Network Working Group
Internet-Draft
Intended status: Standards Track
Expires: March 21, 2020

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September 18, 2019

Related Domains By DNS
draft-brotman-rdbd-03

Abstract

This document describes a mechanism by which a DNS domain can publicly document the existence or absence of a relationship with a different domain, called "Related Domains By DNS", or "RDBD."

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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Table of Contents

1. Introduction 2
1.1. Use-Cases 3
1.2. Terminology 3
2. New Resource Record Types 4
2.1. RDBDKEY Resource Record Definition 4
2.2. RDBD Resource Record Definition 5
3. RDBD processing 7
4. Use-cases for Signatures 8
4.1. Many-to-one Use-Case 8
4.2. Extending DNSSEC 8
5. Security Considerations 9
5.1. Efficiacy of signatures 9
5.2. DNSSEC 9
5.3. Lookup Loops 9
6. IANA Considerations 10
7. Acknowledgements 10
8. References 10
8.1. Normative References 10
8.2. Informative References 11
Appendix A. Implementation (and Toy Deployment:-) Status 11
Appendix B. Examples 11
Appendix C. Possible dig output... 14
Appendix D. Changes and Open Issues 15
D.1. Changes from -02 to -03 15
D.2. Changes from -01 to -02 16
D.3. Changes from -00 to -01 16
Authors' Addresses 16

1. Introduction

Determining relationships between DNS domains can be one of the more difficult investigations on the Internet. It is typical to see something such as "example.com" and "dept-example.com" and be unsure if there is an actual relationship between those two domains, or if one might be an attacker attempting to impersonate the other. In some cases, anecdotal evidence from the DNS or WHOIS/RDAP may be sufficient. However, service providers of various kinds may err on the side of caution and treat one of the domains as untrustworthy or abusive if it is not clear that the two domains are in fact related. This specification provides a way for one domain to explicitly document, or disavow, relationships with other domains, utilizing DNS records.

It is not a goal of this specification to provide a high-level of assurance as to whether or not two domains are definitely related, nor to provide fine-grained detail about the kinds of relationships

that may exist between domains. However, the mechanism defined here is extensible in a way that should allow use-cases calling for such declarations to be handled later.

1.1. Use-Cases

The use cases for this include:

- where an organisation has names below different ccTLDs, and would like to allow others to correlate their ownership more easily, consider "example.de" and "example.ie" registered by regional offices of the same company;

- following an acquisition, a domain holder might want to indicate that example.net is now related to example.com in order to make a later migration easier;

- when doing Internet surveys, we should be able to provide more accurate results if we have information as to which domains are, or are not, related;

- a domain holder may wish to declare that no relationship exists with some other domain, for example "good.example" may want to declare that it is not associated with "g00d.example" if the latter is currently being used in some cousin-domain style attack in which case, it is more likely that there can be a larger list of names (compared to the "positive" use-cases) for which there is a desire to disavow a relationship.

[[Discussion of this draft is taking place on the dnsop@ietf.org mailing list. Previously, discussion was on the dbound@ietf.org list. There's a github repo for this draft at <https://github.com/abrotman/related-domains-by-dns> - issues and PRs are welcome there.]]

1.2. 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 [RFC2119].

The following terms are used throughout this document:

- Relating-domain: this refers to the domain that is declarating a relationship exists. (This was called the "parent/primary" in -00).

- Related-domain: This refers to the domain that is referenced by the Relating-domain, such as "dept-example.com". (This was called the "secondary" in -00.)

2. New Resource Record Types

We define a resource record type (RDBD) that can declare, or disavow, a relationship. RDBD also includes an optional digital signature mechanism that can somewhat improve the level of assurance with which an RDBD declaration can be handled. This mechanism is partly modelled on how DKIM [RFC6376] handles public keys and signatures - a public key is hosted at the Relating-domain (e.g., "club.example.com"), using an RDBDKEY resource record, and the RDBD record of the Related-domain (e.g., "member.example.com") can contain a signature (verifiable with the "club.example.com" public key) over the text representation ('A-label') of the two names (plus a couple of other inputs).

2.1. RDBDKEY Resource Record Definition

The RDBDKEY record is published at the apex of the Relating-domain zone.

The wire and presentation format of the RDBDKEY resource record is identical to the DNSKEY record. [RFC4034]

[[All going well, at some point we'll be able to say...]] IANA has allocated RR code TBD for the RDBDKEY resource record via Expert Review. [[In the meantime we're experimenting using 0xffa8, which is decimal 65448, from the experimental RR code range, for the RDBDKEY resource record.]]

The RDBDKEY RR uses the same registries as DNSKEY for its fields. (This follows the precedent set for CDNSKEY in [RFC7344].)

No special processing is performed by authoritative servers or by resolvers, when serving or resolving. For all practical purposes, RDBDKEY is a regular RR type.

The flags field of RDBDKEY records MUST be zero. [[Is that correct/ ok?]]

There can be multiple occurrences of the RDBDKEY resource record in the same zone.

2.2. RDBD Resource Record Definition

To declare a relationship exists an RDBD resource record is published at the apex of the Related-domain zone.

To disavow a relationship an RDBD resource record is published at the apex of the Relating-domain zone.

[[All going well, at some point we'll be able to say...]] IANA has allocated RR code TBD for the RDBD resource record via Expert Review. [[In the meantime we're experimenting using 0xffa3, which is decimal 65443, from the experimental RR code range, for the RDBD resource record.]]

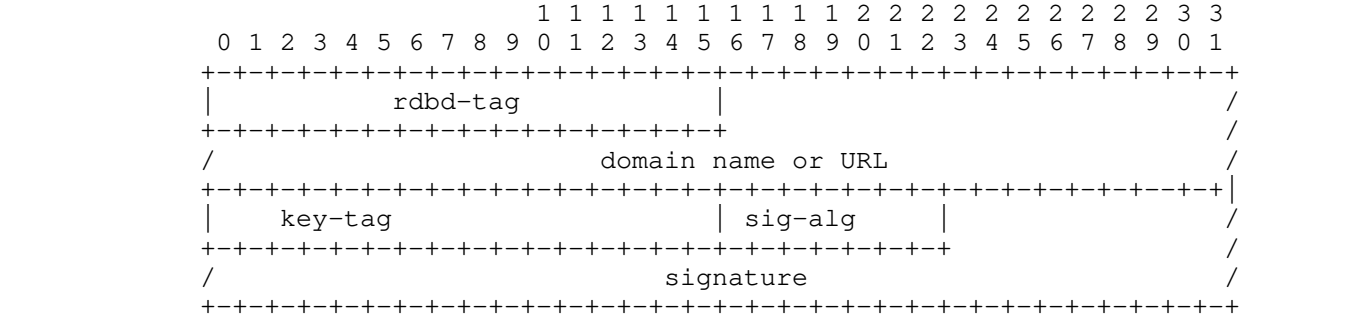
The RDBD RR is class independent.

The RDBD RR has no special Time to Live (TTL) requirements.

There can be multiple occurrences of the RDBD resource record in the same zone.

RDBD relationships are uni-directional. If bi-directional relationships exist, then both domains can publish RDBD RRs and optionally sign those.

The wire format for an RDBD RDATA consists of a two octet rdbd-tag, a domain name or URL, and the optional signature fields which are: a two-octet key-tag, a one-octet signature algorithm, and the digital signature bits.



We define two possible values for the rdbd-tag in this specification, later specifications can define new rdbd-tag values:

- 0: states that no relationship exists between the domains
- 1: states that some relationship exists between the domains

The domain name field contains either a single domain name, or an HTTPS URL. In the latter case, successfully de-referencing that URL is expected to result in a JSON object that contains a list of domain names, such as is shown in the figure below.

```
[
    "example.com",
    "example.net",
    "foo.example"
]
```

If an optional signature is included, the sig-alg field MUST contain the signature algorithm used, with the same values used as would be used in an RRSIG. The key-tag MUST match the RDBDKEY RR value for the corresponding public key, and is calculated as defined in [RFC4034] appendix B.

If the optional signature is omitted, then the presentation form of the key-tag, sig-alg and signature fields MAY be omitted. If not omitted then the sig-alg and key-tag fields MUST be zero and the signature field MUST be a an empty string. [[Is that the right way to have optional fields in prsentation syntax for RRs?]]

The input to signing ("to-be-signed" data) is the concatenation of the following linefeed-separated (where linefeed has the value '0x0a') lines:

```
relating=<Relating-domain name>
related=<Related-domain name or URL>
rdbd-tag=<rdbd-tag value>
key-tag=<key-tag>
sig-alg=<sig-alg>
```

The Relating-domain and Related-domain values MUST be the 'A-label' representation of these names. The trailing "." representing the DNS root MUST NOT be included in the to-be-signed data, so a Relating-domain value above might be "example.com" but "example.com." MUST NOT be used as input to signing.

The rdbd-tag and key-tag and sig-alg fields MUST be in decimal with leading zeros omitted.

A linefeed MUST be included after the "sig-alg" value in the last line.

[[Presentation syntax and to-be-signed details are very liable to change.]]

See the examples in the Appendix for further details.

3. RDBD processing

- If multiple RDBD records exist with conflicting "rdbd-tag" values, those RDBD records SHOULD be ignored.
- If an RDBD record has an invalid or undocumented "rdbd-tag", that RDBD record SHOULD be ignored.
- The document being referenced by a URL within an RDBD record MUST be a well-formed JSON [RFC8259] document. If the document does not validate as a JSON document, the contents of the document SHOULD be ignored. There is no defined maximum size for these documents, but a referring site ought be considerate of the retrieving entity's resources.
- When retrieving the document via HTTPS, the certificate presented MUST properly validate. If the certificate fails to validate, the retreiving entity SHOULD ignore the contents of the file located at that resource.
- Normal HTTP processing rules apply when de-referencing a URL found in an RDBD record, for example, a site may employ HTTP redirection.
- Consumers of RDBD RRs MAY support signature verification. They MUST be able to parse/process unsigned or signed RDBD RRs even if they cannot cryptographically verify signatures.
- Implementations producing RDBD RRs SHOULD support optional signing of those and production of RDBDKEY RRs.
- Implementations of this specification that support signing or verifying signatures MUST support use of RSA with SHA256 (sig-alg==8) with at least 2048 bit RSA keys. [RFC5702]
- RSA keys MUST use a 2048 bit or longer modulus.
- Implementations of this specification that support signing or verifying signatures SHOULD support use of Ed25519 (sig-alg==15). [RFC8080][RFC8032]

- o A validated signature is solely meant to be additional evidence that the relevant domains are related, or that one disavows such a relationship.

4. Use-cases for Signatures

[[The signature mechanism is pretty complex, relative to anything else here, so it might be considered as an at-risk feature.]]

We see two possibly interesting use-cases for the signature mechanism defined here. They are not mutually exclusive.

4.1. Many-to-one Use-Case

If a bi-directional relationship exists between one Relating-domain and many Related-domains and the signature scheme is not used, then making the many required changes to the Relating-domain zone could be onerous. Instead, the signature mechanism allows one to publish a stable value (the RDBDKEY) once in the Relating-domain. Each Related-domain can then also publish a stable value (the RDBD RR with a signature) where the signature provides confirmation that both domains are involved in declaraing the relationship.

This scenario also makes sense if the relationship (represented by the rdbd-tag) between the domains is inherently directional, for example, if the relationship between the Related-domains and Relating-domain is akin to a membership relationship.

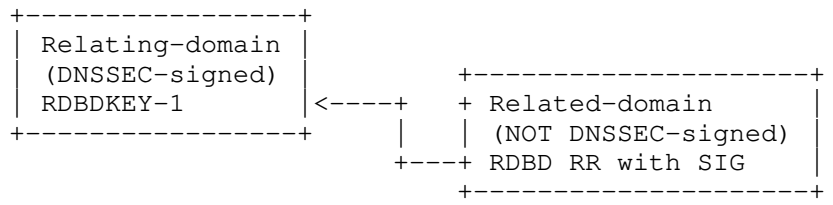
4.2. Extending DNSSEC

If the Relating-domain and Related-domain zones are both DNSSEC-signed, then the signature mechanism defined here adds almost no value and so is unlikely to be worth deploying in that it provides no additional cryptorgraphic security (though the many-to-one advantage could still apply). If neither zone is DNSSEC-signed, then again, there may be little value in deploying RDBD signatures.

The minimal value that remains in either such case, is that if a client has acquired and cached RDBDKEY values in some secure manner, then the RDBD signatures do offer some benefit. However, at this point it seems fairly unlikely that RDBDKEY values will be acquired and cached via some secure out-of-band mechanisms, so we do not expect much deployment of RDBD signatures in either the full-DNSSEC or no-DNSSEC cases.

However, where the Relating-domain’s zone is DNSSEC-signed, but the Related-domain’s zone is not DNSSEC signed, then the RDBD signatures

do provide value, in essence by extending DNSSEC "sideways" to the Related-domain. The figure below illustrates this situation.



Extending DNSSEC use-case for RDBD signatures

5. Security Considerations

5.1. Efficiacy of signatures

The optional signature mechanism defined here offers no protection against an active attack if both the RDBD and RDBDKEY values are accessed via an untrusted path.

5.2. DNSSEC

RDBD does not require DNSSEC. Without DNSSEC it is possible for an attacker to falsify DNS query responses for someone investigating a relationship. Conversely, an attacker could delete the response that would normally demonstrate the relationship, causing the investigating party to believe there is no link between the two domains. An attacker could also replay an old RDBD value that is actually no longer published in the DNS by the Related-domain.

Deploying signed records with DNSSEC should allow for detection of these kinds of attack.

5.3. Lookup Loops

A bad actor could create a loop of relationships, such as a.example->b.example->c.example->a.example or similar. Automated systems SHOULD protect against such loops. For example, only performing a configured number of lookups from the first domain. Publishers of RDBD records SHOULD attempt to keep links direct and so that only the fewest number of lookups are needed, but it is understood this may not always be possible.

6. IANA Considerations

This document introduces two new DNS RR types, RDBD and RDBDKEY. [[Codepoints for those are not yet allocated by IANA, nor have codepoints been requested so far.]]

[[New rdbd-tag value handling will need to be defined if we keep that field. Maybe something like: 0-255: RFC required; 256-1023: reserved; 1024-2047: Private use; 2048-65535: FCFS. It will also likely be useful to define a string representation for each registered rdbd-tag value, e.g. perhaps "UNRELATED" for rdbd-tag value 0, and "RELATED" for rdbd-tag value 1, so that tools displaying RDBD information can be consistent.]]

7. Acknowledgements

Thanks to all who commented on this on the dbound and other lists, in particular to the following who provided comments that caused us to change the draft: Bob Harold, John Levine, Pete Resnick, Andrew Sullivan, Tim Wisinski, Suzanne Woolf, Joe St. Sauver, and Paul Wouters. (We're not implying any of these fine folks actually like this draft btw, but we did change it because of their comments:-) Apologies to anyone we missed, just let us know and we'll add your name here.

8. References

8.1. Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <https://www.rfc-editor.org/info/rfc2119>.

[RFC4034] Arends, R., Austein, R., Larson, M., Massey, D., and S. Rose, "Resource Records for the DNS Security Extensions", RFC 4034, DOI 10.17487/RFC4034, March 2005, <https://www.rfc-editor.org/info/rfc4034>.

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[RFC8032] Josefsson, S. and I. Liusvaara, "Edwards-Curve Digital Signature Algorithm (EdDSA)", RFC 8032, DOI 10.17487/RFC8032, January 2017, <https://www.rfc-editor.org/info/rfc8032>.

[RFC8080] Sury, O. and R. Edmonds, "Edwards-Curve Digital Security Algorithm (EdDSA) for DNSSEC", RFC 8080, DOI 10.17487/RFC8080, February 2017, <https://www.rfc-editor.org/info/rfc8080>.

[RFC8259] Bray, T., Ed., "The JavaScript Object Notation (JSON) Data Interchange Format", STD 90, RFC 8259, DOI 10.17487/RFC8259, December 2017, <https://www.rfc-editor.org/info/rfc8259>.

8.2. Informative References

[RFC6376] Crocker, D., Ed., Hansen, T., Ed., and M. Kucherawy, Ed., "DomainKeys Identified Mail (DKIM) Signatures", STD 76, RFC 6376, DOI 10.17487/RFC6376, September 2011, <https://www.rfc-editor.org/info/rfc6376>.

[RFC7344] Kumari, W., Gudmundsson, O., and G. Barwood, "Automating DNSSEC Delegation Trust Maintenance", RFC 7344, DOI 10.17487/RFC7344, September 2014, <https://www.rfc-editor.org/info/rfc7344>.

Appendix A. Implementation (and Toy Deployment:-) Status

[[Note to RFC-editor: according to RFC 7942, sections such as this one ought not be part of the final RFC. We still dislike that idea, but whatever;-)]]

We are not aware of any independent implementations so far. One of the authors has a github repo at <https://github.com/sftcd/rdbd-deebeedeerrr> with scripts that allow one to produce zone file fragments and signatures for a set of domains. There is also a wrapper script for the dig tool that provides a nicer view of RDBD and RDBDKEY records, and that verifies signatures. See the README there for details.

In terms of deployments, we used the above for a "toy" deployment in the tolerantnetworks.ie domain and other related domains that one can determine by following the relevant trail:-)

Appendix B. Examples

These examples have been generated using the proof-of-concept implementation mentioned above. These are intended for interop, not for beauty:-) The dig wrapper script referred to above produces more readable output, shown further below..

The following names and other values are used in these examples.

- Relating domain: my.example
- Related domain: my-way.example
- Unrelated domain: my-bad.example
- URL for other related domains: <https://my.example/related-names>
- URL for other unrelaed domains: <https://my.example/unrelateds>

my.example zone file fragments:

```
my.example.     3600 IN TYPE65448 \# 298 (
                000003083082012300d06092a864886f70d010101050
                00382010f003082010a0282010100bb3b09979b3c4e61
                0f231dafbd8295d5b6d9475eba8df1cff49b08b99a768
                15e660c243b8ce7175cc9857be00847cff865ca81e56a
                f0ec1813a43787902e8b2560b64016c4c8e64262b7b8e
                ae2e6f735e1186237fff49110227b69fbcefa1cfddf7f
                df052f250871bb03be114493a8e29a95d04b50b9e99b5
                8e40e70381384c159d02d781e6837791c2ead0c547e7f
                fb0aa198b2aef259c42273a69af4f22c7439972d3052d
                4a581895e203115963689044b4cbbdb6cf90ff1866630
                593aad625772e6f540bd93801c5781fdd74481fbb6399
                f745b4525c767e3fb4a4d919e265d541f6bee95d0b9e1
                15bd4749a3a9748e2d8745466629fa6682d36e83cbae8
                30203010001
                )
my.example.     3600 IN TYPE65443 \# 85 (
                0001066d792d776179076578616d706c650039820f039
                b08e9d5a8e057a87c6e7ddb92a680b7a2e69baef46404
                b3bc9fcd93f4fe261bda56c107dba2d672255a86a771f
                cc3eca0f12cdd1b302f20b2234de8610e03
                )
my.example.     3600 IN TYPE65443 \# 18 (
                0000066d792d626164076578616d706c6500
                )
my.example.     3600 IN TYPE65443 \# 39 (
                000123687474707733a2f2f6d792d7761792e6578616d7
                06c652f6d7973747566662e6a736f6e00
                )
my.example.     3600 IN TYPE65443 \# 42 (
                0000266874747073 3a2f2f6d792d7761792e6578616d7
                06c652f6e6f746d7973747566662e6a736f6e00
                )
```

my.example private key:

```
-----BEGIN RSA PRIVATE KEY-----
MIIEpAIBAAKCAQEAuzsJl5s8TmEPIx2vvYKV1bbZR166jfHP9JsIuZp2gV5mDCQ7
jOcXXMmFe+AIR8/4ZcqB5Wrw7BgTpDeHkC6LJWC2QBbEyOZCYre46uLm9zXhGGI3
//SRECJ7afvO+hz933/fBS8lCHG7A74RRJOo4pqV0EtQuembWOQOcDgThMFZ0C14
Hmg3eRwurQxUfn/7CqGYsq7yWcQic6aa9PIsdDmXLTBS1KWBiV4gMRWWNokES0y7
22z5D/GGZjBZOq1iV3Lm9UC9k4AcV4H910SB+7Y5n3RbRSXHZ+P7Sk2RniZdVB9r
7pXQueEVvUdJo6l0ji2HRUZmKfpmgtNug8uugwIDAQABAoIBAF1sJuwkBGJjocb2
4CLijtsVorMu/E0pdIdr+F2MSkdhD/BM//3drVWaJGXcMqWKizpXYptT0iUsGljd
cGIsJzgeWrH96nEIG+XgIH/rei2uD8Q39hNcOCnh2szWXb+FSdQEnQacMJFXFmbW
pw0d1K5FTi2h9wTdIKupF988y9h4OzVkW9qIDqOzKAKnxoyYZ0xiglaUq6NeHRs2
Sv7ow5CErKm4ZDqvtcqxs+uWblm3i5LsPGKexDZfXDQqle7hjFbXKUw+ZREF8hzc
bCfa3A5Xyo7nLdgGR2DOZlzOQA+iz5Cnpb35gdOV+giptlwndrn8Lc8U1Zf1f47T
aOxh2YECgYEA4u/VQ2B4Ux4NNX8g3womc/rJZOMWVxkd8odRhBy4s0c+atGy3ztp
SOprBQrkjcFE831b596MOE11y1GpmKK7q5nI2IcMuStnLoj27a95QVznswnbyA6a
g3cIAz/lOHCexLzi8edjcwTxJv1XNE9518SbkU0EbW2OY5jZsHU4I0MCgYEA0zVt
m3PrU5/JW1GqmRhDa7PyfB9ESq5mIXIaT6mPh0XLryMn2uUmFBMC3iuxNayjQgzI
Gg3XVClcb4vvrVDrkxY5aTDmizvVvF0MletBiLYjCwWHsOGql4hxwhvENYcYvCjs
T0WShG8FuuuHaH371+2hBkREeLHQRlyh0om2c8ECgYEA4JCb5PSNnRJb19hZWtzc
eGBu8lqVPNMqA1lMnQMe8qlJZsLj0mskIHd4N6Ez0eKyrJAcZjKfZwefzPaecOB3
/bNMQJhDSulcTXxTfZjq0HdzAIR87FcnJ3iegTi1R0iKk/ymRuLGUodNa1u+85DB
7XYsy3f/LZoAESasJCWay6kCgYAyGpuc5BvwY5iF5FK/LMVZuH+OuHAf801hI8tg
GI5m/cS7EHD0+aVV38ivYdgRLpowIg4aOCxb19AI2j6KdAbehsgpzyLx5sjmfYBt
1DhgsSyRAcfVy0MH3aN289VRCXJxuJeOmqeOaTQHyrX9sN1ctQ+dB/biVvRcrL7q
ziaNQQKBgQC9MECoVH/bYJVY6RoC5ZYAa6A4CYDhaXnw40lQ90ckSgWr3FenV7gw
b2xg7zLOX2HZZ+6HejMNGC/efZKVN2Okkpe4KGOXcDH3pYrrkLsLCNRXzxBsyOIt
e3e1kAriqiXcr3sPBbn7nakUa7G23O7Hb31C0KGMyf9znN+qWda+3g==
-----END RSA PRIVATE KEY-----
```

my-way.example zone file fragments:

```
        my-way.example. 3600 IN TYPE65448 \# 36 (
                     0000030f6d5a2d3caf0d740e139d36a0e52325c4e078e
                     7623f19be3b872367dc8027ef42
                     )
        my-way.example. 3600 IN TYPE65443 \# 273 (
                     0001026d79076578616d706c65003e6c088d887950e26
                     305a59bbe63263b65d34e11656968497500cbef7af12b
                     e14d173d7368e24da54258c851456d3c2d94437692879
                     d1d2b5d3f0acf1e3de6ebb345f8c31f209af6fd7f2731
                     3804fc79db421231126e3e42115ce51a81d2619ed221a
                     fea2b64d1d9ffbef0bd4786fbe5f42c75951ae645078d
                     b7a5a88ed3173d4a209734f49a23a0920ce38ed44011d
                     784e47cf7658cc313cf01349c80b936b17fca3542f32a
                     ff956e808c2520736a917df648e4e5f2eea5de994ce90
                     dba6d5051a4e0934da4a9f6ff01ef5df98d3b4da52b12
                     ea3b8e7ebabcf6d7a0a170dc1284753e3e6b039f8a32c
                     e707312ea5b02180072b517a6056db6e47f8dd5240ab1
                     874646
                     )
```

my-way.example private key:

```
            0000000 5f24 3132 daa0 4cc4 0a77 4cb6 e834 16db
            0000020 05b0 faf7 ca27 16b6 0ae7 e177 d3f9 db5f
            0000040
```

Appendix C. Possible dig output...

Below we show the output that a modified dig tool might display for the my.example assertions above.

```
 $ dig RDBD my.example

 ; <<>> DiG 9.11.5-P1-1ubuntu2.5-Ubuntu <<>> RDBD my.example
 ;; global options: +cmd
 ;; Got answer:
 ;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 4289
 ;; flags: qr rd ra ad; QUERY: 1, ANSWER: 5, AUTHORITY: 0, ADDITIONAL: 1

 ;; OPT PSEUDOSECTION:
 ; EDNS: version: 0, flags:; udp: 4096
 ; COOKIE: e69085d4b9a18cca63ae96035d7bc0aa96580e0d6255c122 (good)
 ;; QUESTION SECTION:
 ;my.example. IN RDBD

 ;; ANSWER SECTION:
 my.example. 3600 IN RDBD RELATED may-way.example Sig: good
                            KeyId: 50885 Alg: 15 Sig: UIi04agb...
 my.example. 3600 IN RDBD UNRELATED my-bad.example
 my.example. 3600 IN RDBD RELATED https://my-way.example/mystuff.json
 my.example. 3600 IN RDBD UNRELATED https://my-way.example/notmine.json

 ;; Query time: 721 msec
 ;; SERVER: 127.0.0.1#53(127.0.0.1)
 ;; WHEN: Fri Sep 13 17:15:38 IST 2019
 ;; MSG SIZE rcvd: 600
```

Appendix D. Changes and Open Issues

[[RFC editor: please delete this appendix]]

D.1. Changes from -02 to -03

- Incorporated feedback/comments from IETF-105
- Suggest list dicussion move to dnsop@ietf.org
- Adopted some experimental RRCODE values
- Fixed normative vs. informative refs
- Changed the examples to use the PoC implementation.
- Restructured text a lot

D.2. Changes from -01 to -02

- Added negative assertions based on IETF104 feedback
- Added URL option based on IETF104 feedback
- Made sample generation script
- Typo fixes etc.

D.3. Changes from -00 to -01

- Changed from primary/secondary to relating/related (better suggestions are still welcome)
- Moved away from abuse of TXT RRs
- We now specify optional DNSSEC-like signatures (we'd be fine with moving back to a more DKIM-like mechanism, but wanted to see how this looked)
- Added Ed25519 option
- Re-worked and extended examples

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