

UPnP IOT Datamodels

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UPnP Forum
www.upnp.org

- What are IOT data models

- A **data model** organizes data elements and standardizes how the data elements relate to one another.
- Data models are often used as an aid to communication between the business people defining the requirements for a computer system and the technical people defining the design in response to those requirements.

- Device
 - a thing made or adapted for a particular purpose, especially a piece of mechanical or electronic equipment.
 - Most of the time modelled with sensors and actuators.

- Sensors
 - a transducer whose purpose is to sense (that is, to detect) some characteristic of its environment
 - Can be modelled with:
 - (recognizable) Name
 - Unit
 - value

- Actuator
 - a transducer whose purpose is to actuate (that is, to control) some characteristic of its environment
 - Can be modelled with
 - (recognizable) Name
 - Unit
 - value

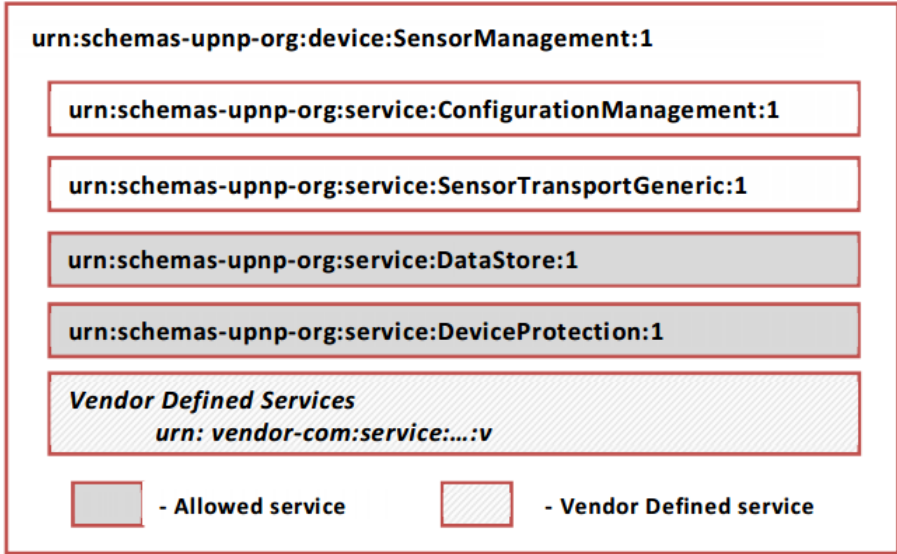
Out of scope for data models are:

- How the sensing/actuating is achieved in the real world
- Architecture to convey the data models

- Environment build around SensorManagement DCP specifications.
- This set of specs are a misnamed:
 - These specifications define
 - ***(IOT)Devices***
 - ***Actuators***
 - ***Sensors***

By means of exposing this data by an UPnP Device

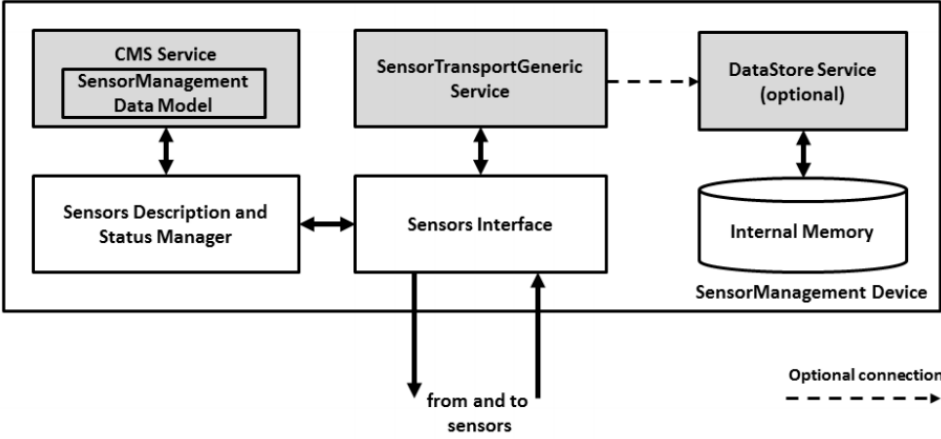
- Existing DCP that exposes IOT (bridged) Devices.
 - Can be an single device
 - Can be an set of (bridged) devices
- Uses nodes in an tree to define an IOT device
 - Using Collection construct to define an device
- Each IOT Device its own sub tree and is represented by:
 - Device identifiers (Common Device Identifiers)
 - Supported Sensors/Actuators (Data Items)



SensorManagement is a UPnP Device

- 2 Mandatory Services
 - ConfigurationManagement
 - SensorTransportGeneric
- 2 Optional Services
 - DataStore
 - DeviceProtection

Interfaces look like this ->



ConfigurationManagement (with specific Sensor DataModel)

This service enables UPnP clients to access sensors and/or actuators without needing a detailed knowledge of the target sensor or actuator or its connectivity to the UPnP network. *Sensors* and *Actuators* are instead treated as generic data sources or sinks.

The UPnP SensorManagement Sensor DataModel service provides a set of uniform Sensor Properties as defined by Annex A, "SensorManagement General Data Model". These properties assist UPnP clients to identify sensors they may be capable of supporting. In addition to uniform Sensor properties described by the General Sensor Data Model, this specification also can reference additional sensor properties which are defined by the Sensor's parent ecosystem.

TransportGeneric Service

The SensorTransportGeneric service enables UPnP clients to obtain sensor data without needing to have detailed understanding of the operation of a target sensor or the sensor's access network protocols. This service abstracts these notions treating the sensor as a generic data source which defines output record formats. Both HTTP transport and a SOAP-

DataStore Service

The DataStore service provides the ability to acquire and persistently store information for later access. This service allows UPnP devices such as mobile phones and sensors to make information available for subsequent retrieval. This increases the flexibility of the UPnP ecosystem by eliminating requirements to have an immediate nexus between information sources and sinks on the UPnP network. The [DataStore](#) service additionally allows UPnP devices with limited or temporary storage capabilities to persist information for subsequent retrieval. The [DataStore](#) service constructs are intended to be modelled after and compatible with well-established database models.

- [UPnP-smgt-SensorDataModel-v1-Service.pdf](#)
 - Available at: <http://upnp.org/specs/smgt/UPnP-smgt-SensorDataModel-v1-Service.pdf>
- Reuses ConfigurationManagement Service
 - Difference is: modelling of the nodes itself
 - Model described in Annex A.
- Tree list of nodes
- Node describes functionality/behaviour
 - Reference to other node
 - Collection of sensors
 - DataItem
 - Can be an real world sensor/actuator

- Achieved by standardizing identifiers for:
 - Device
 - UPnP name: Common Device Identifier
 - Sensors
 - UPnP name: Data Item
 - Read only
 - Actuators
 - UPnP name: Data Item
 - Read/write
 - (Locations)
- And specify the actual behaviour of the modelled data

- Common Device Identifiers (Annex C)
 - List of defined identifiers
 - Includes classification created Lawrence Berkeley National Laboratory
- Sensor URNs (Common DataItems) (Annex E)
 - List of UPnP defined sensors/actuators (features).
 - Generic list that every device can use
 - Units are defined
- Where a Device is located (Annex F)
 - Buildings
 - Rooms in building
 - GPS location
 - vehicles

DataModel Refrigerator Example



Sensor 1 - Status

AccumulatedPowerUsed	(kW-h, Cumulative)
FreezerTemp	(degC, Average)
GroceryTemp	(degC, Average)
VegetableTemp	(degC, Average)
DoorOpenAlarm	("Door Id", Timeout)
PowerFaultAlarm	(0 1)
StatusInterval	(s)

Sensor 2 - Control

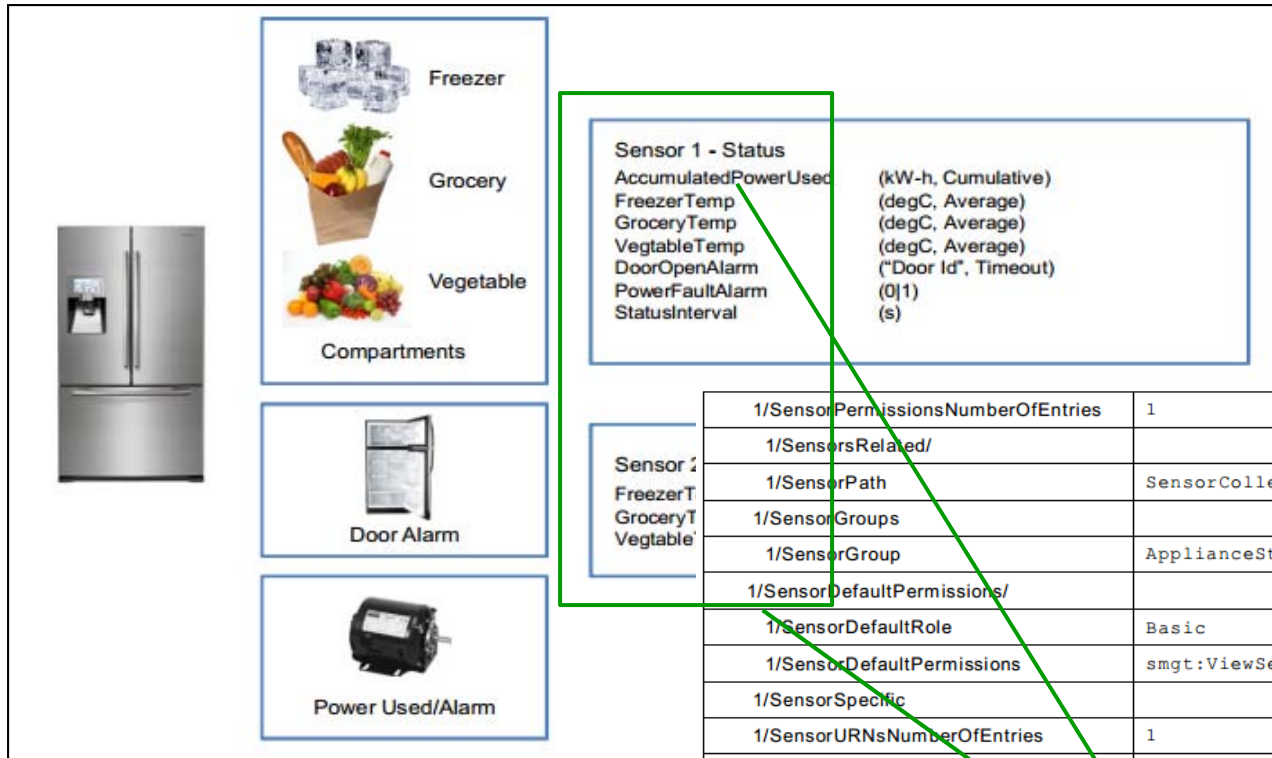
FreezerTempSetting	(degC - Current, LowLimit, HighLimit)
GroceryTempSetting	(degC - Current, LowLimit, HighLimit)
VegetableTempSetting	(degC - Current, LowLimit, HighLimit)

Features are named collection of sensors/actuators

Refrigerator is a modelled device – can be generic or specific

Parameters	Value
/UPnP/SensorMgt	
SensorCollectionsNumberOfEntries	1
SensorCollections/	
1/CollectionID	Collection0001
1/CollectionType	urn:upnp-org:smgt-sct:refrigerator:AcmeSensorsCorp-com:AcmeIntegratedController:FrigidaireCorp:rf217acrs
1/CollectionFriendlyName	"Your Refrigerator"
1/CollectionInformation	"Vendor Refrigerator Model RF217ACRS"
1/CollectionUniqueIdentifier	"123456789"
1/CollectionSpecific	
1/SensorsNumberOfEntries	2
1/Sensors/	
1/SensorID	Sensor0001
1/SensorType	urn:upnp-org:smgt-st:refrigerator:AcmeSensorsCorp-com:AcmeIntegratedController:FrigidaireCorp:rf217acrs:monitor
1/SensorUpdateRequest	0
1/SensorPollingInterval	0
1/SensorReportChangeOnly	0
1/SensorsRelatedNumberOfEntries	1
1/SensorGroupsNumberOfEntries	1

DataModel Refrigerator (Cont)



Model continued from previous slide



1/SensorPermissionsNumberOfEntries	1
1/SensorsRelated/	
1/SensorPath	SensorCollections/1/Sensor/2
1/SensorGroups	
1/SensorGroup	ApplianceStatus
1/SensorDefaultPermissions/	
1/SensorDefaultRole	Basic
1/SensorDefaultPermissions	smgt:ViewSensor, smgt:ReadSensor, smgt:ConnectSensor
1/SensorSpecific	
1/SensorURNsNumberOfEntries	1
1/SensorURNs	
1/SensorURN	urn:upnp-org:smgt-surn:refrigerator:AcmeSensorsCorp-com:AcmeIntegratedController:FrigidaireCorp:rf217acrs:Monitor
1/DataItemsNumberOfEntries	9
1/DataItems/	
1/Name	AccumulatedPowerUsed
1/Type	uda:ui4
1/Encoding	ascii
1/Description	See Annex A.1.1.1
2/Name	FreezerTemp
2/Type	uda:i4
2/Encoding	ascii

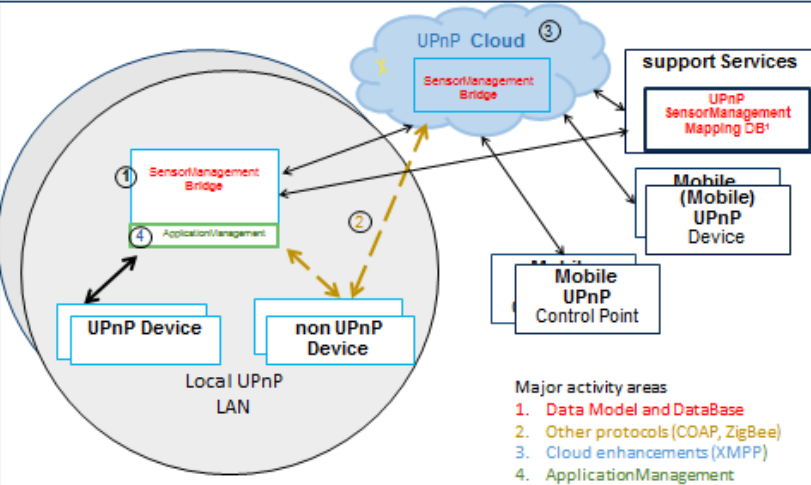
- Member companies – vendor specific models
- Some popular home devices and bridges –
 - HUE, StriimLight, WeMo, ..
- Other SDOs
 - ongoing evaluation based on IPR and accessibility
- Short list of Generic Models and Features
 - UPnP IoT Data Model Task Force

- Manufacturer can define own:
 - Device Identifiers
 - Data Items
- Current ongoing work:
 - Extend list of Common Device Identifiers
 - Support more devices!
 - Which Data Items are required for each Device
 - Extend list of Data Items
 - Support more types of actuators/sensors
 - Extend list of locations

UPnP+ IOT architecture

IOT strategy: embrace other technologies !

UPnP IoT Architecture Overview



UPnP embraces other technologies by Bridging.

- Different transports

- Different DataModels

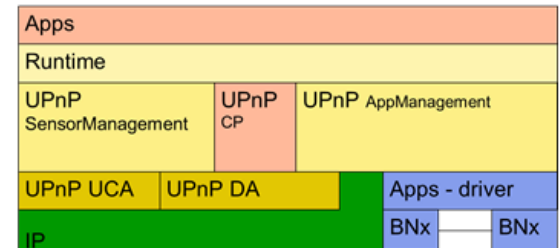
All mapped to same technology:

- All data can be accessed in and outside the home in the same way: unifying the different technologies in the system

Technology is ready:

- Specs are publicly available at www.upnp.org
 - Demo source code available: <https://github.com/upnpforum>
- Works in the home and over the Internet
- Sharing with others is 100% under user control
- Certification program is up and running
- Process in place to incorporate new data models

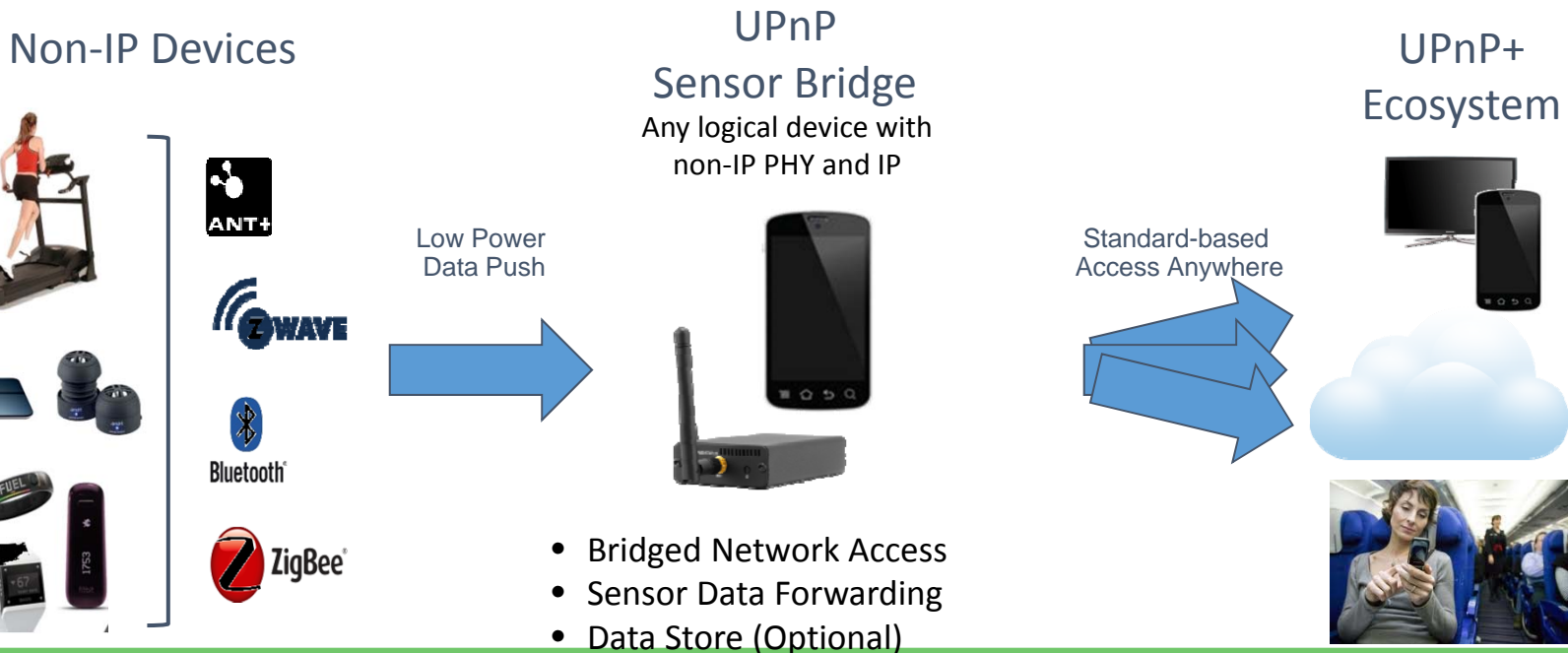
UPnP SensorManagement Bridge via Apps



Applications
UPnP DCPs
UPnP infrastructure
Bridged network infrastructure

UPnP+ Sensor Bridging

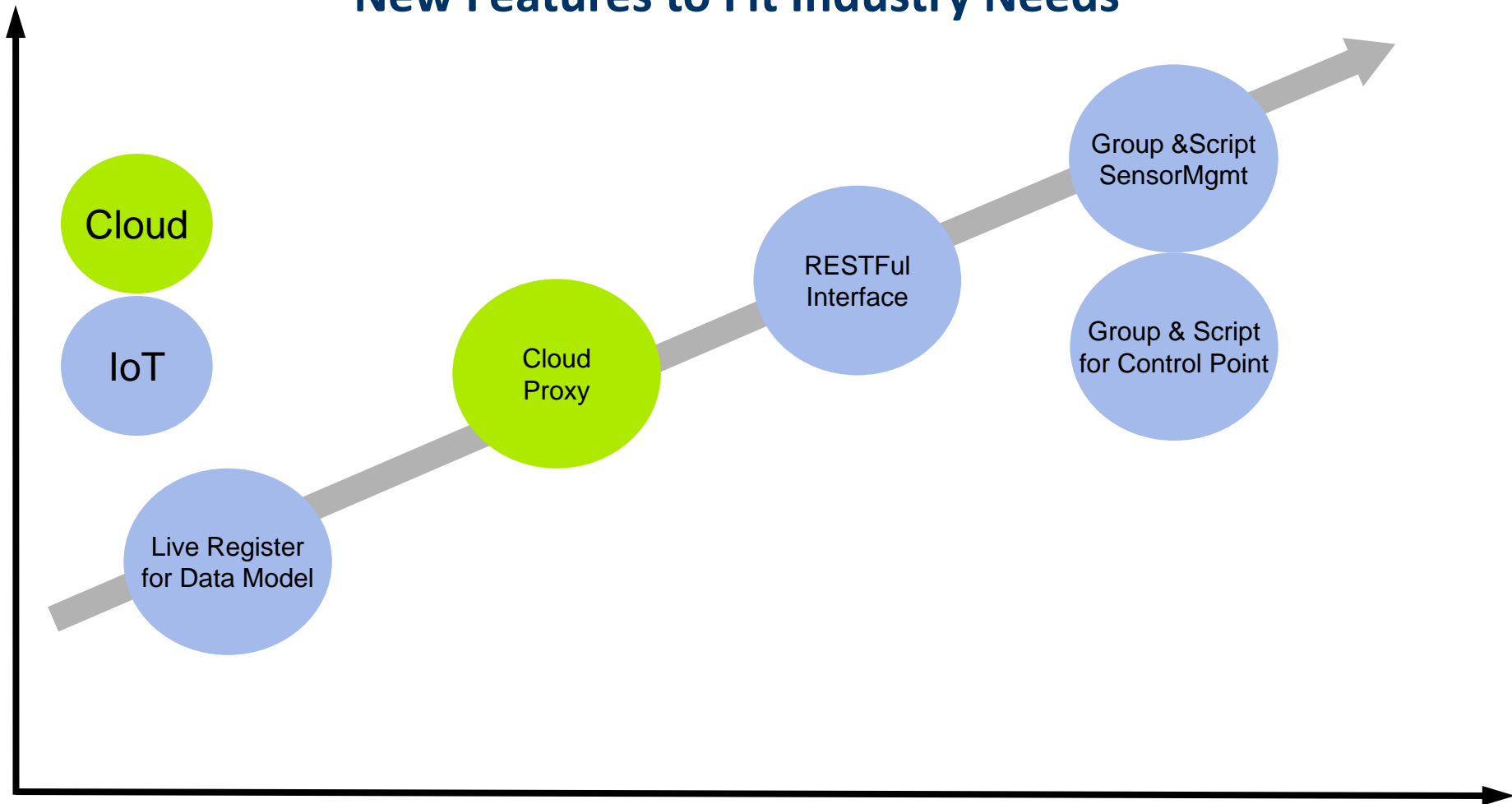
- Provide expanded support for low power sensors that need bridging to the rest of the Internet
 - Low Power efficient bridge
 - Pass-thru and/or storage of existing data



- Uses role-based access control with read-only action for untrusted devices
 - Adds cloud services extending the utility of UPnP devices over the Internet
 - Supports IPv6 as well as IPv4 (for legacy devices)
- ⇒ Uses a simple and complete certification program with new enriched test tools

- Aggregating devices sensor and actuator data in a local network
- Observing and controlling those devices from anywhere regardless of the platform
- Sharing information on a predefined granularity basis across networks with anyone
- Deciding what, when and with whom to share lies completely with the owner of the device
- Securing all communication

New Features to Fit Industry Needs



Thank you

Questions?

- Scott Lofgren, Intel
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- Follow us on Twitter [@UPnP Forum](https://twitter.com/UPnPForum) or join the Forum's Facebook community at <http://www.facebook.com/UPnPForum>

- <https://github.com/upnpforum>
- UPnP Cloud Device Applications
 - Sample desktop applications implementing UPnP Cloud Architecture (UCA). The repository contains the implementation of the following UPnP devices: DimmableLight, MediaServer, MediaRenderer and a light bulb modelled as a SensorManagement device.
- UPnP Cloud Controller Application for Android
 - Sample Android application capable of controlling several types of network devices connected using UPnP protocol for both local (UDA) and cloud devices (UCA).

- Website: www.upnp.org
- UPnP Forum Invites Orgs to use UPnP+ Certification
 - http://upnp.org/news/documents/UPnP_UPnPPlusCertificationLaunch_Nov2014.pdf
- Overview: UPnP+ Initiative
 - <http://upnp.org/latestupdates/upnpplus/>
- Presentation: UPnP Internet of Things Overview
 - http://upnp.org/resources/documents/UPnP_IoT_Overview_Dec2014.pdf
- Presentation: Bringing UPnP to the Cloud and IOT
 - http://upnp.org/resources/documents/Bringing_UPnP_to_the_Cloud_and_IoT_May2014.pdf
- Whitepaper: UPnP Enabling Standard IoT: Future-proofing device communications
 - http://upnp.org/resources/whitepapers/UPnPEnablingIoT_2014.pdf



For the interconnected lifestyle