Domain Name System (DNS) (Contd.)

CPSC 433/533, Spring 2021

Anurag Khandelwal

Evaluating Midterm Performance

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- **Observation: 45+ scorers attend class regularly, and turn up to office hours!**
  - Correlation is not causation, but it does make you wonder…
  - Attend class (encourage your friends to do the same!)
  - Participate (ask questions, post on Piazza, show up for OH, …)

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    - We will award everyone 1 point for the question

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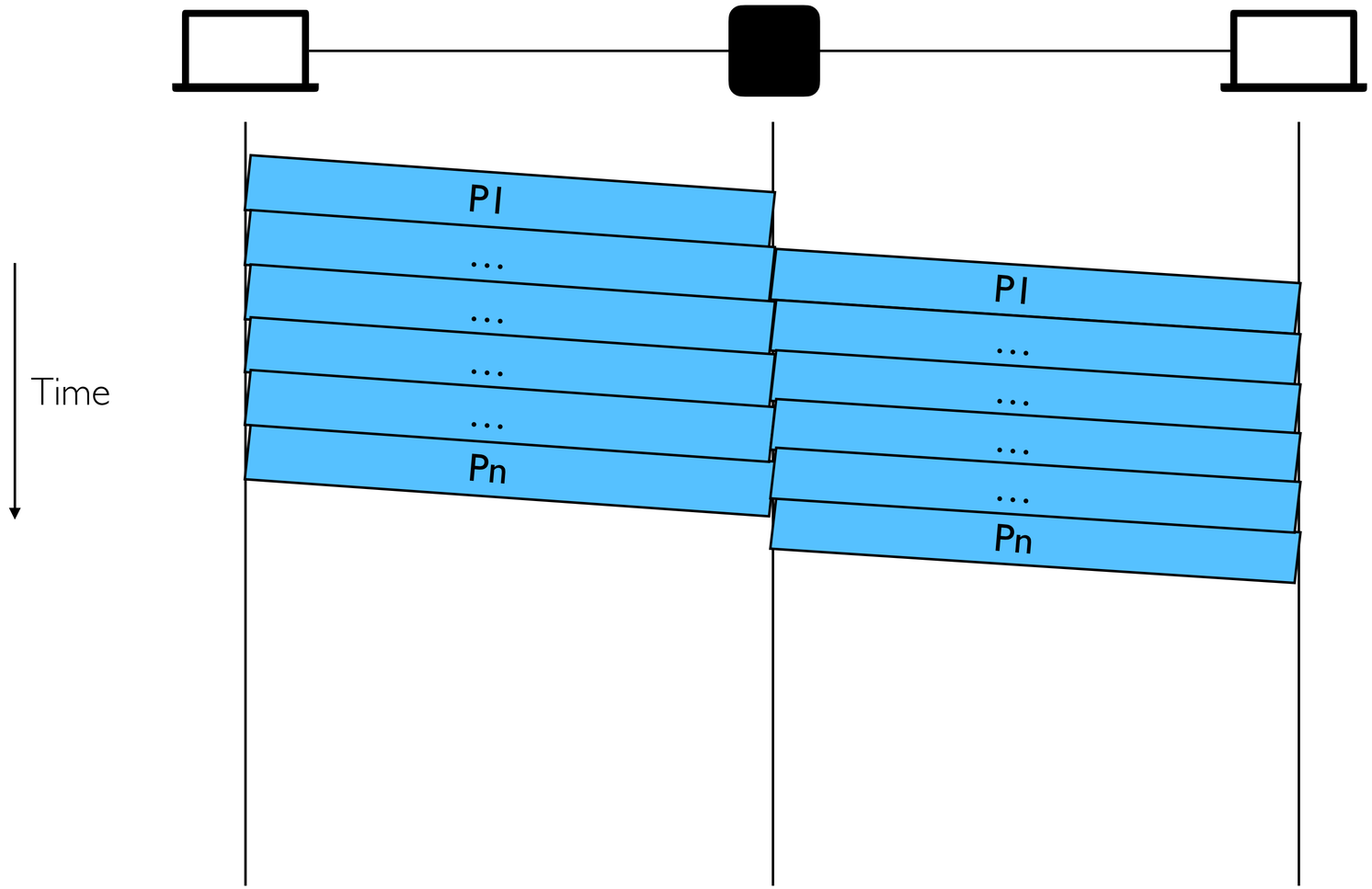

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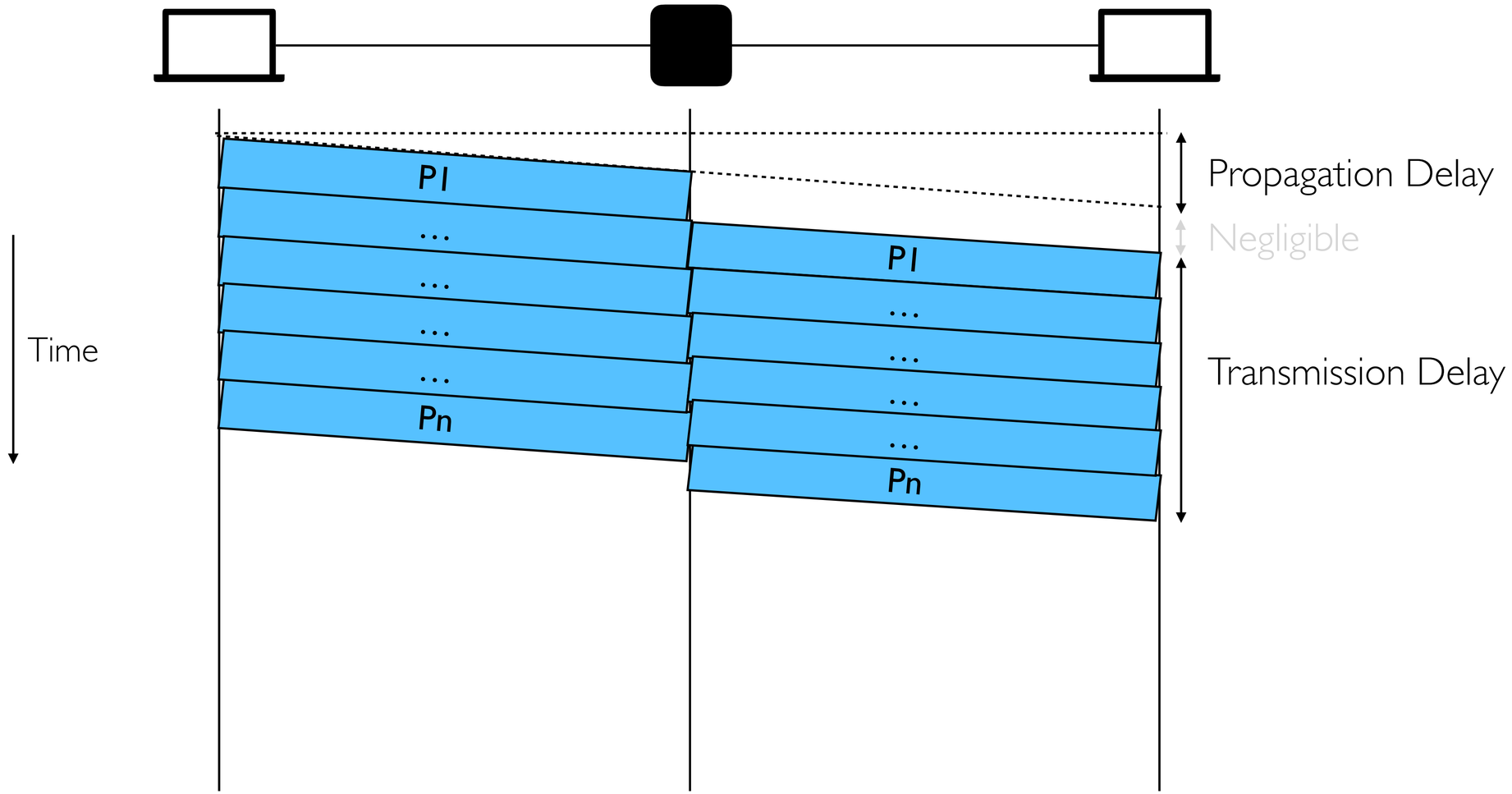

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- **Please fill out the mid-semester survey!**
  - Survey link: https://www.surveymonkey.com/r/XGYCGXD
  - Will help us understand where you are struggling, and what we can do to fix it!
  - If you don't speak up, nothing will change…
    - … but if you do, I promise I will do everything I can to help you learn!

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  - 😅… will post pdfs both with & without animations

Administriva: Project 2

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- **Project 2 will be released tonight, due in 3 weeks**
  - Will let Jonathan tell you more about it…

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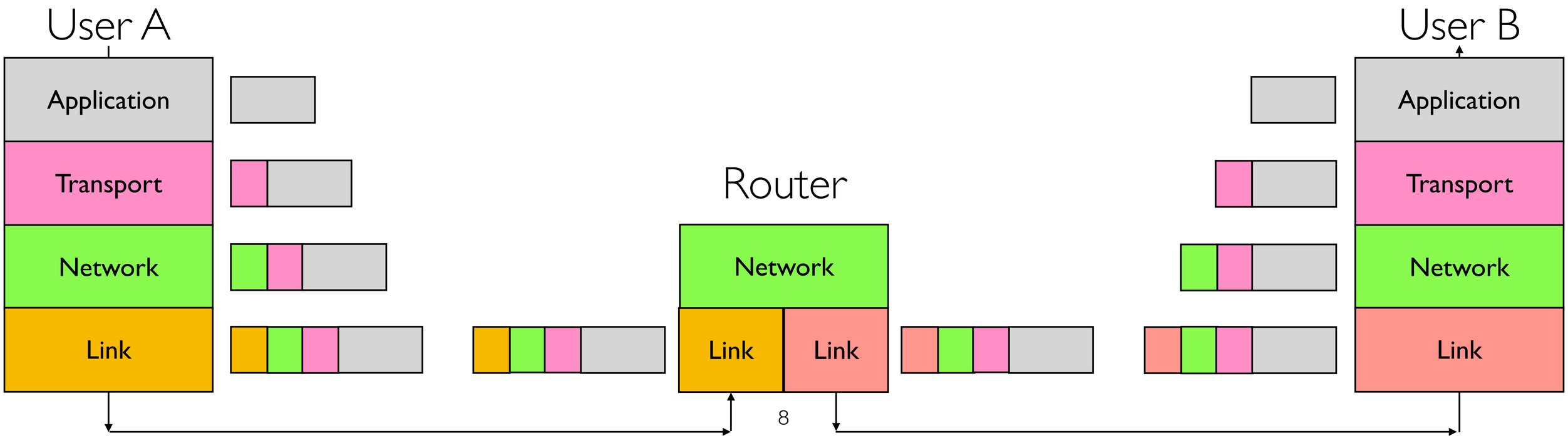

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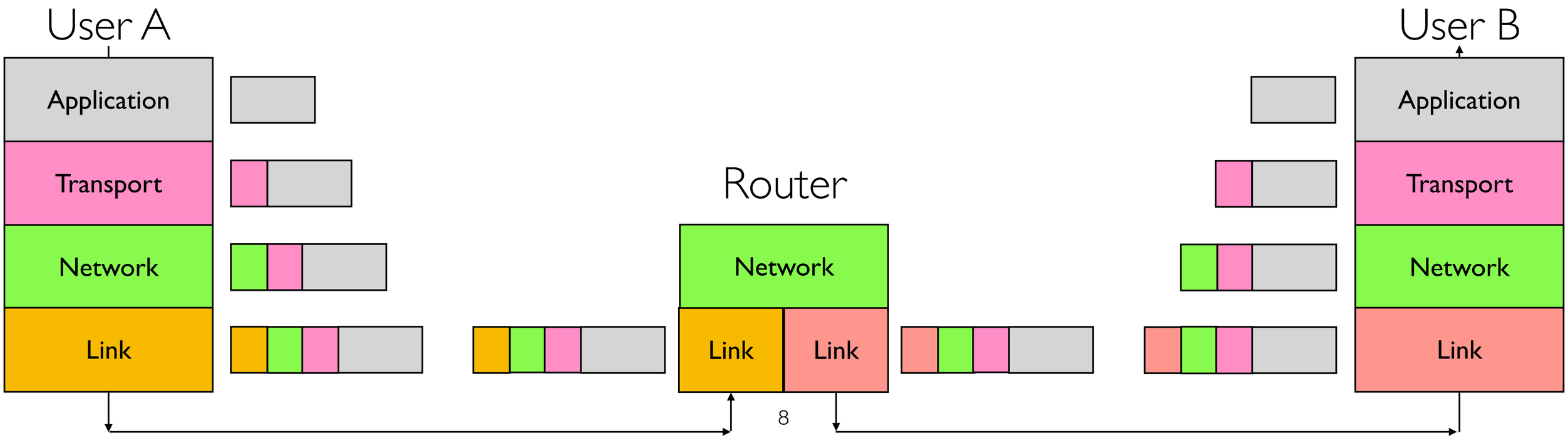

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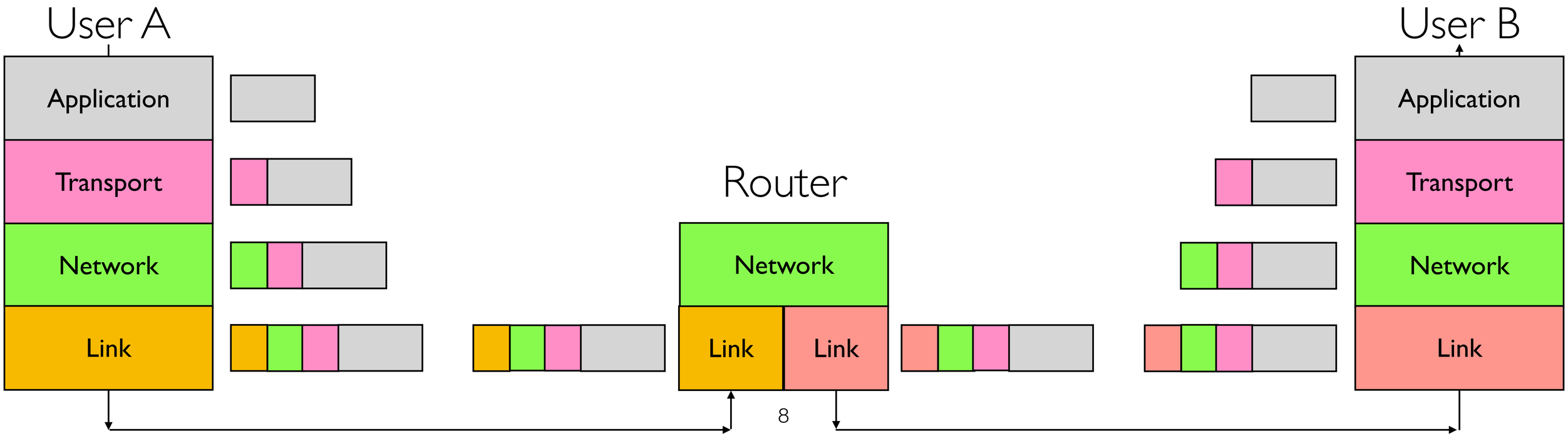

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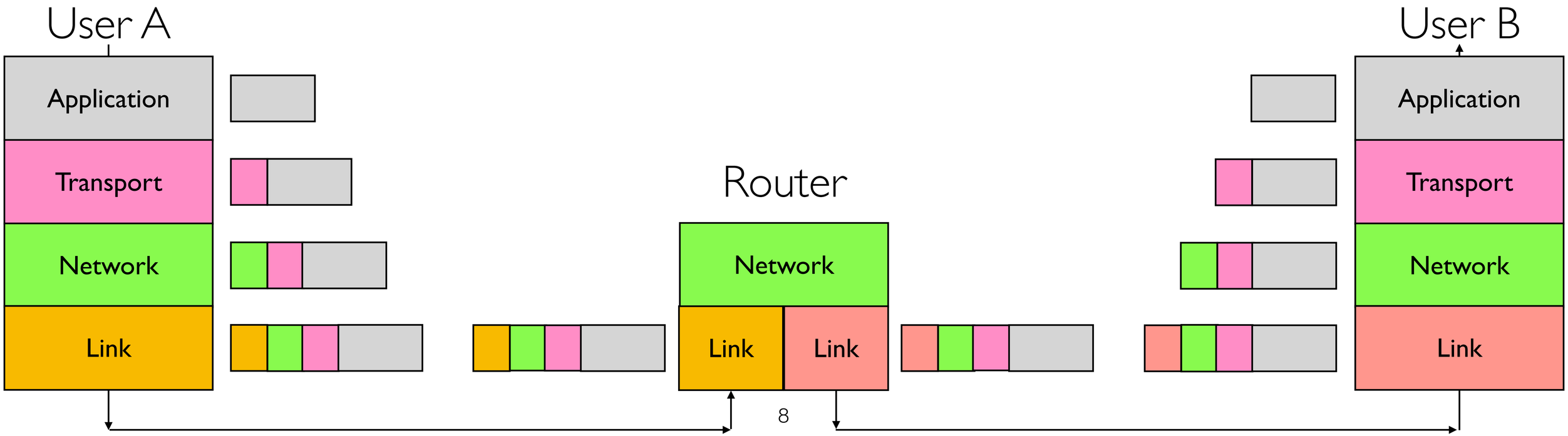

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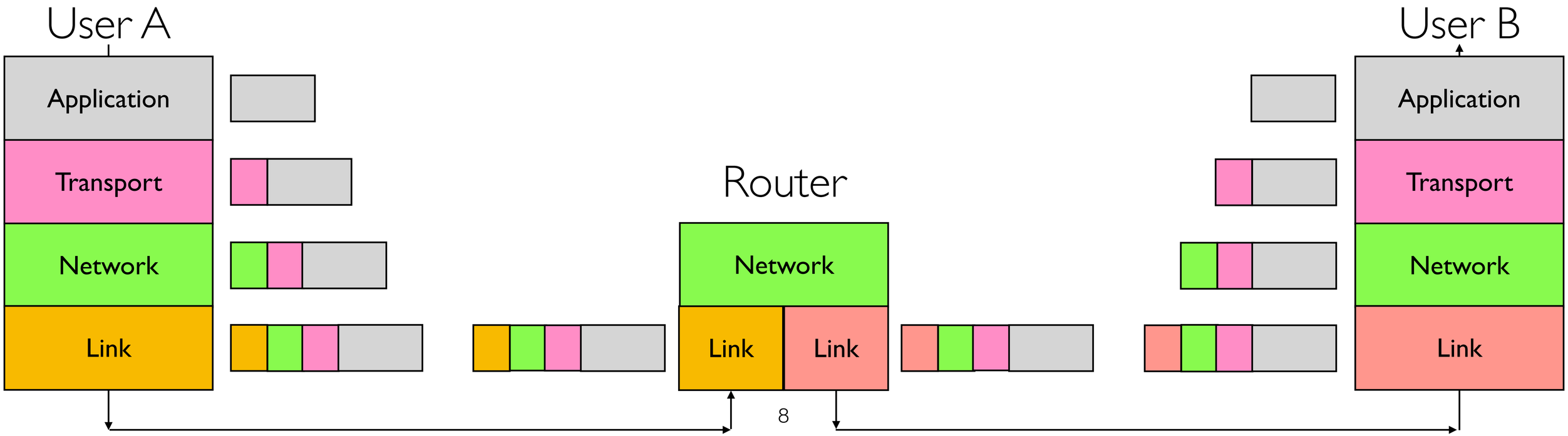

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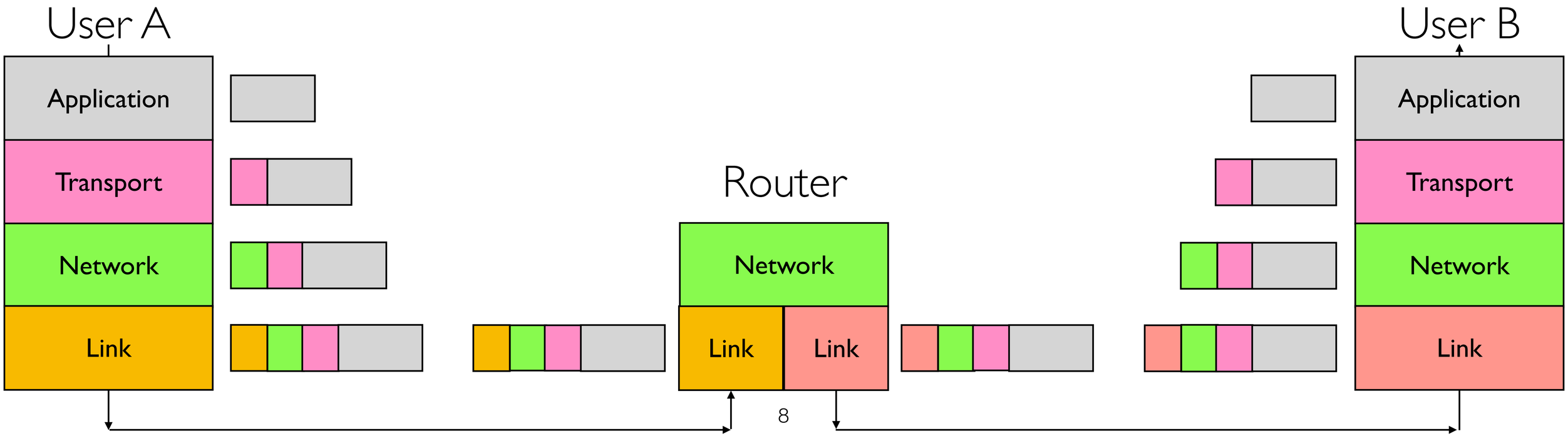

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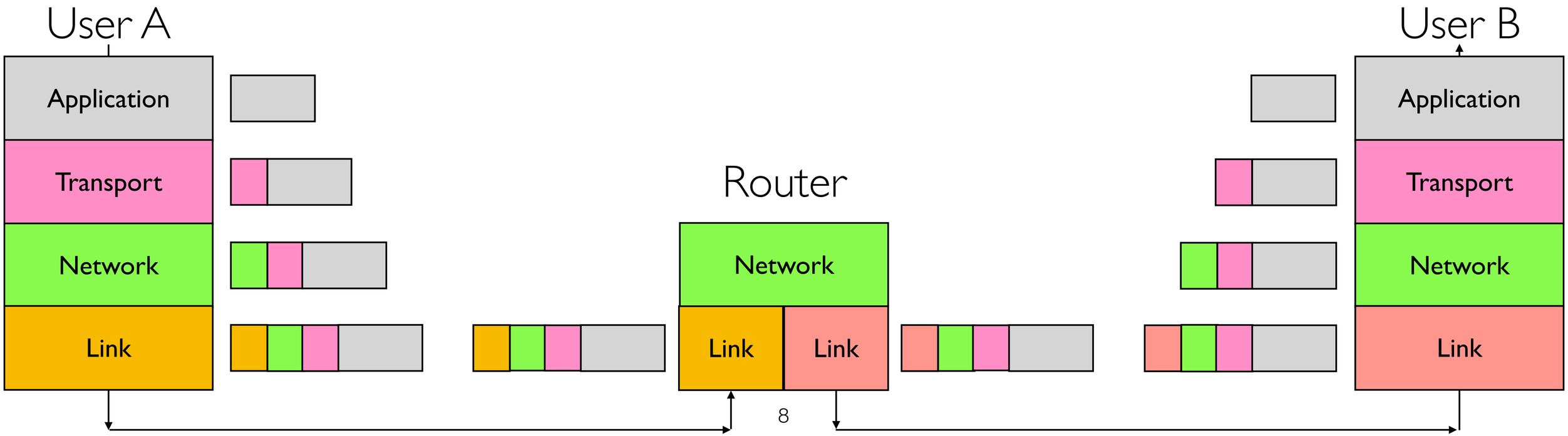

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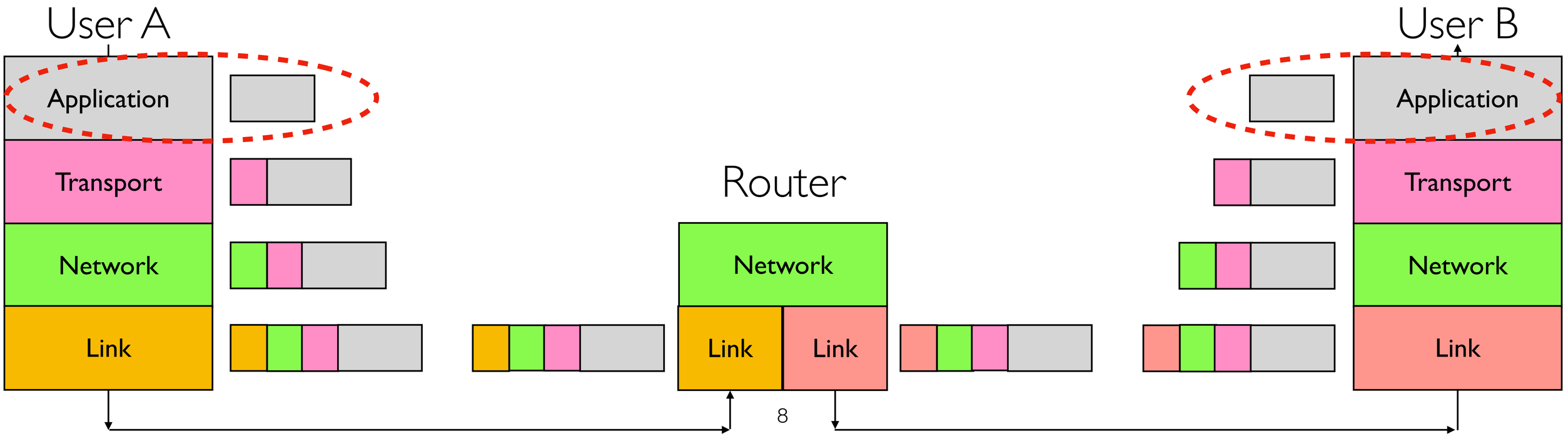

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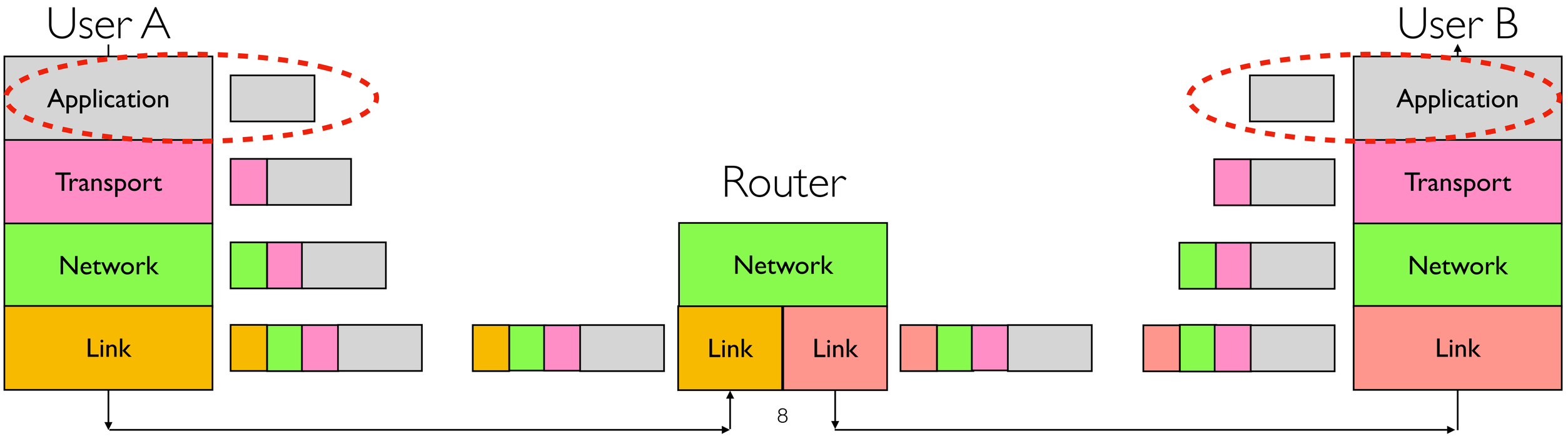

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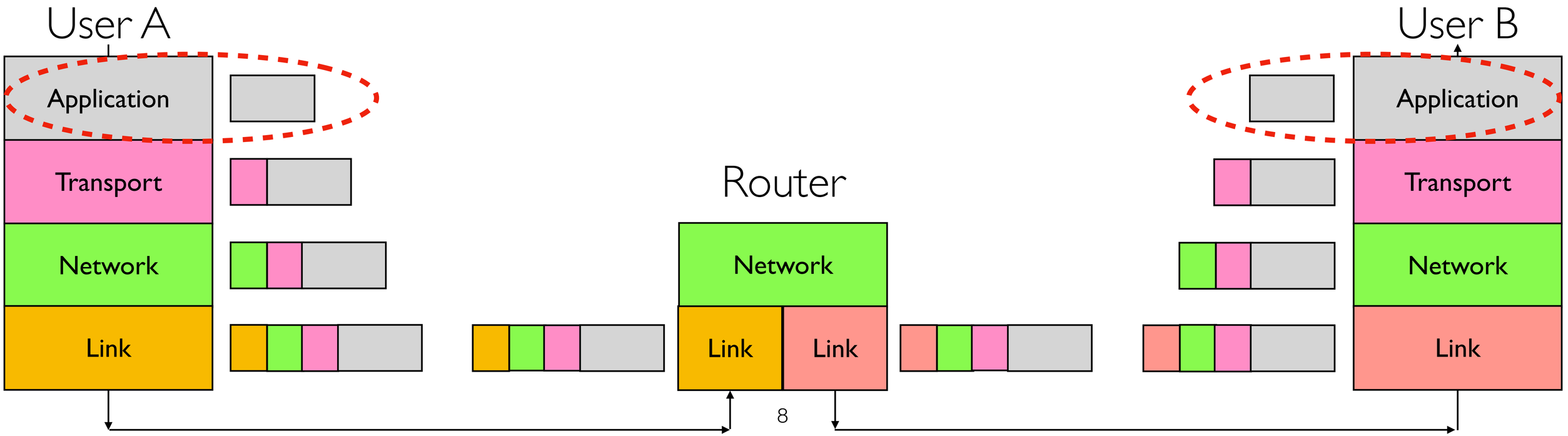

Back to DNS!

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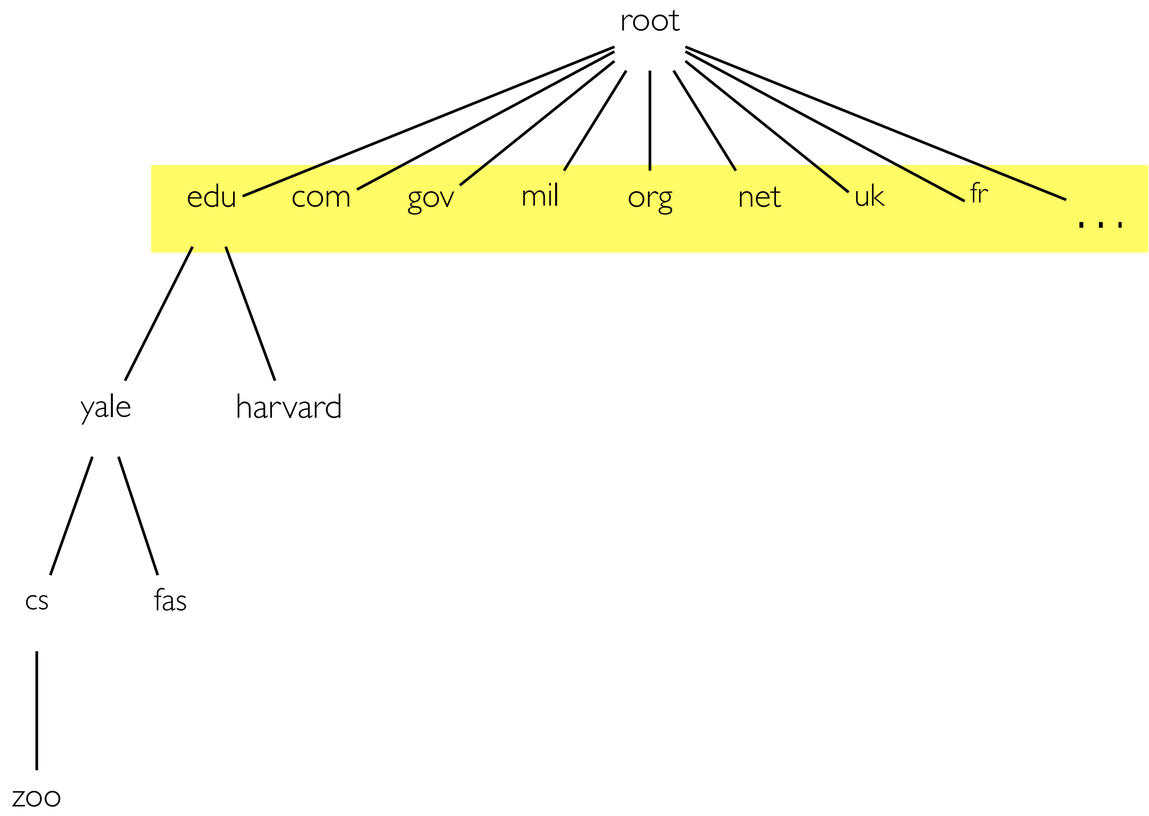
- Provides a level of indirection!
  - Decoupled names from addresses
  - Many uses beyond just naming a specific host

Recap: DNS Goals

- **Scalable**
  - Many *names*
  - Many *updates*
  - Many *users* creating names
  - Many *users* looking up names
- **Highly available**
- **Correct**
  - No naming conflicts (uniqueness)
  - Consistency → observe the latest update
- **Lookups are fast**

Recap: Scaling with Hierarchical Distribution

Three intertwined hierarchies



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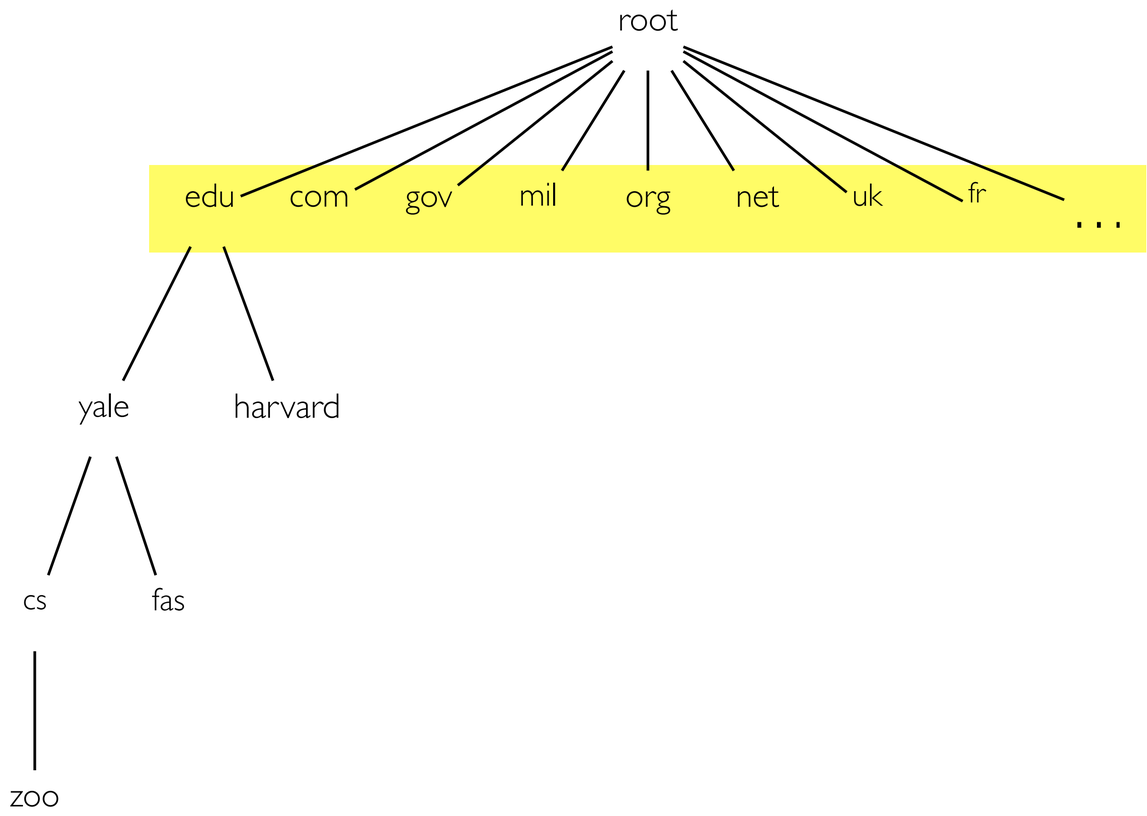

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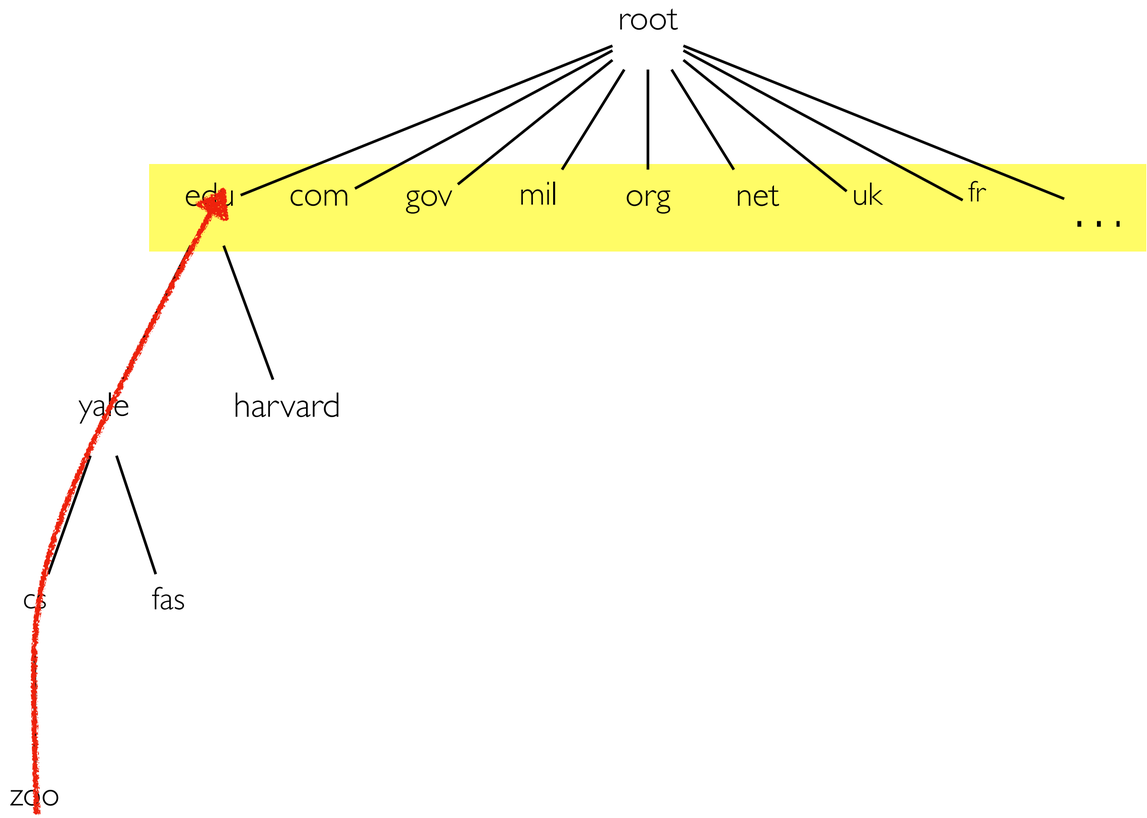

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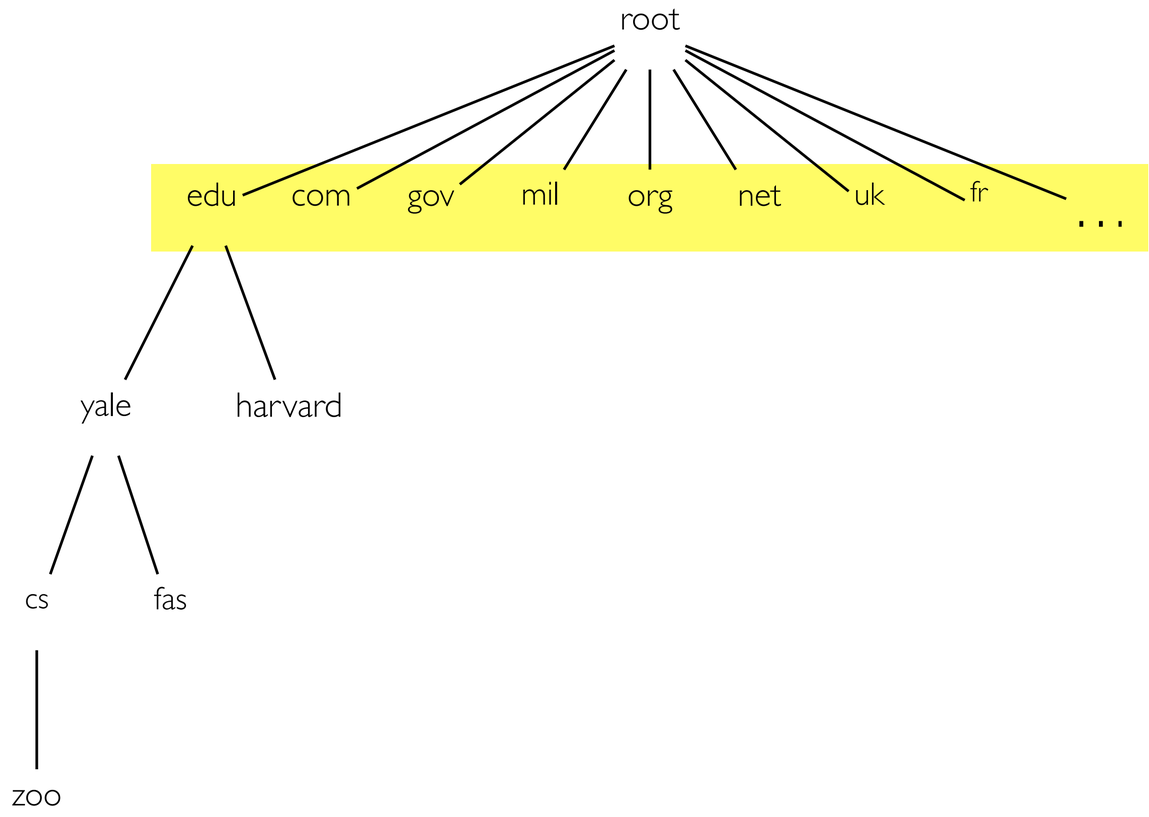

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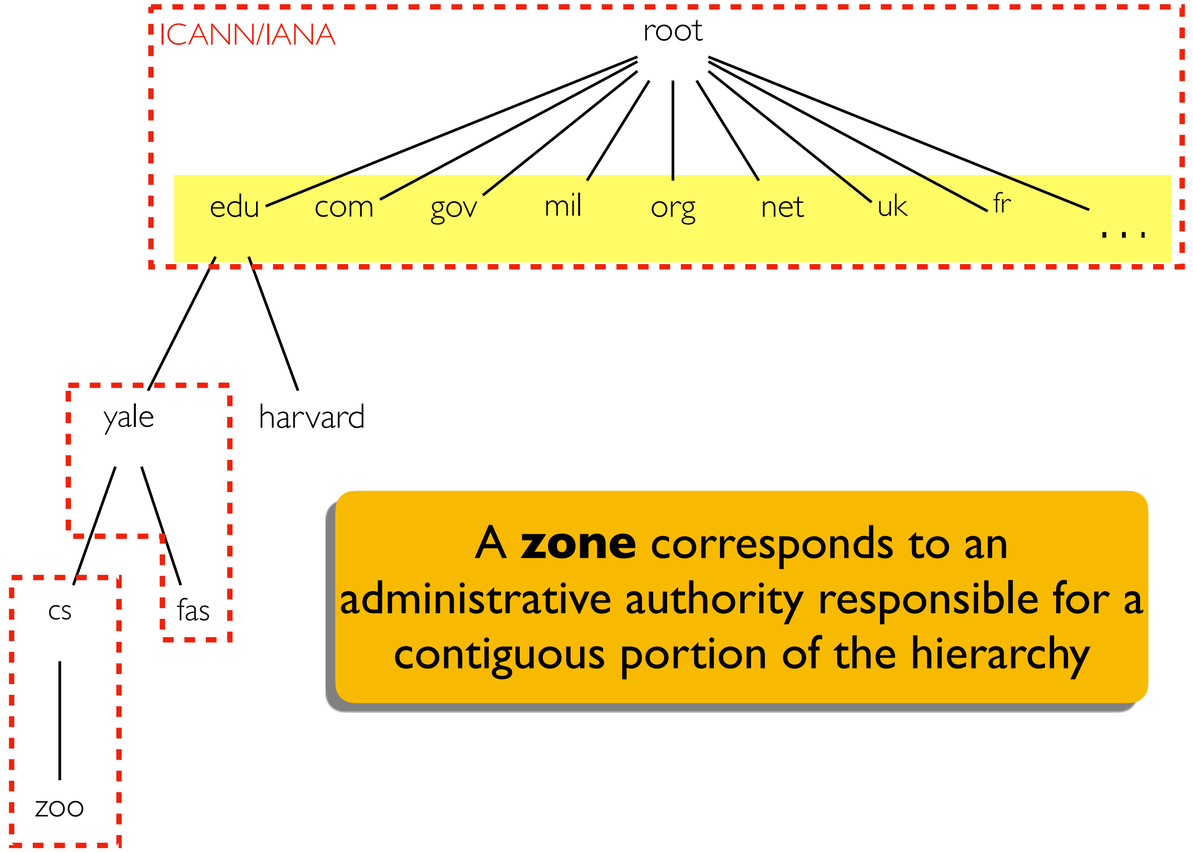

A **zone** corresponds to an administrative authority responsible for a contiguous portion of the hierarchy

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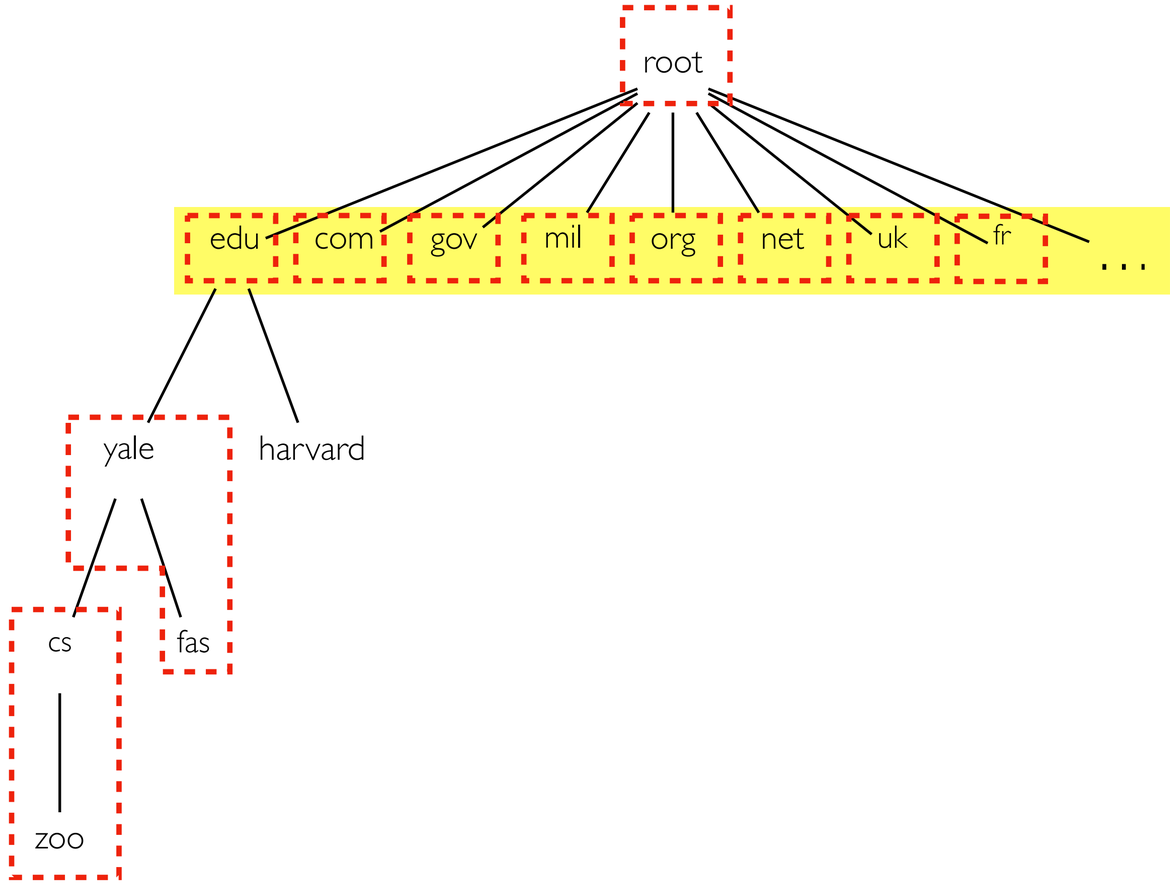

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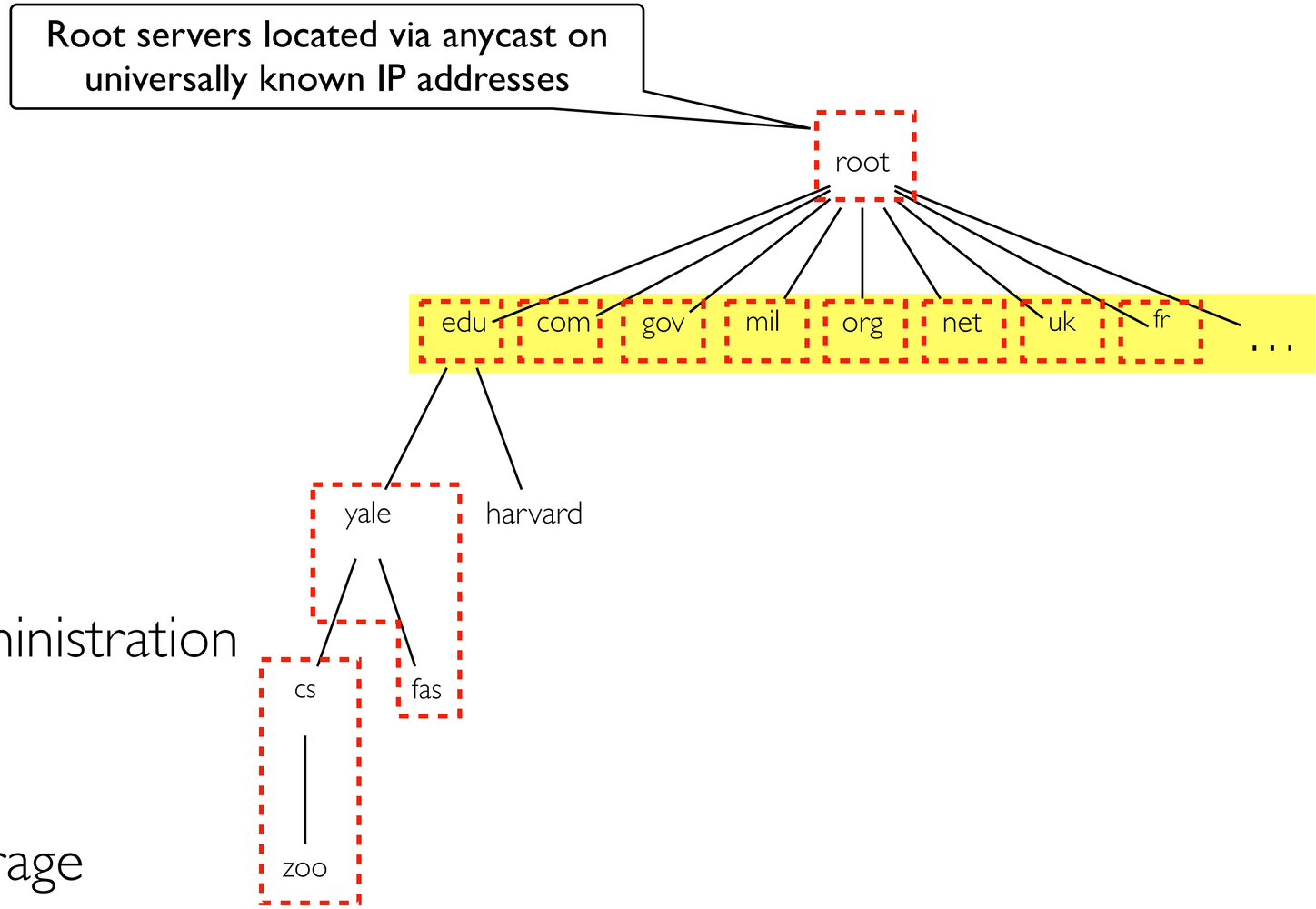

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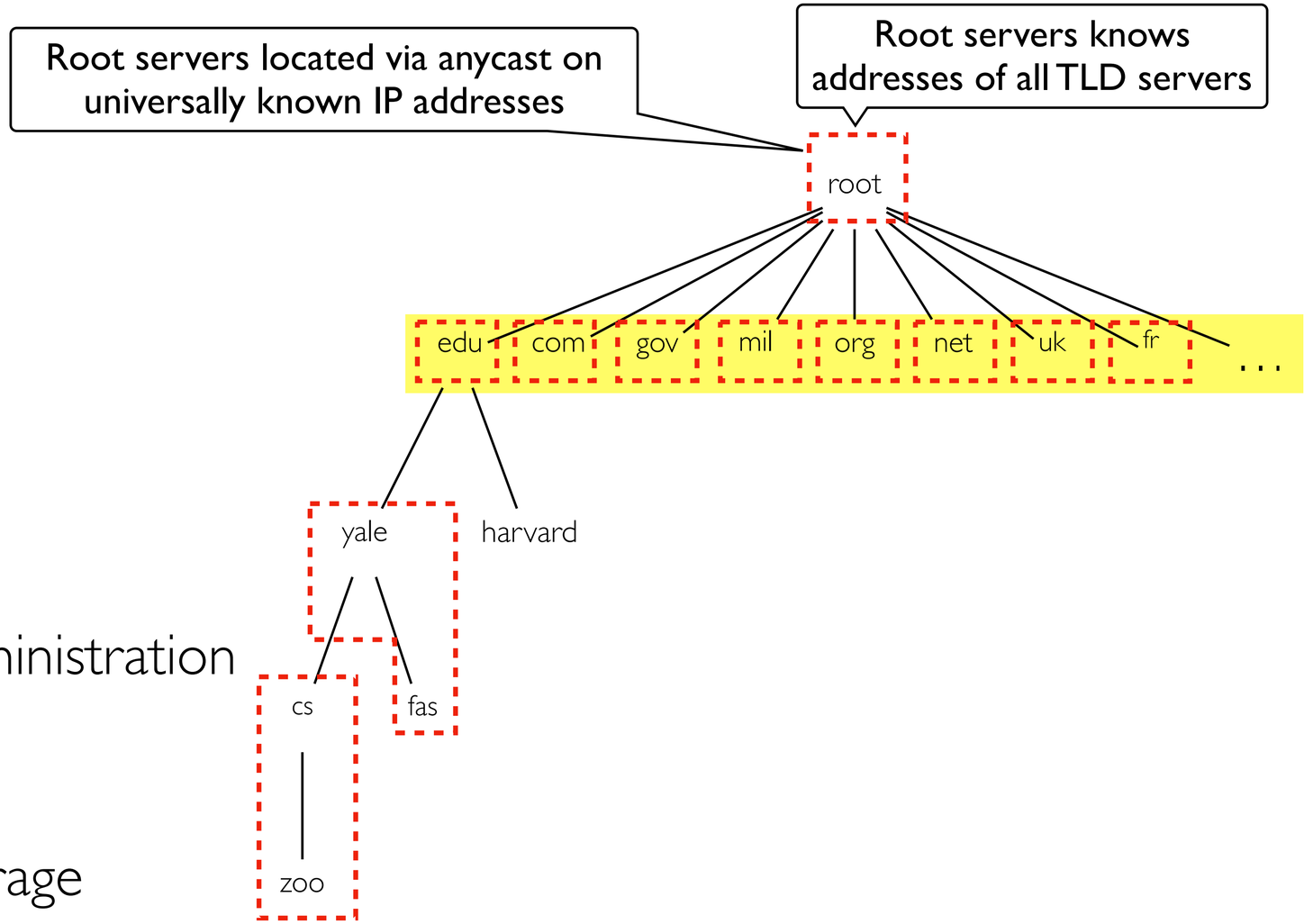

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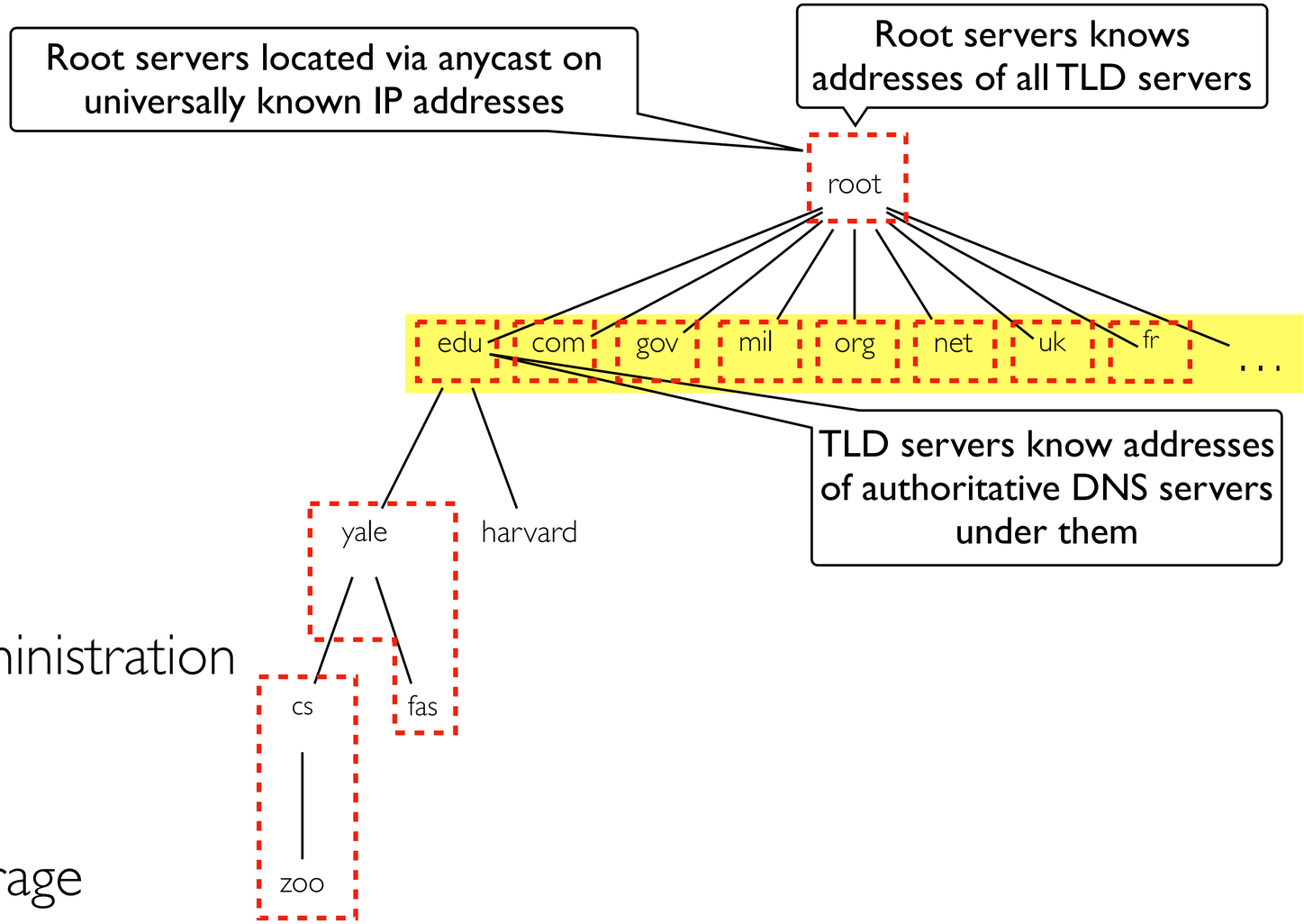

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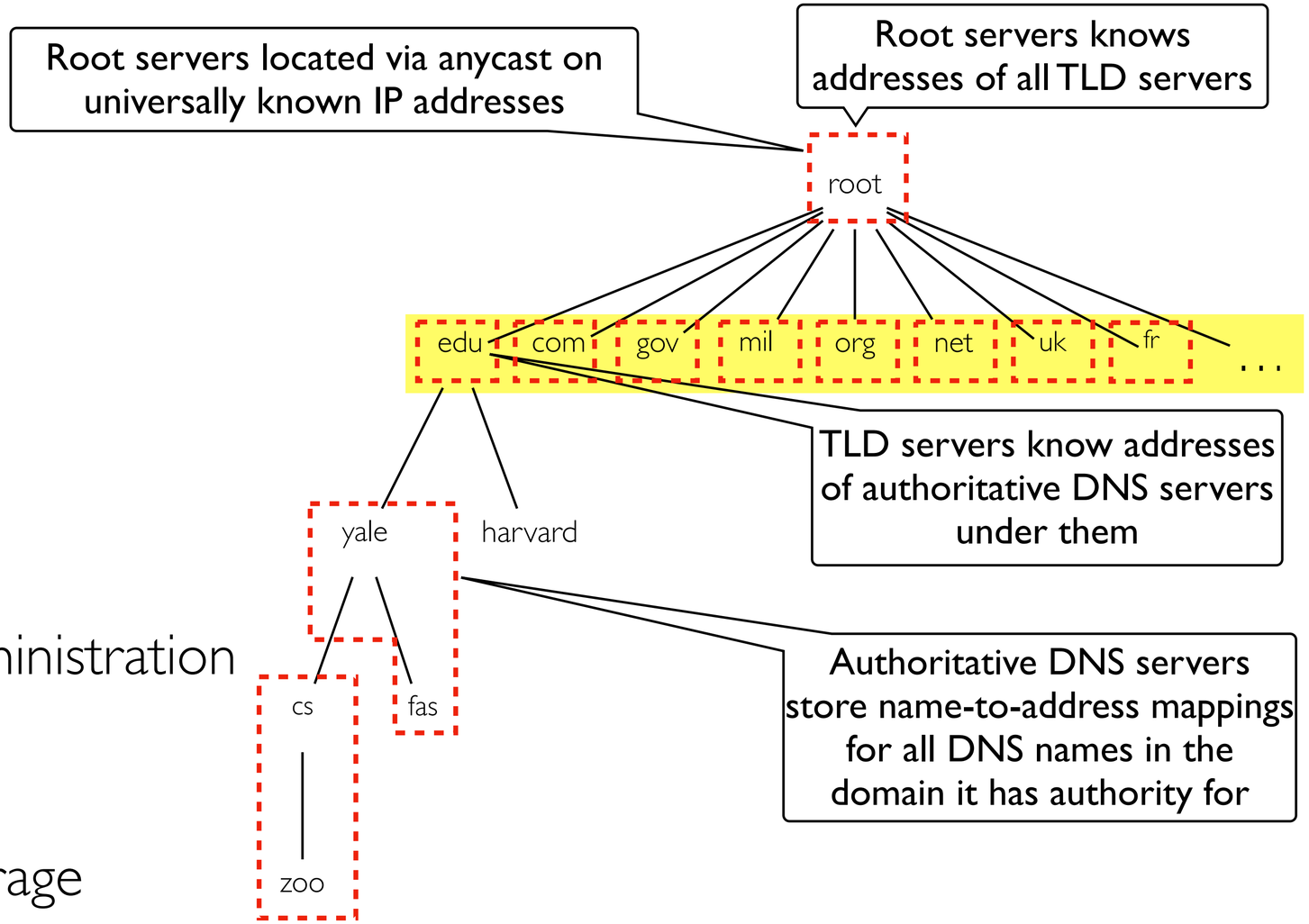

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- Type = MX: (→*Mail eXchanger*)
  - Name = domain in email address
  - Value = name(s) of mail server(s)

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  - Provide registrar with names and IP addresses of your authoritative name server(s)
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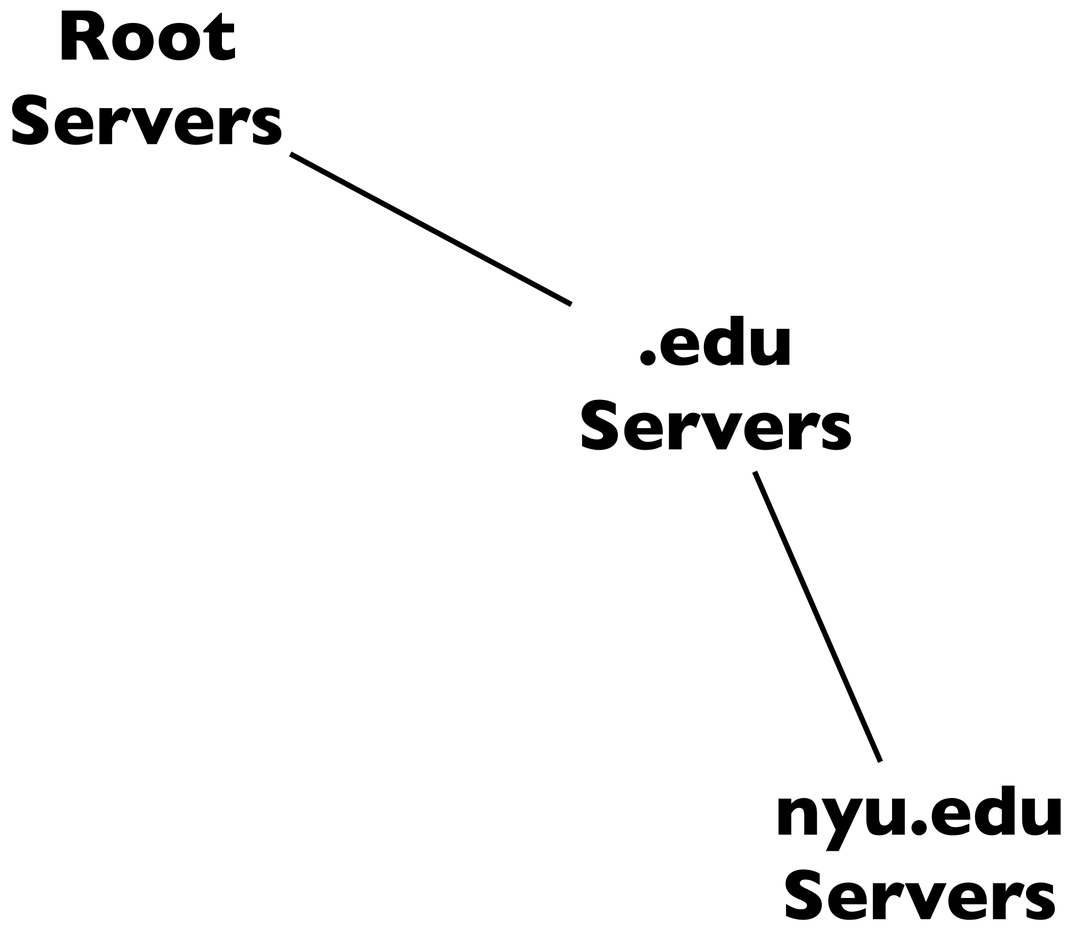
- **Store resource records in your server dns1.foobar.com**
  - e.g., type A records: (foobar.com, 212.44.9.130, A), (social.foobar.com, 212.44.9.131, A), etc.
  - e.g., type MX records for foobar.com

Recap: Using DNS (Client/Application view)



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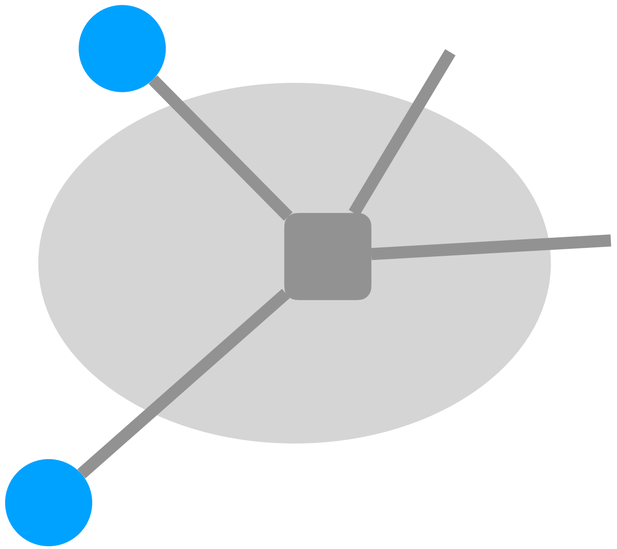

Root Servers

.edu Servers

nyu.edu Servers

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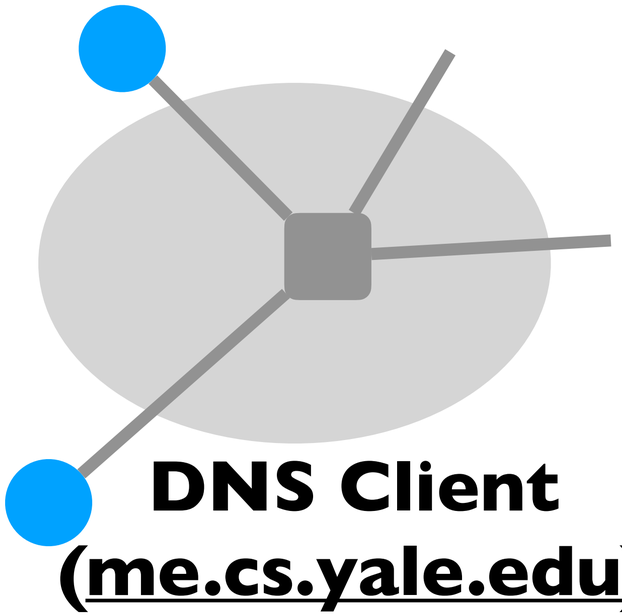

DNS Client
(me.cs.yale.edu)

Root
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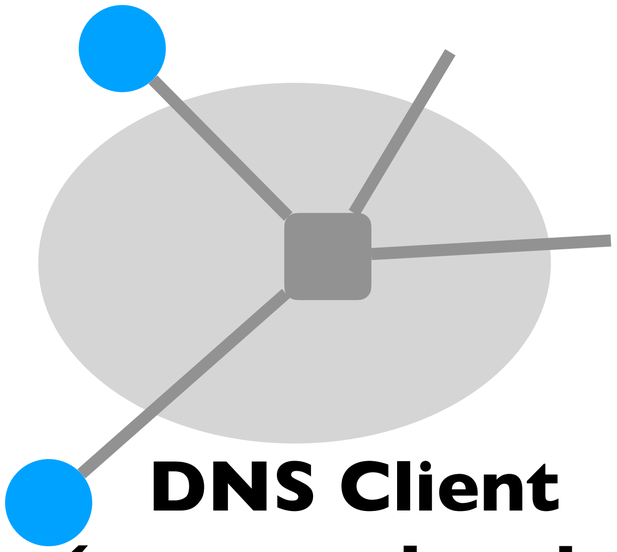

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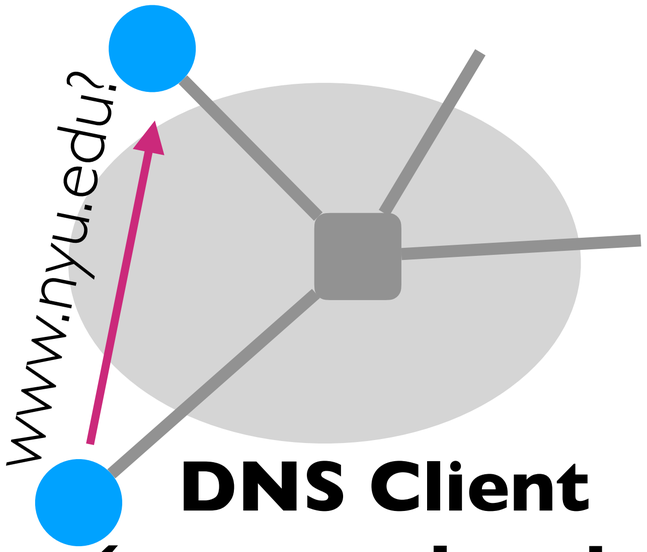

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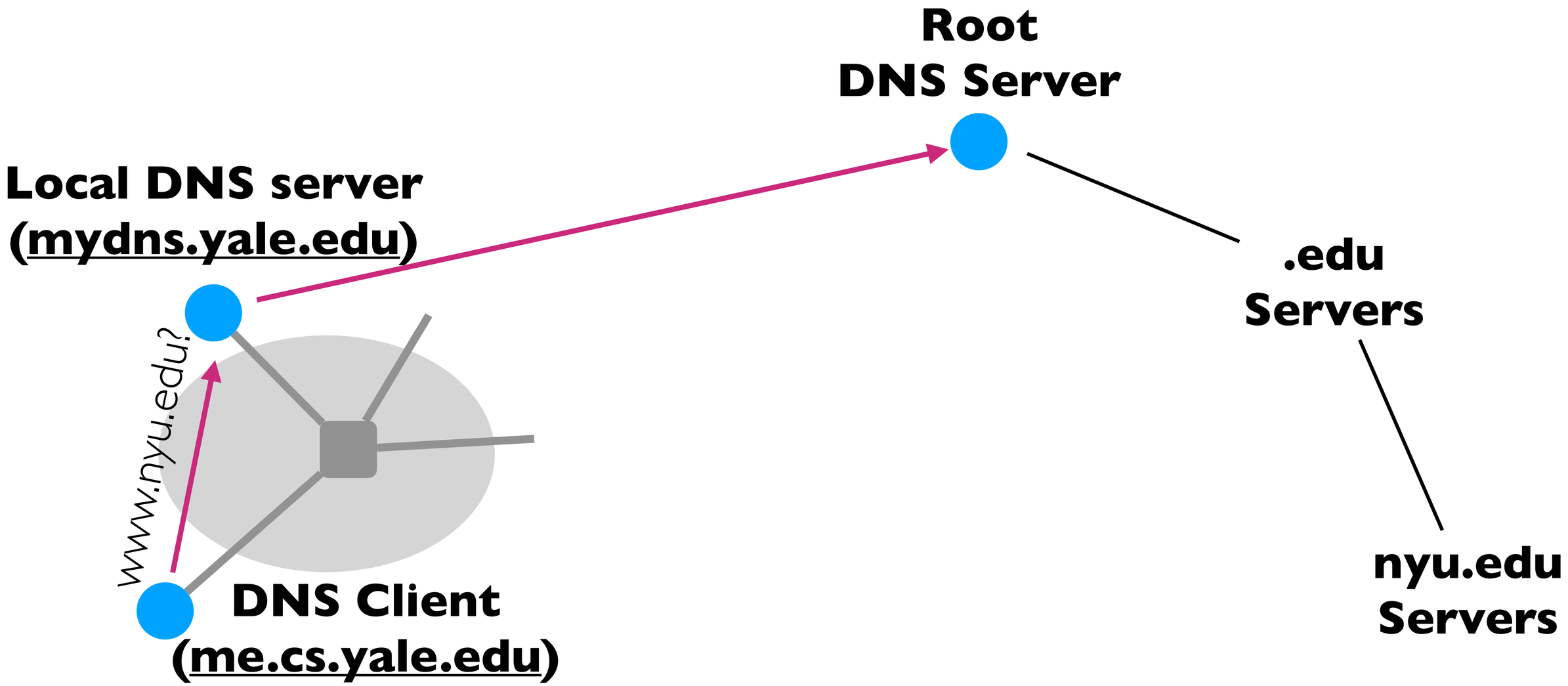
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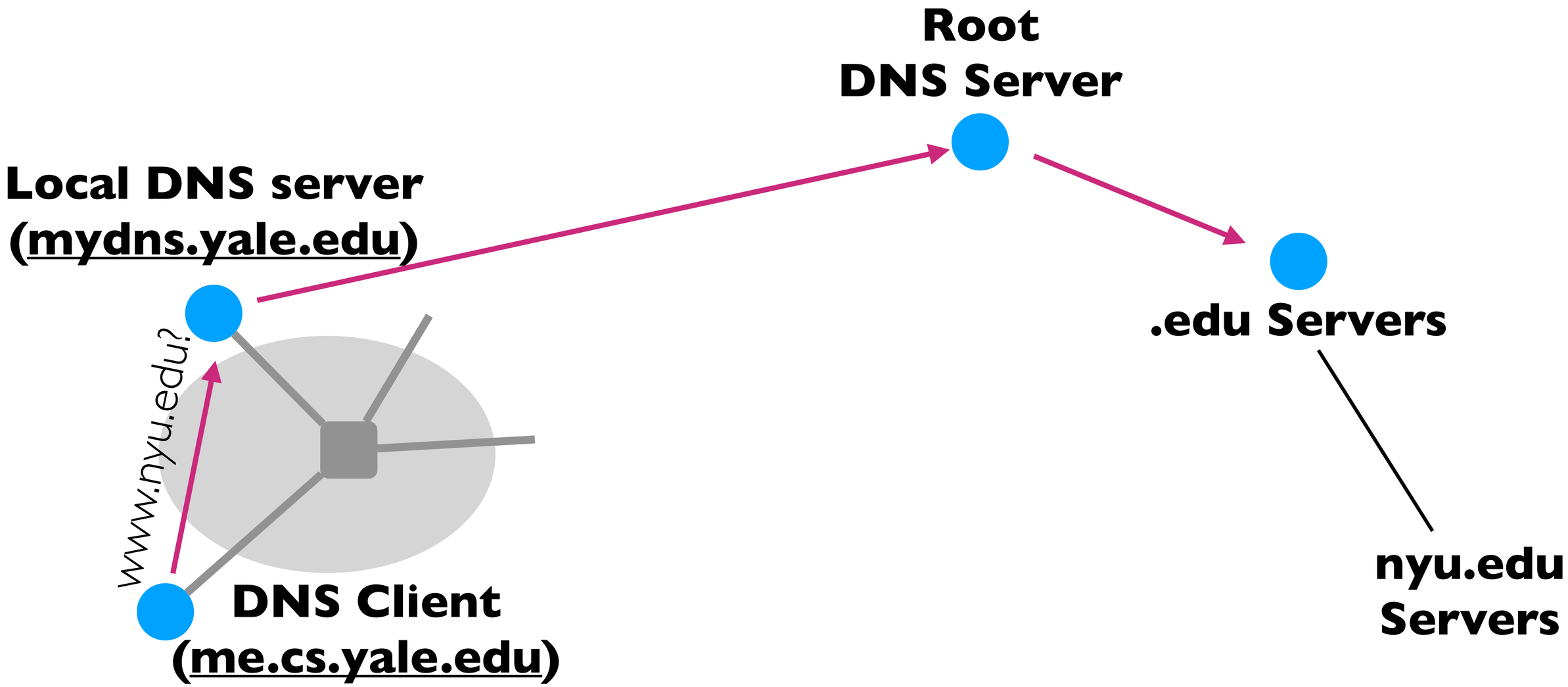
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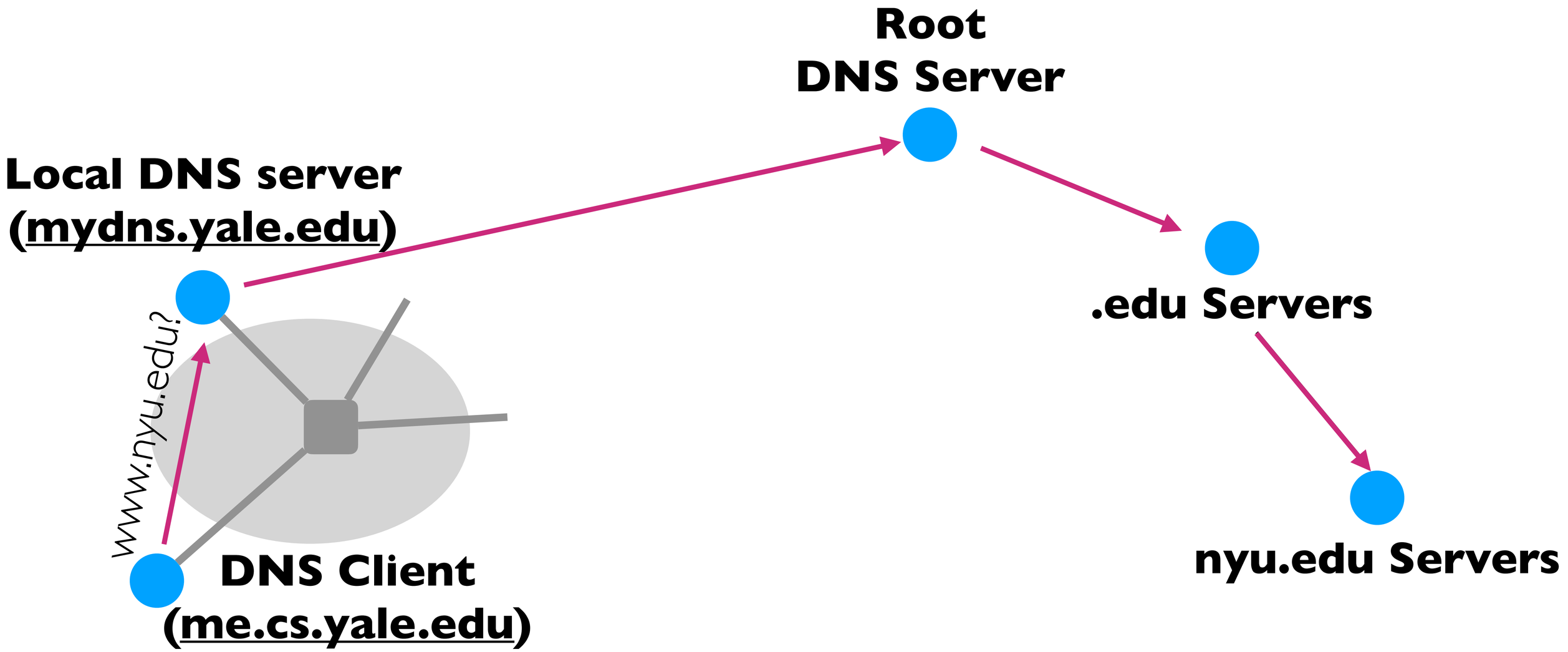
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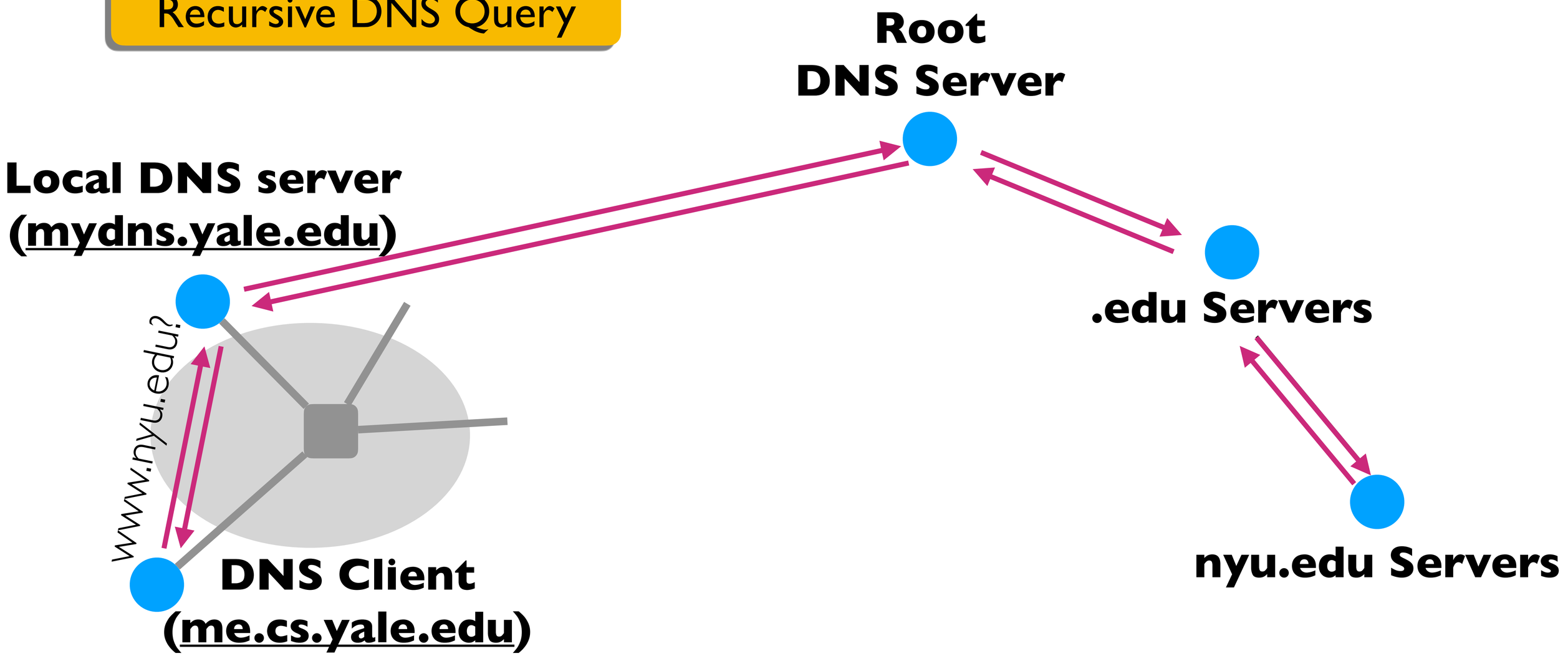
Recursive DNS Query



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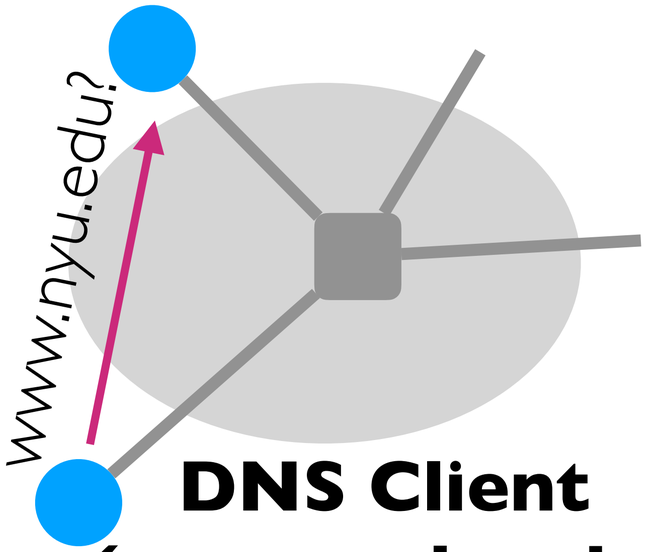

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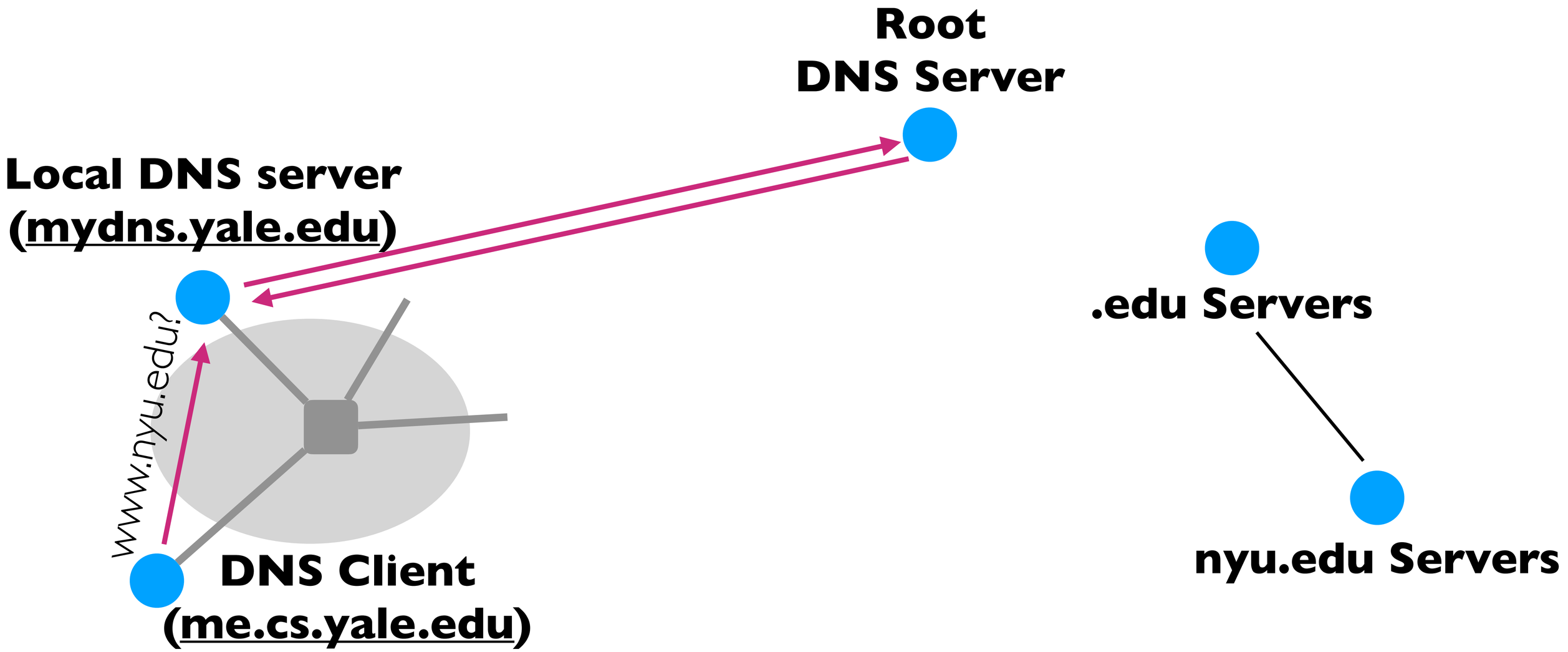
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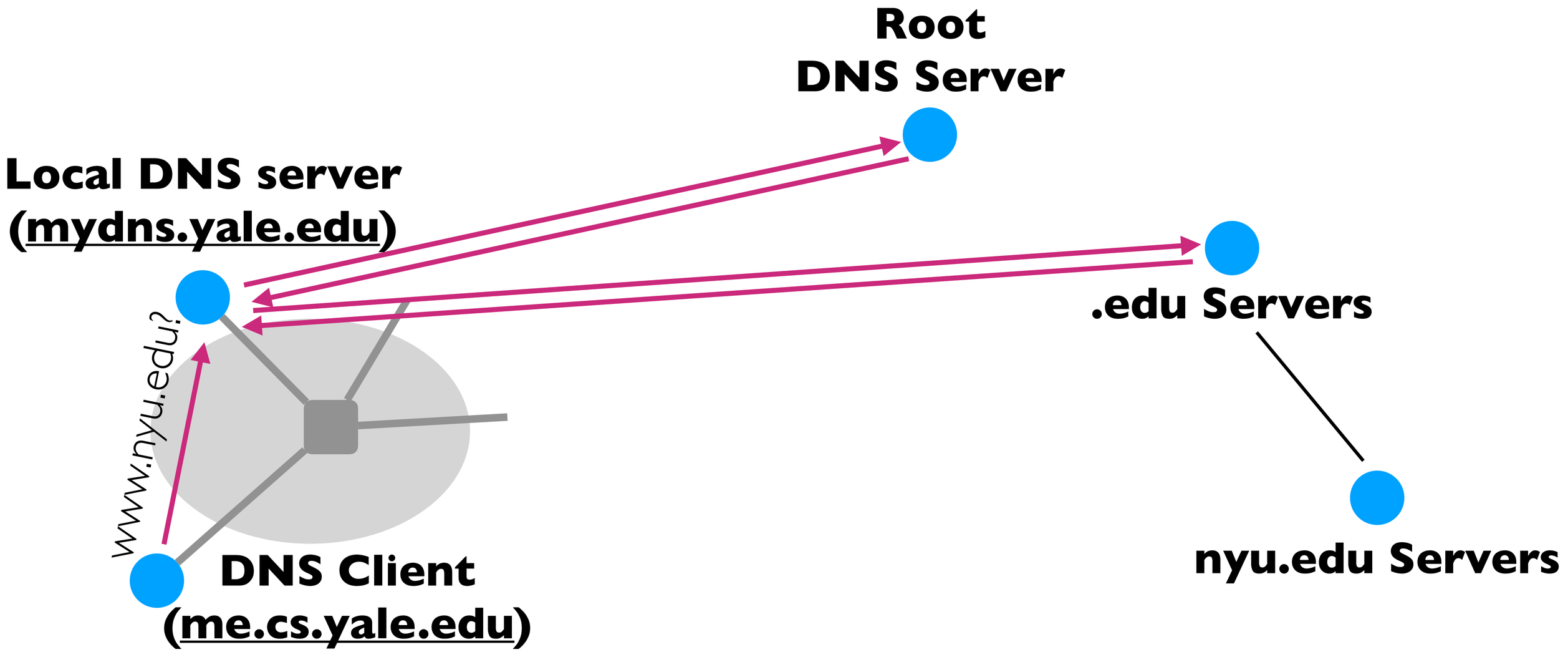
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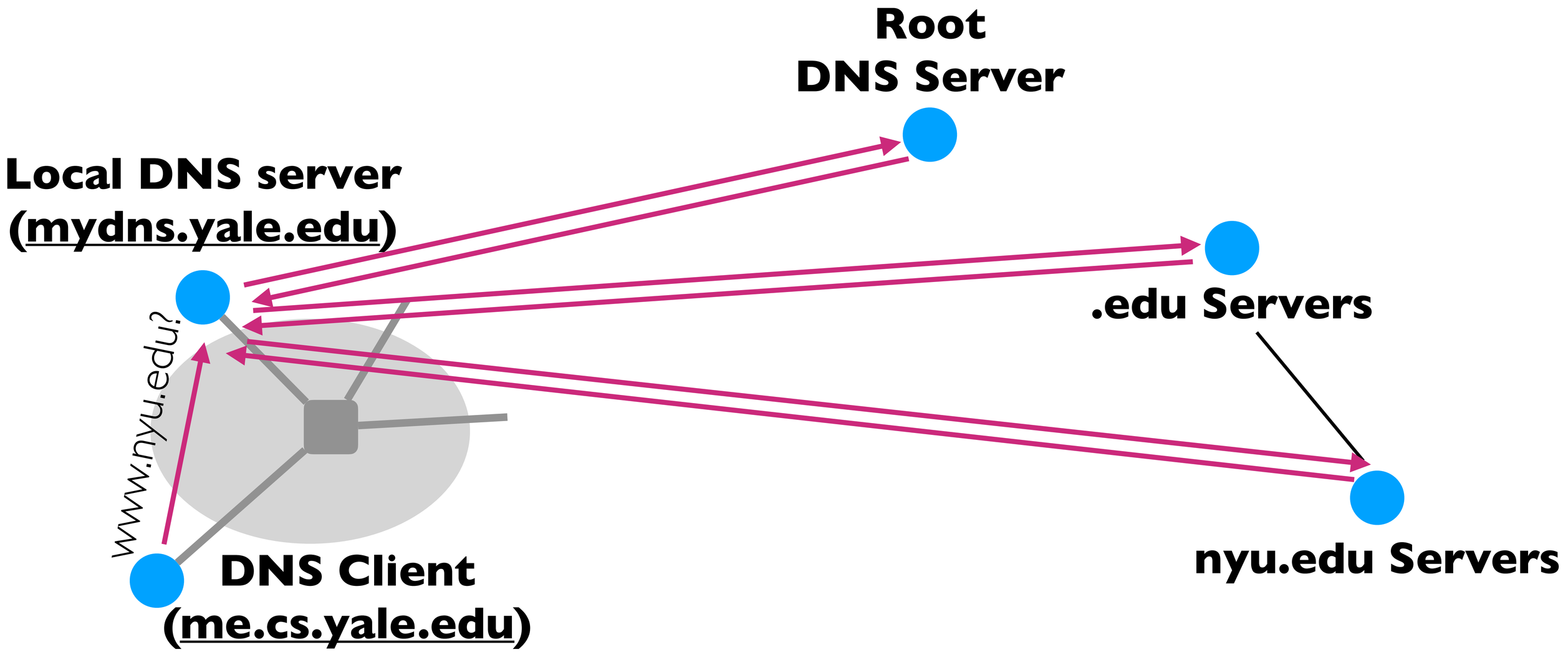
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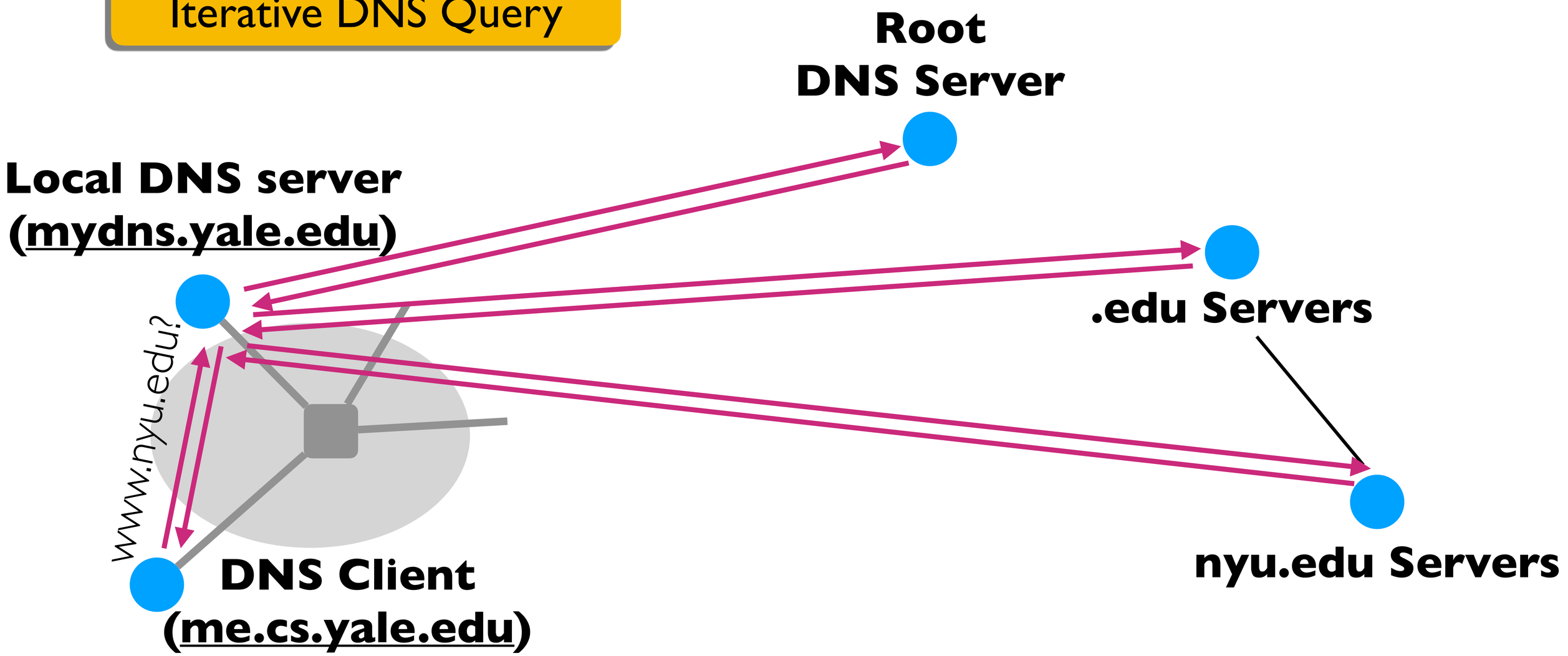
Iterative DNS Query



Recap: DNS Protocol

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- **Query and Reply messages; both with the same message format**
  - *See text for details*

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  - *See text for details*

- **Client-Server Interaction on UDP Port 53**
  - Spec. supports TCP too, but not always implemented

Questions?

Goals: How are we doing?

- Scalable
  - Many names
  - Many updates
  - Many users creating names
  - Many users looking up names
- Highly available
- Correct
  - No naming conflicts (uniqueness)
  - Consistency
- Lookups are fast

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How?

Per-domain Availability

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  - Name service available if at least one replica is up
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- **Try alternate servers on timeout**
  - *Exponential backoff* when retrying same server

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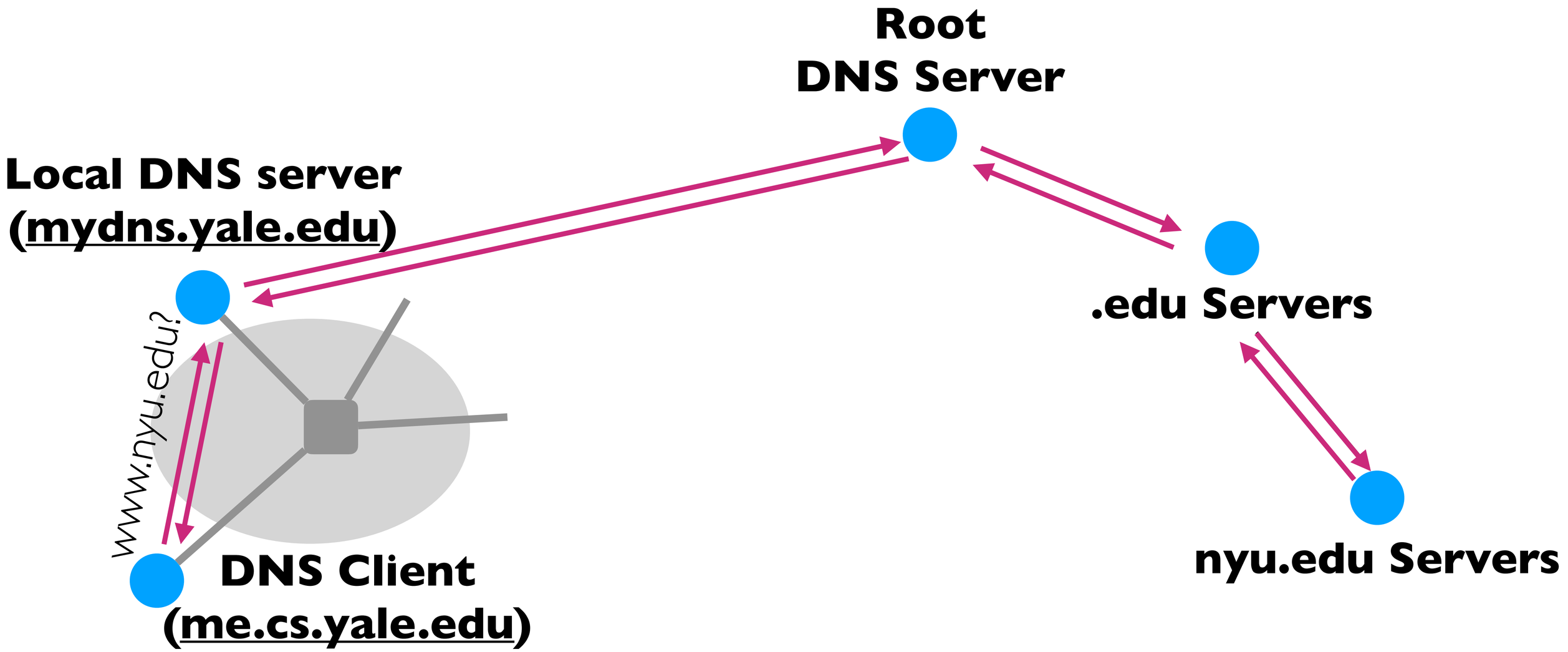
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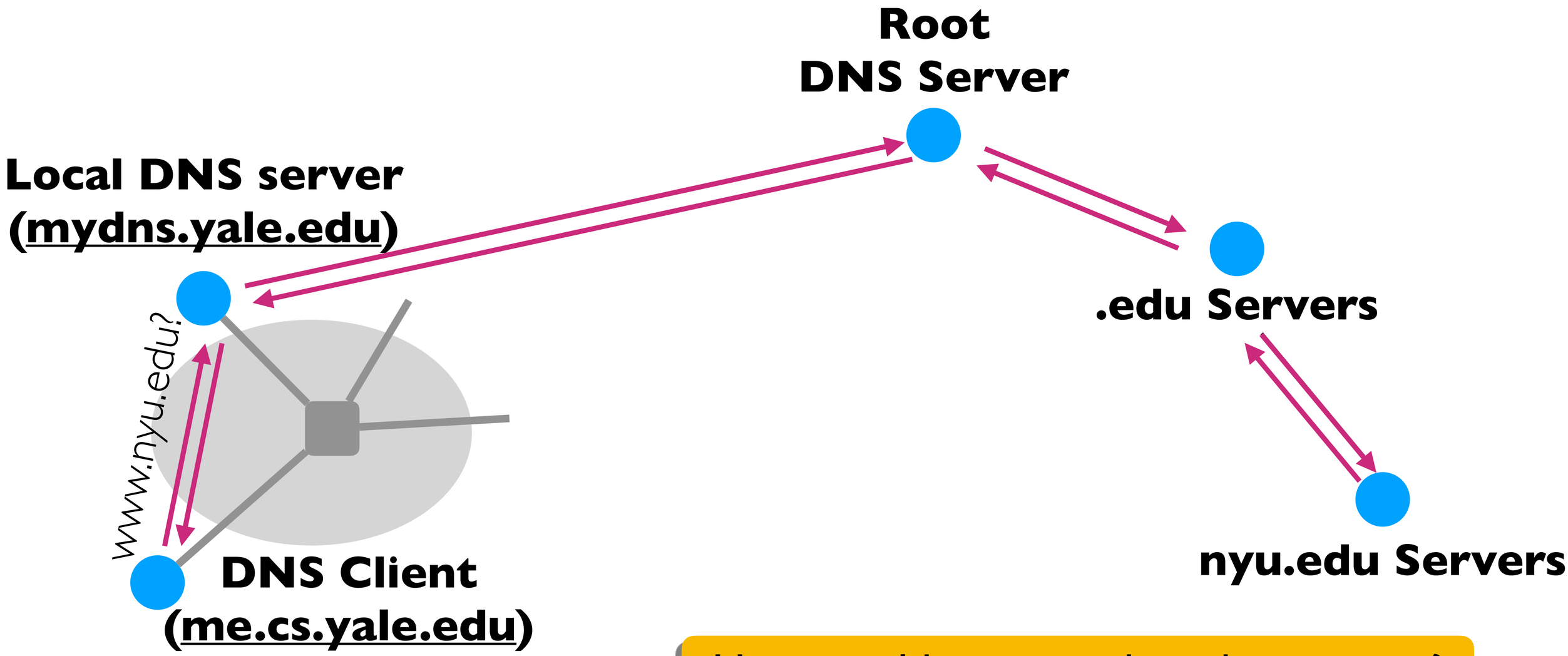

How would you speed up this process?

Caching

Caching

- Caching of DNS responses at all levels

Caching

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- Reduces load at all levels

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- Reduces load at all levels
- Reduces delay experienced by DNS client

DNS Caching

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- **How DNS caching works**
  - DNS servers cache responses to queries
  - Responses include a "time-to-live" (TTL) field
  - Server deletes cached entry after TTL expires

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- **Why caching is effective**
  - The top-level servers very rarely change
  - Popular sites visited often → local DNS server often has the information cached

Negative Caching

Negative Caching

- **Remember things that don't work**
  - Misspellings like *www.cnn.comm* and *www.cnnn.com*
  - These can take a long time to fail the first time
  - Good to remember that they don't work
  - … so the failure takes less time the next time around

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- **Negative caching is optional**

Questions?

Time to put your malicious hats on…

How can one attack DNS?

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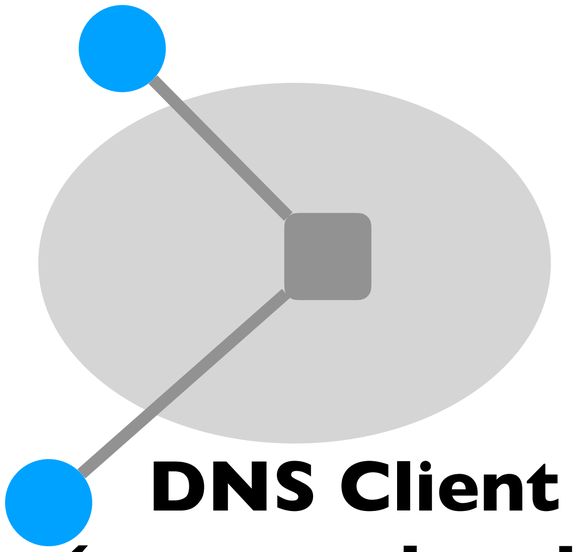
.edu Servers

nyu.edu Servers

Local DNS server
(mydns.yale.edu)



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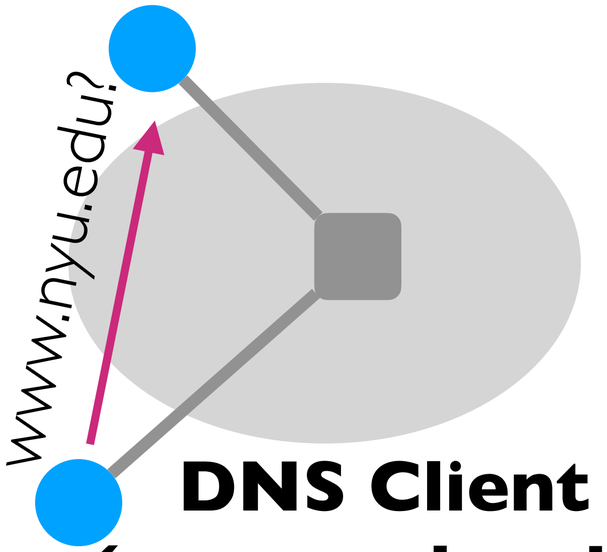

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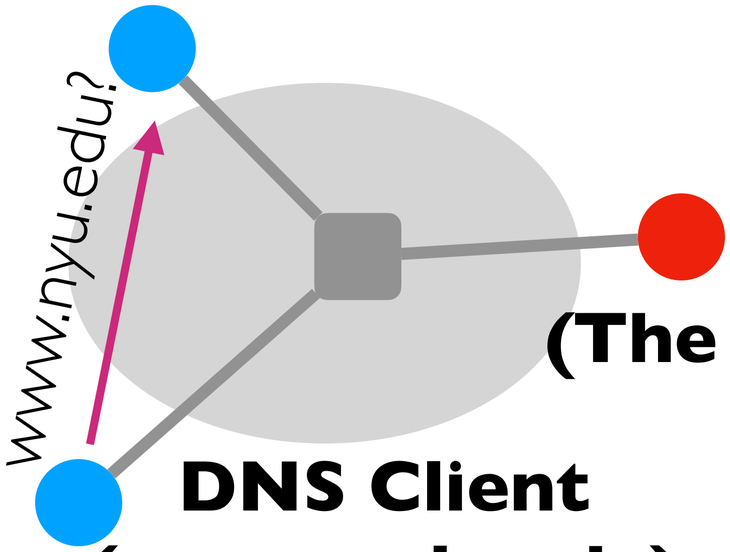

Persa
(The impersonator)

DNS Client
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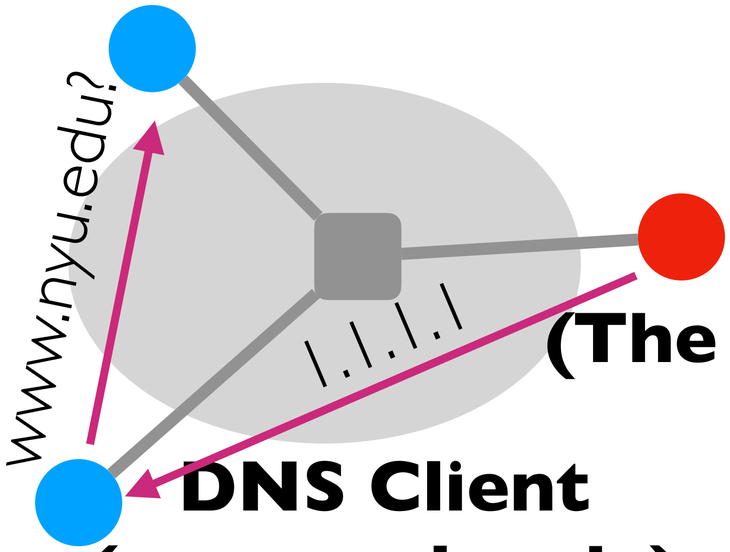

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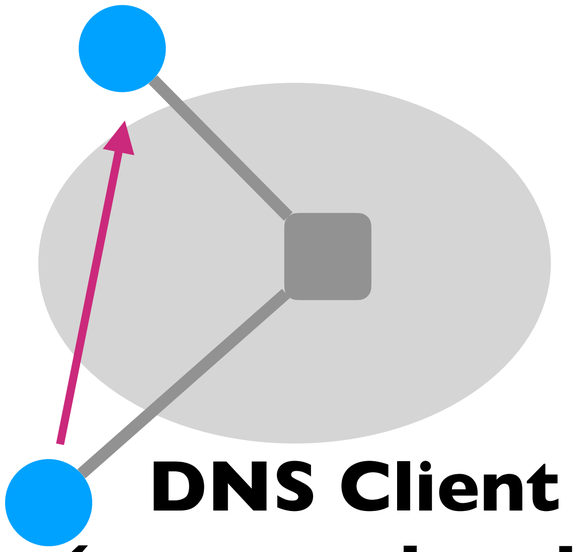

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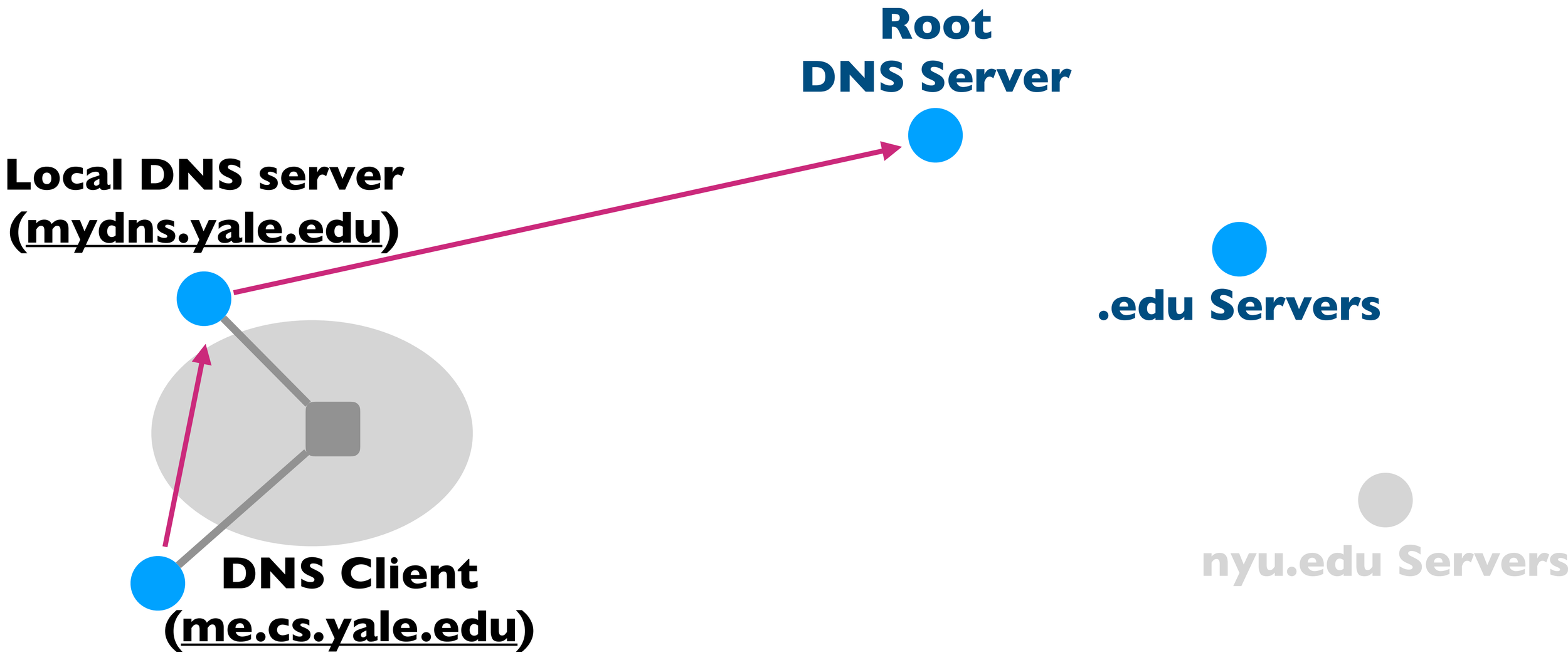
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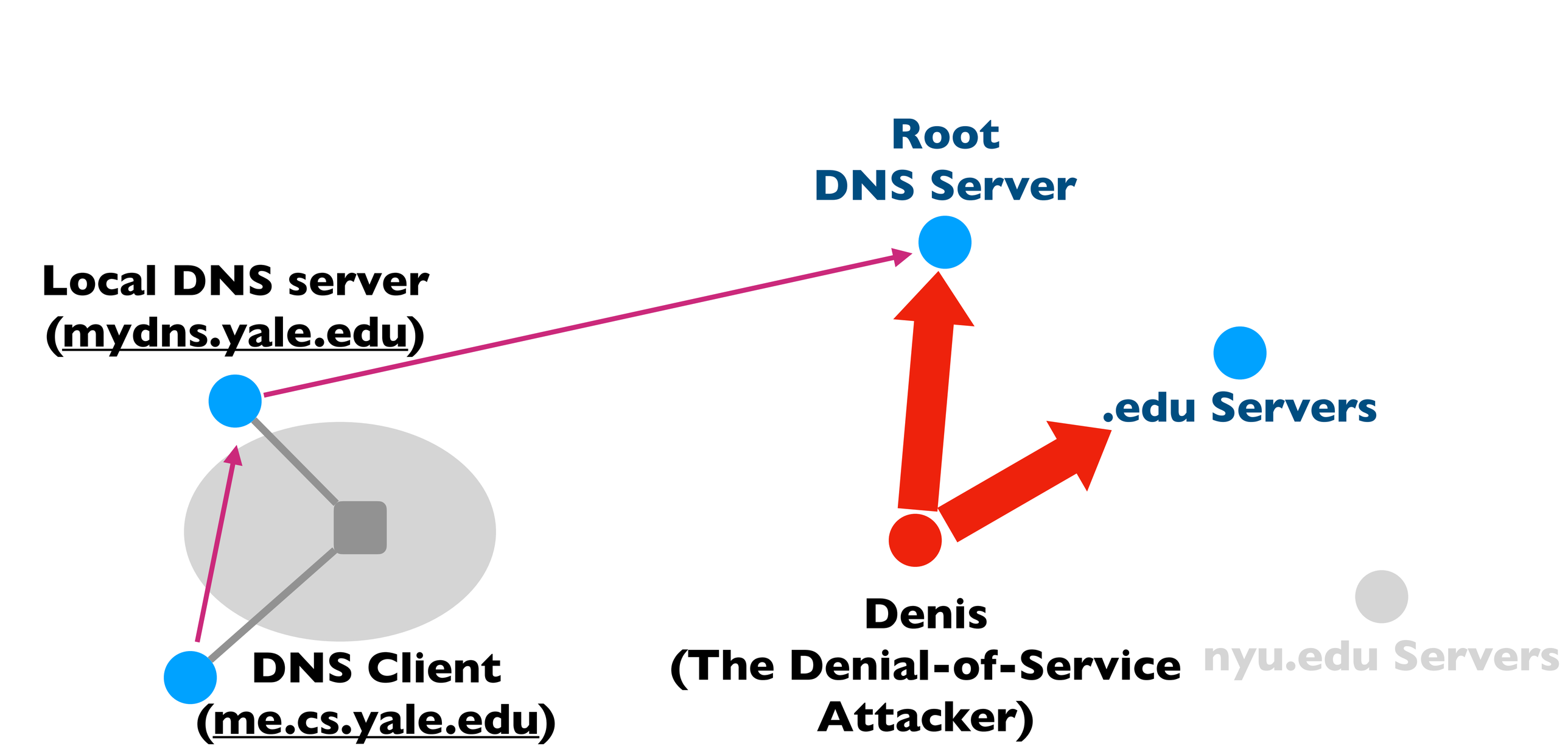
Root
DNS Server
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Denis
(The Denial-of-Service
Attacker)
nyu.edu Servers

How Can One Attack DNS?

- **Impersonate the local DNS server**
  - Give the wrong IP address to the DNS client

- **Denial-of-service the root or TLD servers**
  - Make them unavailable to the rest of the world

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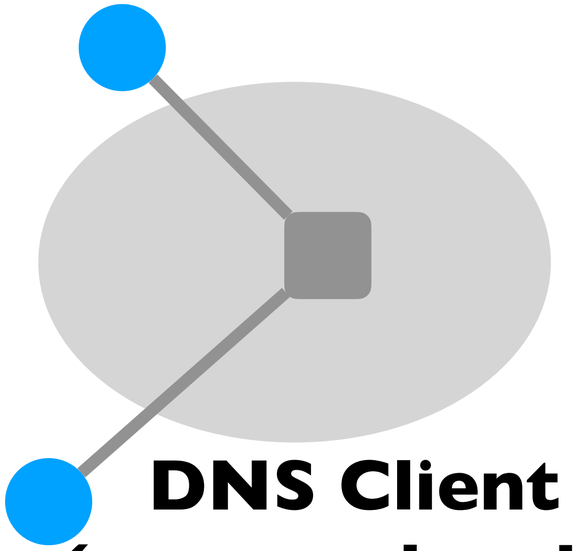

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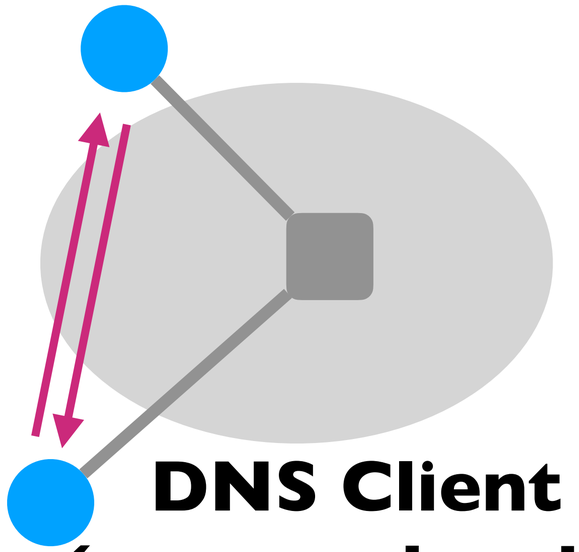

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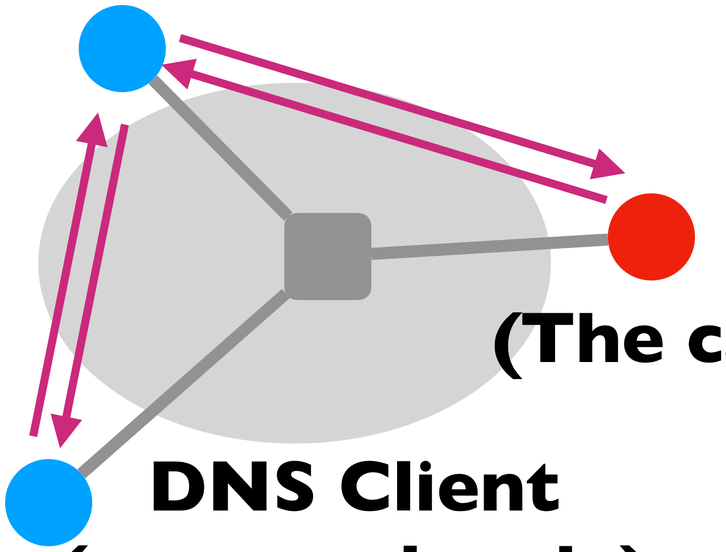

Cacha
(The cache poisoner)

DNS Client
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How Can One Attack DNS?

- **Impersonate the local DNS server**
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- **Denial-of-service the root or TLD servers**
  - Make them unavailable to the rest of the world
- **Poison the cache of a DNS server**
  - Increase the delay experienced by DNS clients

Taking Stock: Important Properties of DNS

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Administrative delegation and hierarchy results in:

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- Easy unique naming

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Administrative delegation and hierarchy results in:

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- “Fate sharing” for network failures
- Reasonable trust model
- Caching lends scalability, performance

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- Addresses can **change** underneath
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- Multiple names for the same addresses
  - E.g., many services (mail, www, ftp) on same machine
- Allowing "host" names to evolve into "service" names

Questions?