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# SECURITY (COMP0141): NETWORK BACKGROUND



# HOW DOES THE INTERNET WORK?

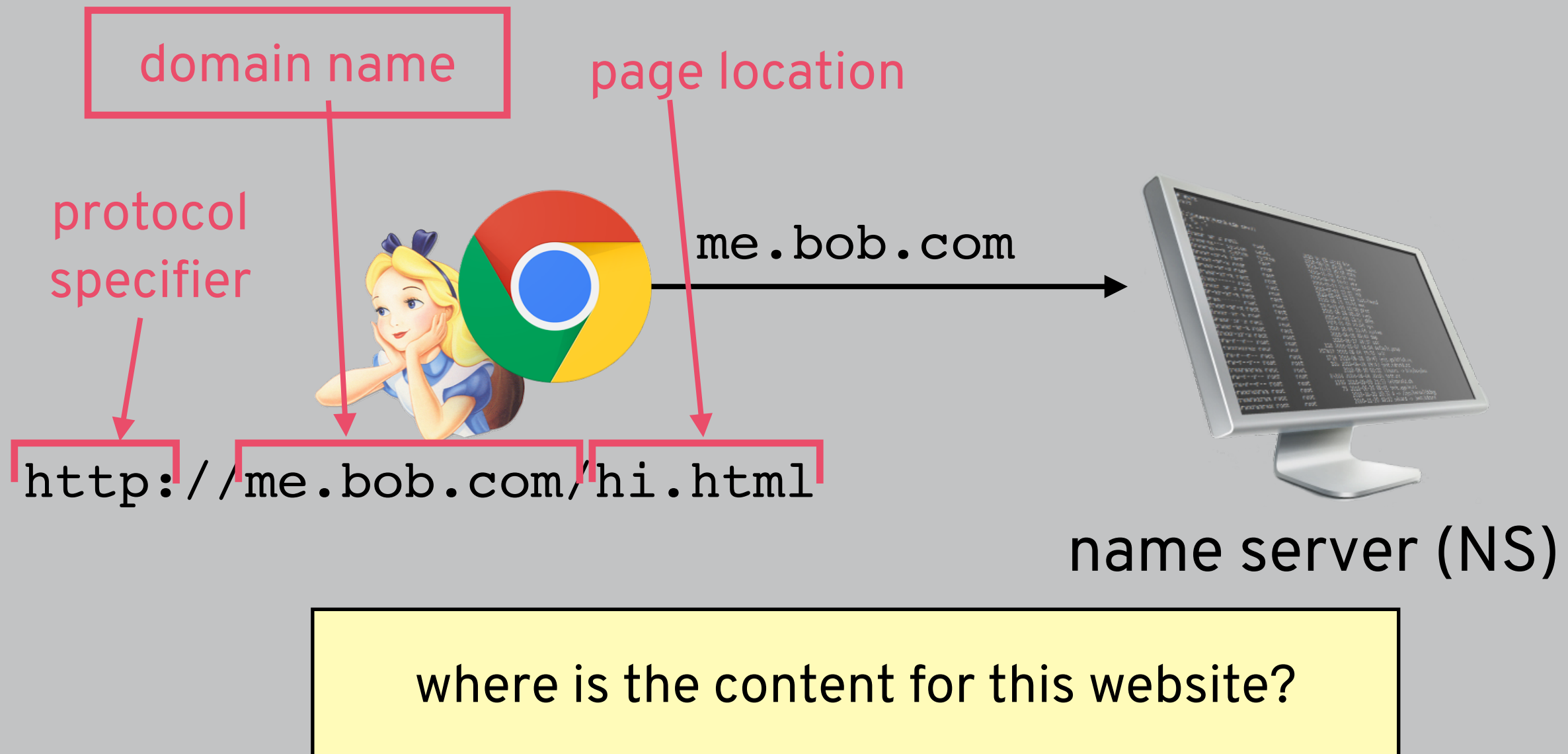
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goal: get Alice to that website!

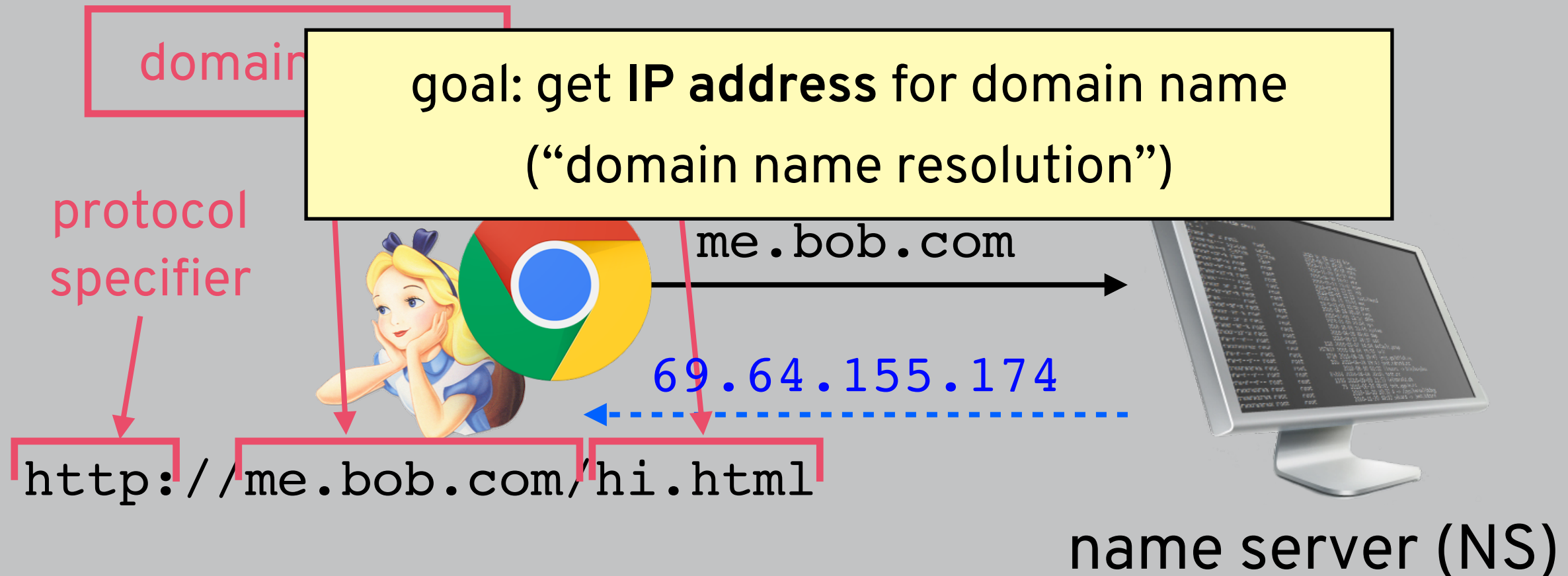


`http://me.bob.com/hi.html`

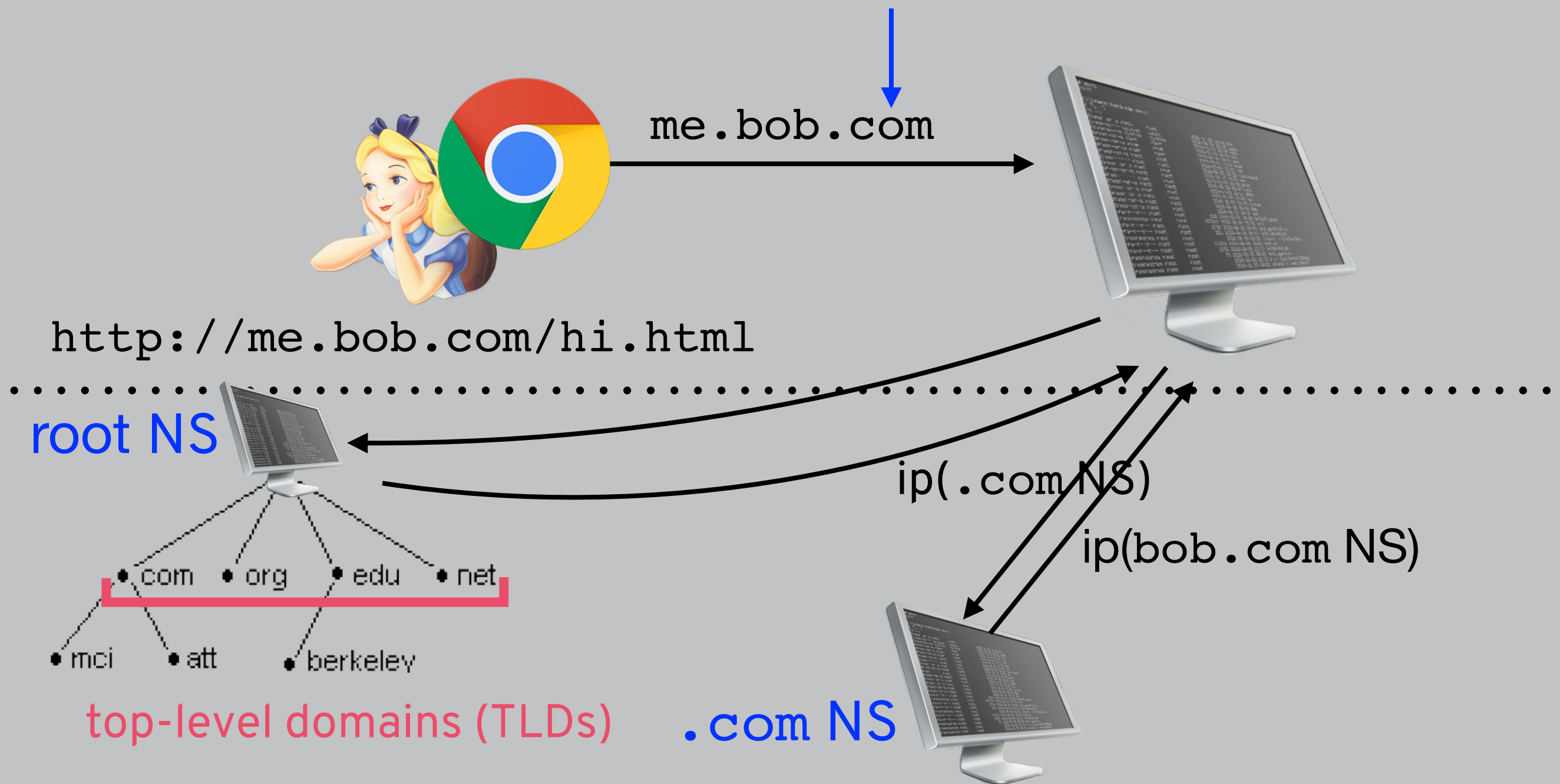
# STEP 1: FIND CONTENT HOST



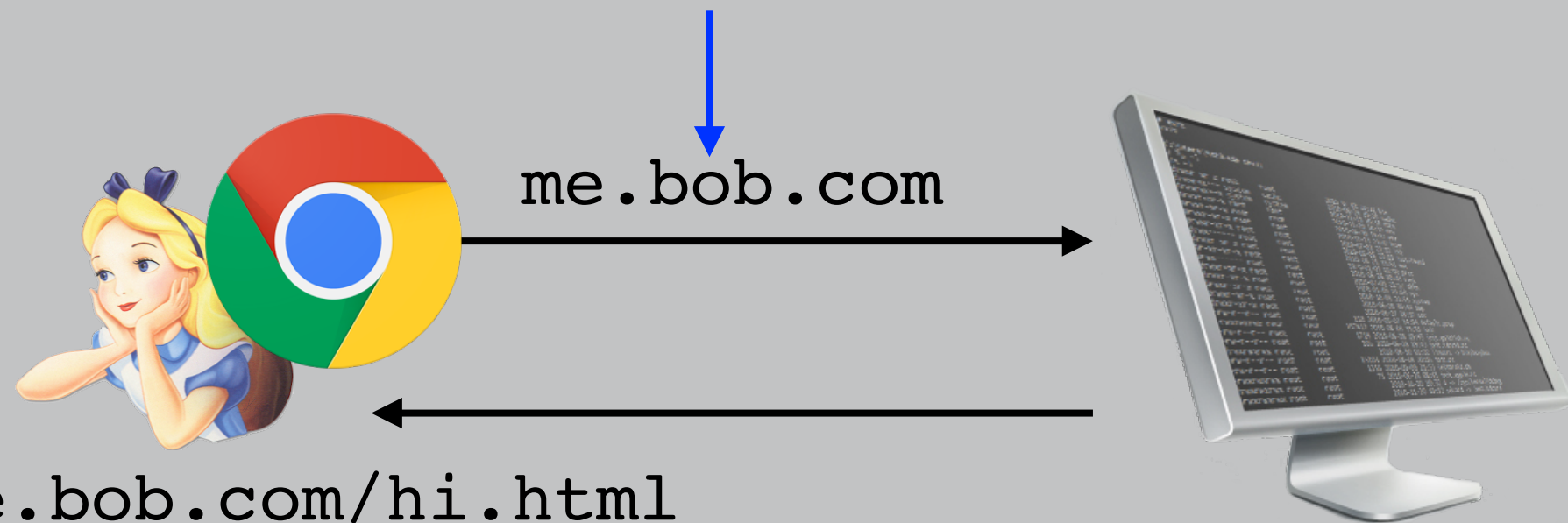
# STEP 1: FIND CONTENT HOST



# DOMAIN NAME SYSTEM

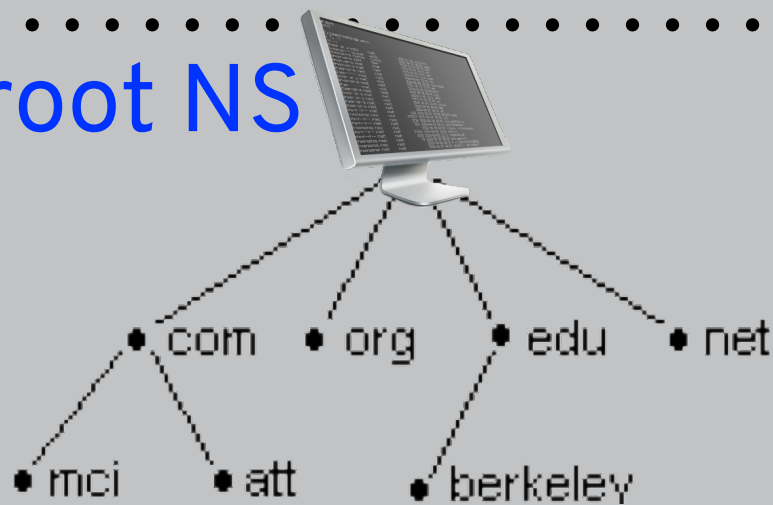


# DOMAIN NAME SYSTEM

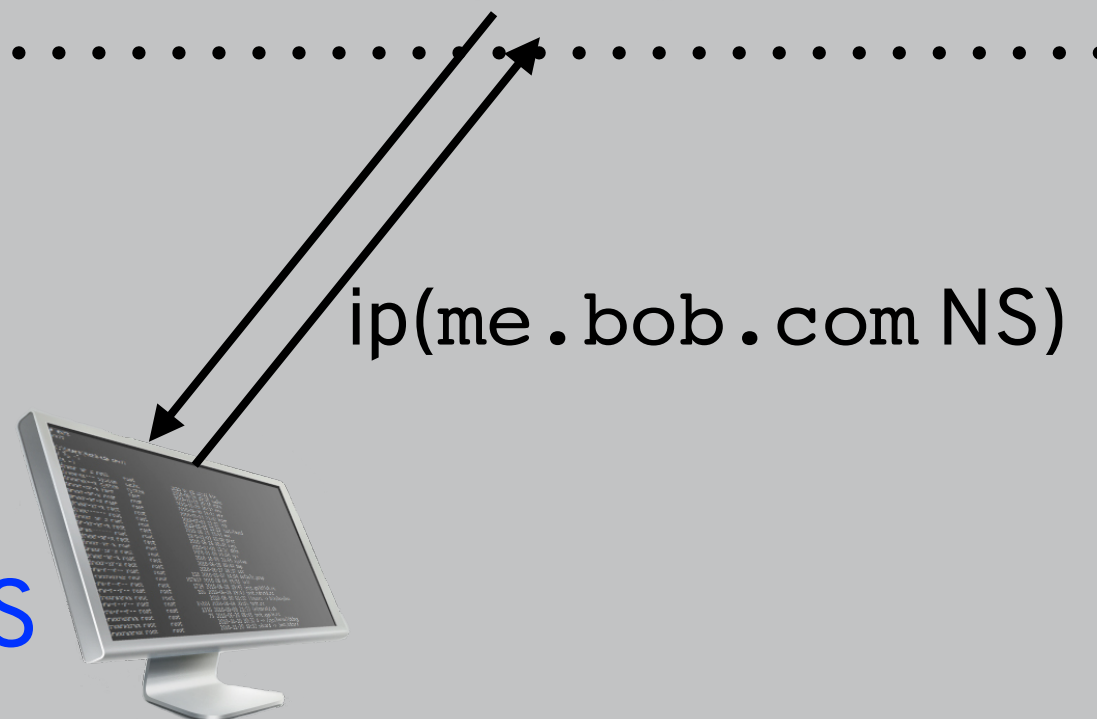


`http://me.bob.com/hi.html`

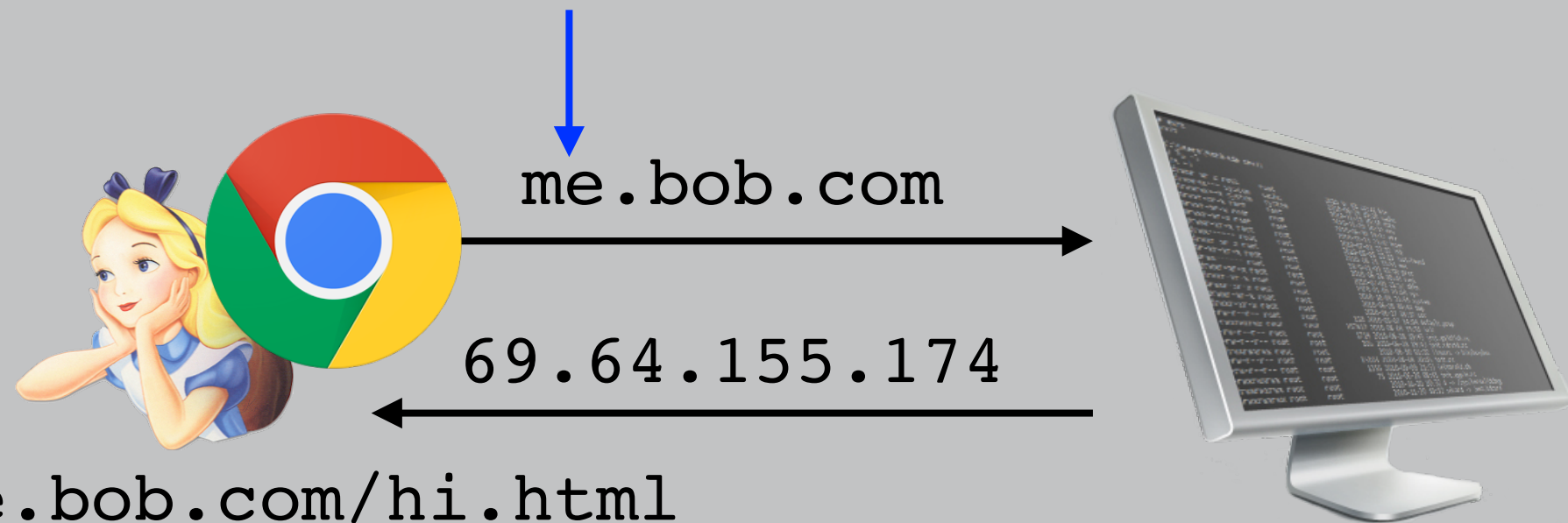
root NS



bob.com NS

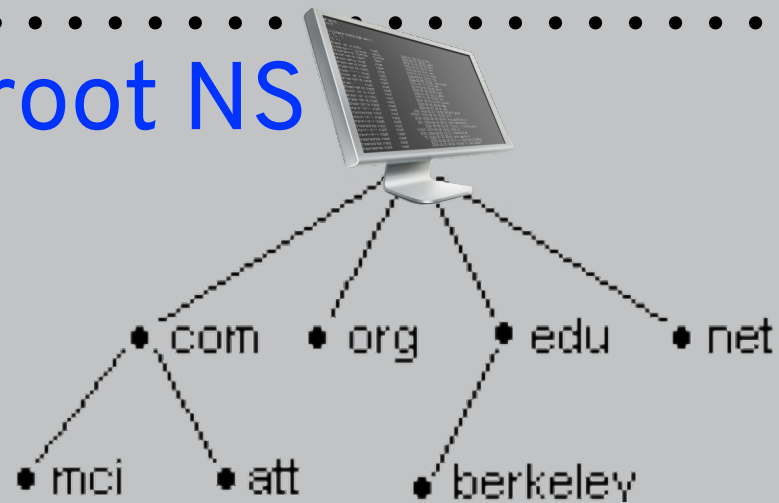


# DOMAIN NAME SYSTEM

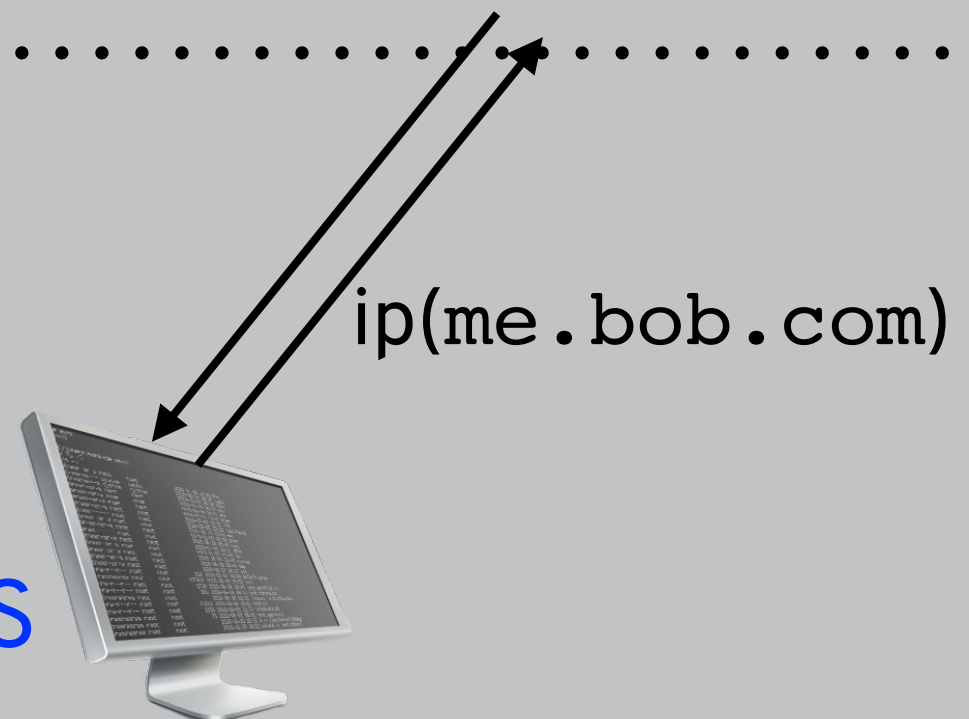


`http://me.bob.com/hi.html`

root NS



`me.bob.com NS`





# DOMAIN NAME SYSTEM

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## FAQs

**q:** do we really do this every time we go to a website?

**a:** no! DNS results are cached by your browser.

**q:** where do you find first name server? or root server?

**a:** basically, they're hard-coded.



# DOMAIN NAME SYSTEM

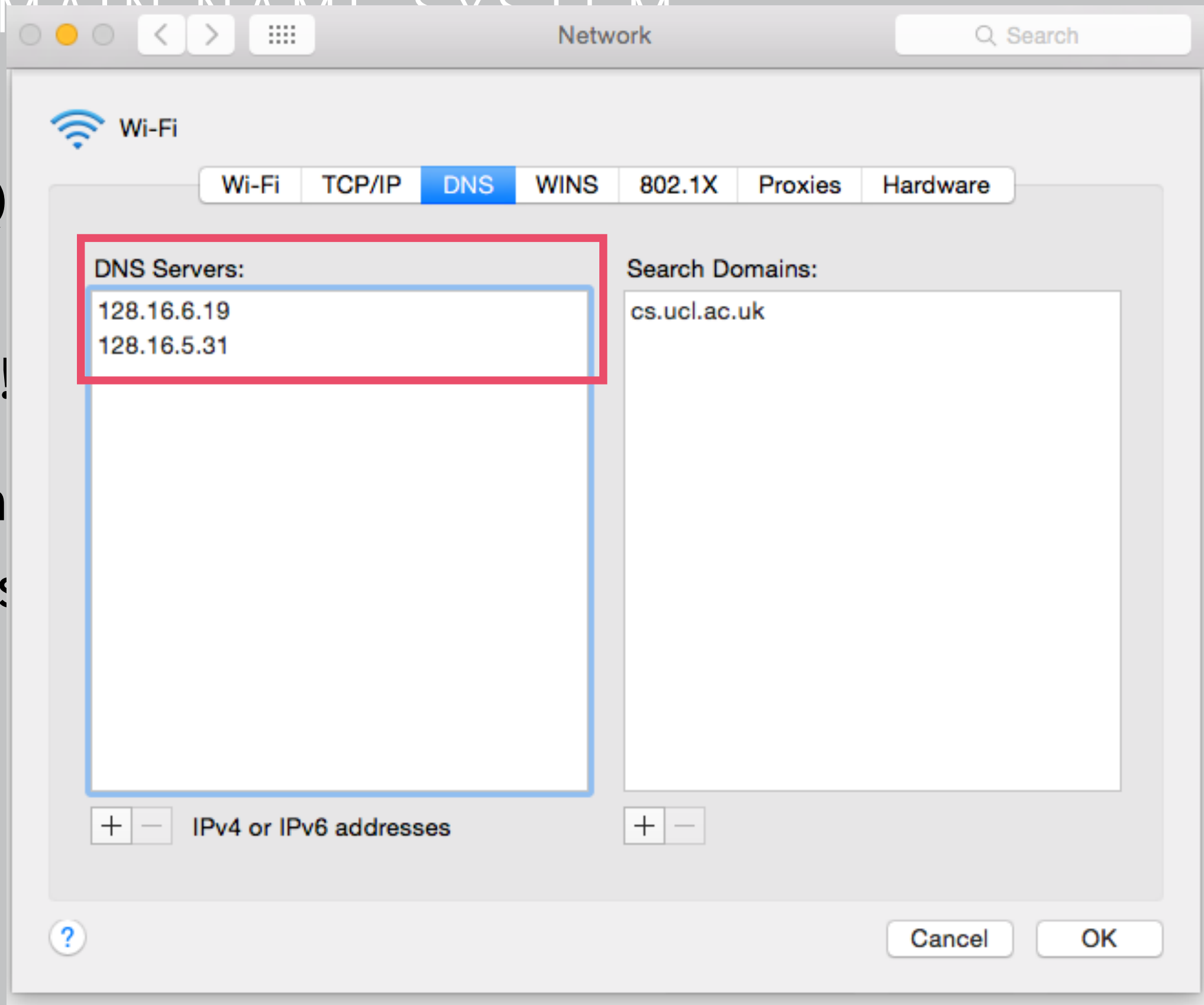
## FAQ

q: do

a: no!

q: wh

a: bas



r?

# DOMAIN NAME SYSTEM

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## FAQs

**q:** do we really do this every time we go to a website?

**a:** no! DNS results are cached by your browser.

**q:** where do you find first name server? or root server?

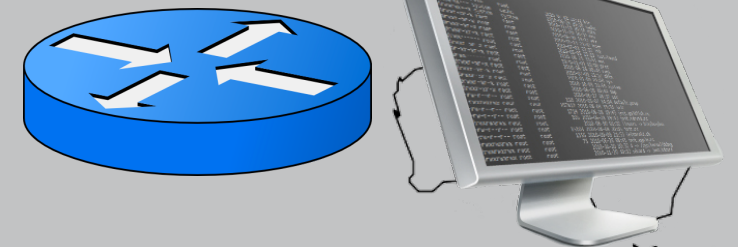
**a:** basically, they're hard-coded.

**q:** how do you actually find these name servers?

**a:** the magic of routing!

# STEP 2: REQUEST CONTENT

`http://me.bob.com/hi.html`  
`69.64.155.174`



`me.bob.com`

# LEASED LINES

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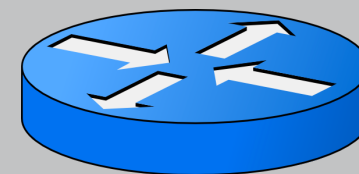
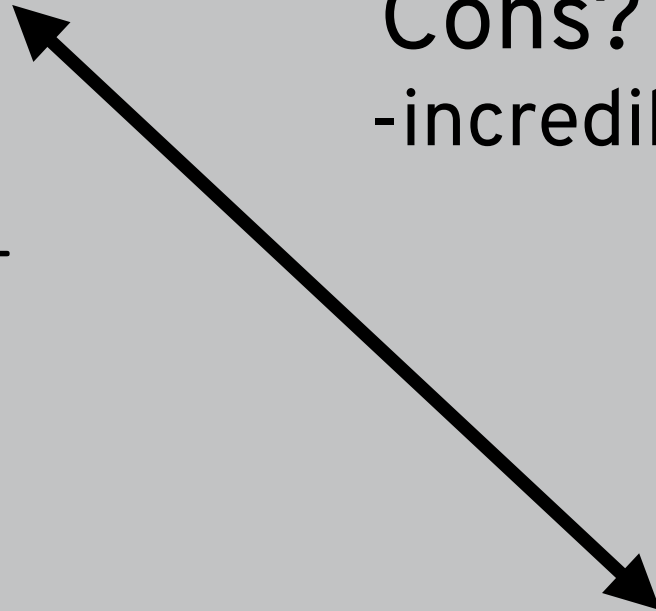
`http://me.bob.com/hi.html`  
`69.64.155.174`

Pros?

- incredibly fast
- reliable
- secure

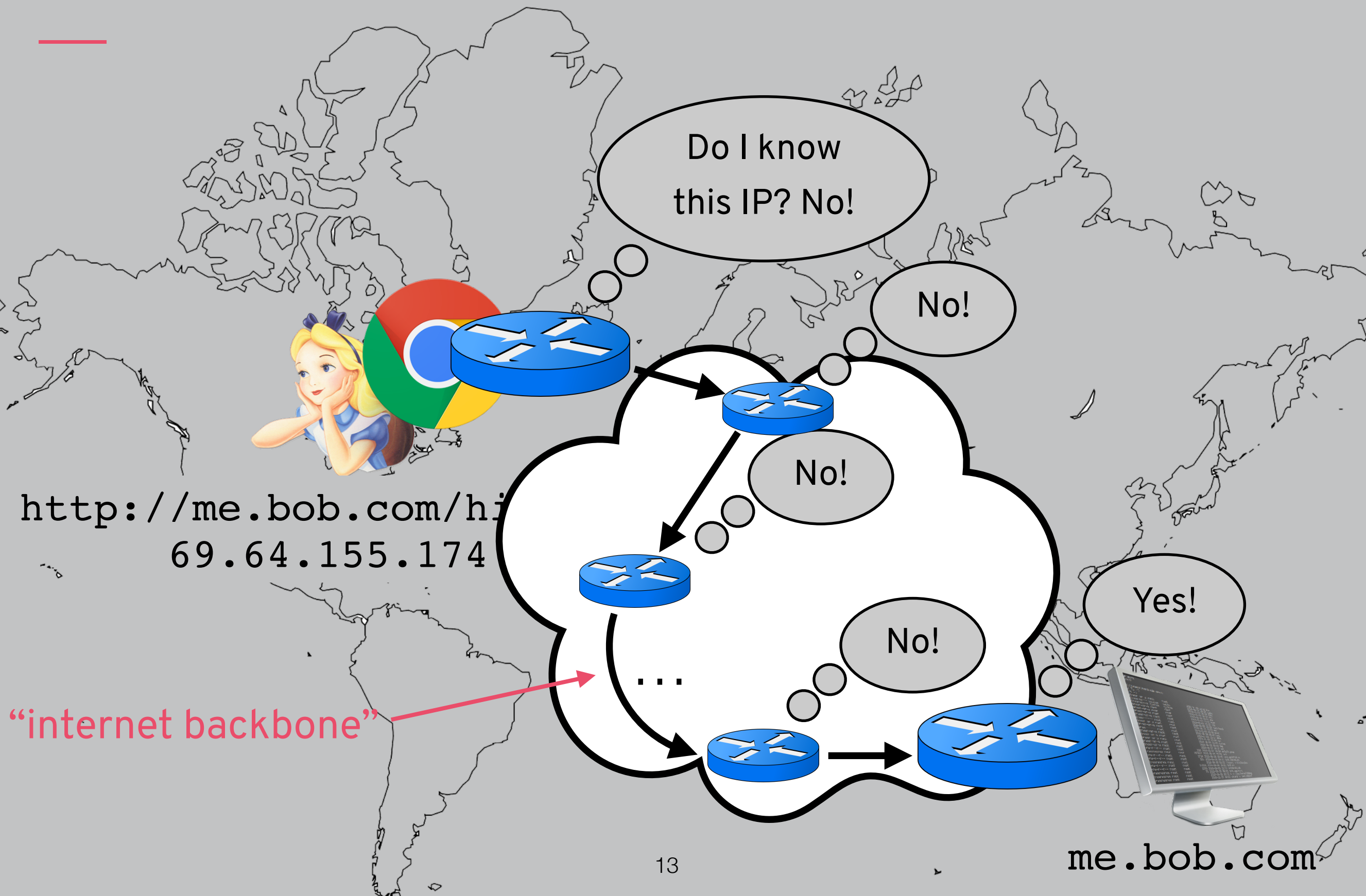
Cons?

- incredibly expensive!



`me.bob.com`

# INTERNET BACKBONE



# ROUTING FAQs

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## FAQs

**q:** how does your router pick another router to ask?




**a:** we'll see later! autonomous systems (ASes), BGP, etc.

**q:** what information are these routers sending?

**a:** packets.

# PACKET

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4-bit version	4-bit Header len	8-bit type of service	16-bit total length (in bytes)	
16-bit identification			3-bit flags	13-bit fragment offset
8-bit time to live (TTL)		8-bit protocol	16-bit header checksum	
 Alice's IP address				
 Bob's IP address				
Options (if any)				
 "I want the content at hi.html"				



# ROUTING FAQs

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## FAQs

**q:** how does your router pick another router to ask?

**a:** fascinating topic! autonomous systems (ASes), BGP, etc.

**q:** what information is Alice's router forwarding?

**a:** packets.

**q:** could requests just go around in a circle?

**a:** no! packets contain information on when to give up.

# TIME TO LIVE

4-bit version	4-bit Header len	8-bit type of service	16-bit total length (in bytes)	
16-bit identification			3-bit flags	13-bit fragment offset
8-bit time to live (TTL)		8-bit protocol	16-bit header checksum	
Alice's IP address				
Bob's IP address				
Options (if any)				
"I want the content at hi.html"				

Time to live (TTL): how many hops before dying?  
(decremented by each router; also used for DNS records)

# ROUTING FAQs

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## FAQs

**q:** how does your router pick another router to ask?

**a:** fascinating topic! autonomous systems (ASes), BGP, etc.

**q:** what information is Alice's router forwarding?

**a:** packets.

**q:** could requests just go around in a circle?

**a:** no! packets contain information on when to give up.

**q:** what happens once Bob's server gets this request?

**a:** everyone lives happily ever after!

# ALICE'S REQUEST

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4-bit version	4-bit Header len	8-bit type of service	16-bit total length (in bytes)	
16-bit identification			3-bit flags	13-bit fragment offset
8-bit time to live (TTL)	8-bit protocol		16-bit header checksum	
Alice's IP address				
Bob's IP address				
Options (if any)				
“I want the content at hi.html”				

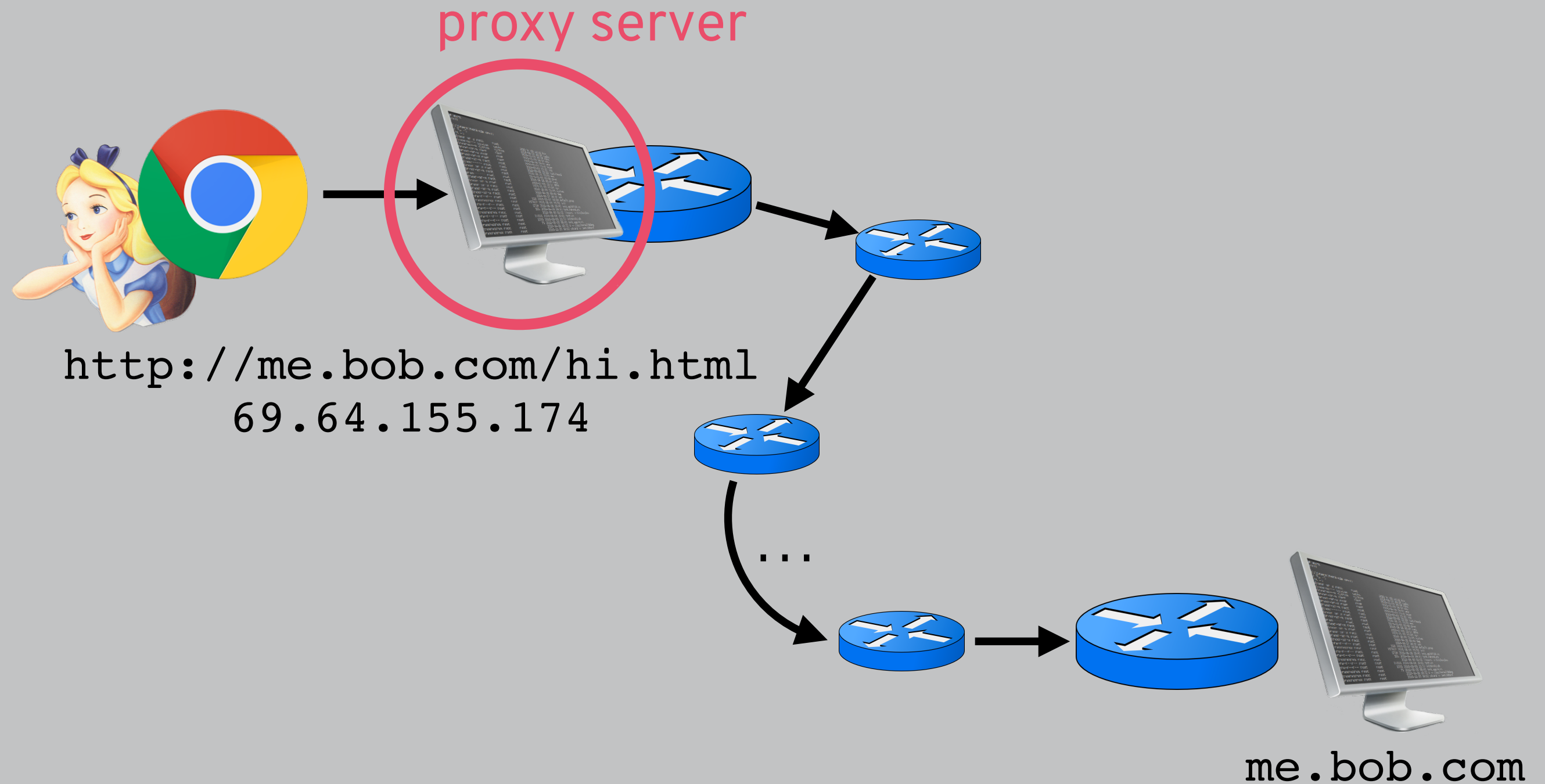
# BOB'S RESPONSE

4-bit version	4-bit Header len	8-bit type of service	16-bit total length (in bytes)	
16-bit identification			3-bit flags	13-bit fragment offset
8-bit time to live (TTL)	8-bit protocol		16-bit header checksum	
Bob's IP address				
Alice's IP address				
Options (if any)				
<Content at hi.html (part 1 of N)>				

as is, anyone can see which sites you're visiting

source and destination IP addresses never get modified!

# ASIDE: PROXY SERVERS AND VPNS



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4-bit version	4-bit Header len	8-bit type of service	16-bit total length (in bytes)	
16-bit identification			3-bit flags	13-bit fragment offset
8-bit time to live (TTL)		8-bit protocol	16-bit header checksum	
Alice's IP address				
<del>Bob's IP address</del> proxy IP address				
Options (if any)				
“I want the content at hi.html”				





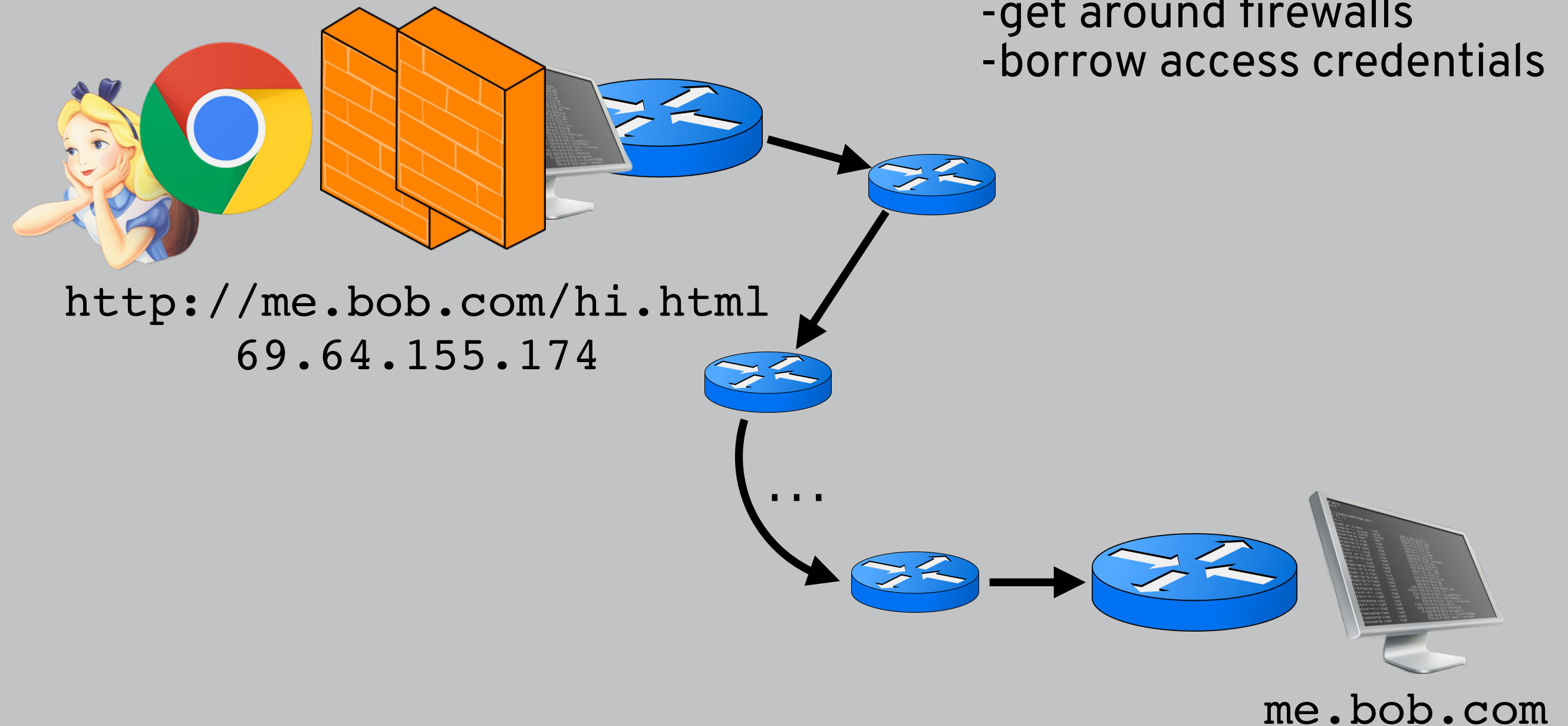
# ASIDE: PROXY SERVERS AND VPNS

4-bit version	4-bit Header len	8-bit type of service	16-bit total length (in bytes)	
16-bit identification			3-bit flags	13-bit fragment offset
8-bit time to live (TTL)		8-bit protocol	16-bit header checksum	
<del>Alice's IP address</del> proxy IP address				
Bob's IP address				
Options (if any)				
“I want the content at hi.html”				



me.bob.com

# ASIDE: PROXY SERVERS AND VPNS

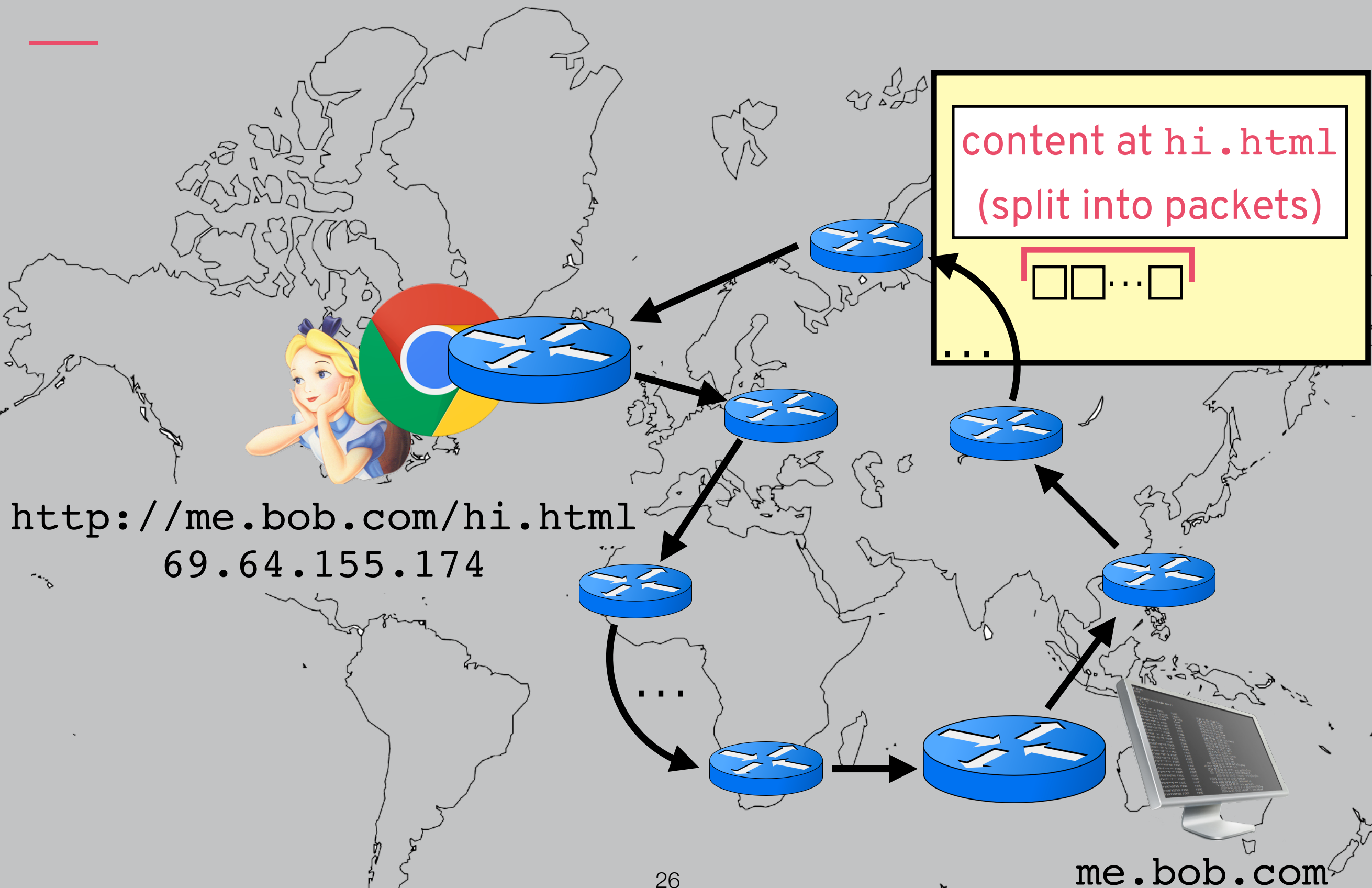


# BOB'S RESPONSE

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4-bit version	4-bit Header len	8-bit type of service	16-bit total length (in bytes)	
16-bit identification			3-bit flags	13-bit fragment offset
8-bit time to live (TTL)		8-bit protocol	16-bit header checksum	
Bob's IP address				
Alice's IP address				
Options (if any)				
<Content at hi.html (part 1 of N)>				

# STEP 3: RECEIVE CONTENT



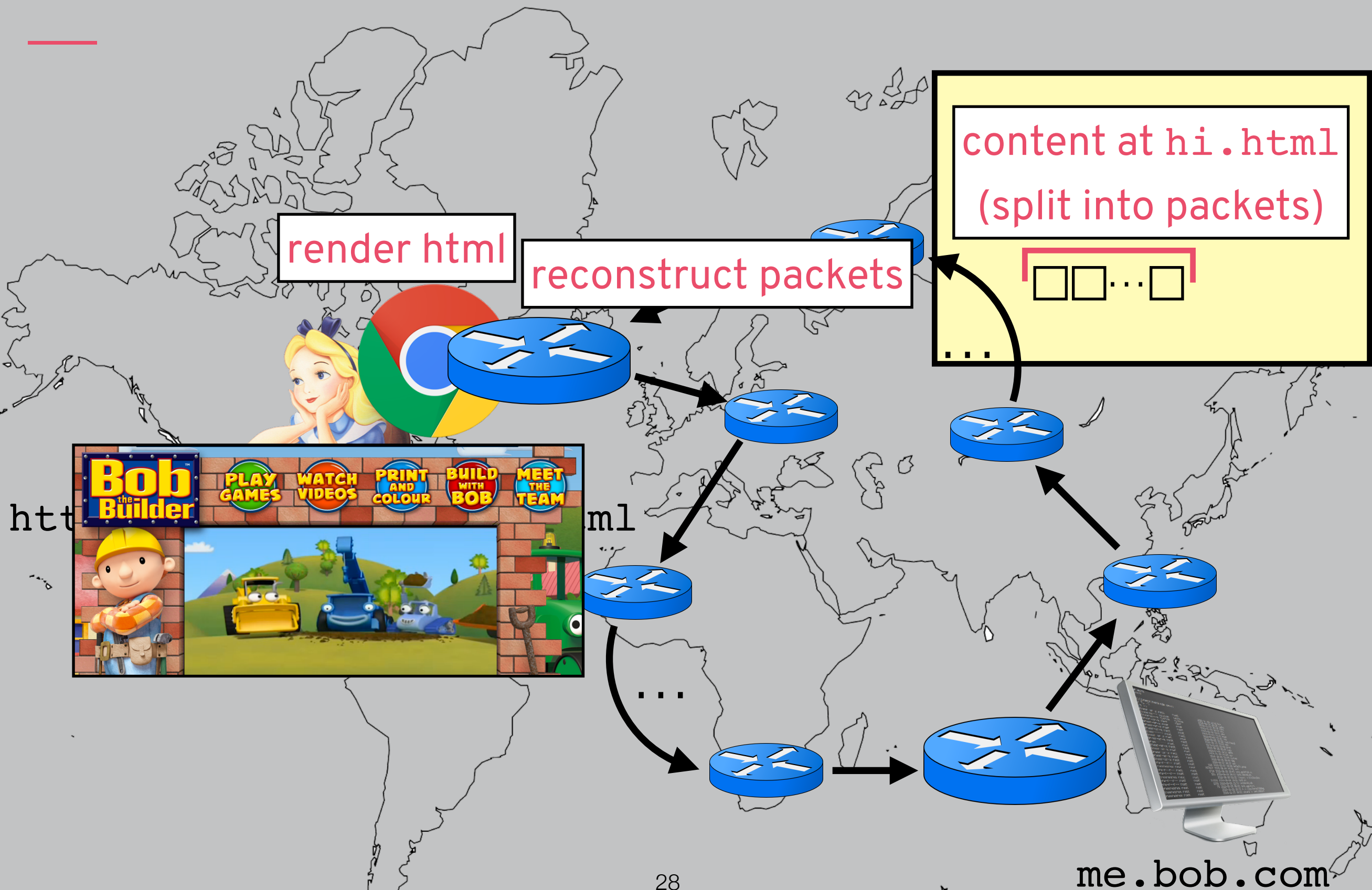
# BOB'S RESPONSE

4-bit version	4-bit Header len	8-bit type of service	16-bit total length (in bytes)	
16-bit identification			3-bit flags	13-bit fragment offset
8-bit time to live (TTL)	8-bit protocol		16-bit header checksum	
Bob's IP address				
Alice's IP address				
Options (if any)				
<Content at hi.html (part 1 of N)>				



as is, anyone can read your web traffic

# STEP 3: RECEIVE CONTENT





# HOW DOES THE INTERNET WORK?

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goal: get Alice to that website!

find content host

get IP address for me.bob.com  
("domain name resolution")

request content

send GET request to IP address  
(routing via the internet backbone) hi.html

receive content

wait for response from IP address,  
then render hi.html and enjoy



# QUIZ!

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Please go to

`https://moodle.ucl.ac.uk/mod/quiz/view.php?id=2723780`

to take this week's quiz!