CS 348: Computer Networks

- DNS; 22nd Oct 2012

Instructor: Sridhar Iyer
IIT Bombay

Domain Name System

- Map between host names and IP addresses
  - People: many identifiers: name, Passport #, …
  - Internet hosts:
    - IP address (32 bit) - used for addressing datagrams
    - “name”, e.g., www.iitb.ac.in - used by humans

DNS

- Provides logical hierarchical view of the Internet
  - globally *distributed database* implemented in hierarchy of many *name servers*
  - *application-layer protocol* to communicate to *resolve* names (address/name translation)
  - client/server interaction

DNS clients and servers

- clients: query servers to resolve names; nslookup
- servers: name server daemons, reply to queries; BIND, named
- gethostbyname: resolver library call that can be invoked from application program

Lazily validated cache for performance

DNS design

Centralized DNS?

- single point of failure
- traffic volume
- distant centralized database
- maintenance
- doesn't *scale!*

So…Distributed DNS

Name hierarchy

- Unique domain suffix is assigned by Internet Authority
- No limit on number of subdomains or number of levels
- Domains within an organization do not have to be uniform in number of subdomains or levels
  - www.iitb.ac.in
  - www.it.iitb.ac.in

Top-level domains

Domain Name/	Assignment
com	Commercial
edu	Educational
gov	Government
mil	Military
net	Network
org	Other organizations
arpa	Advanced Research Project Agency
country code	au, uk, ca

DNS hierarchy

- Servers are organized in a hierarchy
- Each server has an authority over a part of the naming hierarchy
- The server does not need to keep all names
- It needs to know other servers who are responsible for other subdomains

DNS: Local name servers

Local Name Servers:

- each organization/ISP has *local (default) name server*
- host DNS query first goes to local name server

Authoritative Name Server:

- for a host: stores that host's IP address, name
- can perform name/address translation for that host's name

Name server hierarchy

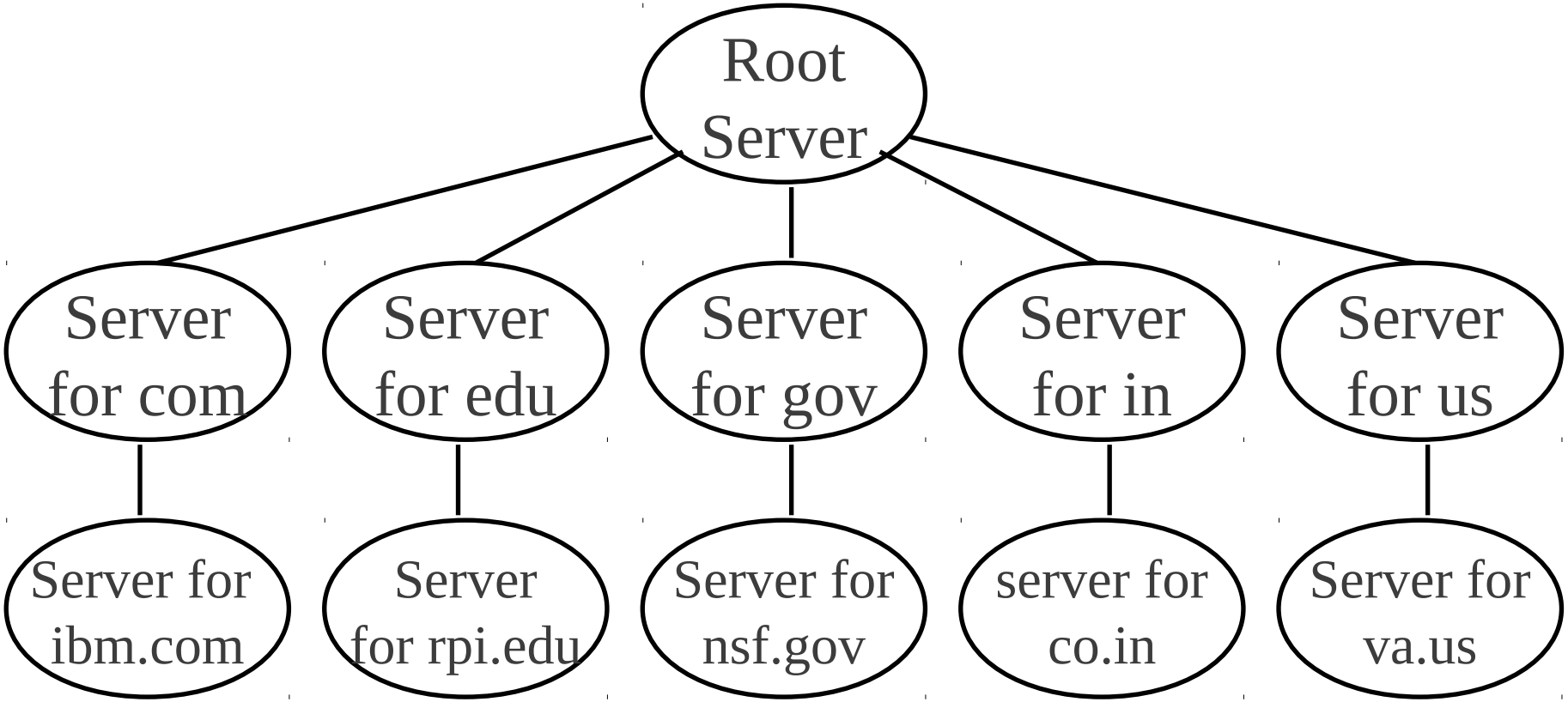
- A single server can serve multiple domains
- Root server knows about servers for top-level domains
- Each server knows the root server

DNS: Root name servers

- Contacted by local name server that cannot resolve name
- Root Name Server:
  - contacts authoritative name server if name mapping not known
  - gets mapping
  - returns mapping to local name server

Several root name servers worldwide

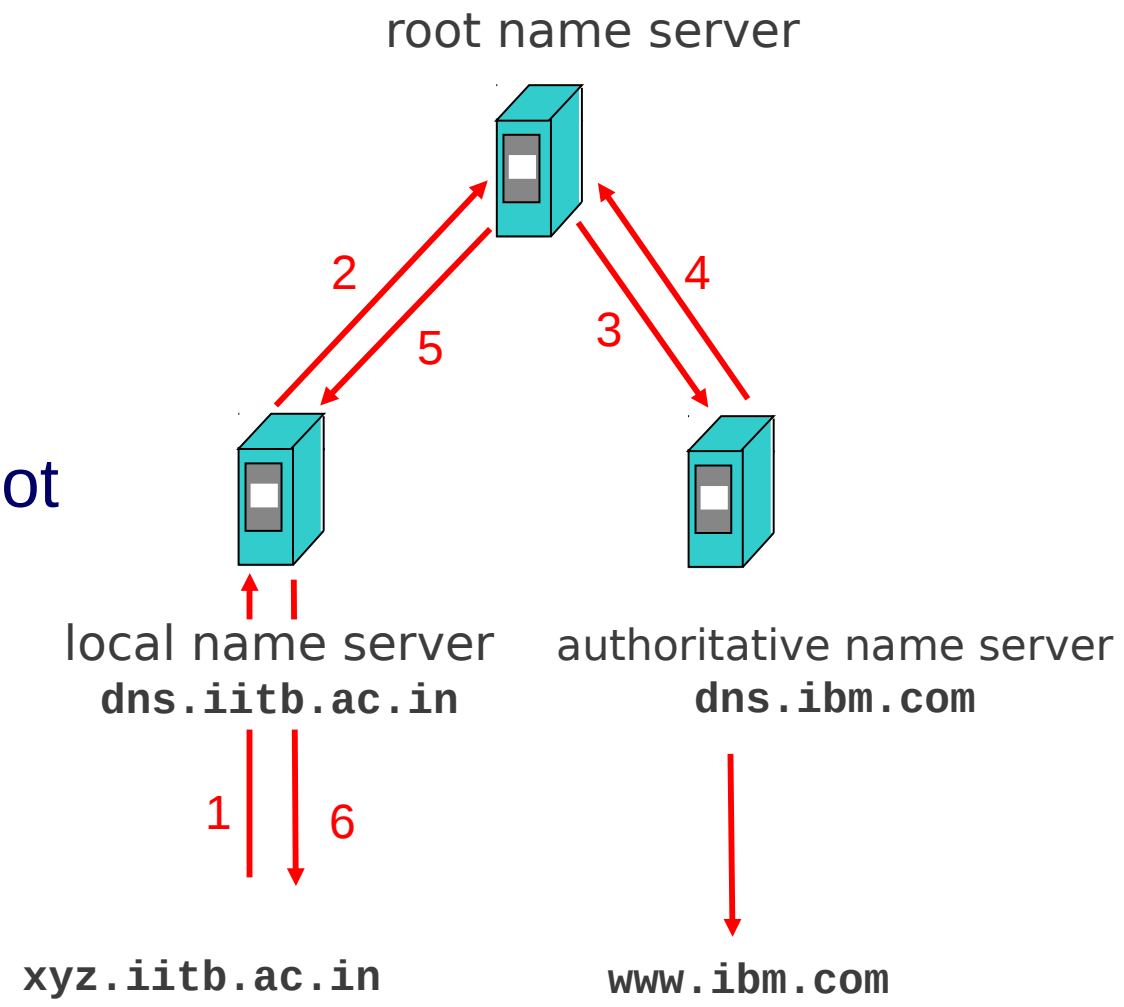
DNS hierarchy: Example



DNS: Example

host xyz.iitb.ac.in wants IP address of www.ibm.com

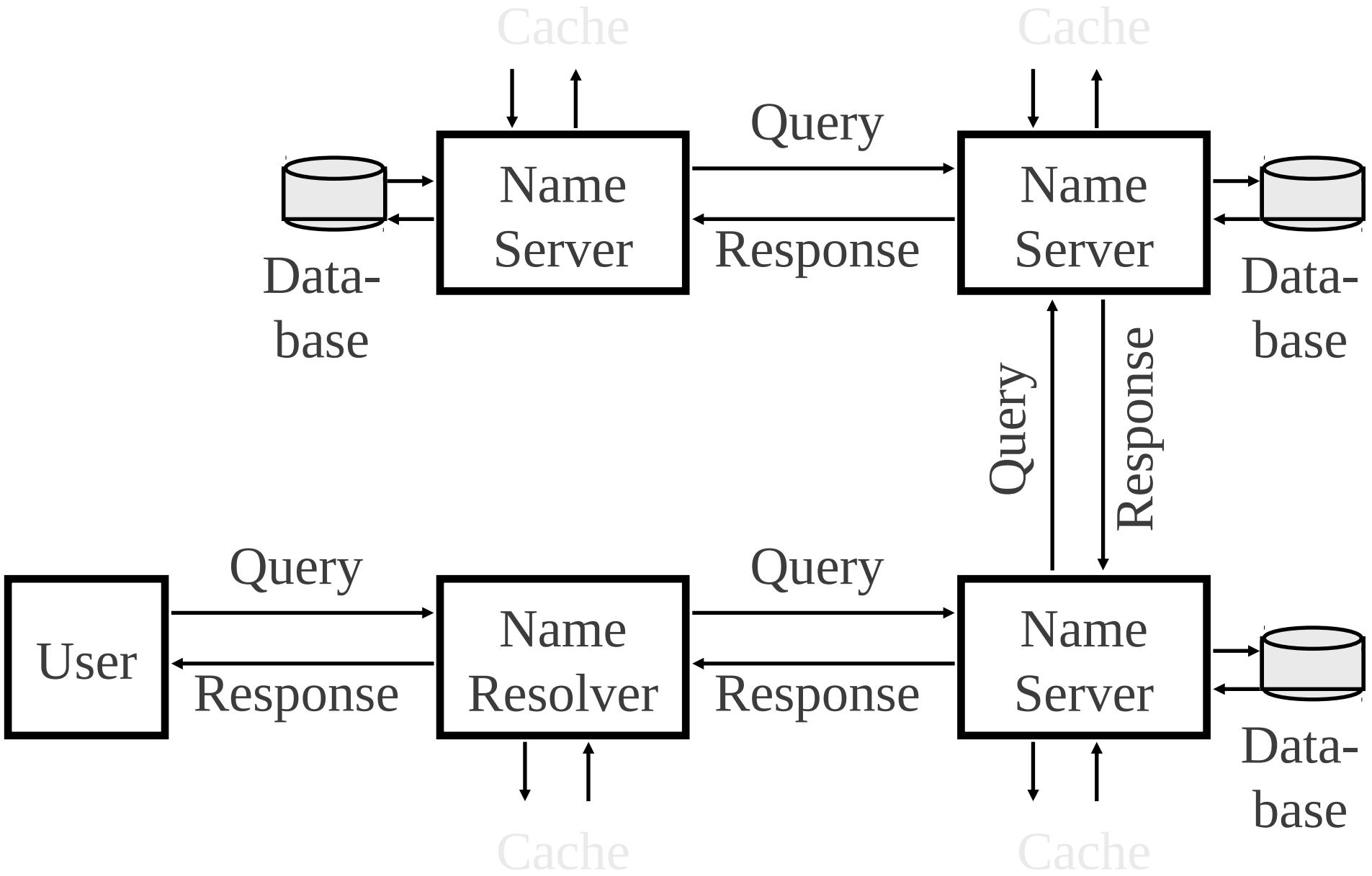
1. Contacts its local DNS server, dns.iitb.ernet.in
2. dns.iitb.ernet.in contacts root name server, if necessary
3. root name server contacts authoritative name server, dns.ibm.com, if necessary



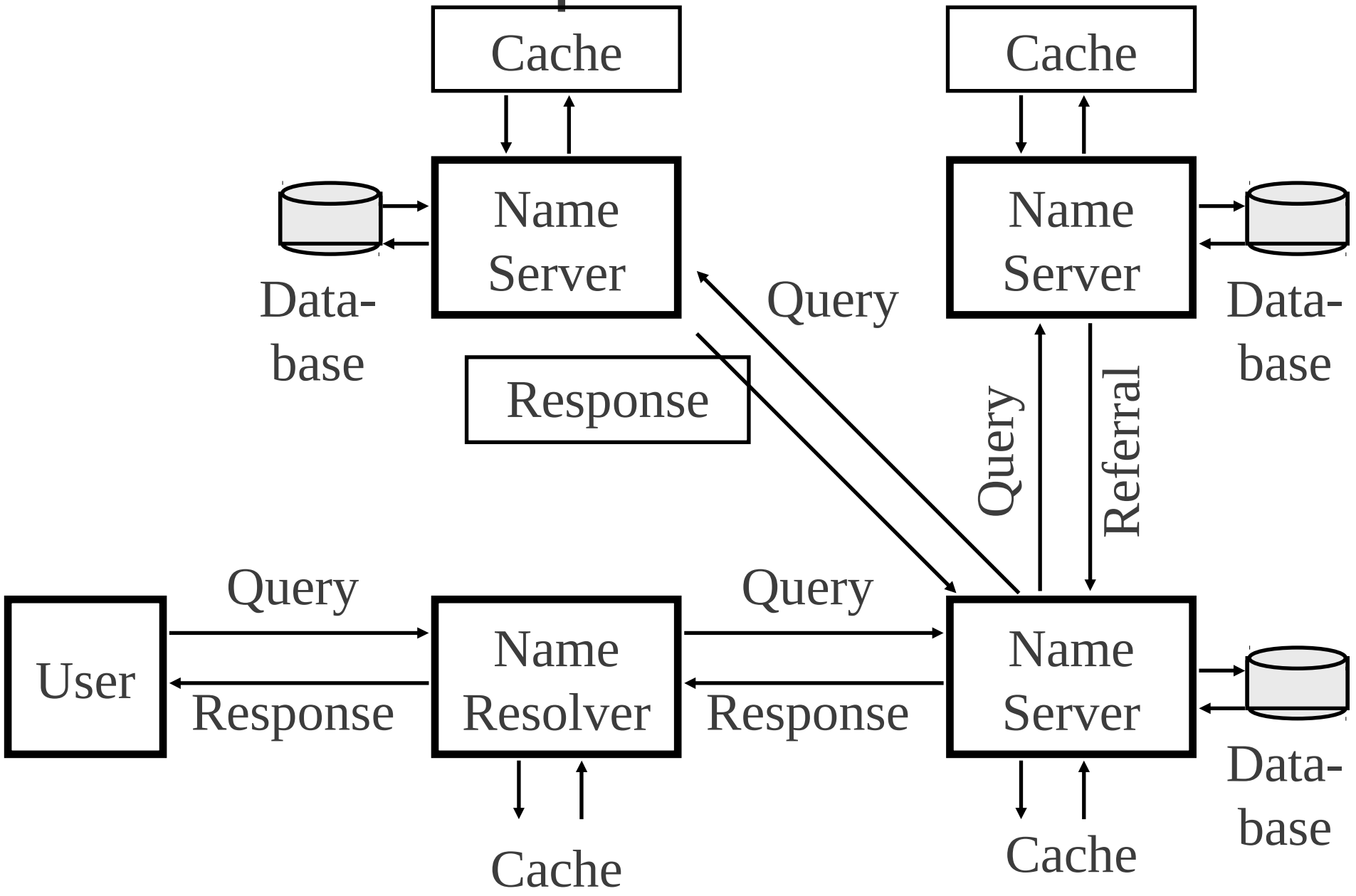
DNS: Name resolution

- Recursive queries:
  - puts burden of name resolution on contacted name server
  - not scalable under heavy load
- Iterated queries:
  - contacted server replies with name of server to contact. Ex: root name server may know *intermediate name server* to contact to find authoritative name server

Recursive queries



Iterated queries



DNS optimization

- Spatial Locality: Local computers referenced more often than remote
- Temporal Locality: Same set of domains referenced repeatedly $\Rightarrow$ Caching
- Each entry has a time to live (TTL)
- Replication:
  - Multiple servers. Multiple roots.
  - Ask the geographically closest server.

DNS: caching and updating

- A name server *caches* the mappings learnt
  - cache entries have a time-to-live period after which they become invalid
  - update/notify mechanisms: RFC 2136

DNS record

- Resource Record (RR) format: (name, value, type, ttl)
- Type=A: **name** is hostname; **value** is IP address
- Type=NS: **name** is domain (e.g. ibm.com); **value** is IP address of authoritative name server for this domain
- Type=CNAME: **name** is an alias name for some “cannonical” (the real) name; **value** is cannonical name
- Type=MX: **value** is hostname of mailserver associated with **name**

DNS protocol

- client-server interaction
  - query and reply messages, both with same message format

- Message header
  - identification: 16 bit # for query, reply uses same #
  - flags: query or reply; recursion desired; recursion available; reply is authoritative

DNS message format