CBOR Encoding of Data Modeled with YANG

draft-ietf-core-yang-cbor-00

Abstract

This document defines encoding rules for serializing configuration data, state data, RPC input and RPC output, Action input, Action output and notifications defined within YANG modules using the Concise Binary Object Representation (CBOR) [RFC7049].

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1. Introduction
The specification of the YANG 1.1 data modelling language [I-D.ietf-netmod-rfc6020bis] defines only an XML encoding for data instances, i.e. contents of configuration datastores, state data, RPC inputs and outputs, action inputs and outputs, and event notifications.

A new set of encoding rules has been defined to allow the use of the same data models in environments based on the JavaScript Object Notation (JSON) Data Interchange Format [RFC7159]. This is accomplished in the JSON Encoding of Data Modeled with YANG specification [I-D.ietf-netmod-yang-json].

The aim of this document is to define a set of encoding rules for the Concise Binary Object Representation (CBOR) [RFC7049]. The resulting encoding is more compact compared to XML and JSON and more suitable for Constrained Nodes and/or Constrained Networks as defined by [RFC7228].

2. Terminology and 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].

The following terms are defined in [I-D.ietf-netmod-rfc6020bis]:

- action
- anydata
- anyxml
- data node
- data tree
- module
- notification
- RPC
The following terms are defined in [I-D.ietf-netmod-yang-json]:

- member name
- name of an identity

The following term is defined in [I-D.vanderstok-core-comi]:

- YANG hash

This specification also makes use of the following terminology:

- child: A schema node defined within a collection such as a container, a list, a case, a notification, an RPC input, an RPC output, an action input, an action output.

- delta: Difference between the SID assigned to the current schema node and the SID assigned to the parent.

- parent: The collection in which a schema node is defined.

- structured identifier or SID: Unsigned integer used to identify different YANG items.

### 2.1. CBOR diagnostic notation

Within this document, CBOR binary contents are represented using an equivalent textual form called CBOR diagnostic notation as defined in [RFC7049] section 6. This notation is used strictly for documentation purposes and is never used in the data serialization.
<table>
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<tr>
<th>CBOR content</th>
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<tbody>
<tr>
<td>Unsigned</td>
<td>0</td>
<td>Decimal digits</td>
<td>123</td>
<td>18 7b</td>
</tr>
<tr>
<td>Negative</td>
<td>1</td>
<td>Decimal digits prefixed by a minus sign</td>
<td>-123</td>
<td>38 7a</td>
</tr>
<tr>
<td>Byte</td>
<td>2</td>
<td>Hexadecimal value enclosed between single quotes and prefixed by an 'h'</td>
<td>h'f15c'</td>
<td>42 f15c</td>
</tr>
<tr>
<td>Text</td>
<td>3</td>
<td>String of Unicode characters enclosed between double quotes</td>
<td>&quot;txt&quot;</td>
<td>63</td>
</tr>
<tr>
<td>Array</td>
<td>4</td>
<td>Comma-separated list of values within square brackets</td>
<td>[ 1, 2 ]</td>
<td>82 01 02</td>
</tr>
<tr>
<td>Map</td>
<td>5</td>
<td>Comma-separated list of key : value pairs within curly braces</td>
<td>{ 1: 123, 2: 456 }</td>
<td>01187b 021901c8</td>
</tr>
<tr>
<td>Boolean</td>
<td>7/20</td>
<td>false</td>
<td>false</td>
<td>f4</td>
</tr>
</tbody>
</table>
Within this document, comments are allowed in CBOR diagnostic notation. Any characters after a Pound sign ('#') outside of a string, up to the end of the line, are treated as a comment.

3. Properties of the CBOR Encoding

This document defines CBOR encoding rules for YANG schema trees and their subtrees.

Basic schema nodes such as leaf, leaf-list, list, anydata and anyxml can be encoded standalone. In this case, only the value of this schema node is encoded in CBOR. Identification of this value need to be provided by some external means when needed.

A collection such as container, list instance, notification, RPC input, RPC output, action input and action output is serialized using a CBOR map in which each child schema node is encoded using a key and a value. This specification supports three type of keys; SID as defined in [I-D.somaraju-core-sid], member names as defined in [I-D.ietf-netmod-yang-json] and YANG hash as defined by [I-D.vanderstok-core-comi]. Each of these key type is encoded using a specific CBOR type which allows their interpretation during the deserialization process. The end user of this mapping specification can mandate the use of a specific key type or a specific subset of key types.

In order to minimize the size of the encoded data, the proposed mapping does not make use of any meta-information beyond those natively supported by CBOR. For instance, CBOR tags are not used for any of the proposed mapping. It is expected that entities generating and decoding CBOR contents have enough knowledge about the information processed in order to perform the expected task without the need of such extra meta-information. The CoAP Content-Format Option, or an HTTP Content-Type header field, conveys that the data is YANG-encoded CBOR in the first place.
4. Encoding of YANG Schema Node Instances

Schema node instances defined using the YANG modeling language are encoded using CBOR [RFC7049] based on the rules defined in this section. We assume that the reader is already familiar with both YANG [I-D.ietf-netmod-rfc6020bis] and CBOR [RFC7049].

4.1. The "leaf" Schema Node

Leafs MUST be encoded based on the encoding rules specified in Section 5.

4.2. The "container" Schema Node

Collections such as containers, list instances, notifications, RPC inputs, RPC outputs, action inputs and action outputs MUST be encoded using a CBOR map data item (major type 5). A map is comprised of pairs of data items, with each data item consisting of a key and a value. This specification supports three type of keys; SID as defined in [I-D.somaraju-core-sid], member names as defined in [I-D.ietf-netmod-yang-json] and YANG hash as defined by [I-D.vanderstok-core-comi].

*SIDs as keys*

Keys implemented using SIDs MUST be encoded using a CBOR unsigned integer (major type 0) and set to the delta value of the associated SID. Delta values are computed as follows:

- The delta value is equal to the SID of the current schema node minus the SID of the parent schema node. When no parent exists in the context of use of this container, the delta is set to the SID of the current schema node (a parent with SID equal to zero is assumed).
- Delta values may result in a negative number, clients and servers MUST support negative deltas.

*Member names as keys*
Keys implemented using member names MUST be encoded using a CBOR text string data item (major type 3). A namespace-qualified member name MUST be used for all members of a top-level collection, and then also whenever the namespaces of the schema node and its parent are different. In all other cases, the simple form of the member name MUST be used. Member names and namespaces are defined in [I-D.ietf-netmod-yang-json] section 4.

*YANG hashes as keys*

Keys implemented using YANG hashes MUST be encoded using a CBOR byte string data item (major type 2).

Values MUST be encoded using the appropriate rules defined in Section 4 and Section 5.

Definition example [RFC7317]:

typedef date-and-time {
    type string {
        pattern '\d{4}-\d{2}-\d{2}T\d{2}:\d{2}:\d{2}(\.\d+)?(Z|\[\+\-] \d{2}:\d{2})';
    }
}

container system {
    leaf hostname {
        type inet:domain-name;
    }

    container clock {
        leaf current-datetime {
            type date-and-time;
        }

        leaf boot-datetime {
            type date-and-time;
        }
    }
}
This example is encoded using the SIDs defined in [I-D.somaraju-core-sid] Appendix C.

CBOR diagnostic notation:

```json
{
    1708 : {                              # clock
        2 : "2015-10-02T14:47:24Z-05:00",   # current-datetime, SID 1710
        1 : "2015-09-15T09:12:58Z-05:00"    # boot-datetime, SID 1709
    }
}
```

CBOR encoding:

```
19 06ac                              # unsigned(1708)
02                                   # map(2)
78 1a                                # text(26)
323031352d31302d303254313433a34373a32345a2d30353a3030  # unsigned(1)
78 1a                                # text(26)
323031352d30392d31355430393a31323a35385a2d30353a3030  # unsigned(1)
```

*Member names example*

CBOR diagnostic notation:

```json
{
    "ietf-system:clock" : {
        "current-datetime" : "2015-10-02T14:47:24Z-05:00",
        "boot-datetime" : "2015-09-15T09:12:58Z-05:00"
    }
}
```

CBOR encoding:
a1  # map(1)
  71  # text(17)
    696574662d73797374656d3a6366c6f6366b  # "ietf-system:clock"
  a2  # map(2)
    70  # text(16)
      63757272656e742d6461746574696d65  # "current-datetime"
    78 1a  # text(26)
      323031352d31302d30325431343a34373a32345a2d30353a3030
  6d  # text(13)
    6266742d6461746574696d65  # "boot-datetime"
    78 1a  # text(26)
      323031352d30392d31355430393a31323a35385a2d30353a3030

*YANG Hashes example*

CBOR diagnostic notation:

```c
{
  h'334c67d9' : {  # clock
    h'047c468b' : "2015-10-02T14:47:24Z-05:00",  # current-datetime
    h'2fe1a167' : "2015-09-15T09:12:58Z-05:00"  # boot-datetime
  }
}
```

CBOR encoding:

```
a1  # map(1)
  44  # bytes(4)
    334c67d9
  a2  # map(2)
    44  # bytes(4)
      047c468b
    78 1a  # text(26)
      323031352d31302d30325431343a34373a32345a2d30353a3030
    44  # bytes(4)
      2fe1a167
    78 1a  # text(26)
      323031352d30392d31355430393a31323a35385a2d30353a3030
```

**4.3. The "leaf-list" Schema Node**

A leaf-list MUST be encoded using a CBOR array data item (major type 4). Each entry of this array MUST be encoded using the rules defined by the YANG type specified.

Definition example [RFC7317]:

---

**Text from the image:**

```
696574662d73797374656d3a6366c6f6366b  # "ietf-system:clock"
63757272656e742d6461746574696d65  # "current-datetime"
6266742d6461746574696d65  # "boot-datetime"
```
typedef domain-name {
    type string {
        length "1..253";
        pattern '(((\[a-zA-Z0-9\._])\{0,61\})?[a-zA-Z0-9-\._])\*(((\[a-zA-Z0-9\._])\{0,61\})?[a-zA-Z0-9-\._])\.|\.';
    }
}

leaf-list search {
    type domain-name;
    ordered-by user;
}

CBOR diagnostic notation: [ "ietf.org", "ieee.org" ]

CBOR encoding: 82 68 6965746662e6f7267 68 69656562e6f7267

4.4. The "list" Schema Node

A list MUST be encoded using a CBOR array data item (major type 4). Each entry of this array is encoded using a CBOR map data item (major type 5) based on the same rules as a YANG container, see Section 4.2.

Definition example [RFC7317]:
list server {
    key name;

    leaf name {
        type string;
    }

    choice transport {
        case udp {
            container udp {
                leaf address {
                    type host;
                    mandatory true;
                }
                leaf port {
                    type port-number;
                }
            }
        }
    }

    leaf association-type {
        type enumeration {
            enum server;
            enum peer;
            enum pool;
        }
        default server;
    }

    leaf iburst {
        type boolean;
        default false;
    }

    leaf prefer {

type boolean;
default false;
}

*SIDs example*

SIDs used in this example are defined in [I-D.somaraju-core-sid] Appendix C. It is important to note that the protocol or method using this mapping may carry a parent SID or may have the knowledge of this parent SID based on its context. In these cases, delta encoding can be performed based on this parent SID which minimizes the size of the encoded data.

CBOR diagnostic notation:


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[{
  1746 : "NRC TIC server",          # name
  1748 : {                          # udp
    1 : "tic.nrc.ca",               # address, SID 1749
    2 : 123                         # port, SID 1750
  },
  1744 : 0,                         # association-type
  1745 : false,                     # iburst
  1747 : true                       # prefer
},
{
  1746 : "NRC TAC server",          # name
  1748 : {                          # udp
    1 : "tac.nrc.ca"                # address, SID 1749
  }                                 #
}
]

CBOR encoding:

82                                    # array(2)
a5                                 # map(5)
  19 06d2                         # unsigned(1746)
  6e                             # text(14)

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*Member names example*

CBOR diagnostic notation:

```
[
  {
    "ietf-system:name" : "NRC TIC server",
    "ietf-system:udp" : {
      "address" : "tic.nrc.ca",
      "port" : 123
    },
    "ietf-system:association-type" : 0,
    "ietf-system:iburst" : false,
    "ietf-system:prefer" : true
  },
  {
    "ietf-system:name" : "NRC TAC server",
    "ietf-system:udp" : {
```
"address" : "tac.nrc.ca"
}
}
]

CBOR encoding:

82
a5
 70
  696574662d73797374656d3a6e616d65
  6e
  4e5243205449320736572666572
  6f
  696574662d73797374656d3a756470
a2
  67
  61646472657373

# array(2)
# map(5)
# text(16)
# "ietf-system:name"
# text(14)
# "NRC TIC server"
# text(15)
# "ietf-system:udp"
# map(2)
# text(7)
# "address"
*YANG hashes example*

CBOR diagnostic notation:

```
[ 
  { 
    h'06c32032' : "NRC TIC server",  # name
    h'11889c84' : {  # udp
      h'06c32032' : "NRC TAC server",  # text(14)
      h'06c32032' : "NRC TAC server",  # text(15)
      h'06c32032' : "tac.nrc.ca"  # text(10)
    }
  }
]```
h'3158c529' : "tic.nrc.ca",  # address
h'34492d05' : 123           # port
},
  h'2c2c2ccf' : 0,            # association-type
  h'1058dc5d' : false,        # iburst
  h'390e346a' : true          # prefer
},

  {
    h'06c32032' : "NRC TAC server",   # name
    h'11889c84' : {          # udp
      h'3158c529' : "tac.nrc.ca"  # address
    }
  }
]

CBOR encoding:
4.5. The "anydata" Schema Node

An anydata serves as a container for an arbitrary set of schema nodes that otherwise appear as normal YANG-modeled data. An anydata instance is encoded using the same rules as a container, i.e., CBOR map. The requirement that anydata content can be modeled by YANG implies the following:
o Keys MUST be set to valid SIDs, member names or YANG hashes. This rule applies to the key of the anydata node and the key of any inner schema node.

o The CBOR array MUST contain either unique scalar values (as a leaf-list, see Section 4.3), or maps (as a list, see Section 4.4).

o Values MUST follow the encoding rules of one of the datatypes listed in Section 5.

4.6. The "anyxml" Schema Node

An anyxml instance is encoded as a CBOR key/value pair. The key of the anyxml schema node MUST be a valid SID, member name or YANG hash but the value is unrestricted, i.e., the value can be any CBOR encoded content.

5. Representing YANG Data Types in CBOR

5.1. The unsigned integer Types

Leafs of type uint8, uint16, uint32 and uint64 MUST be encoded using a CBOR unsigned integer data item (major type 0).

Definition example [RFC7277]:

leaf mtu {
    type uint16 {
        range "68..max";
    }
}

CBOR diagnostic notation: 1280

CBOR encoding: 19 0500

5.2. The integer Types

Leafs of type int8, int16, int32 and int64 MUST be encoded using either CBOR unsigned integer (major type 0) or CBOR signed integer
(major type 1), depending on the actual value.

Definition example [RFC7317]:

```yang
leaf timezone-utc-offset {
    type int16 {
        range "-1500 .. 1500";
    }
}
```

CBOR diagnostic notation: -300

CBOR encoding: 39 012b

5.3. The "decimal64" Type

Leafs of type decimal64 MUST be encoded using either CBOR unsigned integer (major type 0) or CBOR signed integer (major type 1), depending on the actual value. The position of the decimal point is defined by the fraction-digits YANG statement and is not available in the CBOR encoding.

Definition example [RFC7317]:

```yang
leaf my-decimal {
    type decimal64 {
        fraction-digits 2;
        range "1 .. 3.14 | 10 | 20..max";
    }
}
```

CBOR diagnostic notation: 257 (Represents decimal value 2.57)

CBOR encoding: 19 0101

5.4. The "string" Type
Leafs of type string MUST be encoded using a CBOR text string data item (major type 3).

Definition example [RFC7223]:

```yaml
leaf name {
    type string;
}
```

CBOR diagnostic notation: "eth0"

CBOR encoding: 64 65746830

5.5. The "boolean" Type

Leafs of type boolean MUST be encoded using a CBOR true (major type 7, additional information 21) or false data item (major type 7, additional information 20).

Definition example [RFC7317]:

```yaml
leaf enabled {
    type boolean;
}
```

CBOR diagnostic notation: true

CBOR encoding: f5

5.6. The "enumeration" Type

Leafs of type enumeration MUST be encoded using a CBOR unsigned integer data item (major type 0).

Definition example [RFC7317]:

```yaml
leaf oper-status {
    type enumeration {
        enum up { value 1; }
    }
```
enum down { value 2; }
enum testing { value 3; }
enum unknown { value 4; }
enum dormant { value 5; }
enum not-present { value 6; }
enum lower-layer-down { value 7; }
}

CBOR diagnostic notation: 3 (Represents enumeration value "testing")

CBOR encoding: 03

5.7. The "bits" Type

Leaves of type bits MUST be encoded using a CBOR byte string data item (major type 2). Bits position 0 to 7 are assigned to the first byte within the byte string, bits 8 to 15 to the second byte, and subsequent bytes are assigned similarly. Within each byte, bits are assigned from least to most significant.

Definition example [I-D.ietf-netmod-rfc6020bis]:

```
leaf mybits {
  type bits {
    bit disable-nagle {
      position 0;
    }
    bit auto-sense-speed {
      position 1;
    }
    bit 10-Mb-only {
      position 2;
    }
  }
}
```

CBOR diagnostic notation: h'05' (Represents bits disable-nagle and 10-Mb-only set)

CBOR encoding: 41 05
5.8. The "binary" Type

Leaves of type binary MUST be encoded using a CBOR byte string data item (major type 2).

Definition example:

```ycm
leaf aes128-key {
  type binary {
    length 16;
  }
}
```

CBOR diagnostic notation: h'1f1ce6a3f42660d888d92a4d8030476e'

CBOR encoding: 50 1f1ce6a3f42660d888d92a4d8030476e

5.9. The "leafref" Type

Leaves of type leafref MUST be encoded using the rules of the schema node referenced by the "path" YANG statement.

Definition example [RFC7223]:

```ycm
typedef interface-state-ref {
  type leafref {
    path "/interfaces-state/interface/name";
  }
}

container interfaces-state {
  list interface {
    key "name";
    leaf name {
      type string;
    }
  }
}
```
5.10. The "identityref" Type

This specification supports two approaches for encoding identityref, a SID as defined in [I-D.somaraju-core-sid] or a name as defined in [I-D.ietf-netmod-yang-json] section 6.8.

*SIDs as identityref*

SIDs are globally unique and may be used as identityref. This approach is both compact and simple to implement. When SIDs are used, identityref MUST be encoded using a CBOR unsigned integer data item (major type 0) and set to a SID allocated from a registered SID range.

*Name as identityref*

Alternatively, an identityref may be encoded using a name as defined in [I-D.ietf-netmod-yang-json] section 6.8. When names are used, identityref MUST be encoded using a CBOR text string data item (major type 3). If the identity is defined in another module than the leaf node containing the identityref value, the namespace-qualified form MUST be used. Otherwise, both the simple and namespace-qualified forms are permitted.

Definition example [RFC7223]:

```
leaf-list higher-layer-if {
    type interface-state-ref;
}
}
}

CBOR diagnostic notation: "eth1"

CBOR encoding: 64 65746831

identity interface-type {
}

identity iana-interface-type {
    base interface-type;
```
identity ethernetCsmacd {
    base iana-interface-type;
}

leaf type {
    type identityref {
        base interface-type;
    }
}

*SIDs as identityref*

Assuming that the identity "iana-if-type:ethernetCsmacd" has been assigned to the SID value 1179.

CBOR diagnostic notation: 1179
CBOR encoding: 19 049b

*Name as identityref*

CBOR diagnostic notation: "iana-if-type:ethernetCsmacd"
CBOR encoding: 78 1b
69616e612d69662d747970653a65746865744373616364

5.11. The "empty" Type

Leafs of type empty MUST be encoded using the CBOR null value (major type 7, additional information 22).

Definition example [RFC7277]:

leaf is-router {
    type empty;
}

CBOR diagnostic notation: null
CBOR encoding: f6
5.12. The "union" Type

Leaves of type union MUST be encoded using the rules associated with one of the types listed.

Definition example [RFC7317]:

typedef ipv4-address {
    type string {
        pattern '(([0-9]\[1-9][0-9]\[1-9][0-9]\[0-9]\[0-9]\[0-9]\[0-9]\[0-9]\[2][0-4][0-9]\[0-9]\[25][0-5]\]) \{3\}
            ([0-9]\[1-9][0-9]\[1-9][0-9]\[0-9]\[0-9]\[0-9]\[0-9]\[2][0-4][0-9]\[0-9]\[25][0-5]\})(%\[p\{N\] \p\{L\}]\+)?';
    }
}

typedef ipv6-address {
    type string {
        pattern '(([0-9a-fA-F]{0,4}:)\{([0-9a-fA-F]{0,4}:)\{([0-9a-fA-F]{0,4}:)\{([0-9a-fA-F]{0,4}:)\{25[0-5] \[2][0-4][0-9]\[0-9]\[0-9]\[0-9]\[0-9]\[0-9]\[0-9]\[0-9]\[25][0-5]\])(%\[p\{N\] \p\{L\}]\+)?';
    }
}

typedef ip-address {
    type union {
        type ipv4-address;
        type ipv6-address;
    }
}

leaf address {
    type inet:ip-address;
}

CBOR diagnostic notation: "2001:db8:a0b:12f0::1"

CBOR encoding: 74 323030313a6462383a6130623a313266303a3a31

5.13. The "instance-identifier" Type

This specification supports three approaches for encoding an instance-identifier, one based on SIDs as defined in [I-D.somaraju-core-sid], one based on names as defined in [I-D.ietf-netmod-yang-json] section 6.13 and one based on YANG hashes as defined in [I-D.vanderstok-core-comi].
**SIDs as instance-identifier**

SIDs uniquely identify a data node. For a single instance data node, the SID is sufficient to identify this instance. For a multi-instance data node, a SID is combined with the list key(s) to identify each instance of this data node within the YANG list(s).

Single instance data nodes MUST be encoded using a CBOR unsigned integer data item (major type 0) and set to the targeted data node SID.

Multi-instances data nodes MUST be encoded using a CBOR array data item (major type 4) containing the following entries:

- The first entry MUST be encoded as a CBOR unsigned integer data item (major type 0) and set to the targeted data node SID.

- The following entries MUST contain the value of each key required to identify the instance of the targeted data node. These keys MUST be ordered as defined in the "key" YANG statement, starting from top level list, and follow by each of the subordinate list(s).

When SIDs identify a YANG list, the presence of the key(s) for this list is optional. When the key(s) are present, the targeted instance within this list is selected. When the key(s) are absent, the entire YANG list is selected.

**Names as instance-identifier**

The use of names as instance-identifier is defined in [I-D.ietf-netmod-yang-json] section 6.11. The resulting xpath MUST be encoded using a CBOR text string data item (major type 3).

**YANG hashes as instance-identifier**

When YANG hashes are used, xpath can be compressed based on the method defined by [I-D.vanderstok-core-comi] sections 4.1.4.1 and 4.1.4.2.

Definition example [RFC7317]:

...
container system {

  leaf contact {
    type string;
  }

  leaf hostname {
    type inet:domain-name;
  }
}

*First example based on SID*

In this example, a field of type instance-identifier identifies the data node "/system/contact" (SID 1728).

1728

CBOR encoding:

19 06c0

*First example based on name*

Same example as above based on names.

"/ietf-system:system/contact"

CBOR encoding:

78 1c 2f20696574662d73797374656d3a73797374656d2f636e74616374

*First example based on YANG hash*

Same example assuming data node "/system/contact" is associated to
YANG hash 0x09b06d17 or "JsG0X" in base64.

CBOR diagnostic notation:
"/JsG0X"

CBOR encoding:
66 2f4a73473058

Definition example [RFC7317]:


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list user {
    key name;

    leaf name {
        type string;
    }
    leaf password {
        type ianach:crypt-hash;
    }
}

list authorized-key {
    key name;

    leaf name {
        type string;
    }
    leaf algorithm {
        type string;
    }
    leaf key-data {
        type binary;
    }
}

*Second example based on SID*

In this example, a field of type instance-identifier identify the data node "/system/authentication/user/authorized-key/key-data" (SID
1721) for the user name "bob" and the authorized-key name "admin".

CBOR diagnostic notation:

[1721, "bob", "admin"]

CBOR encoding:

83                      # array(3)
  19 06b9              # unsigned(1721)
  63                   # text(3)
  626f62              # "bob"
  65                   # text(5)
  61646d696e          # "admin"

*Second example based on name*

Same example as above based on names.

CBOR diagnostic notation:

"/ietf-system:system/authentication/user[name='bob']/authorized-key[name='admin']/key-data"

CBOR encoding:

78 59
  2f696574662d73797374656d3a73797374656d2f61757468656674696361
  74696f6e2f757365725b6e616d653d27626f62275d2f61757468656e72697a
  65642d6b65795b6e616d653d2761646d696e275d2f6b65792d64617461

*Second example based on YANG hash*

Same example assuming data node "/ietf-
 system:system/authentication/user/authorized-key/key-data" is
associated to YANG hash 0x0d6e7afb or "Nbnr7" in base64.

CBOR diagnostic notation:

"/Nbnr7?keys="bob","admin"

CBOR encoding:
This third example identifies an instance within the list "/system/authentication/user" (SID 1717) corresponding to the user name "jack".

CBOR diagnostic notation:

[1717, "jack"]

CBOR encoding:

82                      # array(2)
  19 06b5              # unsigned(1717)
  64                   # text(4)
    6a61636b         # "jack"

*Third example based on name*

Same example as above based on names.

CBOR diagnostic notation:

"/ietf-system:system/authentication/user[name='bob']"

*Third example based on YANG hash*

Same example assuming data node "/ietf-system:system/authentication/user" is associated to YANG hash 0x2677c6c1 or "md8bB" in base64.

CBOR diagnostic notation:

"/md8bB?keys="bob""
CBOR encoding:

71 2f6d643862423f6b6579733d22626f6222

6. Security Considerations

The security considerations of [RFC7049] and [I-D.ietf-netmod-rfc6020bis] apply.

This document defines an alternative encoding for data modeled in the YANG data modeling language. As such, this encoding does not contribute any new security issues in addition of those identified for the specific protocol or context for which it is used.

To minimize security risks, software on the receiving side SHOULD reject all messages that do not comply to the rules of this document and reply with an appropriate error message to the sender.

7. Acknowledgments

This document has been largely inspired by the extensive works done by Andy Bierman and Peter van der Stok on [I-D.vanderstok-core-comi]. [I-D.ietf-netmod-yang-json] has also been a critical input to this work. The authors would like to thank the authors and contributors to these two drafts.

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8. References

8.1. Normative References

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8.2.  Informative References


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