

IPSO Smart Objects

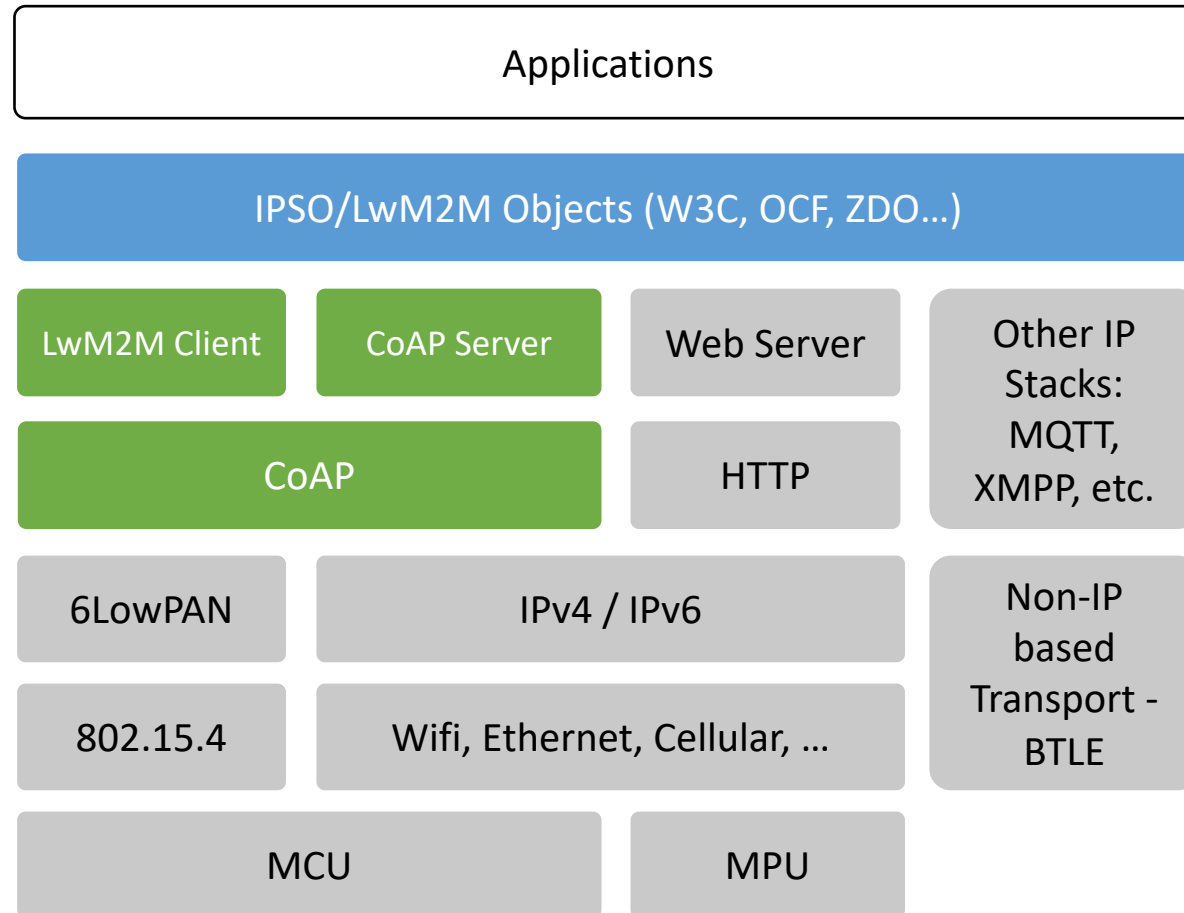
and related IoT Standards

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July 2019

The IP for Smart Objects (IPSO) device stack (recap)



Application

Data Models

API / Services

Application Protocol

Routing

HW Network

Hardware

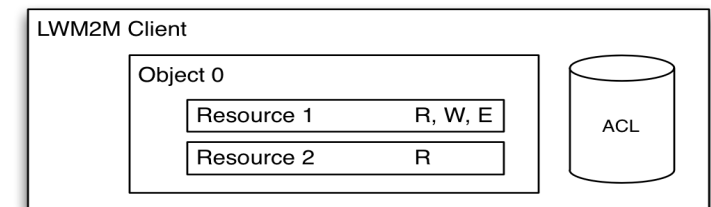
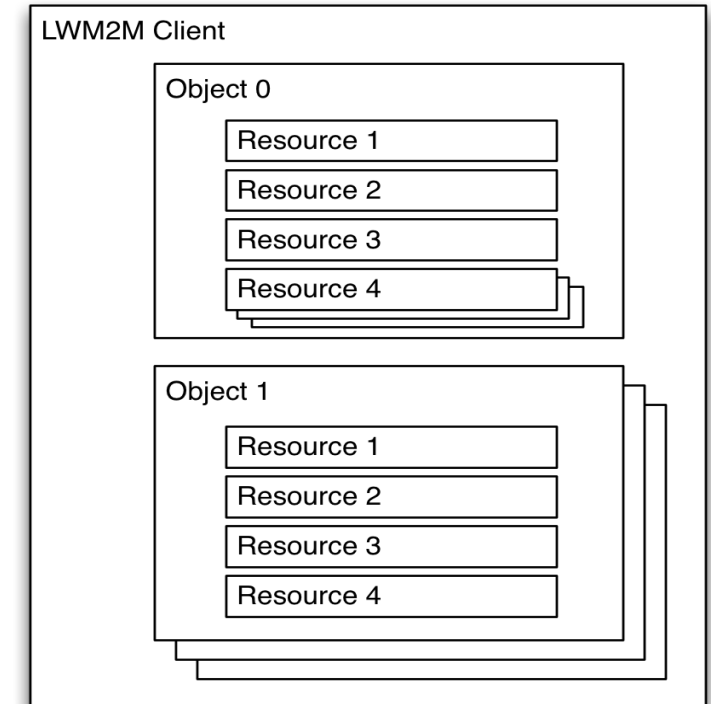
IPSO Object Structure

- Same URIs as LwM2M : `/ {Object ID} / {Object Instance} / {Resource ID}`

`/3300/0/5700`

- `3300` Temperature Sensor
- `0` Instance 0 of a Temperature Sensor
- `5700` Resource having the current value

- Data Types (String, Integer, ...) as LwM2M
- Operations (Read, Write, Create...) as LwM2M
- Object Linking and Core Link
 - Object Linking is used to refer to Objects within the device.
 - Allows composition without nasty large nested structures
 - Allows for complex objects (i.e. appliance made of several sensors)
- Web Linking to refer to external items (over CoAP).
 - Query parameters: `GET <URL>?rt="urn:oma:lwm2m:temp"`
- Extensible data model
 - Only few "Mandatory" Resources to enable interoperability
 - Use of versioning for model updates



IPSO Example Temperature Object

Object definition

Name	Object ID	Instances	Mandatory	Object URN
Temperature	3303	Multiple	Mandatory	urn:oma:lwm2m:3303

Resource definitions

ID	Name	Operations	Instances	Mandatory	Type	Units	Description	
5700	Sensor Value	R	Single	Mandatory	Float	...	...	Data
5601	Min Measured Value	R	Single	Optional	Float	...	...
5602	Max Measured Value	R	Single	Optional	Float	...	...
5603	Min Range Value	R	Single	Optional	Float	...	...	Metadata
5604	Max Range Value	R	Single	Optional	Float	...	...
5701	Sensor Units	R	Single	Optional	String	...	...
5605	Reset Min and Max	E	Single	Optional	Opaque	...	...	Actions

IPSO Smart Objects

<u>Object</u>	<u>Object ID</u>	<u>Object</u>	<u>Object ID</u>	<u>Object</u>	<u>Object ID</u>
Digital Input	3200	Current	3317	Gyrometer	3334
Digital Output	3201	Frequency	3318	Color	3335
Analogue Input	3202	Depth	3319	GPS Location	3336
Analogue Output	3203	Percentage	3320	Positioner	3337
Generic Sensor	3300	Altitude	3321	Buzzer	3338
Illuminance Sensor	3301	Load	3322	Audio Clip	3339
Presence sensor	3302	Pressure	3323	Timer	3340
Temperature Sensor	3303	Loudness	3324	Addressable Text Display	3341
Humidity Sensor	3304	Concentration	3325	On/Off Switch	3342
Power Measurement	3305	Acidity	3326	Dimmer	3343
Actuation	3306	Conductivity	3327	Up/Down Control	3344
Set Point	3308	Power	3328	Multiple Axis Joystick	3345
Load Control	3310	Power Factor	3329	Rate	3346
Light Control	3311	Distance	3330	Push Button	3347
Power Control	3312	Energy	3331	Multi-state Selector	3348
Accelerometer	3313	Direction	3332	Bitmap	3349
Magnetometer	3314	Time	3333	Stopwatch	3350
Barometer	3315				
Voltage	3316				

IPSO Reusable Resources

<u>Resource</u>	<u>Resource ID</u>	<u>Resource</u>	<u>Resource ID</u>	<u>Resource</u>	<u>Resource ID</u>	<u>Resource</u>	<u>Resource ID</u>
Digital Input State	5500	X Coordinate	5528	Reset Min and Max Measured Values	5605	Reactive Power Calibration	5816
Digital Input Counter	5501	Y Coordinate	5529	Analog Output Current Value	5650	Power Factor	5820
Digital Input Polarity	5502	Clear Display	5530	Sensor Value	5700	Current Calibration	5821
Digital Input Debounce	5503	Contrast	5531	Sensor Units	5701	Reset Cumulative energy	5822
Digital Input Edge Selection	5504	Increase Input State	5532	X Value	5702	Event Identifier	5823
Digital Input Counter Reset	5505	Decrease Input State	5533	Y Value	5703	Start Time	5824
Current Time	5506	Counter	5534	Z Value	5704	Duration In Min	5825
Fractional Time	5507	Current Position	5536	Compass Direction	5705	Criticality Level	5826
Min X Value	5508	Transition Time	5537	Colour	5706	Avg Load Adj Pct	5827
Max X Value	5509	Remaining Time	5538	Application Type	5750	Duty Cycle	5828
Min Y Value	5510	Up Counter	5541	Sensor Type	5751	On/Off	5850
Max Y Value	5511	Down Counter	5542	Instantaneous active power	5800	Dimmer	5851
Min Z Value	5512	Digital State	5543	Min Measured active power	5801	On Time	5852
Max Z Value	5513	Cumulative Time	5544	Max Measured active power	5802	Muti-state Output	5853
Latitude	5514	Max X Coordinate	5545	Cumulative active power	5805	Off Time	5854
Longitude	5515	Max Y Coordinate	5546	Active Power Calibration	5806	Set Point Value	5900
Uncertainty	5516	Multi-state Input	5547	Instantaneous reactive power	5810	Busy to Clear delay	5903
Velocity	5517	Level	5548	Min Measured reactive power	5811	Clear to Busy delay	5904
Timestamp	5518	Digital Output State	5550	Max Measured reactive power	5812	Bitmap Input	5910
Min Limit	5519	Digital Output Polarity	5551	Min Range reactive power	5813	Bitmap Input Reset	5911
Max Limit	5520	Analog Input State	5600			Element Description	5912
Delay Duration	5521	Min Measured Value	5601			UUID	5913

IPSO Object example

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- MIT License
...
-->
<LWM2M xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:noNamespaceSchemaLocation="http://openmobilealliance.org/tech/profiles/LWM2M.xsd">
  <Object ObjectType="MODefinition">
    <Name>Generic Sensor</Name>
    <Description1>This IPSO object ...</Description1>
    <ObjectID>3300</ObjectID>
    <ObjectURN>urn:oma:lwm2m:ext:3300</ObjectURN>
    <LWM2MVersion>1.0</LWM2MVersion>
    <ObjectVersion>1.0</ObjectVersion>
    <MultipleInstances>Multiple</MultipleInstances>
    <Mandatory>Optional</Mandatory>
    <Resources>
      <Item ID="5700">
        <Name>Sensor Value</Name>
        <Operations>R</Operations>
        <MultipleInstances>Single</MultipleInstances>
        <Mandatory>Mandatory</Mandatory>
        <Type>Float</Type>
        <RangeEnumeration></RangeEnumeration>
        <Units></Units>
        <Description>Last or Current Measured Value from the Sensor</Description>
      </Item>
      . . . . Other Resources . . . .
    </Resources>
    <Description2></Description2>
  </Object>
</LWM2M>
```

XML Schema

Object Definition

Resource Definition

IPSO Serialization Formats

TLV (legacy)

```
C8 00 14 4F 70 65 6E 20 4D 6F 62 69 6C 65 20 41 6C
6C 69 61 6E 63 65
C8 01 16 4C 69 67 68 74 77 65 69 67 74 20 4D 32 4D
20 43 6C 69 65 6E 74
C8 02 09 33 34 35 30 30 30 31 32 33
C3 03 31 2E 30
86 06
    41 00 01
    41 01 05
88 07 08
    42 00 0E D8
    42 01 13 88
87 08
    41 00 7D
    42 01 03 84
C1 09 64
C1 0A 0F
83 0B
    41 00 00
C4 0D 51 82 42 8F
C6 0E 2B 30 32 3A 30 30
C1 10 55
```

SenML - JSON

```
[{"bn":"/3/0/","n":"0","vs":"Open Mobile Alliance"},
{"n":"1","vs":"Lightweight M2M Client"},
{"n":"2","vs":"345000123"},
{"n":"3","vs":"1.0"},
{"n":"6/0","v":1},
{"n":"6/1","v":5},
{"n":"7/0","v":3800},
{"n":"7/1","v":5000},
{"n":"8/0","v":125},
{"n":"8/1","v":900},
{"n":"9","v":100},
{"n":"10","v":15},
{"n":"11/0","v":0},
{"n":"13","v":1367491215},
{"n":"14","vs":"+02:00"},
{"n":"16","vs":"U"}]
```


IPSO Serialization Formats

SenML-CBOR

```
90 a3 21 65 2f 33 2f 30 2f 00 61 30 03 74 4f 70
65 6e 20 4d 6f 62 69 6c 65 20 41 6c 6c 69 61 6e
63 65 a2 00 61 31 03 76 4c 69 67 68 74 77 65 69
67 68 74 20 4d 32 4d 20 43 6c 69 65 6e 74 a2 00
61 32 03 69 33 34 35 30 30 30 31 32 33 a2 00 61
33 03 63 31 2e 30 a2 00 63 36 2f 30 02 01 a2 00
63 36 2f 31 02 05 a2 00 63 37 2f 30 02 19 0e d8
a2 00 63 37 2f 31 02 19 13 88 a2 00 63 38 2f 30
02 18 7d a2 00 63 38 2f 31 02 19 03 84 a2 00 61
39 02 18 64 a2 00 62 31 30 02 0f a2 00 64 31 31
2f 30 02 00 a2 00 62 31 33 02 1a 51 82 42 8f a2
00 62 31 34 03 66 2b 30 32 3a 30 30 a2 00 62 31
36 03 61 55
```

SenML-CBOR diagnostic

```
[{-2: "/3/0/", 0: "0", 3: "Open Mobile Alliance"},
{0: "1", 3: "Lightweight M2M Client"},
{0: "2", 3: "345000123"},
{0: "3", 3: "1.0"},
{0: "6/0", 2: 1},
{0: "6/1", 2: 5},
{0: "7/0", 2: 3800},
{0: "7/1", 2: 5000},
{0: "8/0", 2: 125},
{0: "8/1", 2: 900},
{0: "9", 2: 100},
{0: "10", 2: 15},
{0: "11/0", 2: 0},
{0: "13", 2: 1367491215},
{0: "14", 3: "+02:00"},
{0: "16", 3: "U"}]
```

Implementations and OMNA Registry

- Several Implementations support IPSO:
 - [Example XML](#) of the supported LwM2M and IPSO Objects in [Leshan](#).
 - Sample [C package](#) for use of IPSO Objects in [Contiki](#).
 - JS code templates of IPSO-defined devices [code templates](#).
 - Sample [Smart Objects](#) Class can be used to create IPSO Smart Objects in your JavaScript applications.
 - [BIPSO](#) defines a set of BLE Characteristics that follows the IPSO Objects.
 - Contiki, Mbed, Zephyr and RIOT are example OS's that support IPSO Objects.
- Full object set available at the OMNA Registry:
 - <http://www.openmobilealliance.org/wp/OMNA/LwM2M/LwM2MRegistry.html>