Constrained Objects Language CoOL

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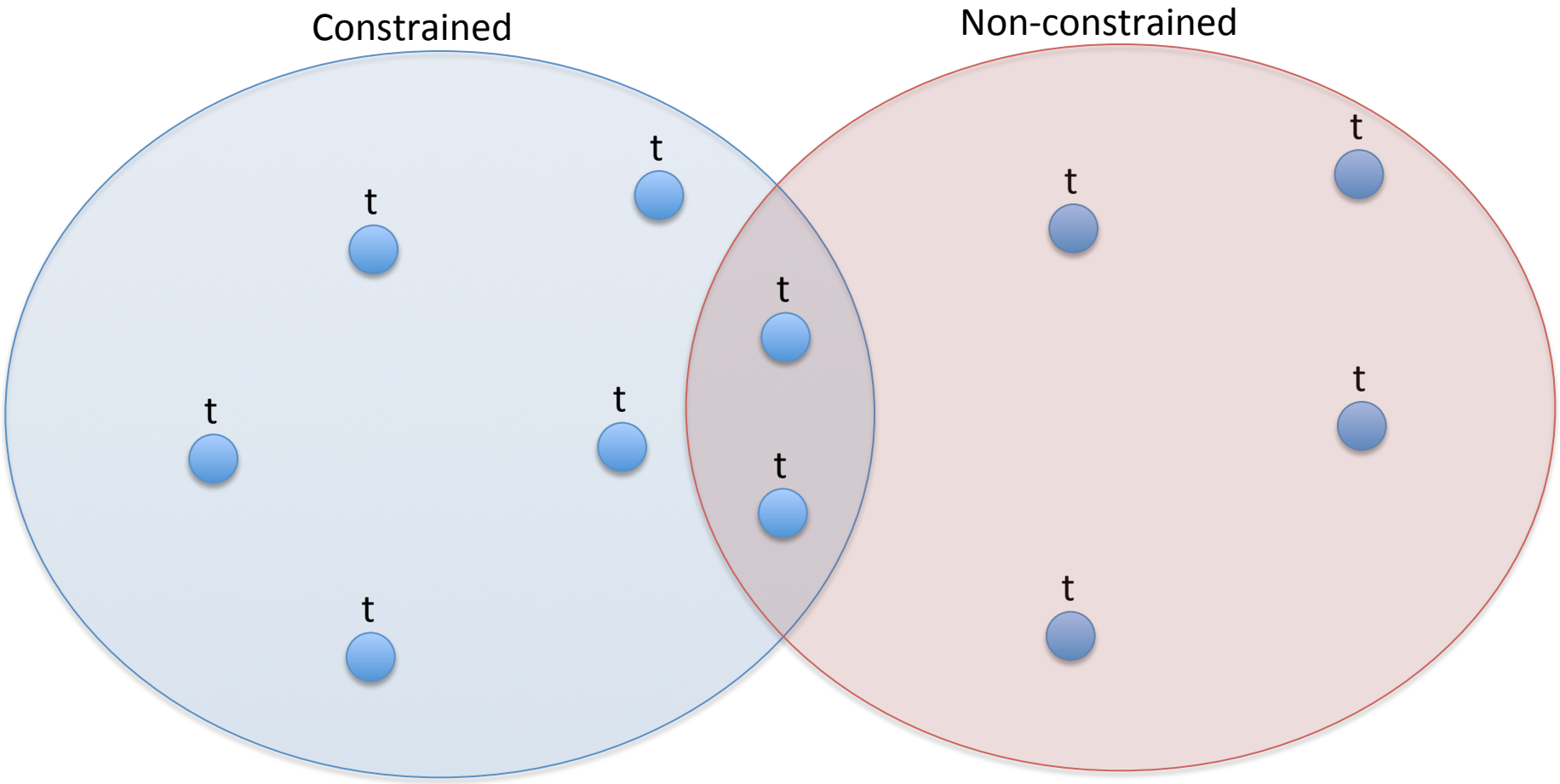
You want to manage things



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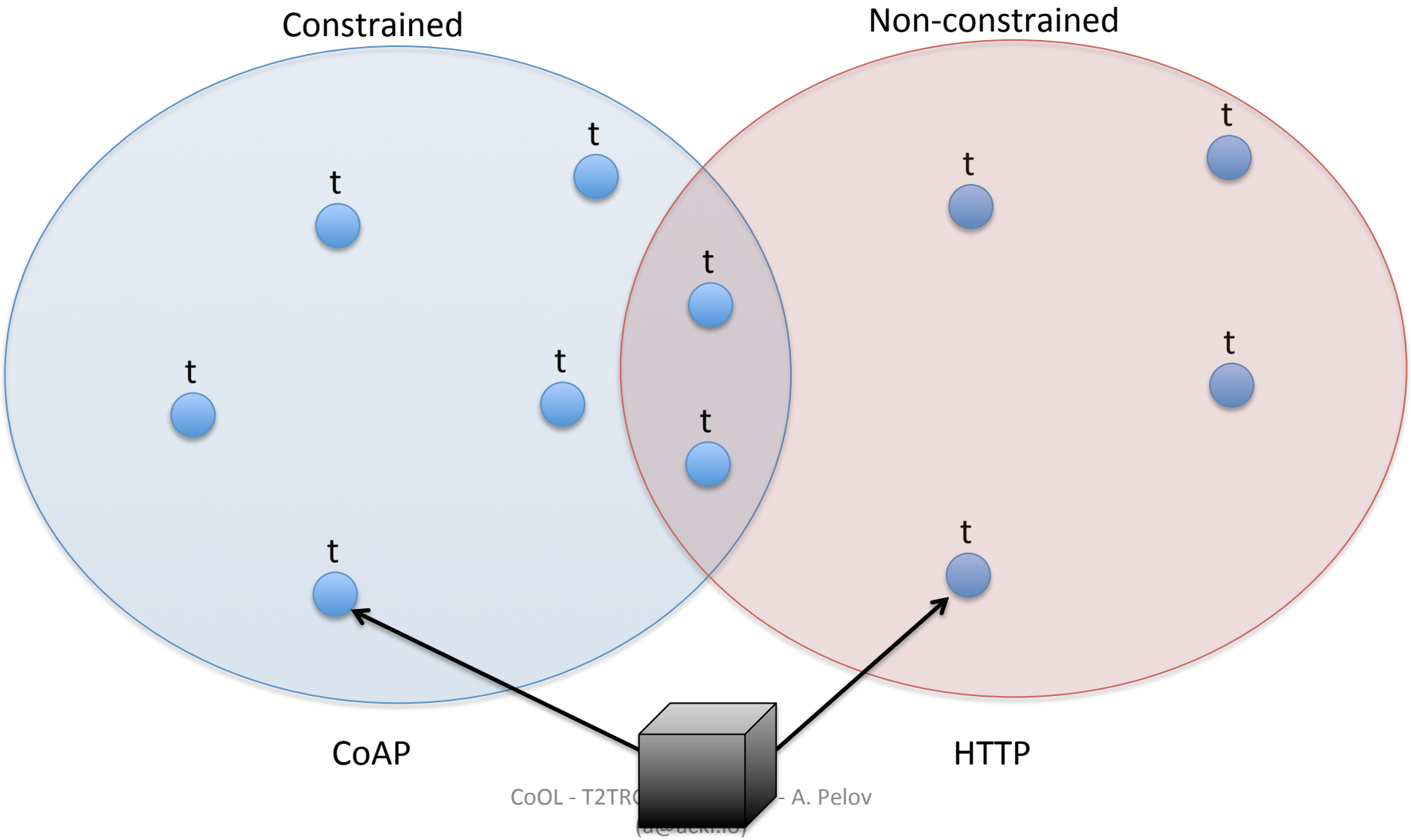

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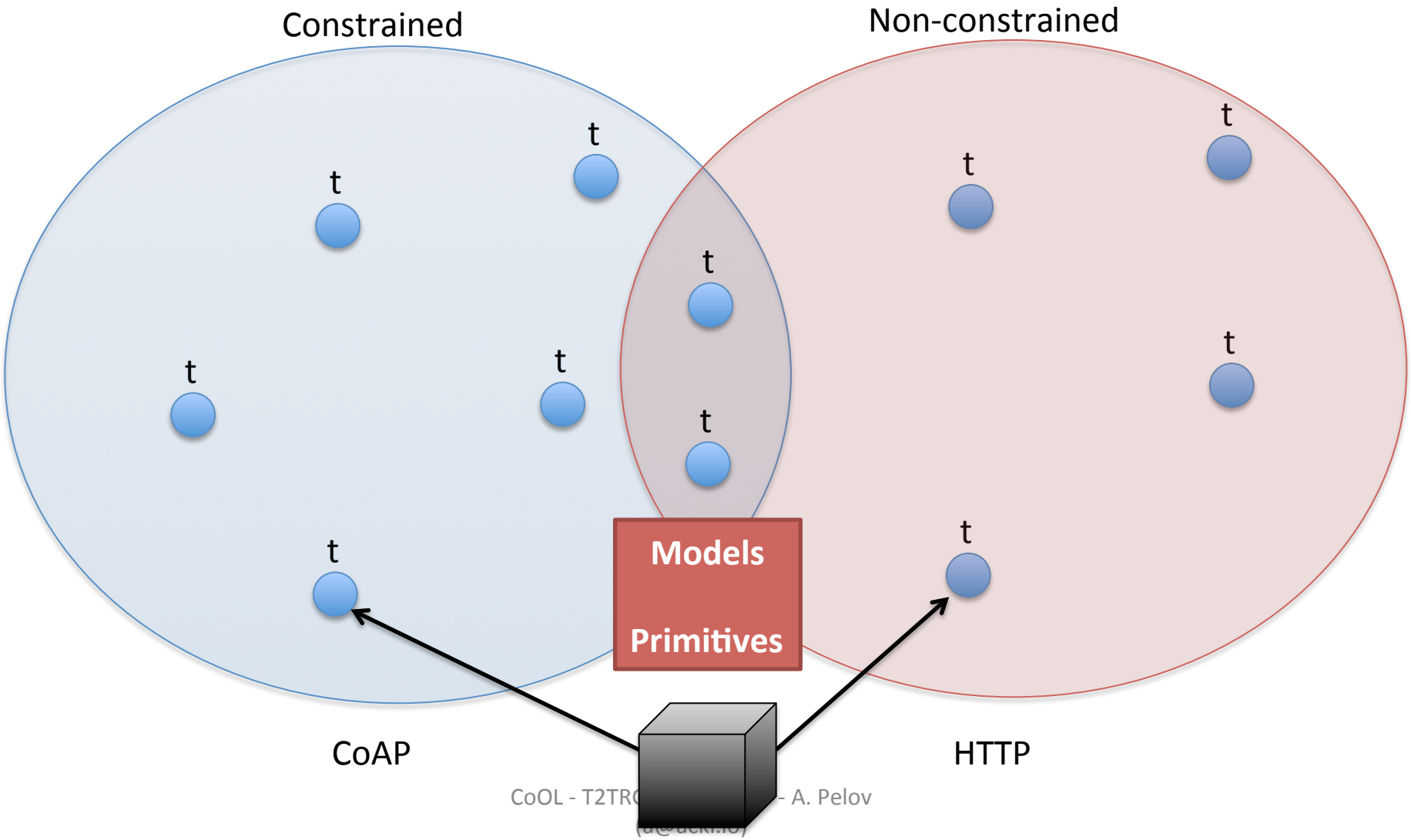

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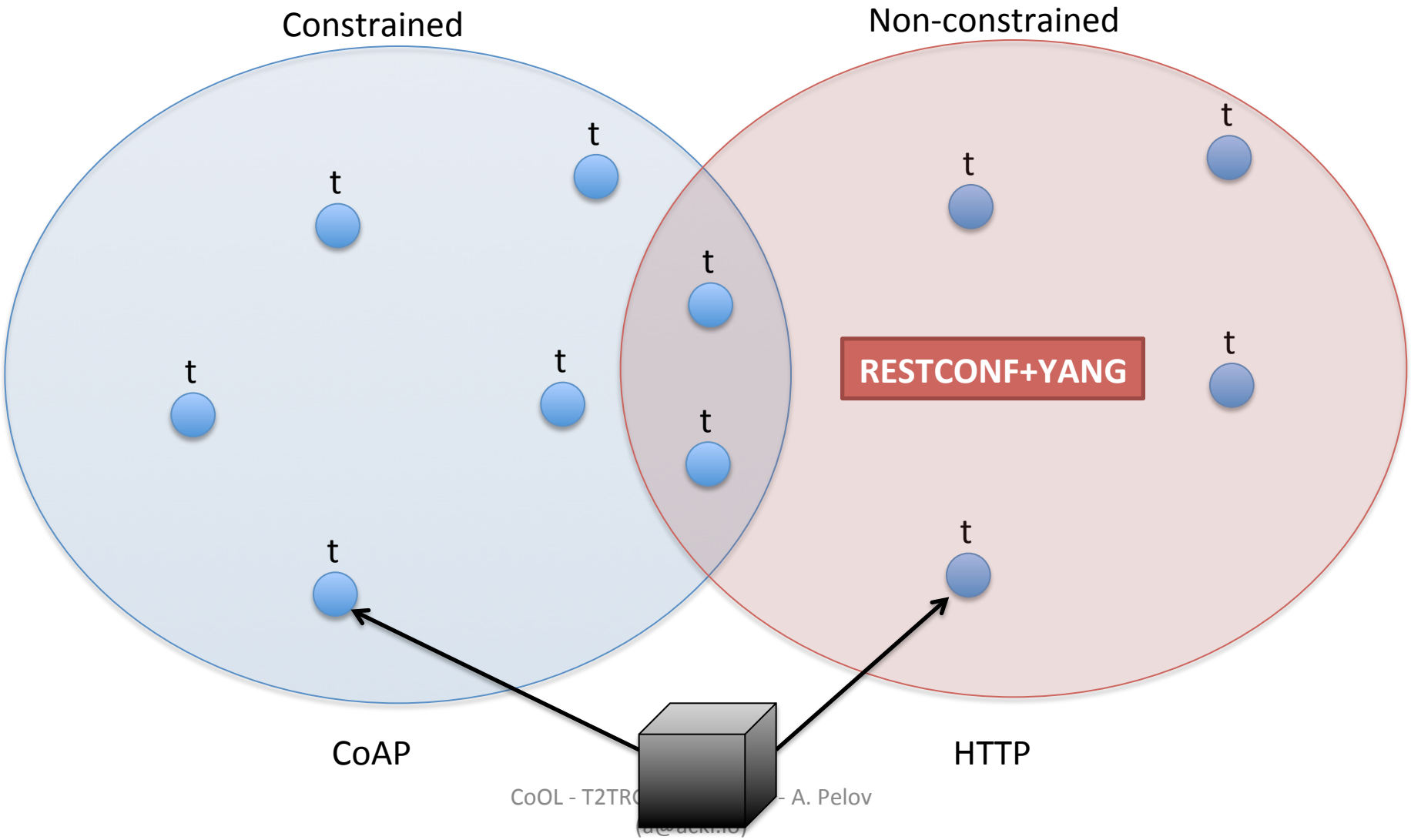

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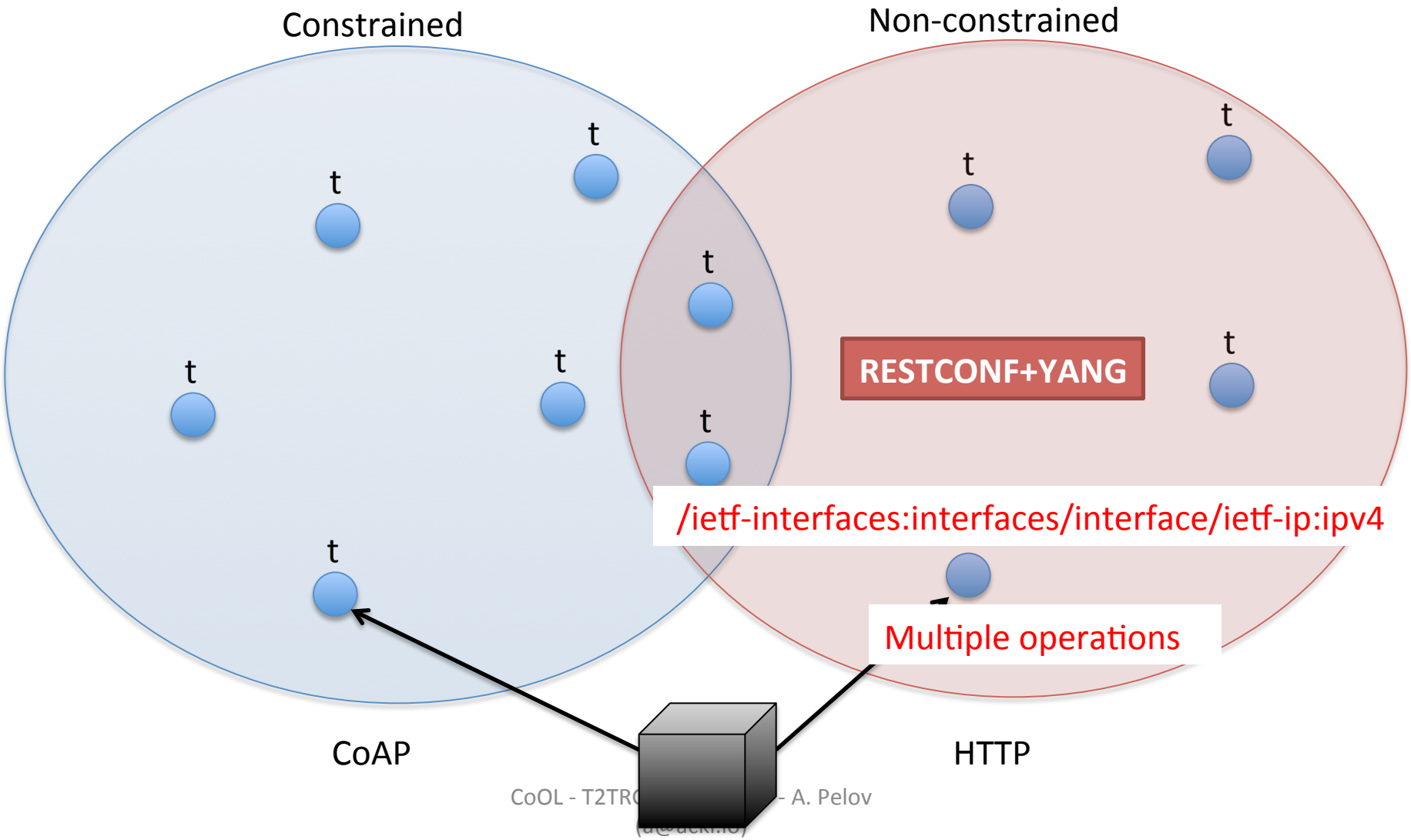

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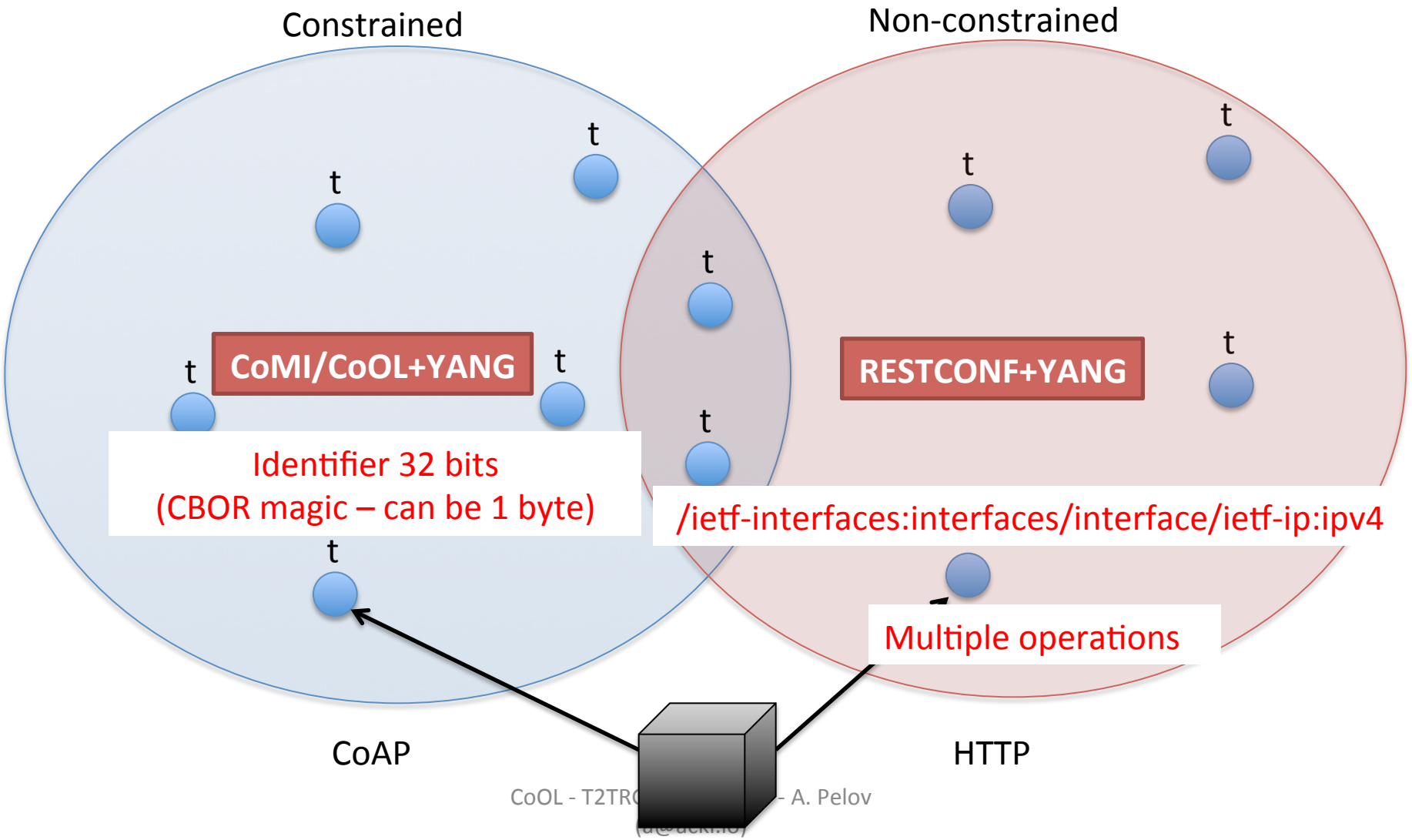

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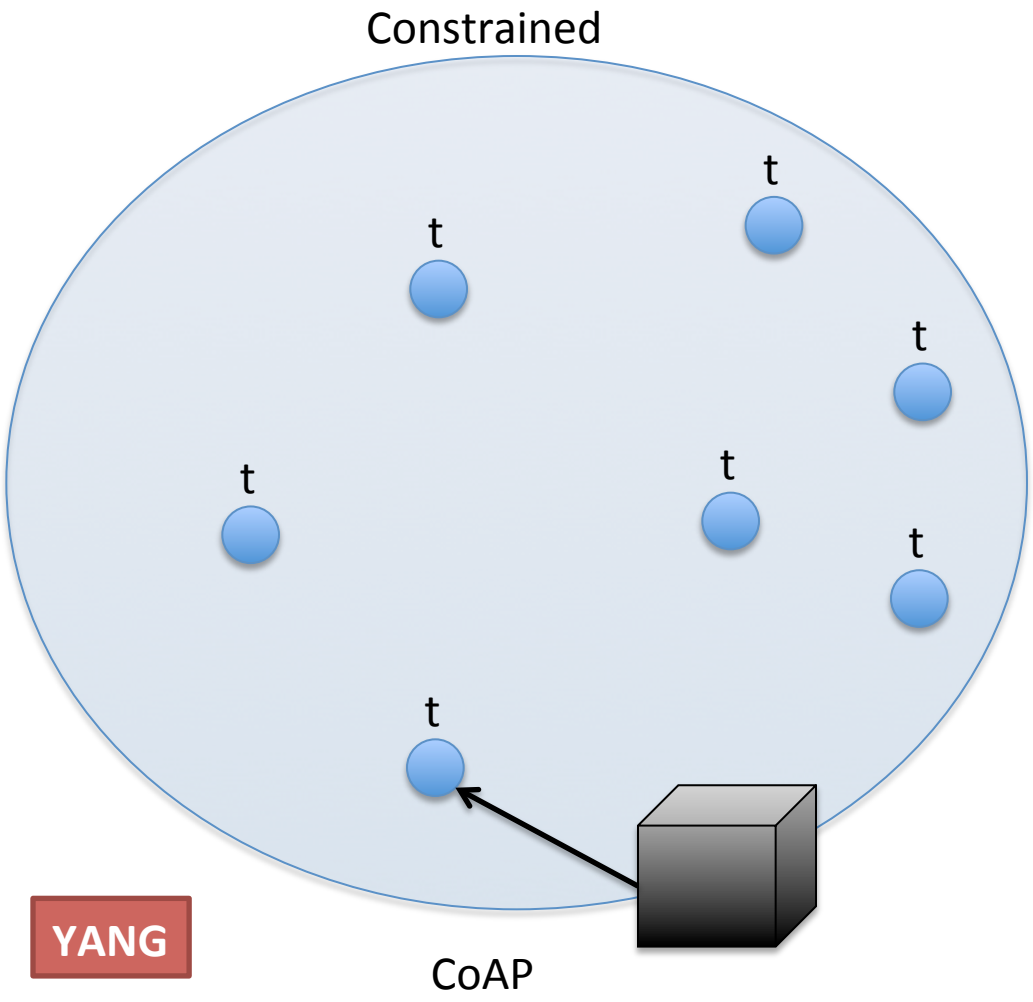

I want to manage LPWAN (LR-WAN)

- 10 000 devices per antenna
- 50 kbps max (can be 270 bps)
- 1-10% duty cycle

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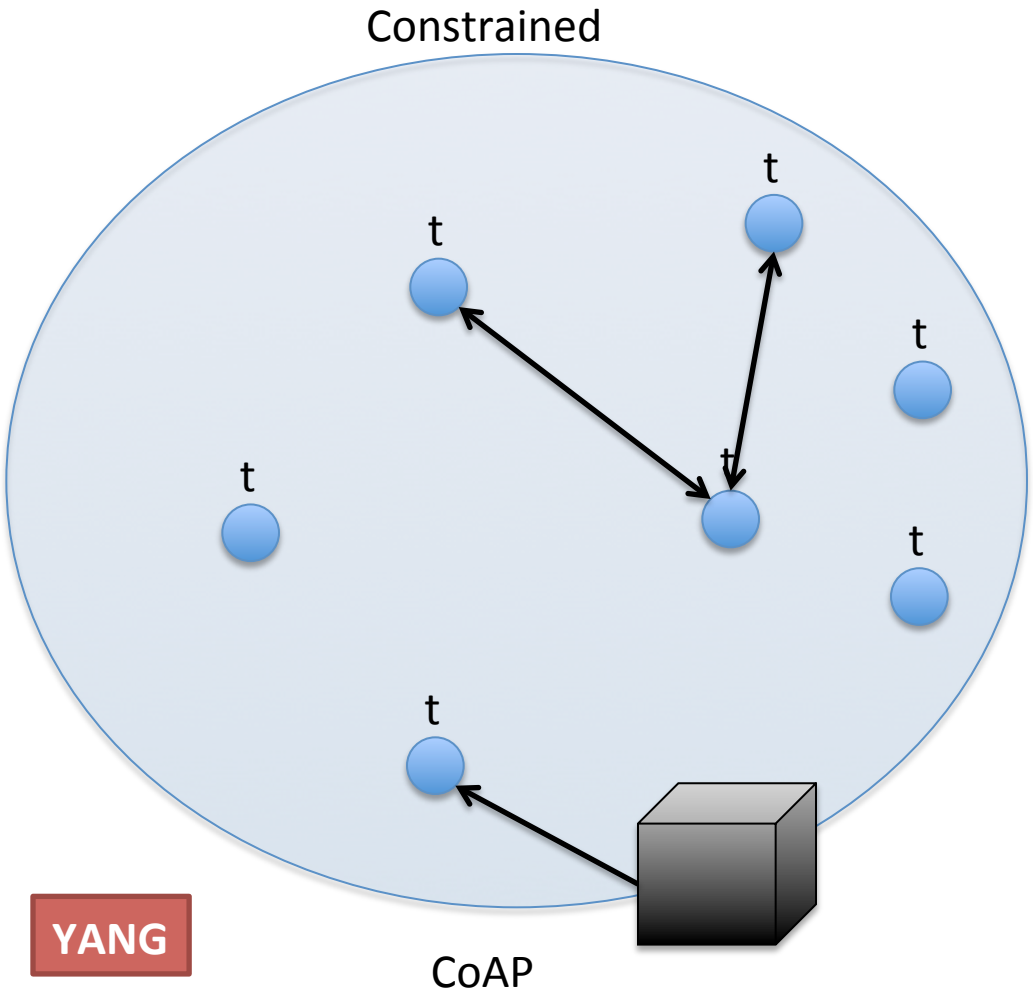

I want to manage LPWAN (LR-WAN)
- 10 000 devices per antenna
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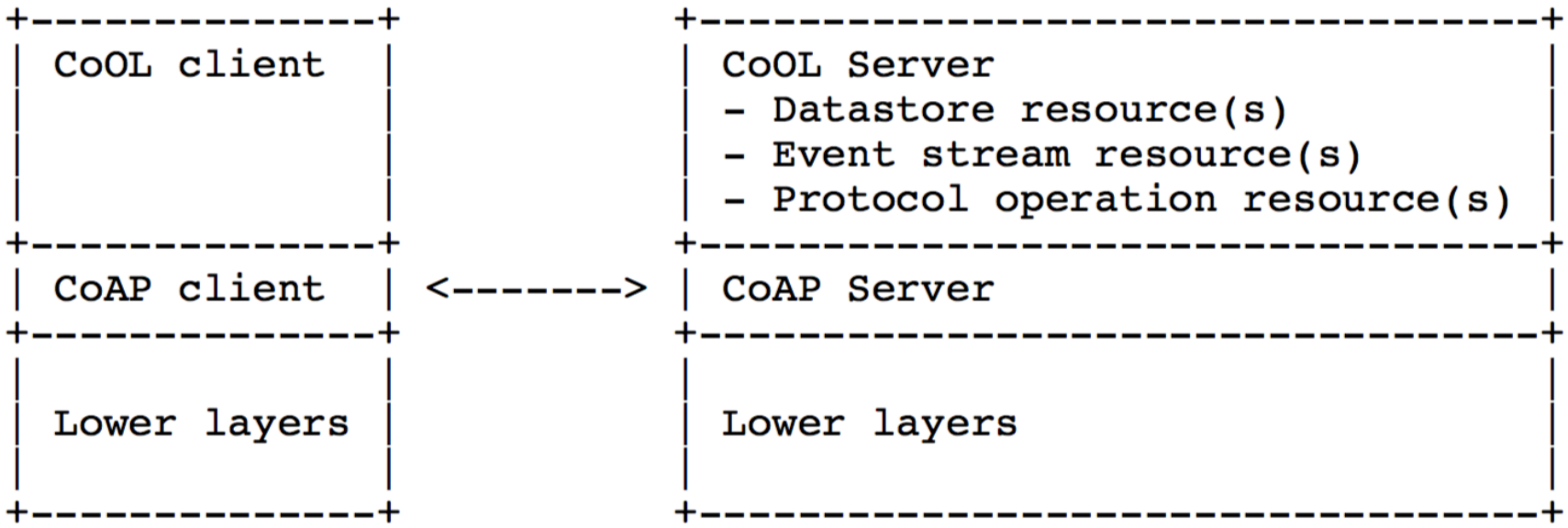
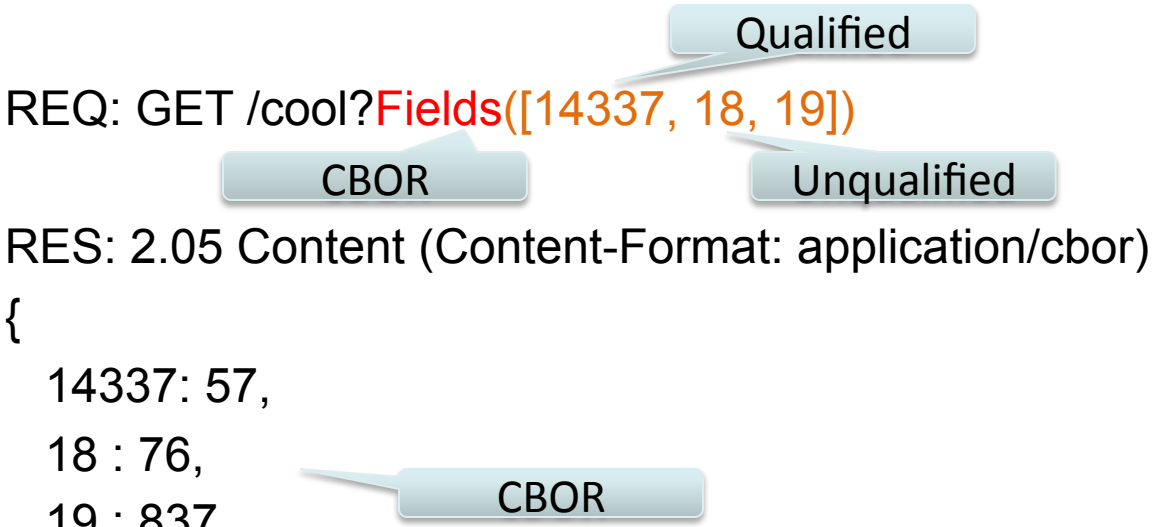
T2T management
- Thread / ZigBee / Other

Architecture



- Perform on a single resource (e.g. GET /cool)
- *"Fields"* option contains the list of nodes selected, encoded using a CBOR array



CoMI vs CoOL - Identifiers

	CoMI	**CoOL**
30 bits	Unmanaged **Hash(long identifier)**	Managed **Module ID (20 bit) + Node ID (10 b)** -> NID is LSB

CoMI vs CoOL - Identifiers

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30 bits	Unmanaged **Hash(long identifier)** Collisions - Re-hashing - Handling thousands of nodes puts strain on client (learn re-hashes and hashes for each dev) - Dynamic module loading – rehashing in a retrieved tree can be painful	Managed **Module ID (20 bit) + Node ID (10 b)** -> NID is LSB Automatically allocated (can be manual) Central repository for modules - Need IANA action - Distributed scenarios (t2t!) - Lots of magic (*module discovery*,…) ID of DATA, EVENTS and RPCs !

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URI	BASE64 mapping 30 bits -> 5 URI-safe characters	CoAP option CBOR encoded (1-5 bytes, mostly 3 bytes)
Body	CBOR encoded (5 bytes)	CBOR encoded (1-5 bytes, mostly 3 bytes)
Collection of nodes	Not supported	CBOR array Optimized

Conclusion CoOL

- Managed IDs
  - Data nodes, notification streams, protocol operations (RPC)
- RESTful collections
  - Use of binary option -> optimal representation
- Explicit PATCH (vs diff-like in CoMI)
- Use CoOL to manage applications
- Next steps
  - Use of deterministic multimaps vs maps
  - Multicast for application management
    - E.g. turn all lights on a controller

BACKUP SLIDES

URIs

CoMI

/mg/XXXXX
/mg/stream

CoOL

- Default endpoint + CoAP « Fields » option
  /cool + Fields(ID)
  /cool/rpc + Fields(ID)
  /cool/stream + Fields(ID) (optional)

- Endpoint 0, 1, … (optional)
  /cool/ep0, /cool/ep1, …
  /cool/ep0/rpc, /cool/ep1/rpc, …
  /cool/ep0/stream, /cool/ep0/stream …

Nodes, collections and filtering

CoMI

/mg/XXXXX?***keys=****keyValue1,keyValue2,…*&***select=****YYYYY(value1, value2, value3, …)*

CoOL

- Fields:

  CBOR integer = single data node

  0x11023

  CBOR array = more than one data nodes

  [0x11023, 0x24, 0x25, 0x26]

  -> if an item is an array, then – key + search

  [0x11023, 0x24, **[0x25, [keyValue1, keyValue2,…], [value1, value2, …]]**, 0x26]

Example: Part of a YANG module

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

    leaf boot-datetime {
         type date-and-time;
    }
}
```

CoMI

/ietf-system:system-state/clock (0x021ca491 and CDKSQ)
/ietf-system:system-state/clock/current-datetime (0x047c468b)
/ietf-system:system-state/clock/boot-datetime (0x1fb5f4f8)

REQ: GET example.com/mg/CDKSQ
(Content-Format: application/cbor)

RES: 2.05 Content (Content-Format: application/cbor)

```
{
  0x021ca491 : {
     0x047c468b : "2014-10-26T12:16:51Z",
     0x1fb5f4f8 : "2014-10-21T03:00:00Z"
   }
}
```

CoOL

ietf-system module ID=0x44
/ietf-system:system-state/clock (DNID=0x23, FQDNID=0x11023)
/ietf-system:system-state/clock/current-datetime (DNID=0x24)
/ietf-system:system-state/clock/boot-datetime (DNID=0x25)

REQ: GET example.com/cool *Fields(0x11023)*
(Content-Format: application/cbor)

RES: 2.05 Content (Content-Format: application/cbor)

```
{
  0x11023 : {
    0x24 : "2015-10-02T14:47:24Z-05:00",
    0x25: "2015-09-15T09:12:58Z-05:00"
  }
}
```

CoOL – two data nodes

ietf-system module ID=0x44
/ietf-system:system/clock (DNID=0x05, FQDNID=0x11005)
/ietf-system:system/clock/timezone/timezone-utc-offset/timezone-utc-offset (DNID=0x07)
/ietf-system:system-state/clock/current-datetime (DNID=0x24, FQDNID=0x11024)

REQ: **GET /cool *Fields([0x11005, 55])***

RES: 2.05 Content (Content-Format: application/cbor)

```
{
   0x11005: {
     0x7 : 540
   },
   0x11024 : "2015-10-08T14:10:08Z09:00”
}
```

CoOL – filtering + search

CoAP request:
GET /cool *Fields([69635, [66562, ["eth0"], [5, 6]])*

CoAP response:
2.05 Content Content-Format(application/cbor)
{
69635 : "datatracker.ietf.org",
66562 : {
5 : "iana-interface-type.ethernetCsmacd",
6 : true
}
}

OR

2.05 Content Content-Format(application/cbor)
{
69635 : "datatracker.ietf.org",
66562 : undefined
}

URI question

- How do you modify a collection of objects
  - PATCH in CoMI
    - Someday FETCH
    - Cannot do PUT/POST/DELETE on a collection
  - PATCH in CoOL
    - FETCH

- FETCH + PATCH = REST ?

CoMI vs CoOL PATCH

- CoMI = run a diff
  - New entries are added, existing are updated, null-ed are deleted

- CoOL= YANG module
  - patch-request + modification type + data node + value
    - Delete, merge, replace, remove, insert-first, insert-last, insert-before, insert-after
    - List entry
    - List value

CoOL PATCH vs CoMI PATCH

CoAP request:
PATCH /cool Content-Format(app/cbor)

```
{
  1028 : [
    {
      5 : 0, 6 : 4, 7 : [69642, [null]]
    },
    {
      5 : 1, 6 : 0, 8: {
        69642 : {
          11 : "NTP Pool server 2",
          12 : {
            13 : "2.pool.ntp.org"
          }
    } }
    }, {
      5 : 2, 6 : 3, 8: {69641 : true }
    } ]
}
```

```
{
     "B":  {
      { "key1" : "author1",
       "key2" : "book2"}:
       { null : null},
      { "key1" : "author5"} :
        {"counter1" : 4444},
      { "key1" : "newauthor",
       "key2" : "newbook"}:
      { "col1" : 1,
        "counter1" : 1}
      },
    "book" : {
      "title" : "favoured",
      "author": {"familyName" : null},
      "tags" : [ "example"],
      "phoneNumber" : "+01-123-456-7890"
    }
}
```

CoOL protocol operations (aka RPC)

module ietf-system: module ID 68
rpc set-current-datetime: protocol operation ID 1
input parameter current-datetime: input parameter ID 1

CoAP request:
POST /cool/rpc/68/1 Content-Format(application/cbor)
{
  1 : "2015-10-08T14:10:08Z09:00”
}

CoAP response:
2.05 Content
…

Questions

- How do we identify items?
  - Data nodes, event streams, protocol operations (RPC)
  - Managed vs Unmanaged
- How do we identify a collection of items?
  - Query parameters, FETCH method
    - How do we PUT/POST/DELETE them? PATCH all?
  - CoAP option
- How do we PATCH?
  - Diff vs explicit operations
- How do we represent requests/responses?
  - Death of the JSON object (CBOR map) as a main carrier
- How do we manage applications on devices?

But wait, there is more…

- Application management
  - Endpoints
  - Application multicast
    - Do not confuse with network multicast
- Deterministic MultiMaps instead of objects
  - (or Ordered Pairs)