Domain Name System (DNS)

Session-3: Configuration of Authoritative Nameservers

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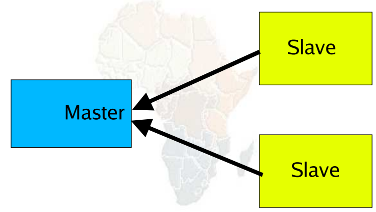
Recap

- DNS is a distributed database
- Resolver asks Cache for information
- Cache traverses the DNS delegation tree to find Authoritative name server which has the information requested
- Bad configuration of authoritative server can result in broken domains

DNS Replication

- For every domain, we need more than one authoritative nameserver with the same information (RFC 2182)
- Data is entered in one server (Master) and replicated to the others (Slaves)
- Outside world cannot tell the difference between master and slave
  - NS records are returned in random order for equal load sharing
- Was called “primary” and “secondary”

Slaves connect to Master to retrieve copy of zone data



- The master does not “push” data to slaves

When does replication take place?

- Slaves poll the master periodically - called the “Refresh Interval” - to check for new data.
  - Originally this was the only mechanism
- With new software, master can also notify the slaves when the data changes
  - results in quicker updates
- The notification is unreliable (e.g. network might lose a packet) so we still need checks at the Refresh Interval.

Serial Numbers

- Every zone file has a Serial Number
- Slave will only copy data when this number INCREASES
  - Periodic UDP query to check Serial Number
  - If increased, TCP transfer of zone data
- It is your responsibility to increase the serial number after every change, otherwise slaves and master will be inconsistent

Recommended serial number format: YYYYMMDDNN

- YYYY = year
- MM = month (01-12)
- DD = day (01-31)
- NN = number of changes today (00-99)
  - e.g. if you change the file on 3rd March 2004, the serial number will be 2004030300. If you change it again on the same day, it will be 2004030301

Serial Numbers: Danger 1

- If you ever *decrease* the serial number, the slaves will *never update again* until the serial number goes above its previous value
- RFC1912 section 3.1 explains how to fix this problem
- At worst, you have to contact all your slaves and get them to delete their copy of the zone data

Serial Numbers: Danger 2

- Serial no. is a 32-bit unsigned number
- Range: 0 to 4,294,967,295
- Any value larger than this is silently truncated
- e.g. 20040303000 (note extra digit)
  - = 4AA7EC198 (hex)
  - = AA7EC198 (32 bits)
  - = 2860433816
- If you make this mistake, then correct it, the serial number will have decreased

Configuration of Master

- /etc/namedb/named.conf points to zone file (manually created)
- Choose a logical place to keep them
- e.g. /etc/namedb/m/example.com
- or /etc/namedb/m/com.example

```
zone "example.com" {
    type master;
    file "m/example.com";
    allow-transfer { 192.188.58.126; 192.188.58.2; };
};
```

Configuration of Slave

- /etc/named.conf points to IP address of master and location of zone file
- Zone files are transferred automatically
  - Don't touch them

```
zone "example.com" {
    type slave;
    masters { 192.188.58.126; };
    file "s/example.com";
    allow-transfer { none; };
};
```

Master and Slave

- It's perfectly OK for one server to be Master for some zones and Slave for others
- That's why we recommend keeping the files in different directories
  - /var/named/m/
  - /var/named/s/

allow-transfer { ... }

- Remote machines can request a transfer of the entire zone contents
- By default, this is permitted to anyone
- Better to restrict this
- You can set a global default, and override this for each zone if required

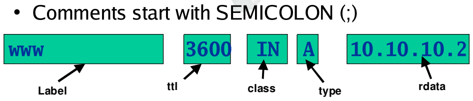
```
options {
    allow-transfer { 127.0.0.1; };
};
```

The Structure of a zone file

- Global options
  - $TTL 1d
  - Sets the default TTL for all other records
- SOA RR
  - "Start Of Authority"
  - Housekeeping information for the zone
- NS RRs
  - List all the nameservers for the zone, master and slaves
- Other RRs
  - The actual data you wish to publish

Format of Resource Records

- One per line (except SOA can extend over several lines)
- If you omit the Domain Name, it is the same as the previous line
- TTL shortcuts: eg. 60s, 30m, 4h, 1w2d
- If you omit the TTL, it takes the $TTL default value
- If you omit the Class, it defaults to IN
- Type and Data cannot be omitted
- Comments start with SEMICOLON (;)



Shortcuts

- If the Domain Name does not end in a dot, the zone's own domain ("origin") is appended
- A Domain Name of "@" means the origin itself
- e.g. in zone file for example.com:
  - @ means **example.com.**
  - www means **www.example.com.**

If you write this...

```
$TTL 1d
@                         SOA ( ... )
                          NS  ns0
                          NS  ns0.as9105.net.
; Main webserver
www                       A   212.74.112.80
                          MX 10 mail
```

... it becomes this

```
example.com.     86400  IN  SOA ( ... )
example.com.     86400  IN  NS  ns0.example.com.
example.com.     86400  IN  NS  ns0.as9105.net.
www.example.com. 86400  IN  A   212.74.112.80
www.example.com. 86400  IN  MX 10
mail.example.com.
```

Format of the SOA record

```
$TTL 1d

@  1h  IN  SOA ns1.example.net. brian.nsrc.org. (
           2004030300      ; Serial
           8h              ; Refresh
           1h              ; Retry
           4w              ; Expire
           1h )            ; Negative

       IN  NS  ns1.example.net.
       IN  NS  ns2.example.net.
       IN  NS  ns1.othernetwork.com.
```

Format of SOA record

- ns1.example.net
  - hostname of master nameserver
- brian.nsrc.org.
  - E-mail address of responsible person, with "@" changed to dot
- Serial number
- Refresh interval
  - How often Slave checks serial number on Master
- Retry interval
  - How often Slave checks serial number if the master did not respond

Format of SOA record (cont)

- Expiry time
  - If the slave is unable to contact the master for this period of time, it will delete its copy of the zone data
- Negative / Minimum
  - Old software used this as a minimum value of the TTL
  - Now it is used for negative caching: indicates how long a cache may store the non-existence of a RR
- RIPE-203 has recommended values
  - http://www.ripe.net/ripe/docs/dns-soa.html

Format of NS records

```
$TTL 1d

@  1h  IN  SOA  ns1.example.net. brian.nsrc.org. (
             2004030300      ; Serial
             8h              ; Refresh
             1h              ; Retry
             4w              ; Expire
             1h )            ; Negative

       IN  NS  ns1.example.net.
       IN  NS  ns2.example.net.
       IN  NS  ns1.othernetwork.com.
```

- List all authoritative nameservers for the zone - master and slave(s)
- Must point to HOSTNAME not IP address

Format of other RRs

- IN A 1.2.3.4
- IN MX 10 mailhost.example.com.
  - The number is a "preference value". Mail is delivered to the lowest-number MX first
  - Must point to HOSTNAME not IP address
- IN CNAME host.example.com.
- IN PTR host.example.com.
- IN TXT "any text you like"

When you have added or changed a zone file:

- Check the serial number!
- **`named-checkzone example.com /etc/namedb/m/example.com`**
  - bind 9 feature
  - reports syntax errors; correct them!
- **`ndc reload`**
  - or: ndc reload example.com
- **`tail /var/log/messages`**

These checks are ESSENTIAL

- If you have an error in named.conf or a zone file, named will continue to run but not authoritative for the bad zone(s)
- You will be lame for the zone without realising it
- Slaves will not be able to contact the master
- Eventually (e.g. 4 weeks later) the slaves will expire the zone
- Your domain will stop working

Other checks you can do

- dig +norec @x.x.x.x example.com. soa
  - Check the AA flag
  - Check the master and all the slaves
  - Check the serial numbers match
- dig @x.x.x.x example.com. axfr
  - "Authority Transfer"
  - Requests a full copy of the zone contents over TCP, as slaves do to master
  - This will only work from IP addresses listed in the allow-transfer {...} section

So now you have working authoritative nameservers!

- But remember that none of this will work until you have *delegation* from the domain above
- That is, they put in NS records for your domain, pointing at your nameservers
- You have also put NS records within the zone file
- The two sets should match

TOP TEN ERRORS in authoritative nameservers

- All operators of auth nameservers should read RFC 1912
  - Common DNS Operational and Configuration Errors
- See also RFC 2182
  - Selection and Operation of Secondary DNS Servers

1. Serial number errors

- Forgot to increment serial number
- Incremented serial number, and then decremented it
- Used serial number greater than 2^32
- Impact:
  - Slaves do not update
  - Master and slaves have inconsistent data
  - Caches will sometimes get the new data and sometimes old - intermittent problem

2. Comments in zone files starting '#' instead of ';'

- Syntax error in zone file
- Master is no longer authoritative for the zone
- Slaves cannot check SOA
- Slaves eventually expire the zone, and your domain stops working entirely
- Use 'named-checkzone'
- Use 'tail /var/log/messages'

3. Other syntax errors in zone files

- e.g. omitting the preference value from MX records
- Same impact

4. Missing the trailing dot

```
; zone example.com.
@  IN  MX 10  mailhost.example.com

becomes

@  IN  MX 10  mailhost.example.com.example.com.
```

```
; zone 2.0.192.in-addr.arpa.
1  IN  PTR  host.example.com

becomes

1  IN  PTR  host.example.com.2.0.192.in-addr.arpa.
```

5. NS or MX records pointing to IP address

- They must point to hostnames, not IP addresses
- Unfortunately a few mail servers *do* accept IP addresses in MX records, so you may not see a problem with all remote sites
- accept IP addresses in MX records, so you may not see a problem with all remote sites
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6. Slave cannot transfer zone from master

- Access restricted by allow-transfer { ... } and slave not listed
- Or IP filters not configured correctly
- Slave will be lame (non-authoritative

7. Lame delegation

- You cannot just list any nameserver in NS records for your domain
- You must get agreement from the nameserver operator and they must configure it as a slave for your zone
- At best: slower DNS resolution and lack of resilience
- At worst: intermittent failures to resolve your domain

8. No delegation at all

- You can configure "example.com" on your nameservers but the outside world will not send requests to them until you have delegation
- The problem is hidden if your nameserver is acting both as your cache and as authoritative nameserver
- Your own clients can resolve www.example.com, but the rest of the world cannot

9. Out-of-date glue records

- See later

10. Not managing TTL correctly during changes

- e.g. if you have a 24 hour TTL, and you swing www.example.com to point to a new server, then there will be an extended period when some users hit one machine and some hit the other
- Follow the procedure:
  - Reduce TTL to 10 minutes
  - Wait at least 24 hours
  - Make the change
  - Put the TTL back to 24 hours

?

Final topics

- Reverse DNS
- How to delegate a subdomain

How to manage reverse DNS

- If you have at least a /24 of address space then your provider will arrange delegation to your nameservers
- e.g. your netblock is 192.0.2.0/24
- Set up zone 2.0.192.in-addr.arpa.
- If you have more than a /24 then each /24 will be a separate zone
- If you are lucky enough to have a /16 then it will be a single zone
  - 172.16.0.0/16 is 16.172.in-addr.arpa.

Example: 192.0.2.0/24

```
zone "2.0.192.in-addr.arpa" {
   type master;
   file "m/192.0.2";
   allow-transfer { ... };
};
```

/etc/namedb/m/192.0.2

```
@  IN  SOA   ....
   IN  NS    ns0.example.com.
   IN  NS    ns0.othernetwork.com.

1  IN  PTR   router-e0.example.com.
2  IN  PTR   ns0.example.com.
3  IN  PTR   mailhost.example.com.
4  IN  PTR   www.example.com.
; etc
```

How it works

- e.g. for 192.0.2.4, the remote host will lookup 4.2.0.192.in-addr.arpa. (PTR)
- The query follows the delegation tree as normal. If all is correct, it will reach your nameservers and you will reply
- Now you can see why the octets are reversed
  - The owner of a large netblock (192/8) can delegate reverse DNS in chunks of /16. The owner of a /16 can delegate chunks of /24

There is nothing special about reverse DNS

- You still need master and slave(s)
- It won't work unless you get delegation from above
- DO make sure that if you have PTR records for an IP address, that the hostname resolves back to the same IP address
  - Otherwise many sites on the Internet will believe you are spoofing reverse DNS and will refuse to let you connect

What if you have less than /24?

- Reverse DNS for the /24 has been delegated to your upstream provider
- Option 1: ask your provider to insert PTR records into their DNS servers
  - Problem: you have to ask them every time you want to make a change
- Option 2: follow the procedure in RFC2317
  - Uses a trick with CNAME to redirect PTR requests for your IPs to your nameservers

e.g. You own 192.0.2.64/29

```
; In the provider's 2.0.192.in-addr.arpa zone file
64    IN  CNAME  64.64/29.2.0.192.in-addr.arpa.
65    IN  CNAME  65.64/29.2.0.192.in-addr.arpa.
66    IN  CNAME  66.64/29.2.0.192.in-addr.arpa.
67    IN  CNAME  67.64/29.2.0.192.in-addr.arpa.
68    IN  CNAME  68.64/29.2.0.192.in-addr.arpa.
69    IN  CNAME  69.64/29.2.0.192.in-addr.arpa.
70    IN  CNAME  70.64/29.2.0.192.in-addr.arpa.
71    IN  CNAME  71.64/29.2.0.192.in-addr.arpa.
64/29 IN  NS   ns0.customer.com.
64/29 IN  NS   ns1.customer.com.
```

Set up zone "64/29.2.0.192.in-addr.arpa" on your nameservers

```
65    IN  PTR    www.customer.com.
66    IN  PTR    mailhost.customer.com.
; etc
```

How do you delegate a subdomain?

- In principle straightforward: just insert NS records for the subdomain, pointing at someone else's servers
- If you are being careful, you should first *check* that those servers are authoritative for the subdomain
  - using "dig" on all the servers
- If the subdomain is managed badly, it reflects badly on you!

Zone file for "example.com"

```
$TTL 1d
@  1h  IN  SOA  ns1.example.net. brian.nsrc.org. (
             2004030300     ; Serial
             8h             ; Refresh
             1h             ; Retry
             4w             ; Expire
             1h )           ; Negative

       IN  NS  ns1.example.net.
       IN  NS  ns2.example.net.
       IN  NS  ns1.othernetwork.com.

; My own zone data
       IN  MX  10  mailhost.example.net.
www    IN  A   212.74.112.80

; A delegated subdomain
subdom IN  NS  ns1.othernet.net.
       IN  NS  ns2.othernet.net.
```

There is one problem here:

- NS records point to names, not IPs
- What if "example.com" is delegated to "ns.example.com"?
- Someone who is in the process of resolving (say) www.example.com has to first resolve ns.example.com
- But they cannot resolve ns.example.com without first resolving ns.example.com !!

In this case you need "glue"

- A "glue record" is an A record for the nameserver
- Example: consider the .com nameservers

```
; this is the com. zone

example          NS   ns.example.com.
                 NS   ns.othernet.net.

ns.example.com.  A   192.0.2.1     ; GLUE RECORD
```

Don't put in glue records except where necessary

- In the previous example, "ns.othernet.net" is not a subdomain of "example.com". Therefore no glue is needed.
- Out-of-date glue records are a big source of problems
  - e.g. after you have renumbered your nameserver to another network
- Difficult to debug, requires "dig +norec"

Example where a glue record IS needed

```
; My own zone data
       IN  MX  10  mailhost.example.net.
www    IN  A   212.74.112.80

; A delegated subdomain
subdom      IN  NS  ns1.subdom          ; needs it
            IN  NS  ns2.othernet.net.   ; doesn't
ns1.subdom  IN  A   192.0.2.4
```

Checking for glue records

- dig +norec @a.gtld-servers.net. www.as9105.net. a
- Look for A records in the "Additional" section whose TTL does not count down

```
$ dig +norec @a.gtld-servers.net. www.as9105.net. a
 ...
;; flags: qr; QUERY: 1, ANSWER: 0, AUTHORITY: 2, ADD'L: 1
;; QUERY SECTION:
;;      www.as9105.net, type = A, class = IN

;; AUTHORITY SECTION:
as9105.net.             2D IN NS        ns0.as9105.com.
as9105.net.             2D IN NS        ns0.tiscali.co.uk.

;; ADDITIONAL SECTION:
ns0.as9105.com.         2D IN A         212.139.129.130
```

DNS: overall summary

- Distributed database of RRs
- Three roles: resolver, cache, authoritative
- Resolver statically configured with the nearest cache(s)
  - e.g. /etc/resolv.conf
- Caches statically configured with a list of root nameservers
  - zone type "hint", /var/named/named.ca

DNS: overall summary (cont)

- Root nameservers contain delegations (NS records) to gtld or country-level servers (com, uk etc)
- Further delegations to subdomains
- Cache finally locates an authoritative server containing the RRs we require
- Errors in delegation or in configuration of authoritative servers result in no answer or inconsistent answers