A Concise Binary Object Representation (CBOR) of DNS Messages

draft-lenders-dns-cbor-01

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Motivation

Objectives and Definition

Feedback from DNSOP in CoRE discussions

Next Steps for draft-lenders-dns-over-coap
Packet size exceeds 802.15.4 PDU depending on queried name length

⇒ Fragmentation

**Motivation: DNS in Constrained Networks**

IEEE 802.15.4+6LoWPAN RIOT-most (w/o L2 security)
CoAP with OSCORE, Content-Format and URI-Path “/dns”

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DNS over CoAP ([draft-ietf-core-dns-over-coap](https://datatracker.ietf.org/doc/draft-ietf-core-dns-over-coap)) messages for different name lengths
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⇒ Fragmentation

<table>
<thead>
<tr>
<th>Frame Size [bytes]</th>
<th>IEEE 802.15.4+6LoWPAN RIOT-most (w/o L2 security)</th>
<th>CoAP with OSCORE, Content-Format and URI-Path &quot;/dns&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Query</td>
<td>Response (AAAA)</td>
</tr>
<tr>
<td>64</td>
<td>Query</td>
<td>Response (AAAA)</td>
</tr>
<tr>
<td>128</td>
<td>Query</td>
<td>Response (AAAA)</td>
</tr>
<tr>
<td>192</td>
<td>Query</td>
<td>Response (AAAA)</td>
</tr>
<tr>
<td>256</td>
<td>Query</td>
<td>Response (AAAA)</td>
</tr>
<tr>
<td>320</td>
<td>Query</td>
<td>Response (AAAA)</td>
</tr>
</tbody>
</table>

Compression of DNS messages is needed!

application/dns+cbor

DNS over CoAP (draft-ietf-core-dns-over-coap) messages for different name lengths
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)
Feedback from DNSOP in CoRE discussions

• Concise format might hamper future DNS extensions
• Possible ways to address:
  • Allow for unstructured resource records as byte string
  • Content negotiation
    • e.g., application/dns-message as fallback is not off the table
  • ⟨Your thoughts?⟩
Using CDDL (RFC8610)

domain-name = \texttt{tstr}

type-spec = (
    record-type: \texttt{uint},
    ? record-class: \texttt{uint},
)

dns-question = (
    ? id: \texttt{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 \texttt{AAAA}, record-class to \texttt{IN})
CoRE & DNSOP discussions:

- Does not consider additional section for EDNS(0) pseudo-RRs
- How to express DNS Stateful Operations (DSO)?
  - Opcode = 6
  - All section counts = 0
  - TLVs after traditional sections
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 Resource Record

CoRE & DNSOP discussions:

- $\text{dns-rr} = [\text{rr}] \lor \text{bstr}$ for potential future DNS extensions?
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)
CBOR array of arrays:

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]

CoRE & DNSOP discussions:

- DNS Stateful Operations again missing
- Fields completely ignored at the moment:
  Opcode, Rcode, Flags
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']
    ]
]
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  [[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
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[[3600, ".coap._udp.local"],
[[3600, 2, "ns1.example.org"],
[[3600, 2, "ns2.example.org"],
[".coap._udp.local", 3600, 28, h'20010db800000000000000000000001'],
["ns1.example.org", 3600, 28, h'20010db8000000000000000000000035'],
["ns2.example.org", 3600, 28, h'20010db8000000000000000000003535']
]
\\]

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

**Packed CBOR (draft-ietf-cbor-packed) comes with prefix- and suffix-based compression.**
Our Proposal: Name and Address Compression Using Packed CBOR

- Optional packed CBOR support for responses negotiated using media type parameter packed=1 (own media type in draft -01)
- Make shared value and argument tables one list for that media type

```python
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)
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'20010db80000000000000000000000001'],
 ["ns1.example.org", 3600, 28,
  h'20010db80000000000000000000000035'],
 ["ns2.example.org", 3600, 28,
  h'20010db80000000000000000000003535']]

Packed CBOR response (119 bytes)

[[h'20010db80000000000000000000000000',
  "_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%)
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'20010db80000000000000000000003535']]]

Packed CBOR response (119 bytes)

[[h'20010db8000000000000000000000000',
 "_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%)

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

- Back to the drawing board?
  - Major format change needed for EDNS(0)/DSO etc.
  - Or keep as is (with minor changes)? Use application/dns-message as fallback

- Define more details on using packed CBOR:
  - How to construct packing table?
  - Global compression contexts, DNS-specific implied table entries
  - (Your thoughts.)