BIND 9

(Part 5 - Dynamic DNS Update Security, TSIG and Catalog-Zones)

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Welcome

Welcome to part five of our BIND 9 webinar series

In this Webinar

- Authenticating dynamic updates with TSIG
- Access Control Lists for dynamic DNS updates
- Catalog-Zones
- Hands-On dynamic zone management

Transaction Signatures (TSIG)

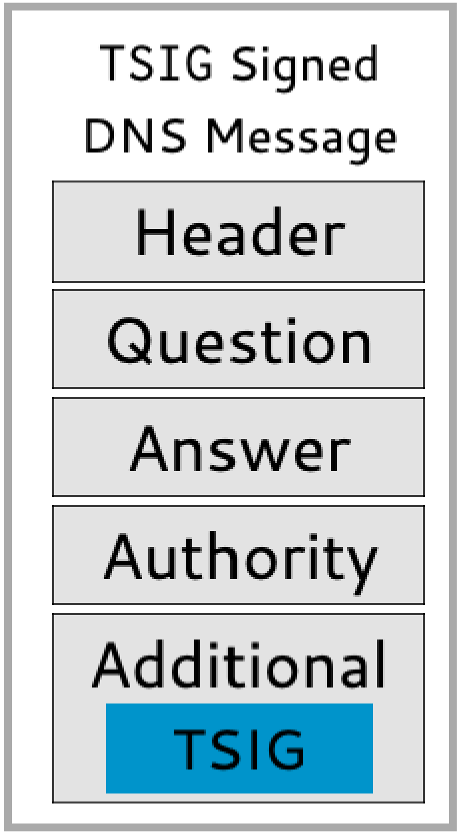
What is TSIG

- DNS Transaction Signatures (TSIG) are defined in RFC 8945 "Secret Key Transaction Authentication for DNS (TSIG)".
- TSIGs secure the communication between two endpoints.
    - TSIGs use HMAC (i.e. symmetric encryption).
    - Trust is required between all systems (all endpoints).
    - Securely installing the key on all systems is external to DNS.
    - The endpoints must have reasonably accurate clocks.
- TSIG is independent of DNSSEC.

TSIG use cases

- TSIG use cases:
    - DNS dynamic updates (client / dhcp-server <-> server)
    - BIND server control messages (rndc <-> server)
    - Server communication (zone transfers, notifies, queries, …)
    - Queries (client <-> server): Impractical and rare.

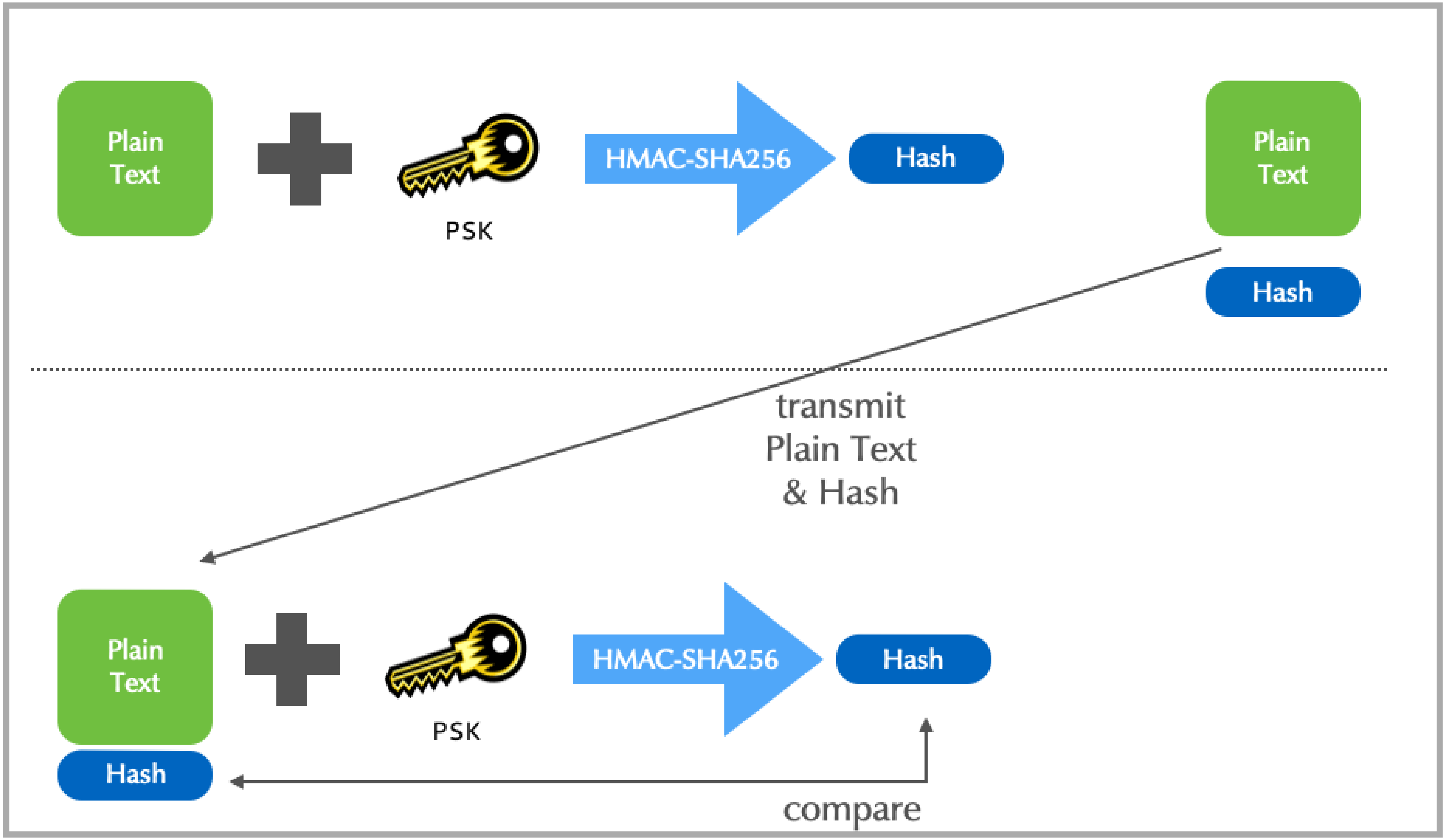
TSIG implementation



TSIG implementation

- A TSIG is a dynamically generated pseudo-RR.
  - TSIG RRs are **not** found in zone files, but do have the standard format of RRs.
  - TSIGs are never cached (TTL=0).
  - A TSIG RR is sent in the additional section.
  - A TSIG assures the integrity and authenticity of the entire DNS message.

TSIG operation



TSIG algorithms

- TSIG offers a choice of HMAC algorithms:
  - ~~hmac-md5~~ (deprecated)
  - ~~hmac-sha1~~ (deprecated)
  - hmac-sha224
  - **hmac-sha256**
  - hmac-sha384
  - hmac-sha512

TSIG algorithms

- All the algorithms take a random length input and create a fixed length fingerprint.

Algorithm	fingerprint length
MD5	16 byte
SHA1	20 byte
SHA256	32 byte
SHA512	64 byte

Generating TSIG keys

- These BIND tools generate HMAC (TSIG) keys:
  - `rndc-confgen`: designed for keys for remote control.
  - `ddns-confgen`: designed for keys for DDNS/nsupdate.
  - `tsig-keygen`: a generic tool HMAC key creation. It was introduced in BIND 9.10.

Generating TSIG keys

- BIND 9.10 comes with the new command `tsig-keygen` to generate TSIG-keys.

```
% tsig-keygen my-key
key "my-key" {
        algorithm hmac-sha256;
        secret "EvfRifkexW+81OmqFJSc9Z07IBVZxvZbKVJBhF8BwHo=";
};
```

TSIG for Remote Control (RNDC)

- BIND's remote control tool, `rndc`, may use TSIG for authentication.
  - `rndc-confgen` creates a template configuration including keys.

TSIG to Secure Zone Transfer

- A TSIG can be used to secure zone transfers (e.g. primary to secondary).
    - The key must be configured on the server providing the zone and on the server transferring it in.

```
key prim-sec-example.com {
       algorithm hmac-sha256;
       secret "pDCQLRGpPN0h9ksqHBnGBra3U15QwlpQI5aPNO5d5xE=";
};

zone "example.com" {
 type primary;
 file "example.com";
 allow-transfer { key prim-sec-example.com; };
};
```

TSIG to Secure Zone Transfer

- Note that both the key and the key-name must match on the sender and receiver.

```
key prim-sec-example.com {
       algorithm hmac-sha256;
       secret "pDCQLRGpPN0h9ksqHBnGBra3U15QwlpQI5aPNO5d5xE=";
};

# secondary zone
zone "example.com" {
 type secondary;
 file "example.com";
 masters { 192.0.2.53 key prim-sec-example.com; };
};
```

TSIGs for Securing All Communication Between DNS Servers

- TSIGs can be used to secure all communication between servers (queries, notifies, zone-transfers …):

```
key server1-server2 {
        algorithm hmac-sha256;
        secret "pDCQLRGpPN0h9ksqHBnGBra3U15QwlpQI5aPNO5d5xE=";
};

server 192.0.2.53 {   # <-- IP Address of the remote DNS server
  keys { server1-server2; };
};
```

dynamic update security with ACLs and TSIG keys

- On a primary authoritative server, `allow-update {};` enables DDNS.
    - It also limits the updates to specifics keys or addresses.
    - in part 1 of this webinar on dynamic DNS zone management, we've used IP addresses to authenticate dynamic update sources
    - using IP addresses for authentication is weak security, as the source address of UDP based DNS update messages can be spoofed
    - attackers might be able to make unauthorized changes to the DNS zone content

dynamic update security with ACLs and TSIG keys

- Using a symmetric key (TSIG) is more secure and recommended practice:

```
key dynamic-update-example.com {
          algorithm hmac-sha256;
          secret "pDCQLRGpPN0h9ksqHBnGBra3U15QwlpQI5aPNO5d5xE=";
};

zone "example.com" {
       type primary;
       file "example.com";
       allow-update { key dynamic-update-example.com; };
};
```

Dynamic Update Policies

Fine Grained control for dynamic updates

- With `allow-update`, any change to the primary zone is secured by a key
  - The key can update the whole zone
  - Often more fine grained control is required
- The option `update-policy` can be used to provide a more flexible access control for dynamic updates
  - `update-policy` is mutually exclusive with `allow-update`

Update-Policy configuration syntax

- With `update-policy` we can `grant` or `deny` the resource record (RR) *identity* making changes
  - the *identity* is the name of a TSIG key

```
update-policy { grant identity matchtype tname [rr]; };
update-policy { deny  identity matchtype tname [rr]; };
```

Update-Policy matchtype

- The *matchtype* controls which domain names can be updated with a TSIG key

```
update-policy { grant identity matchtype tname [rr]; };
update-policy { deny  identity matchtype tname [rr]; };
```

Matchtype (literal)	Modification available
name	Target name (`tname`) only
subdomain	Subdomains of `tname`
zonesub	Subdomains of zone in which the `update-policy` statement appears
self	Own name (TSIG key name) only
selfsub	Updates own name and sub-domains of TSIG key name
selfwild	Only subdomains of self can be updated
wildcard	Wildcard expansion

Update-Policy matchtype (Microsoft and Kerberos)

- The `matchtype` can be used to create rules for updates from Microsoft AD or Kerberos signed updates

```
update-policy { grant identity matchtype tname [rr]; };
update-policy { deny  identity matchtype tname [rr]; };
```

Matchtype (literal)	Modification available
ms-self	allows a Microsoft client to update its own hostname
ms-selfsub	allows a Microsoft client to update its own hostname and subdomains
ms-subdomain	allows a Microsoft client to update any records inside its domain
krb5-self	allows a Kerberos client to update its own hostname
krb5-selfsub	allows a Kerberos client to update its own hostname and subdomains
krb5-subdomain	allows a Kerberos client to update any records inside its domain

Update-Policy matchtype (Microsoft and Kerberos)

- The `matchtype` can also be used to create rules for updates matching IP-addresses via TCP or 6to4 prefix names. The decision about update permission can also be delegated to an external process:

```
update-policy { grant identity matchtype tname [rr]; };
update-policy { deny  identity matchtype tname [rr]; };
```

Matchtype (literal)	Modification available
tcp-self	Allows updates via TCP that match the domain name of the sender's IP address reverse name resolution
6to4-self	Allows the name matching a 6to4 IPv6 prefix to be updated via TCP from the 6to4 network or from the corresponding IPv4 address
external	Delegates the decision of whether to allow a given update to an external daemon

⚠ **It is theoretically possible to spoof TCP sessions.**

Update-Policy target name

```
update-policy { grant identity matchtype tname [rr]; };
update-policy { deny  identity matchtype tname [rr]; };
```

- The target name `tname` defines the domain name or start of domain name-space that can be updated by this TSIG key
  - The target name can be a wild card

Update Policy Resource Record list

```
update-policy { grant identity matchtype tname [rr]; };
update-policy { deny  identity matchtype tname [rr]; };
```

- `rr`: an optional space-delimited list of the resource record types on which updates are allowed (or denied)
- Keyword `ANY` matches any resource record type except `NSEC` and `NSEC3`
- If no record type is specified, it matches all record types except RRSIG, NS, SOA, NSEC, and NSEC3.

Example: Changing only record for a specific domain name

- holder of `update-key` can change `A` and `AAAA` records of `www.example.com` (and nothing below)

```
update-policy { grant update-key name www.example.com A AAAA; };
```

Example: Match TSIG key name to record

- The dynamic DNS update configuration below allows a system with a TSIG key with its own name to update its own IPv6 AAAA record
  - if the TSIG key is named `www.example.com`, that key can change the IPv6 address of the domain name `www.example.com`

```
update-policy { grant * self * AAAA; };
```

Example: A TSIG key to change all records below a sub-domain

- The holder of the TSIG key with the name `superkey` can change anything at or below `example.org`:

```
update-policy { grant superkey subdomain example.org ANY; };
```

automatic DNS provisioning with Catalog-Zones

Provisioning New Zones

- Adding or deleting new zones can be a challenge.
- In addition to updating the primary, every secondary needs to be modified.
- It is intensive work for installations with many secondaries, or with frequent zone additions & deletions.

Provisioning New Zones - Solutions

- Many organizations have written scripts (or use tools like Ansible or SaltStack) for automatically modifying secondary DNS servers.
- A catalog zone provisions normal zones using standard DNS content and communication.
  - They are an ISC creation, new in BIND 9.11 (2016), and are being standardized by the IETF.
  - Internet draft (RFC "work in progress"): DNS Catalog Zones / February 2021
  - in addition to BIND 9, KnotDNS already has a fully functional implementation since version 3.0.0 (September 2020)
  - PowerDNS has a proof of concept external program called PowerCATZ (https://github.com/PowerDNS/powercatz/), that can process DNS Catalog Zones

Catalog Zone

- A catalog zone works like a normal DNS zone.
- A catalog zone is maintained on the primary server.
- It contains zone names and configuration metadata that should exist on secondaries.
- Zones added to the catalog zone are automatically provisioned on secondaries.
  - Zones in a catalog zone are member zones.

Prerequisites for Catalog Zones

- A primary DNS server hosting a catalog zone, does not need to be updated to BIND 9.11 or later.
  - This is because catalog zones use standard DNS content and communication.
  - Secondaries need to be updated so they will use a catalog zone's content as provision information.
- A secondary will have a catalog zone for each primary.
  - Assuming the primary is configured with a catalog zone.

Catalog Zone: named.conf:Primary

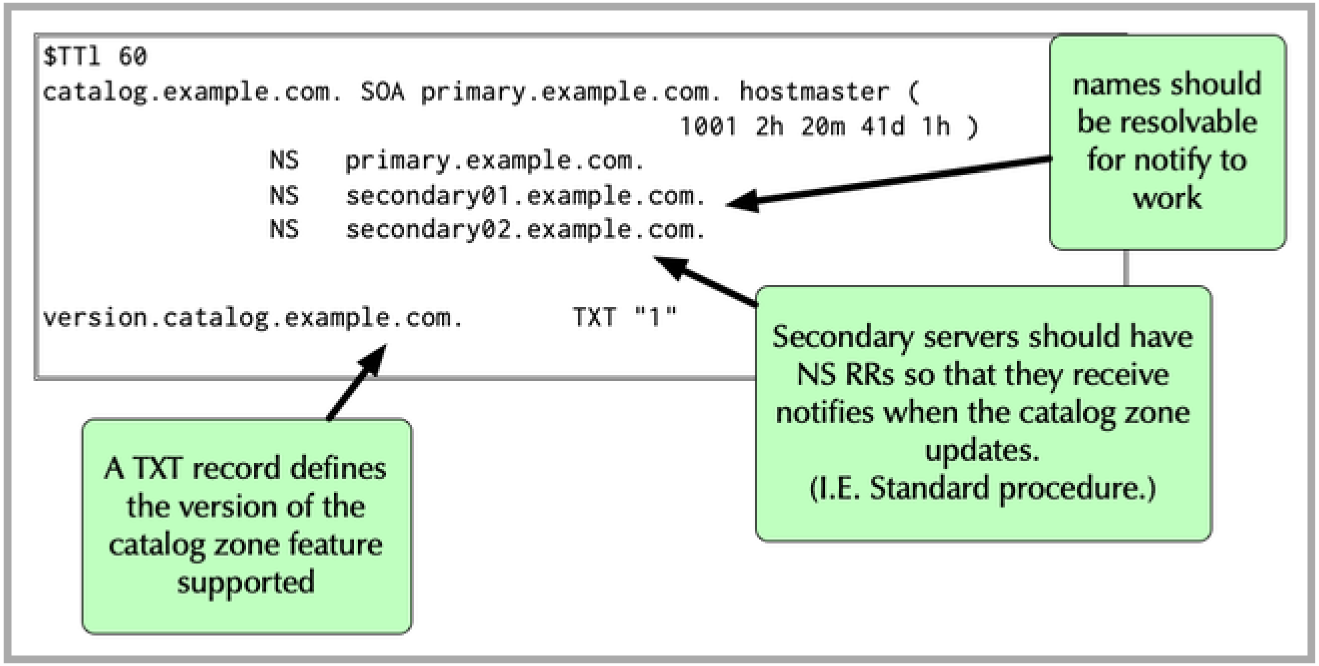
- In a primary's `named.conf`, a catalog zone is a completely normal zone.
- It can be a static (managed via text editor) or dynamic zone
- There are no special requirements for the configuration, nor for the name of the zone. However, the name of the catalog zone should not collide with any domain name used in the network (Internet and private DNS)

```
zone "catalog.example.com" {
         type primary;
         file "catalog.example.com";
};
```

Catalog Zone: Zonefile:Primary

- A catalog zone has a PTR RR for each member zone. In the catalog zone shown, no member zones are provisioned yet. It is empty. (It has no PTR RRs).
- It must also contain a TXT record with the version number of the catalog zone protocol implementation
  - Version 1: the catalog zone protocol as it has been implemented in BIND 9.11
  - Version 2: the catalog zone protocol as described in the Internet Draft and implemented in BIND 9.16
  - DNS server software will ignore catalog zones with a version number it does not support

Catalog Zone: Zonefile:Primary



```
$TTl 60
catalog.example.com. SOA primary.example.com. hostmaster (
                                             1001 2h 20m 41d 1h )
                   NS    primary.example.com.
                   NS    secondary01.example.com.
                   NS    secondary02.example.com.

version.catalog.example.com.        TXT "1"
```

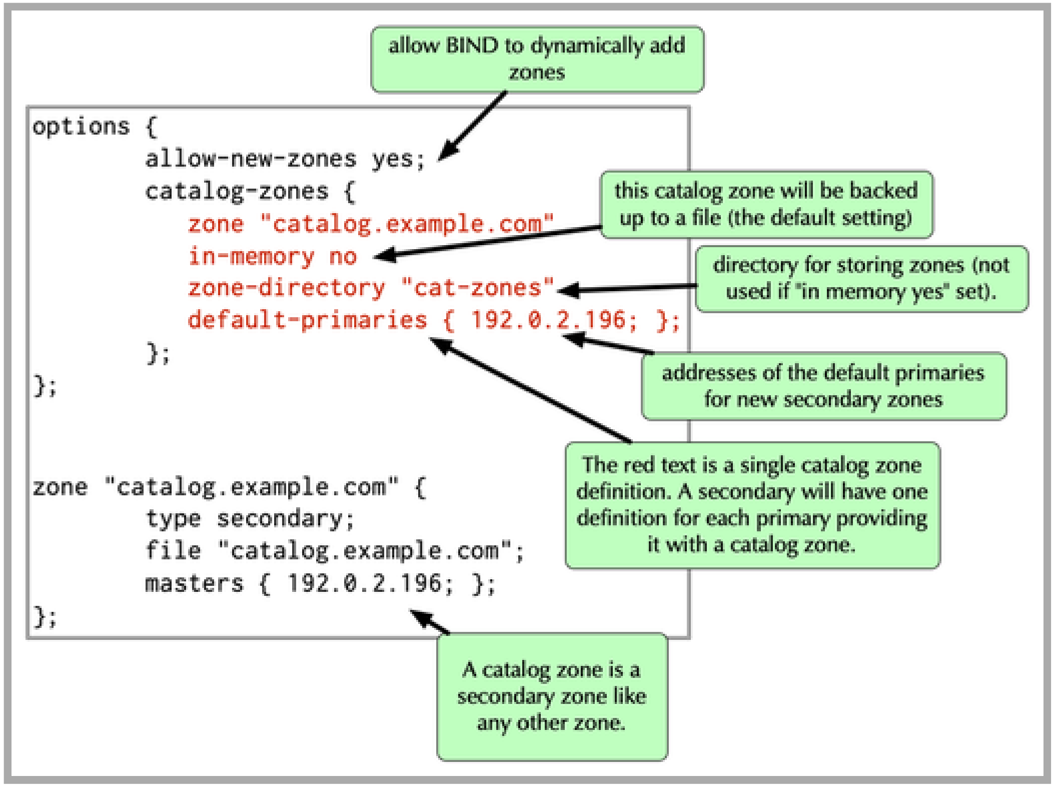
names should be resolvable for notify to work

Secondary servers should have NS RRs so that they receive notifies when the catalog zone updates.
(I.E. Standard procedure.)

A TXT record defines the version of the catalog zone feature supported

Catalog Zone: named.conf:Secondary

- Configuration for catalog zones is found on secondaries.



```
options {
        allow-new-zones yes;
        catalog-zones {
           zone "catalog.example.com"
           in-memory no
           zone-directory "cat-zones"
           default-primaries { 192.0.2.196; };
        };
};


zone "catalog.example.com" {
        type secondary;
        file "catalog.example.com";
        masters { 192.0.2.196; };
};
```

allow BIND to dynamically add zones

this catalog zone will be backed up to a file (the default setting)

directory for storing zones (not used if "in memory yes" set).

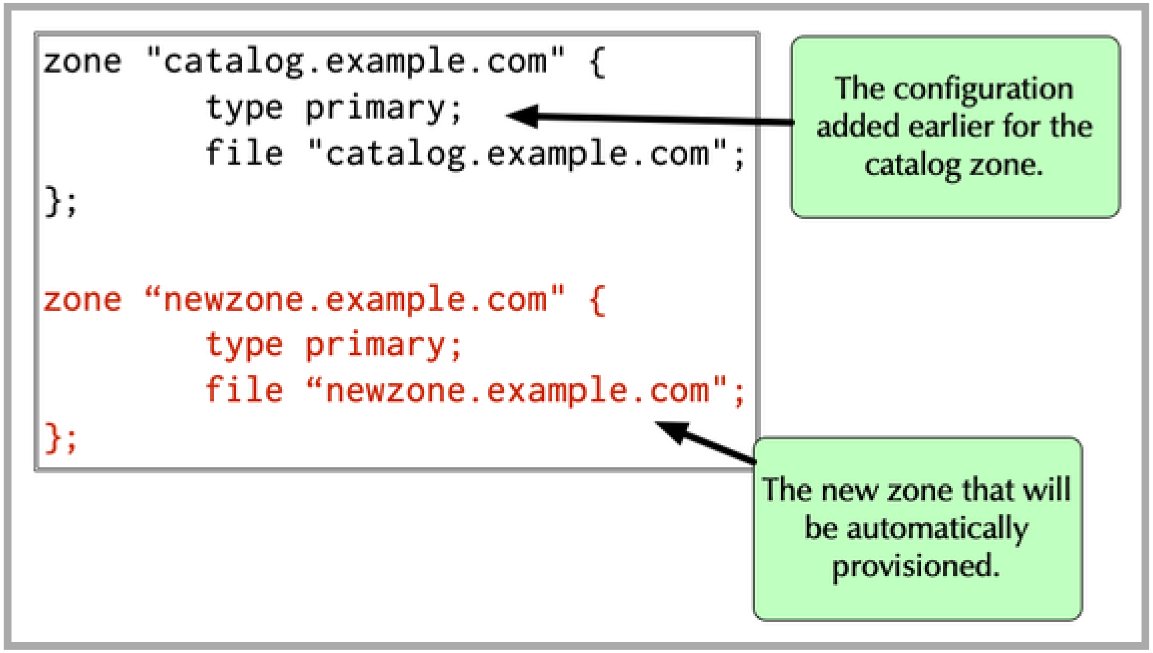
addresses of the default primaries for new secondary zones

The red text is a single catalog zone definition. A secondary will have one definition for each primary providing it with a catalog zone.

A catalog zone is a secondary zone like any other zone.

Provisioned Member Zone

- The zone file for a member zone is created as normal on the primary, just as is done with any zone (not shown). It is added to `named.conf` just like any other zone



```
zone "catalog.example.com" {
        type primary;
        file "catalog.example.com";
};

zone “newzone.example.com" {
        type primary;
        file “newzone.example.com";
};
```

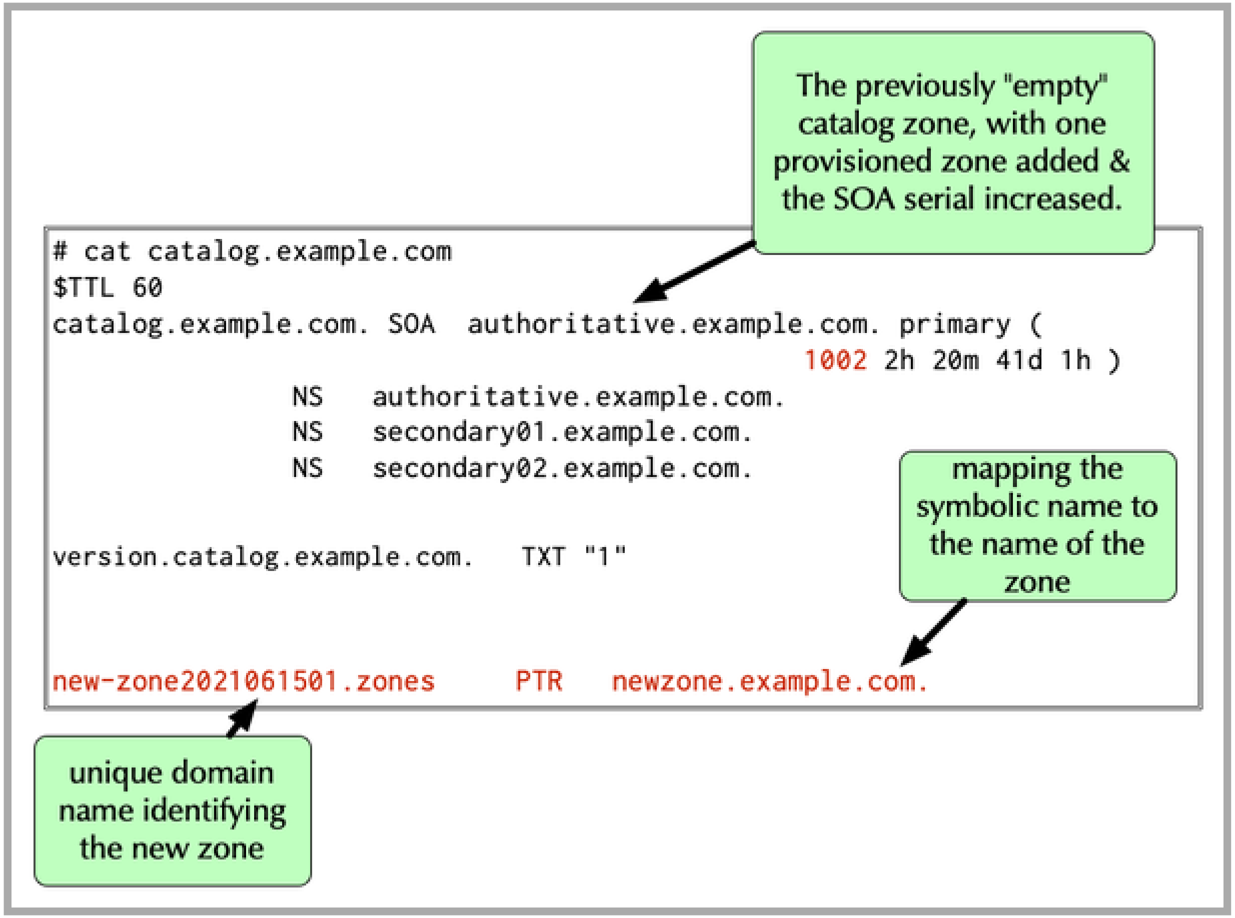
The configuration added earlier for the catalog zone.

The new zone that will be automatically provisioned.

registering a new zone in the catalog

- the new zone needs to be registered in the catalog zone
- registration happens with a `PTR` (Pointer) record where the data part of that record is the zone name (`newzone.example.com` in this example)
  - the domain name of the record must be a unique name (for example the SHA1 hash of the new zone's name), the label `zones` and the domain name of the catalog zone (`new-zone20210615.zones.catalog.example.com.` in the example)

registering a new zone in the catalog



```
# cat catalog.example.com
$TTL 60
catalog.example.com.  SOA  authoritative.example.com. primary (
                                                   1002 2h 20m 41d 1h )
               NS   authoritative.example.com.
               NS   secondary01.example.com.
               NS   secondary02.example.com.

version.catalog.example.com.   TXT "1"


new-zone2021061501.zones     PTR   newzone.example.com.
```

The previously "empty" catalog zone, with one provisioned zone added & the SOA serial increased.

mapping the symbolic name to the name of the zone

unique domain name identifying the new zone

Provisioning Success

- The secondary automatically serves the new member zone.
- Updates to the member zone will automatically be transferred to the secondary.
    - This is with normal methods (NOTIFY, IXFR, etc).
- Additional zones added to the catalog zone will also be automatically provisioned on the secondaries.
- A zone removed from the catalog zone will be removed by the secondaries.
    - A zone backup file on a secondary will be deleted.

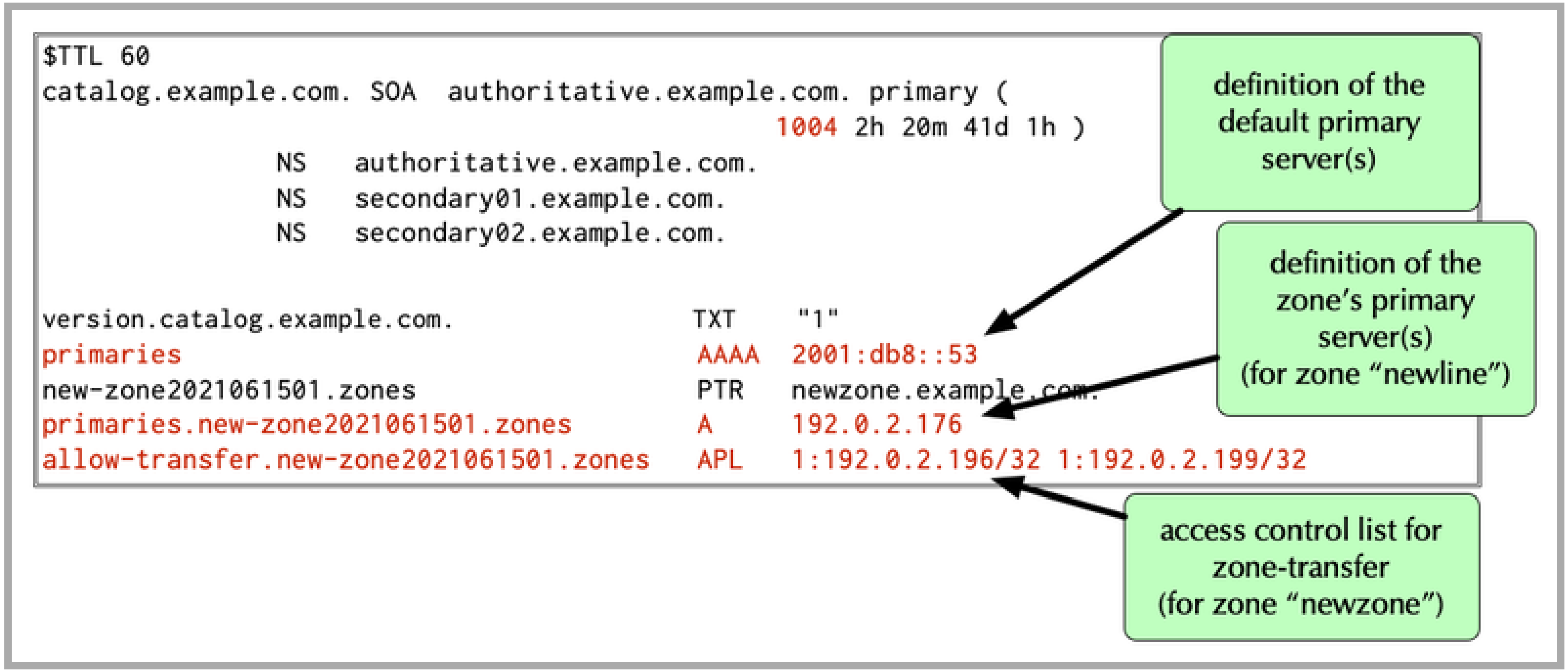
additional zone block configuration

- Catalog zones can contain configuration options for the new zone block (like Access Control Lists, list of `primaries`
- Options can be specified global for the whole catalog zone, or specific for each zone listed in the catalog zone etc.
- Details can be found in the BIND Administrator Referenc Manual: https://downloads.isc.org/isc/bind9/9.16.16/doc/arm/html/advanced.html#catalo zones

additional zone block configuration

- `primaries`: this option sets one or more primary DNS servers for the secondary zone. Primaries can be defined as IPv4 A or IPv6 AAAA records.
- `allow-query`: this option defines the `allow-query` ACL. The ACLs are defined with the help of the `APL` Resource record (see RFC 3123 "A DNS RR Type for Lists of Address Prefixes (APL RR)")
- `allow-transfer`: this option defines the `allow-transfer` ACL. It also uses the APL record.

additional zone block configuration



```
$TTL 60
catalog.example.com. SOA  authoritative.example.com. primary (
                                         1004 2h 20m 41d 1h )
               NS   authoritative.example.com.
               NS   secondary01.example.com.
               NS   secondary02.example.com.

version.catalog.example.com.              TXT    "1"
primaries                                 AAAA   2001:db8::53
new-zone2021061501.zones                  PTR    newzone.example.com.
primaries.new-zone2021061501.zones        A      192.0.2.176
allow-transfer.new-zone2021061501.zones   APL    1:192.0.2.196/32 1:192.0.2.199/32
```

definition of the default primary server(s)

definition of the zone’s primary server(s) (for zone “newline”)

access control list for zone-transfer (for zone “newzone”)

Resources

- TSIG:
  - https://downloads.isc.org/isc/bind9/9.16.16/doc/arm/html/advanced.html#tsig
- Dynamic Update Policies:
  - https://downloads.isc.org/isc/bind9/9.16.16/doc/arm/html/reference.html#dynamic-update-policies
- BIND 9 Catalog Zones:
  - https://downloads.isc.org/isc/bind9/9.16.16/doc/arm/html/advanced.html?highlight=catalog#catalog-zones

Questions and Answers

Hands-On

- We have prepared a VM machine for every participant
- This time the sessions does not build upon each other and do not need to be done in order
- find the instructions at https://webinar.defaultroutes.de/webinar/05-ddns-workshop.html