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DNS Error Reporting
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Abstract

DNS Error Reporting is a lightweight error reporting mechanism that provides the operator of an authoritative server with reports on DNS resource records that fail to resolve or validate, that a Domain Owner or DNS Hosting organization can use to improve domain hosting. The reports are based on Extended DNS Errors [RFC8914].

When a domain name fails to resolve or validate due to a misconfiguration or an attack, the operator of the authoritative server may be unaware of this. To mitigate this lack of feedback, this document describes a method for a validating recursive resolver to automatically signal an error to an agent specified by the authoritative server. DNS Error Reporting uses the DNS to report errors.

Status of This Memo

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1. Introduction

When an authoritative server serves a stale DNSSEC signed zone, the cryptographic signatures over the resource record sets (RRsets) may have lapsed. A validating recursive resolver will fail to validate these resource records.

Similarly, when there is a mismatch between the DS records at a parent zone and the key signing key at the child zone, a validating recursive resolver will fail to authenticate records in the child zone.

These are two of several failure scenarios that may go unnoticed for some time by the operator of a zone.

There is no direct relationship between operators of validating recursive resolvers and authoritative servers. Outages are often noticed indirectly, by end users, and reported via social media, if reported at all.

When records fail to validate there is no facility to report this failure in an automated way. If there is any indication that an error or warning has happened, it is buried in log files of the validating resolver, if these errors are logged at all.

This document describes a facility that can be used by validating recursive resolvers to report errors in an automated way.

It allows an authoritative server to signal a reporting agent where the validating recursive resolver can report issues if it is configured to do so.

The burden of reporting a failure falls on the validating recursive resolver. It is important that the effort needed to report failure is low, with minimal impact to its main functions. To accomplish this goal, the DNS itself is utilized to report the error.

2. Requirements Notation

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].

3. Terminology

Reporting Resolver: In the context of this document, the term reporting resolver is used as a shorthand for a validating recursive resolver that supports DNS Error Reporting.

Reporting Query: The DNS query used to report an error is called a reporting query. A reporting query is for DNS resource record type NULL. The details of the error report are encoded in the QNAME of the reporting query.

Reporting Agent: A facility responsible for receiving error reports on behalf of authoritative servers. This facility is indicated by a domain name.

Reporting Agent Domain: a domain name which the reporting resolver includes in the QNAME of the reporting query.

4. Overview

In a query-response exchange, a reporting resolver indicates support for DNS Error Reporting by including an EDNS option with OPTION-CODE [TBD] [RFC Editor: change TBD to the proper code when assigned by IANA.] and OPTION-LENGTH zero. The REPORTING AGENT DOMAIN field in the EDNS option is absent in a query.

An authoritative server indicates support for DNS Error Reporting by including an EDNS0 option with OPTION-CODE [TBD] [RFC Editor: change TBD to the proper code when assigned by IANA.] and the REPORTING AGENT DOMAIN in the option's payload. The authoritative server MUST NOT include this option if the reporting resolver has not signalled support for DNS Error Reporting. The authoritative server MUST NOT include this option in the response if the configured reporting agent

domain is empty or the null label (the root).

When a reporting resolver sends a reporting query to report an error, it MUST NOT include the EDNS0 Error Reporting option in the reporting query. This avoids additional compounding error reporting when the reporting agent server is misconfigured.

To report an error, the reporting resolver encodes the error report in the QNAME of the reporting query. The reporting resolver builds this QNAME by concatenating the extended error code [RFC8914], the QTYPE and QNAME that resulted in failure, the label "_er", and the reporting agent domain. See the example in section 4.2. Note that a regular RCODE is not included, as the RCODE is not relevant to the extended error code.

The resulting concatenated domain name is sent as a standard DNS query for DNS resource record type NULL by the reporting resolver. This query MUST NOT have the EDNS0 option code [TBD] set to avoid compounding error notifications.

The query will ultimately arrive at an authoritative server of the reporting agent. A NODATA negative response is returned by the authoritative server of the reporting agent domain, which in turn can be cached by the reporting resolver.

This caching is essential. It ensures that the number of reports sent by a reporting resolver for the same problem is dampened, i.e. once per TTL, however, certain optimizations such as [RFC8020] and [RFC8198] may reduce the error reporting.

4.1. Managing Caching Optimizations

The reporting resolver may utilize various caching optimizations that inhibit subsequent error reporting by the reporting resolver to the authoritative server for an agent domain.

If the authoritative server for the agent domain were to respond with NXDOMAIN (name error), [RFC8020] rules state that any name at or below that domain should be considered unreachable, and negative caching would prohibit subsequent queries for anything at or below that domain for a period of time, depending on the negative TTL [RFC2308].

Since the authoritative server for an agent domain may not know the contents of all the zones it acts as an agent for, it is crucial that the authoritative does not respond with NXDOMAIN, as that may inhibit subsequent queries. The use of a wildcard domain name [RFC4592] in the zone for the agent domain will ensure the RCODE is consistently NOERROR.

Considering the Resource Record type for this wildcard record, type NULL is prohibited in master zone files [RFC1035]. However, any type

that is not special according to [RFC4592] section 4 will do, such as a TXT record with an email address for the reporting agent in the RDATA.

Wildcard expansion occurs, even if the QTYPE is not for the type owned by the wildcard domain name. The response is a "no error, but no data" response ([RFC4592], section 2.2.1.) that contains a NOERROR RCODE and empty answer section. Note that reporting resolvers are not expected to query for this TXT record, since reporting queries use type NULL. This record is solely present to ensure a NODATA response is returned in response to reporting queries.

When the zone for the reporting agent domain is signed, a resolver may utilize aggressive negative caching, discussed in [RFC8198]. This optimization makes use of NSEC and NSEC3 (without opt-out) records and allows the resolver to do the wildcard synthesis. When this happens, the resolver may not send subsequent queries as it will be able to synthesize a response from previously cached material.

A solution is to avoid DNSSEC for the reporting agent domain's zone. Signing the agent domain's zone will incur an additional burden on the reporting resolver, as it has to validate the response. However, this response has no utility to the reporting resolver.

If an operator does sign a reporting agent domain's zone for whatever reason, one option is to use NSEC3 with opt-out, as that configuration precludes wildcard synthesis on the resolver.

4.2. Example

The domain broken.test is hosted on a set of authoritative servers. One of these serves a stale version. This authoritative server has a reporting agent configured: a01.reporting-agent.example.

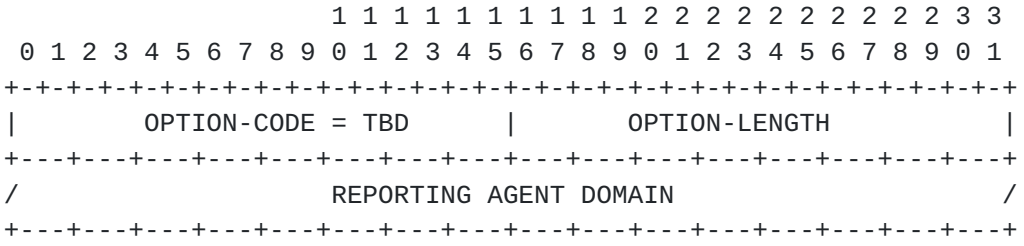
The reporting resolver is unable to validate the broken.test RRSet for type A, due to an RRSIG record with an expired signature.

The reporting resolver constructs the QNAME 7.1.broken.test._er.a01.reporting-agent.example and resolves it. This QNAME indicates extended DNS error 7 occurred while trying to validate broken.test type 1 (A) record.

After this query is received at one of the authoritative servers for the reporting agent domain (a01.reporting-agent.example), the reporting agent (the operators of the authoritative server for a01.reporting-agent.example) determines that the authoritative server for the broken.test zone suffers from an expired signature record (extended error 7) for type A for the domain name broken.test. The reporting agent can contact the operators of broken.test to fix the issue.

5. EDNS0 Option Specification

This method uses an EDNS0 [RFC6891] option to indicate support for sending DNS error reports and responding with the Reporting Agent Domain in DNS messages. The option is structured as follows:



Field definition details:

- OPTION-CODE, 2-octets/16-bits (defined in [RFC6891]), for indicating error reporting support is TBD. [RFC Editor: change TBD to the proper code when assigned by IANA.]

- OPTION-LENGTH, 2-octets/16-bits ((defined in [RFC6891]) contains the length of the REPORTING AGENT DOMAIN field in octets.

- REPORTING AGENT DOMAIN, a Domain name [RFC8499].

6. DNS Error Reporting Specification

The various errors that a reporting resolver may encounter are listed in [RFC8914]. Note that not all listed errors may be supported by the reporting resolver. This document does not specify what is an error and what is not.

The DNS class is not specified in the error report.

6.1. Reporting Resolver Specification

Reporting Resolvers may have a configuration that allows the following:

- DNS Error Reporting level: warning and / or errors

- Do nothing: the reporting resolver does not indicate support for DNS Error Reporting.

- Report to Reporting Agent: Indicate DNS Error Reporting in queries and use the reporting agent specified in the EDNS0 option received from the authoritative server.

- Report to Configured Agent: Use the reporting agent specified in local configuration. This may override or supplement "Reporting Agent Domain". The use for such an option could be to allow a recursive resolver to report all errors to a reporting agent of its choosing, not just in zones with DNS Error Reporting enabled.

The reporting resolver MUST NOT use DNS error reporting to report a failure in resolving the reporting query.

The reporting resolver MUST NOT use DNS error reporting if the authoritative server has an empty Reporting Agent Domain field in the EDNS Error Reporting option.

6.1.1. Constructing the Reporting Query

The QNAME for the reporting query is constructed by concatenating the following elements, appending each successive element in the list to the right-hand side of the QNAME:

- The Extended DNS error, presented as a decimal value, in a single DNS label.
- The QTYPE that was used in the query that resulted in the extended DNS error, presented as a decimal value, in a single DNS label.
- The QNAME that was used in the query that resulted in the extended DNS error. The QNAME may consist of multiple labels and is concatenated as-is.
- A label containing the string "_er".
- The reporting agent domain. The reporting agent domain consists of multiple labels and is concatenated exactly as received in the EDNS option sent by the authoritative server.

If the resulting reporting query QNAME would exceed 255 octets, it MUST NOT be sent.

The purpose of the "_er" label is twofold. First, it allows the reporting agent to quickly differentiate between the agent domain and the faulty query name. Second, if the specified agent domain is empty, or a NULL label (even if it is not allowed in this specification), the reporting query will have "_er" as a top-level domain as a result and not the original query.

6.2. Authoritative Server Specification

The Authoritative Server MUST NOT have multiple reporting agent domains configured for a single zone. To support multiple reporting agents, a single agent can act as a syndicate to subsequently inform additional agents.

An authoritative server for a zone with DNS error reporting enabled MUST NOT also be authoritative for that zone's reporting agent domain's zone.

6.3. Reporting Agent Specification

While there are many zone configurations possible for the reporting agent domain, such as DNAME, CNAME or special delegation structures to redistribute errors, please note that the burden of reporting is on the reporting resolvers and that creating complicated configurations that cause additional work for the reporting resolver on behalf of misconfigured servers is NOT RECOMMENDED.

It is RECOMMENDED that the reporting agent zone uses a wildcard DNS record of type TXT with an arbitrary string in the RDATA and a TTL of at least one hour.

6.4. Choosing a Reporting Agent Domain

Each authoritative server SHOULD be configured with a unique reporting agent domain. When different authoritative servers share the same reporting agent domain, it is not possible to determine which authoritative server the reported error relates to.

It is RECOMMENDED that the reporting agent domain be kept relatively short to allow for a longer QNAME in the reporting query.

While it may be obvious to use the hostname of the authoritative server as the reporting agent domain, it is not a requirement, as long as the reporting agent is able to map the reporting agent domain to the proper authoritative server. Using the hostname of the authoritative server as the reporting agent domain is NOT RECOMMENDED when the hostname has multiple addresses, or when addresses are anycast.

7. Limitations

The length of the owner name for which errors can be reported is limited due to the requirement to append the reporting agent domain and prepend the Extended Error value and the QTYPE to the reporting query's QNAME.

8. IANA Considerations

IANA is requested to assign the following DNS EDNS0 option code registry:

Value	Name	Status	Reference
TBD	DNS ERROR REPORT	Standard	[this document]

[RFC Editor: change TBD to the proper code when assigned by IANA.]

IANA is requested to assign the following Underscored and Globally Scoped DNS Node Name registry:

RR Type	_NODE NAME	Reference

TXT	_er	[this document]

9. Security Considerations

Use of DNS Error Reporting may expose local configuration mistakes in the reporting resolver, such as stale DNSSEC trust anchors to the reporting agent.

DNS Error reporting SHOULD be done using DNS Query Name Minimization [RFC7816] to improve privacy.

DNS Error Reporting is done without any authentication between the reporting resolver and the authoritative server of the agent domain. Authentication significantly increases the burden on the reporting resolver without any benefit to the reporting agent, authoritative server or reporting resolver.

The reporting resolver MUST NOT report about queries and responses from an encrypted channel (such as DNS over TLS [RFC7858] and DNS over HTTPS [RFC8484]).

The reporting resolver MUST NOT report about responses that did not match the qname/qtype/qclass and query-id in the original query [RFC5452], section 4.2.

The method described in this document will cause additional queries by the reporting resolver to authoritative servers in order to resolve the reporting query. This additional load is equivalent to the additional load when a resolver resolves the canonical name in a CNAME record.

This method can be abused by deploying broken zones with agent domains that are delegated to servers operated by the intended victim in combination with open resolvers [RFC8499]. This method MUST NOT be deployed by default on reporting resolvers and authoritative servers without requiring an explicit configuration element.

10. Acknowledgements

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