

Domain Name System (DNS)

Session 3: Authoritative Name Server using BIND9



Michuki Mwangi

AfNOG Workshop, AIS 2019, Kampala

Recap

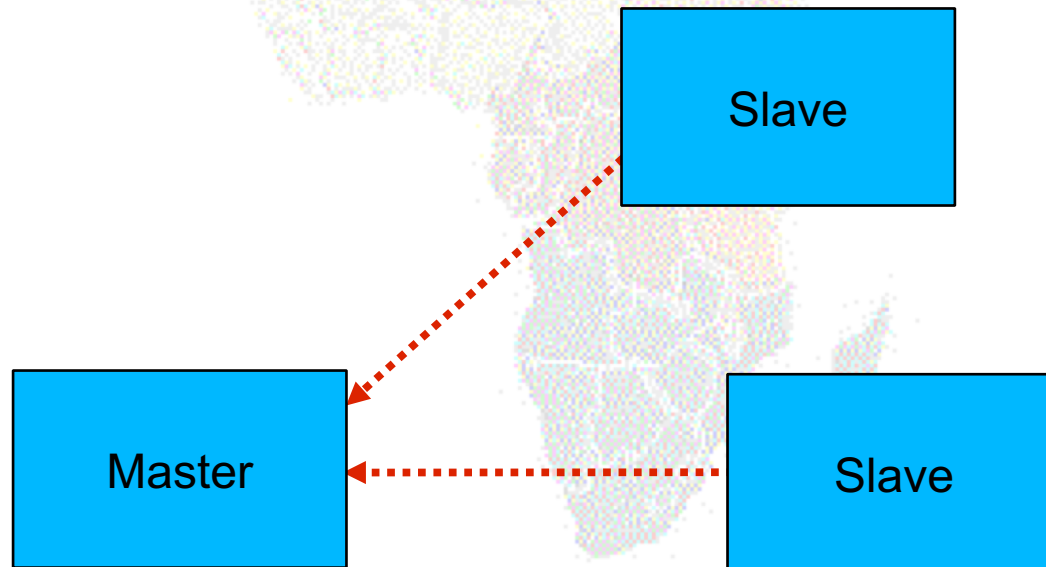
- DNS is a distributed database
- Stub asks Resolver for information
- Resolver traverses the DNS delegation tree to find Authoritative nameserver which has the information requested
- Bad configuration of authoritative servers can result in broken domains

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/bind/named.conf.local points to zone files (manually created) containing your RRs
- Choose a logical place to keep them
 - e.g. /var/cache/bind/master/tiscali.co.uk
 - or /var/cache/bind/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

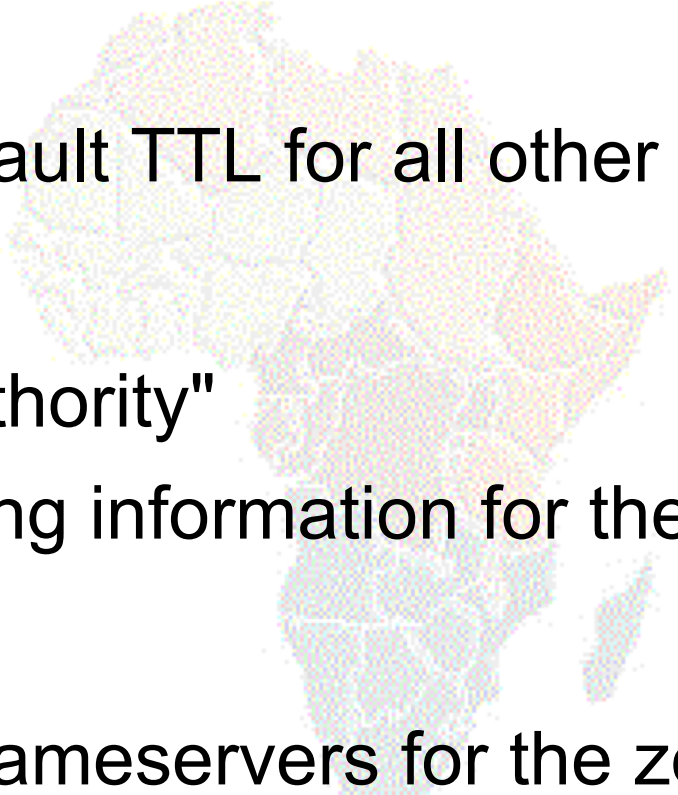
- It's perfectly OK for one server to be Master for some zones and Slave for others
- That's why we recommend keeping the files in different directories
 - /var/cache/bind/master/
 - /var/cache/bind/slave/
 - (also, the slave directory can have appropriate permissions so that the daemon can create files)

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
<i>Domain</i>	<i>TTL</i>	<i>Class</i>	<i>Type</i>	<i>Data</i>

- 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.othertextwork.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.othertext.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 \`
`/var/cache/bind/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`
- `tail /var/log/messages`

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
```



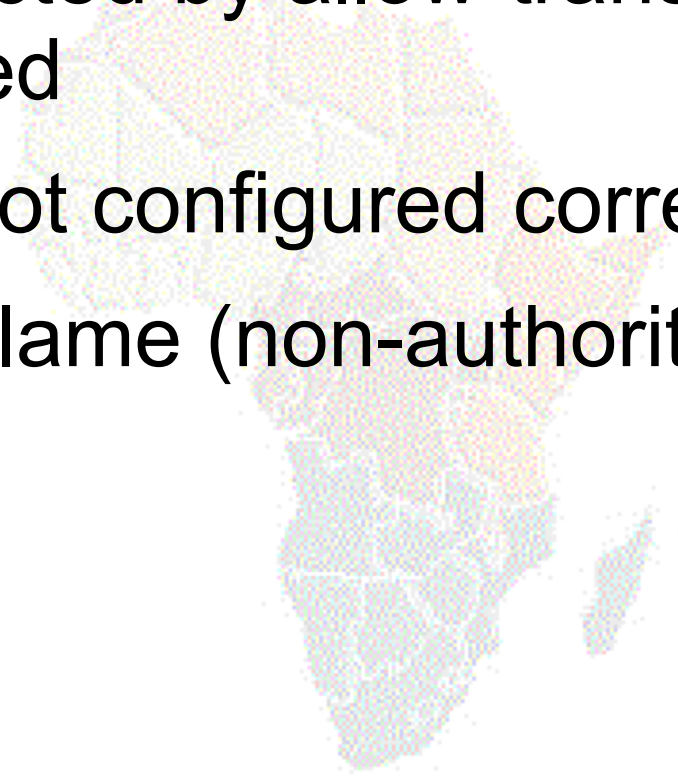
becomes

```
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
- 