

CSC7970 – NEXT-GENERATION NETWORKING

CONTENT DELIVERY NETWORKS

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CDNs

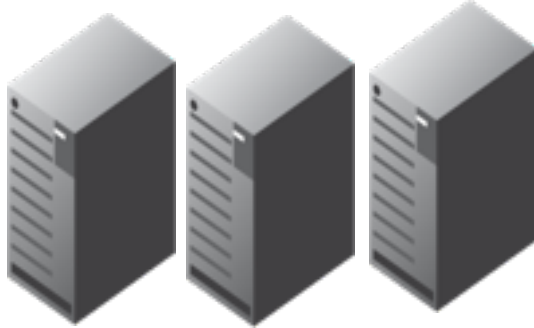
- Content is the primary focus of the Internet
 - What was the Internet designed for?
 - Content distribution requires workarounds
- Main idea
 - Move content near the user using geographically distributed servers
 - Cache popular content in a application overlay
- **Goal: Scalable** content distribution
 - Example: Stranger things

The CDN model

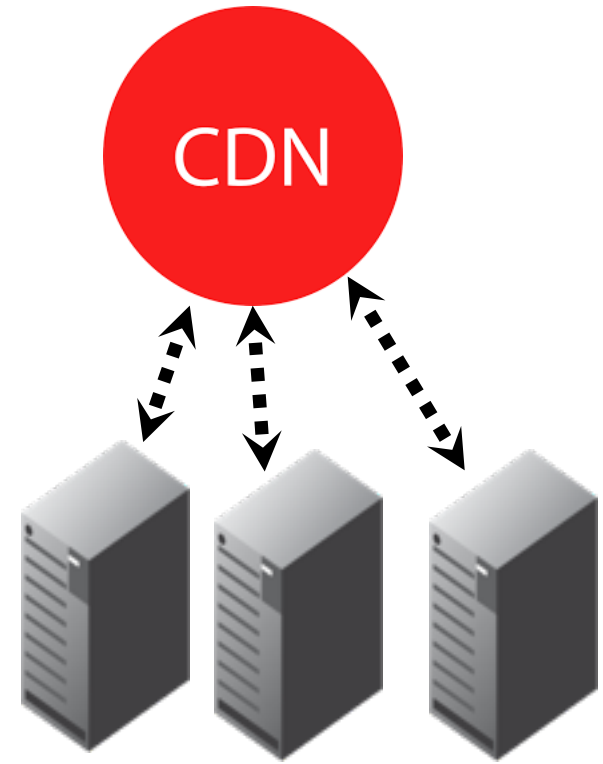
Single server model



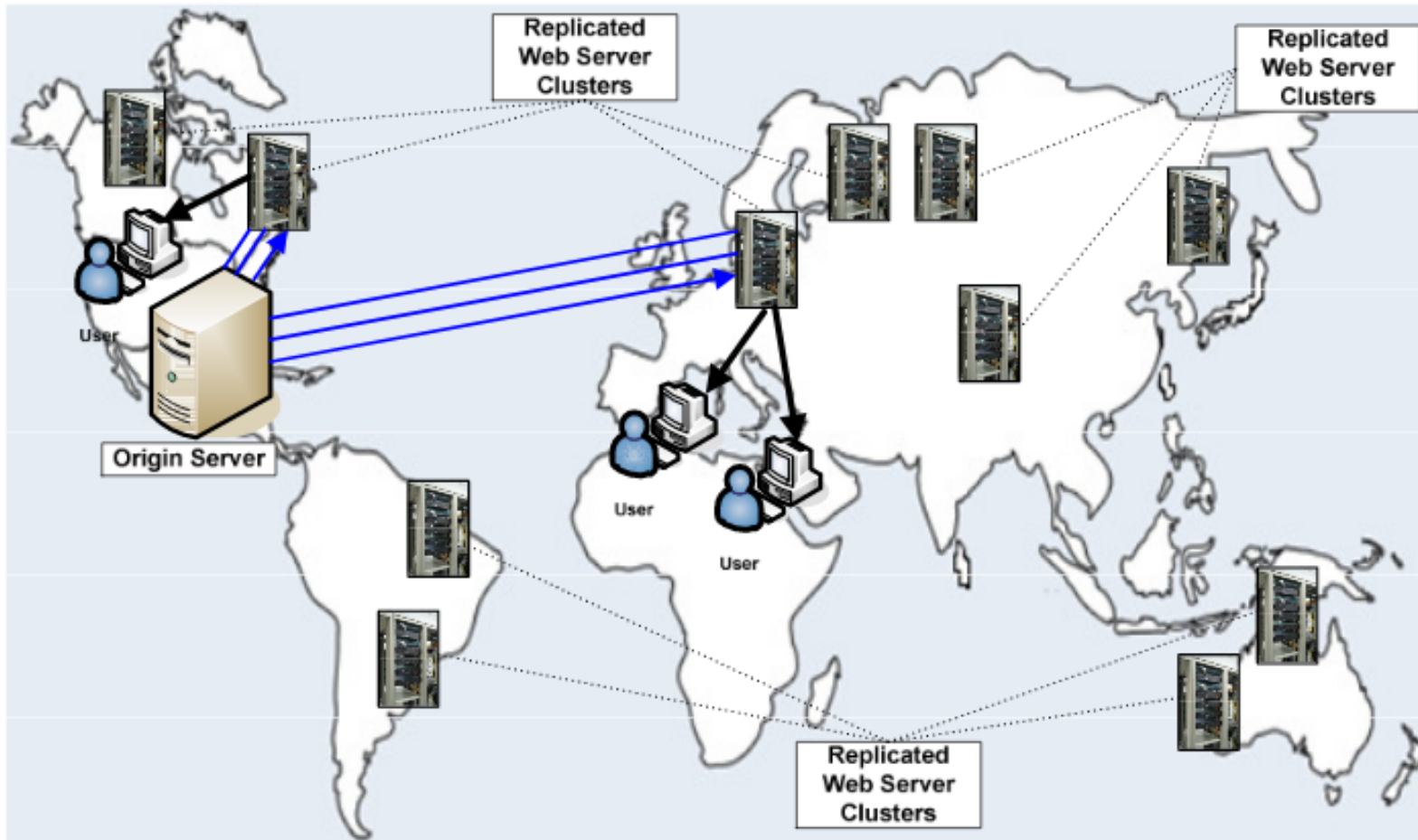
Multi-server model
(replicated content)



CDN model



CDN Entities



Origin Server

Replica Servers

Clients

Point of Presence (POP)

Caches

DNS

Who uses CDNs?

- Everyone
 - But mainly geared towards content distribution
- Why would a content owner use them?
 - TCP/IP Internet architecture does scale for content distribution
 - Load and performance challenges
 - Improved response times

How important can “latency” be?

- Affects user experience

- Users lose attention if a page takes more than a few hundred ms to load
- 2 Seconds is an eternity

- Affects corporate revenue. Examples:

- *Amazon*: revenue increase of 1% for every 100ms of reduction in page response time
- Google experienced a 20% decrease in ad revenue with a half-second increase in page load time.
- *Shopzilla*: revenue increase of 12% by reducing page response time from 6 seconds to 1.2 seconds

Who provides CDN services?

- Also everyone:
 - Akamai started it, Amazon, Google, MS, Verizon,
- Big companies have their own CDNs
 - Why?
 - Expensive
 - If a provider fails, their data becomes unavailable
 - Vendor lock-in
 - Costs money to migrate

Percent of content coming from CDNs

- Any guess/idea?
- *Conservative estimation*: half of the bits of Internet traffic
- *Probably closer to reality*: 80-90% of the bits of Internet traffic

“Reverse-engineering” CDNs

Spyros\$ dig www.apple.com

; <<>> DiG 9.10.6 <<>> www.apple.com

;; global options: +cmd

;; Got answer:

;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 57705

;; flags: qr rd ra; QUERY: 1, ANSWER: 4, AUTHORITY: 0, ADDITIONAL: 0

;; QUESTION SECTION:

;www.apple.com. IN A

;; ANSWER SECTION:

www.apple.com. 57 IN CNAME www.apple.com.edgekey.net.

www.apple.com.edgekey.net. 16510 IN CNAME www.apple.com.edgekey.net.globalredir.akadns.net.

www.apple.com.edgekey.net.globalredir.akadns.net. 1975 IN CNAME e6858.dsce9.akamaiedge.net.

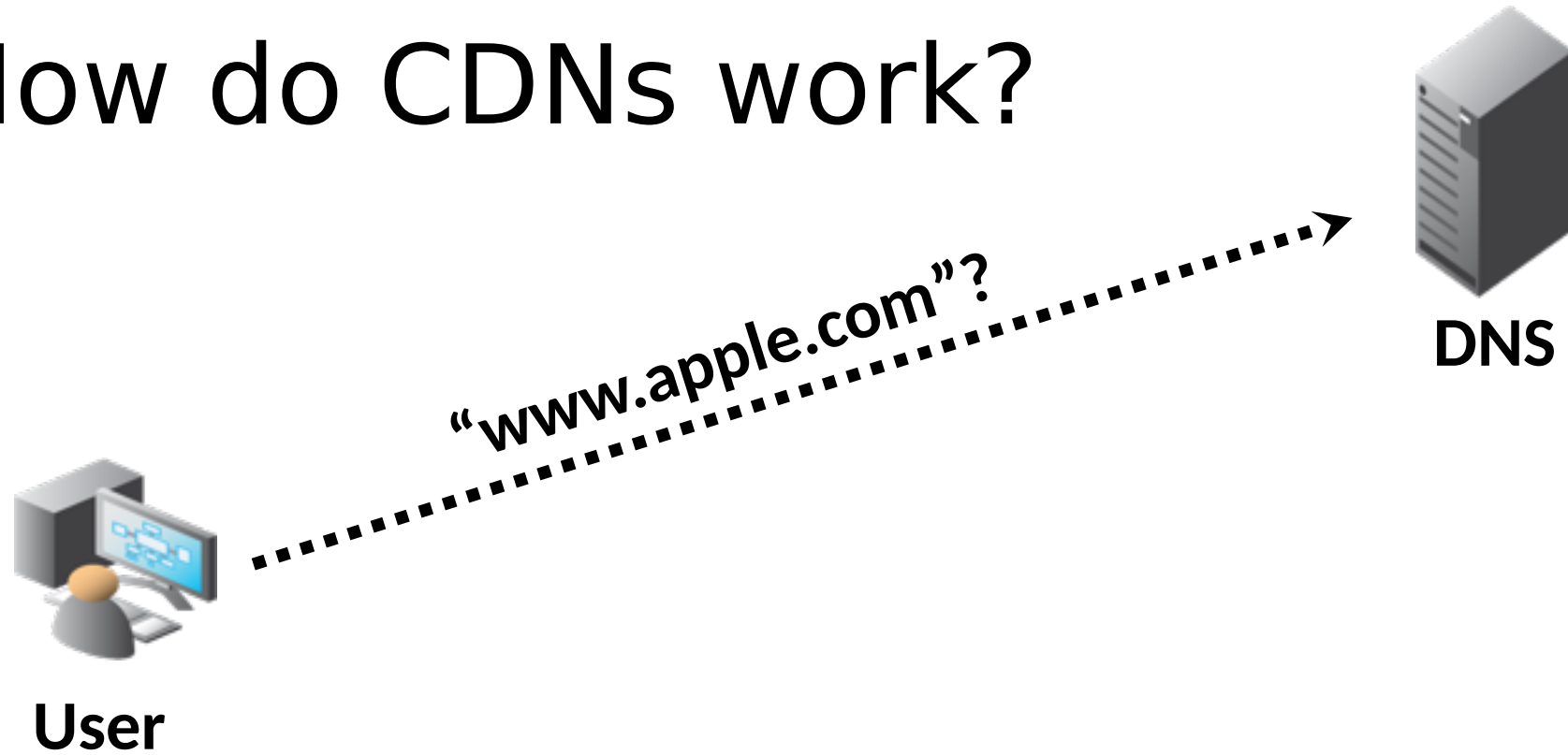
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How do CDNs work?

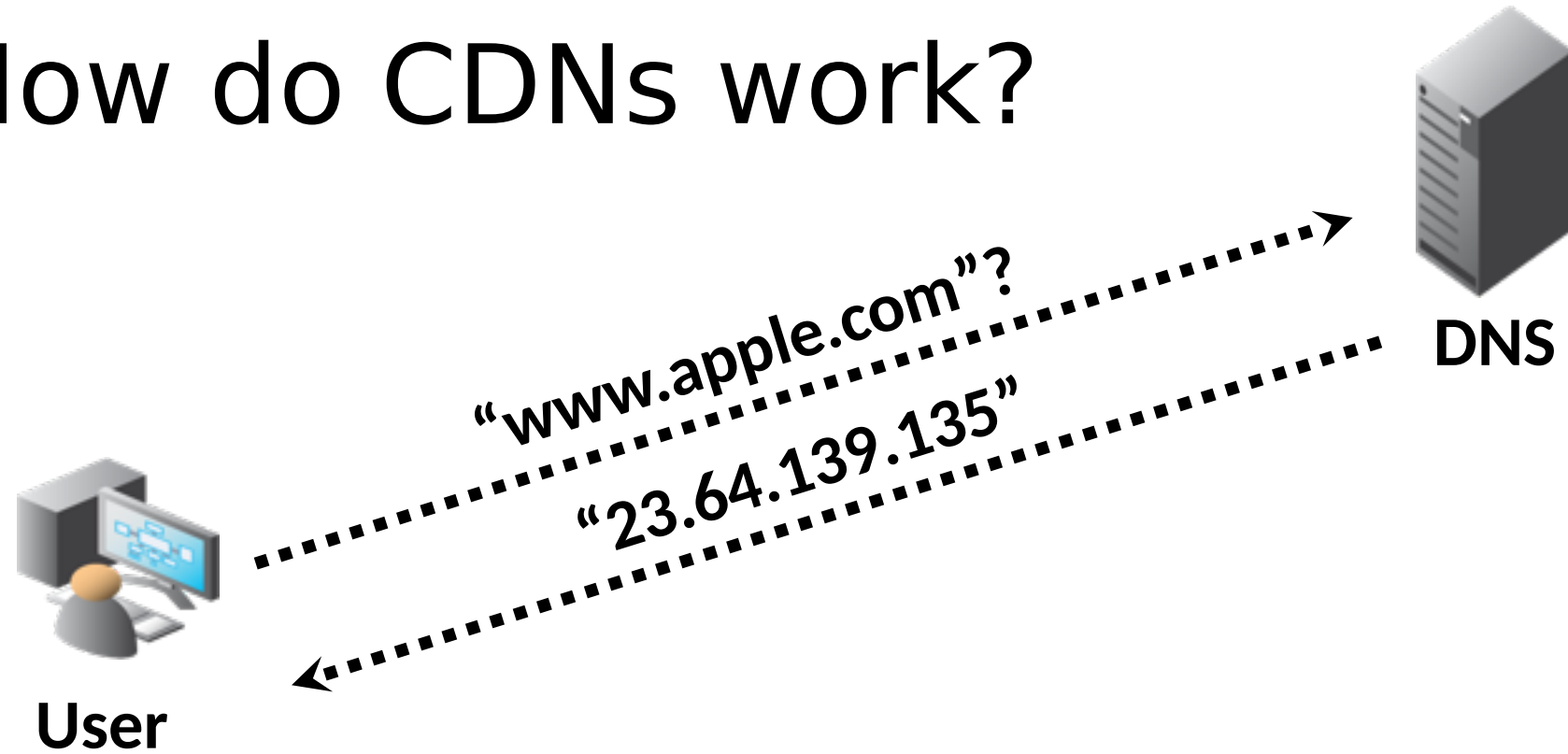


User

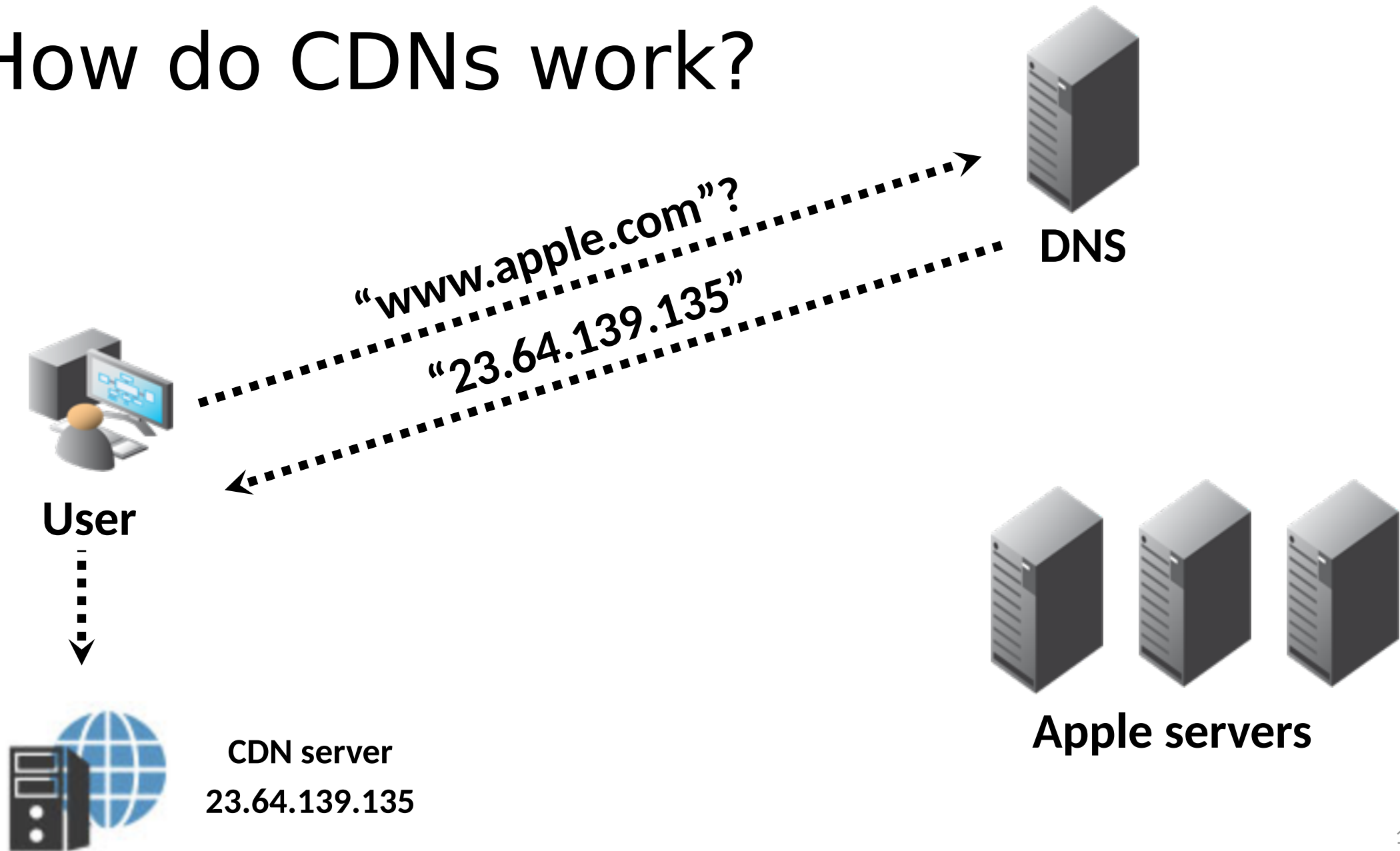
How do CDNs work?



How do CDNs work?



How do CDNs work?



Discovering a CDN server

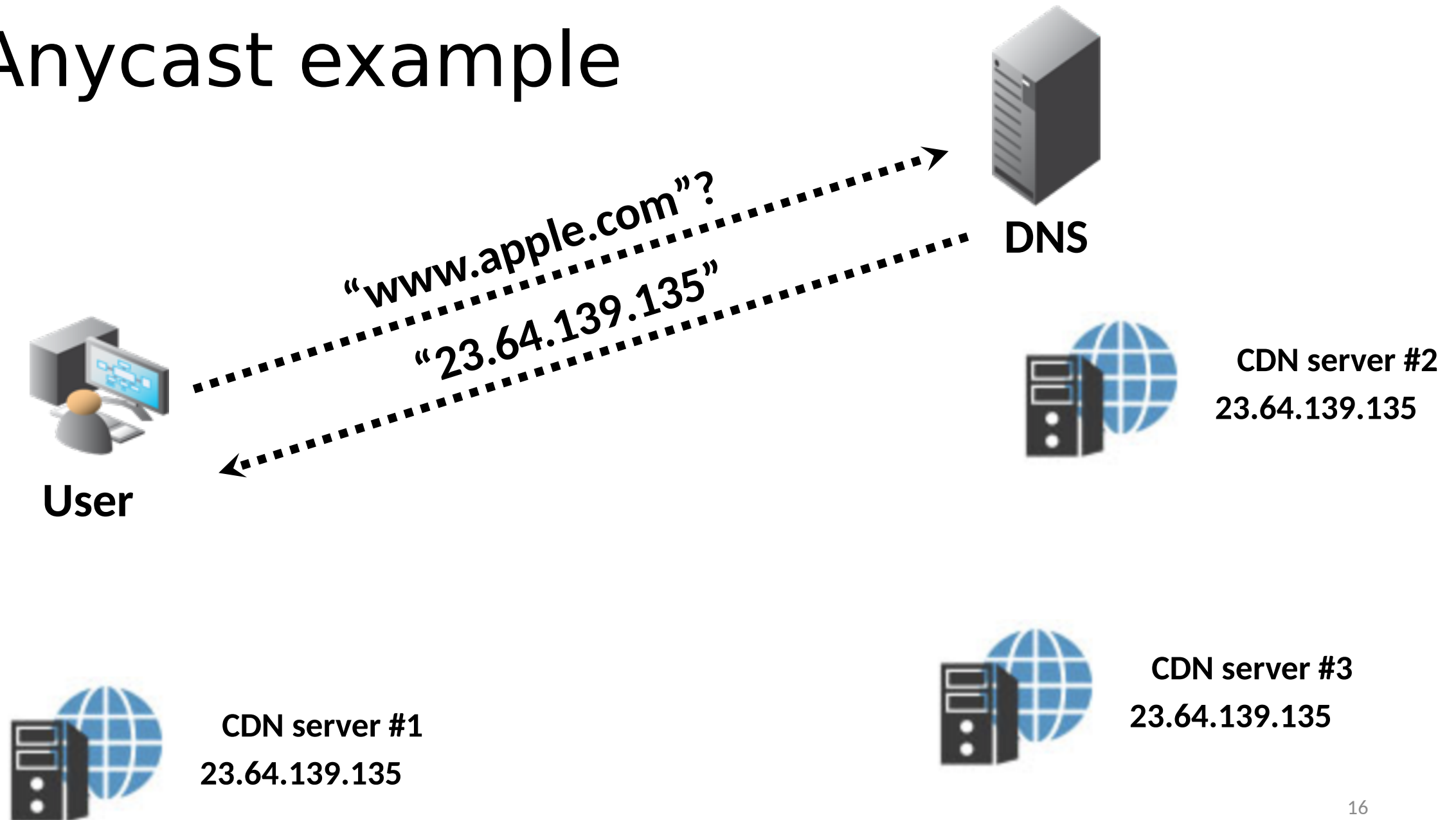
- DNS redirection
 - DNS returns IP address of CDN server(s) to clients
- Advantages
 - Any ideas?
 - DNS already has scalable infrastructure
 - URLs need no change
- Limitations
 - Who controls the user content?
 - DNS typically returns a single IP address
 - This IP address might be unicast

How to get around the DNS limitations?

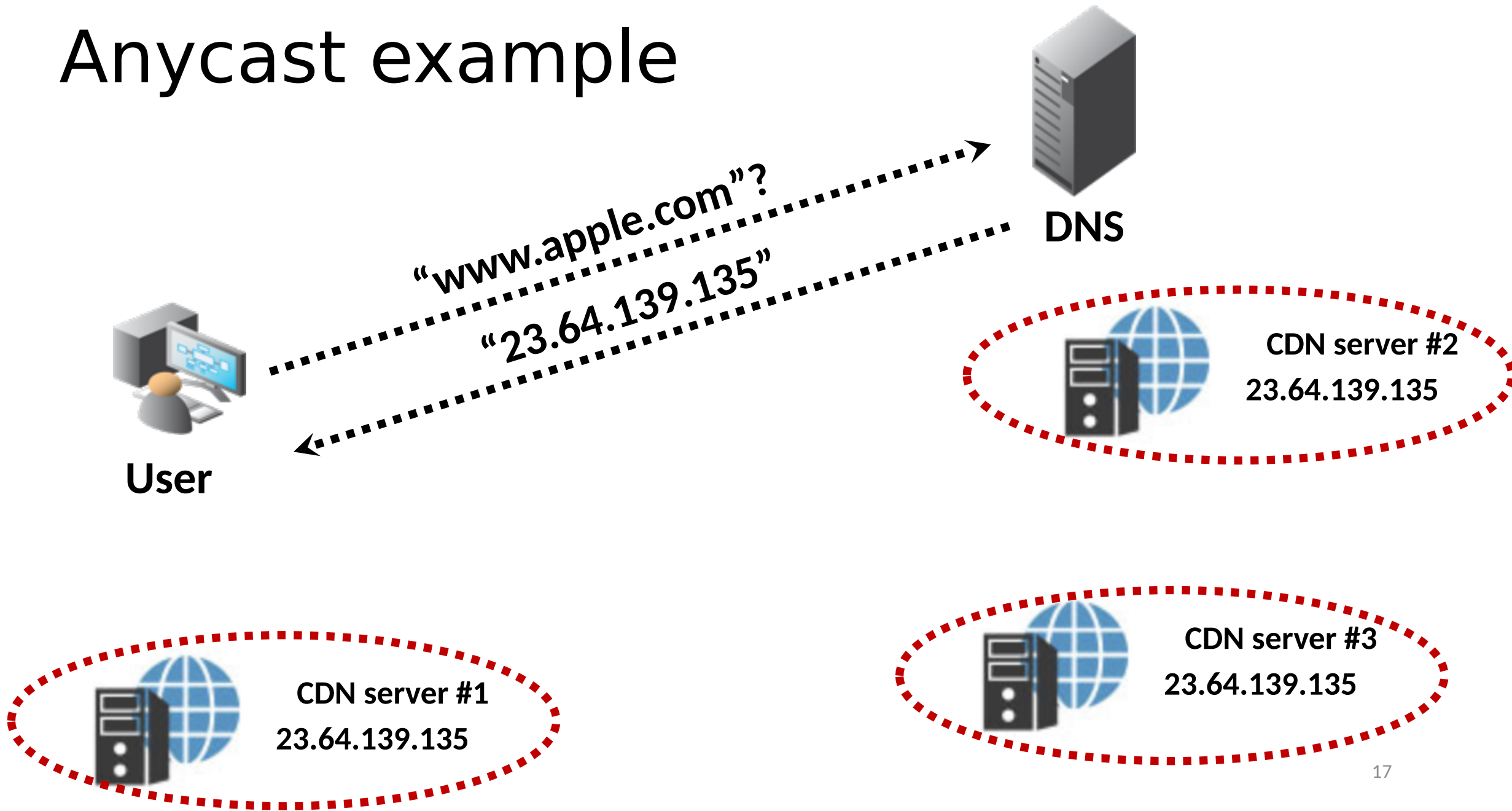
- IP anycast

- Deploy multiple CDN servers with same IP address
- All these servers have the requested content
- Content requests reach the closest CDN server to the user

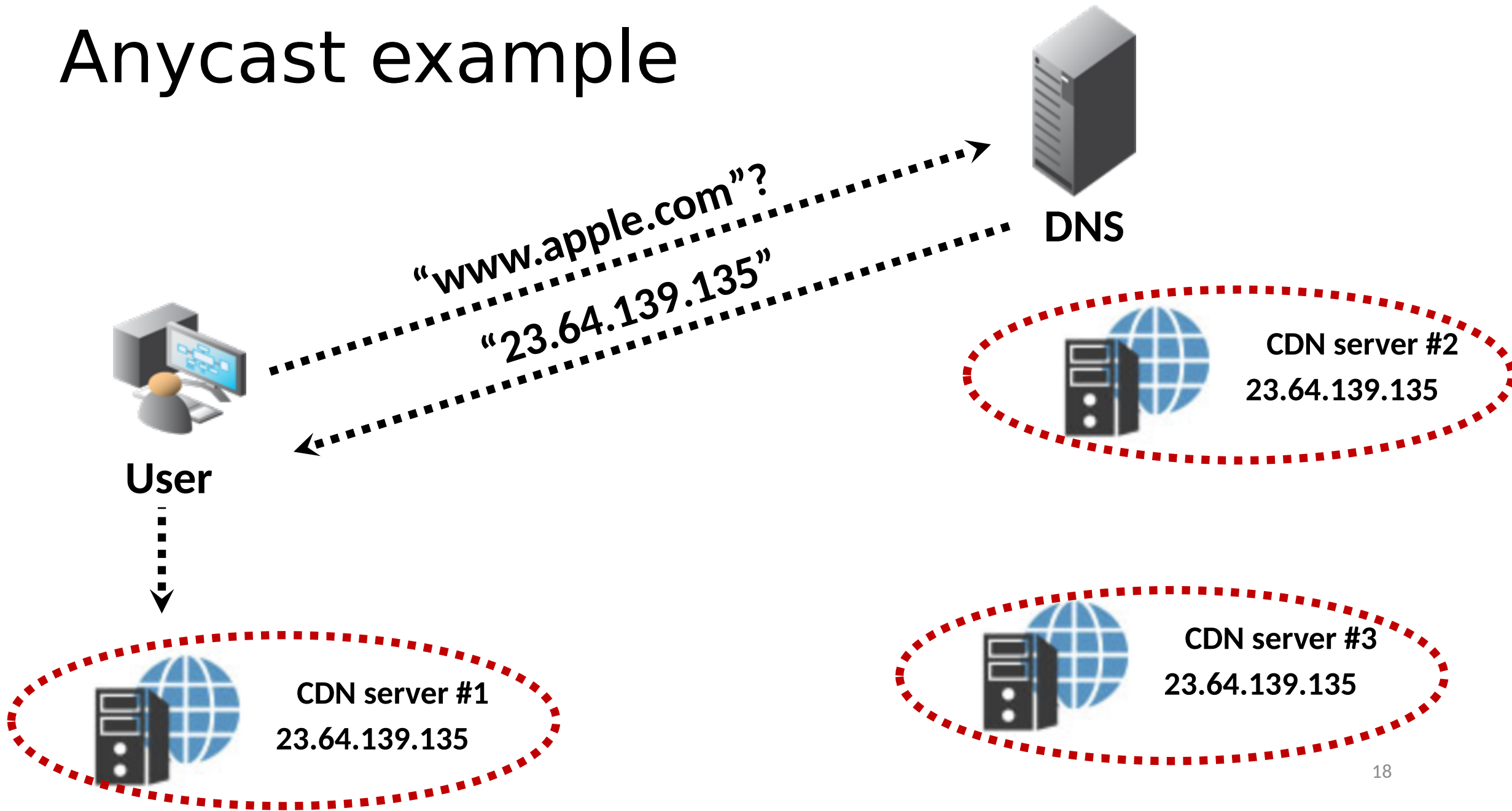
Anycast example



Anycast example



Anycast example



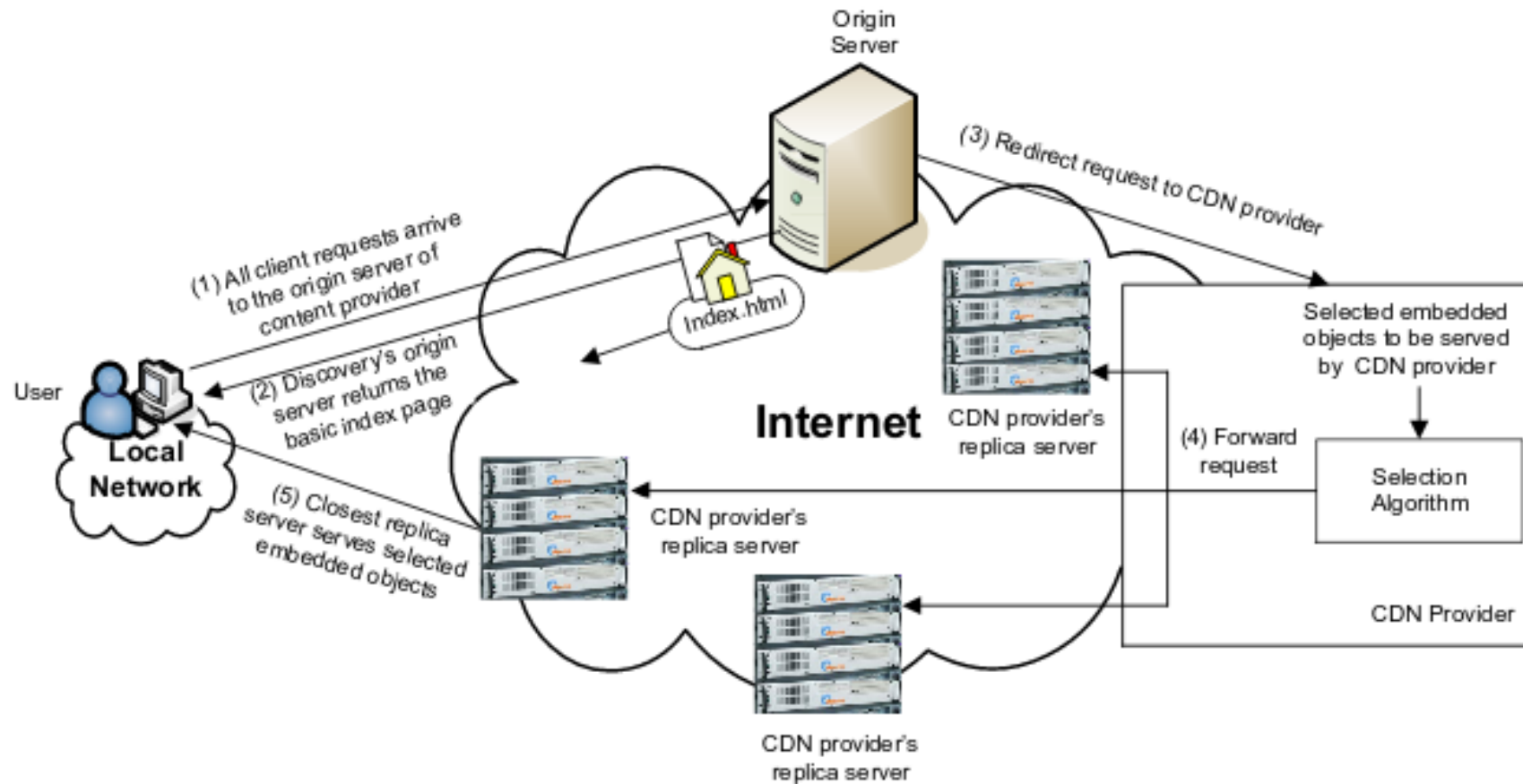
Further optimizing on performance

- Multiple CDN servers in same data-center having the requested content
 - How to pick the "best" one?
- It depends on how we define "the best one"
 - Load, network conditions, service level agreements
 - Typically solved through load balancers, network monitoring, and configuration

Request Routing

- Multiple CDN servers in same data-center having the requested content
 - How to pick the "best" one? ← Request routing
- It depends on how we define "the best one"
 - Load, network conditions, service level agreements
 - Typically solved through load balancers, network monitoring, and configuration

Request Routing



How CDNs handle dynamic content?

- What to do with dynamic content?
 - Examples: webpages with ads or websites that require passwords
 - Break dynamic pages into parts that can be cached and parts that cannot
 - CDN server fetches non-cacheable parts (e.g., response to a password) from the original content server and cacheable parts from its own cache
 - CDN server puts non-cacheable and cacheable parts together, assembles the website, and sends it back to the user
- How effective could that be?
 - According to Akamai, this reduces bandwidth requirements for dynamic content by 95-99%

Security/Privacy

- Impact on security/privacy?
 - Users and content providers need to trust CDNs!
- Who has control over user content?
 - For sure, not the user!
- What happens if the CDN gets compromised?
 - Content poisoning!

Encrypted content

- Why not using end-to-end encryption to solve all the security/privacy problems?
 - CDNs need to have access to unencrypted content to optimize content delivery!
- *User think they establish an encrypted connection to the content server!*
 - Typically NOT true!
 - CDNs usually have access to encryption/decryption keys!
 - CDNs fetch content from content servers --> store content (typically unencrypted) --> encrypt requested content and provide it to users

Mitigate DDoS attacks through CDNs

- Lately, DDoS attacks are against applications/services (e.g., Facebook) in addition to network services (e.g., DNS)
 - Attack a large distributed network of caches harder than attacking a few content servers directly!
 - Attacks against CDNs (big guys) instead of content owners (smaller guys)
 - CDNs monitor traffic -> detect anomalies and attacks
 - Drop or reroute malicious traffic almost in real-time

Conclusion

- CDNs are ubiquitous now
- CDNs are still under active development
- Many free CDNs you can use today
 - Cloudflare, netli and many others