DNS over CoAP (DoC) & DNS messages in CBOR

`[draft-ietf-core-dns-over-coap, draft-lenders-dns-cbor]`

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Outline

Draft 1: DNS over CoAP (DoC)

Next Steps for draft-ietf-core-dns-over-coap

Draft 2: A Concise Binary Object Representation (CBOR) of DNS Messages

Next Steps for draft-lenders-dns-over-coap

Motivation for DNS over CoAP

Attack Scenario

Countermeasure: Encrypt name resolution triggered by IoT devices against eavesdropping

Our Proposal: DNS over CoAP (DoC), `draft-ietf-core-dns-over-coap`

- **Encrypted communication** based on DTLS or OSCORE
- **Block-wise message transfer** to overcome Path MTU problem (DNS over DTLS)
- **Share system resources** with CoAP applications
  - Same socket and buffers can be used
  - Re-use of the CoAP retransmission mechanism

Changes to DoC Draft Since IETF 114

+ Add security considerations on ID=0 in unencrypted use
• Replace layer violating statement for CON with statement of fact
– Remove “DoC Server Considerations” (moved to `draft-lenders-dns-cns`)

Open Discussions on DoC

Feedback from DNSOP (thanks!):

- Why isn't DoH via CoAP gateway sufficient? The draft should explain.
- Explain why TTL rewriting proposed is notably different from DoH.
- Does DoC live at a URI path? If so, consider defining a default path, if this is a common practice in CoAP.
- Recommendation to add a section describing how to bootstrap DoC in a SVCB-DNS record. May require to allocate a new ALPN ID for CoAP/DTLS.

Next Steps

DoC

- Address feedback where possible
- Pick ID for `application/dns-message` Content-Format

Guidance on DNS in constrained networks

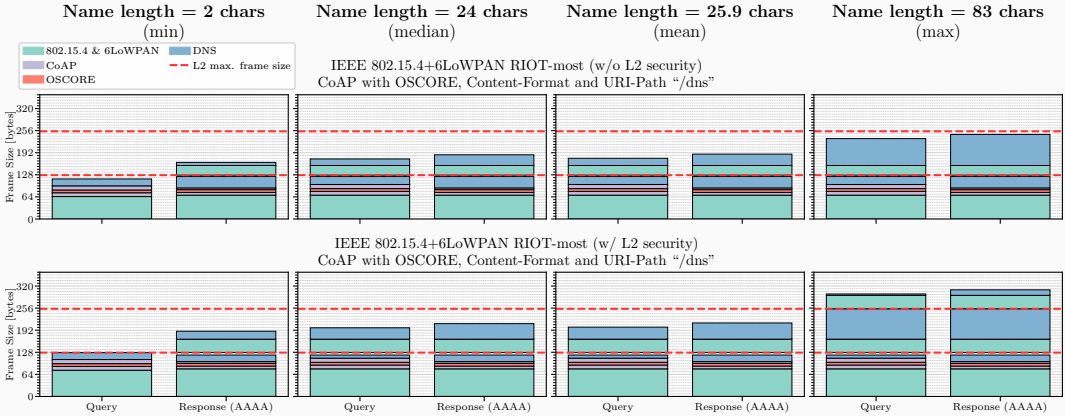
- Details see `draft-lenders-dns-cns`
- Do we see value in such guidance?

Draft 2: A Concise Binary Object Representation (CBOR) of DNS Messages

Drawback of DNS in Constrained Networks

Packet size exceeds 802.15.4 PDU depending on queried name length

⇒ Fragmentation



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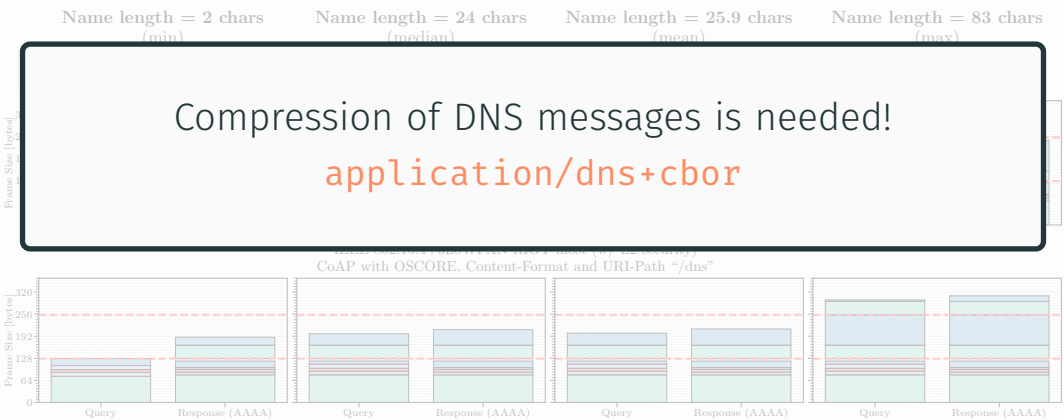

Compression of DNS messages is needed!

`application/dns+cbor`

Objectives of draft-lenders-dns-cbor (`application/dns+cbor`)

Reduce packet sizes of DNS queries and replies:

1. Encoding of DNS messages in CBOR
2. Omit (redundant) DNS fields in DNS queries and responses
3. Address and name compression using packed CBOR (optional)

DNS Query

Using CDDL (RFC8610)

```
domain-name = tstr
type-spec = (
  record-type: uint,
  ? record-class: uint,
)
dns-question = (
  ? id: uint,
  name: domain-name,
  ? type-spec,
)
dns-query = [dns-question]
```

CBOR array:

- At minimum containing text string domain name (IDNA encoded)
- Optional ID and record type specification
  (ID defaults to 0, record-type to `AAAA`, record-class to `IN`)

DNS Resource Record

```
rr = (
  ? name: domain-name,
  ttl: uint,
  ? type-spec,
  rdata: bstr / domain-name,
)
dns-rr = [rr]
```

CBOR array:

- At minimum containing TTL and resource data
- Optional name and record type specification
  (both default to question values)

DNS Response

```
extra-sections = (
  ? authority: [+ dns-rr],
  additional: [+ dns-rr]
)
sections = ((
  ? id: uint,
  answer: [+ dns-rr]
) // (
  ? id: uint,
  question: dns-query,
  answer: [+ dns-rr],
  ? extra-sections,
))
dns-response = [sections]
```

CBOR array of arrays:

- At minimum containing answer section (array of DNS resource records)
- Generally assumes that transport can map query to response! (original question and ID may be amended optionally)

Simple Example

Query IPv6 address for `example.org`
(13 bytes vs. 52 bytes wire-format: compression 400%)

```
["example.org"]
```

Corresponding response (24 bytes vs. 68 bytes wire-format: compression 283.3%):

```
[[[3600, h'20010db8000000000000000000000001']]]
```

A More Complex Example

Query ANY record for `example.org` (*cf.* DNS-SD)
(17 bytes vs. 52 bytes wire-format: compression 305,9%)

```
["example.org", 255, 255]
```

Corresponding response (200 bytes vs. 195 bytes wire-format: compression 97.5%):

```
[
  ["example.org", 12, 1],
  [[3600, "_coap._udp.local"]],
  [[3600, 2, "ns1.example.org"], [3600, 2, "ns2.example.org"]],
  [
    ["_coap._udp.local", 3600, 28, h'20010db8000000000000000000000001'],
    ["ns1.example.org", 3600, 28, h'20010db8000000000000000000000035'],
    ["ns2.example.org", 3600, 28, h'20010db8000000000000000000003535']
  ]
]
```

A More Complex Example

Query ANY record for `example.org` (*cf.* DNS-SD)
(17 bytes vs. 52 bytes wire-format: compression 305,9%)

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["example.org", 255, 255]
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Corresponding response (200 bytes vs. 195 bytes wire-format: compression 97.5%):

```
[
  ["example.org", 12, 1],
  [[3600, "_coap._udp.local"]],
  [[3600, 2, "ns1.example.org"], [3600, 2, "ns2.example.org"]],
  [
    ["_coap._udp.local", 3600, 28, h'20010db8000000000000000000000001'],
    ["ns1.example.org", 3600, 28, h'20010db8000000000000000000000035'],
    ["ns2.example.org", 3600, 28, h'20010db8000000000000000000003535']
  ]
]
```

⇒ Larger than wire-format! Address and name compression needed

A More Complex Example

Query ANY record for `example.org` (*cf.* DNS-SD)
(17 bytes vs. 52 bytes wire-format: compression 305,9%)

```
["example.org", 255, 255]
```

Corresponding response (200 bytes vs. 195 bytes wire-format: compression 97.5%):

```
[
  [
    ["example.org", 16, 32],
    [3600, "_coap._udp.local", 33, 0, 5683, "ns1.example.org"],
    [3600, "_coaps._udp.local", 33, 0, 5684, "ns1.example.org"],
    [3600, 2, "ns1.example.org", "ns2.example.org"],
    [
      ["_coap._udp.local", 3600, 28, h'20010db8000000000000000000000001'],
      ["ns1.example.org", 3600, 28, h'20010db8000000000000000000000035'],
      ["ns2.example.org", 3600, 28, h'20010db8000000000000000000003535']
    ]
  ]
]
```

Packed CBOR (`draft-ietf-cbor-packed`) comes with prefix- and suffix-based compression.

⇒ Larger than wire-format! Address and name compression needed

Our Proposal: Name and Address Compression Using Packed CBOR

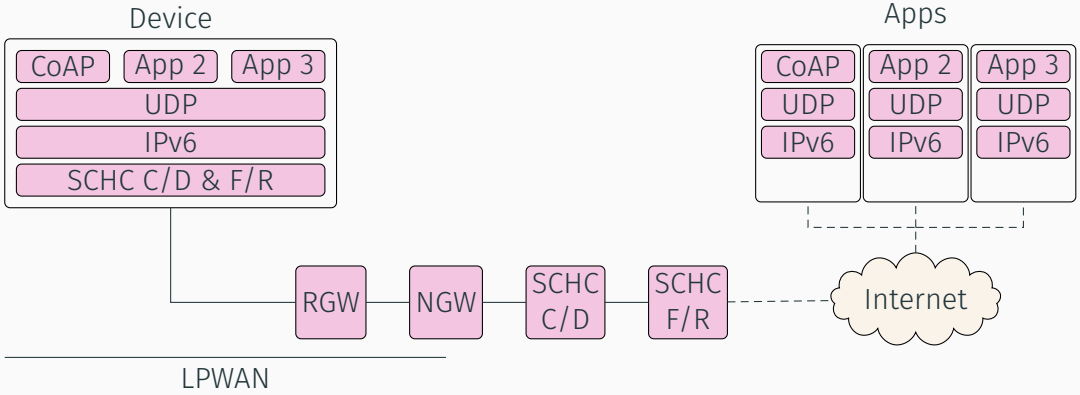
- Optional packed CBOR support *for responses* negotiated using parameter `application/dns+cbor;packed=1` (own media type in draft `-01`)
- Make shared value and argument tables one list for that media type

```
compr-dns-response = any # TBD; how to express packed CBOR in CDDL?
packed-dns-response = [[pack-table], compr-dns-response]
pack-table = any
```

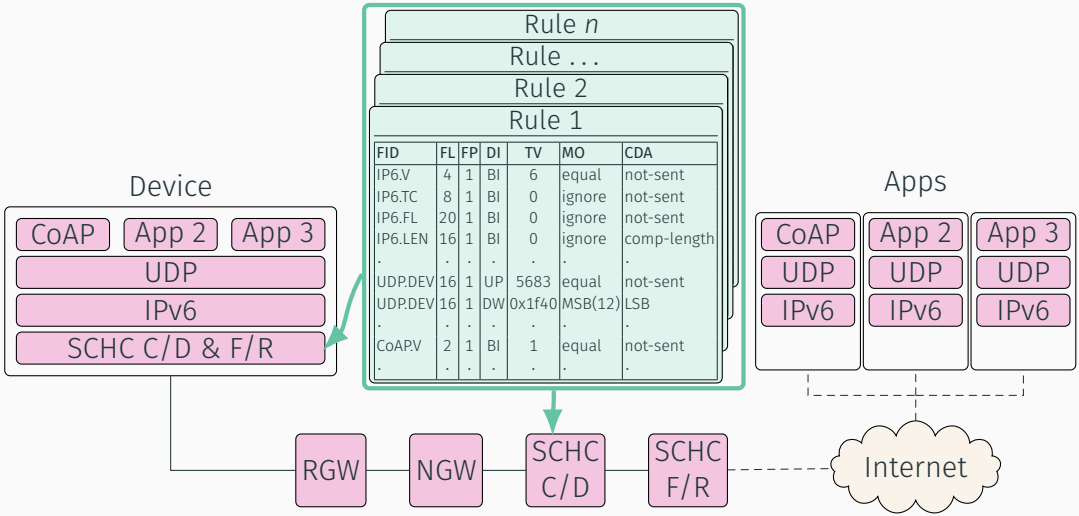
Response becomes another CBOR array of two arrays:

1. Packing table (combined shared value and argument table)
2. Compressed `dns-response`
   (structure as defined before: CBOR array of sections)

Why Not SCHC?


Device
CoAP
App 2
App 3
UDP
IPv6
SCHC C/D & F/R
Apps
CoAP
App 2
App 3
UDP
UDP
UDP
IPv6
IPv6
IPv6
RGW
NGW
SCHC C/D
SCHC F/R
Internet
LPWAN

Why Not SCHC?


Rule n
Rule . . .
Rule 2
Rule 1
FID FL FP DI TV MO CDA
IP6.V 4 1 BI 6 equal not-sent
IP6.TC 8 1 BI 0 ignore not-sent
IP6.FL 20 1 BI 0 ignore not-sent
IP6.LEN 16 1 BI 0 ignore comp-length
. . . . . .
UDP.DEV 16 1 UP 5683 equal not-sent
UDP.DEV 16 1 DW 0x1f40 MSB(12) LSB
. . . . . .
CoAP.V 2 1 BI 1 equal not-sent
. . . . . .
Device
CoAP
App 2
App 3
UDP
IPv6
SCHC C/D & F/R
Apps
CoAP
UDP
IPv6
App 2
UDP
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App 3
UDP
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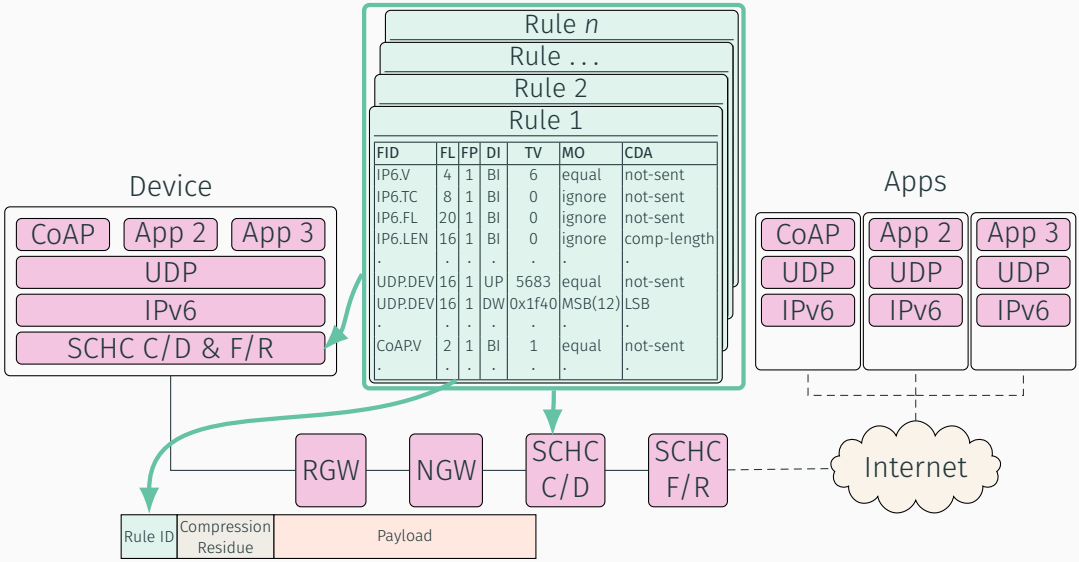
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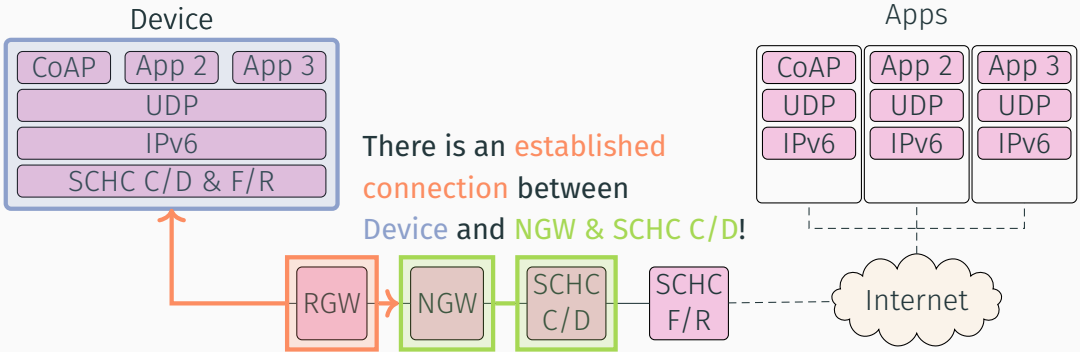
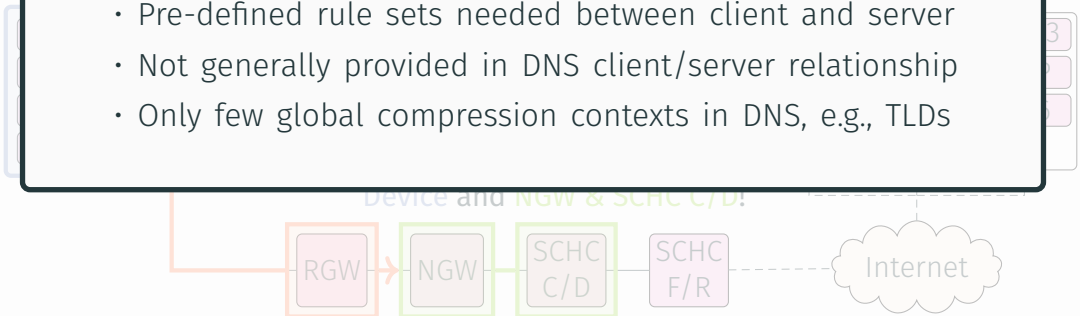
Device
CoAP
App 2
App 3
UDP
IPv6
SCHC C/D & F/R
Apps
CoAP
UDP
IPv6
App 2
UDP
IPv6
App 3
UDP
IPv6
RGW
NGW
SCHC C/D
SCHC F/R
Internet
Rule ID
Compression Residue
Payload

Why Not SCHC?


Device
CoAP
App 2
App 3
UDP
IPv6
SCHC C/D & F/R
There is an established connection between Device and NGW & SCHC C/D!
RGW
NGW
SCHC C/D
SCHC F/R
Internet
Apps
CoAP
UDP
IPv6
App 2
UDP
IPv6
App 3
UDP
IPv6

Why Not SCHC?

- Pre-defined rule sets needed between client and server
- Not generally provided in DNS client/server relationship
- Only few global compression contexts in DNS, e.g., TLDs



Example: ANY Record Response in `application/dns+cbor;packed=1`

Original CBOR response (200 bytes)

```
[["example.org", 12, 1],
 [[3600, "_coap._udp.local"]],
 [[3600, 2, "ns1.example.org"],
  [3600, 2, "ns2.example.org"]],
 [["_coap._udp.local", 3600, 28,
   h'20010db8000000000000000000000001'],
  ["ns1.example.org", 3600, 28,
   h'20010db8000000000000000000000035'],
  ["ns2.example.org", 3600, 28,
   h'20010db8000000000000000000003535']]]
```

Packed CBOR response (119 bytes)

```
[[h'20010db800000000000000000000',
  "_coap._udp.local", "example.org",
  3600, 28, 2
 ],
 [[simple(2), 12, 1],
  [[simple(3), simple(1)]],
  [[simple(2), simple(5), 219("ns1.")],
   [simple(2), simple(5), 219("ns2.")]],
  [[simple(1), simple(3), simple(4), 6(h'0001')],
   [219("ns1."), simple(3), simple(4), 6(h'0035')],
   [219("ns2."), simple(3), simple(4), 6(h'3535')]
  ]]]
```

(*cmp.* 195 bytes wire-format: compression 163.9%)

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   h'20010db8000000000000000000000001'],
  ["ns1.example.org", 3600, 28,
   h'20010db8000000000000000000000035'],
  ["ns2.example.org", 3600, 28,
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  ]]]
```

(*cmp.* 195 bytes wire-format: compression 163.9%)

Implied DNS-specific table entries for global compression contexts (e.g. TLDs) enable potential for more elision

Next Steps

Define more details on using packed CBOR:

- How to construct packing table?
- Global compression contexts, DNS-specific implied table entries
- ⟨Your thoughts.⟩