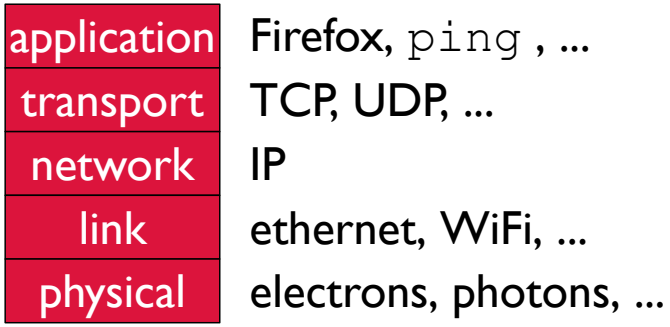
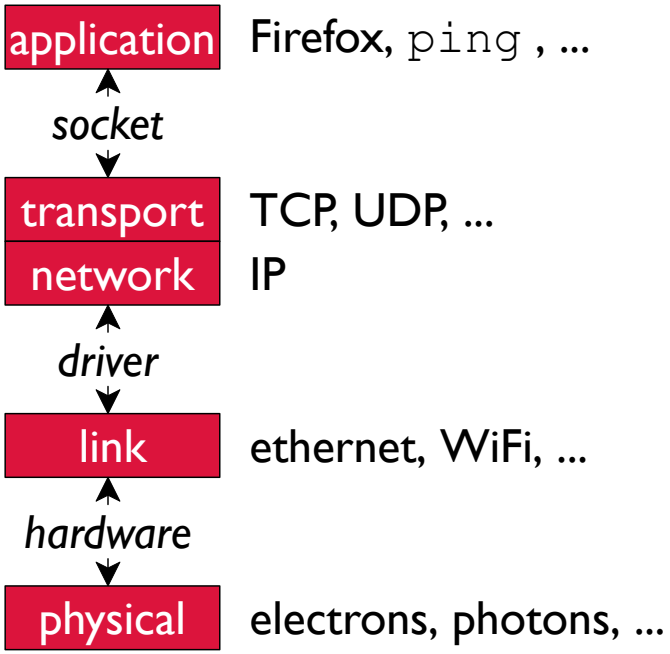
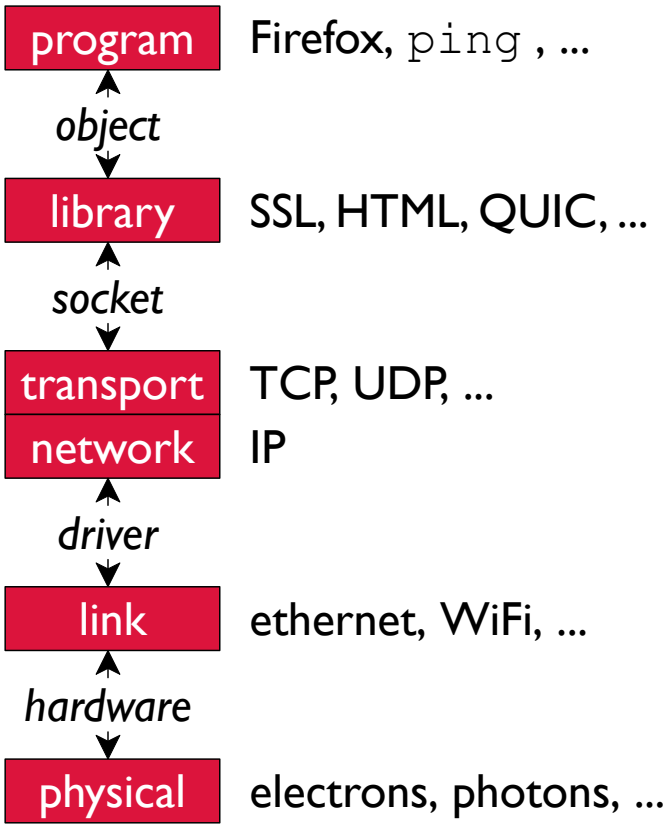
Network Layers



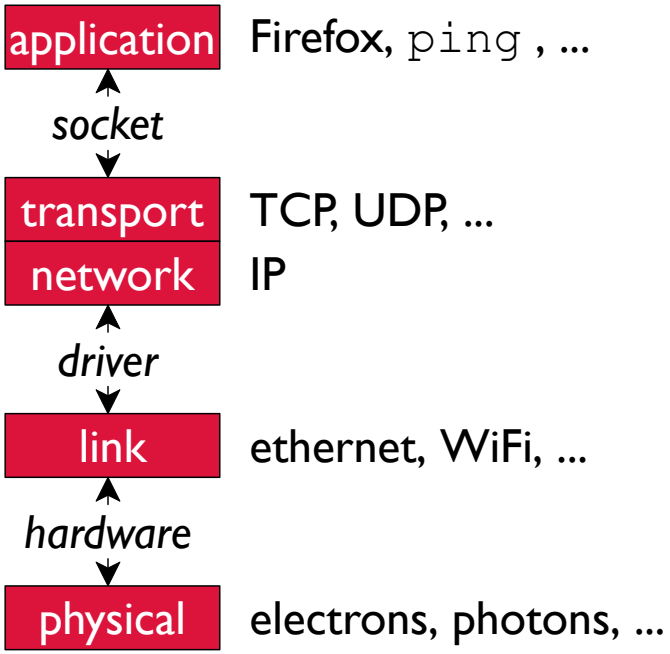
Network Layers



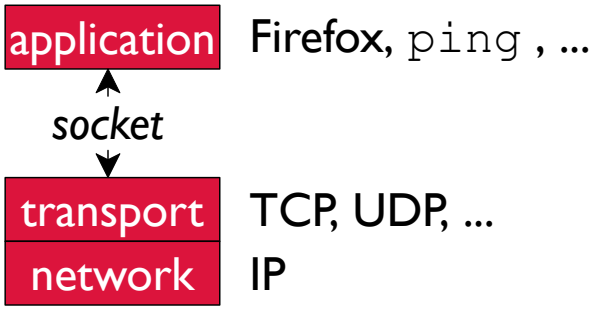
Network Layers



Network Layers



Network Layers



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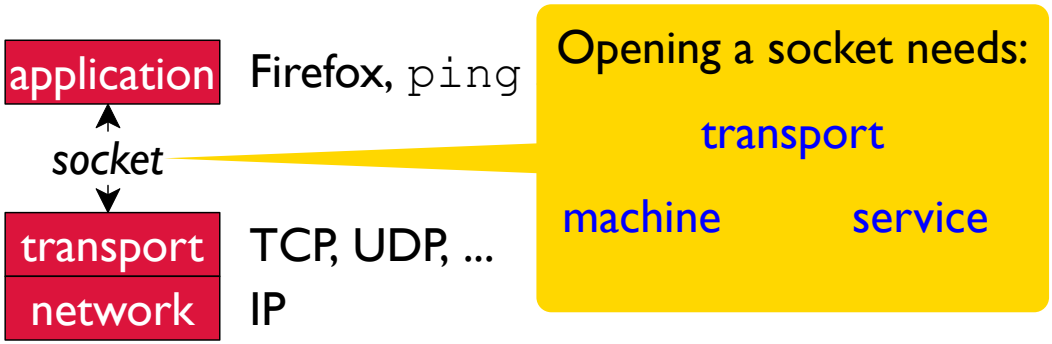

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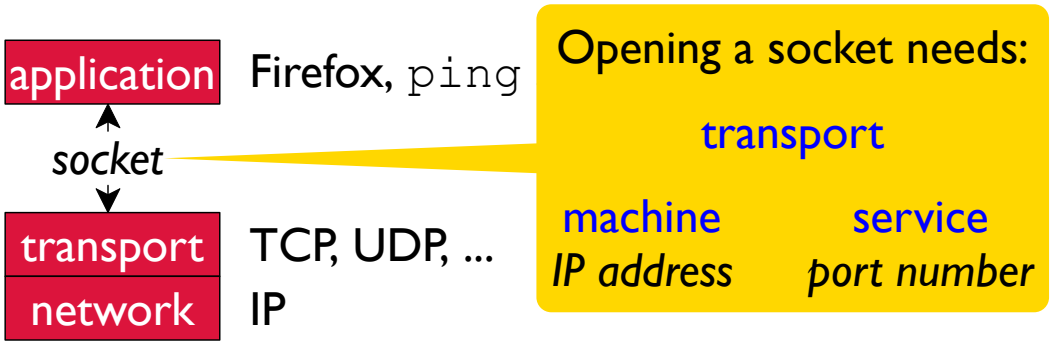

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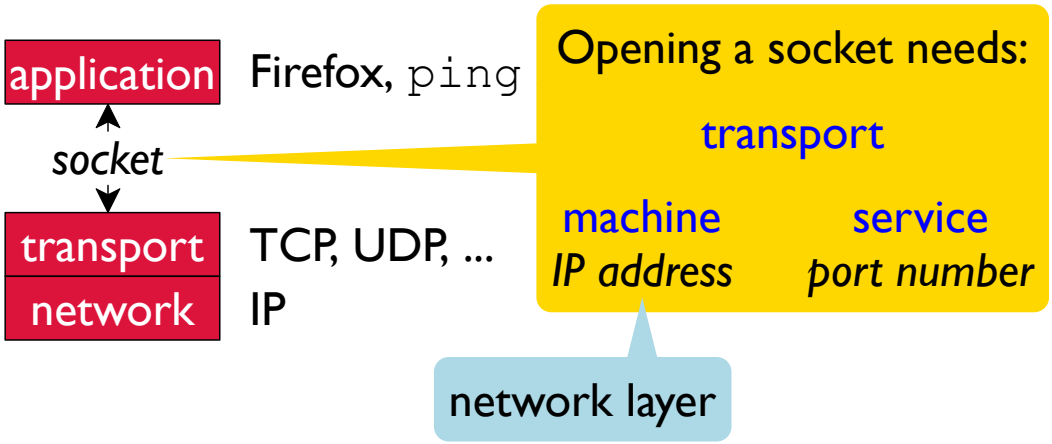

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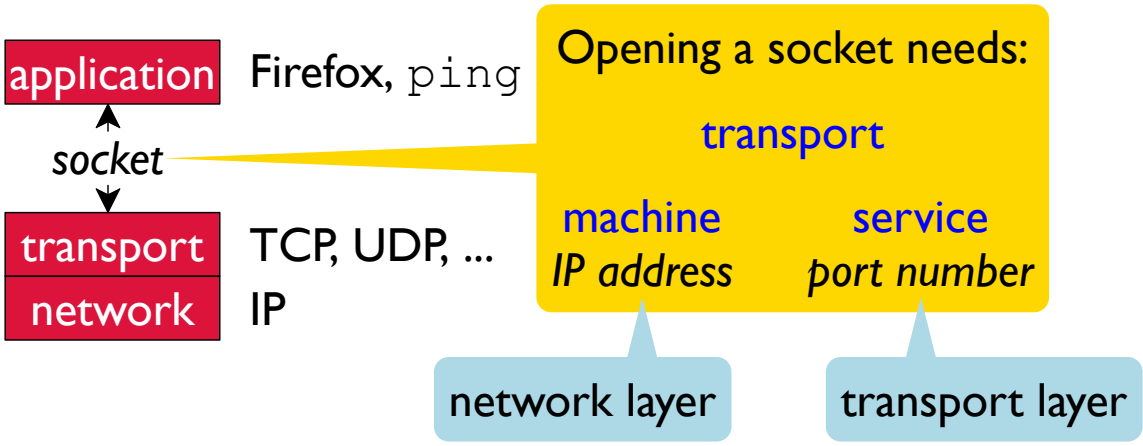

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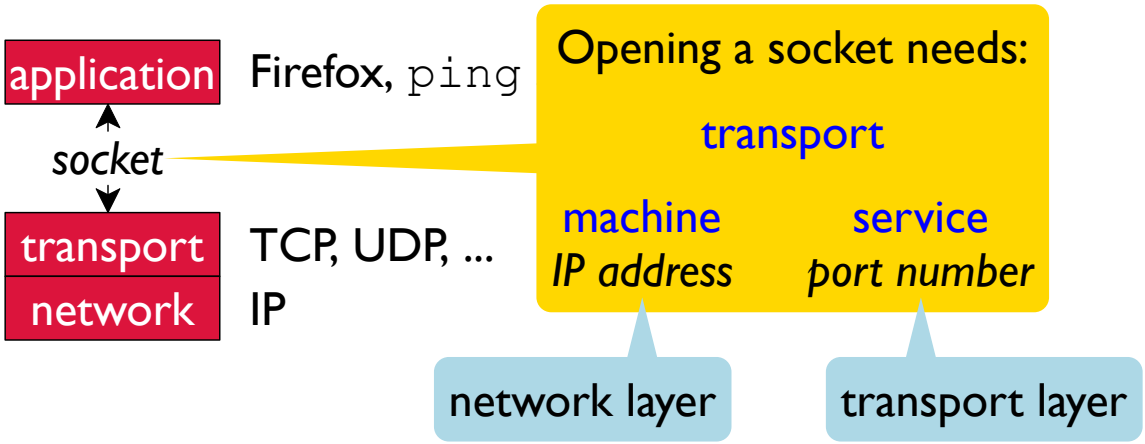
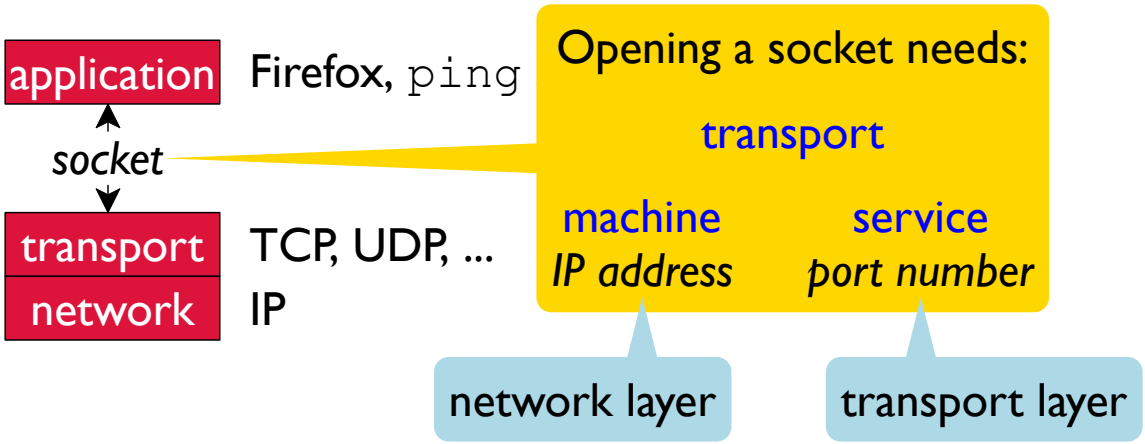


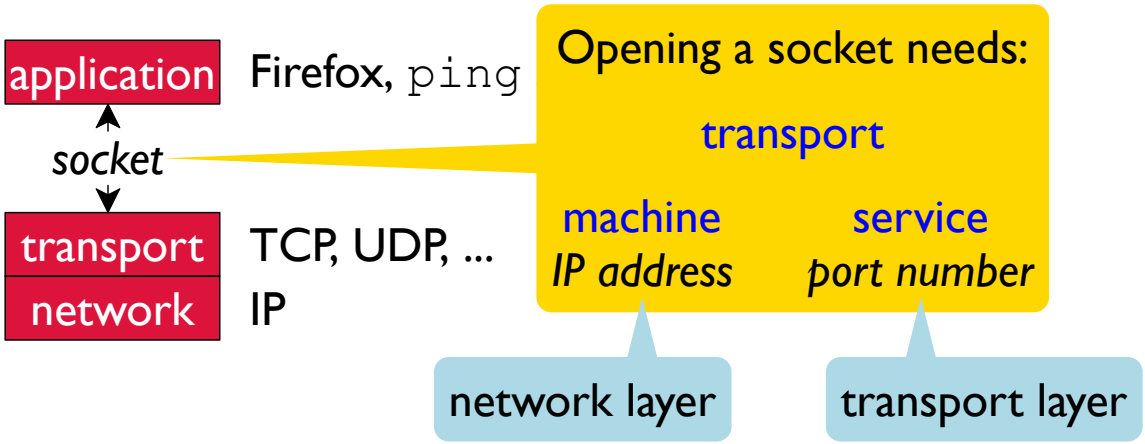
Web server TCP `www.cs.utah.edu 80`

Network Layers



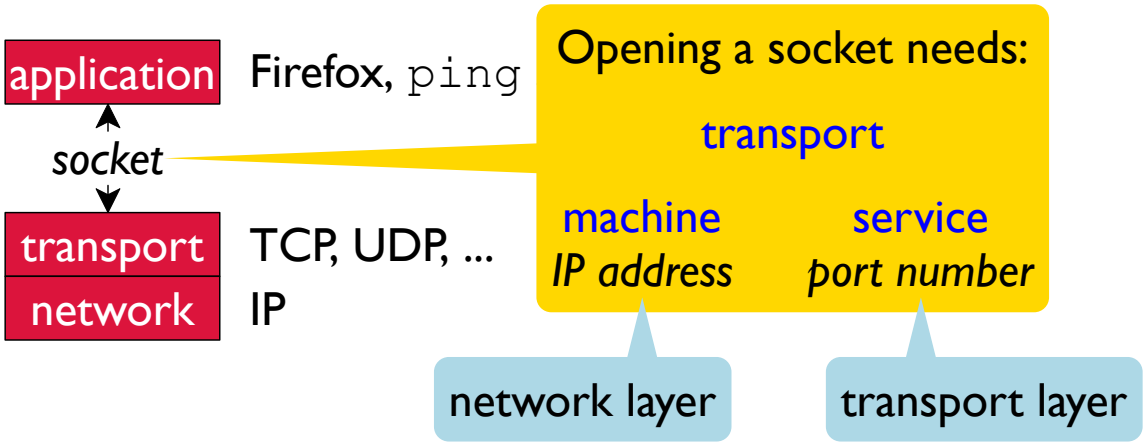
Web server	TCP	`www.cs.utah.edu`	`80`
Modern web server	TCP	`www.cs.utah.edu`	`443`

Network Layers



Web server	TCP	`www.cs.utah.edu`	`80`
Modern web server	TCP	`www.cs.utah.edu`	`443`
Mail receiver	TCP	`smtp.cs.utah.edu`	`25`

Network Layers



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Modern web server	TCP	`www.cs.utah.edu`	`443`
Mail receiver	TCP	`smtp.cs.utah.edu`	`25`
Name resolver	UDP	`8.8.8.8`	`53`

Transport Layer Options

TCP **UDP**

Transport Layer Options

TCP

stream

UDP

datagram

Transport Layer Options

TCP	**UDP**
stream	*datagram*
reliable delivery	unreliable delivery

Transport Layer Options

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Transport Layer Options

TCP	**UDP**
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potentially slow	potentially fast

Transport Layer Options

When you need the right answer and can wait a little while

TCP	**UDP**
stream	*datagram*
reliable delivery	unreliable delivery
reliable order	unreliable order
flow/congestion control	no flow/congestion control
potentially slow	potentially fast

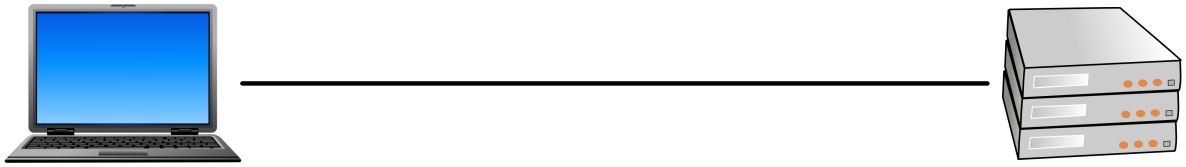
Transport Layer Options

When you need the right answer and can wait a little while

For small data, or for getting most data as fast as possible

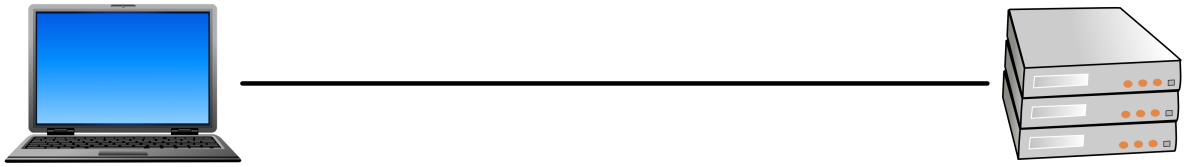
TCP	**UDP**
stream	*datagram*
reliable delivery	unreliable delivery
reliable order	unreliable order
flow/congestion control	no flow/congestion control
potentially slow	potentially fast

Example: Web Browsing



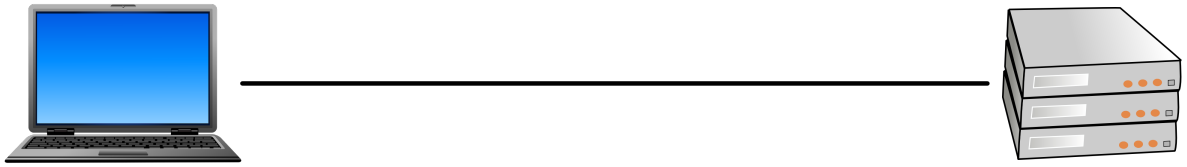
Example: Web Browsing

client–server



Example: Web Browsing

```
GET /index.html HTTP/1.1
Host: www.cs.utah.edu
Accept-Encoding: gzip, deflate
```



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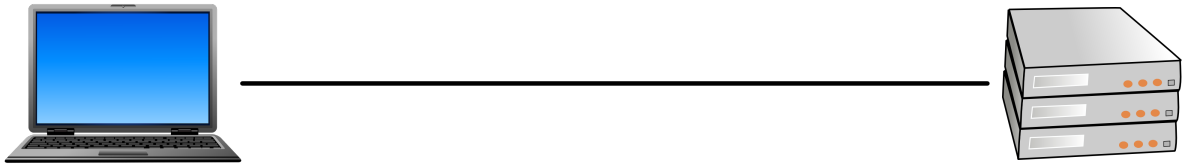
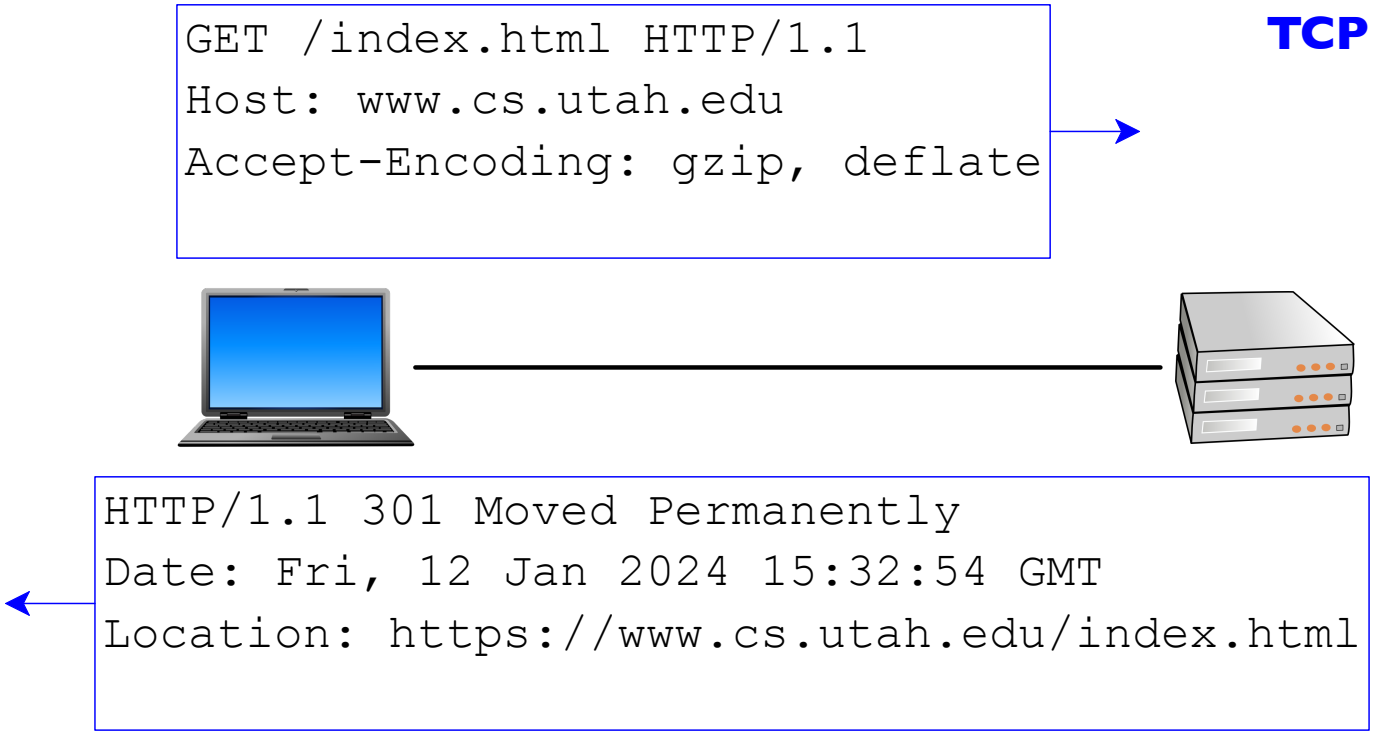


```
HTTP/1.1 301 Moved Permanently
Date: Fri, 12 Jan 2024 15:32:54 GMT
Location: https://www.cs.utah.edu/index.html
```

Example: Web Browsing



Example: Web Browsing

```
netcat www.cs.utah.edu 80
```

```
GET /index.html HTTP/1.1
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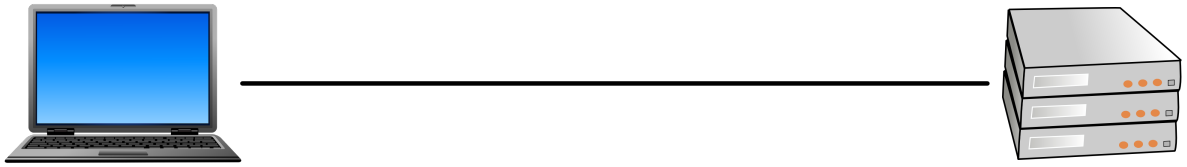

```
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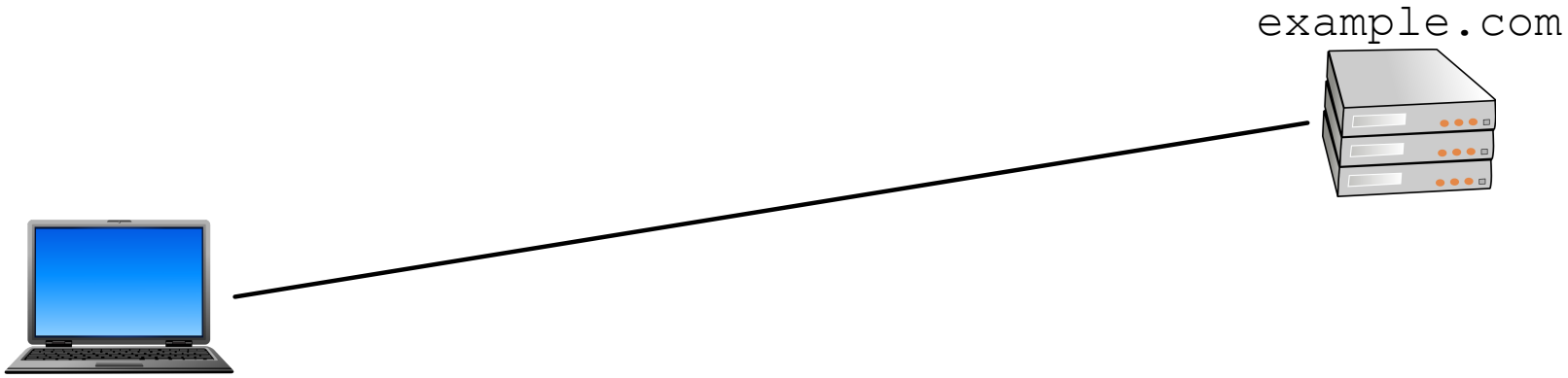
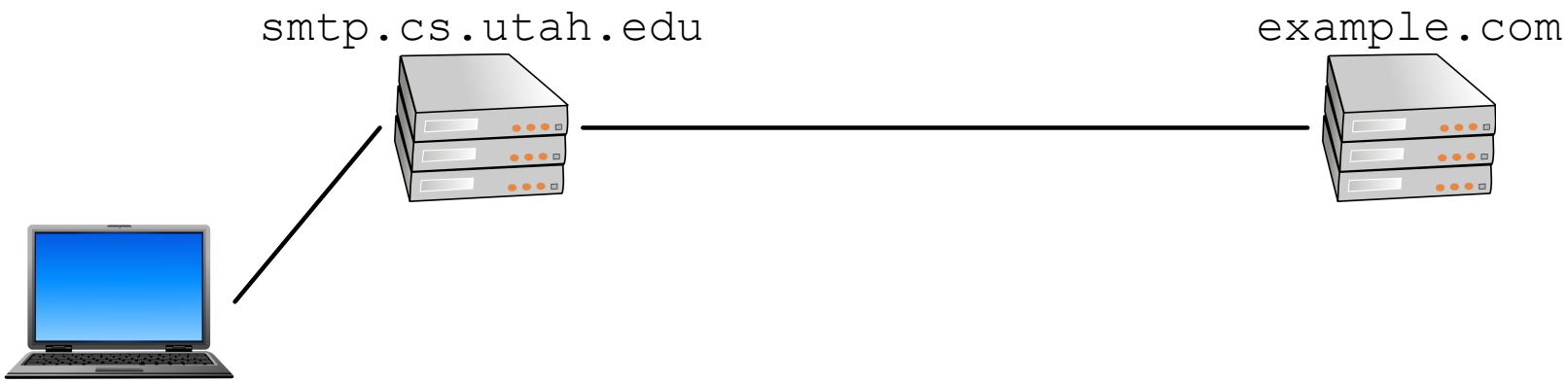
Location: https://www.cs.utah.edu/index.html
```

Example: Email



Example: Email



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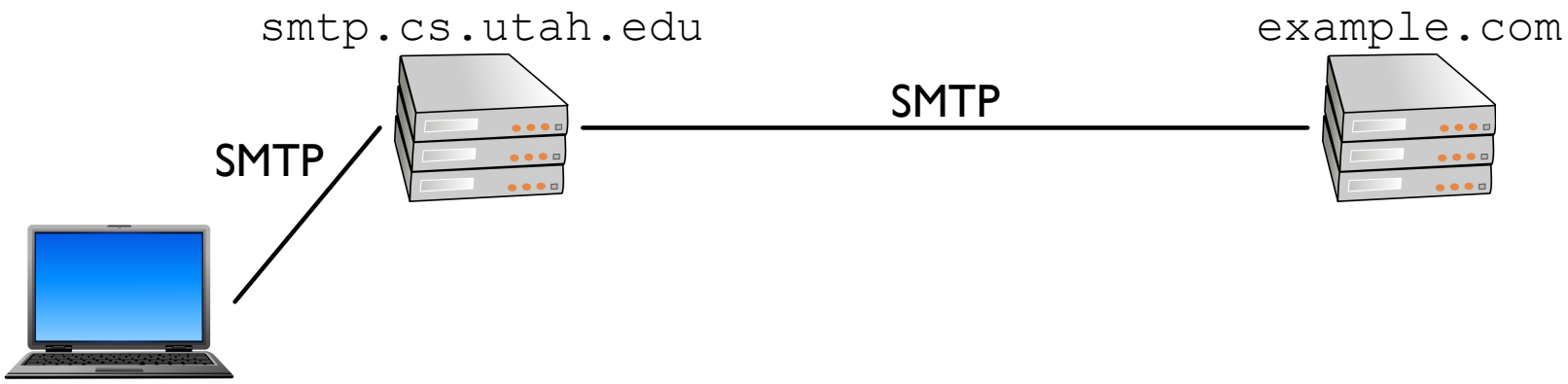
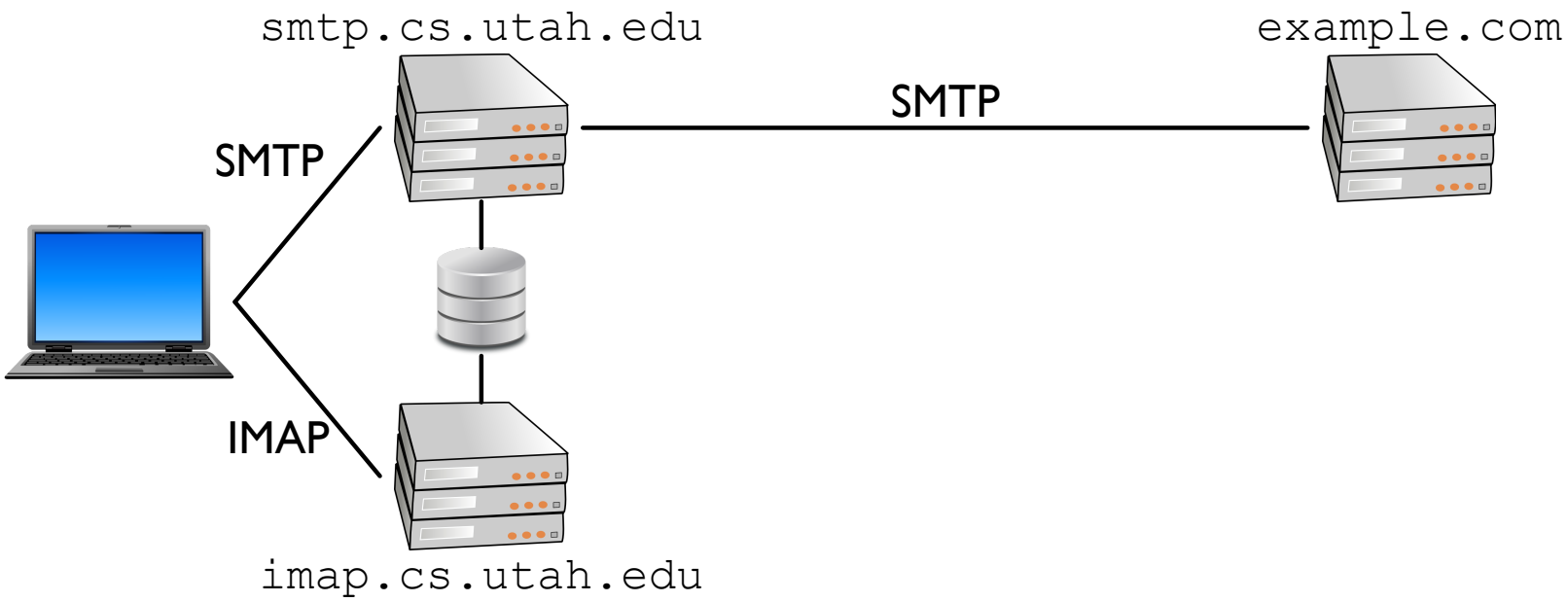
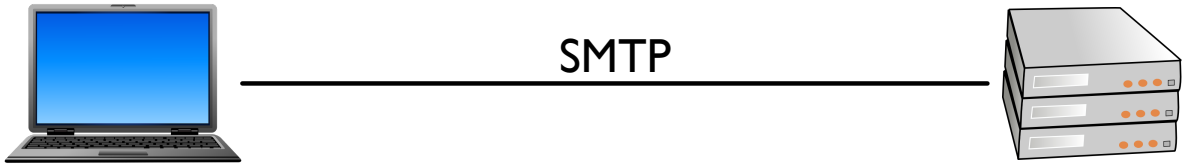


Example: Email



Example: Sending Email



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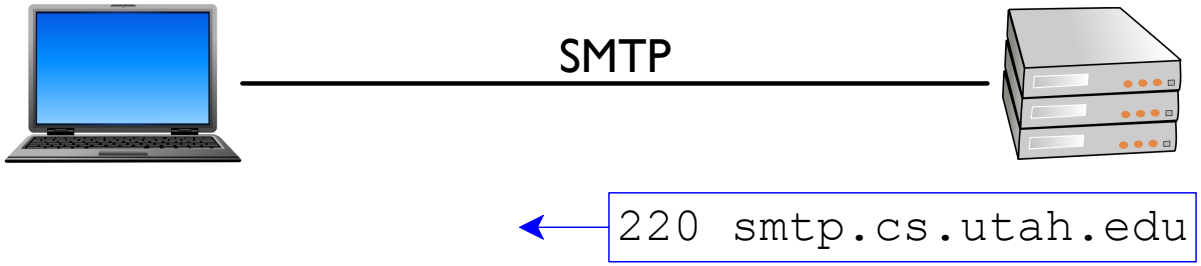

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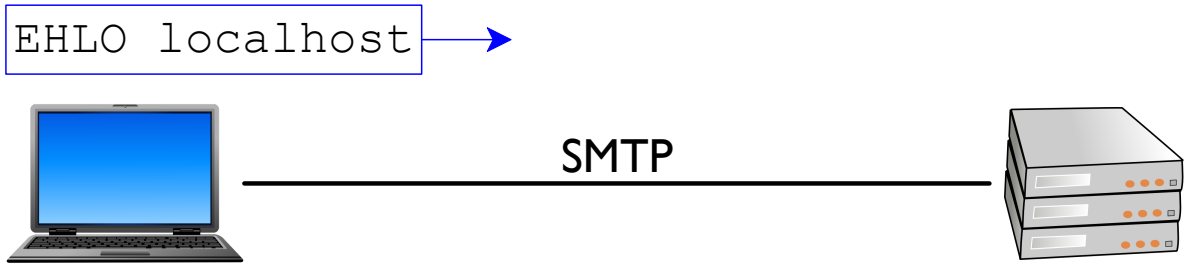

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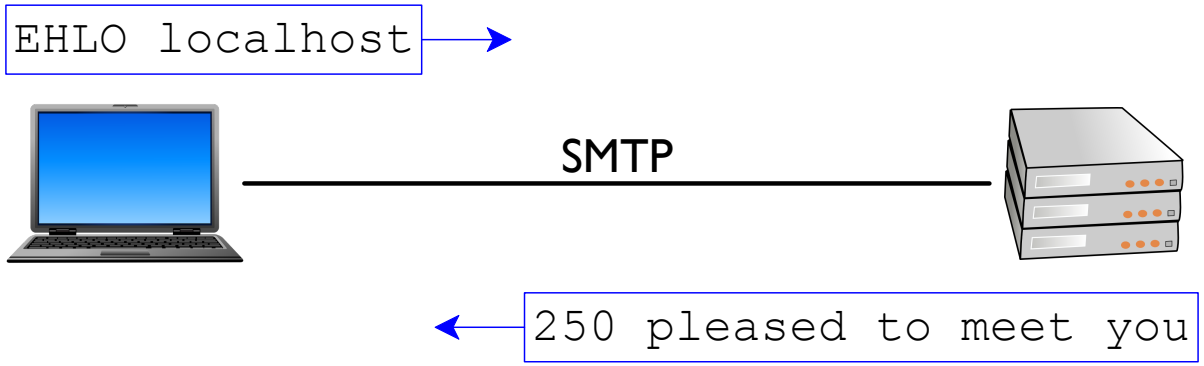

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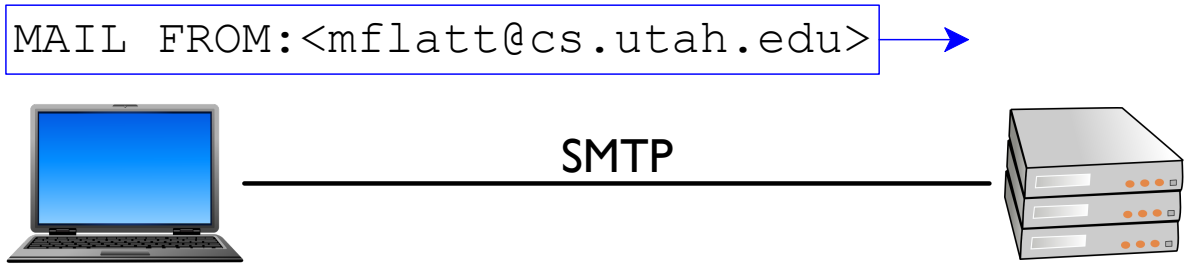

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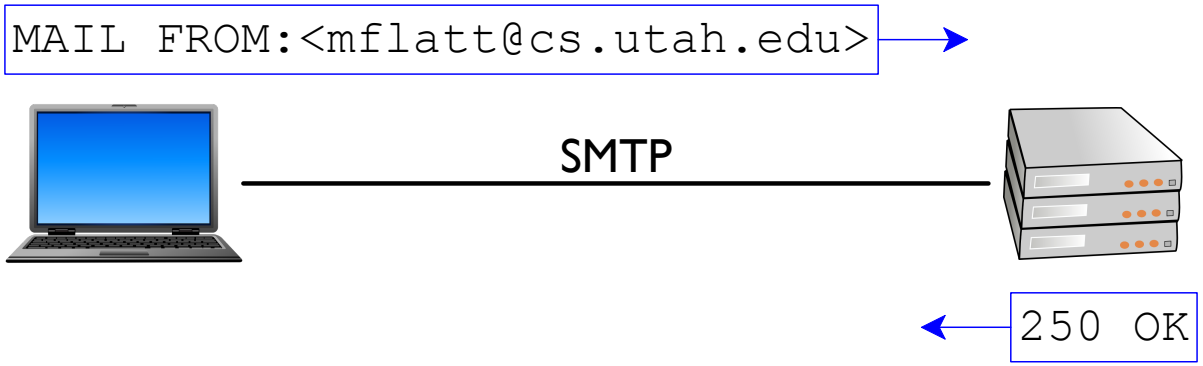

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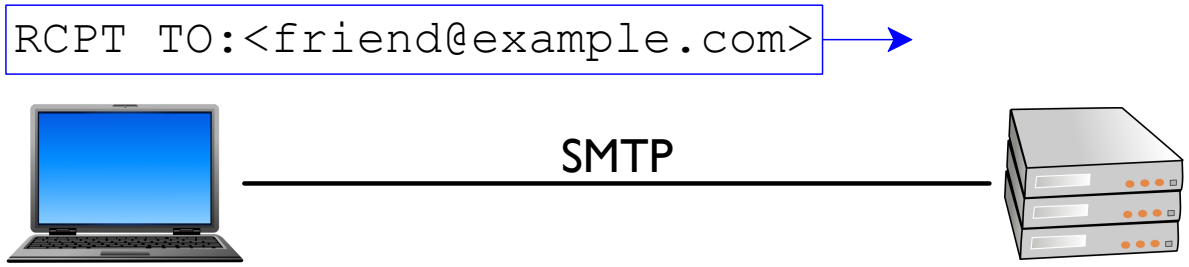

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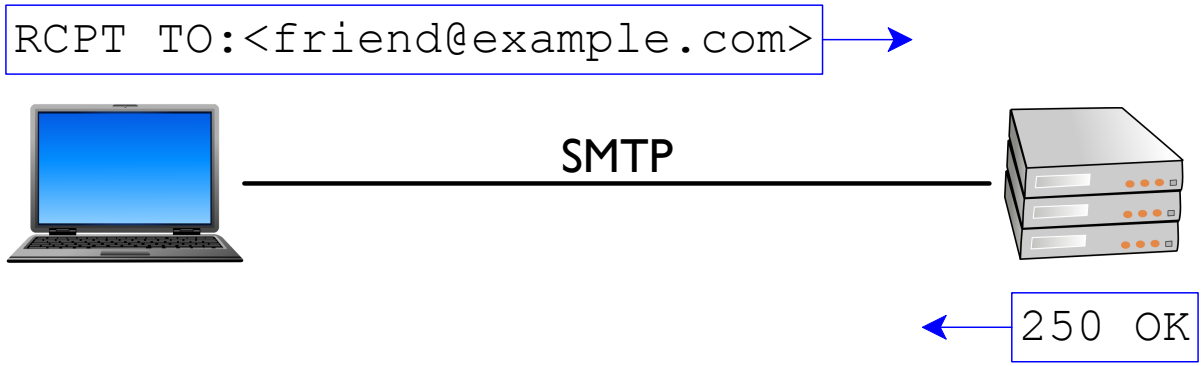

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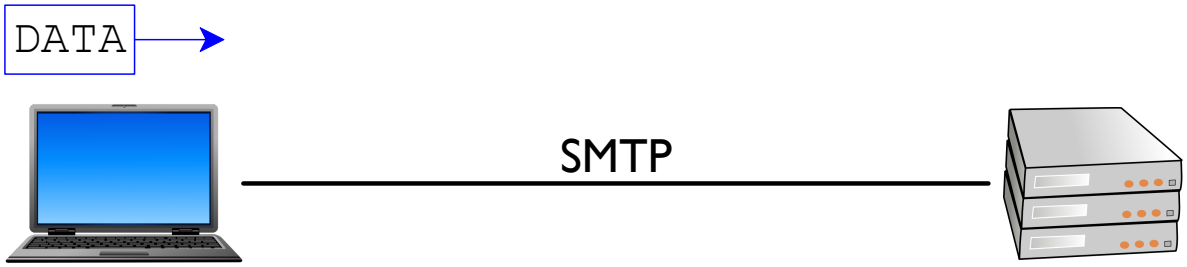

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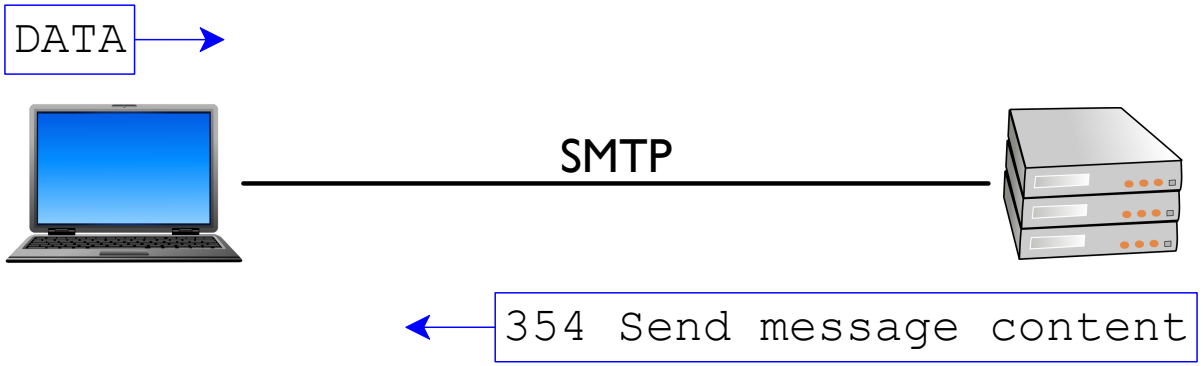
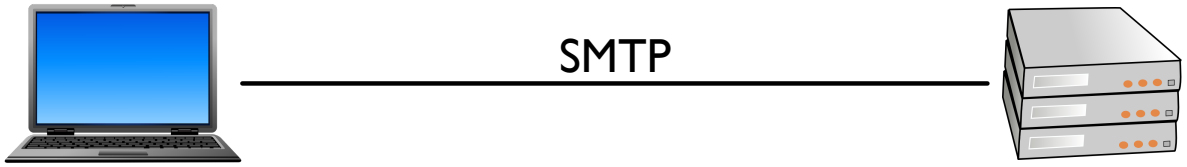


Example: Sending Email

```
Date: Thu, 11 Jan 2023 01:02:03 -0700
From: Matthew Flatt <mflatt@cs.utah.edu>
Subject: Hi
To: Friend <friend@example.com>

Howdy
.
```



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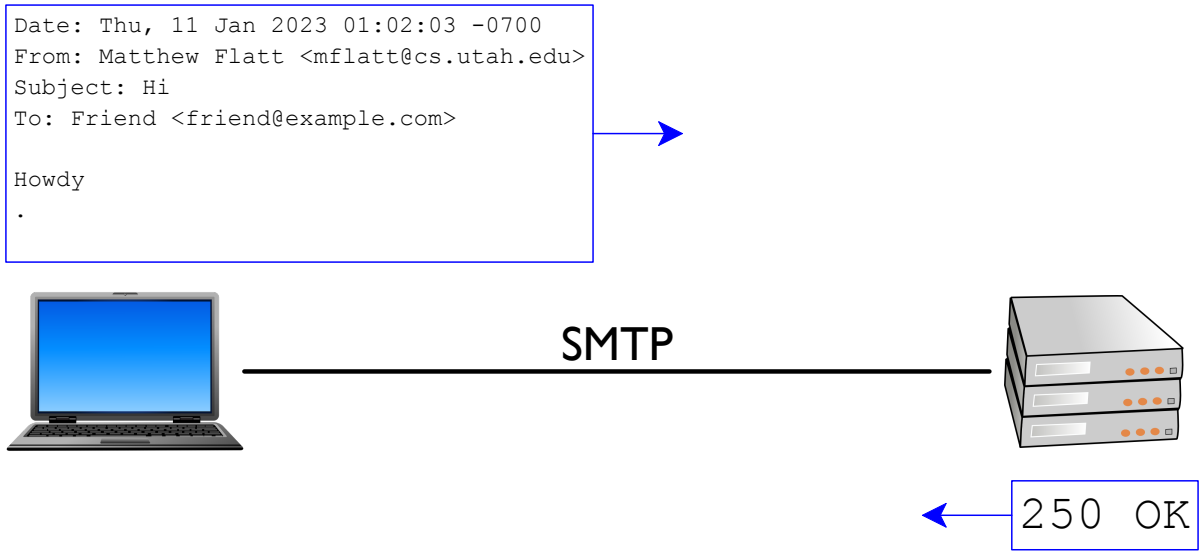

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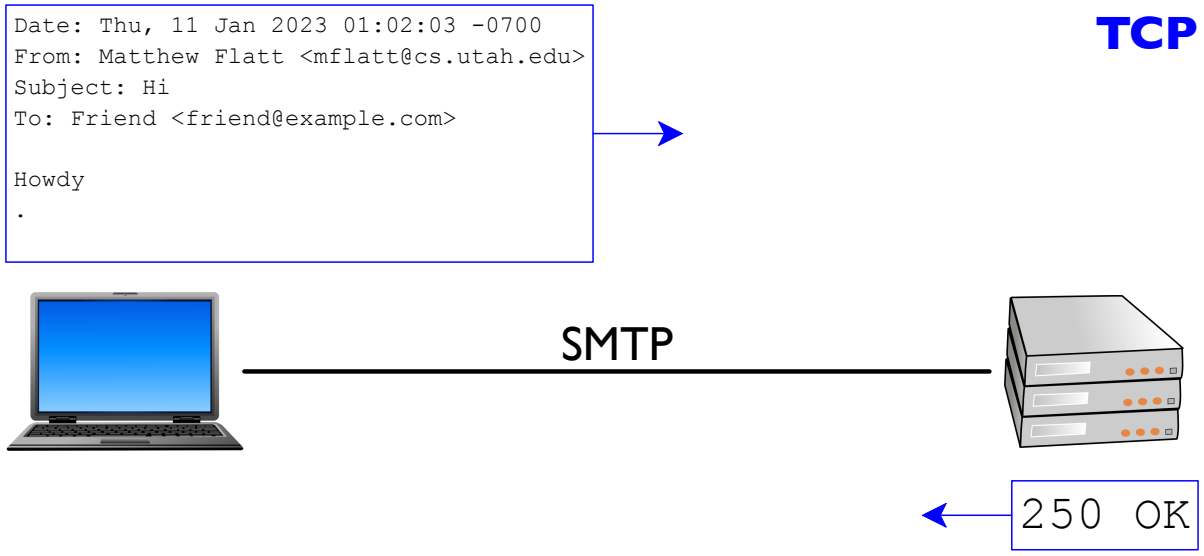

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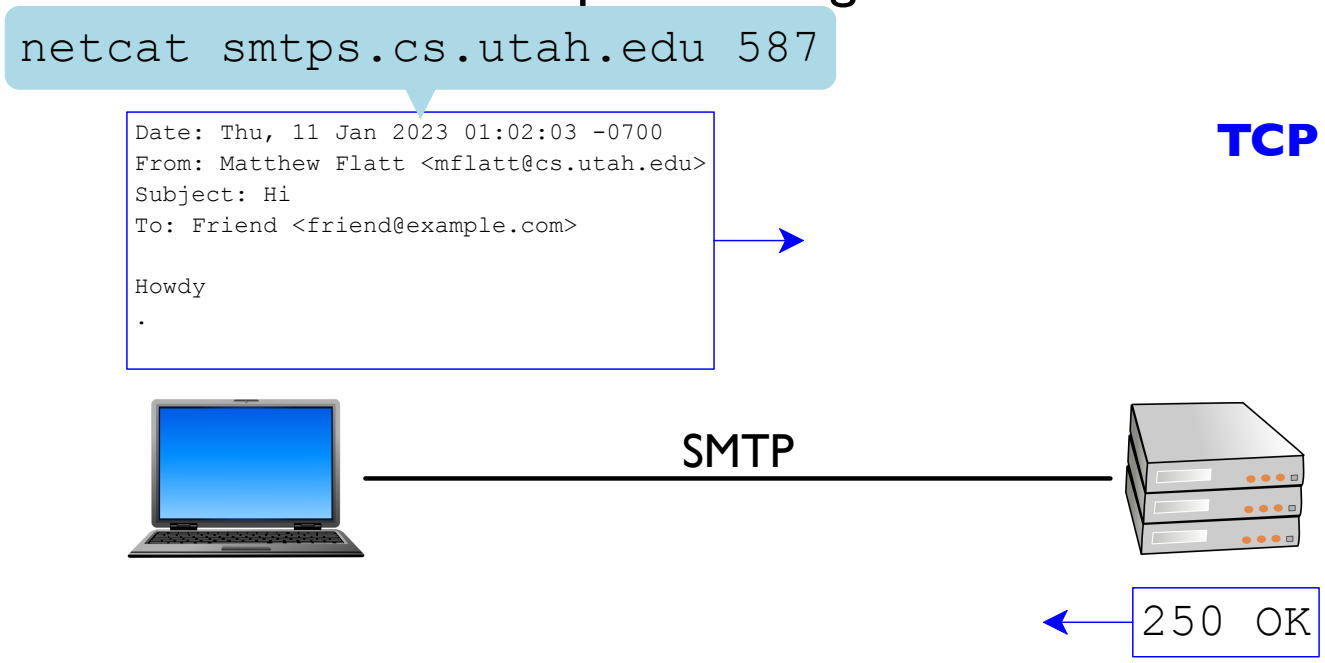
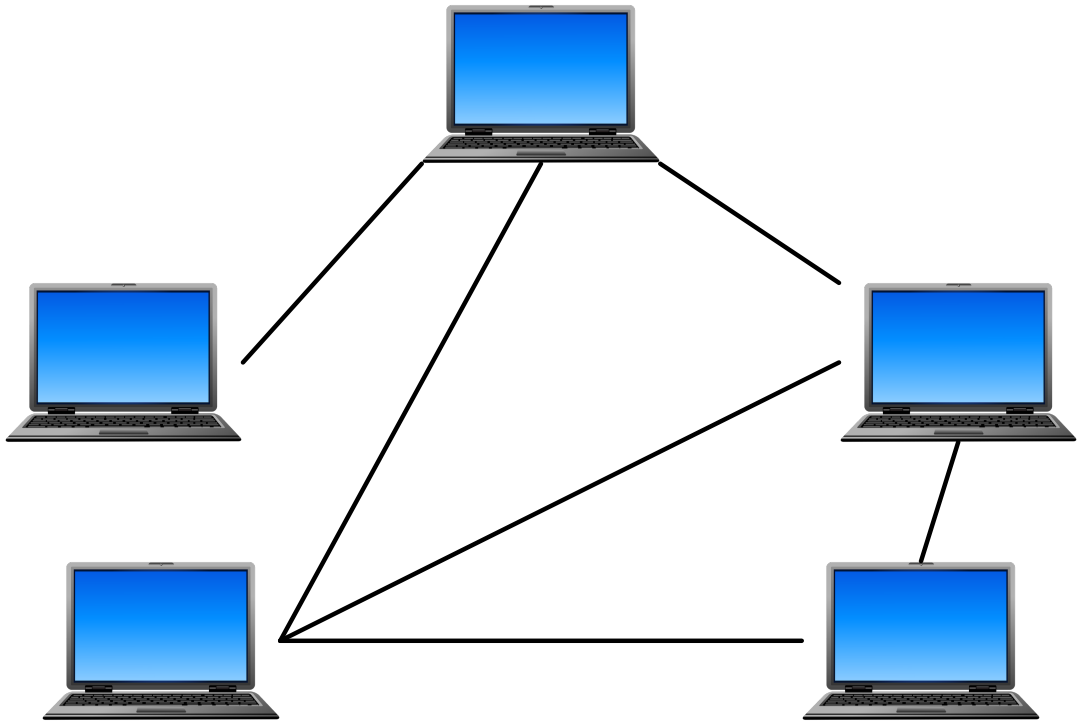


Example: BitTorrent



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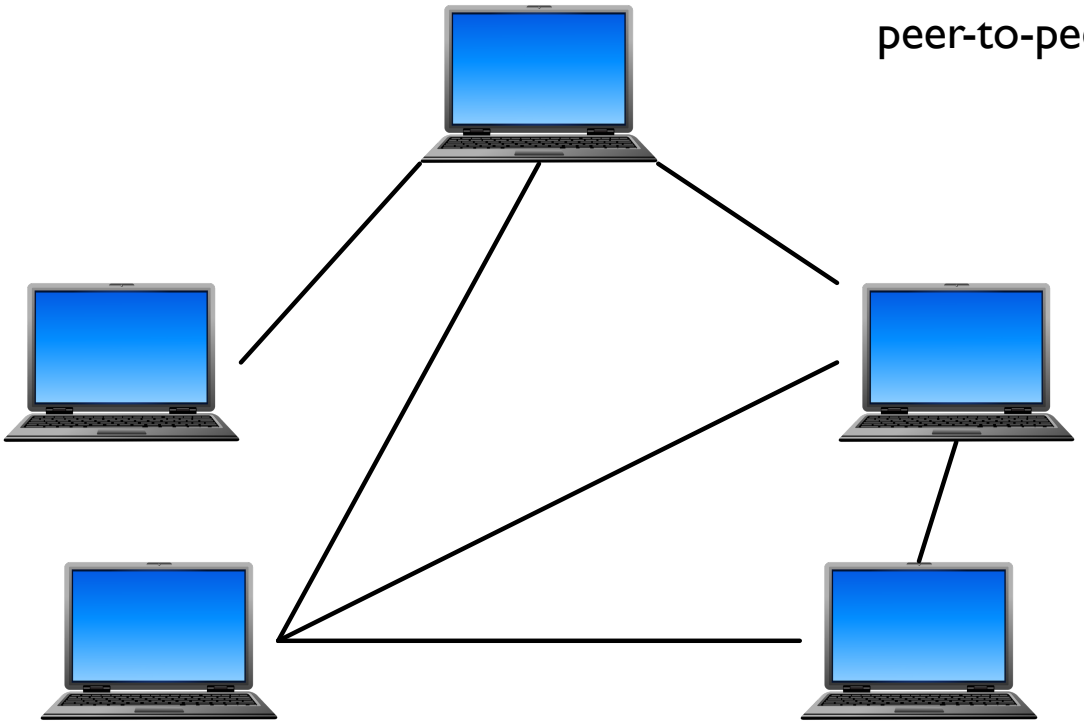

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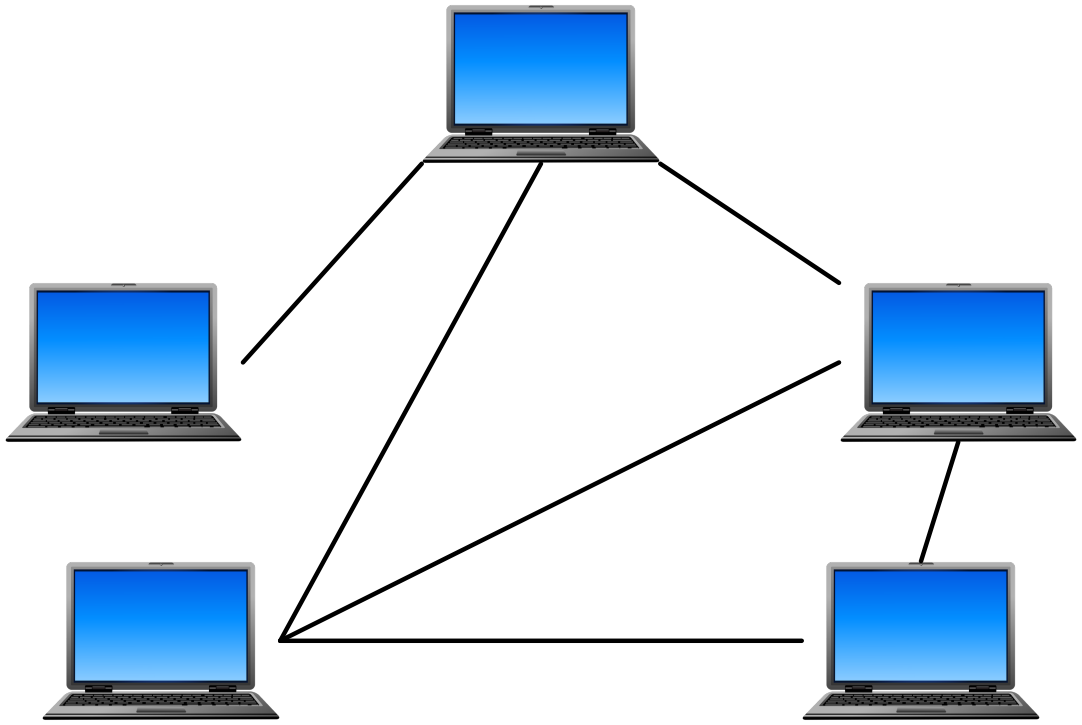
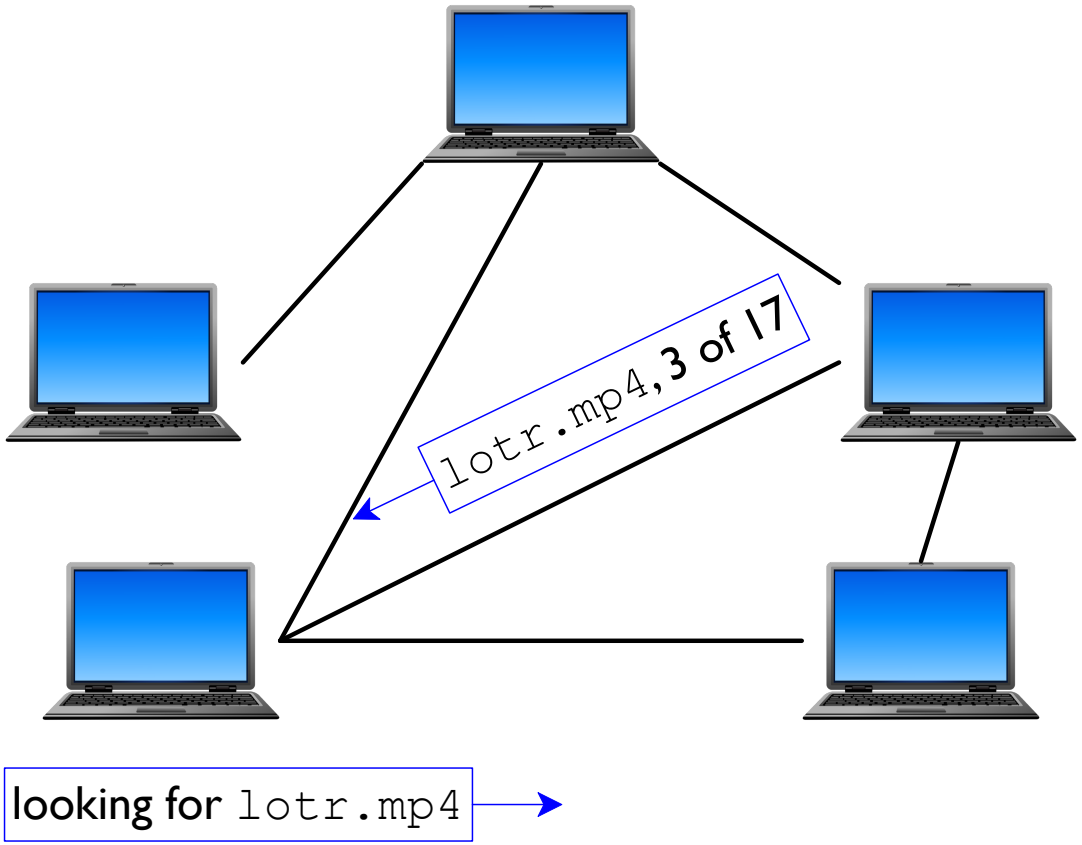


looking for `lotr.mp4`

Example: BitTorrent



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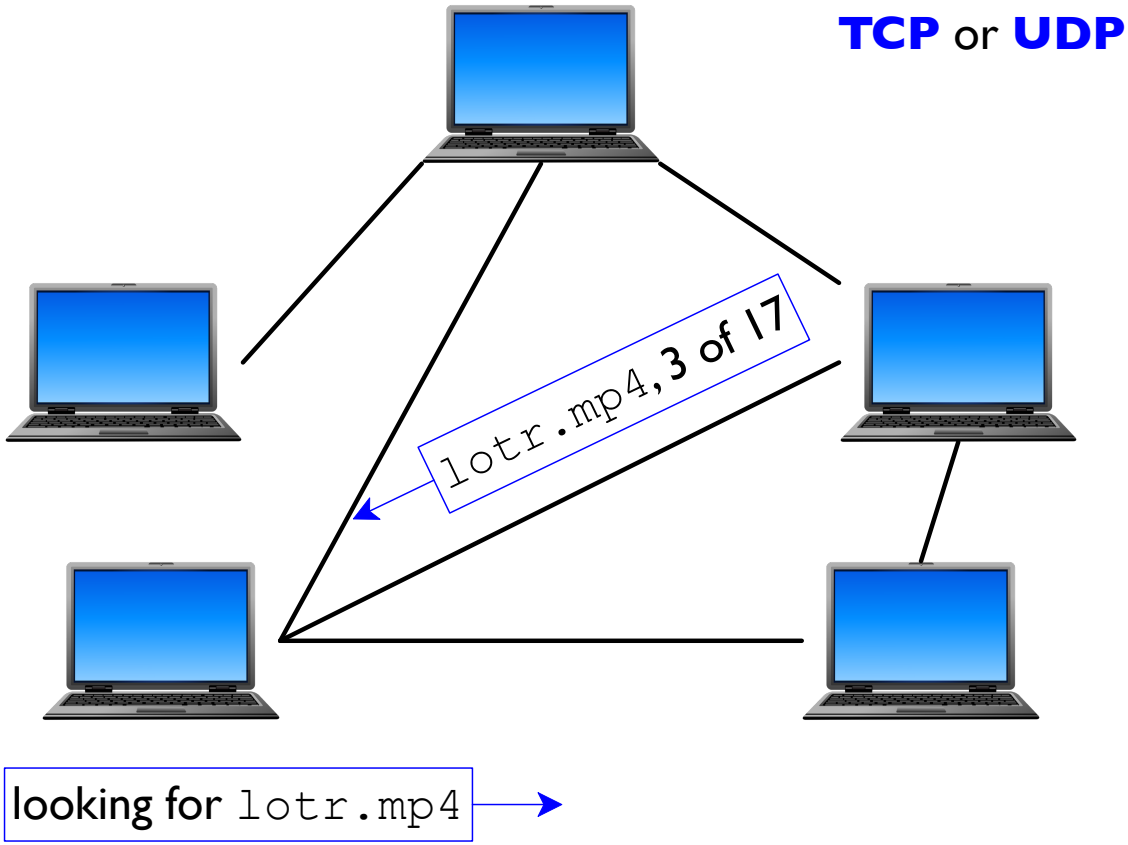
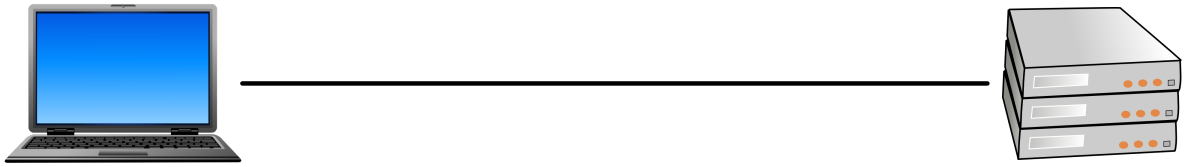


Example: DNS



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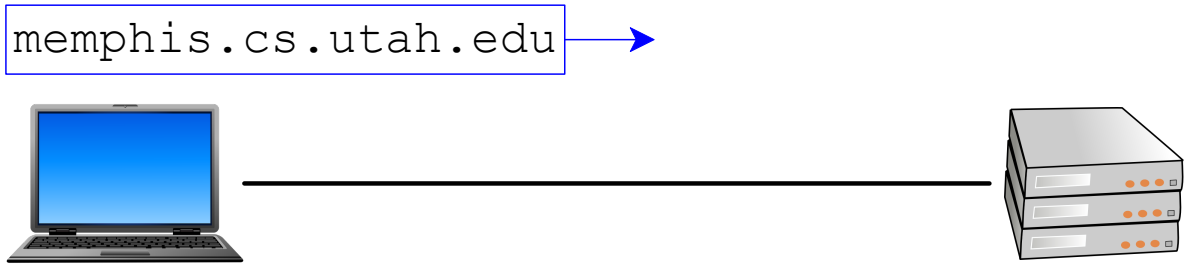

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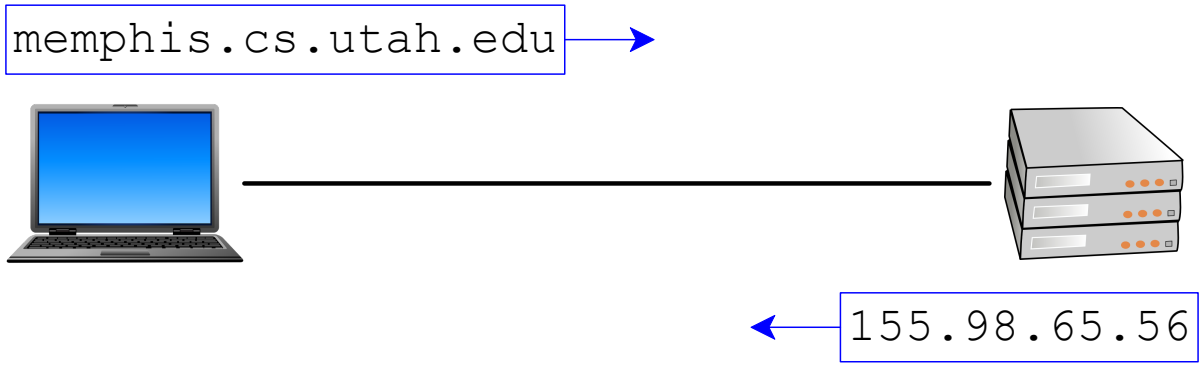

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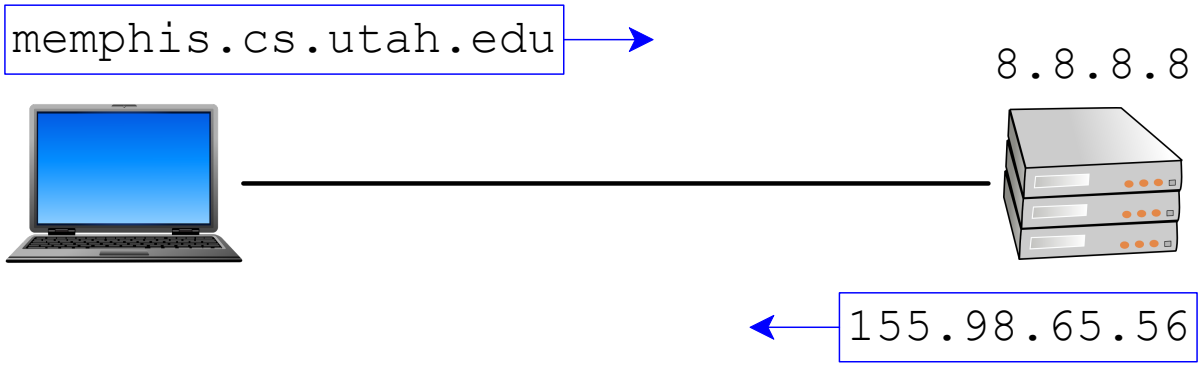

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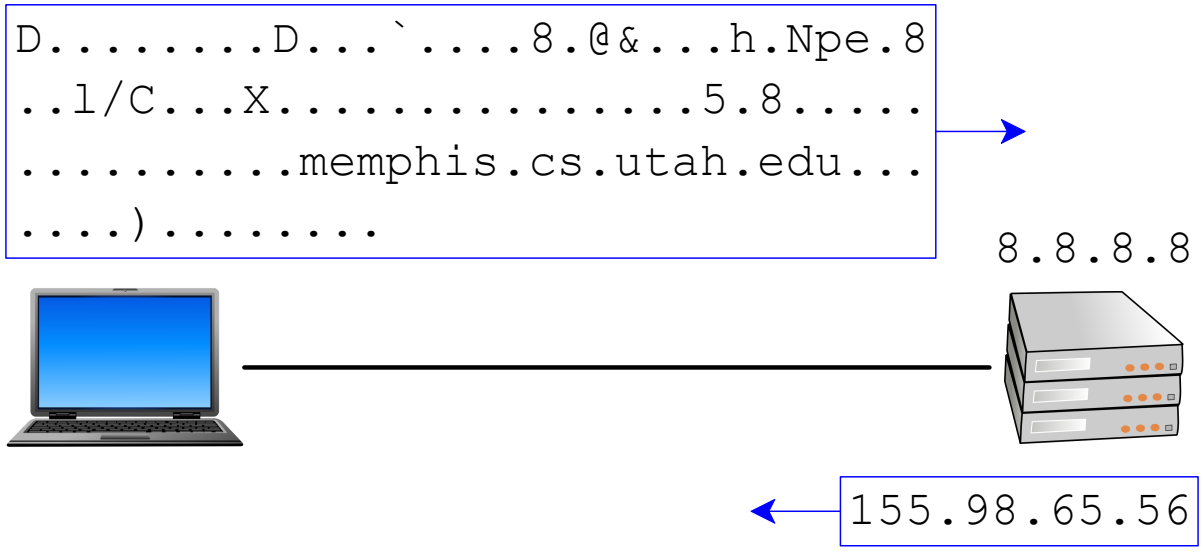

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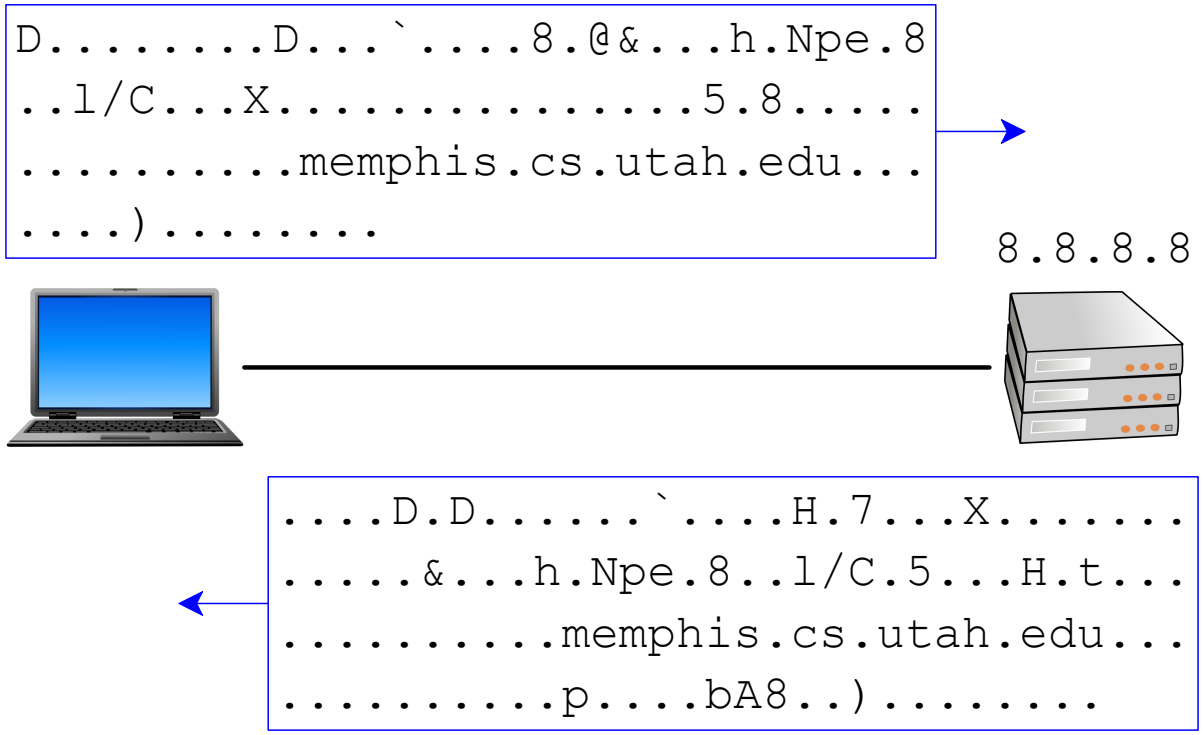
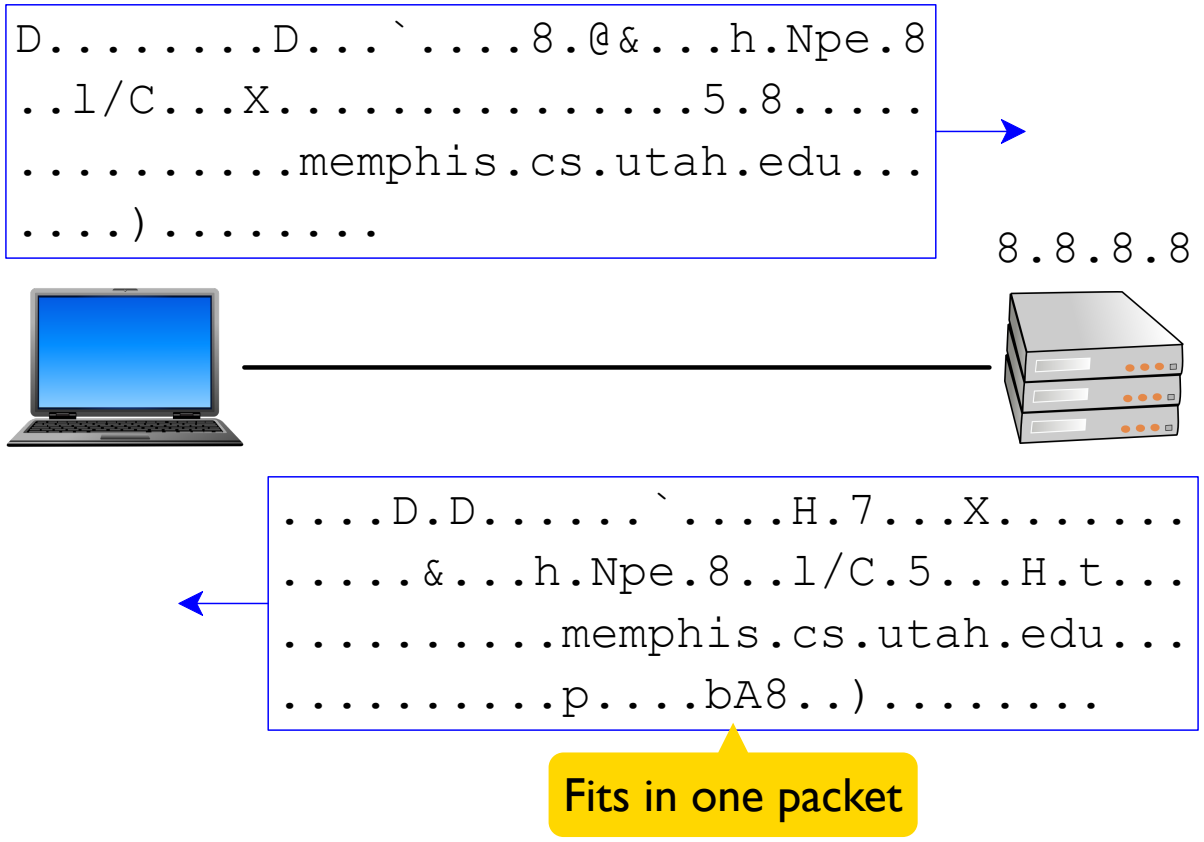

D.......D...`....8.@&...h.Npe.8
..l/C...X..............5.8.....
.........memphis.cs.utah.edu...
....).......
8.8.8.8
....D.D.....`....H.7...X.......
.....&...h.Npe.8..l/C.5...H.t...
.........memphis.cs.utah.edu...
.........p....bA8..).......

Example: DNS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..l/C...X..............5.8.....
.........memphis.cs.utah.edu...
....).......
8.8.8.8
....D.D.....`....H.7...X.......
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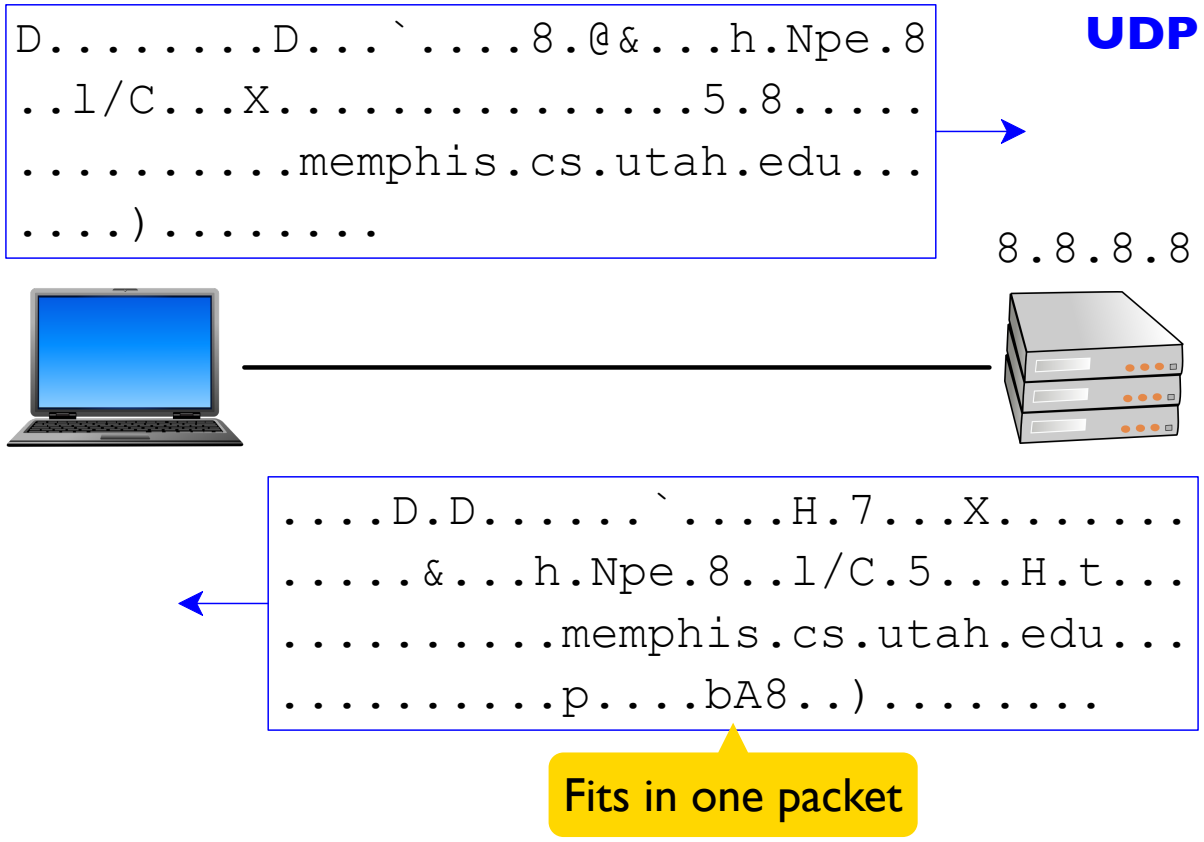
.........p....bA8..).......
Fits in one packet

Example: DNS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UDP
8.8.8.8
....D.D......`....H.7...X.......
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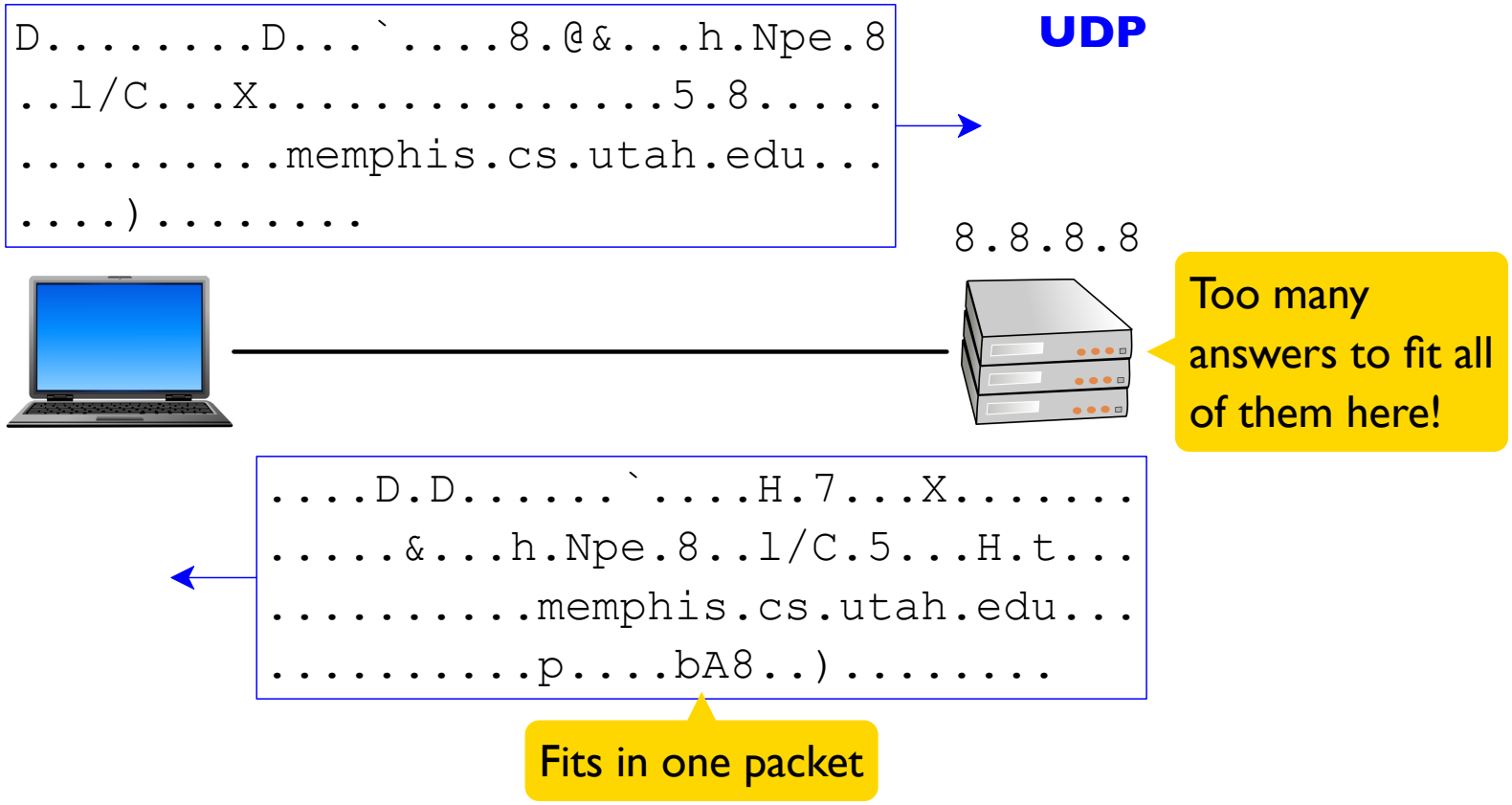
Fits in one packet

Example: DNS


D.......D...`....8.@&...h.Npe.8
..l/C...X..............5.8.....
..........memphis.cs.utah.edu...
....).........
UDP
8.8.8.8
Too many answers to fit all of them here!
....D.D......`....H.7...X.......
.....&...h.Npe.8..l/C.5...H.t...
..........memphis.cs.utah.edu...
..........p....bA8..).........
Fits in one packet

Name Resolution

`www.cs.utah.edu`

Name Resolution

domain name

`www.cs.utah.edu`

Name Resolution

domain name

`www.cs.utah.edu`

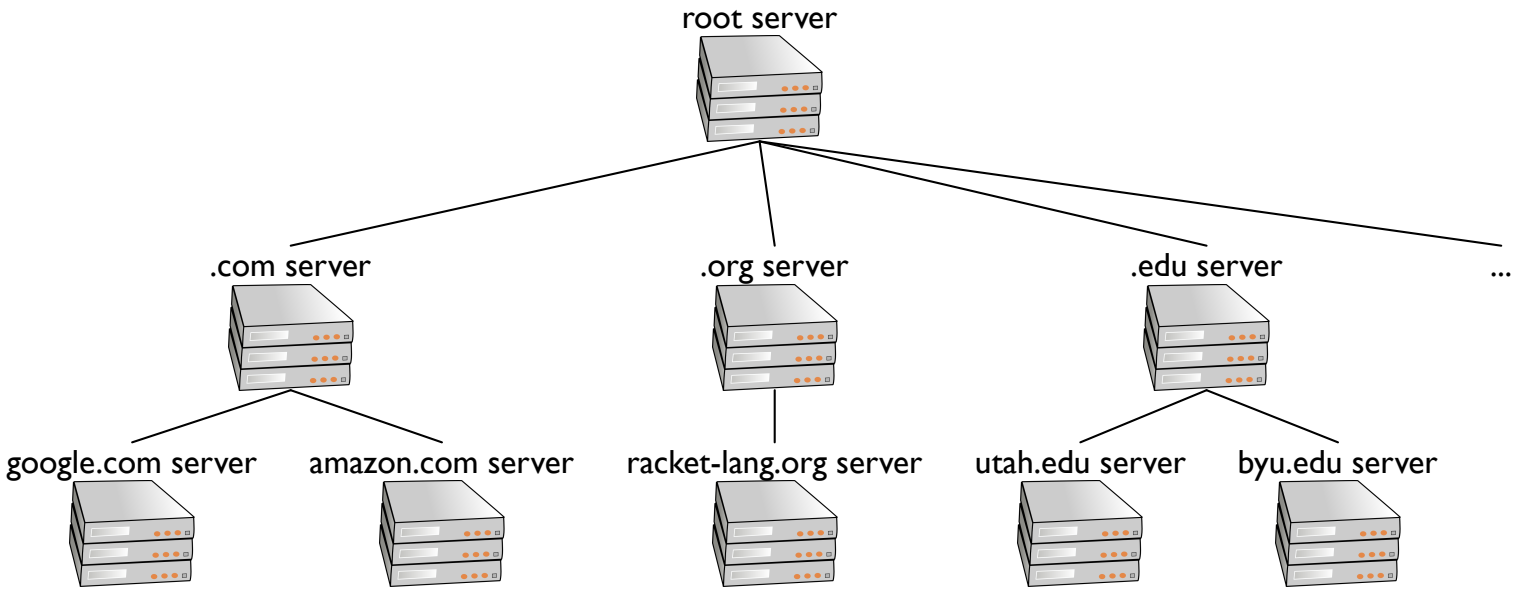
top-level domain

Name Resolution

domain name

`www.cs.utah.edu`

top-level domain



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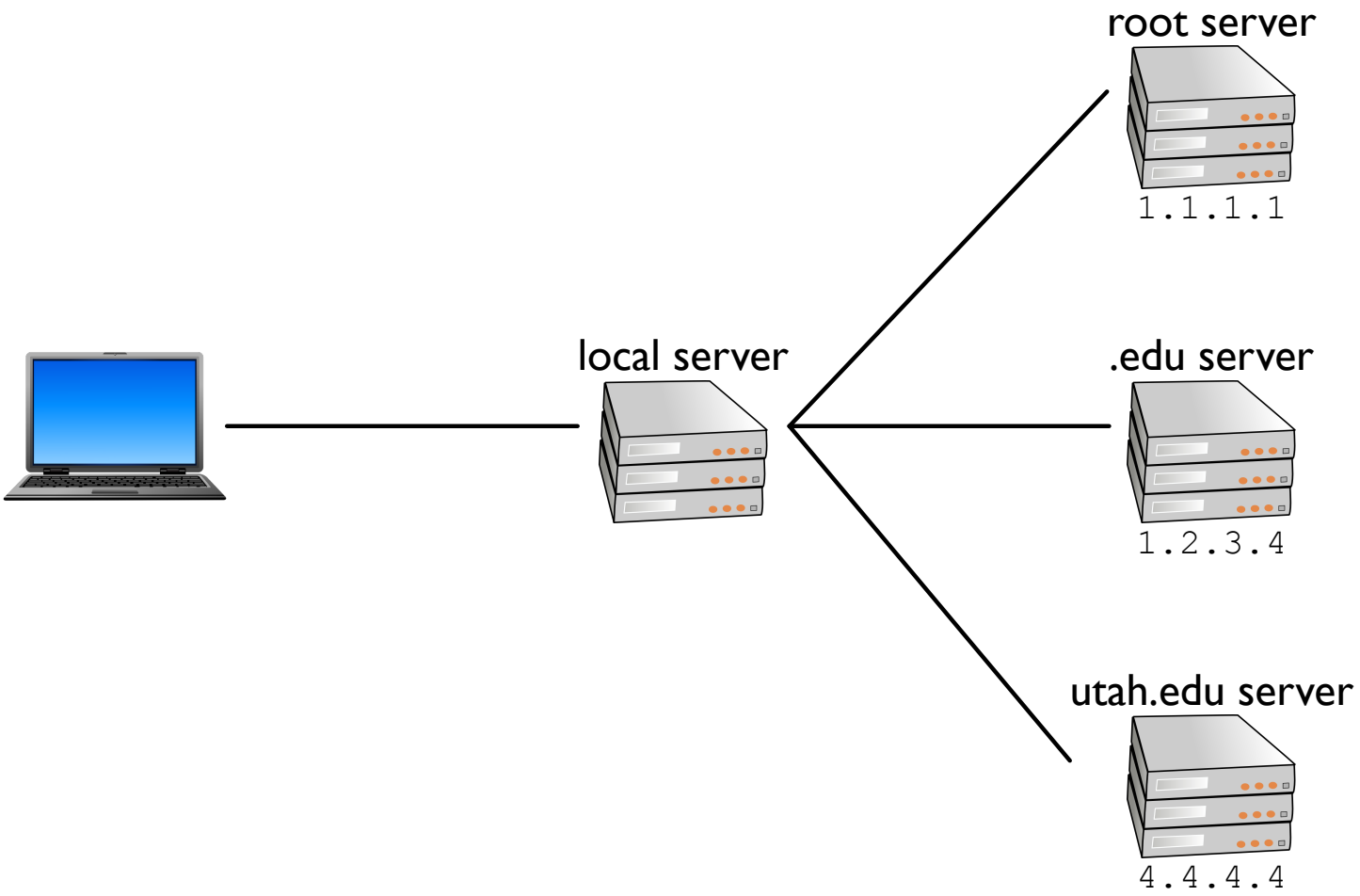

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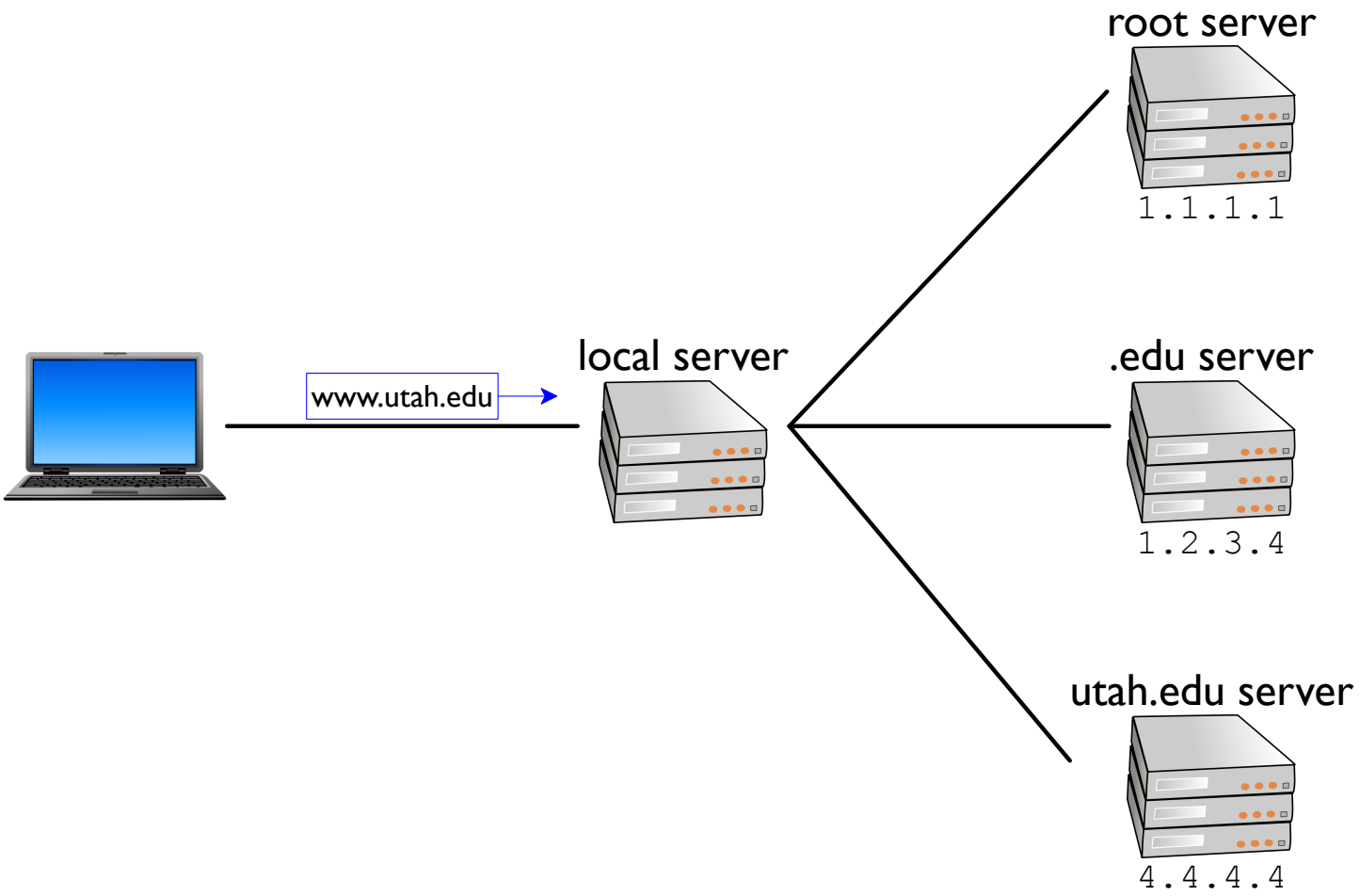

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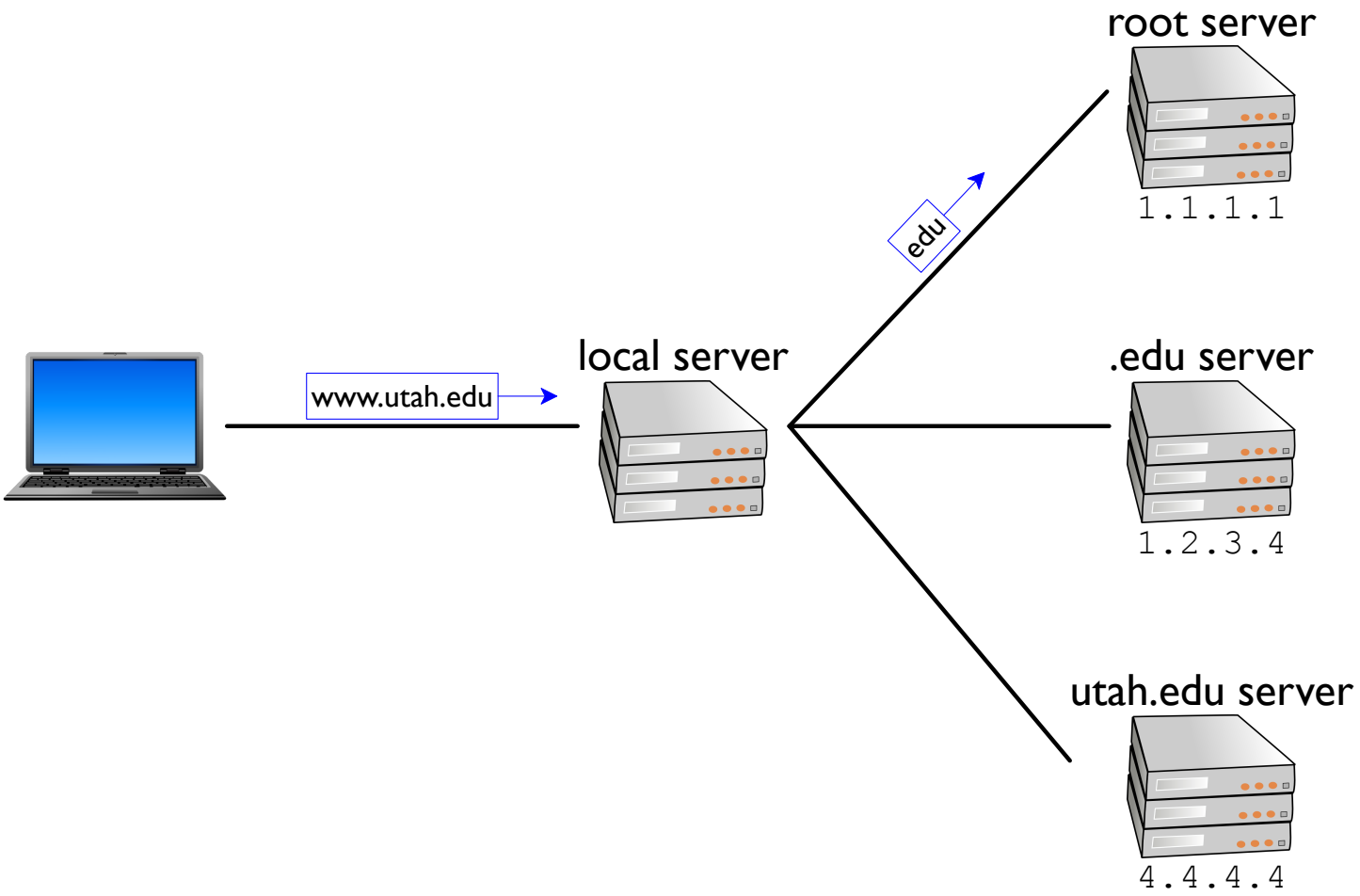

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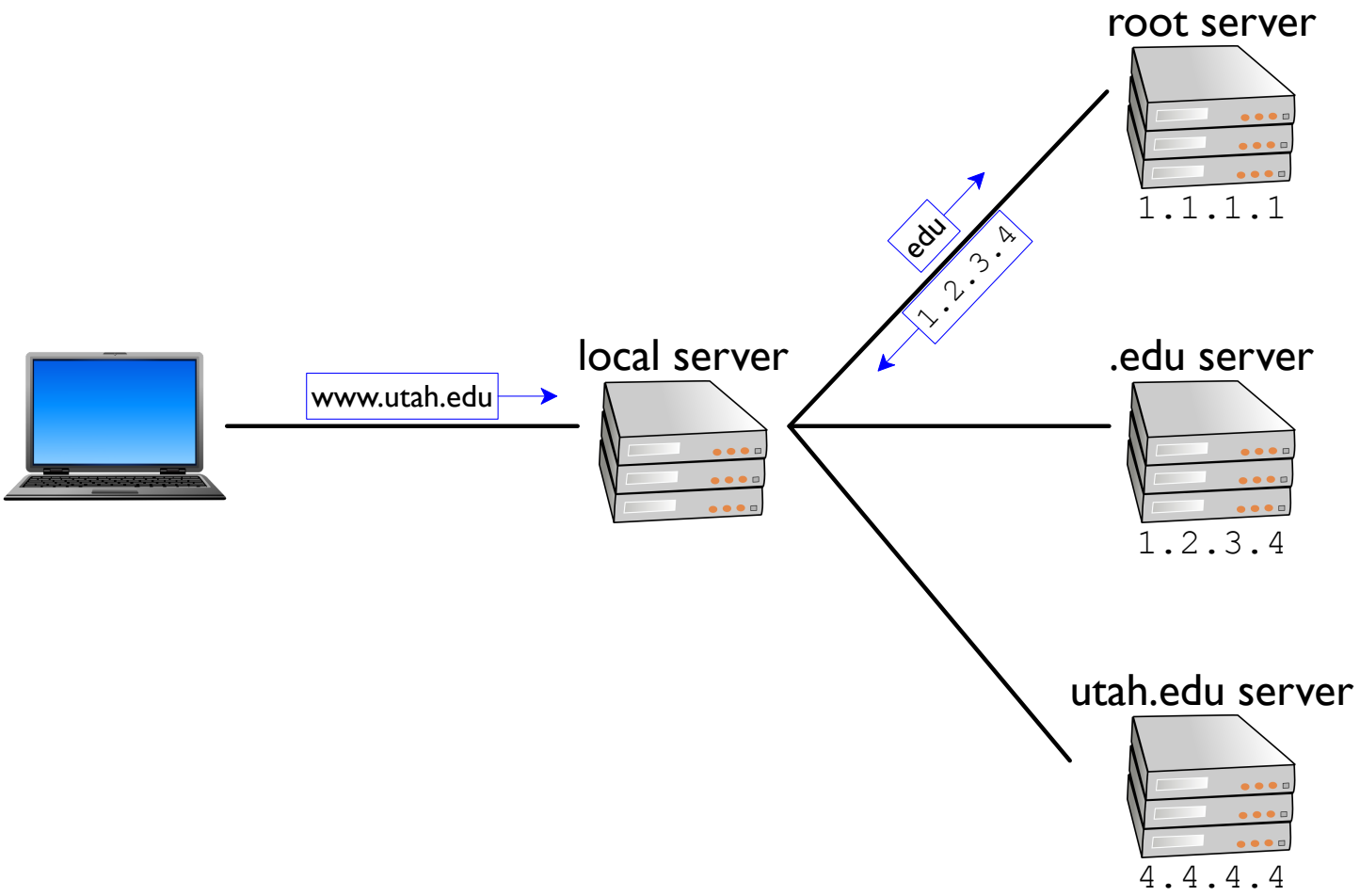

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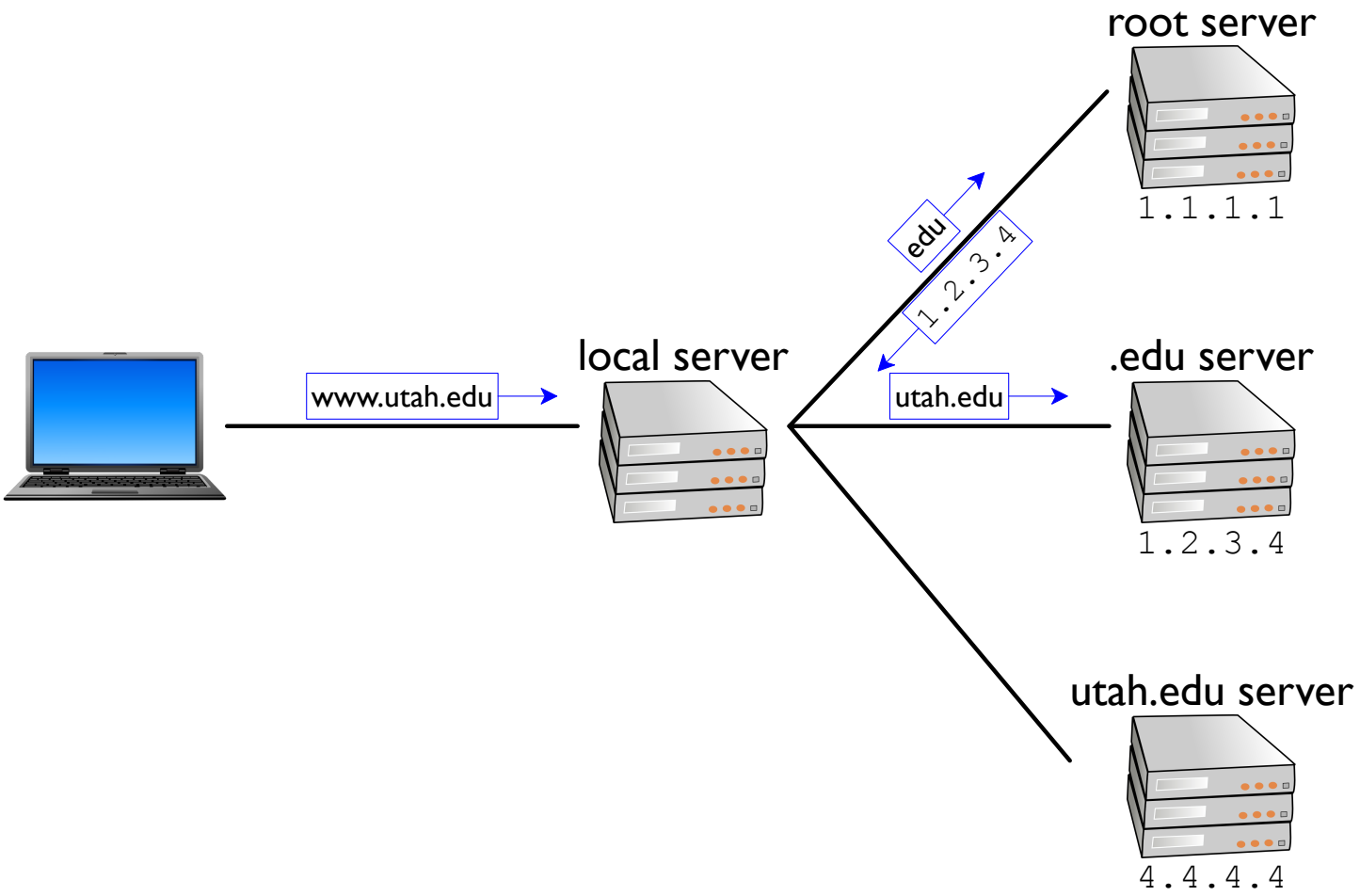

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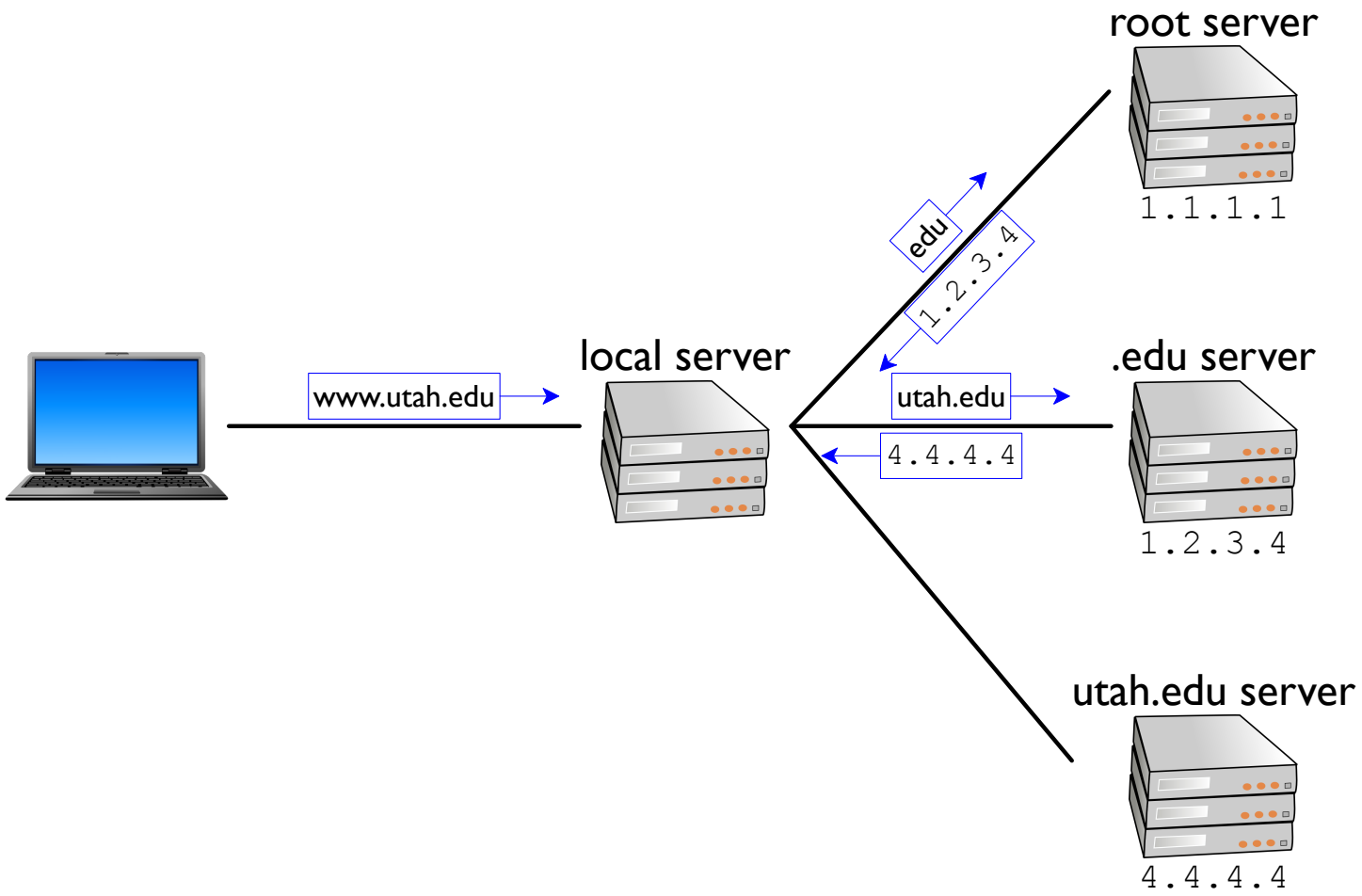

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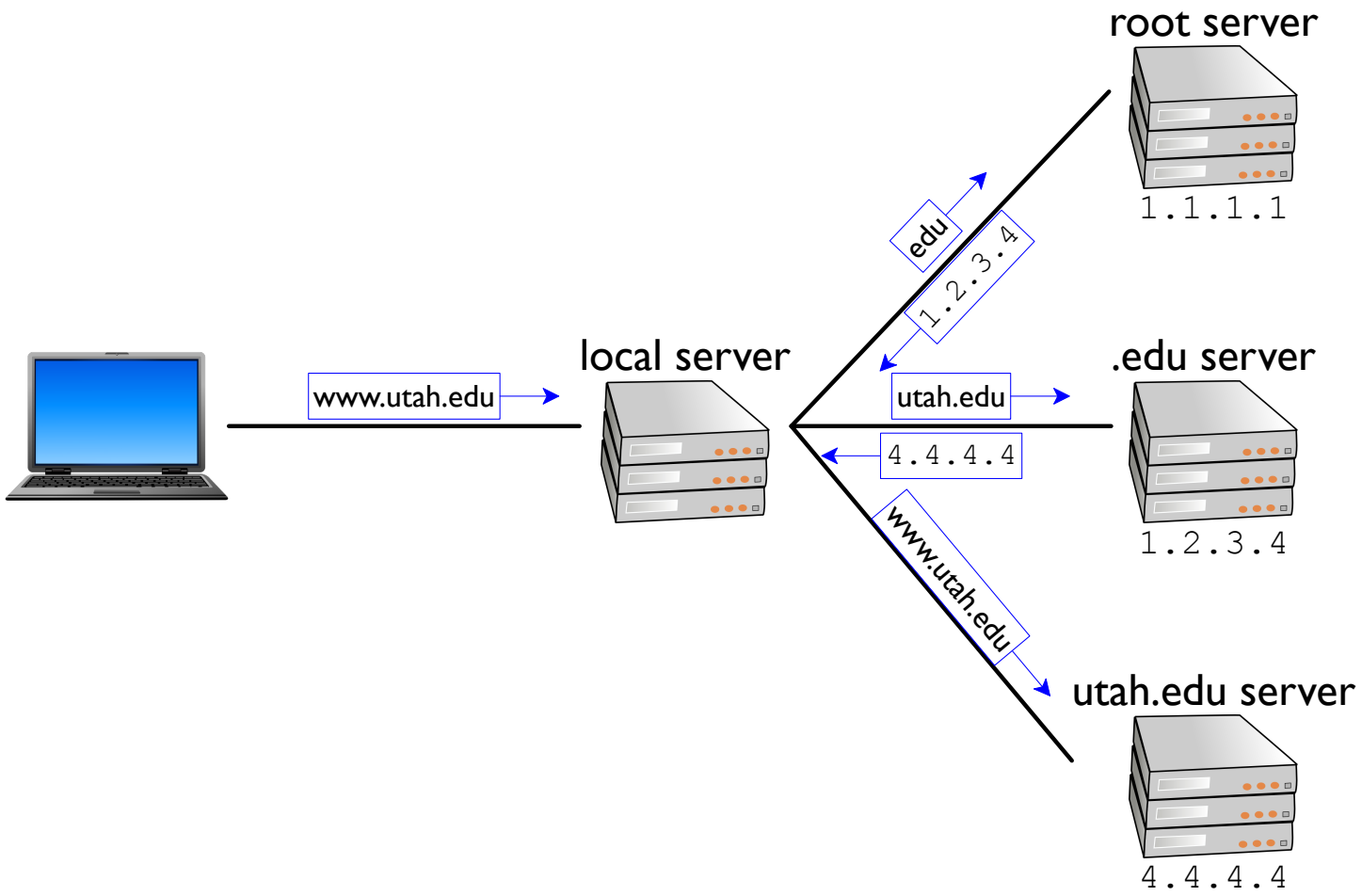

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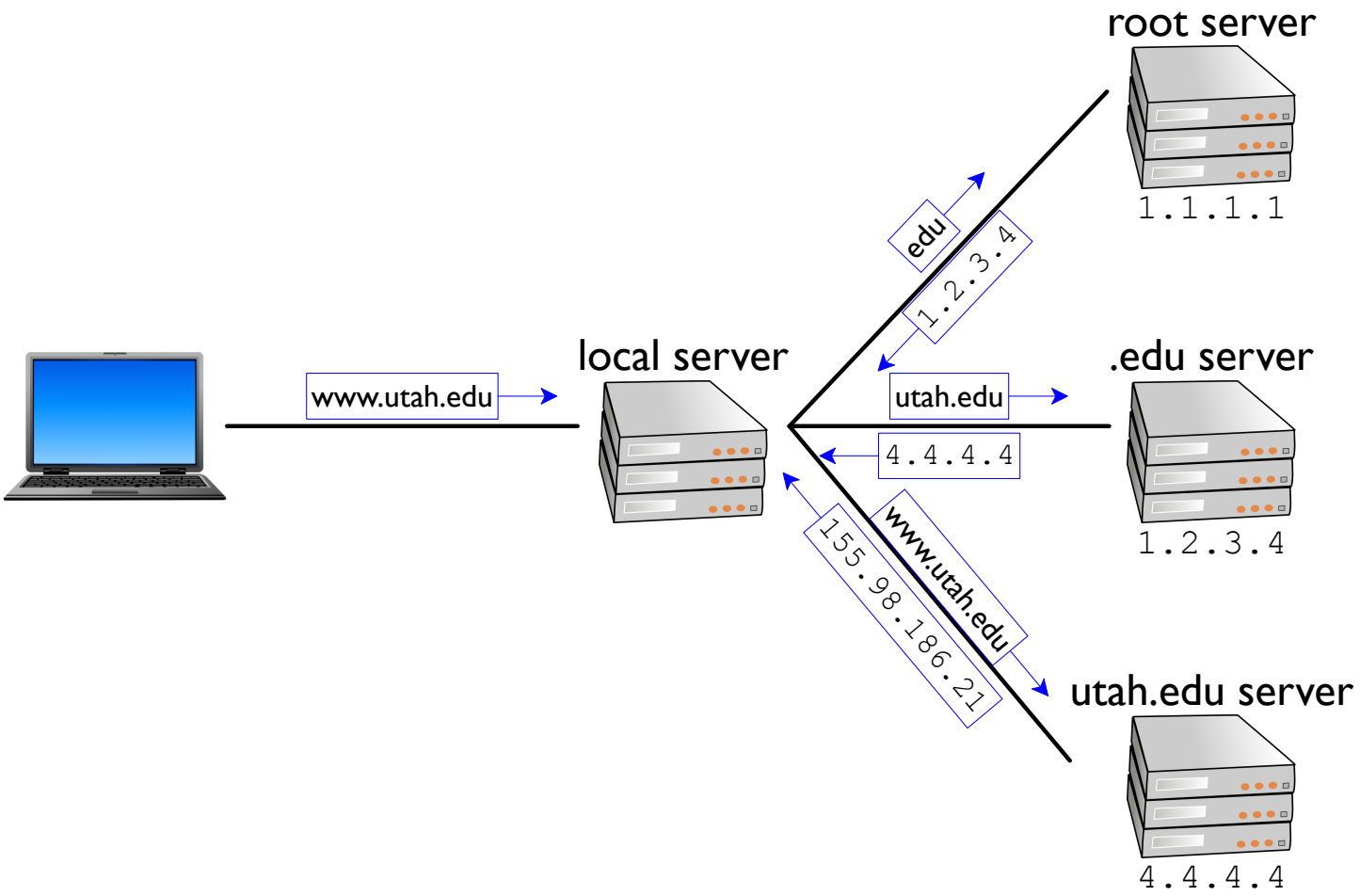

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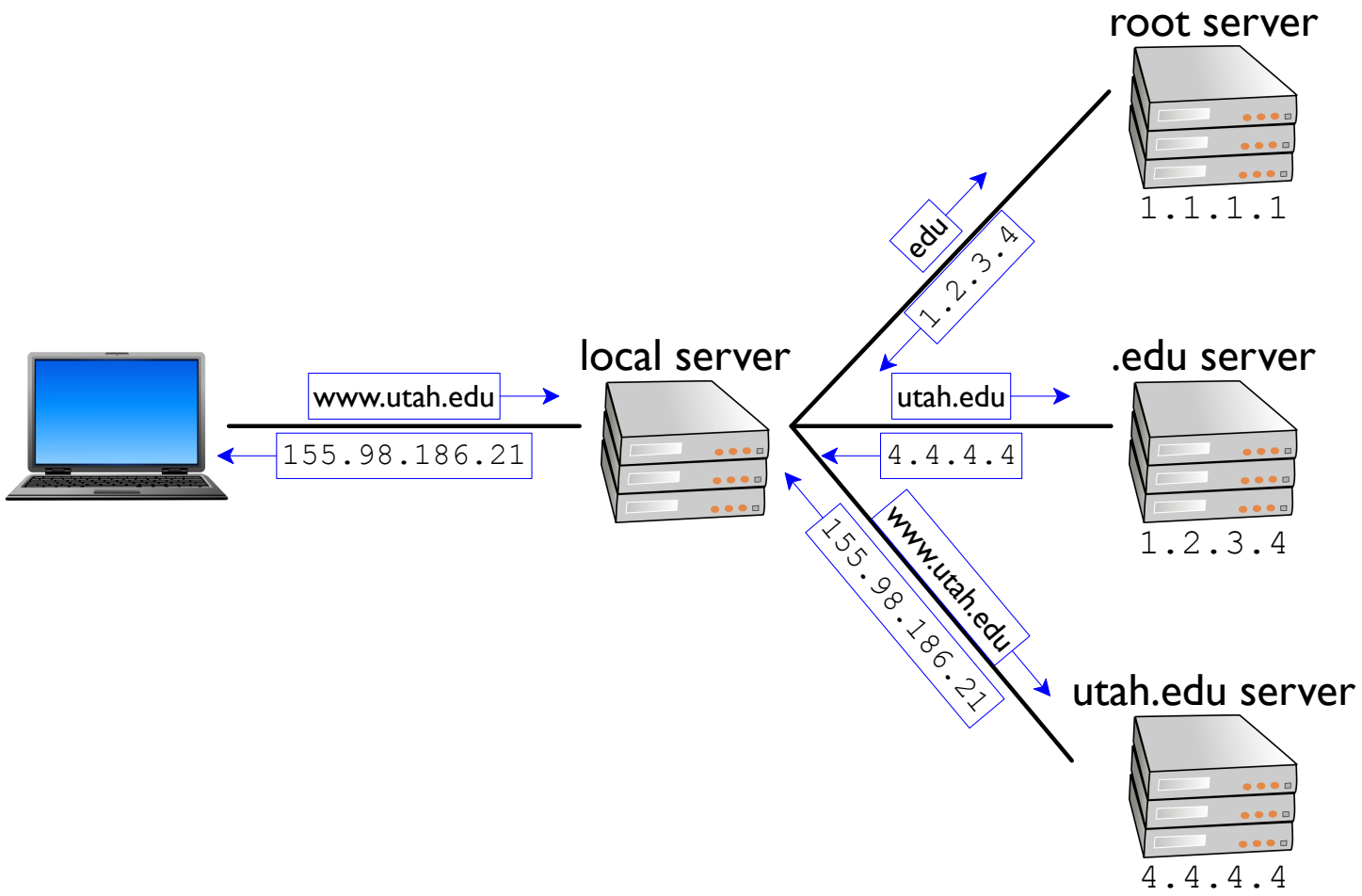

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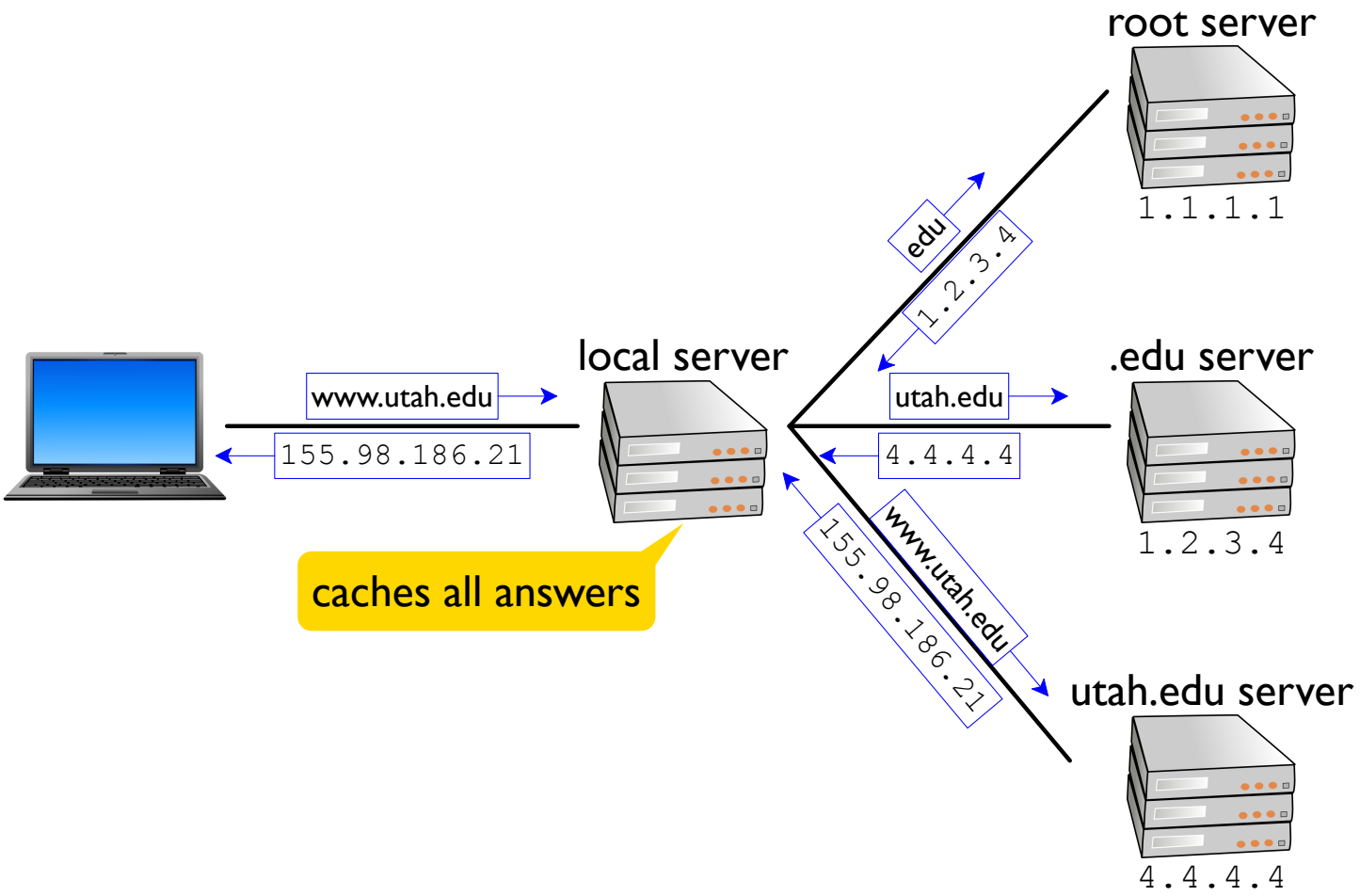

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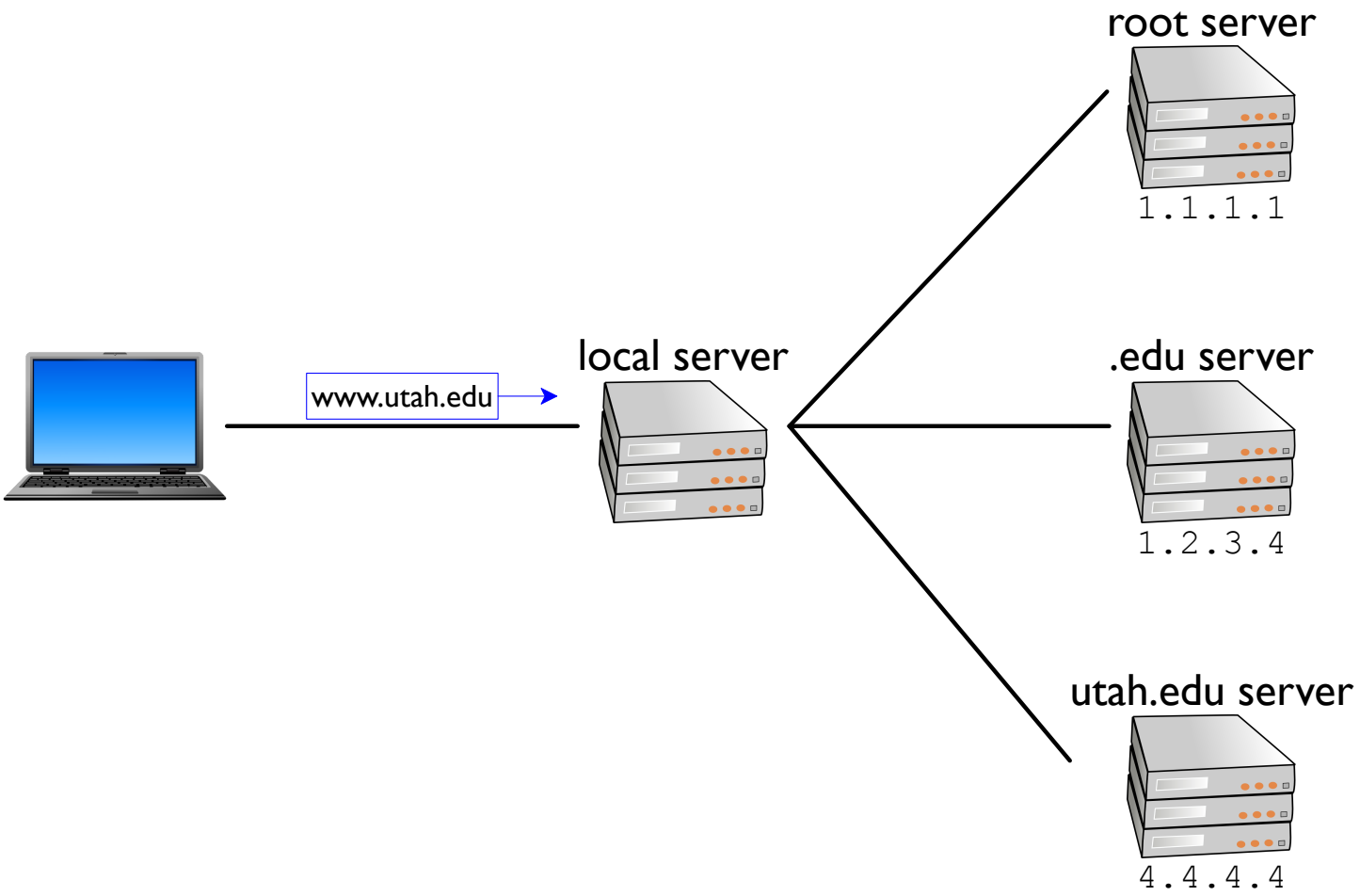

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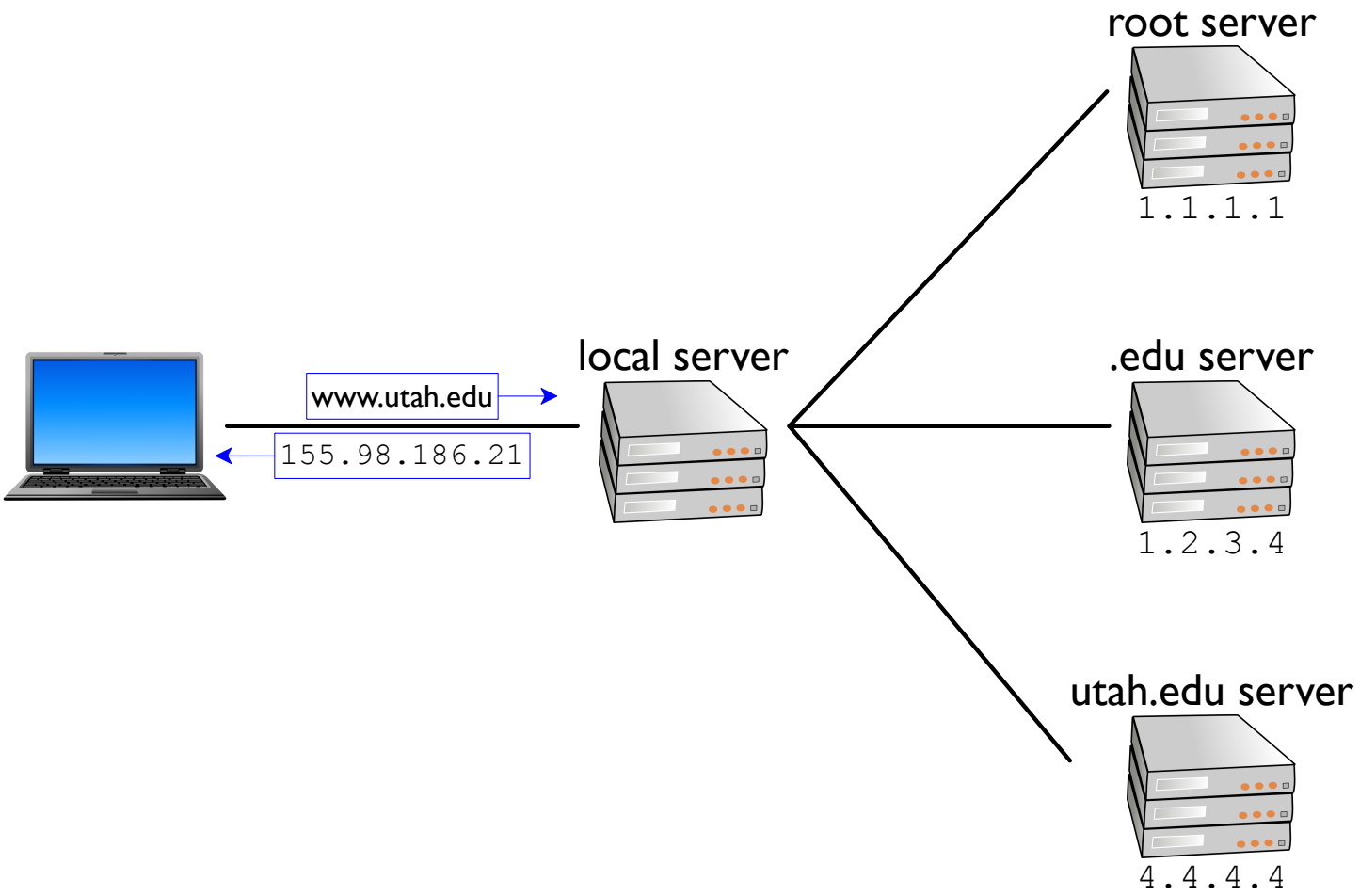

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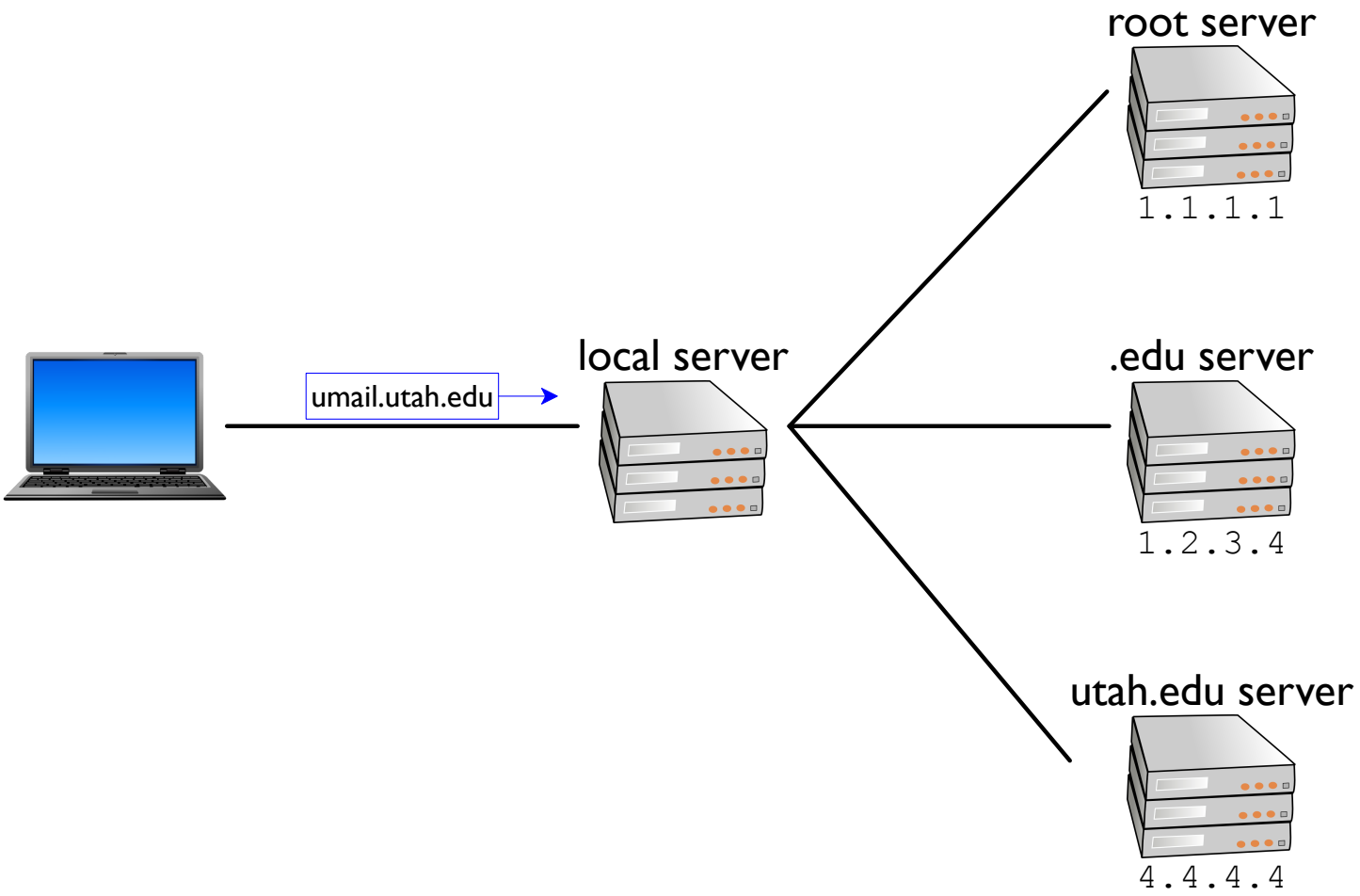

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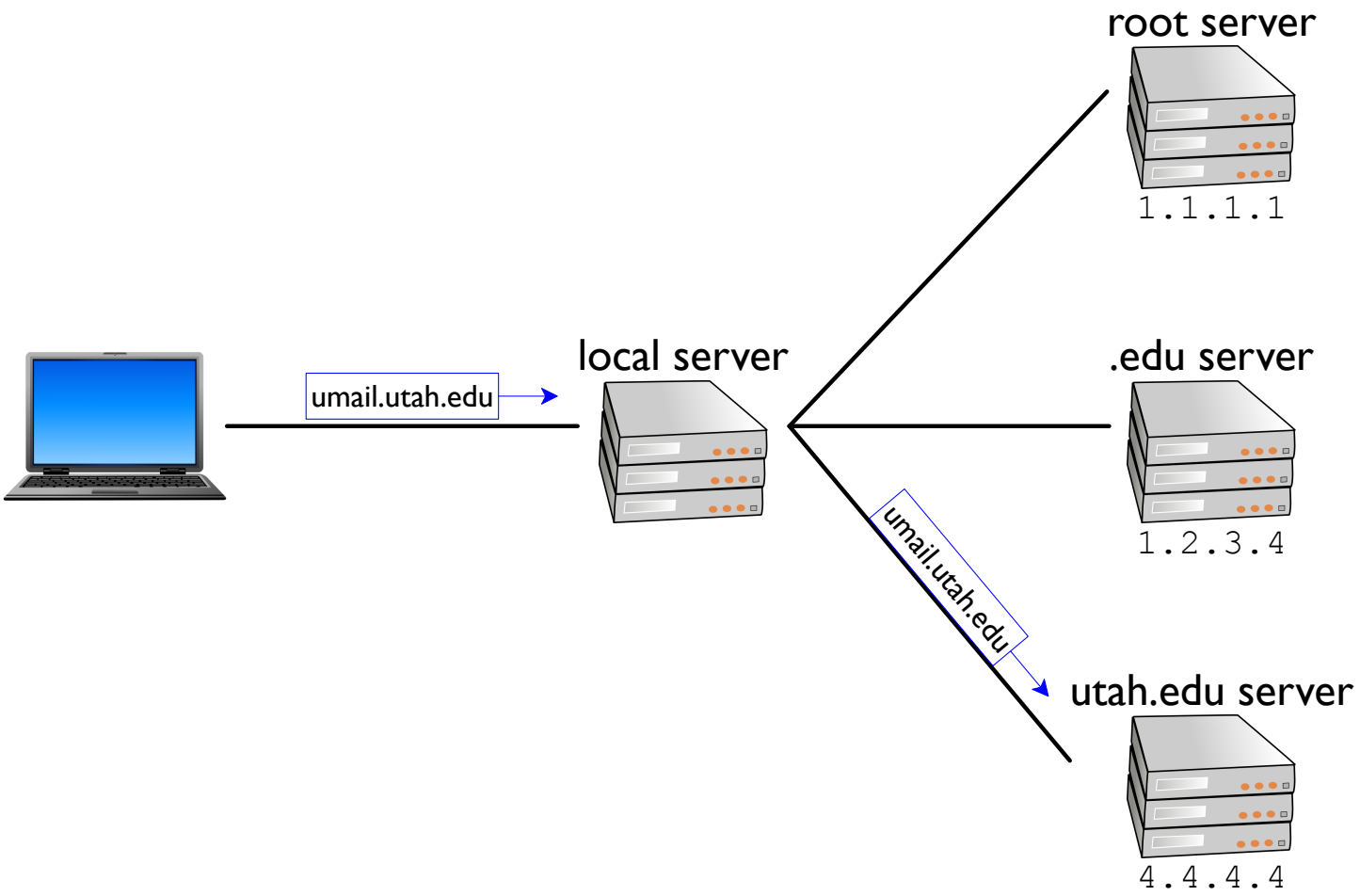

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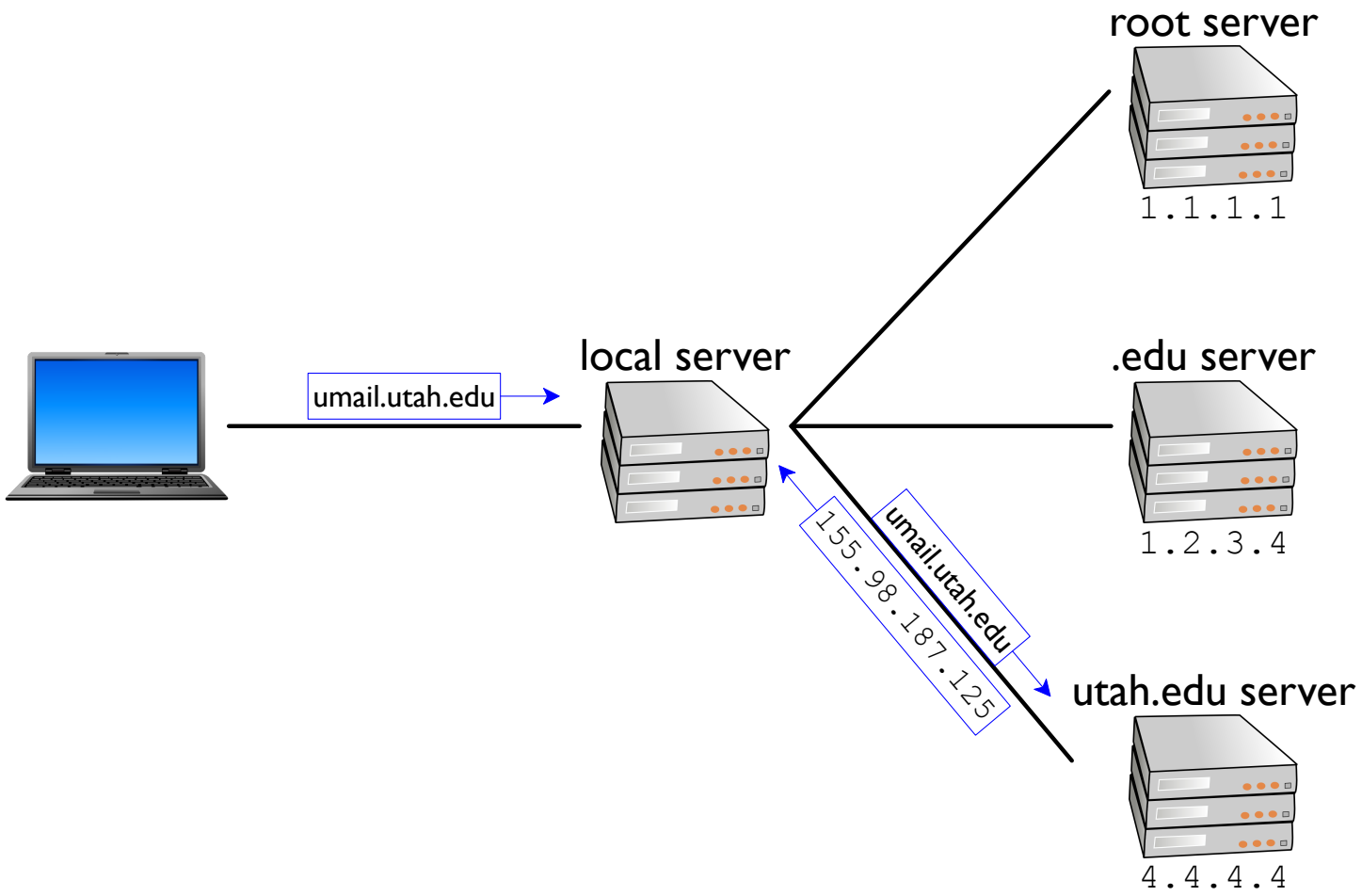

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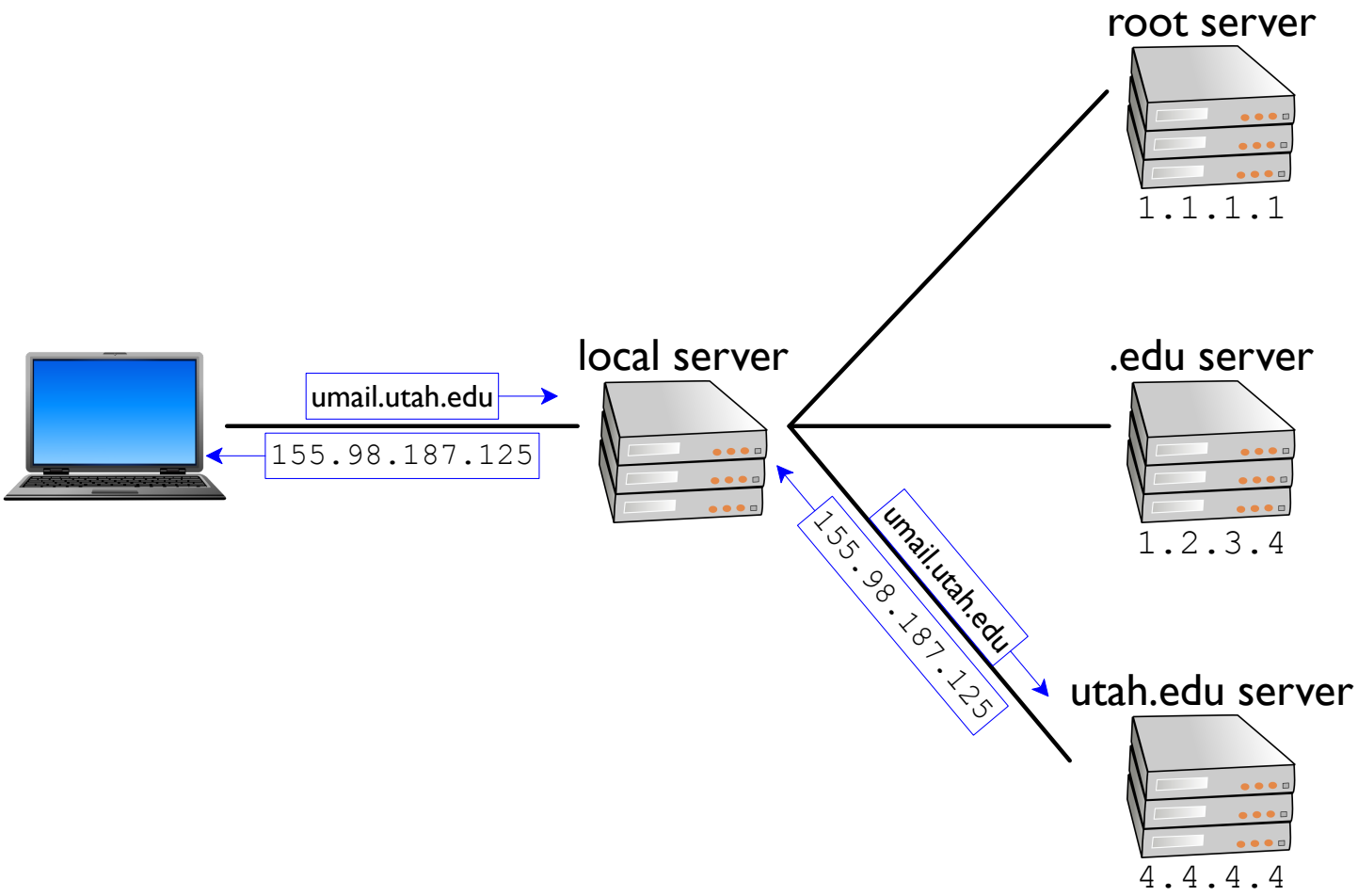

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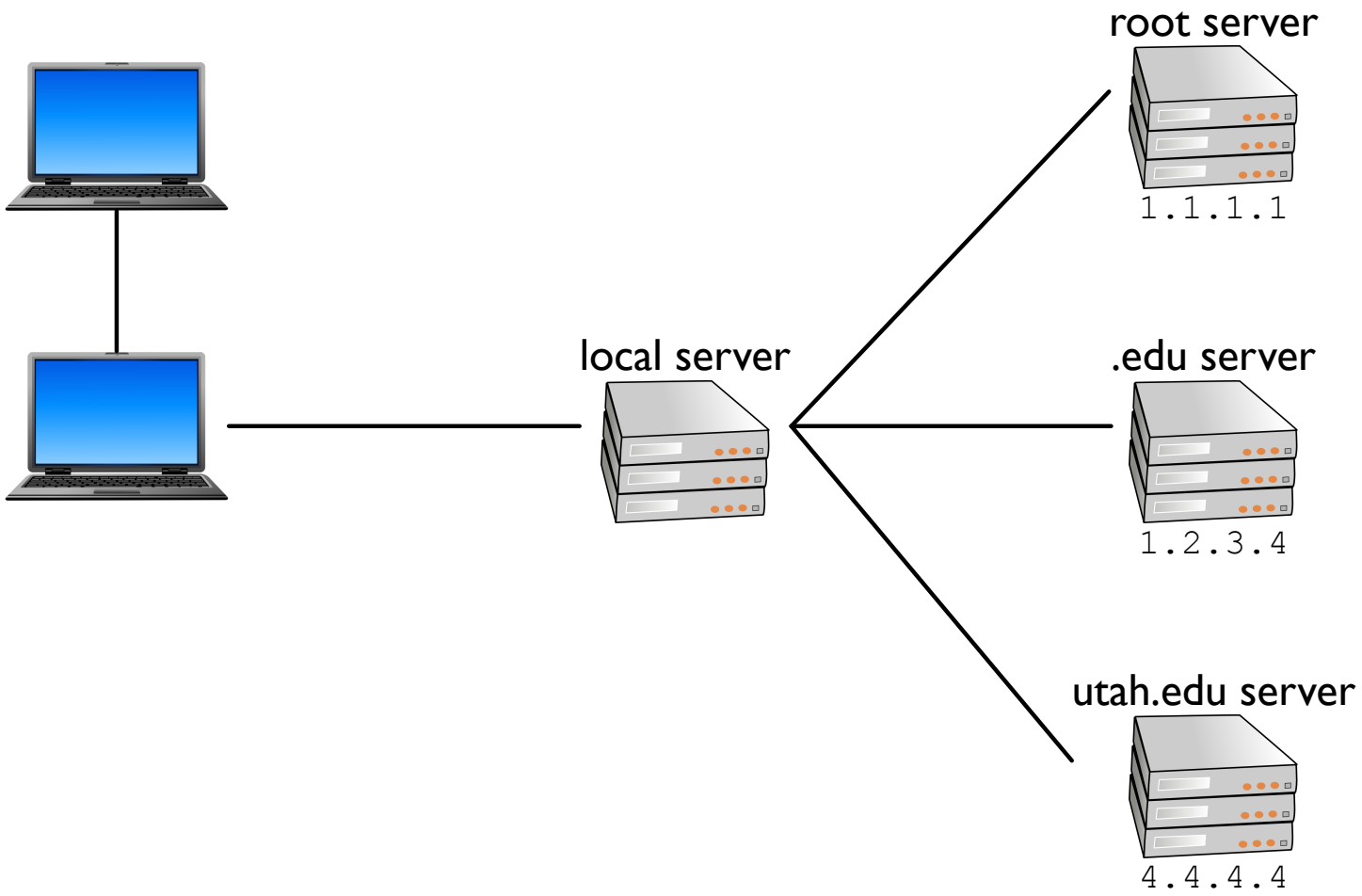

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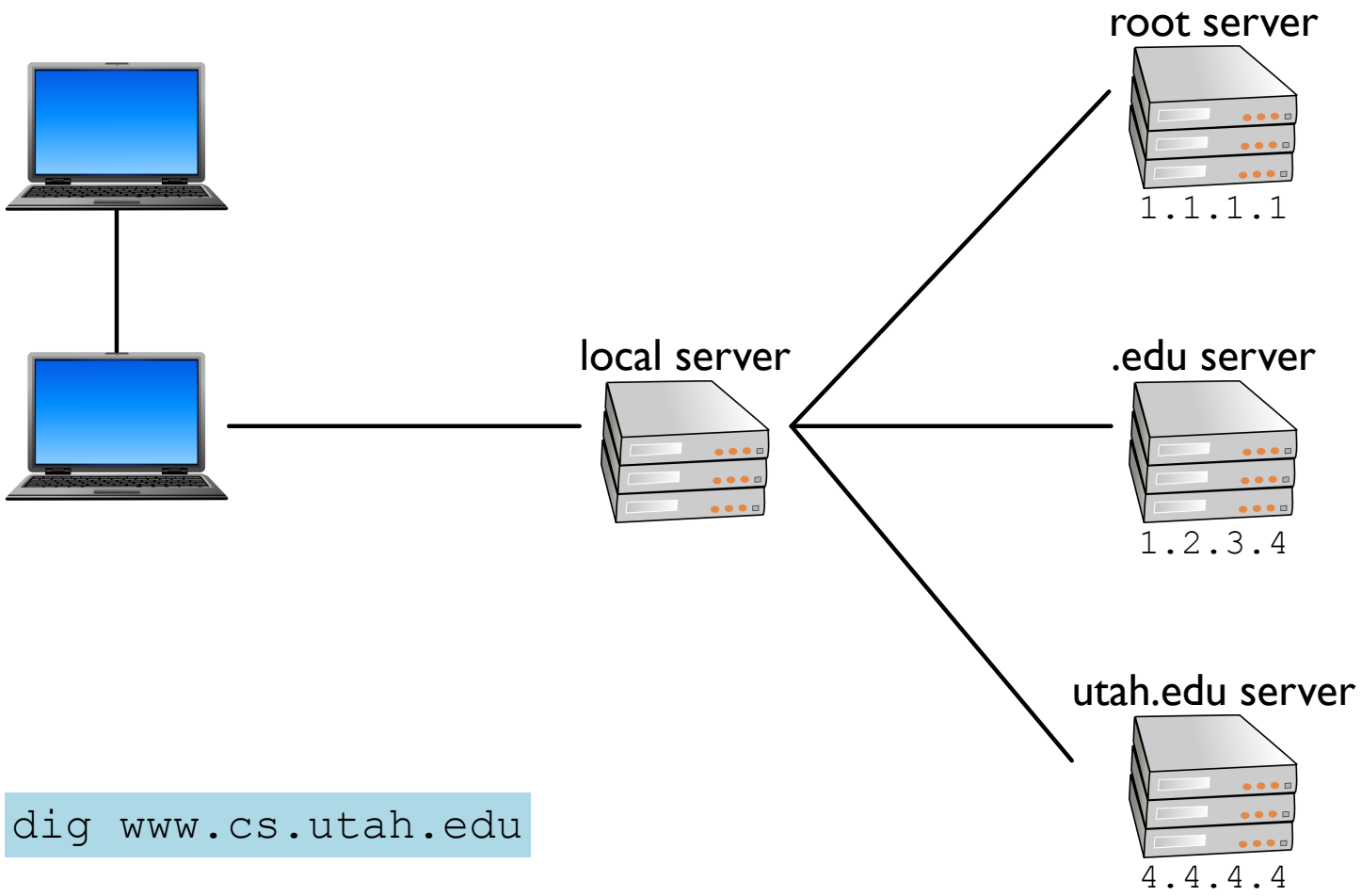


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dig www.cs.utah.edu
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