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Child To Parent Synchronization in DNS
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Abstract

This document specifies how a child zone in the DNS can publish a record to indicate to a parental agent that the parental agent may copy and process certain records from the child zone. The existence of the record and any change in its value can be monitored by a parental agent and acted on depending on local policy.

Status of this Memo

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1. Introduction

This document specifies how a child zone in the DNS ([RFC1034], [RFC1035]) can publish a record to indicate to a parental agent (see section Section 2 for a definition of "parental agent") that it can copy and process certain records from the child zone. The existence of the record and any change in its value can be monitored by a parental agent and acted on depending on local policy.

Currently today, some resource records (RRs) in a parent zone are typically expected to be in sync with the source data in the child's zone. The most common records that should match are the nameserver (NS) records and any necessary associated address records (A and AAAA), also known as "glue records". These records are referred to as "delegation records".

It has been challenging for operators of child DNS zones to update their delegation records within the parent's set in a timely fashion. These difficulties may stem from operator laziness, as well as from the complexities of maintaining a large number of DNS zones. Having an automated mechanism for signaling updates will greatly ease the child zone operator's maintenance burden and improve the robustness of the DNS as a whole.

This draft introduces a new Resource Record Type (RRType) named "CSYNC" that indicates which delegation records published by a child DNS operator should be processed by a parental agent and used to update the parent zone's DNS data.

This specification was not designed to synchronize DNSSEC security records, such as DS RRsets. For a solution to this problem, see the complementary solution [RFC7344], which is designed to maintain security delegation information. In addition, this specification does not address how to perform bootstrapping operations, including to get the required initial DNSSEC-secured operating environment in place.

1.1. Terminology Used in This Document

The terminology used in this document is defined in this section.

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].

Terminology describing relationships between the interacting roles involved in this document are defined in the following list:

Child: The entity on record that has the delegation of the domain from the parent

Parent: The domain in which the child is registered

Child DNS operator: The entity that maintains and publishes the zone information for the child DNS

Parental agent: The entity that the child has relationship with, to change its delegation information

2. Definition of the CSYNC RRType

The CSYNC RRType contains, in its RDATA component, these parts: an SOA serial number, a set of flags and a simple bit-list indicating the DNS RRTypes in the child that should be processed by the parental agent in order to modify the DNS delegation records within the parent's zone for the child DNS operator. Child DNS operators wanting a parental agent to perform the synchronization steps outlined in this document MUST publish a CSYNC record at the apex of the child zone. Parental agent implementations MAY choose to query child zones for this record and process DNS record data as indicated by the Type Bit Map field in the RDATA of the CSYNC record. How the data is processed is described in Section 3.

Parental agents MUST process the entire set of child data indicated by the Type Bit Map field (i.e., all record types indicated along with all of the necessary records to support processing of that type)

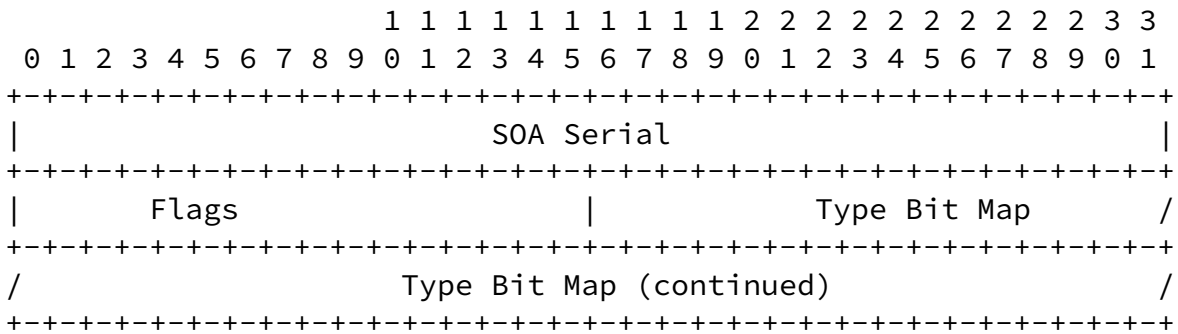
or else parental agents MUST NOT make any changes to parental records at all. Errors due to unsupported Type Bit Map bits, or otherwise nonpunishable data, SHALL result in no change to the parent zone's delegation information for the Child. Parental agents MUST ignore a Child's CSYNC RDATA set if multiple CSYNC resource records are found; only a single CSYNC record should ever be present.

The parental agent MUST perform DNSSEC validation ([RFC4033], [RFC4034], [RFC4035]), of the CSYNC RRType data and MUST perform DNSSEC validation of any data to be copied from the Child to the Parent. Parents MUST NOT process any data from any of these records if any of the validation results indicate anything other than "Secure" [RFC4034] or if any the required data can not be successfully retrieved.

2.1. The CSYNC Resource Record Format

2.1.1. The CSYNC Resource Record Wire Format

The CSYNC RDATA consists of the following fields:



2.1.1.1. The SOA Serial Field

The SOA Serial field contains a copy of the 32-bit SOA serial number from the child zone. If the soaminimum flag is set, parental agents querying children's authoritative servers MUST NOT act on data from zones advertising an SOA serial number less than this value. See [RFC1982] for properly implementing "less than" logic. If the soaminimum flag is not set, parental agents MUST ignore the value in

the SOA Serial Field. Clients can set the field to any value if the soaminimum flag is unset, such as the number zero.

Note that a child zone's current SOA serial number may be greater than the number indicated by the CSYNC record. A child SHOULD update the SOA Serial field in the CSYNC record every time the data being referenced by the CSYNC record is changed (e.g. an NS record or associated address record is changed). A child MAY choose to update the SOA Serial field to always match the current SOA serial field.

Parental agents MAY cache SOA serial numbers from data they use and refuse to process data from zones older than the last instance they pulled data from.

Although Section 3.2 of [RFC1982] describes how to properly implement a less-than comparison operation with SOA serial numbers that may wrap beyond the 32-bit value in both the SOA record and the CSYNC record, it is important than a child using the soaminimum flag must not increment it's SOA serial number value more than 2^16 within the period of time that a parent might wait between polling the child for the CSYNC record.

2.1.1.2. The Flags Field

The Flags field contains 16 bits of boolean flags that define operations which affect the processing of the CSYNC record. The

flags defined in this document are as follows:

0x00 0x01: "immediate"

0x00 0x02: "soaminimum"

The definitions for how the flags are to be used can be found later in Section Section 3.

The remaining flags are reserved for use by future specifications. Undefined flags MUST be set to 0 by CSYNC publishers. Parental agents MUST NOT process a CSYNC record if it contains a 1 value for a flag that is unknown to or unsupported by the parental agent.

2.1.1.2.1. The Type Bit Map Field

The Type Bit Map field indicates the record types to be processed by the parental agent, according to the procedures in Section Section 3. The Type Bit Map field is encoded in the same way as the Type Bit Maps field of the NSEC record, described in [RFC4034], Section 4.1.2. If a bit has been set that a parental agent implementation does not understand, the parental agent MUST NOT act upon the record. Specifically: a parental agent must not just copy the data and must understand the semantics associated with an bit in the Type Bit Map field that has been set to 1.

2.1.2. The CSYNC Presentation Format

The CSYNC presentation format is as follows:

The SOA Serial field is represented as an integer.

The Flags field is represented as an integer.

The Type Bit Map field is represented as a sequence of RR type mnemonics. When the mnemonic is not known, the TYPE representation described in [RFC3597], Section 5, MUST be used. Implementations that support parsing of presentation format records SHOULD be able to read and understand these TYPE representations as well.

2.1.3. CSYNC RR Example

The following CSYNC RR shows an example entry for "example.com" that indicates the NS, A and AAAA bits are set and should be processed by the parental agent for example.com. The parental agent should pull data only from a zone using a minimum SOA serial number of 66 (0x42 in hexadecimal).


```
example.com. 3600 IN CSYNC 66 3 A NS AAAA
```

The RDATA component of the example CSYNC RR would be encoded on the wire as follows:

```
0x00 0x00 0x00 0x42             (SOA Serial)
0x00 0x03                       (Flags = immediate | soaminimum)
0x00 0x04 0x60 0x00 0x00 0x08   (Type Bit Map)
```

3. CSYNC Data Processing

The CSYNC record and associated data must be processed as an "all or nothing" operation set. If a parental agent fails to successfully query for any of the required records, the whole operation MUST be aborted. (Note that a query resulting in "no records exist" as proven by NSEC or NSEC3 is to be considered successful).

Parental agents MAY:

Process the CSYNC record immediately if the "immediate" flag is set. If the "immediate" flag is not set, the parental agent MUST NOT act until the zone administrator approves the operation through an out-of-band mechanism (such as through pushing a button via a web interface).

Choose not to process the CSYNC record immediately, even if the "immediate" flag is set. That is, a parental agent might require the child zone administrator approve the operation through an out-of-band mechanism (such as through pushing a button via a web interface).

Note: how the approval is done out-of-band is outside the scope of this document and is implementation-specific to parental agents.

3.1. Processing Procedure

The following shows a sequence of steps that SHOULD be used when collecting and processing CSYNC records from a child zone. Because DNS queries are not allowed to contain more than one "question" at a time, a sequence of requests is needed. When processing a CSYNC transaction request, all DNS queries should be sent to a single authoritative name server for the child zone. To ensure a single host is being addressed, DNS over TCP SHOULD be used to avoid conversing with multiple nodes at an anycast address.

1. Query for the child zone's SOA record

2. Query for the child zone's CSYNC record

3. Query for the child zone's data records, as required by the CSYNC record's Type Bit Map field

    * Note: if any of the resulting records being queried are not authoritative within the child zone but rather in a grandchild or deeper, SOA record queries must be made for the grandchildren. This will require the parental agent to determine where the child/grandchild zone cuts occur. Because of the additional operational complexity, parental agents MAY choose not to support this protocol with children making use of records that are authoritative in the grandchildren.

4. Query for the collected SOA records again, starting with the deepest and ending with the SOA of the child's.

If the SOA records from the first, middle and last steps for a given zone have different serial numbers (for example, because the zone was edited and republished during the interval between steps 1 and 4), then the CSYNC record obtained in the second set SHOULD NOT be processed (rapidly changing child zones may need special consideration or processing). The operation MAY be restarted or retried in the future.

If the soaminimum flag is set and the SOA serial numbers are equal but less than the CSYNC record's SOA Serial Field [RFC1982], the record MUST NOT be processed. If state is being kept by the parental agent and the SOA serial number is less than the last time a CSYNC record was processed, this CSYNC record SHOULD NOT be processed. Similarly, if state is being kept by the parental agent and the SOA Serial Field of the CSYNC record is less than the SOA Serial Field of the CSYNC record from last time, then this CSYNC record SHOULD NOT be processed.

If a failure occurs of any kind while trying to obtain any of the required data, or if DNSSEC fails to validate all of the data returned for these queries as "secure", then this CSYNC record MUST NOT be processed.

See the "Operational Consideration" section (Section Section 4) for additional guidance about processing.

3.2. CSYNC Record Types

This document defines how the following record types may be processed if the CSYNC Type Bit Map field indicates they are to be processed.

3.2.1. The NS type

The NS type flag indicates that the NS records from the child zone should be copied into the parent's delegation information records for the child.

NS records found within the child's zone should be copied verbatim (with the exception of the TTL field, for which the parent MAY want to select a different value) and the result published within the parent zone should be an exact matching set of NS records. If the child has published a new NS record within their set, this record should be added to the parent zone. Similarly, if NS records in the parent's delegation records for the child contain records that have been removed in the child's NS set, then they should be removed in the parent's set as well.

Parental agents MAY refuse to perform NS updates if the replacement records fail to meet NS record policies required by the parent zone (e.g. "every child zone must have at least 2 NS records"). Parental agents MUST NOT perform NS updates if there are no NS records returned in a query, as verified by DNSSEC denial of existence protection. This situation should never happen unless the child nameservers are misconfigured.

Note that it is permissible for a child's nameserver to return a CSYNC record that removes the queried nameserver itself from the future NS or address set.

3.2.2. The A and AAAA types

The A and AAAA type flags indicates that the A and AAAA address glue records for in-bailiwick NS records within the child zone should be copied verbatim (with the exception of the TTL field, for which the parent MAY want to select a different value) into the parent's delegation information.

Queries should be sent by the parental agent to determine the A and AAAA record addresses for each NS record within a NS set for the child that are in-bailiwick.

Note: only the matching types should be queried. E.g., if the AAAA bit has not been set, then the AAAA records (if any) in the parent's delegation should remain as is. If a given address type is set and the child's zone contains no data for that type (as proven by appropriate NSEC or NSEC3 records), then the result in the parent's delegation records for the child should be an empty set. However, if

the end result of processing would leave no glue records present in the parent zone for any of the of the in-bailiwick NS records, then

the parent MUST NOT update the glue address records. I.E., if the result of the processing would leave no in-bailiwick A or AAAA records when there are in-bailiwick NS records, then processing of the address records can not happen as it would leave the parent/child relationship without any address linkage.

The procedure for querying for A and AAAA records MUST occur after the procedure, if required, for querying for NS records as defined in Section Section 3.2.1. This ensures that the right set of NS records is used as provided by the current NS set of the child. I.e., for CSYNC records that have the NS bit set, the NS set used should be the one pulled from the child while processing the CSYNC record. For CSYNC records without the NS bit set, the existing NS records within the parent should be used to determine which A and/or AAAA records to update.

4. Operational Considerations

There are a number of important operational aspects to consider when deploying a CSYNC RRType.

4.1. Error Reporting

There is no inline mechanism for a parental agent to report errors to operators of child zones. Thus, the only error reporting mechanisms must be out of band, such as through a web console or over email. Parental agents should, at a minimum, at least log errors encountered when processing CSYNC records. Child operators utilizing the "immediate" flag that fail to see an update within the parental agent's specified operational window should access the parental agent's error logging interface to determine why an update failed to be processed.

4.2. Child Nameserver Selection

Parental agents will need to poll child nameservers in search of CSYNC records and related data records.

Parental agents MAY perform best-possible verification by querying all NS records for available data to determine which has the most recent SOA and CSYNC version (in an ideal world, they would all be equal, but this is not possible in practice due to synchronization delays and transfer failures).

Parental agents may offer a configuration interface to allow child operators to specify which nameserver should be considered the master to send data queries too. Note that this master could be a different

nameserver than the publically listed nameservers in the NS set (i.e., it may be a "hidden master").

Parental agents with a large number of clients may choose to offer a programmatic interface to let their children indicate that new CSYNC records and data are available for polling rather than polling every child on a frequent basis.

Children that wish to phase out a nameserver will need to publish the CSYNC record to the nameserver being removed and wait for the parental agent to process the published record before turning off the service. This is required because the child can not control which nameserver in the existing NS set the parental agent may choose to query when performing CSYNC processing.

4.3. Out-of-balliwick NS Records

When a zone contains NS records where the domain-name pointed at does not fall within the zone itself, there is no way for the parent to safely update the associated glue records. Thus, the child DNS operator MAY indicate that the NS records should be synchronized, and MAY set any glue record flags (A, AAAA) as well, but the parent will only update those glue records which are below the child's delegation point.

Children deploying NS records pointing to domain-names within their own children (the "grandchildren") SHOULD ensure the grandchildren's associated glue records are properly set before publishing the CSYNC record. I.e., it is imperative that proper communication and synchronization exist between the child and the grandchild.

4.4. Documented Parental Agent Type Support

Parental agents that support processing CSYNC records SHOULD publicly document the following minimum processing characteristics:

The fact that they support CSYNC processing

The Type Bit Map bits they support

The frequency with which they poll clients (which may also be configurable by the client)

If they support the "immediate" flag

If they poll a child's single nameserver, a configured list of nameservers, or all of the advertised nameservers when querying records

If they support SOA serial number caching to avoid issues with regression and/or replay

Where errors for CSYNC processing are published

If they support sending queries to a "hidden master".

4.5. Removal of the CSYNC records

Children MAY remove the CSYNC record upon noticing that the parent zone has published the required records, thus eliminating the need for the parent to continually query for the CSYNC record and all corresponding records. By removing the CSYNC record from the child zone, the parental agent will only need to perform the query for the CSYNC record and can stop processing when it finds it missing. This will reduce resource usage by both the child and the parental agent.

4.6. Parent/Child/Grandchild Glue Synchronization

When a child needs to publish a CSYNC record that synchronizes NS and A/AAAA glue records and the NS record is actually pointing to a child of the child (a grandchild of the parent), then it is critical that the glue records in the child point to the proper real addresses records published by the grandchild. It is assumed that if a child is using a grandchild's nameserver that they must be in careful

synchronization. Specifically, this specification requires this to be the case.

5. Security Considerations

This specification requires the use of DNSSEC in order to determine that the data being updated was unmodified by third-parties. Parental agents implementing CSYNC processing MUST ensure all DNS transactions are validated by DNSSEC as "secure". Clients deploying CSYNC MUST ensure their zones are signed, current and properly linked to the parent zone with a DS record that points to an appropriate DNSKEY of the child's zone.

This specification does not address how to perform bootstrapping operations to get the required initial DNSSEC-secured operating environment in place. Additionally, this specification was not designed to synchronize DNSSEC security records, such as DS pointers, or the CSYNC record itself. Thus, implementations of this protocol MUST NOT use it to synchronize DS records, DNSKEY materials, CDS records, CDNSKEY records, or CSYNC records. Similarly, future documents extending this protocol MUST NOT offer the ability to synchronize DS, DNSKEY materials, CDS records, CDNSKEY records, or

CSYNC records. For such a solution, please see the complimentary solution [RFC7344] for maintaining security delegation information.

To ensure that an older CSYNC record making use of the soaminimum flag can not be replayed to revert values, the SOA serial number MUST NOT be incremented by more than 2^16 during the lifetime of the signature window of the associated RRSIGs signing the SOA and CSYNC records. Note that this is independent of whether or not the increment causes the 2^32 bit serial number field to wrap.

6. IANA Considerations

This document defines a new DNS Resource Record Type, named "CSYNC". The IANA is requested to assign a code point from the "Resource Record (RR) TYPEs" sub-registry of the "Domain Name System (DNS) Parameters" registry (http://www.iana.org/assignments/dns-parameters) for this record.

TYPE	Value	Meaning	Reference
CSYNC	TBD	Child To Parent Synchronization	[This document]

The IANA is also requested to create and maintain a sub-registry (the "Child Synchronization (CSYNC) Flags" registry) of the "Domain Name System (DNS) Parameters" registry. The initial values for this registry are below.

A "Standards Action" [RFC5226] is required for the assignment of new flag value.

This registry will hold a set of single-bit "Flags" for use in the CSYNC record within the 16 bit Flags field. Thus, a maximum of 16 flags may be defined.

The initial assignments in this registry are:

Bit	Flag	Description	Reference
Bit 0	immediate	Immediately process this CSYNC record.	[This document, Section 3]
Bit 1	soaminimum	Require a SOA serial number greater than the one specified.	[This document, Section 2.1.1.1]

For new assignments to be made to this registry, a new standards track RFC must be published via a Standards Action.

7. Acknowledgments

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