

LwRSD

LWM2M Resource Semantic Distance



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Presentation based on:

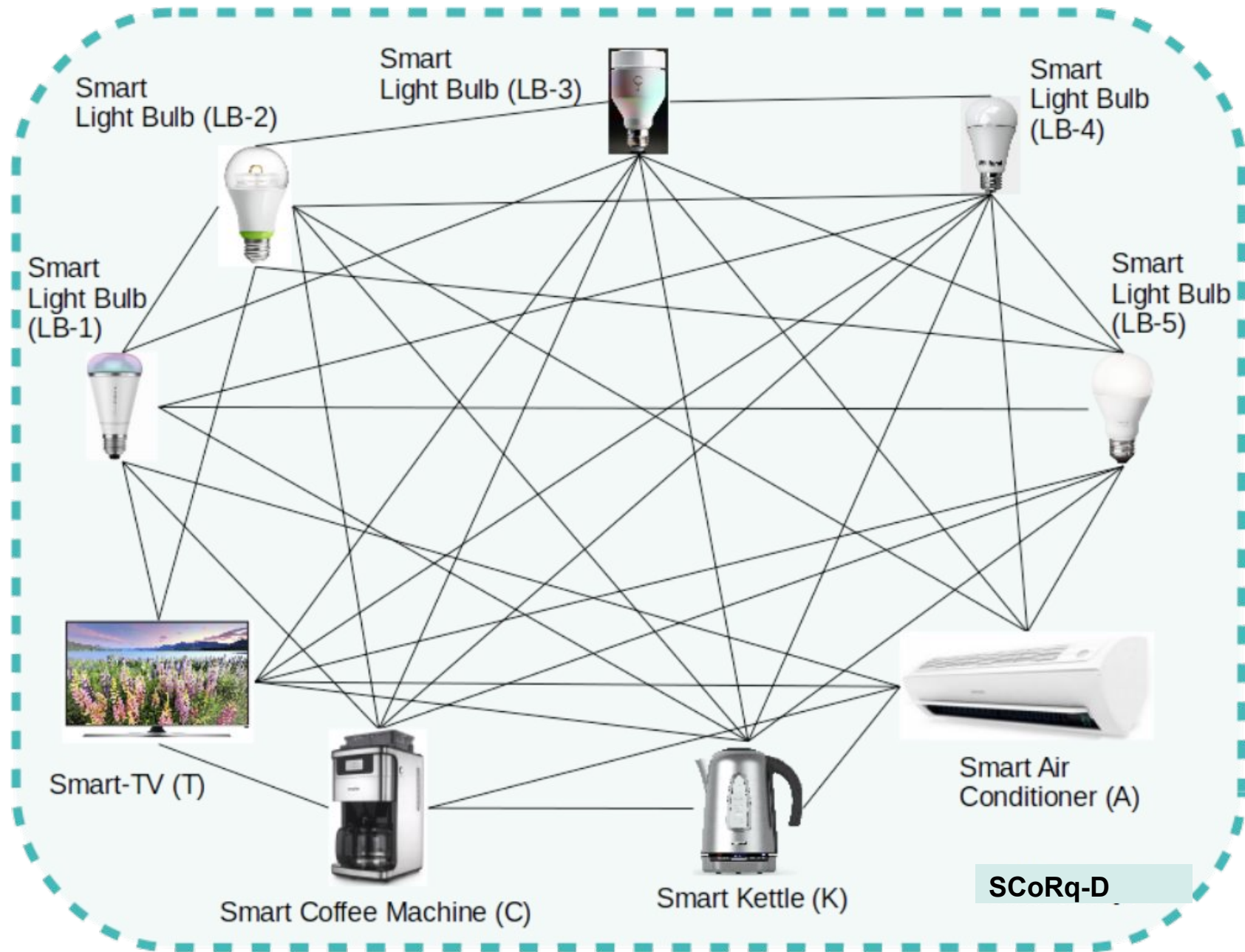
M. Robles and et.al. 2017. Measuring Semantic Distance between LWM2M Resources. IEEE International Conference on Internet of Things (iThings-2017)

Group Management

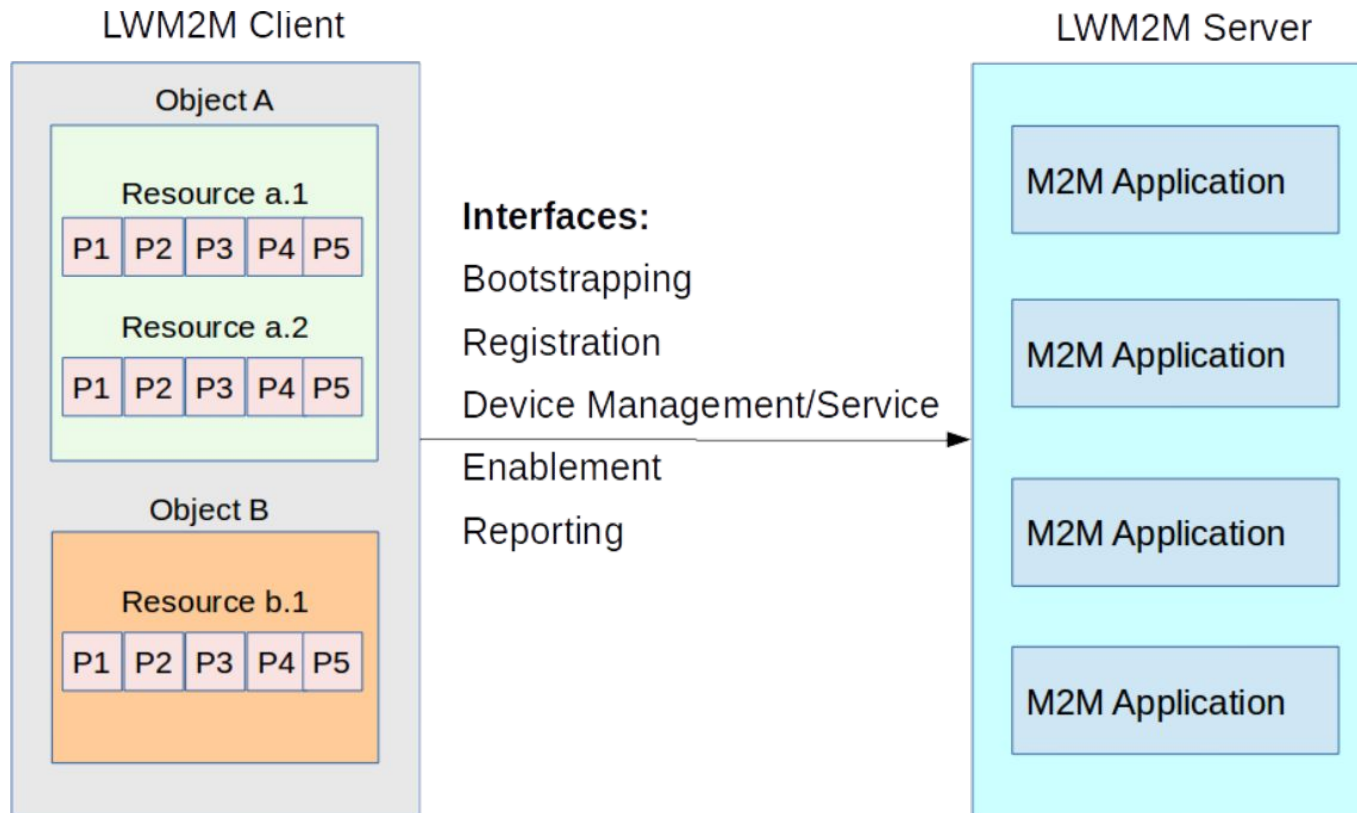
Grouping devices to manage them together

Management involves:

- Fault
- Configuration
- Accounting
- Performance
- Security



Lightweight M2M (LWM2M) is a client-server IoT management protocol



LwM2M = CoAP + IPSO Objects

LWM2M Resource Semantic Distance (LwRSD)

Goal/Problem:

The LWM2M protocol treats every device uniquely regardless of its similarity to other IoT devices.

In certain usage scenarios, it is ideal to identify the IoT devices that have similar properties as a group and control them with a single management command.

LWM2M Resource Semantic Distance (LwRSD)

Solution:

To measure the similarity between the manageable properties of any two IoT devices, we define a metric called LWM2M Resource Semantic Distance (LwRSD).

LwRSD assigns weights to the properties of an IoT device based on a Set of Contextual Requirements (SCoRq).

LWM2M Resource Semantic Distance (LwRSD)

Using these weights, and based on the contextual requirements, the LwRSD calculates a specific “distance” between the two devices, said distance being an indication of the extent to which one device can be substituted for the other.



In other words

We refer to the semantic distance as a measure of the capability of two devices to perform the same function.

LWM2M Resource Semantic Distance (LwRSD)

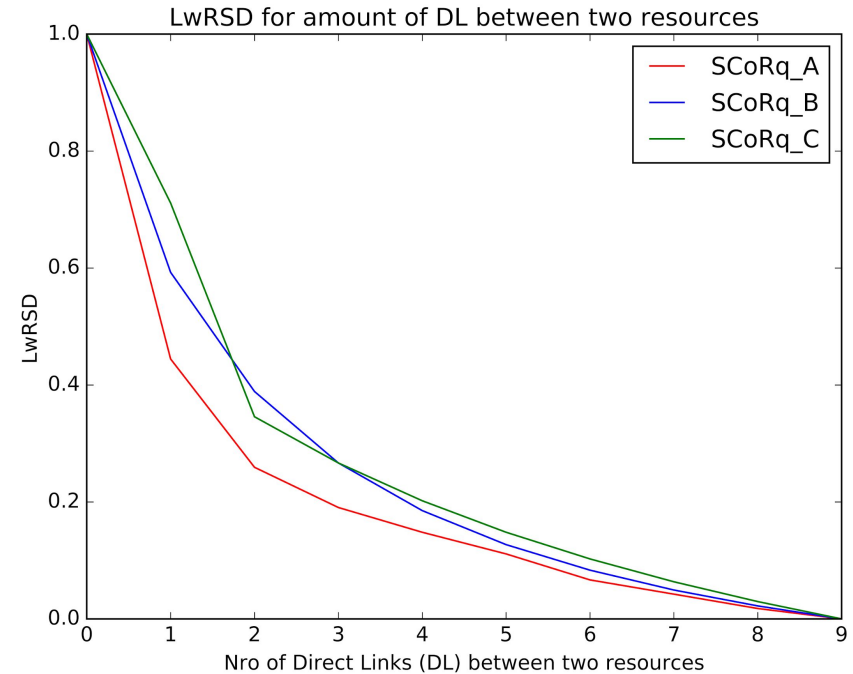
The method that calculates the semantic distance between two objects should have these properties:

- The objects that are equal semantically should have distance of 0.
- The objects that are quite close semantically should have distance close to 0
- The objects that are far semantically should have distance close to 1.
- The objects that are not related semantically should have distance of 1.
- The distance between object A and B should be the same that between the object B and A.
- The method should be able to be adapted to any type of environment and objects

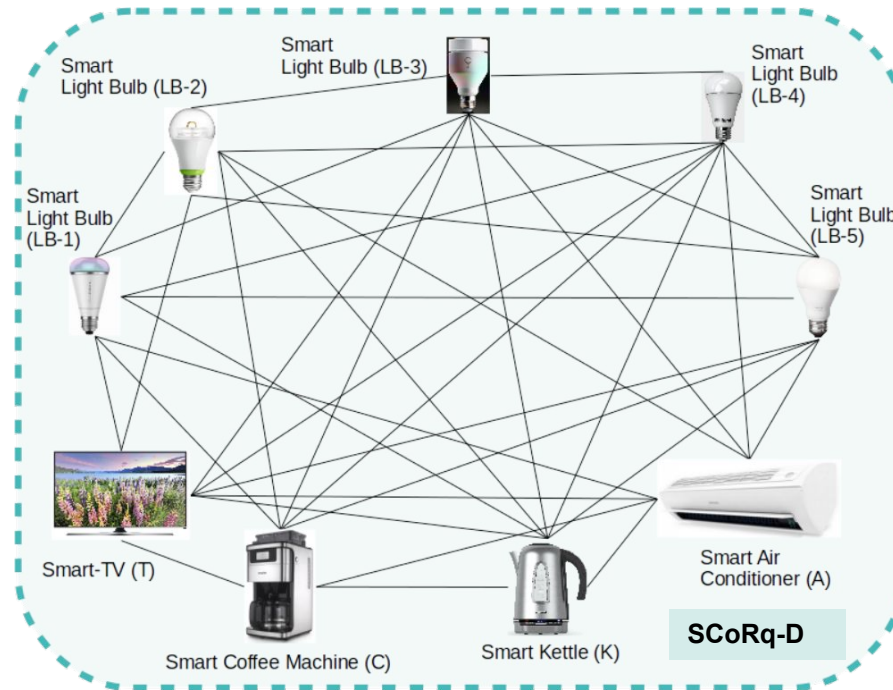
LWM2M Resource Semantic Distance (LwRSD)

Property	SCoRq-A		SCoRq-B		SCoRq-C	
	p	v	p	v	p	v
ID	0.95	0.05	0.45	0.05	0.20	0.05
Name	0.95	0.05	0.45	0.05	0.95	0.05
Operations	0.45	0.05	0.45	0.05	0.20	0.05
Instances	0.20	0.05	0.45	0.05	0.20	0.05
Mandatory	0.20	0.05	0.45	0.05	0.20	0.05
Type	0.95	0.05	0.45	0.05	0.20	0.05
Range	0.20	0.05	0.45	0.05	0.20	0.05
Units	0.95	0.05	0.45	0.05	0.20	0.05
Description	0.25	0.05	0.45	0.05	0.20	0.05

Resource weights q and v for three contexts



We observe that independent of the weights given to the SCoRq, when there are no links between the resources the LwRSD is 1, and when two resources matches in all the links between them, LwRSD is 0.



SCoRq-D goals:

-To group devices that are able to alert in case of fire.

- Currently, the Light-Bulb Number 3 (LB-3) is set to change to a specific color in case of fire, the preference in this SCoRq is to pick up a device that presents a similar functionality

SCoRq-D
Resources of Buzzer Object
Resources of On/Off Object
Resources of Light Control Object
Resources of Audio Clip Object
Resources of Text Display Object
Resources of Timer Object

IPSO Objects Actuators

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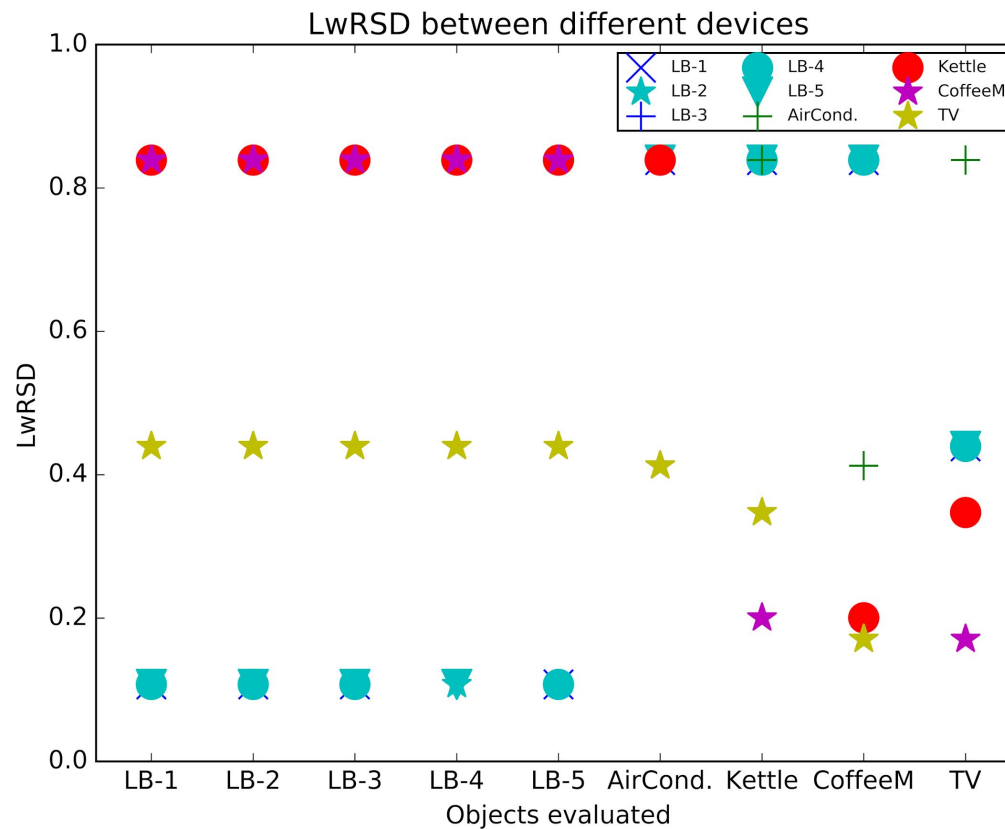
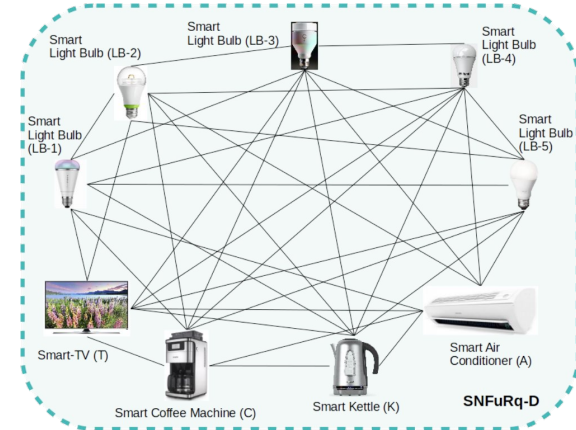
SCoRq-D
Resources of Buzzer Object
Resources of On/Off Object
Resources of Light Control Object
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Resources of Timer Object

IPSO Objects Actuators

No	IPSO Light Control Obj.		
17	On/Off	p	0.90
		v	0.10
18	Dimmer	p	0.90
		v	0.10
19	Colour	p	0.90
		v	0.10
20	Units	p	0.30
		v	0.70
21	On-Time	p	0.90
		v	0.30
22	Cumulative active Power	p	0.30
		v	0.01
23	Power factor	p	0.70
		v	0.05

We observe that:

- We can group the light bulbs,
- We observe that LwRSD uncovers properties between devices that are not straightforward, e.g.,
 - The TV is close to the CoffeMachine
 - The TV is close to the light bulbs



Model definition for LwRSD

Model definition for LwRSD

- A set of Contextual Requirements (SCoRq)

$$SCoRq = \{pr_1, pr_2, \dots, pr_{tr}\} \quad t_r = |SCoRq|$$

- p: weight assigned to the resource property

- v: weight assigned to the value of the resource property

Model definition for LwRSD

- Direct Links (DL) between resources:

$$DL_{r_a, r_b} = p \times Ep(r_a, r_b) + v \times Ev(r_a, r_b)$$

$$Ep(r_a, r_b) = \begin{cases} 0, & \text{if does not exist } p \text{ in } r_a \text{ and } r_b \\ 1, & \text{if exists } p \text{ in } r_a \text{ and } r_b, \end{cases} \quad Ev(r_a, r_b) = \begin{cases} 0, & \text{if } p_a \neq p_b \text{ or } p_a = p_b \ \& \ v_a \neq v_b \\ 1, & \text{if } p_a = p_b \ \& \ v_a = v_b \end{cases}$$

- n: the total number of direct links (DL) that exists between two resources based on the SCoRq

- the sum of all direct links (DL) that exist between two resources ra and rb as,

$$S_{DL}(n, r_a, r_b) = \sum_{i=1}^n DL_i(r_a, r_b)$$

LWM2M Resource Semantic Distance (LwRSD)

$$LwRSD(ra, rb) = \frac{t_r - n}{(1 + S_{DL}(n, r_a, r_b)) \times t_r}$$

LWM2M Object Semantic Distance (LwOSD)

$$LwOSD(A, B) = \frac{\sum_{i=1}^{i=m} LwRSD_i}{m}$$

Q&A

Thanks!