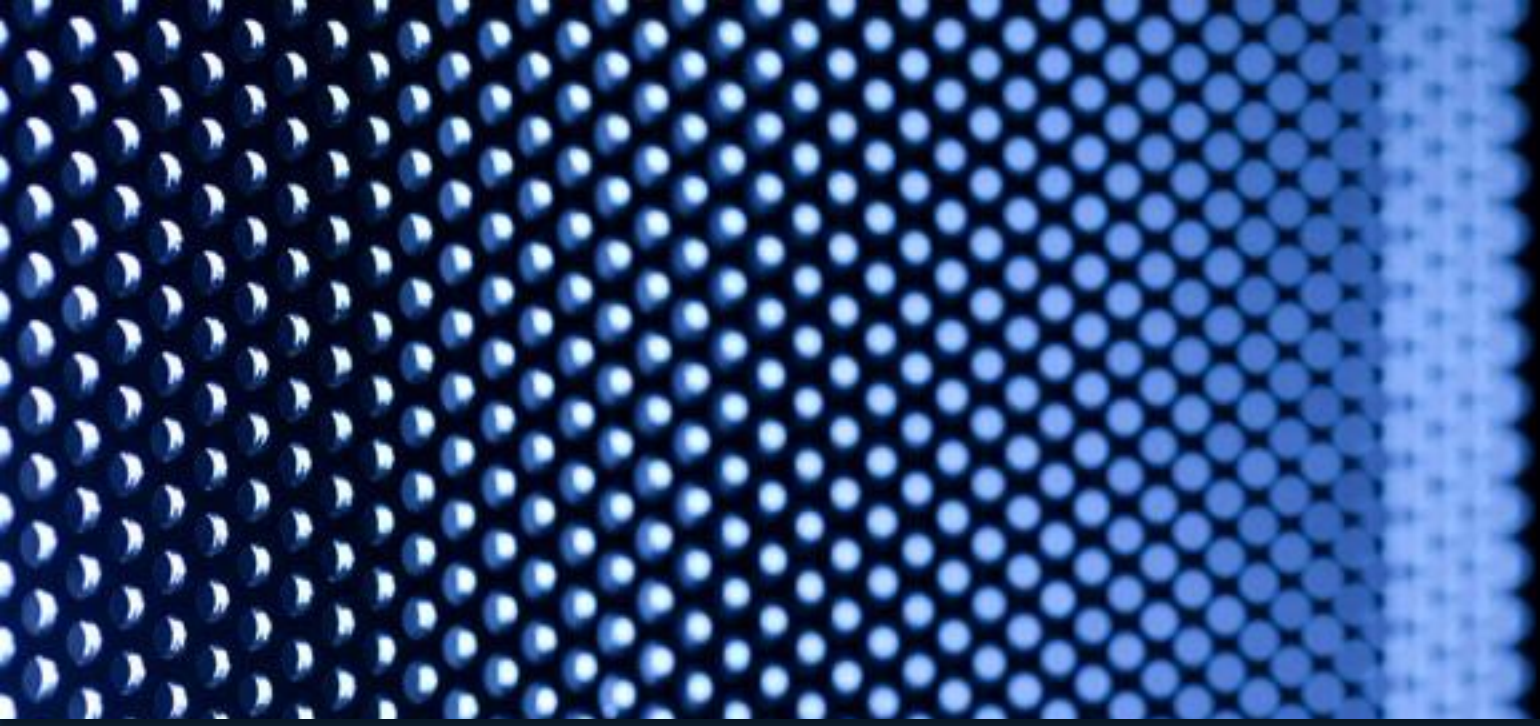


VERISIGN

Message Digests for DNS Zones

Including Plans for the Root Zone

DNS-OARC 38

July 2022

What is a DNS Zone Digest?

- A cryptographic digest, or hash, of the data in a DNS zone
- Embedded in the zone data itself as ZONEMD resource record
- Computed by zone publishers
- Verified by zone recipients

Analogous to Checksum Files for Software

Index of ftp://ftp.ubuntu.com/cdimage/daily-live/20210418/

Up to higher level directory

Name	Size	Last Modified
File: FOOTER.html	1 KB	4/18/21 1:21:00 AM PDT
File: HEADER.html	4 KB	4/18/21 1:21:00 AM PDT
File: SHA256SUMS	1 KB	4/18/21 1:21:00 AM PDT
File: SHA256SUMS.gpg	1 KB	4/18/21 1:21:00 AM PDT
File: hirsute-desktop-amd64.iso	2752696 KB	4/18/21 1:19:00 AM PDT
File: hirsute-desktop-amd64.iso.zsync	5377 KB	4/18/21 1:20:00 AM PDT
File: hirsute-desktop-amd64.list	16 KB	4/18/21 1:19:00 AM PDT
File: hirsute-desktop-amd64.manifest	56 KB	4/18/21 1:02:00 AM PDT
File: hirsute-desktop-arm64.iso	2226348 KB	4/18/21 1:20:00 AM PDT
File: hirsute-desktop-arm64.iso.zsync	4349 KB	4/18/21 1:21:00 AM PDT
File: hirsute-desktop-arm64.list	1 KB	4/18/21 1:20:00 AM PDT
File: hirsute-desktop-arm64.manifest	56 KB	4/18/21 1:16:00 AM PDT

How Does it Work?

- Specified in RFC 8976
- Zone data is given as input to a digest function
  - Using a well-defined and consistent ordering
  - And in a well-defined and consistent format
  - Excluding the ZONEMD record itself (and its signatures)
- Digest is included in the zone itself, and (ideally) signed with DNSSEC

Why is this Useful?

- Protects zone data “at rest”
  - e.g., data security vs channel security
- Useful in distributing zone data between primary and secondary name servers, especially in modern, complex environments
- Increased interest in serving root zone data locally (e.g., RFC 8806)
- CZDS – Centralized Zone Data Service
- RPZ – Response Policy Zones

Additional Technical Details

```
example.  86400  IN  ZONEMD  2018031900 1 1
8ee54f64ce0d57fd70e1a4811a9ca9e849e2e50cb598edf3ba9c2a58
625335c1f966835f0d4338d9f78f557227d63bf6
```

- Serial field
- Must match SOA record serial

Additional Technical Details

```
example.  86400  IN  ZONEMD  2018031900 1 1
8ee54f64ce0d57fd70e1a4811a9ca9e849e2e50cb598edf3ba9c2a58
625335c1f966835f0d4338d9f78f557227d63bf6
```

- Scheme field

Value	Description	Mnemonic
0	Reserved	
1	Simple ZONEMD collation	SIMPLE
240-254	Private Use	
255	Reserved	

Additional Technical Details

```
example.  86400  IN  ZONEMD  2018031900 1 1
8ee54f64ce0d57fd70e1a4811a9ca9e849e2e50cb598edf3ba9c2a58
625335c1f966835f0d4338d9f78f557227d63bf6
```

- Hash Algorithm field

Value	Description	Mnemonic
0	Reserved	
1	SHA-384	SHA384
2	SHA-512	SHA512
240-254	Private Use	
255	Reserved	

Additional Technical Details

```
example.  86400  IN  ZONEMD  2018031900 1 1
8ee54f64ce0d57fd70e1a4811a9ca9e849e2e50cb598edf3ba9c2a58
625335c1f966835f0d4338d9f78f557227d63bf6
```

- Digest field
- Length depends on chosen Hash Algorithm
  - Always 48 octets for SHA-384
  - Always 64 octets for SHA-512
  - Never less than 12 octets for any hash algorithm, including private use

Implementations

Implementation	Publish	Verify	Notes
ldns-zone-digest	yes	yes	RFC reference implementation
Unbound	no	yes	v1.13.2; *auth-zone* stanza
ldns	yes	yes	*ldns-signzone* and *ldns-verifyzone*
dns-tools from NIC Chile Labs	yes	yes	implemented in Go
NSD	no	no	parse only
PowerDNS Recursor	no	yes	v4.7.0, ”Zone to Cache”
Knot DNS	yes	yes	v3.1.0
Knot Resolver			work in progress
BIND9			parse only; further work in progress
Perl Net::DNS			parse only

Summary of ZONEMD Parsing and Verification

	Load Zone with native ZONEMD RR	Verify zone based on ZONEMD RR
BIND [1]	9.11.6 9.12.4 9.13.7	-
Unbound	1.13.2	1.13.2
NSD	4.3.4	4.6.0 [2]
Knot DNS	2.8.0	3.1.2
PowerDNS Recursor	4.6.0	4.7.0

[1] BIND versions released between Feb 2020 – May 2021 don't accept SHA-512 or other digest lengths not equal to 48 octets.
[2] NSD relies on an external validator, such as ldns-verifyzone

Summary of Zone Transfer Properties

	Accepts zone with ZONEMD RR via AXFR	When AXFR zone fails ZONEMD verification
BIND [1]	all	-
Unbound	1.12.0	SERVFAIL
NSD	3.0.6	[still testing]
Knot DNS	1.1.1	Serves previous zone
PowerDNS Recursor	4.6.0	[still testing]

[1] BIND versions released between Feb 2020 – May 2021 don't accept SHA-512 or other digest lengths not equal to 48 octets.

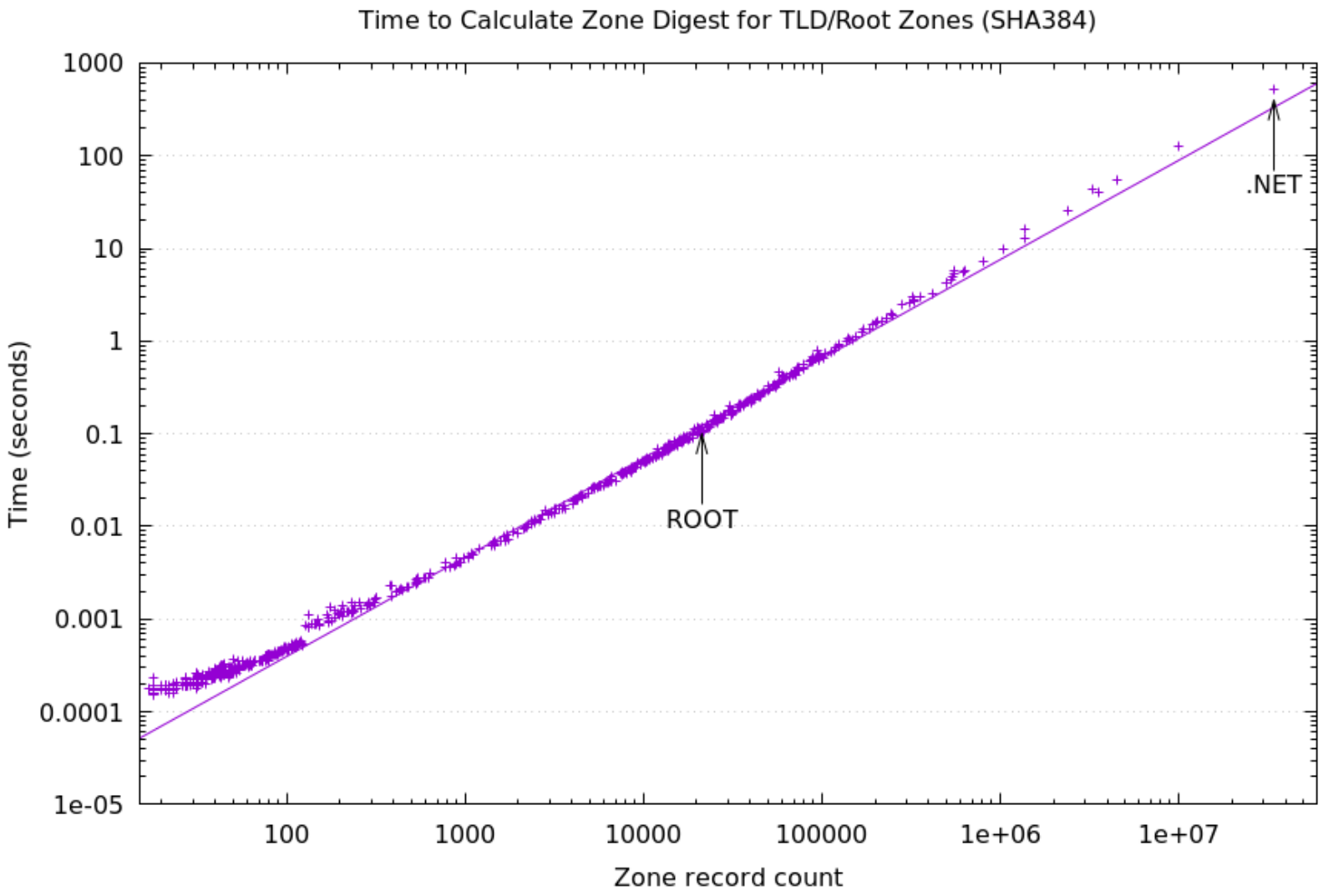
Example Using Unbound 1.13.2

```
server:
        verbosity: 3
        interface: 127.0.0.1

auth-zone:
        name: “example”
        zonefile: “example.zone”
        zonemd-check: yes
```

```
[1619565823] unbound[73900:0] debug: module config: "validator iterator"
[1619565823] unbound[73900:0] notice: init module 0: validator
[1619565823] unbound[73900:0] debug: validator nsec3cfg keysz 1024 mxiter 150
[1619565823] unbound[73900:0] debug: validator nsec3cfg keysz 2048 mxiter 500
[1619565823] unbound[73900:0] debug: validator nsec3cfg keysz 4096 mxiter 2500
[1619565823] unbound[73900:0] notice: init module 1: iterator
[1619565823] unbound[73900:0] debug: target fetch policy for level 0 is 3
[1619565823] unbound[73900:0] debug: target fetch policy for level 1 is 2
[1619565823] unbound[73900:0] debug: target fetch policy for level 2 is 1
[1619565823] unbound[73900:0] debug: target fetch policy for level 3 is 0
[1619565823] unbound[73900:0] debug: target fetch policy for level 4 is 0
[1619565823] unbound[73900:0] debug: donotq: 127.0.0.0/8
[1619565823] unbound[73900:0] debug: donotq: ::1
[1619565823] unbound[73900:0] debug: read zonefile example.zone for example.
[1619565823] unbound[73900:0] debug: auth-zone example. ZONEMD hash is correct
[1619565823] unbound[73900:0] debug: auth zone example. ZONEMD verification successful
```

Benchmarks with ldns-zone-digest



ZONEMD for the Root Zone

RZERC Recommendations

Earlier this year, ICANN's Root Zone Evolution Review Committee (RZERC) made the following recommendations to the ICANN Board regarding ZONEMD in the root zone:

1. The root zone maintainer and root server operators should verify and confirm that the addition of a ZONEMD resource record will in no way negatively impact the distribution of root zone data within the RSS.
2. The DNS and Internet community should be made aware of plans to use ZONEMD in the root zone, and be given an opportunity to offer feedback.
3. Developers of name server software are encouraged to implement ZONEMD and consider enabling it by default when the software is configured to locally serve root zone data.
4. Public Technical Identifiers (PTI) and the RZM should jointly develop a plan for deploying ZONEMD in the root zone, and make this plan available for review by RZERC.

Source: https://www.icann.org/iana_rzerc_docs/449-rzerc003-adding-zone-data-protections-to-the-root-zone-v-final

Tentative Root ZONEMD Deployment Plans

- A single ZONEMD record
- Two phases
  - Phase 1: a private-use hash algorithm
  - Phase 2: SHA-384
- Presentation format: Native ZONEMD or Generic format?
- Expecting a published statement from root server operators:
  - Confirming their systems are able to support ZONEMD
  - Agreeing to not enable ZONEMD verification for at least one year

Native vs Generic / Unknown RR Format

- These two formats are equivalent:

```
. 86400 IN ZONEMD 2021101902 1 1
7d016e7badfd8b9edbfb515deebe7a866bf972104fa06fece85402cc4ce9b69bd0cbd652
cec4956a0f206998bfb34483
```

```
. 86400 IN TYPE63 \# 54
7877914e01017d016e7badfd8b9edbfb515deebe7a866bf972104fa06fece85402cc4ce9
b69bd0cbd652cec4956a0f206998bfb34483
```

- For distribution within the root server system, this won't matter
- Only matters when zone is written in text or presentation format (e.g., at www.internic.net) and later parsed by DNS software
- Generic format probably minimizes potential disruption for users that download and parse root zone files
- Probably difficult to change and could set a bad precedent for introducing new RR types

Questions?

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