Professional Lighting Control Using IPSO Smart Objects Design Patterns

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IPSO Smart Objects

- Define Application Specific Objects with a Data Model based on encapsulation
- An Object contains a set of Resources
- Reusable Object and Resource types have semantic meaning, e.g. “Color Temperature Actuator” is an Object Type which contains a Resource with a type defined as “Current Color Temperature”

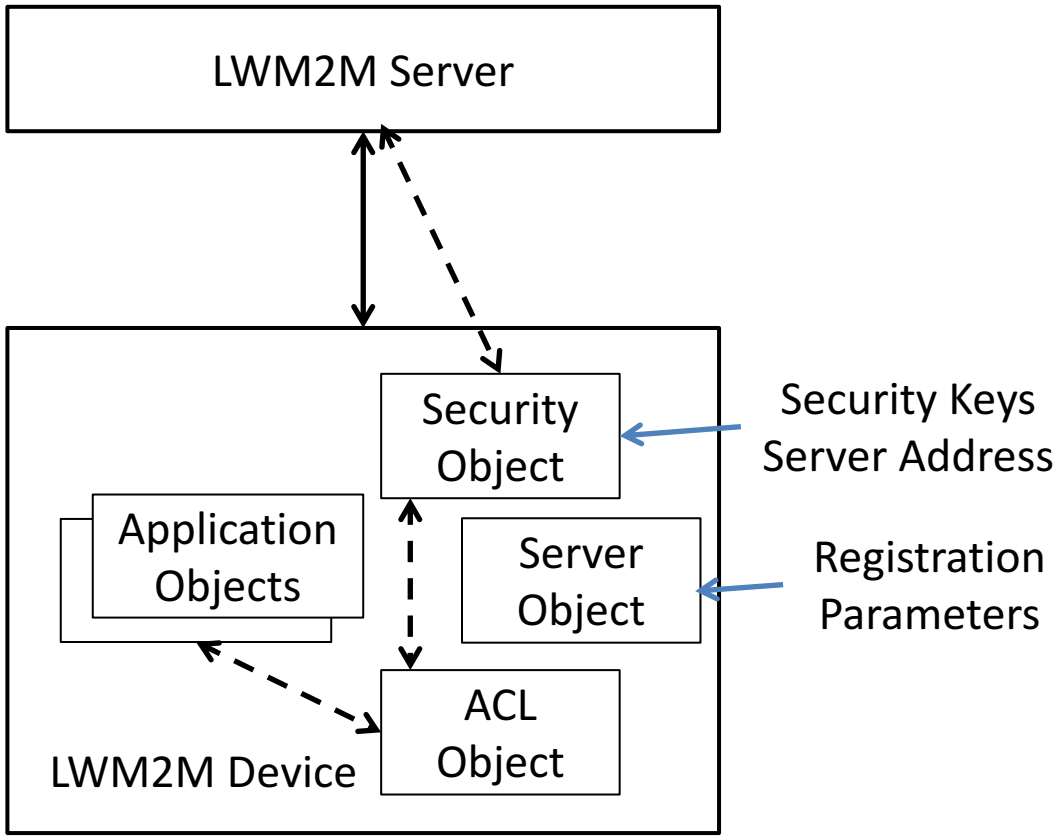
Proposed IPSO Smart Objects for Lighting and Control

Object	Object ID	Multiple Instances?
OnOff	3000	Yes
Level	3001	Yes
ColorHS	3002	Yes
ColorXY	3003	Yes
ColorTemperature	3004	Yes
ColorRGB	3005	Yes
Controller	3006	Yes
Binding	3007	Yes
Peer	3008	Yes
Group	3009	Yes
Batch	3010	Yes
Scene	3011	Yes
Scene Control	3012	Yes

LWM2M

- Devices are called “clients” and function as CoAP Clients and Servers
- Devices contain management objects that associate the device with one or more LWM2M “servers” for secure connection and interaction
- Management objects mediate the connection security and other paramenters

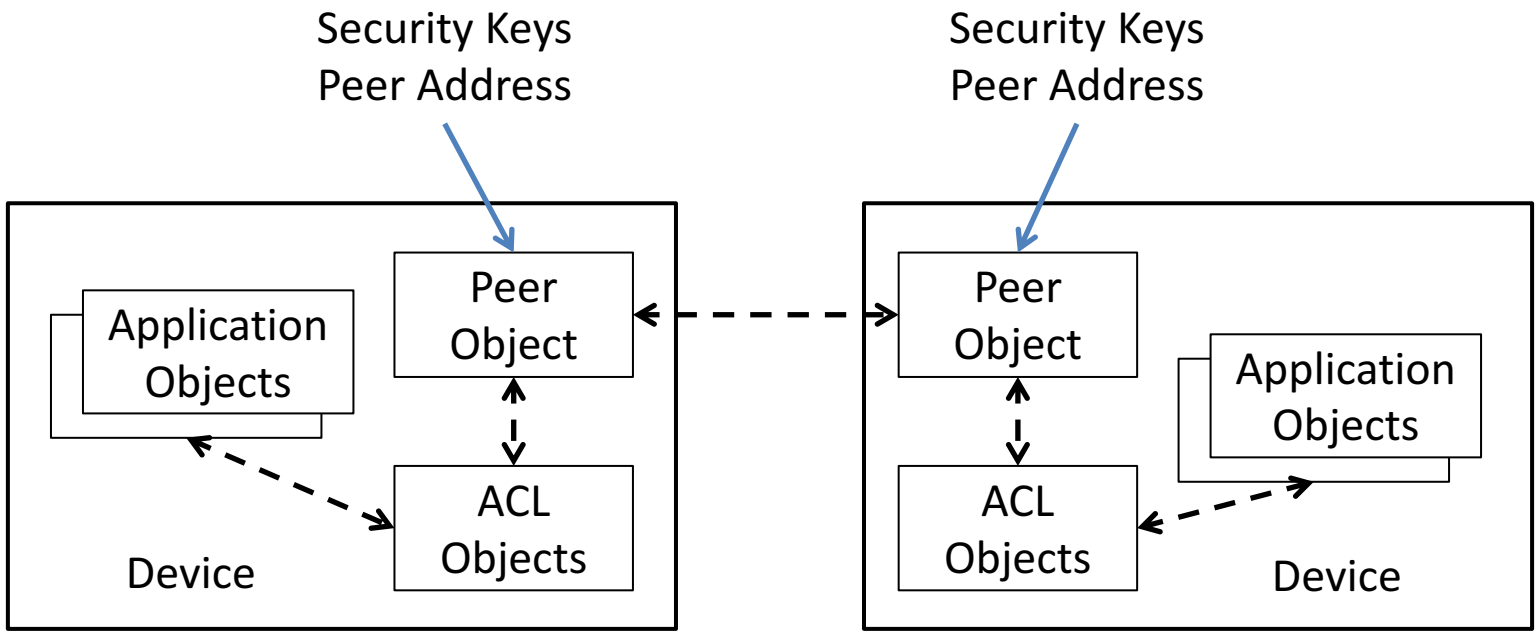
LWM2M Service Connection



Peer to Peer Interaction

- Device to Device interaction through peer object configuration
- Peer Object contains security keys and network address of trusted peer device
- Service Layer can be used to manage the trusted peer relationships
- Device to device interactions use the Peer Object in communication
- Peer Object is associated with object level ACLs

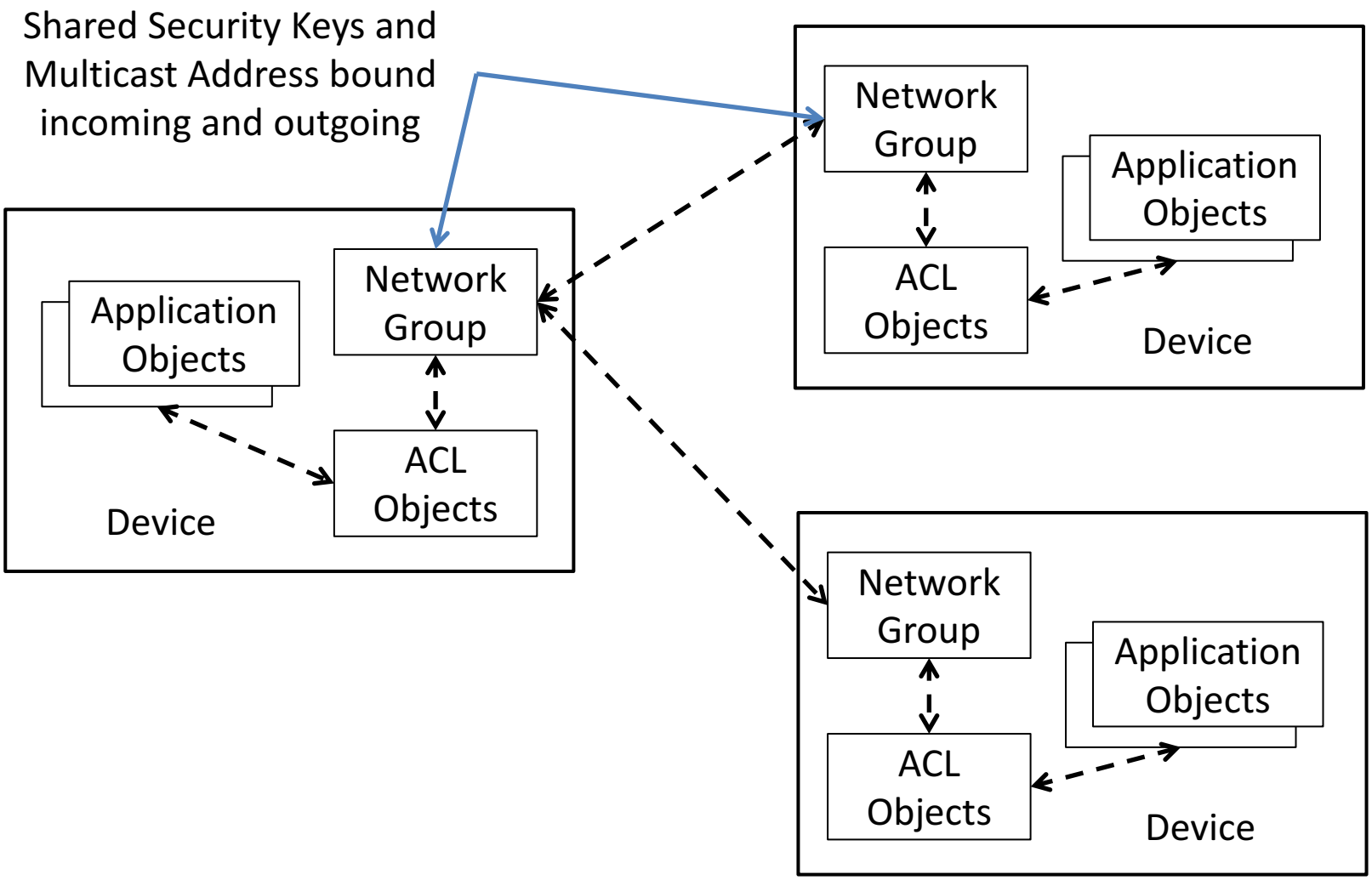
Peer Object


Security Keys
Peer Address
Security Keys
Peer Address
Application
Objects
Peer
Object
ACL
Objects
Device
Peer
Object
ACL
Objects
Application
Objects
Device

Group Interaction

- Network Group Object is like the Peer Object, but used for multicast group membership of an endpoint
- Contains the multicast group network address and group shared security material
- The Service Layer can be used to manage trusted group membership
- Group communication uses the Group Object
- A Network Group Object is associated with object ACLs
- Multiple application groups may share a single multicast network address by using a protocol specific application group ID, for example as a header option

Network Group Object

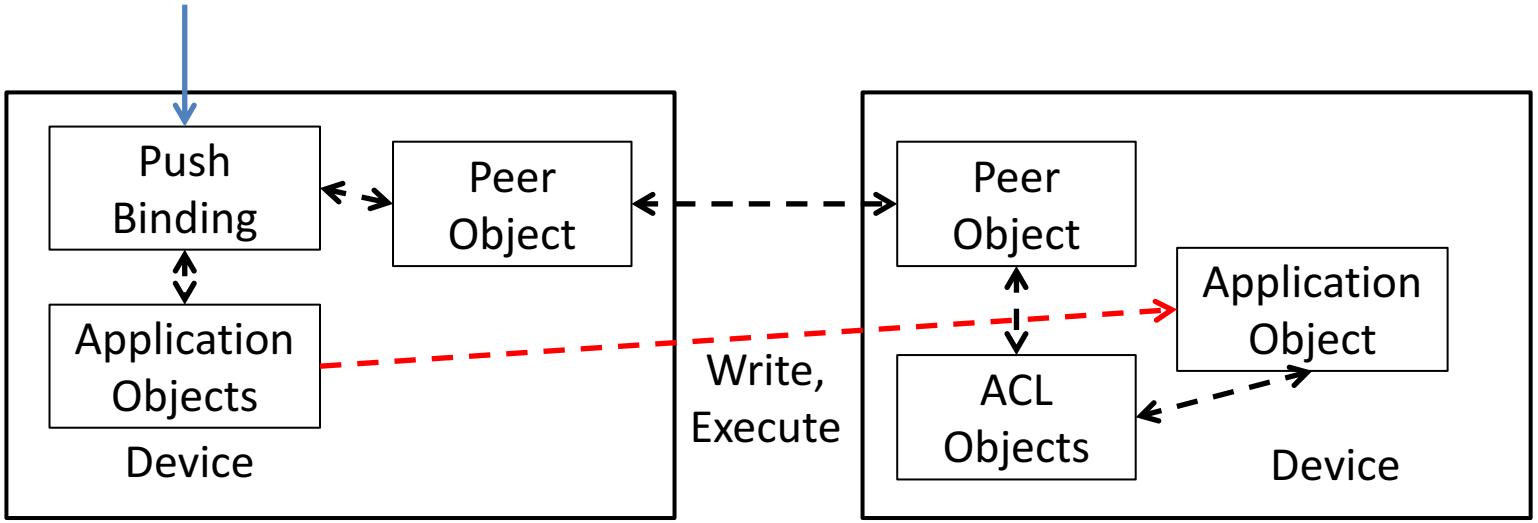


Bindings

- Binding Objects are used to associate CoAP Client functionality with resources on an endpoint to enable state updates to be received from or pushed to another endpoint, or pushed to an endpoint group
- Conditional updates based on time and threshold configuration in each Binding Object
- Binding Object contains a link to the Peer Object or Group Object for network address and security

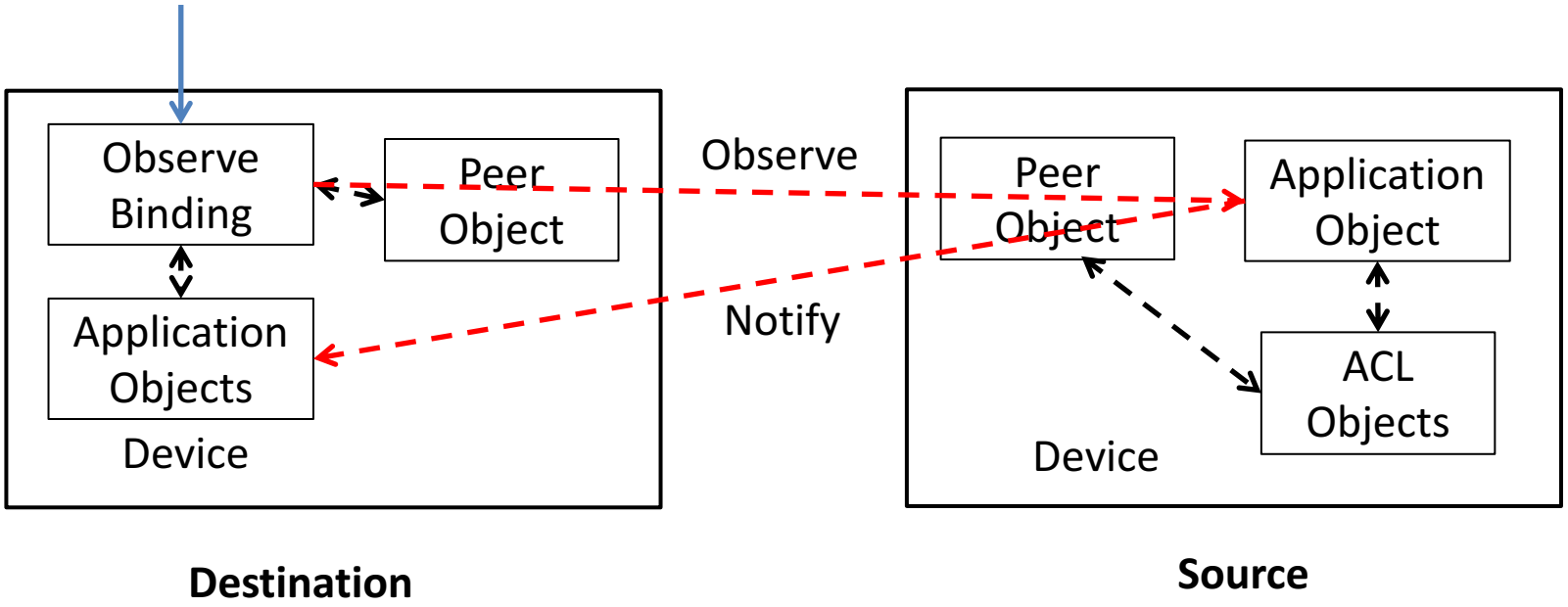
Push Binding

Push Binding Monitors the Object state and transmits selected updates



Observe Binding, Polling

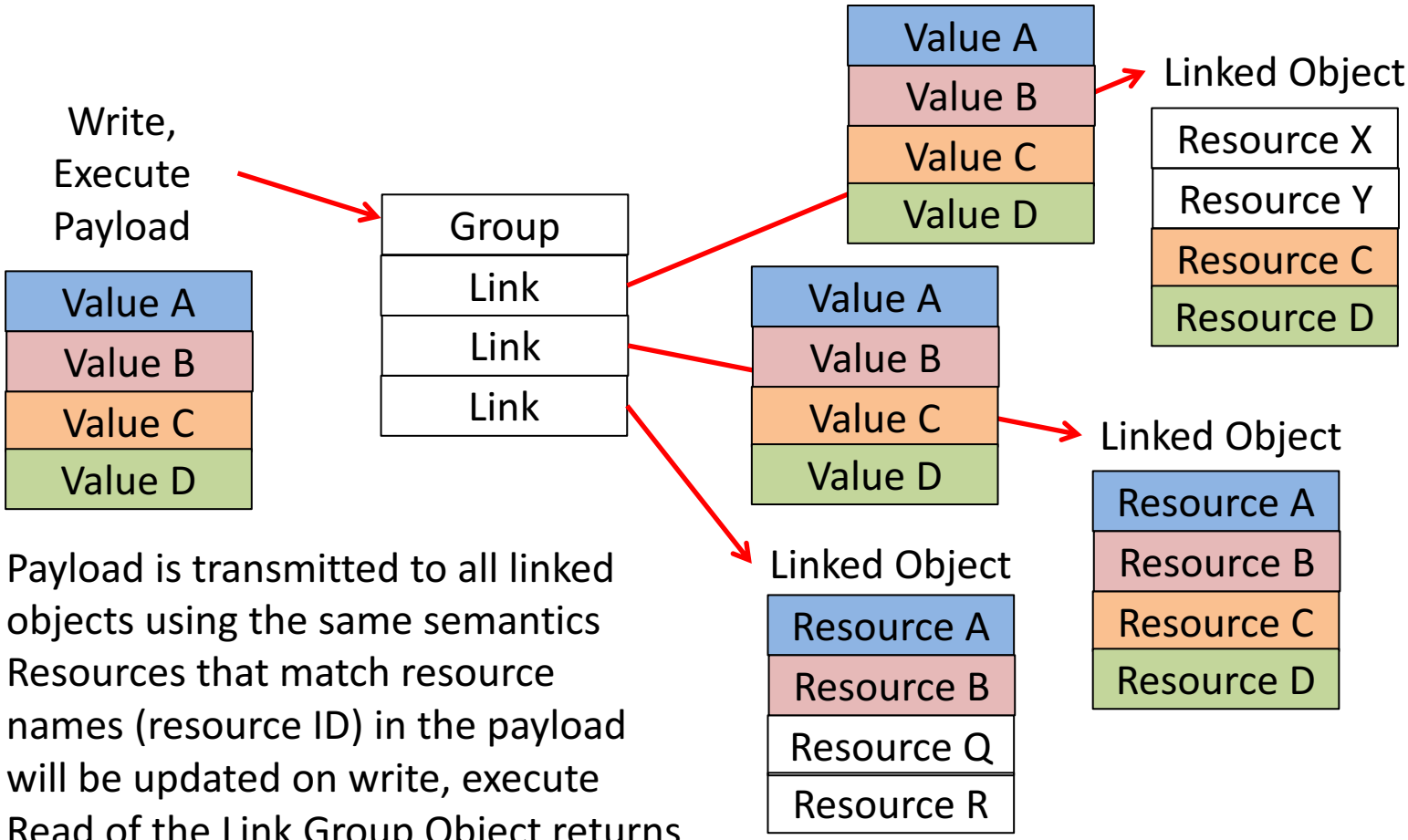
Observe Binding transmits
Observe to monitor state
of external object



Link Group Object

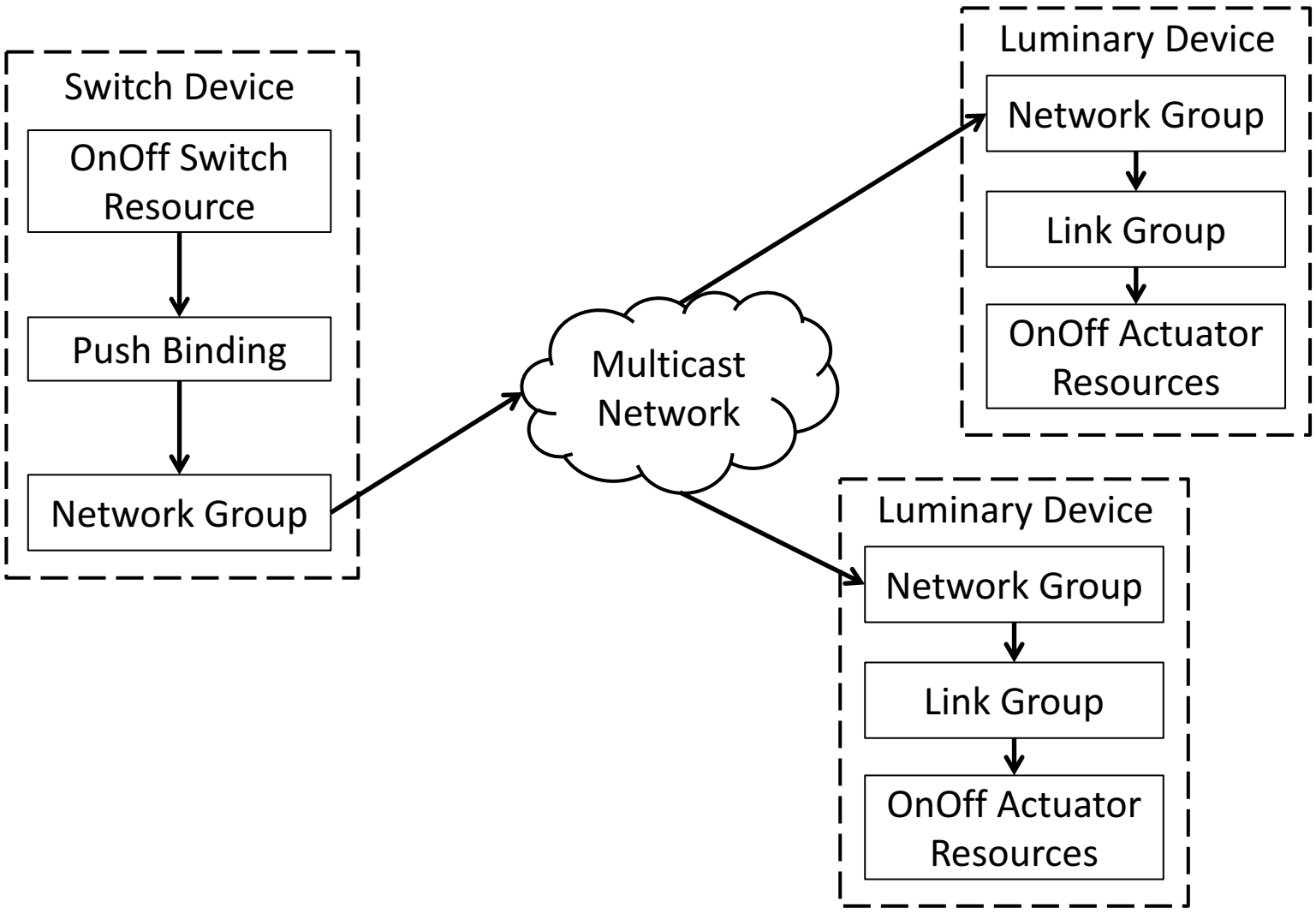
- A Link Group contains set of links that point to local objects that are inspected, updated, or actuated together using a single operation
- Consists of a dynamically created Link Group Object which contains a collection of links to other objects
- Link Group URIs can be harmonized across endpoints, enabling update or actuation of objects in multiple endpoints in a multicast network group using a single REST operation

Link Group Object



- Payload is transmitted to all linked objects using the same semantics
- Resources that match resource names (resource ID) in the payload will be updated on write, execute
- Read of the Link Group Object returns all resources from all linked objects

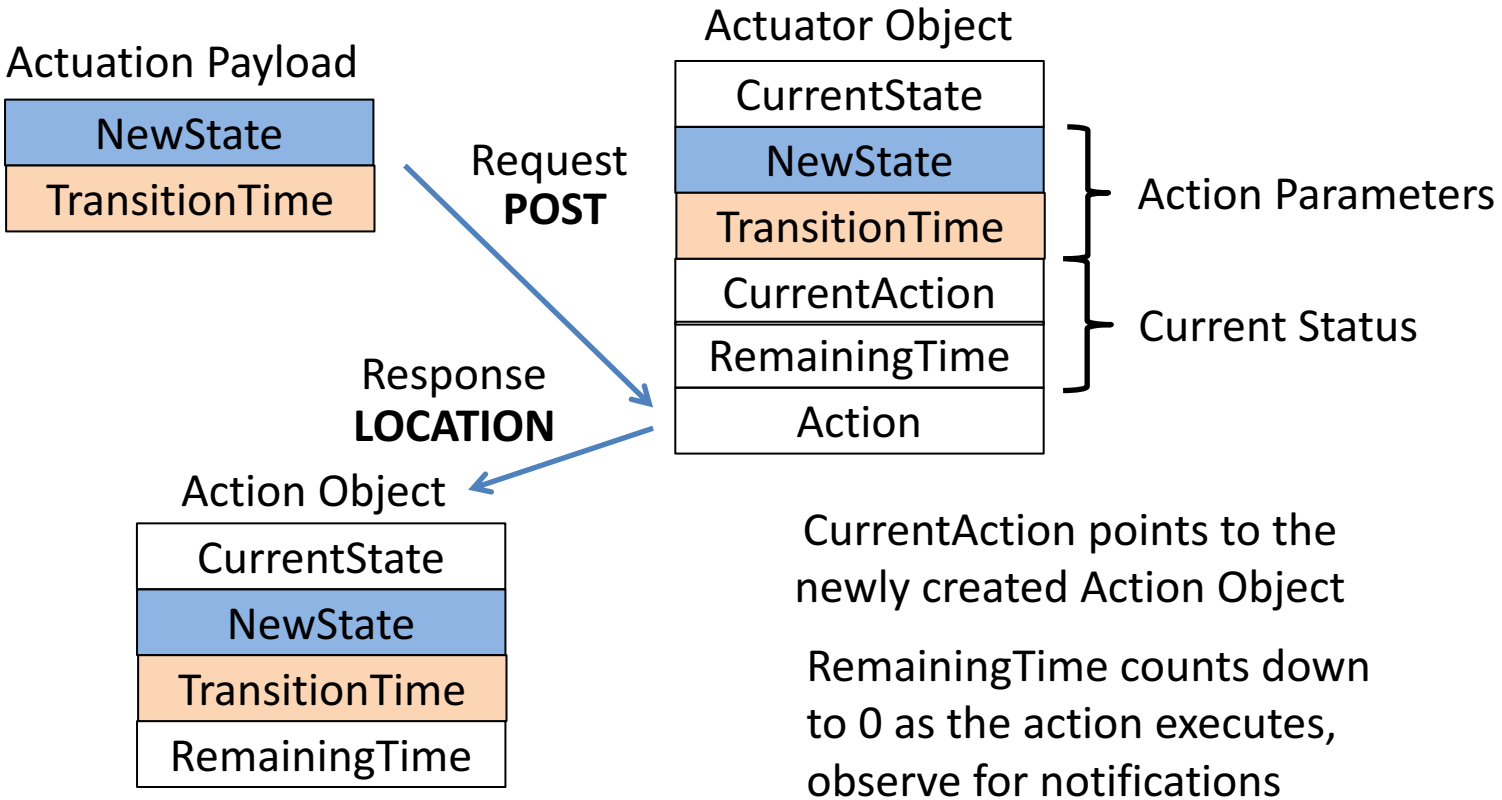
Binding + Network Group + Link Group



Actions

- Actions are operations that change the state of an Object, potentially over time
- Resources in the object are used as function parameters for the execution of the Action
- Actions are executed in the order they were invoked
- Invoking an Action creates an observable resource that represents the Action
- Actions can be cancelled by deleting the resource
- Actions may update the state of multiple resources, for example changing the Brightness of a lamp with a specific Transition Time for the Action to occur

Example Action



CurrentAction points to the newly created Action Object

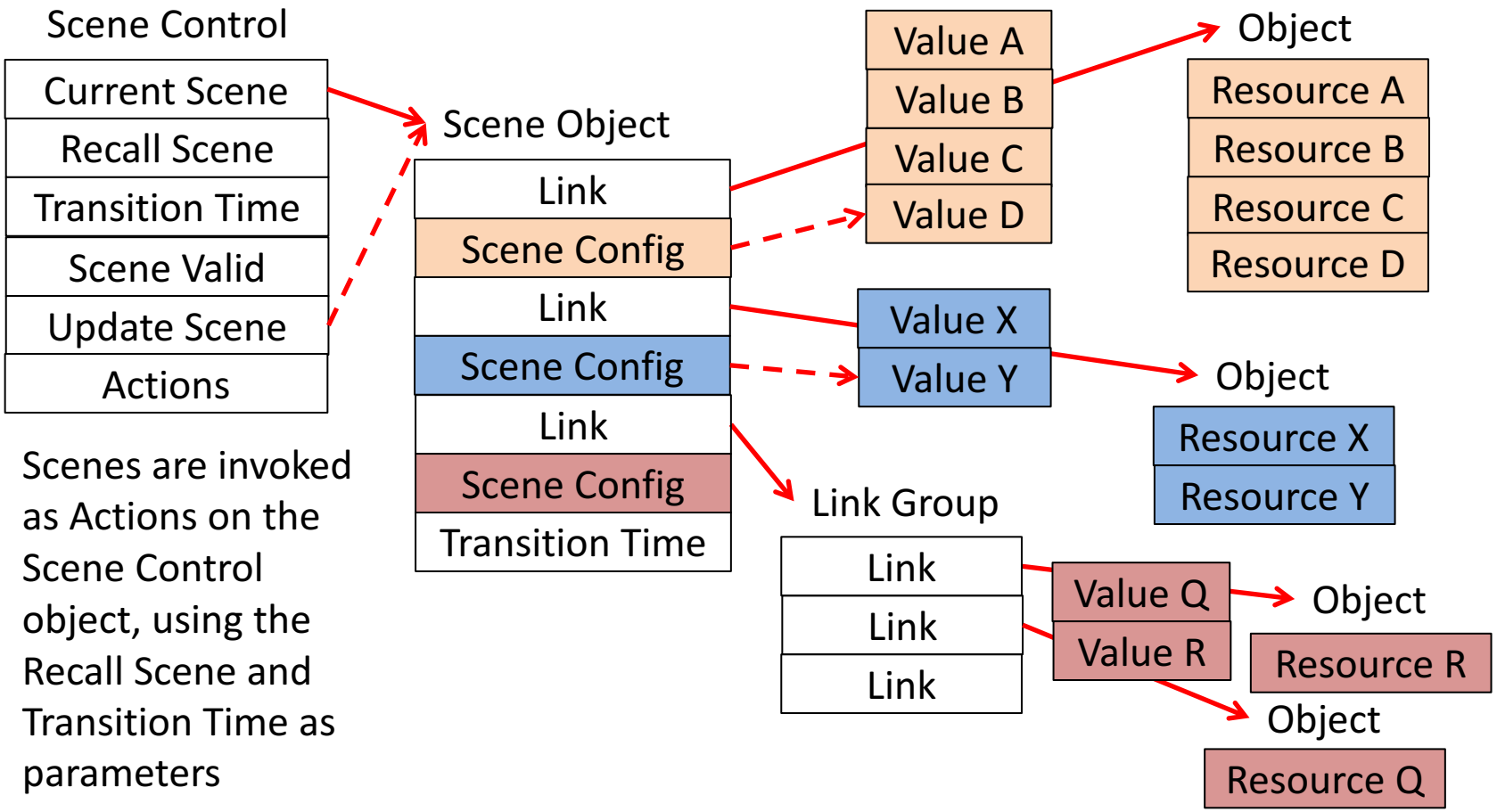
RemainingTime counts down to 0 as the action executes, observe for notifications

Delete the Actuation Object to cancel the Action

Scenes

- A Scene is a collection of pre-defined Actions to be performed together on an endpoint or on a Network Group of endpoints
- A collection of Scene Objects is created on each endpoint to control the objects on that endpoint associated with the Scenes
- A Scene Control Object is used to invoke, recall, manage, or store a particular Scene
- A Scene may actuate or be actuated by a Link Group operation, and may be actuated in a Network Group

Scene and Scene Control Objects



Scenes are invoked as Actions on the Scene Control object, using the Recall Scene and Transition Time as parameters

Object and Payload Formats

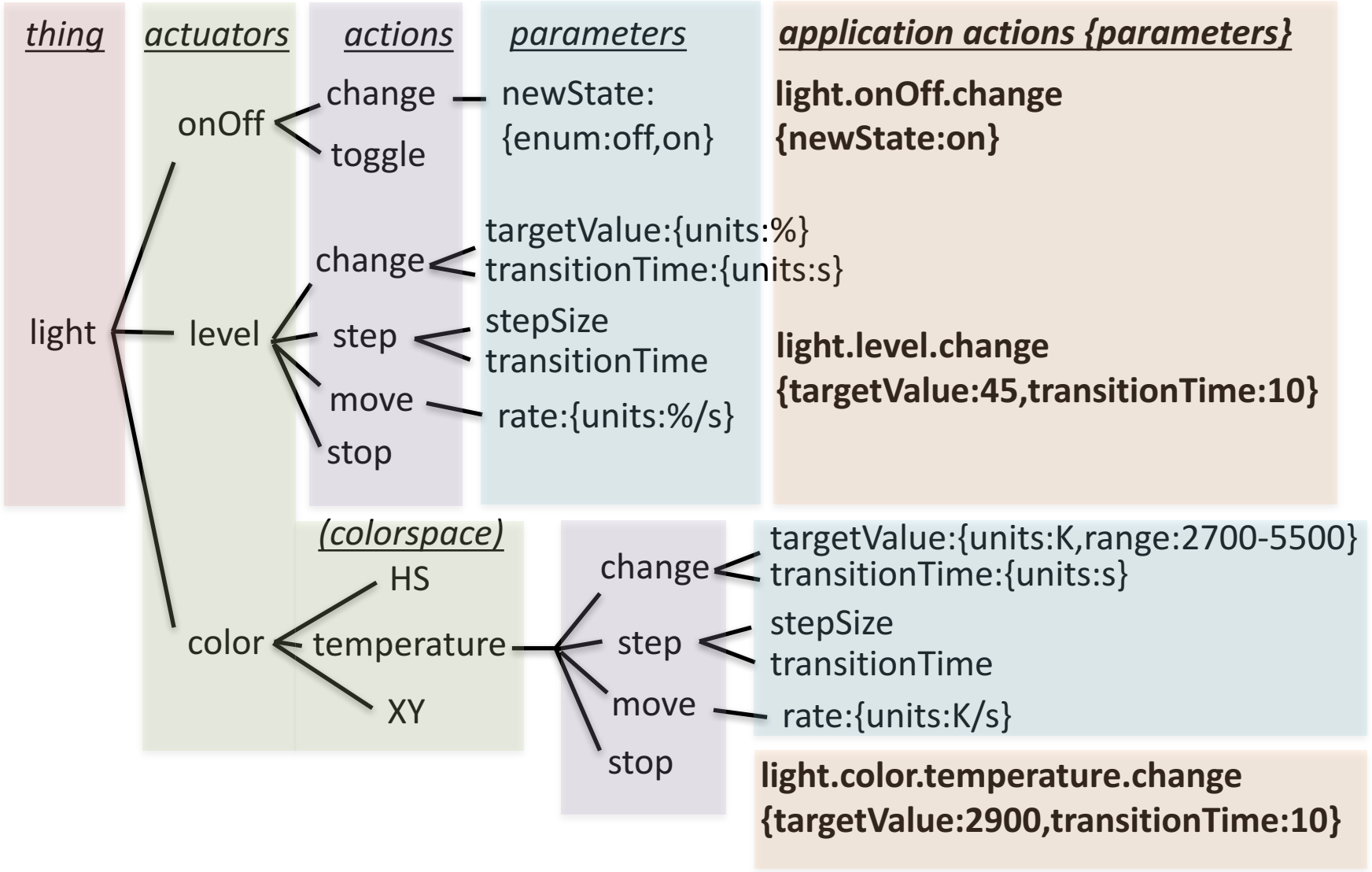
- All operations on objects exchange data using the object serialization format supported by the available media types
- For IPSO Smart Objects and LWM2M the available types are TLV and SENML
- The object format is used as a template for all update and execute payloads, actuation payloads, Action objects, and scene configuration elements

Object Format Example – senml+json

```
{“e”: [
  {“n”: “5031”, “v”: 2837}, //Current Color Temp
  {“n”: “5052/0”,“sv”: “[{“n”: “5059”, ”v”: 2900},
                         {“n”: ”5002”, ”v”: 120”}]”
  }                                        //Actions
  {“n”: “5053”, “v”: 0}, //Current Action
  {“n”: “5002”, “v”: 120}, //Transition Time
  {“n”: “5003”, “v”: 37.3}, //Remaining Time
  {“n”: “5059”, “v”: 2900}, //Change Color Temp
  {“n”: “5750”, “sv”: “south wall wash color temperature”}
  ]
```

In this example of an IPSO Color Temperature Actuator, there is a currently executing Action which is displayed in the Actions resource representation (5052). The Action contains representations of the parameter resources 5059 (Change Color Temp) and 5002 (Transition Time). The action is to move the Color Temp to a value of 2900 with a Transition Time of 120 seconds. The Action has 37.3 seconds remaining and the current color temperature is 2837. The Action was invoked by performing a POST operation of the Action parameter representation shown to the Actions resource (5052).

Lighting Model - Control Actions



Batch Object