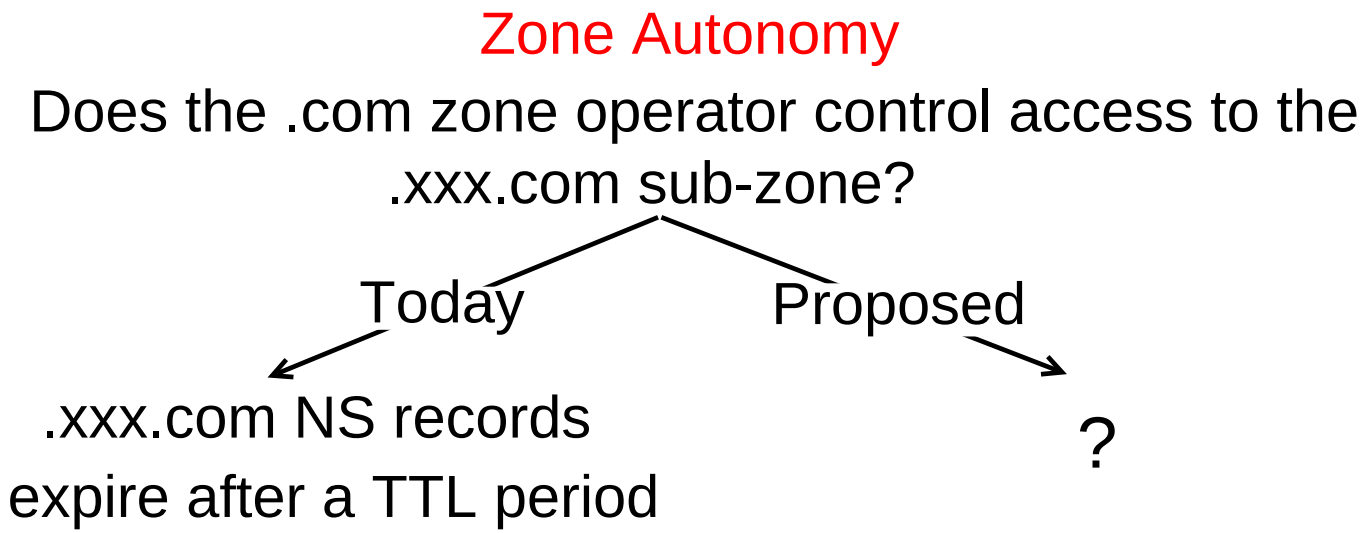

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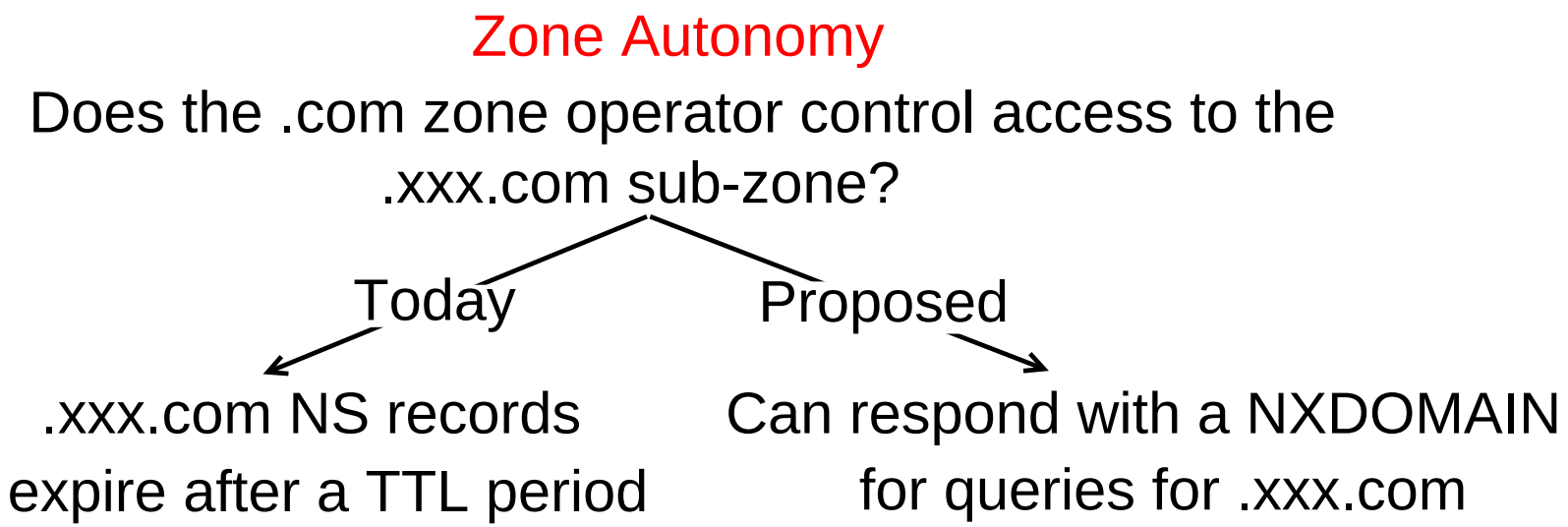

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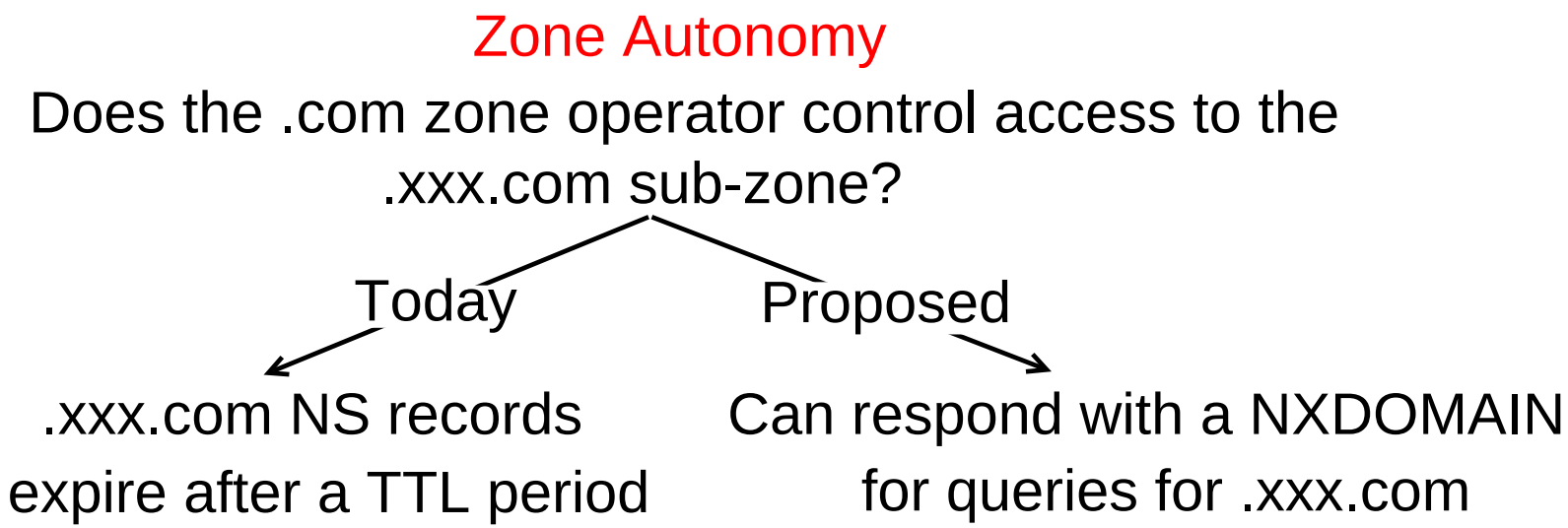

Zone operators still control access to their sub-zones

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Possibility of obsolete information being used

Obselete zone records used by a resolver only if

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Use of stale cache could be restricted to Infrastructure Records

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Attackers forcing the use of obsolete records for a zone by

- Waiting for the zone's records to be updated
- And then flooding the zone's nameservers

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Resolution latency in the face of attacks

- Resolver must query each nameserver of a zone before using the zone's records from the stale cache
- Given default resolver timeout configurations, this can lead to high resolution latencies

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Alleviative: Resolvers configured with aggressive retry and timeout values

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DNS servers can still be overwhelmed

- Unable to update the zone's records

Application servers can still be DoS'ed

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Application servers can still be DoS'ed

- Do DNS servers and Application servers share the network bottleneck?

Future Work

Quantifying the benefits of the stale cache

- Currently collecting DNS traces at Cornell
- Simulate stale cache usage under different attack scenarios

Implementation

- As an add-on to the CoDNS service on PlanetLab
- Quantify benefits under real-world attacks

Summary

A minor modification in the caching behavior of DNS resolvers

- Resolvers evict expired records to a stale cache
- Stale records can **only** be used when nameservers are unavailable
- Reduces the need for nameserver availability in the **existing DNS framework**

Mitigates the impact of DoS attacks on DNS

- Modifies the DNS caching semantics
- **Does not impact** fundamental DNS characteristics

Thank You!