DNS/DNSSEC Tutorial

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Brief Overview of DNS

The World's Network – the Domain Name System

- Internet Protocol numbers are unique addresses that allow computers to find one another
- The Domain Name System matches IP numbers with a name
- DNS is the underpinning of unified Internet
- DNS keeps Internet secure, stable and interoperable
- ICANN was formed in 1998 to coordinate DNS

What is the Domain Name System?

A distributed database primarily used to obtain the

IP address, a number, e.g.,
192.168.23.1 or fe80::226:bbff:fe11:5b32

that is associated with a

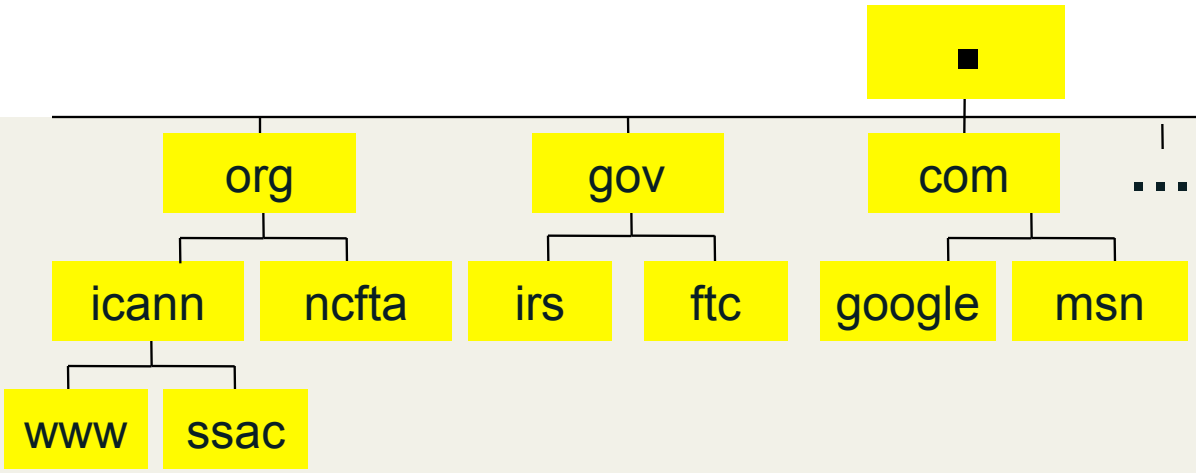
user-friendly name (www.example.com)

Why do we need a DNS?

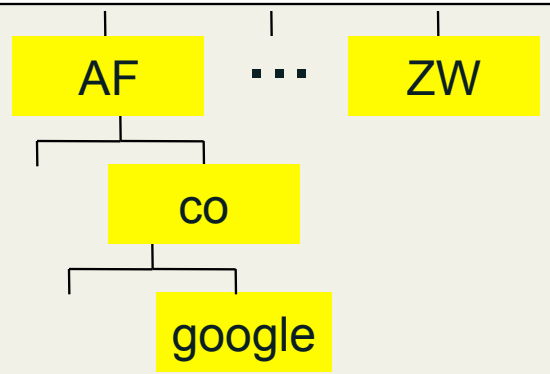
It's hard to remember lots of four decimal numbers and it's impossibly hard to remember hexadecimal ones

DNS Structure

- A **domain** is a node in the Internet name space
  - A domain includes all its descendants
- Domains have names
  - Top-level domain (TLD) names are generic or country-specific
  - TLD *registries* administer domains in the top-level
  - TLD registries *delegate* labels beneath their top level delegation



Names in generic Top Level Domains



Names in country-code TLDs

Root Servers to benefit Internet Stability and Resiliency

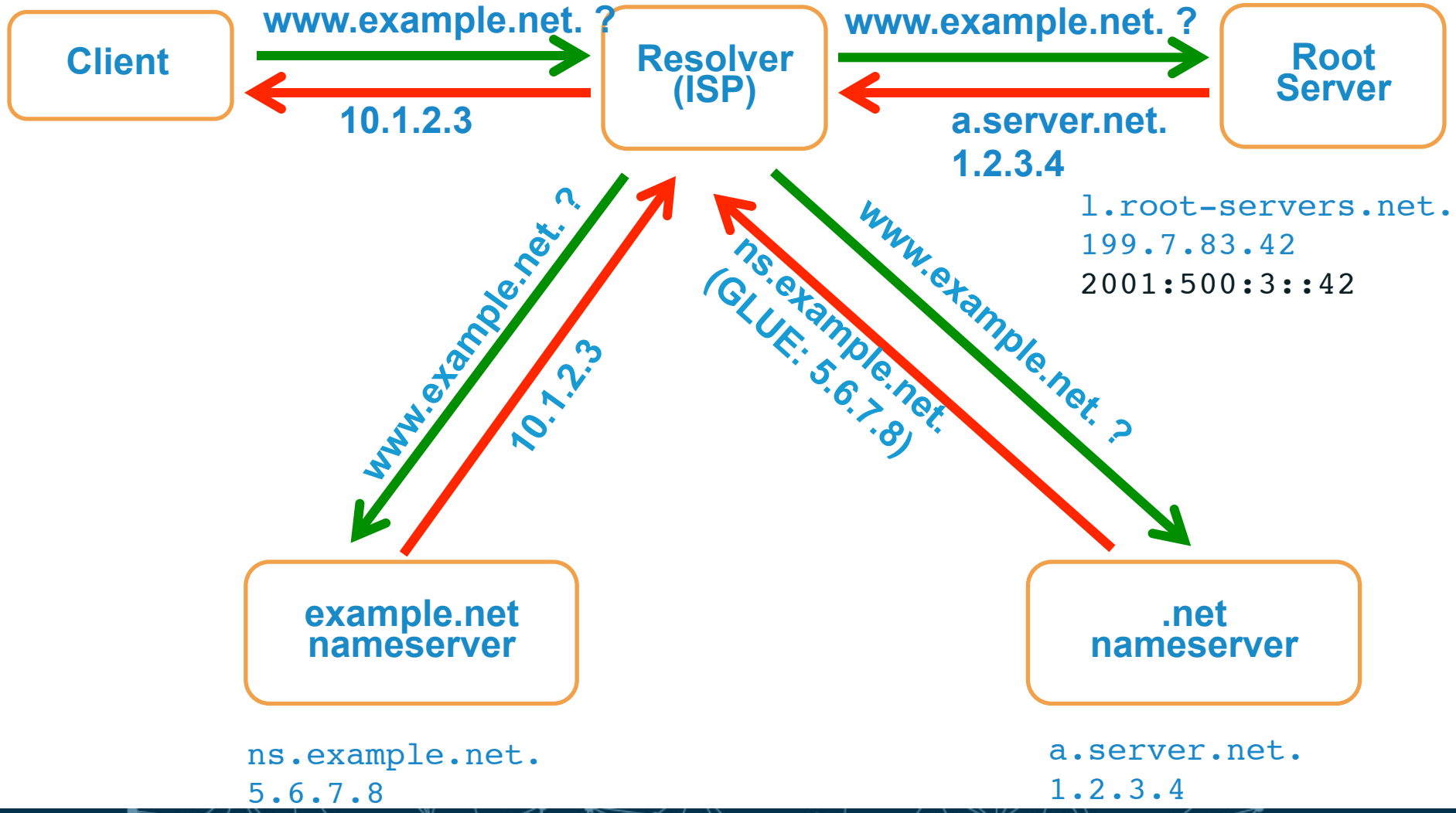
- ICANN is the L-Root Operator
- L-Root nodes keep Internet traffic local and resolve queries faster
- Make it easier to isolate attacks
- Reduce congestion on international bandwidth
- Redundancy and load balancing with multiple instances

L-Root presence

DNS Servers

- DNS is a distributed database
- Types of DNS servers
  - DNS Authoritative
    - Primary (Master)
    - Secondary (Slaves)
  - DNS Resolver
    - Recursive
    - Cache
    - Stub resolver

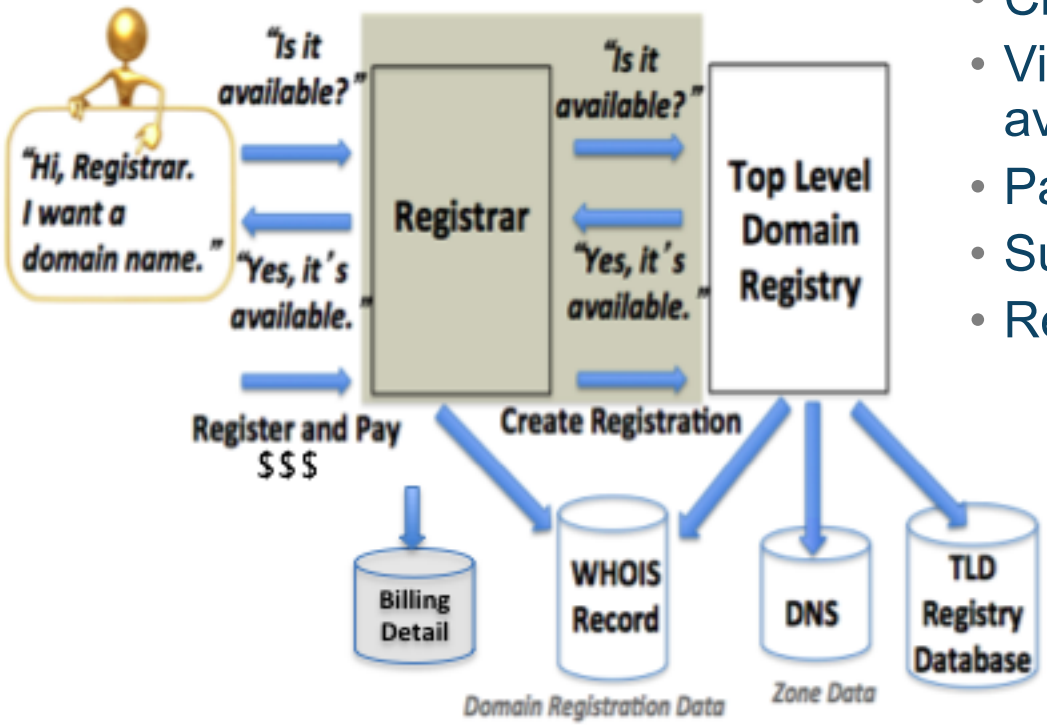
DNS Resolution



Operational elements of the DNS

- Authoritative Name Servers host zone data
  - The set of “DNS data” that the registrant publishes
- Recursive Name Resolvers (“resolvers”)
  - Systems that find answers to queries for DNS data
- Caching resolvers
  - Recursive resolvers that not only find answers but also store answers locally for “TTL” period of time
- Client or “stub” resolvers
  - Software in applications, mobile apps or operating systems that query the DNS and process responses

Domain Name Registration 101



How to register a domain:

- Choose a string e.g., `example`
- Visit a registrar to check string availability in a TLD
- Pay a fee to register the name
- Submit registration information
- Registrar and registries manage:
  - "string" + TLD (managed in registry DB)
  - Contacts, DNS (managed in Whois)
  - DNS, status (managed in Whois DBs)
  - Payment information

DNS Resource Records (RR)

- Unit of data in the Domain Name System
- Define attributes for a domain name

Label	TTL	Class	Type	RData
www	3600	IN	A	192.168.0.1

  - Most common types of RR
    - A
    - AAAA
    - NS
    - SOA
    - MX
    - CNAME

What is a DNS zone *data*?

- DNS zone data are hosted at an *authoritative name server*
  - Each “cut” has zone data (root, TLD, delegations)
- DNS zones contain *resource records that* describe
  - name servers,
  - IP addresses,
  - Hosts,
  - Services
  - Cryptographic keys & signatures…

```
$TTL    86400 ; 24 hours could have been written as 24h or 1d
; $TTL used for all RRs without explicit TTL value
$ORIGIN example.com.
@  1D          IN  SOA ns1.example.com. hostmaster.example.com. (
                       2002022401 ; serial
                       3H ; refresh
                       15 ; retry
                       1w ; expire
                       3h ; minimum
                       )
               IN  NS     ns1.example.com.    ; NS in the domain bailiwick
               IN  NS     ns2.smokeyjoe.com.  ; NS external to domain
               IN  MX  10 mail.another.com.   ; external mail provider
;
; Sender policy framework with hard fail
; Use A and MX resource records for verification and google too
;
example.com. IN TXT "v=spf1 a mx include:google.com ~all"
;
; server host definitions
;
ns1            IN  A      192.168.0.1        ;name server definition
www            IN  A      192.168.0.2        ;web server definition
;
; web and ftp server on same address
;
ftp            IN  CNAME  www.example.com.   ;ftp server definition
;
; endpoint or non server domain hosts
;
mikeslaptop    IN  A      192.168.0.3
fredsipad      IN  A      192.168.0.4
```

Only US ASCII-7 letters, digits, and hyphens can be used as zone data.

In a zone, IDNs strings begin with XN--

Common DNS Resource Records

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; server host definitions
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;
; web and ftp server on same address
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ftp            IN  CNAME  www.example.com.   ;ftp server definition
;
; endpoint or non server domain hosts
;
mikeslaptop    IN  A      192.168.0.3
fredsipad      IN  A      192.168.0.4
```

Time to live (TTL)

- *How long RRs are accurate*

Start of Authority (SOA) RR

- *Source: zone created here*
- *Administrator's email*
- *Revision number of zone file*

Name Server (NS)

- *IN (Internet)*
- *Name of authoritative server*

Mail Server (MX)

- *IN (Internet)*
- *Name of mail server*

Sender Policy Framework (TXT)

- *Authorized mail senders*

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```

Name server address record

- *NS1 (name server name)*
- *IN (Internet)*
- *A (IPv4) * AAAA is IPv6*
- *IPv4 address (192.168.0.1)*

Web server address record

- *www (world wide web)*
- *IN (Internet)*
- *A (IPv4) * AAAA is IPv6*

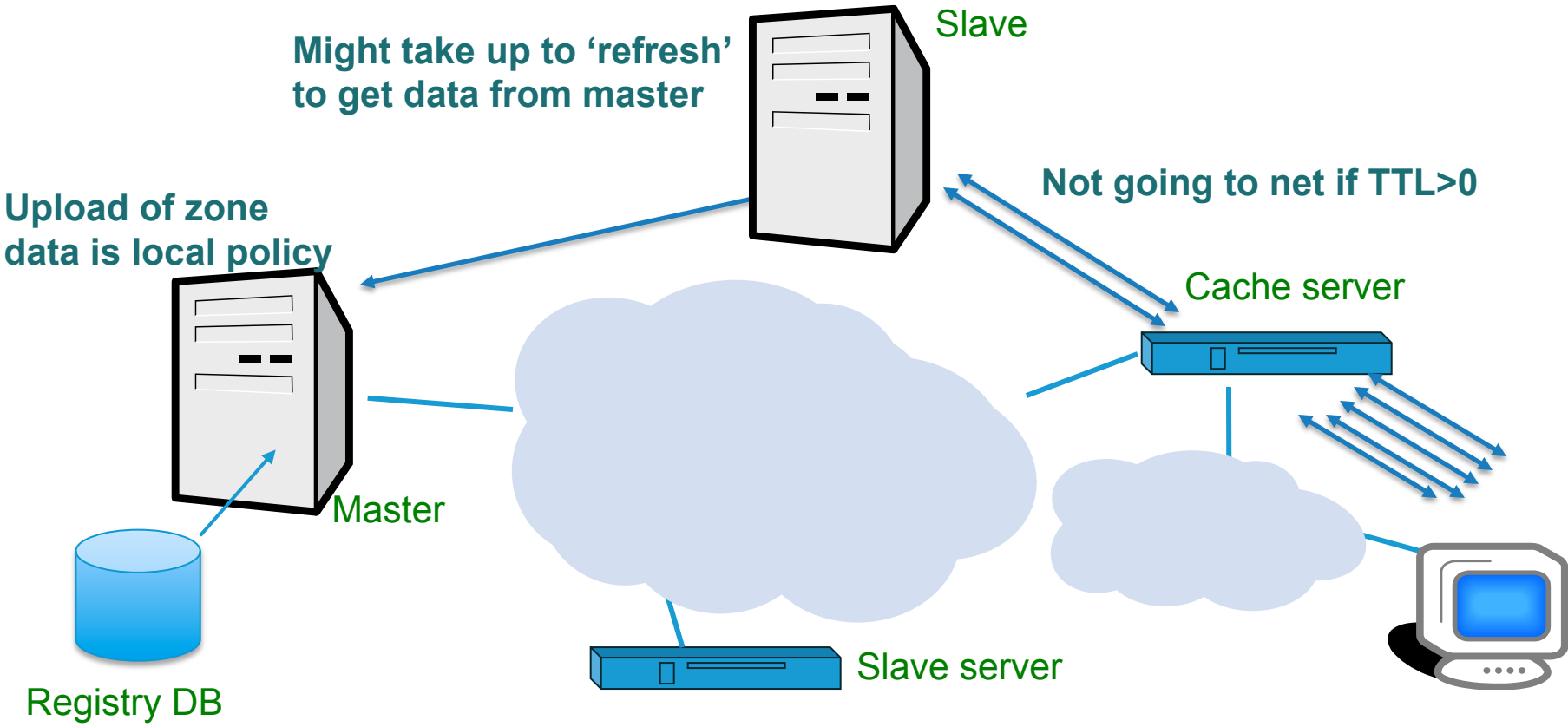
IPv4 address (192.168.0.2)

File server address record

- *FTP (file transfer protocol)*
- *IN (Internet)*
- *CNAME means “same address spaces and numbers as www”*

Places where DNS data lives

Changes do not propagate instantly



Delegating a Zone

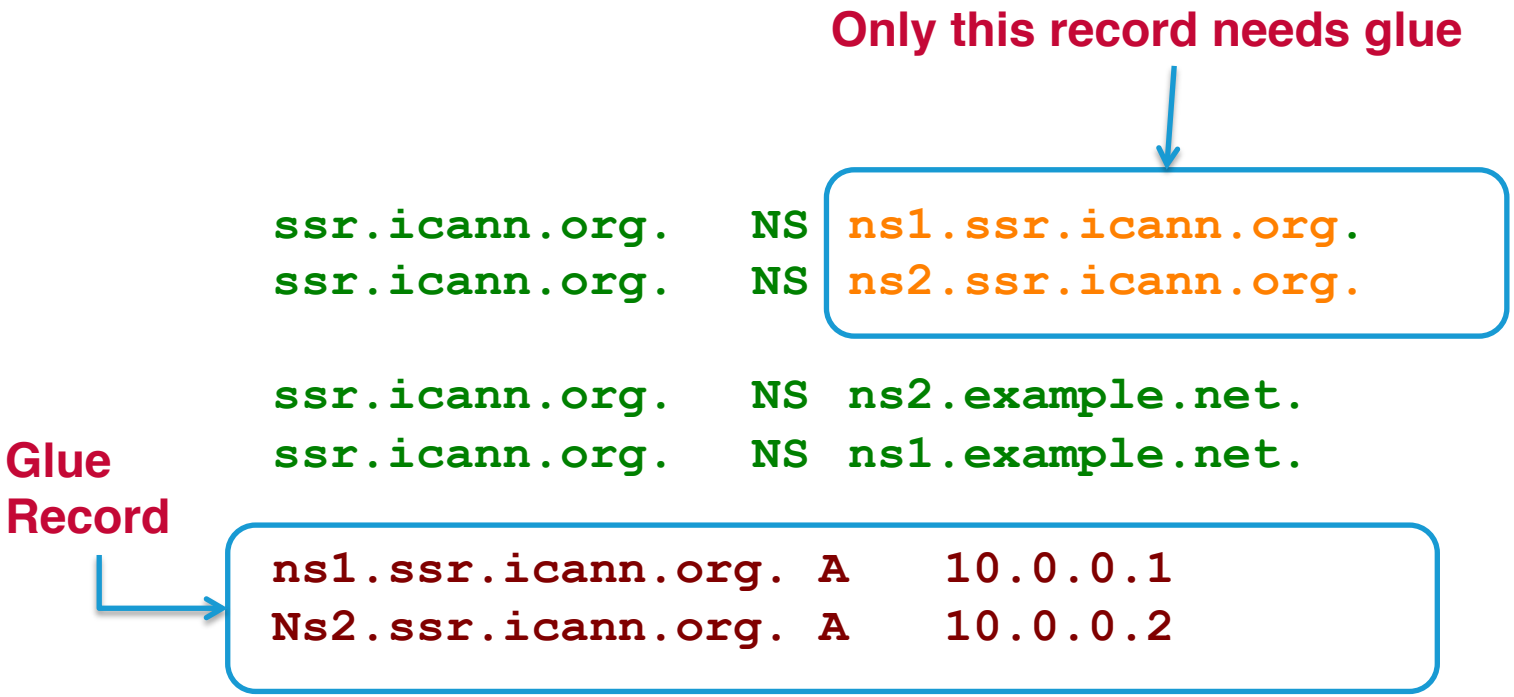
- Delegation is passing of authority for a subdomain to another party
- Delegation is done by adding NS records
  - Ex: if icann.org wants to delegate ssr.icann.org

```
ssr.icann.org.    NS ns1.ssr.icann.org.
ssr.icann.org.    NS ns2.ssr.icann.org.
```

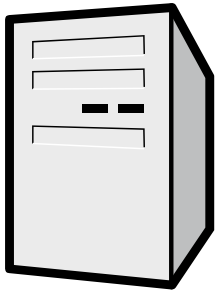
- Now how can we go to ns1 and ns2?
  - We must add a **Glue Record**

Glue Record

- Glue is a ‘non-authoritative’ data
- Don’t include glue for servers that are not in the sub zones

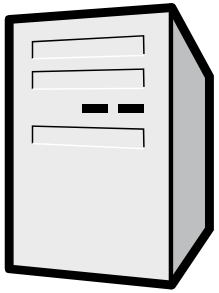


Delegating ssr.icann.org. from icann.org.



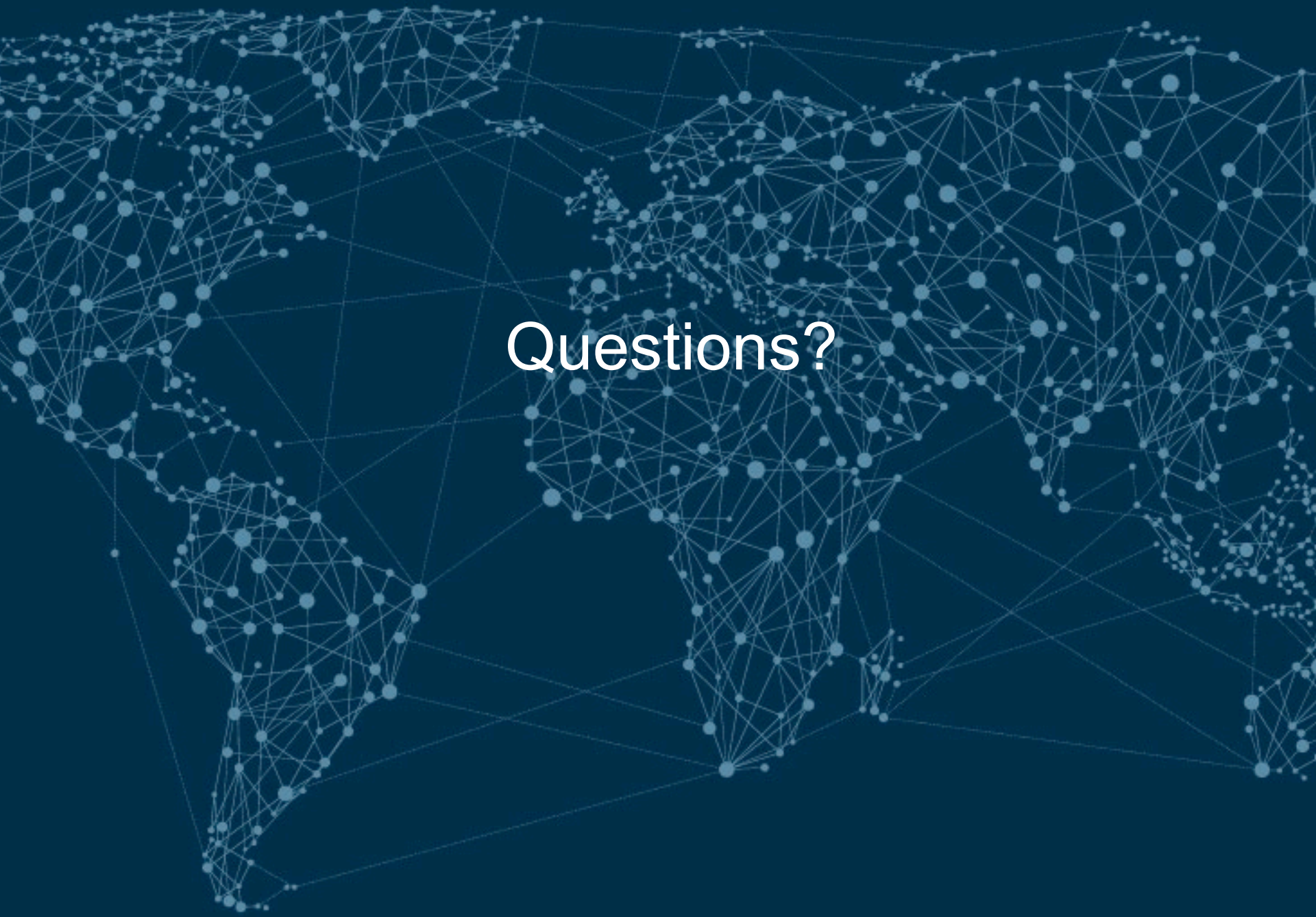
ns.icann.org

1. Add NS records and glue
2. Make sure there is no other data from the ssr.icann.org. zone in the zone file



ns.ssr.icann.org

1. Setup minimum two servers
2. Create zone file with NS records
3. Add all ssr.icann.org data


Questions?


Thank You!
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