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DNS Catalog Zones

Abstract

This document describes a method for automatic DNS zone provisioning among DNS primary and secondary nameservers by storing and transferring the catalog of zones to be provisioned as one or more regular DNS zones.

Status of This Memo

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Authors' Addresses

1. Introduction

DISCLAIMER: The authors wish to apologize for the current state of the document, which is in a bit of a rough and somewhat inconsistent shape. It contains multiple different approaches for similar tasks, some of which are described spread out over the document. We will work with the DNSOP working group to improve on this.

The content of a DNS zone is synchronized amongst its primary and secondary nameservers using AXFR and IXFR. However, the list of zones served by the primary (called a catalog in [RFC1035]) is not

automatically synchronized with the secondaries. To add or remove a zone, the administrator of a DNS nameserver farm not only has to add or remove the zone from the primary, they must also add/remove the zone from all secondaries, either manually or via an external application. This can be both inconvenient and error-prone; it is also dependent on the nameserver implementation.

This document describes a method in which the catalog is represented as a regular DNS zone (called a "catalog zone" here), and transferred using DNS zone transfers. As zones are added to or removed from the catalog zone, these changes are distributed to the secondary nameservers in the normal way. The secondary nameservers then add/remove/modify the zones they serve in accordance with the changes to the catalog zone.

The contents and representation of catalog zones are described in Section 3. Nameserver behavior is described in Section 6.

2. Terminology

The key words "**MUST**", "**MUST NOT**", "**REQUIRED**", "**SHALL**", "**SHALL NOT**", "**SHOULD**", "**SHOULD NOT**", "**RECOMMENDED**", "**NOT RECOMMENDED**", "**MAY**", and "**OPTIONAL**" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

Catalog zone A DNS zone containing a DNS catalog, that is, a list of DNS zones and associated properties.

Member zone A DNS zone whose configuration is published inside a catalog zone.

$CATZ Used in examples as a placeholder to represent the domain name of the catalog zone itself (c.f. $ORIGIN).

Member node The DNS name of the DNS subtree representing a given member zone (two levels below $CATZ).

3. Description

A catalog zone is a specially crafted DNS zone that contains, as DNS zone content:

* A list of DNS zones (called "member zones"), plus properties associated with those zones.

Implementations of catalog zones SHOULD ignore any RR in the catalog zone which is meaningless or useless to the implementation.

Authoritative servers may be preconfigured with multiple catalog zones, each associated with a different set of configurations. A member zone can as such be reconfigured with a different set of preconfigured settings by removing it as a member of one catalog zone and making it a member of another.

Although the contents of a catalog zone are interpreted and acted upon by nameservers, a catalog zone is a regular DNS zone and so must adhere to the standards for such zones.

A catalog zone is primarily intended for the management of a farm of authoritative nameservers. It is not expected that the content of catalog zones will be accessible from any recursive nameserver.

4. Catalog Zone Structure

4.1. SOA and NS Records

As with any other DNS zone, a catalog zone MUST have a syntactically correct SOA record and at least one NS record at its apex.

The SOA record's SERIAL, REFRESH, RETRY and EXPIRE fields [RFC1035] are used during zone transfer. A catalog zone's SOA SERIAL field MUST increase when an update is made to the catalog zone's contents as per serial number arithmetic defined in [RFC1982]. Otherwise, secondary nameservers might not notice updates to the catalog zone's contents.

There is no requirement to be able to query the catalog zone via recursive nameservers. Implementations of catalog zones MUST ignore and MUST NOT assume or require NS records at the apex. However, at least one is still required so that catalog zones are syntactically correct DNS zones. A single NS RR with an NSDNAME field containing the absolute name "invalid." is RECOMMENDED [RFC2606].

4.2. Catalog Zone Schema Version

The catalog zone schema version is specified by an integer value embedded in a TXT RR named version.$CATZ. All catalog zones MUST have a TXT RRset named version.$CATZ with at least one RR. Primary and secondary nameservers MUST NOT apply catalog zone processing to zones without the expected value in one of the RRs in the version. $CATZ TXT RRset, but they may be transferred as ordinary zones. For this memo, the value of one of the RRs in the version.CATZ TXT RRset MUST be set to "2", i.e.

```
version.$CATZ 0 IN TXT "2"
```

NB: Version 1 was used in a draft version of this memo and reflected the implementation first found in BIND 9.11.

4.3. List of Member Zones

The list of member zones is specified as a collection of member nodes, represented by domain names under the owner name "zones" where "zones" is a direct child domain of the catalog zone.

The names of member zones are represented on the RDATA side (instead of as a part of owner names) so that all valid domain names may be represented regardless of their length [RFC1035].

For example, if a catalog zone lists three zones "example.com.", "example.net." and "example.org.", the member node RRs would appear as follows:

```
<unique-1>.zones.$CATZ 0 IN PTR example.com.
<unique-2>.zones.$CATZ 0 IN PTR example.net.
<unique-3>.zones.$CATZ 0 IN PTR example.org.
```

where <unique-N> is a label that tags each record in the collection. <unique-N> has a unique value in the collection.

Member node labels carry no informational meaning beyond labeling member zones. A changed label may indicate that the state for a zone needs to be reset (see Section 6.1, Paragraph 8).

Having the zones uniquely tagged with the <unique-N> label ensures that additional RRs can be added at or below the member node, for signifying member-zone-specific information (described below). Further, if member zones do not share a PTR RRset, the list of member zones can be split over multiple DNS messages in a zone transfer.

The CLASS field of every RR in a catalog zone MUST be IN (1).

The TTL field's value is not defined by this memo. Catalog zones are for authoritative nameserver management only and are not intended for general querying via recursive resolvers.

5. Properties

Member zones may optionally be assigned additional properties represented by RRsets below the corresponding member node. This document suggests a few properties which are all optional to implement.

5.1. The Group Property

The group property allows to add at most one tag per member zone. The consumer might handle/configure member zones differently based on the tag. The group property is represented by a TXT Resource Record, for example:

```
<unique-1>.zones.$CATZ        0 IN PTR    example.com.
group.<unique-1>.zones.$CATZ  0 IN TXT    sign-with-nsec3
<unique-2>.zones.$CATZ        0 IN PTR    example.net.
group.<unique-2>.zones.$CATZ  0 IN TXT    nodnssec
```

5.2. Custom properties

Implementations and operators of catalog zones may choose to provide their own properties below the label private-extension.<unique-N>.zones.$CATZ. private-extension is not a placeholder, so a custom property would have the domain name <your-label>.private-extension.<unique-N>.zones.$CATZ

5.3. The Epoch Property

The epoch property is represented by a the TIMESTAMP Resource Record (see Section 5.3.1).

*epoch.<unique-N>.zones.$CATZ 0 IN TIMESTAMP ...

When a member zone's epoch changes, the secondary server resets the member zone's state. The secondary can detect a member zone epoch change as follows:

*When the epoch changes, the primary will set the TIMESTAMP RR of the member zone's epoch property to the current time.

*When the secondary processes a member node with an epoch property that is larger than the point in time when the member zone itself was last retrieved, then a new epoch has begun.

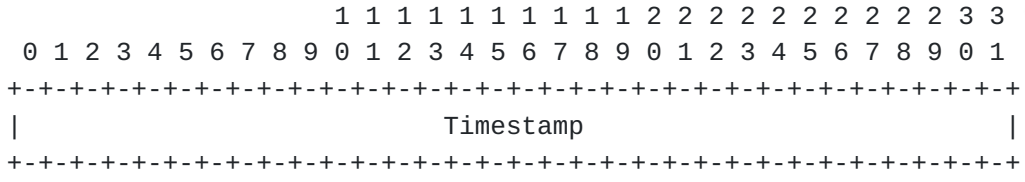
The steps entailed in the process of resetting the zone state depend on the operational context of the secondary (e.g. regenerate DNSSEC keys).

5.3.1. The TIMESTAMP Resource Record

Epoch values (both for the catalog zone and for member zones) are provided with a TIMESTAMP Resource Record. The Type value for the TIMESTAMP RR is TBD. The TIMESTAMP RR is class independent [FIXME: Should it?]. The RDATA of the resource record consist of a single field: Timestamp.

5.3.1.1. TIMESTAMP RDATA Wire Format

The TIMESTAMP RDATA wire format is encoded as follows:



The wire format is identical to the wire format of the Signature Expiration and Inception Fields of the RRSIG RR ([RFC4034] section 3.1.5) and follows the same rules with respect to wrapping.

[FIXME: Should it be 64 bit? I did it this way because a) RRSIG implementations already exist, b) for 64-bit, we also need to discuss timestamp precision (float?)]

5.3.1.2. TIMESTAMP RDATA Presentation Format

The presentation format is identical to that of the Signature Expiration and Inception Fields of the RRSIG RR ([RFC4034] section 3.2). Example:

```
epoch.$CATZ                    0 IN TIMESTAMP    20210304124652
epoch.<unique-1>.zones.$CATZ   0 IN TIMESTAMP    20201231235959
```

5.4. The Serial Property

The current default mechanism for prompting notifications of zone changes from a primary nameserver to the secondaries via DNS NOTIFY [RFC1996], can be unreliable due to packet loss, or secondary nameservers temporarily not being reachable. In such cases the secondary might pick up the change only after the refresh timer runs out, which might take long time and be out of the control of the primary nameserver operator. Low refresh values in the zones being served can alleviate update delays, but burden both the primary and secondary nameservers with more refresh queries, especially with larger numbers of secondary nameservers serving large numbers of zones. To mitigate this, updates of zones MAY be signalled via catalog zones with the help of a serial property.

The serial number in the SOA record of the most recent version of a member zone MAY be provided by a serial property. When a serial property is present for a member zone, implementations of catalog zones MAY assume this number to be the current serial number in the SOA record of the most recent version of the member zone.

Nameservers that are secondary for that member zone, MAY compare the serial property with the SOA serial since the last time the zone was

fetched. When the serial property is larger, the secondary MAY initiate a zone transfer immediately without doing a SOA query first. The SOA query may be omitted, because the SOA serial has been obtained reliably via the catalog zone already.

When a serial property is present for a member zone and it matches the SOA serial of that member zone, implementations of catalog zones which are secondary for that member zone MAY ignore the refresh time in the SOA record of the member zone and rely on updates via the serial property of the member zone. A refresh timer of a catalog zone MUST not be ignored.

Primary nameservers MAY be configured to omit sending DNS NOTIFY messages to secondary nameservers which are known to process the serial property of the member zones in that catalog. However they MAY also combine signalling of zone changes with the serial property of a member zone, as well as sending DNS NOTIFY messages, to anticipate slow updates of the catalog zone (due to packet loss or other reasons) and to cater for secondaries that do not process the serial property.

All comparisons of serial numbers MUST use "Serial number arithmetic", as defined in [RFC1982]

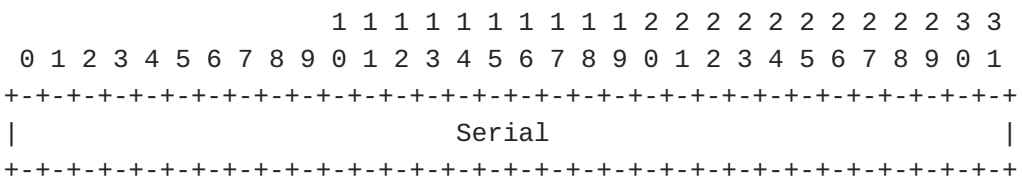
Note to the DNSOP Working Group: In this section we present three ways to provide a serial property with a member zone. The first two ways make use of a new Resource Record type: SERIAL as described in Section 5.4.1, Section 5.4.2 and Section 5.4.3. The two different ways to provide a serial property with the SERIAL RR are described in Section 5.4.4 and Section 5.4.5 respectively. The third way is with a TXT RR and is described in Section 5.4.6. Additionally, https://mailarchive.ietf.org/arch/msg/dnsop/DcdnwolVVpMjQzR4gtlrLyXsYtk/ suggests reusing CSYNC instead of creating a new SERIAL rrtype. (That message also contains other ideas not yet fully considered by the authors.)

5.4.1. The SERIAL Resource Record

The serial property value is provided with a SERIAL Resource Record. The Type value for the SERIAL RR is TBD. The SERIAL RR is class independent. The RDATA of the resource record consist of a single field: Serial.

5.4.2. SERIAL RDATA Wire Format

The SERIAL RDATA wire format is encoded as follows:



5.4.2.1. The Serial Field

The Serial field is a 32-bit unsigned integer in network byte order. It is the serial number of the member zone's SOA record ([RFC1035] section 3.3.13).

5.4.3. SERIAL Presentation Format

The presentation format of the RDATA portion is as follows:

The Serial fields is represented as an unsigned decimal integer.

5.4.4. SERIAL RR Usage - option 1

The serial property of a member zone is provided by a SERIAL RRset with a single SERIAL RR named serial.<unique-N>.zones.$CATZ.

For example, if a catalog zone lists three zones "example.com.", "example.net." and "example.org.", and a serial property is provided for each of them, the RRs would appear as follows:

```
<unique-1>.zones.$CATZ        0 IN PTR    example.com.
serial.<unique-1>.zones.$CATZ 0 IN SERIAL 2020111712
<unique-2>.zones.$CATZ        0 IN PTR    example.net.
serial.<unique-2>.zones.$CATZ 0 IN SERIAL 2020111709
<unique-3>.zones.$CATZ        0 IN PTR    example.org.
serial.<unique-3>.zones.$CATZ 0 IN SERIAL 2020112405
```

5.4.5. SERIAL RR Usage - option 2

The serial property of a member zone is provided by a SERIAL RRset on the same owner name as the PTR RR of the member zone.

For example, if a catalog zone lists three zones "example.com.", "example.net." and "example.org.", and a serial property is provided for each of them, the RRs would appear as follows:

```
<unique-1>.zones.$CATZ 0 IN PTR    example.com.
<unique-1>.zones.$CATZ 0 IN SERIAL 2020111712
<unique-2>.zones.$CATZ 0 IN PTR    example.net.
<unique-2>.zones.$CATZ 0 IN SERIAL 2020111709
<unique-3>.zones.$CATZ 0 IN PTR    example.org.
<unique-3>.zones.$CATZ 0 IN SERIAL 2020112405
```

5.4.6. Serial property as TXT RR - option 3

The serial property of a member zone is provided by a TXT RRset with a single TXT RR named serial.<unique-N>.zones.$CATZ. The TXT RR contains a single RDATA field consisting of the textual representation of the SOA serial number.

For example, if a catalog zone lists three zones "example.com.", "example.net." and "example.org.", and a serial property is provided for each of them, the RRs would appear as follows:

```
<unique-1>.zones.$CATZ        0 IN PTR example.com.
serial.<unique-1>.zones.$CATZ 0 IN TXT 2020111712
<unique-2>.zones.$CATZ        0 IN PTR example.net.
serial.<unique-2>.zones.$CATZ 0 IN TXT 2020111709
<unique-3>.zones.$CATZ        0 IN PTR example.org.
serial.<unique-3>.zones.$CATZ 0 IN TXT 2020112405
```

6. Nameserver Behavior

6.1. General Requirements

As it is a regular DNS zone, a catalog zone can be transferred using DNS zone transfers among nameservers.

Although they are regular DNS zones, catalog zones contain only information for the management of a set of authoritative nameservers. For this reason, operators may want to limit the systems able to query these zones. It may be inconvenient to serve some contents of catalog zones via DNS queries anyway due to the nature of their representation. A separate method of querying entries inside the catalog zone may be made available by nameserver implementations (see Section 8.1).

Catalog updates should be automatic, i.e., when a nameserver that supports catalog zones completes a zone transfer for a catalog zone, it SHOULD apply changes to the catalog within the running nameserver automatically without any manual intervention.

As with regular zones, primary and secondary nameservers for a catalog zone may be operated by different administrators. The secondary nameservers may be configured to synchronize catalog zones from the primary, but the primary's administrators may not have any administrative access to the secondaries.

A catalog zone can be updated via DNS UPDATE on a reference primary nameserver, or via zone transfers. Nameservers MAY allow loading and transfer of broken zones with incorrect catalog zone syntax (as they are treated as regular zones), but nameservers MUST NOT process such

broken zones as catalog zones. For the purpose of catalog processing, the broken catalogs MUST be ignored.

[FIXME: reword this if we do coo, or the CSYNC immediate flag, or something else] If there is a clash between an existing member zone's name and an incoming member zone's name (via transfer or update), the new instance of the zone MUST be ignored and an error SHOULD be logged.

When zones are deleted from a catalog zone, a primary MAY delete the member zone immediately. It is up to the secondary nameserver to handle this condition correctly.

[FIXME: we now have two mechanisms to reset zones and we should bring that back to one at some point.]

When the <unique-N> label of a member zone changes and the zone does not have an epoch property (see Section 5.3), all its associated state MUST be reset, including the zone itself. This can be relevant for example when zone ownership is changed. In that case one does not want the new owner to inherit the metadata. Other situations might be resetting DNSSEC state, or forcing a new zone transfer. This reset is tied to <unique-N because A simple removal followed by an addition of the member zone would be insufficient for this purpose because it is infeasible for secondaries to track, due to missed notifies or being offline during the removal/addition.

If an epoch property is present, the steps in Section 5.3 describe how to signal a zone reset.

7. Migrating zones between catalogs

[FIXME: clarify 2119 status of this and other properties and features. MUST? SHOULD? MAY? Because this one has security implications, also clearly note how ownership changes work without coo - namely, removing a member zone from catz A will cause catz B or C or D to pick up the zone on their next refresh.]

If there is a clash between an existing member zone's name and an incoming member zone's name (via transfer or update), this may be an attempt to do a Change Of Ownership.

A Change Of Ownership is signaled by the 'coo' property in the catalog zone currently owning the zone. The 'coo' property looks like "coo.<unique-N>.old.catalog PTR new.catalog".

If there is no 'coo' property that resolves the clash, the zone remains owned by its current catalog and an error may be logged.

If there is a 'coo' property that resolves the clash, member zone ownership is transferred to 'new.catalog'.

[FIXME: remove this after we agree on what IDs even mean and how zone resets work within and between catalog zones] If <unique-N> for the member zone is different in the new catalog zone, associated state is reset as described earlier, including existing zone data.

The new owner is advised to increase the serial of the member zone after the ownership change, so that the old owner can detect that the transition is done. The old owner then removes the member zone from old.catalog.

8. Updating Catalog Zones

TBD: Explain updating catalog zones using DNS UPDATE.

8.1. Implementation Notes

Catalog zones on secondary nameservers would have to be setup manually, perhaps as static configuration, similar to how ordinary DNS zones are configured. Members of such catalog zones will be automatically synchronized by the secondary after the catalog zone is configured.

An administrator may want to look at data inside a catalog zone. Typical queries might include dumping the list of member zones, dumping a member zone's effective configuration, querying a specific property value of a member zone, etc. Because of the structure of catalog zones, it may not be possible to perform these queries intuitively, or in some cases, at all, using DNS QUERY. For example, it is not possible to enumerate the contents of a multi-valued property (such as the list of member zones) with a single QUERY. Implementations are therefore advised to provide a tool that uses either the output of AXFR or an out-of-band method to perform queries on catalog zones.

9. Implementation Status

Note to the RFC Editor: please remove this entire section before publication.

In the following implementation status descriptions, "DNS Catalog Zones" refers to DNS Catalog Zones as described in this document.

* Knot DNS has processing of DNS Catalog Zones since Knot DNS Version 3.0.0, which was released on September 9, 2020.

* Knot DNS has generation of DNS Catalog Zones on a development branch.

* PowerDNS has a proof of concept external program called PowerCATZ, that can process DNS Catalog Zones.

* Proof of concept python scripts that can be used for both generating and consuming DNS Catalog Zones with NSD have been developed during the hackathon at the IETF-109.

Interoperability between the above implementations has been tested during the hackathon at the IETF-109.

10. Security Considerations

As catalog zones are transmitted using DNS zone transfers, it is key for these transfers to be protected from unexpected modifications on the route. So, catalog zone transfers SHOULD be authenticated using TSIG [RFC8945]. A primary nameserver SHOULD NOT serve a catalog zone for transfer without using TSIG and a secondary nameserver SHOULD abandon an update to a catalog zone that was received without using TSIG.

Use of DNS UPDATE [RFC2136] to modify the content of catalog zones SHOULD similarly be authenticated using TSIG.

Zone transfers of member zones SHOULD similarly be authenticated using TSIG [RFC8945]. The TSIG shared secrets used for member zones MUST NOT be mentioned anywhere in the catalog zone data. However, key identifiers may be shared within catalog zones.

Catalog zones do not need to be signed using DNSSEC, their zone transfers being authenticated by TSIG. Signed zones MUST be handled normally by nameservers, and their contents MUST NOT be DNSSEC-validated.

11. IANA Considerations

This document has no IANA actions.

#

12. Acknowledgements

Our deepest thanks and appreciation go to Stephen Morris, Ray Bellis and Witold Krecicki who initiated this draft and did the bulk of the work.

Catalog zones originated as the chosen method among various proposals that were evaluated at ISC for easy zone management. The chosen method of storing the catalog as a regular DNS zone was proposed by Stephen Morris.

The initial authors discovered that Paul Vixie's earlier [Metazones] proposal implemented a similar approach and reviewed it. Catalog zones borrows some syntax ideas from Metazones, as both share this scheme of representing the catalog as a regular DNS zone.

Thanks to Brian Conry, Tony Finch, Evan Hunt, Patrik Lundin, Victoria Risk, Carsten Strotmann, Peter Thomassen and Kees Monshouwer for reviewing draft proposals and offering comments and suggestions.

Thanks to Klaus Darilion who came up with the idea for the serial property during the hackathon at the IETF-109. Thanks also to Shane Kerr, Petr Spacek, Brian Dickson for further brainstorming and discussing the serial property and how it would work best with catalog zones.

13. Normative References

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14. Informative References

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Appendix A. Change History (to be removed before final publication)

*draft-muks-dnsop-dns-catalog-zones-00

Initial public draft.

*draft-muks-dnsop-dns-catalog-zones-01

Added Witold, Ray as authors. Fixed typos, consistency issues. Fixed references. Updated Area. Removed newly introduced custom RR TYPEs. Changed schema version to 1. Changed TSIG requirement from MUST to SHOULD. Removed restrictive language about use of DNS QUERY. When zones are introduced into a catalog zone, a primary SHOULD first make the new zones available for transfers first (instead of MUST). Updated examples, esp. use IPv6 in examples per Fred Baker. Add catalog zone example.

*draft-muks-dnsop-dns-catalog-zones-02

Addressed some review comments by Patrik Lundin.

*draft-muks-dnsop-dns-catalog-zones-03

Revision bump.

*draft-muks-dnsop-dns-catalog-zones-04

Reordering of sections into more logical order. Separation of multi-valued properties into their own category.

*draft-toorop-dnsop-dns-catalog-zones-00

> New authors to pickup the editor pen on this draft
>
> Remove data type definitions for zone properties Removing configuration of member zones through zone properties altogether
>
> Remove Open issues and discussion Appendix, which was about zone options (including primary/secondary relationships) only.

*draft-toorop-dnsop-dns-catalog-zones-01

> Added a new section "The Serial Property", introducing a new mechanism which can help with disseminating zones from the primary to the secondary nameservers in a timely fashion more reliably.
>
> Three different ways to provide a "serial" property with a member zone are offered to or the workgroup for discussion.
>
> Added a new section "Implementation Status", listing production ready, upcoming and Proof of Concept implementations, and reporting on interoperability of the different implementations.

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