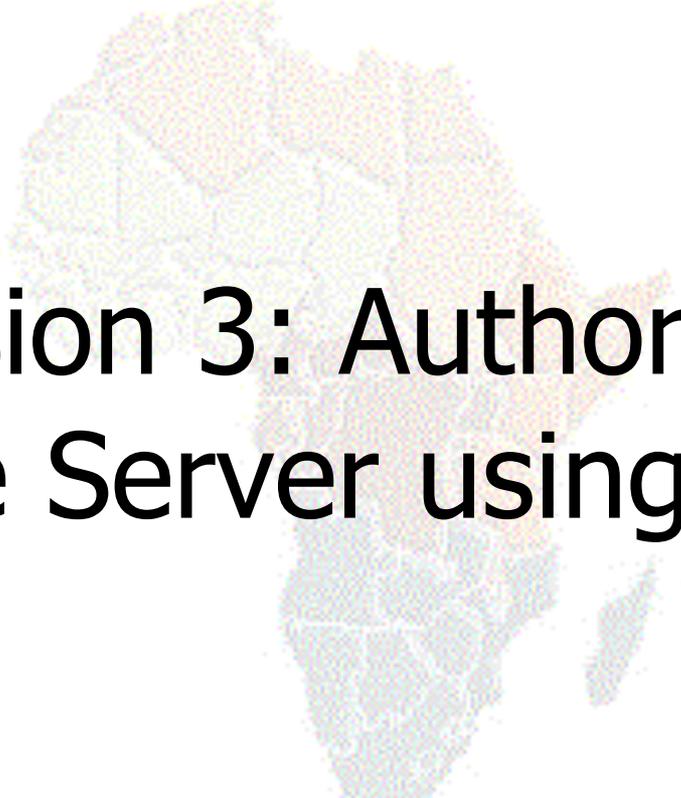# Domain Name System (DNS)

Session 3: Authoritative Name Server using BIND9

Joe Abley

AfNOG Workshop, AIS 2017, Nairobi

Recap

- DNS is a distributed database

- Stub asks Resolver for information

- Resolver traverses the DNS delegation tree to find Authoritative nameserver which has the information requested

- Bad configuration of authoritative servers 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 (Slave(s))

- Outside world cannot tell the difference between master and slave
    - NS records are returned in random order for equal load sharing

- Used to be called "primary" and "secondary"

Slaves connect to Master to retrieve copy of zone data

- The master does not "push" data to the slaves
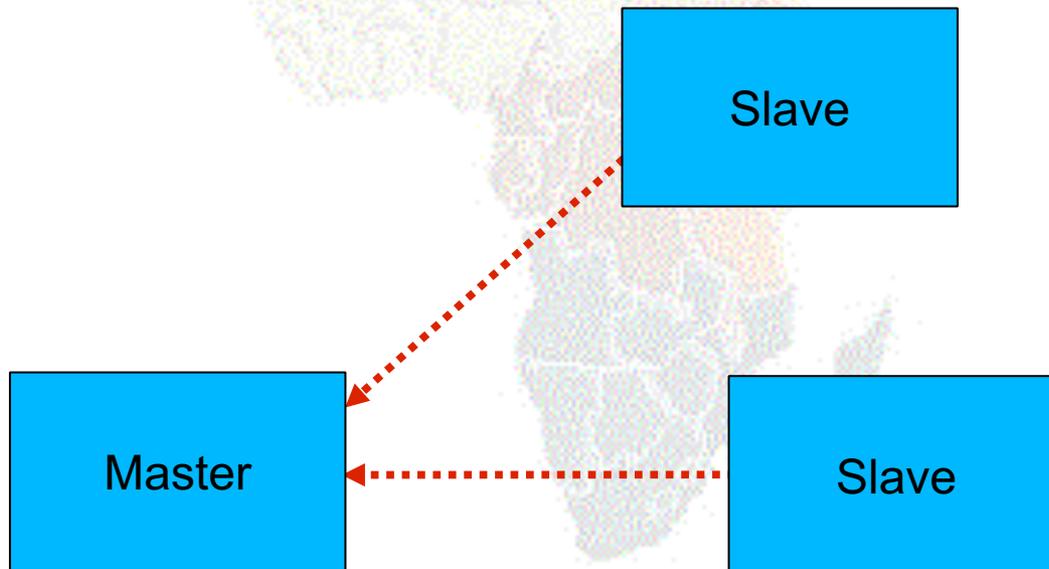
When does replication take place?

- 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 23rd April 2007, the serial number will be 2008052700. If you change it again on the same day, it will be 2008052701.

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 a method to fix this problem

- At worst, you can 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. 20080527000 (note extra digit)

  = 4ACE48698 (hex)

  =   ACE48698 (32 bits)

  = 2900657816

- If you make this mistake, then later correct it, the serial number will have decreased

Configuration of Master

- /etc/namedb/named.conf points to <u>zone file</u> (manually created) containing your RRs

- Choose a logical place to keep them
  - e.g. /usr/local/etc/namedb/master/tiscali.co.uk
  - or /usr/local/etc/namedb/master/uk.co.tiscali

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

Configuration of Slave

- named.conf points to IP address of master and location where zone file should be created

- Zone files are transferred automatically

- Don't touch them!

```
zone "example.com" {
        type slave;
        masters { 192.188.58.126; };
        file "slave/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

  – /usr/local/etc/namedb/master/

  – /usr/local/etc/namedb/slave/

    - (also, the slave directory can have appropriate permissions so that the daemon can create files)

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; };
};
```

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
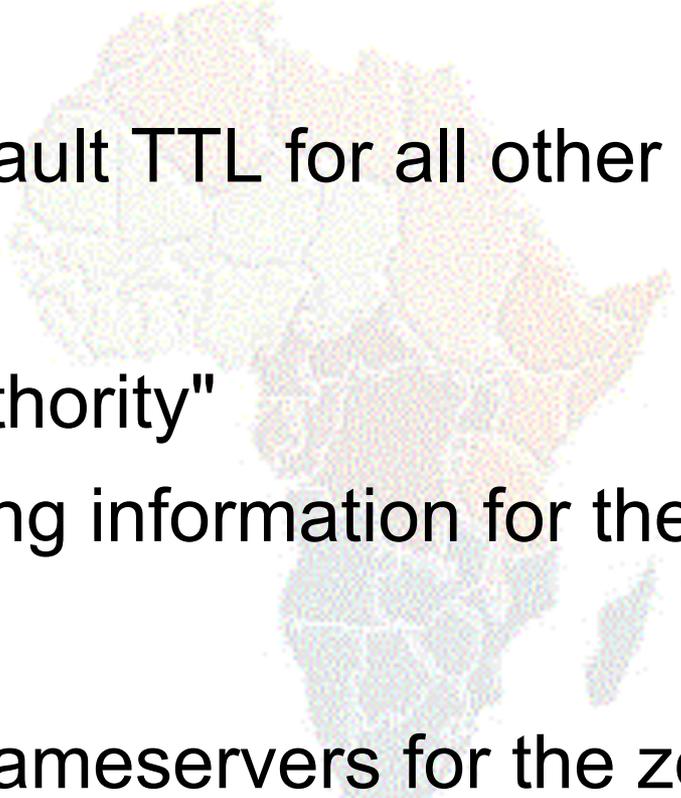
Format of a Resource Record

```
www        3600   IN      A       212.74.112.80
Domain     TTL    Class   Type    Data
```

- 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: e.g. 60s, 30m, 4h, 1w2d

- If you omit the TTL, uses 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. joe.pooh.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 the SOA record

- `ns1.example.net.`
  - hostname of master nameserver
- `jabley.hopcount.ca.`
  - E-mail address of responsible person, with "@" changed to dot, and trailing 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 the 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

- List all authoritative nameservers for the zone - master and slave(s)

- Must point to HOSTNAME not IP address

```
$TTL 1d

@   1h   IN   SOA   ns1.example.net. joe.pooh.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 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:

- Remember to increase the serial number!

- `named-checkzone example.com \`

  `/usr/local/etc/namedb/master/example.com`

  – bind 9 feature

  – reports zone file syntax errors; correct them!

- `named-checkconf`

  – reports errors in named.conf

- `rndc reload`

  – or: `rndc reload example.com`

These checks are ESSENTIAL

- If you have an error in named.conf or a zone file, named may continue to run but will not be 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

  - Repeat for 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 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

Any questions?

?

TOP TEN ERRORS in authoritative nameservers

- All operators of auth nameservers should read RFC 1912

    – Common DNS Operational and Configuration Errors

- And also RFC 2182

    – Selection and Operation of Secondary DNS servers

1. Serial number errors

- Forgot to increment serial number

- Incremented serial number, 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 addresses

- 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

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)
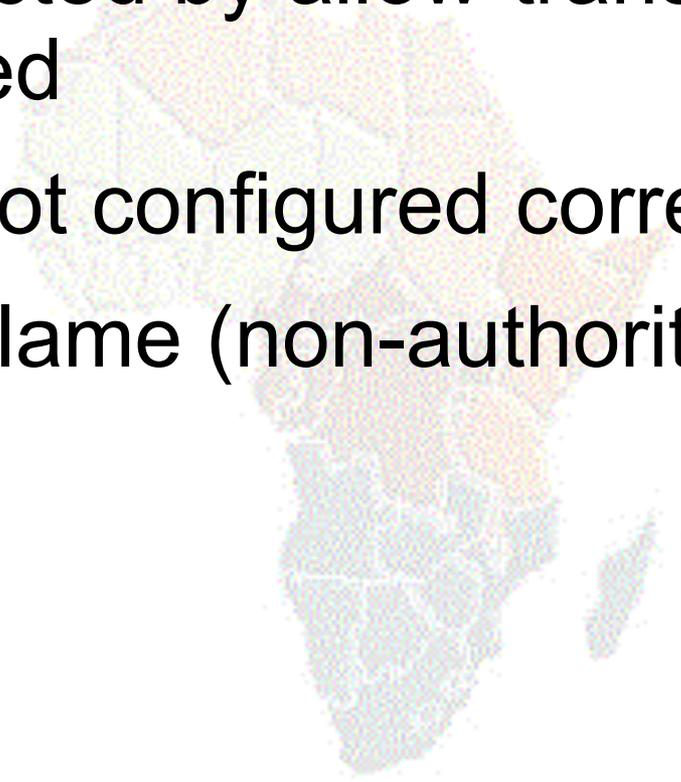
7. Lame delegation

- 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

Practical

- Create a new domain

- Set up master and slave nameservice

- Obtain delegation from the domain above

- Test it