Agenda

• What are IOT data models
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.
IOT Devices

• 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.
IOT Sensors

• 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
UPnP IOT specifications

• Environment build around SensorManagement DCP specifications.
• This set of specs are a misnamed:
  • These specifications define
    • \textit{(IOT)Devices}
    • \textit{Actuators}
    • \textit{Sensors}

By means of exposing this data by an UPnP Device
SensorManagement

- 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 DCP Overview

SensorManagement is a UPnP Device
- 2 Mandatory Services
  - ConfigurationManagement
  - SensorTransportGeneric
- 2 Optional Services
  - DataStore
  - DeviceProtection

Interfaces look like this ->

![Diagram showing the structure of SensorManagement services and interfaces](image-url)
Sensor Management Services

Configuration Management (with specific Sensor Data Model)

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 Sensor Management Sensor Data Model service provides a set of uniform Sensor Properties as defined by Annex A, "Sensor Management 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.

Transport Generic Service

The Sensor Transport Generic service enables UPnP clients to obtain sensor data without needing to have detailed understanding 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-

Data Store Service

The Data Store 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 increase the flexibility of the UPnP ecosystem by eliminating requirements to have an immediate nexus between information sources and sinks on the UPnP network. The Data Store service additionally allows UPnP devices with limited or temporary storage capabilities to persist information for subsequent retrieval. The Data Store service constructs are intended to be modelled after and compatible with well-established database models.
SensorManagement
Data 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
Interoperability (2)

• 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

Refrigerator is a modelled device – can be generic or specific

Features are named collection of sensors/actuators
DataModel Refrigerator (Cont)

Model continued from previous slide

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

```
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/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:14
2/Encoding ascii
2/Description
```

```
```
Sources of Models

- 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
Deployment

• 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 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](http://www.upnp.org)
  - Demo source code available: [https://github.com/upnpforum](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+ 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

Non-IP Devices

UPnP Sensor Bridge
Any logical device with non-IP PHY and IP

- Low Power Data Push
- Bridged Network Access
- Sensor Data Forwarding
- Data Store (Optional)

UPnP+ Ecosystem

Standard-based Access Anywhere
• 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
UPnP+ IoT solves

- 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

- Cloud
- IoT
- Live Register for Data Model
- Cloud Proxy
- RESTful Interface
- Group & Script for Control Point
- Group & Script SensorMgmt

UPnP+ Next Steps
Thank you

Questions?
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Cloud source code

- [https://github.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).
Other Resources

• Website: www.upnp.org

• UPnP Forum Invites Orgs to use UPnP+ Certification

• Overview: UPnP+ Initiative
  • http://upnp.org/latestupdates/upnpplus/

• Presentation: UPnP Internet of Things Overview

• 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