IMT Atlantique
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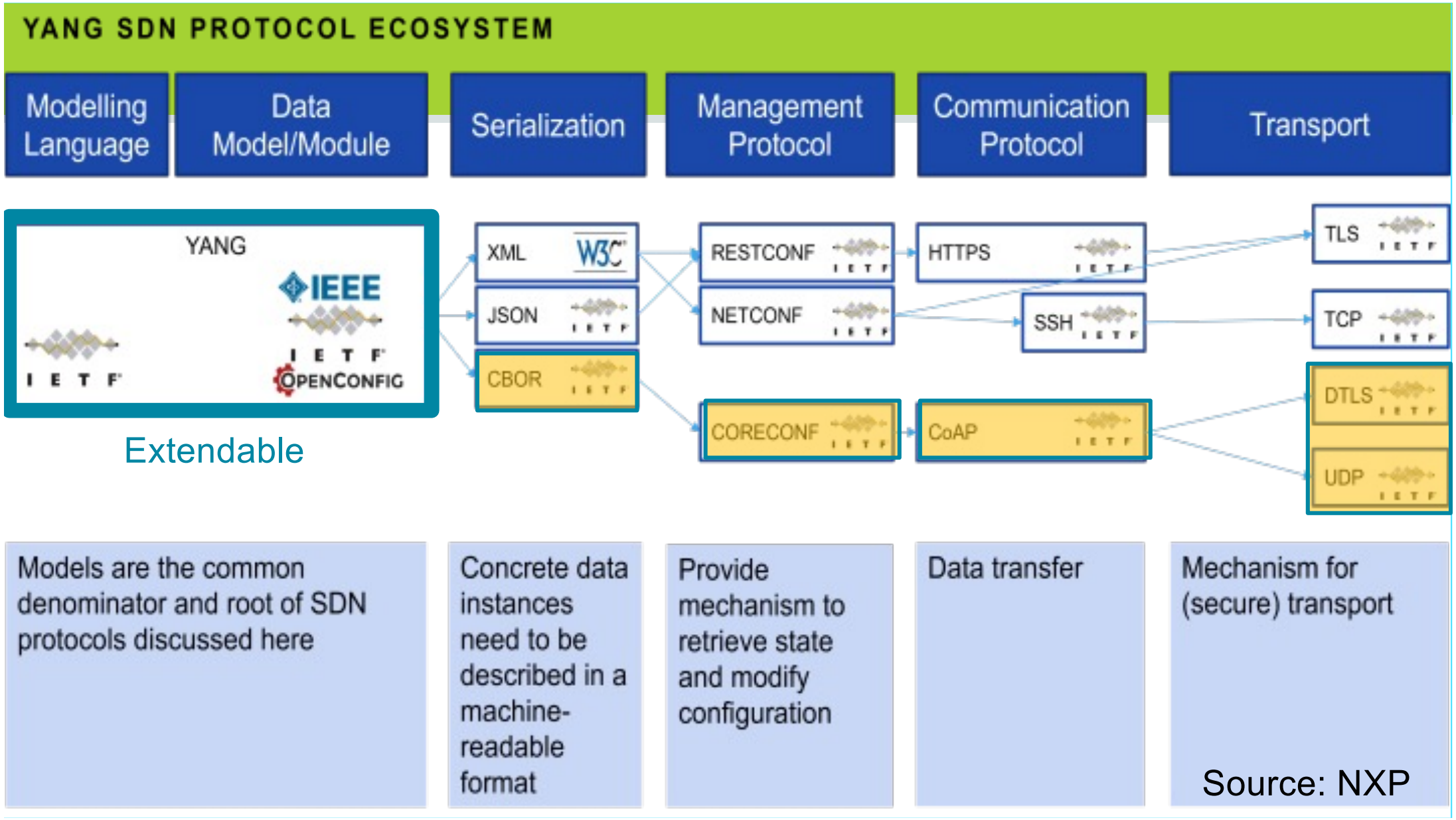
YANG: THE NEW LANGUAGE FOR IOT INTEROPERABILITY

Laurent Toutain
laurent.toutain@imt-atlantique.fr


YANG SDN PROTOCOL ECOSYSTEM
Modelling Language
Data Model/Module
Serialization
Management Protocol
Communication Protocol
Transport
YANG
IEEE
IETF
OPENCONFIG
Extendable
XML
JSON
CBOR
RESTCONF
NETCONF
CORECONF
HTTPS
SSH
CoAP
TLS
TCP
DTLS
UDP
Models are the common denominator and root of SDN protocols discussed here
Concrete data instances need to be described in a machine-readable format
Provide mechanism to retrieve state and modify configuration
Data transfer
Mechanism for (secure) transport
Source: NXP

SIMPLE POKEMON CARD DATA MODEL

```
module pokemon {

   yang-version 1.1;

   namespace "https://www.plido.net/pokemons";
   prefix pokemons;

   identity move-base-type {
        description "Identify pokemon attacks
   }

   identity move-absorb {
        base move-base-type;
   }

   identity move-amnesia {
         base move-base-type;
   }

   typedef move-type {
         type identityref {
             base move-base-type;
   }
}
```

```
container card {
     leaf name {
          type string {
               length "1..10";
          }
          mandatory true;
     }
     leaf hit-point {
          type uint32;
          mandatory true;
     }
     list moves {
           key move;
           leaf move {
                type move-type;
     }
     leaf power {
           must "derived-from-or-self(../move, 'move-amnesia')"{
               error-message "Power is for Amnesia";
           }
          type uint8;
     }
     leaf accuracy {
          type uint8;
     }
     leaf power-point {
          type uint8;
      }
}
```

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   }

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         base move-base-type;
   }

   typedef move-type {
         type identityref {
             base move-base-type;
   }
}
```

```
container card {
     leaf name {
                                    string {
                                    true;
     }
     leaf hit-point {
          type uint32;
          mandatory true;
     }
     list moves {
           key move;
           leaf move {
                type move-type;
     }
     leaf power {
           must "derived-from-or-self(../move, 'move-amnesia')"{
               error-message " Power is for Amnesia move only.";
           }
          type uint8;
     }
     leaf accuracy {
          type uint8;
     }
     leaf power-point {
          type uint8;
      }
}
```

Definition of the namespace for the module to be unique

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```
module pokemon {

    yang-version 1.1;

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         description "Identify pokemon attacks
    }

    identity move-absorb {
         base move-base-type;
    }

    identity move-amnesia {
          base move-base-type;
    }

    typedef move-type {
          type identityref {
               base move-base-type;
    }
}
```

Structure name

```
container card {
     leaf name {
          type string {
               length "1..10";
          }
          mandatory true;
     }
     leaf hit-point {
          type uint32;
          mandatory true;
     }
     list moves {
           key move;
           leaf move {
                type move-type;
     }
     leaf power {
           must "derived-from-or-self(../move, 'move-amnesia')"{
               error-message " Power is for Amnesia move only.";
           }
          type uint8;
     }
     leaf accuracy {
          type uint8;
     }
     leaf power-point {
          type uint8;
      }
}
```

Leaf = elements
Typed

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SIMPLE POKEMON CARD DATA MODEL


```
module pokemon {

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   namespace "https://www.plido.net/pokemons";
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   identity move-base-type {
        description "Identify pokemon attacks ";
   }

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        base move-base-type;
   }

   identity move-amnesia {
         base move-base-type;
   }

   typedef move-type {
         type identityref {
              base move-base-type;
   }
}
```

```
container card {
     leaf name {
          type string {
               length "1..10";
          }
          mandatory true;
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     }
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          key move;
          leaf move {
               type move-type;
     }
     leaf power {
          must "derived-from-or-self(../move, 'move-amnesia')"{
              error-message " Power is for Amnesia move only.";
          }
          type uint8;
     }
     leaf accuracy {
          type uint8;
     }
     leaf power-point {
          type uint8;
      }
}
```

List = several elements repeated

Need a key to identify each instance

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SIMPLE POKEMON CARD DATA MODEL


```
module pokemon {

   yang-version 1.1;

   namespace "https://www.plido.net/pokemons";
   prefix pokemons;

   identity move-base-type {
        description "Identify pokemon attacks
   }

   identity move-absorb {
        base move-base-type;
   }

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         base move-base-type;
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   typedef move-type {
         type identityref {
              base move-base-type;
   }
}
```

```
container card {
     leaf name {
          type string {
               length "1..10";
          }
          mandatory true;
     }
     leaf hit-point {
          type uint32;
          mandatory true;
     }
     list moves {
          key move;
                                   e-type;

                                   -from-or-self(../move, 'move-amnesia')"{
                                   sage " Power is for Amnesia move only.";
                                   type uint8;
     }
     leaf accuracy {
          type uint8;
     }
     leaf power-point {
          type uint8;
      }
}
```

Types can be defined

Here deriving from YANG identity

Since identities are unique, they can be augmented.

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SIMPLE POKEMON CARD DATA MODEL


```
module pokemon {

   yang-version 1.1;

   namespace "https://www.plido.net/pokemons";
   prefix pokemons;

   identity move-base-type {
        description "Identify pokemon attacks
   }

   identity move-absorb {
        base move-base-type;
   }

   identity move-amnesia {
         base move-base-type;
   }

   typedef move-type {
         type identityref {
              base move-base-type;
   }
}
```

```
container card {
     leaf name {
          type string {
               length "1..10";
          }
          mandatory true;
     }
     leaf hit-point {
          type uint32;
          mandatory true;
     }
     list moves {
           key move;
           leaf move {
                type move-type;
     }
     leaf power {
           must "derived-from-or-self(../move, 'move-amnesia')"{
               error-message " Power is for Amnesia move only.";
           }
          type uint8;
     }
     leaf accuracy {
          type uint8;
     }
     leaf power-point {
          type uint8;
      }
}
```

Relation between leaves can be defined

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PYANG IS YOUR FRIEND / IDENTIFIERS


```
>pyang -f identifiers pokemon.yang
nodes:
  accuracy
  card
  hit-point
  move
  moves
  name
  power
  power-point
typedefs:
  move-type
identities:
  move-absorb
  move-amnesia
  move-base-type
```

PYANG IS YOUR FRIEND / IDENTIFIERS


```
>pyang --sid-generate-file=1000:30 --sid-list pokemon.yang
SID         Assigned to
---------   ---------------------------------------------------
1000        module pokemon
1001        identity move-absorb
1002        identity move-amnesia
1003        identity move-base-type
1004        data /pokemon:card
1005        data /pokemon:card/hit-point
1006        data /pokemon:card/moves
1007        data /pokemon:card/moves/accuracy
1008        data /pokemon:card/moves/move
1009        data /pokemon:card/moves/power
1010        data /pokemon:card/moves/power-point
1011        data /pokemon:card/name

File pokemon@unknown.sid created
Number of SIDs available : 30
Number of SIDs used : 12
```

PYANG IS YOUR FRIEND / IDENTIFIERS


```
>pyang -f tree pokemon.yang
module: pokemon
  +--rw card
     +--rw name          string
     +--rw hit-point     uint32
     +--rw moves* [move]
        +--rw move            move-type
        +--rw power?          uint8
        +--rw accuracy?       uint8
        +--rw power-point?    uint8
```

PYANG IS YOUR FRIEND / XML SKELETON


```
> pyang -f sample-xml-skeleton pokemon.yang
<?xml version='1.0' encoding='UTF-8'?>
<data xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
  <card xmlns="https://www.plido.net/pokemons">
    <name/>
    <hit-point/>
    <moves>
      <move/>
      <power/>
      <accuracy/>
      <power-point/>
    </moves>
  </card>
</data>
```

YANGLINT IS ANOTHER FRIEND.


```
<?xml version='1.0' encoding='UTF-8'?>
  <card xmlns="https://www.plido.net/pokemons">
    <name>Pikachu</name>
    <moves>
      <move>move-absorb</move>
      <power>10</power>
      <accuracy>10</accuracy>
      <power-point>100</power-point>
    </moves>
    <moves>
      <move>move-amnesia</move>
      <power>110</power>
      <accuracy>10</accuracy>
      <power-point>100</power-point>
    </moves>
  </card>
```

```
>yanglint  -f xml pokemon.yang pikachu.xml
libyang err : Mandatory node "hit-point" instance
does not exist. (Schema location
/pokemon:card/hit-point.)
```

YANGLINT IS ANOTHER FRIEND.


```
<?xml version='1.0' encoding='UTF-8'?>
  <card xmlns="https://www.plido.net/pokemons">
    <name>Pikachu</name>
    <hit-point>60</hit-point>
    <moves>
      <move>move-absorb</move>
      <power>10</power>
      <accuracy>10</accuracy>
      <power-point>100</power-point>
    </moves>
    <moves>
      <move>move-amnesia</move>
      <power>110</power>
      <accuracy>10</accuracy>
      <power-point>100</power-point>
    </moves>
  </card>
```

```
>yanglint -f xml pokemon.yang pikachu.xml

libyang err : Power is for Amnesia move only.
(Schema location /pokemon:card/moves/power, data
location /pokemon:card/moves[move='pokemon:move-
absorb']/power.)
```

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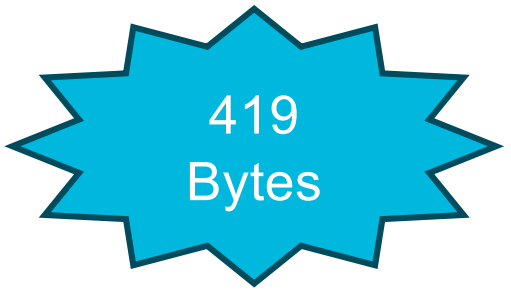
Hooray

```
>yanglint -f xml pokemon.yang pikachu.xml
<card xmlns="https://www.plido.net/pokemons">
  <name>Pikachu</name>
  <hit-point>60</hit-point>
  <moves>
    <move xmlns:pokemons="https://www.plido.net/pokemons">pokemons:move-
  absorb</move>
    <accuracy>10</accuracy>
    <power-point>100</power-point>
  </moves>
  <moves>
    <move xmlns:pokemons="https://www.plido.net/pokemons">pokemons:move-
  amnesia</move>
    <power>110</power>
    <accuracy>10</accuracy>
    <power-point>100</power-point>
  </moves>
</card>
```



Hooray – And JSON ?

```
>yanglint -f xml pokemon.yang pikachu.xml
<card xmlns="https://www.plido.net/pokemons">
  <name>Pikachu</name>
  <hit-point>60</hit-point>
  <moves>
    <move xmlns:pokemons="https://www.plido.net/pokemons">pokemons:move-
absorb</move>
    <accuracy>10</accuracy>
    <power-point>100</power-point>
  </moves>
  <moves>
    <move xmlns:pokemons="https://www.plido.net/pokemons">pokemons:move-
amnesia</move>
    <power>110</power>
    <accuracy>10</accuracy>
    <power-point>100</power-point>
  </moves>
</card>
```

Hooray – And JSON ?

```
>yanglint -f xml pokemon.yang pikachu.xml
<card xmlns="https://www.plido.net/pokemons">
  <name>Pikachu</name>
  <hit-point>60</hit-point>
  <moves>
    <move xmlns:pokemons="https://www.plido.net/pokemons">pokemons:move-
  absorb</move>
    <accuracy>10</accuracy>
    <power-point>100</power-point>
  </moves>
  <moves>
    <move xmlns:pokemons="https://www.plido.net/pokemons">pokemons:move-
  amnesia</move>
    <power>110</power>
    <accuracy>10</accuracy>
    <power-point>100</power-point>
  </moves>
</card>
```

<tag>value</tag> => {“tag”: value}

Hooray – And JSON ?

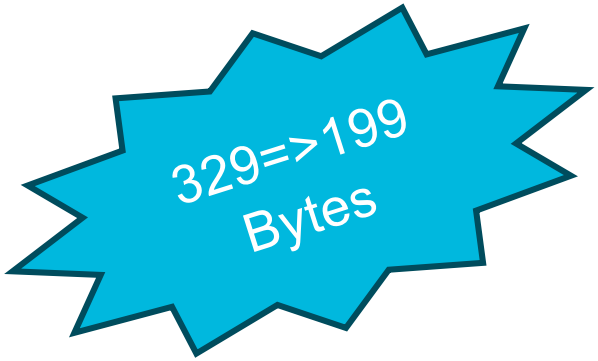
```
>yanglint -f xml pokemon.yang pikachu.xml
<card xmlns="https://www.plido.net/pokemons">
  <name>Pikachu</name>
  <hit-point>60</hit-point>
  <moves>
    <move xmlns:pokemons="https://www.plido.net/pokemons">pokemons:move-
  absorb</move>
    <accuracy>10</accuracy>
    <power-point>100</power-point>
  </moves>
  <moves>
    <move xmlns:pokemons="https://www.plido.net/pokemons">pokemons:move-
  amnesia</move>
    <power>110</power>
    <accuracy>10</accuracy>
    <power-point>100</power-point>
  </moves>
</card>
```

<tag>value</tag> => {“tag”: value}

YANGLINT IS ANOTHER FRIEND.


```
> yanglint pokemon.yang pikachu.xml -f json
{
  "pokemon:card": {
    "name": "Pikachu",
    "hit-point": 60,
    "moves": [
      {
        "move": "pokemon:move-absorb",
        "accuracy": 10,
        "power-point": 100
      },

      {
        "move": "pokemon:move-amnesia",
        "power": 110,
        "accuracy": 10,
        "power-point": 100
      }
    ]
  }
}
```



CORECONF

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AND CBOR?

CBOR

Diagnostic → ☐plain hex ☐deterministic

```
{
  "pokemon:card": {
    "name": "Pikachu",
    "hit-point": 60,
    "moves": [
      {
        "move": "pokemon:move-absorb",
        "accuracy": 10,
        "power-point": 100
      },
      {
        "move": "pokemon:move-amnesia",
        "power": 110,
        "accuracy": 10,
        "power-point": 100
      }
    ]
  }
}
```

← 156 Bytes ☐as text ☐utf8 ☐emb cbor ☐cborseq

enter hex below or Choisir un fichier Aucun fichier n'a été sélectionné

```
A1                                      # map(1)
   6C                                   # text(12)
      706F6B656D6F6E3A63617264           # "pokemon:card"
   A3                                   # map(3)
      64                                # text(4)
         6E616D65                       # "name"
      67                                # text(7)
         50696B61636875                 # "Pikachu"
      69                                # text(9)
         6869742D706F696E74             # "hit-point"
      18 3C                             # unsigned(60)
      65                                # text(5)
         6D6F766573                     # "moves"
      82                                # array(2)
         A3                             # map(3)
            64                          # text(4)
               6D6F7665                 # "move"
            73                          # text(19)
               706F6B656D6F6E3A6D6F76652D6162736F7262 # "pokemon:move-absorb"
            68                          # text(8)
               6163637572616379         # "accuracy"
            0A                          # unsigned(10)
            6B                          # text(11)
               706F7765722D706F696E74    # "power-point"
            18 64                       # unsigned(100)
         A4                             # map(4)
            64                          # text(4)
               6D6F7665                 # "move"
            74                          # text(20)
               706F6B656D6F6E3A6D6F76652D616D6E65736961 # "pokemon:move-amnesia"
            65                          # text(5)
               706F776572               # "power"
            18 6E                       # unsigned(110)
            68                          # text(8)
               6163637572616379         # "accuracy"
            0A                          # unsigned(10)
            6B                          # text(11)
               706F7765722D706F696E74    # "power-point"
            18 64                       # unsigned(100)
```

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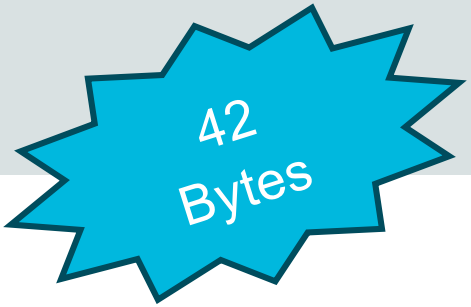


```
>pyang --sid-generate-file=1000:30 --sid-list pokemon.yang
SID         Assigned to
---------   ---------------------------------------------
1000        module pokemon
1001        identity move-absorb
1002        identity move-amnesia
1003        identity move-base-type
1004        data /pokemon:card
1005        data /pokemon:card/hit-point
1006        data /pokemon:card/moves
1007        data /pokemon:card/moves/accuracy
1008        data /pokemon:card/moves/move
1009        data /pokemon:card/moves/power
1010        data /pokemon:card/moves/power-point
1011        data /pokemon:card/name

File pokemon@unknown.sid created
Number of SIDs available : 30
Number of SIDs used : 12
```

```
A1                      # map(1)
   19 03EC              # unsigned(1004)
   A3                   # map(3)
      07                # unsigned(7)
      67                # text(7)
         50696B61636875 # "Pikachu"
      01                # unsigned(1)
      18 3C             # unsigned(60)
      02                # unsigned(2)
      82                # array(2)
         A3             # map(3)
            02          # unsigned(2)
            19 03E9     # unsigned(1001)
            01          # unsigned(1)
            0A          # unsigned(10)
            04          # unsigned(4)
            18 64       # unsigned(100)
         A4             # map(4)
            02          # unsigned(2)
            19 03EA     # unsigned(1002)
            03          # unsigned(3)
            18 6E       # unsigned(110)
            01          # unsigned(1)
            0A          # unsigned(10)
            04          # unsigned(4)
            18 64       # unsigned(100)
```

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CONVERSION


```
{1004:                    {"pokemon:card": {
    {7: "Pikachu",
     1: 60,
     2: [
        {2: 1001,
         1: 10,
         4: 100},
        {2: 1002,
         3: 110,
         1: 10,
         4: 100}
         ]
     }
}
```

```
>pyang --sid-generate-file=1000:30 --sid-list p
SID         Assigned to
---------   -----------------------------------
1000        module pokemon
1001        identity move-absorb
1002        identity move-amnesia
1003        identity move-base-type
1004        data /pokemon:card
1005        data /pokemon:card/hit-point
1006        data /pokemon:card/moves
1007        data /pokemon:card/moves/accuracy
1008        data /pokemon:card/moves/move
1009        data /pokemon:card/moves/power
1010        data /pokemon:card/moves/power-point
1011        data /pokemon:card/name

File pokemon@unknown.sid created
Number of SIDs available : 30
Number of SIDs used : 12
```

CONVERSION

1004+7 = 1011


```
{1004:
    {7: "Pikachu",
     1: 60,
     2: [
        {2: 1001,
         1: 10,
         4: 100},
        {2: 1002,
         3: 110,
         1: 10,
         4: 100}
         ]
     }
}
```

```
{"pokemon:card": {
  "name": "Pikachu",
```

```
>pyang --sid-generate-file=1000:30 --sid-list p
SID         Assigned to
---------   -----------------------------------
1000        module pokemon
1001        identity move-absorb
1002        identity move-amnesia
1003        identity move-base-type
1004        data /pokemon:card
1005        data /pokemon:card/hit-point
1006        data /pokemon:card/moves
1007        data /pokemon:card/moves/accuracy
1008        data /pokemon:card/moves/move
1009        data /pokemon:card/moves/power
1010        data /pokemon:card/moves/power-point
1011        data /pokemon:card/name

File pokemon@unknown.sid created
Number of SIDs available : 30
Number of SIDs used : 12
```

CONVERSION

1004+1 = 1005


```
{1004:
    {7: "Pikachu",
     1: 60,
     2: [
        {2: 1001,
         1: 10,
         4: 100},
        {2: 1002,
         3: 110,
         1: 10,
         4: 100}
         ]
     }
}
```

```
{"pokemon:card": {
  "name": "Pikachu",
  "hit-point" : 60,
```

```
>pyang --sid-generate-file=1000:30 --sid-list p
SID         Assigned to
---------   -----------------------------------
1000        module pokemon
1001        identity move-absorb
1002        identity move-amnesia
1003        identity move-base-type
1004        data /pokemon:card
1005        data /pokemon:card/hit-point
1006        data /pokemon:card/moves
1007        data /pokemon:card/moves/accuracy
1008        data /pokemon:card/moves/move
1009        data /pokemon:card/moves/power
1010        data /pokemon:card/moves/power-point
1011        data /pokemon:card/name

File pokemon@unknown.sid created
Number of SIDs available : 30
Number of SIDs used : 12
```

CONVERSION

1004+2 = 1006


```
{1004:
    {7: "Pikachu",
     1: 60,
     2: [
        {2: 1001,
         1: 10,
         4: 100},
        {2: 1002,
         3: 110,
         1: 10,
         4: 100}
         ]
    }
}
```

```
{"pokemon:card": {
  "name": "Pikachu",
  "hit-point" : 60,
  "move" : {
```

```
>pyang --sid-generate-file=1000:30 --sid-list p
SID         Assigned to
---------   -----------------------------------
1000        module pokemon
1001        identity move-absorb
1002        identity move-amnesia
1003        identity move-base-type
1004        data /pokemon:card
1005        data /pokemon:card/hit-point
1006        data /pokemon:card/moves
1007        data /pokemon:card/moves/accuracy
1008        data /pokemon:card/moves/move
1009        data /pokemon:card/moves/power
1010        data /pokemon:card/moves/power-point
1011        data /pokemon:card/name

File pokemon@unknown.sid created
Number of SIDs available : 30
Number of SIDs used : 12
```

CONVERSION

1004+2+2 = 1008


```
{1004:
    {7: "Pikachu",
     1: 60,
     2: [
         {2: 1001,
          1: 10,
          4: 100},
         {2: 1002,
          3: 110,
          1: 10,
          4: 100}
          ]
     }
}
```

```
{"pokemon:card": {
  "name": "Pikachu",
  "hit-point" : 60,
  "moves" : {
   "move": "move-absorb",
```

```
>pyang --sid-generate-file=1000:30 --sid-list p
SID         Assigned to
---------   -----------------------------------
1000        module pokemon
1001        identity move-absorb
1002        identity move-amnesia
1003        identity move-base-type
1004        data /pokemon:card
1005        data /pokemon:card/hit-point
1006        data /pokemon:card/moves
1007        data /pokemon:card/moves/accuracy
1008        data /pokemon:card/moves/move
1009        data /pokemon:card/moves/power
1010        data /pokemon:card/moves/power-point
1011        data /pokemon:card/name

File pokemon@unknown.sid created
Number of SIDs available : 30
Number of SIDs used : 12
```

CONVERSION

1004+2+1 = 1007


```
{1004:
    {7: "Pikachu",
     1: 60,
     2: [
         {2: 1001,
          1: 10,
          4: 100},
         {2: 1002,
          3: 110,
          1: 10,
          4: 100}
          ]
     }
}
```

```
{"pokemon:card": {
  "name": "Pikachu",
  "hit-point" : 60,
  "moves" : {
   "move": "move-absorb",
   "accuracy" : 10,
```

```
>pyang --sid-generate-file=1000:30 --sid-list p
SID         Assigned to
---------   -----------------------------------
1000        module pokemon
1001        identity move-absorb
1002        identity move-amnesia
1003        identity move-base-type
1004        data /pokemon:card
1005        data /pokemon:card/hit-point
1006        data /pokemon:card/moves
1007        data /pokemon:card/moves/accuracy
1008        data /pokemon:card/moves/move
1009        data /pokemon:card/moves/power
1010        data /pokemon:card/moves/power-point
1011        data /pokemon:card/name

File pokemon@unknown.sid created
Number of SIDs available : 30
Number of SIDs used : 12
```

CONVERSION

1004+2+4 = 1010


```
{1004:
    {7: "Pikachu",
     1: 60,
     2: [
        {2: 1001,
         1: 10,
         4: 100},
        {2: 1002,
         3: 110,
         1: 10,
         4: 100}
         ]
    }
}
```

```
{"pokemon:card": {
  "name": "Pikachu",
  "hit-point" : 60,
  "moves" : {
   "move": "move-absorb",
   "accuracy" : 10,
   "power-point": 100},
```

```
>pyang --sid-generate-file=1000:30 --sid-list p
SID         Assigned to
---------   -----------------------------------
1000        module pokemon
1001        identity move-absorb
1002        identity move-amnesia
1003        identity move-base-type
1004        data /pokemon:card
1005        data /pokemon:card/hit-point
1006        data /pokemon:card/moves
1007        data /pokemon:card/moves/accuracy
1008        data /pokemon:card/moves/move
1009        data /pokemon:card/moves/power
1010        data /pokemon:card/moves/power-point
1011        data /pokemon:card/name

File pokemon@unknown.sid created
Number of SIDs available : 30
Number of SIDs used : 12
```

CONVERSION


```
{1004:
    {7: "Pikachu",
     1: 60,
     2: [
         {2: 1001,
          1: 10,
          4: 100},
         {2: 1002,
          3: 110,
          1: 10,
          4: 100}
          ]
     }
}
```

```
{"pokemon:card": {
  "name": "Pikachu",
  "hit-point" : 60,
  "moves" : {
   "move": "move-absorb",
   "accuracy" : 10,
   "power-point": 100},
  {"move" : "move-amnesia",
   "power": 110,
   "accuracy": 10,
   "power-point": 100}
  }
 }
}
```

```
>pyang --sid-generate-file=1000:30 --sid-list p
SID         Assigned to
---------   -----------------------------------
1000        module pokemon
1001        identity move-absorb
1002        identity move-amnesia
1003        identity move-base-type
1004        data /pokemon:card
1005        data /pokemon:card/hit-point
1006        data /pokemon:card/moves
1007        data /pokemon:card/moves/accuracy
1008        data /pokemon:card/moves/move
1009        data /pokemon:card/moves/power
1010        data /pokemon:card/moves/power-point
1011        data /pokemon:card/name

File pokemon@unknown.sid created
Number of SIDs available : 30
Number of SIDs used : 12
```

TYPE MAPPING

NETCONF/JSON	YANG	CORECONF
number	int8, int16, int32, int64 uint8, uint16, uint32, uint64	+int/-int (majors 0/1)
true/false/null	Boolean/empty	special (major 7)
string(base64)	binary	bytearray (major 2)
string	string	string (major 3)
string	indentityref	+int
string	enumeration	-int/+int

PYCORECONF


```
{
  "namespace": "data",
  "identifier": "/pokemon:card/moves/power-point",
  "sid": 1010,
  "type": "uint8"
},
{
  "namespace": "data",
  "identifier": "/pokemon:card/name",
  "sid": 1011,
  "type": "string"
}
],
"key-mapping": {
  "1006": [
    1008
```

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* https://github.com/ltn22/pyang

** https://github.com/alex-fddz/pycoreconf

USE CASES

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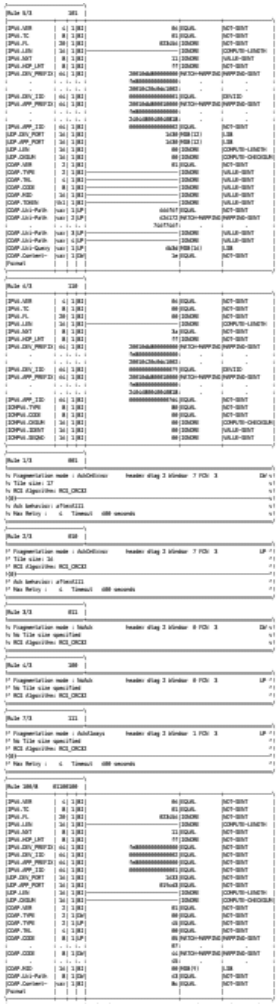
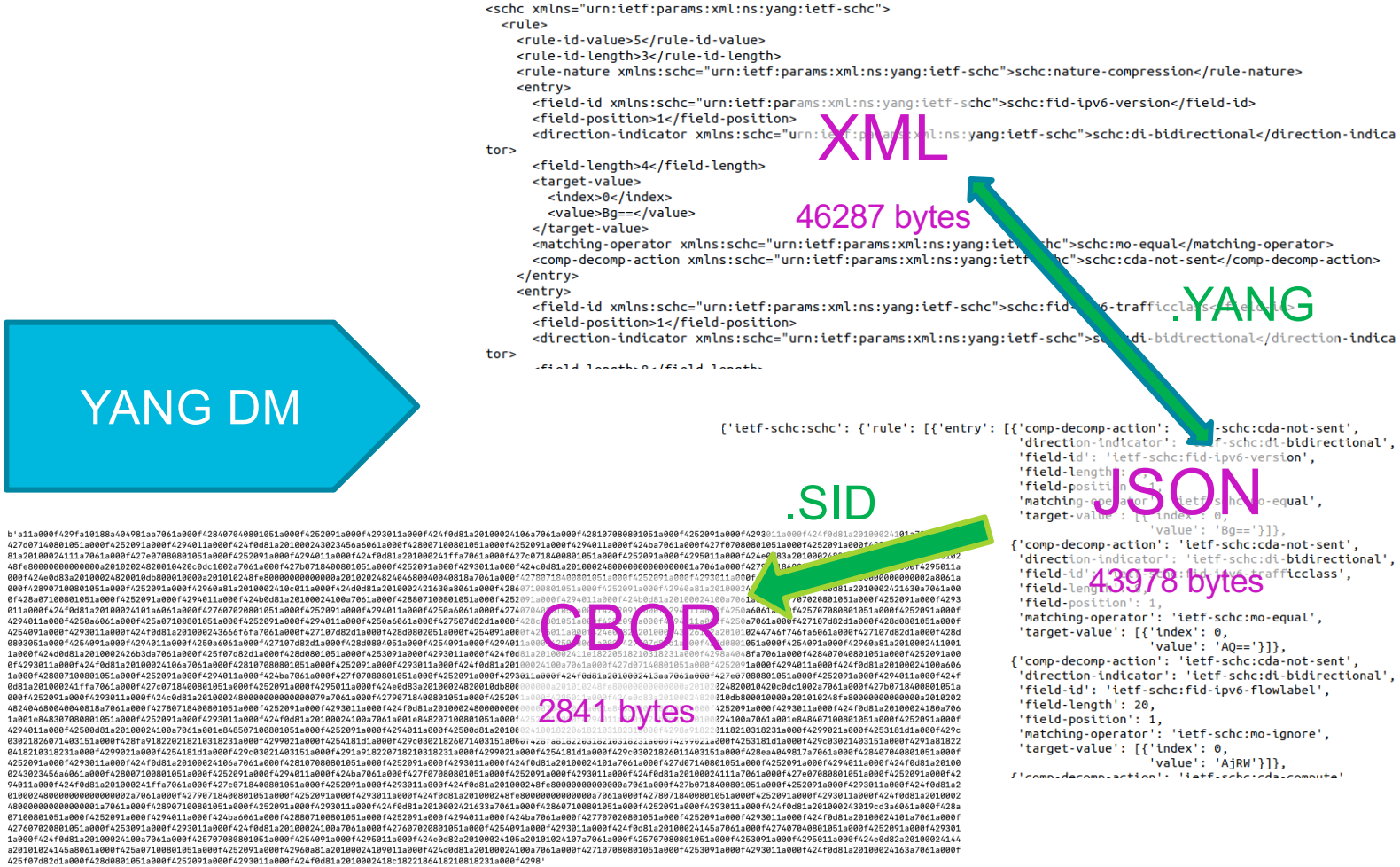
With SCHC



YANG DM



SDN for IoT: draft-marin-yang-edhoc-oscore-00

CORE Working Group
Internet-Draft
Intended status: Standards Track
Expires: 1 September 2023

R. Marin-Lopez(Ed.)
G. Lopez-Millan
University of Murcia
L. Toutain
A. Fernandez
IMT
28 February 2023

A YANG data model for SDN-based key management with EDHOC and OSCORE
draft-marin-yang-edhoc-oscore-00

Abstract

This document defines YANG data models which allow a Software-Defined Networking (SDN) Controller (Controller) using NETCONF, RESTCONF or CORECONF to provide configuration and monitoring Internet-of-Things devices (Things) that support Ephemeral Diffie-Hellman Over COSE (EDHOC) and/or OSCORE. In particular, a YANG data model defines the required configuration parameters to perform EDHOC between two Things (EDHOC case). Another YANG data model is to configure the OSCORE contexts directly into the Thing (OSCORE case). The service described in this document allows the configuration and monitoring Things that supports EDHOC and OSCORE or only OSCORE by allowing a protected Thing-to-Thing communication based on CoAP.

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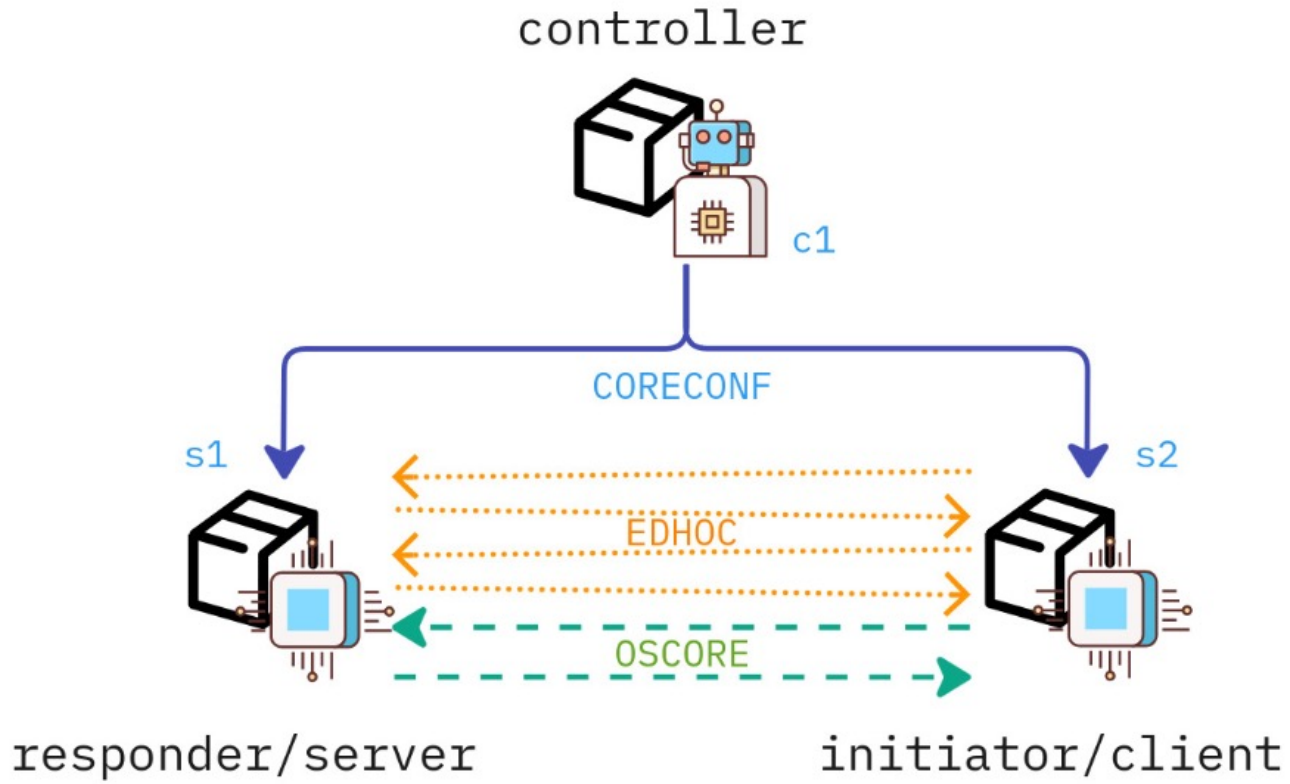

2 data models

```
module: ietf-i2nsf-oscore
  +--rw oscore
     +--rw context* [name]
     |  +--rw name                string
     |  +--rw common-ctx
     |  |  +--rw id?              binary
     |  |  +--rw aead-alg?        uint32
     |  |  +--rw hkdf-alg?        uint32
     |  |  +--rw master-key?      binary
     |  |  +--rw master-salt?     binary
     |  +--rw sender-ctx
     |  |  +--rw id?   binary
     |  +--rw recipient-ctx
     |     +--rw id?                binary
     |     +--rw replay-window?     uint64
     +--rw target-resource* [target]
     |  +--rw target       inet:uri
     |  +--rw policy?      policy-t
     |  +--rw name-ref?    string
     +--rw local-resource* [local]
        +--rw local        inet:uri
        +--rw policy?      policy-t
        +--rw name-ref?    string
```

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```
module: ietf-i2nsf-edhoc
  +--rw edhoc
     +--rw auth-entry* [name]
     |  +--rw name             string
     |  +--rw id-cred-x        binary
     |  +--rw auth-method?     auth-method-t
     |  +--rw cred-x?          binary
     |  +--rw private-key?     binary
     +--rw connection* [name]
     |  +--rw name                      string
     |  +--rw local
     |  |  +--rw autostartup?      boolean
     |  |  +--rw auth-cred-ref     string
     |  |  +--rw c-x?              binary
     |  |  +--rw suites-x?         binary
     |  |  +--rw ead-x
     |  |     +--rw ead-a?    binary
     |  |     +--rw ead-b?    binary
     |  +--rw remote
     |  |  +--rw id-cred-x     binary
     |  |  +--rw auth-method? auth-method-t
     |  |  +--rw cred-x?       binary
     |  +--rw key-confirmation?     boolean
     |  +--rw set-oscore?           boolean
     |  +--rw key-update-context?   binary
     |  +--rw reauth-time
     |     +--rw soft?   uint32
     |     +--rw hard?   uint32
     +--rw target-resource* [target]
     |  +--rw target       inet:uri
     |  +--rw policy?      policy-t
     |  +--rw conn-ref?
     +--rw local-resour
        +--rw local
        +--rw policy?
        +--rw conn-ref?    string
```

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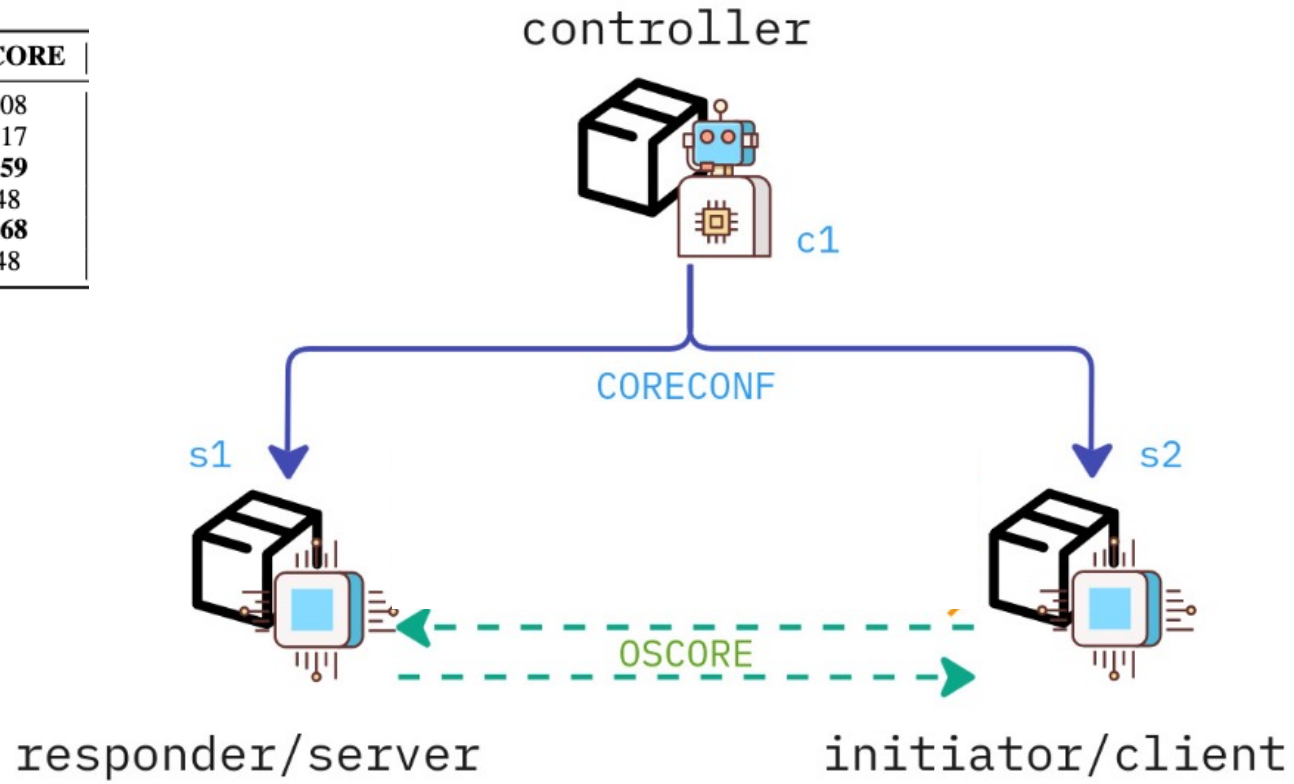
Model used	OSCORE	EDHOC+OSCORE
EDHOC Exchange	**0**	**1057**
Request Payload	21	21
Response Payload	20	20
OSCORE Request	**99**	**89**
OSCORE Response	**82**	**82**
Total Data Sent	181	1228

SDN for IoT

UNPROTECTED DATA EXCHANGE BETWEEN CONTROLLER AND TARGET DEVICES THROUGH CORECONF.

Model used	OSCORE
Payload to Server	108
Payload to Client	117
POST to Server	**159**
Server ACK	48
POST to Client	**168**
Client ACK	48



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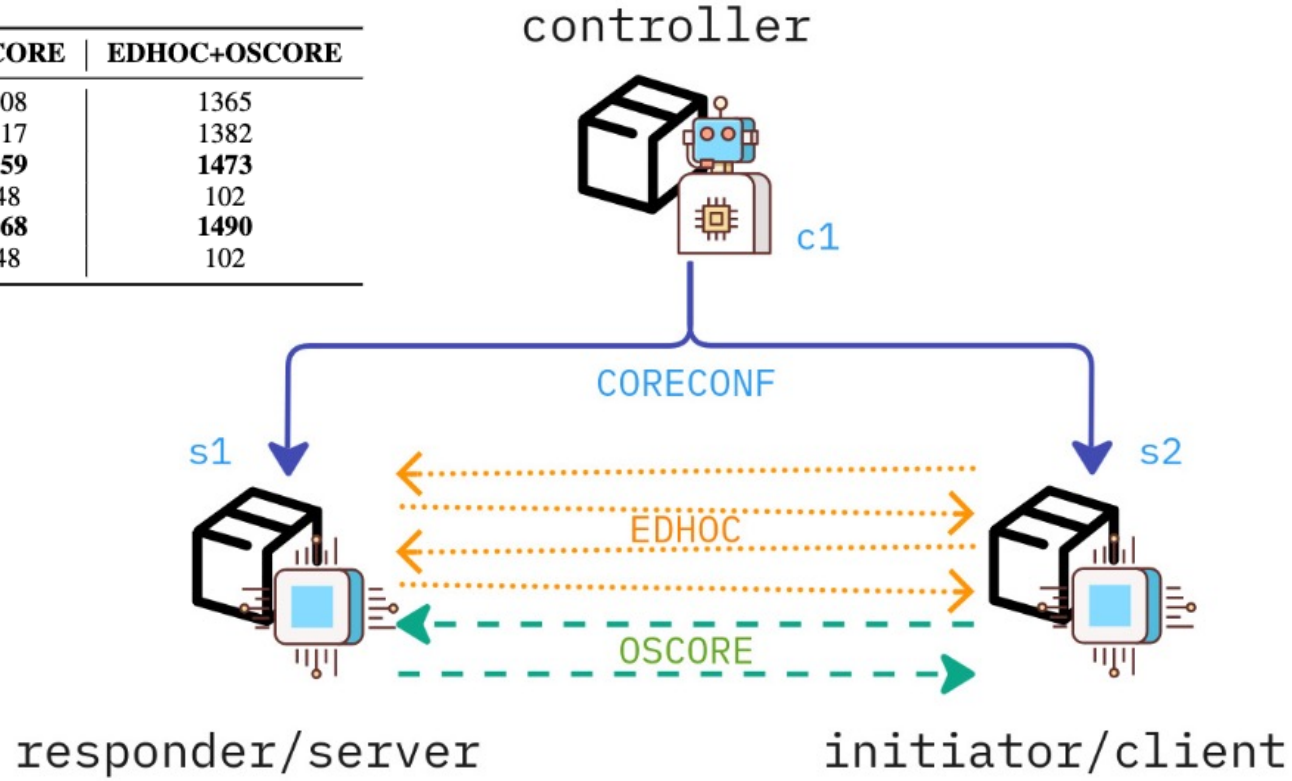
SDN for IoT

UNPROTECTED DATA EXCHANGE BETWEEN CONTROLLER AND TARGET DEVICES THROUGH CORECONF.

Model used	OSCORE	EDHOC+OSCORE
Payload to Server	108	1365
Payload to Client	117	1382
POST to Server	**159**	**1473**
Server ACK	48	102
POST to Client	**168**	**1490**
Client ACK	48	102



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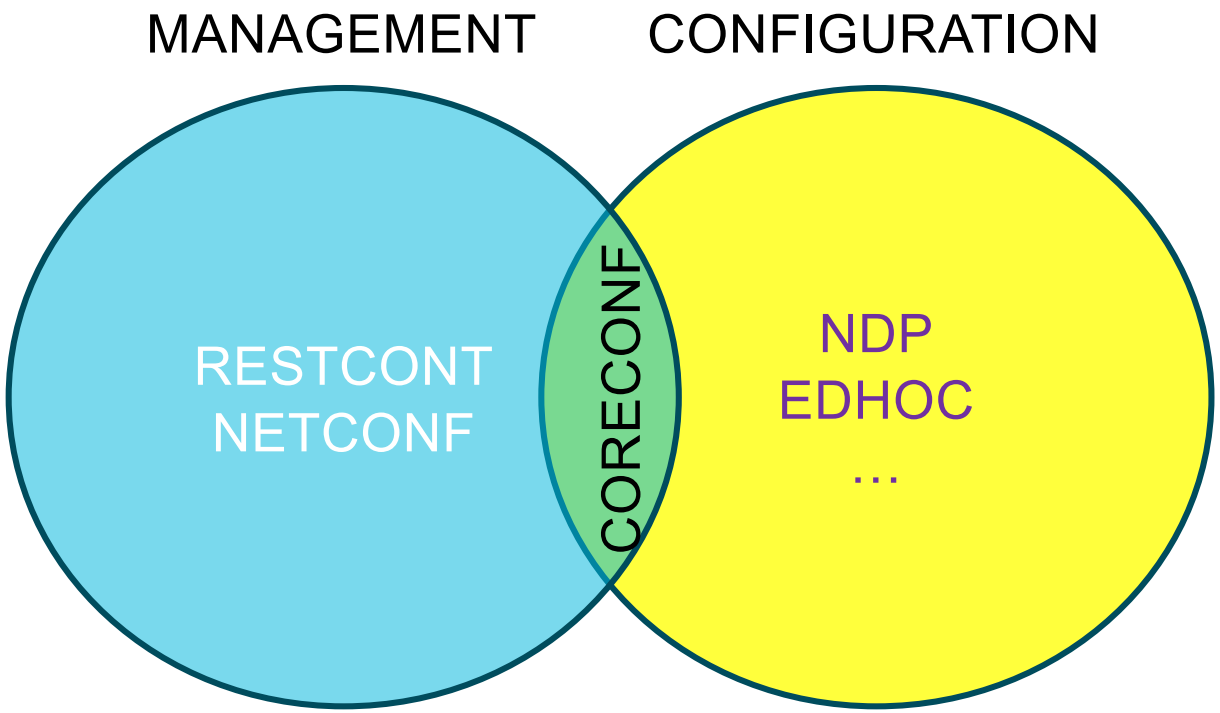
Conclusion: Don’t develop protocols, define Data Models



Dall.e IETF YANG Doctor

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THANK YOU

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