UPnP Internet of Things

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Keith Miller – Intel
Wouter van der Beek – Cisco
UPnP Internet of Things Task Force
Overview

- Scope
- Architecture
  - Local components description
  - Sensor Management Bridge
  - Bridging types
  - Bridge component descriptions
  - Cloud components description
  - UDA 2.X for IoT
- Sensor Management Overview
  - Structure, Use Case Example (Aggregation)
- Sensor Management Data Modelling
  - Modelling Approach, Example (refrigerator)
- Security
UPnP IoT solves:

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

Using UPnP infrastructure
Existing Open Standards

• Billions of deployed devices.
  • Smart TVs, Gateways, Mobile Devices, Game Consoles, PCs
• Existing Device Control Protocols for home automation
  • HVAC, light, security camera, ...
  • Sensor, Device, and Energy Management

New Open Standards

• UPnP+
  • UPnP Cloud based on RFC 6120, 6121 [XMPP]
  • IPv6 support
  • ApplicationManagement
UPnP IoT Architecture Overview

Major activity areas
1. Data Model and Database
2. Other protocols (COAP, ZigBee)
3. Cloud enhancements (XMPP)
4. Application Management
• Multiple local networks are connected to the cloud by means of UPnP Cloud architecture
  • This can include cloud services
• Individual UPnP devices and control points can be connected to the cloud with presence, state, and events shared securely with other local networks
• Ecosystem is easily extended using simple and flexible Data Models
• Data Models can be stored and interacted with via the SensorManagement Database (Service)
Bridging between UPnP and non UPnP devices includes

• Devices sensors/actuators supporting IP
  • For example, HTTP, COAP, REST, XMPP, MQTT
• Devices sensors/actuators on non-IP networks
  • For example, sensor hardware bridging between IP and non-IP networks (ZigBee, Z-Wave, ANT+, Bluetooth, etc)
• Runtime conversion Apps
  • ApplicationManagement (DIAL-like) for conversion
Sensor Management Bridge via Apps

Applications
UPnP DCPs
UPnP infrastructure
Bridged network infrastructure
• UPnP Cloud connects UPnP Devices (UCCD) and Control Points (UCC-CP) as XMPP clients via an XMPP server.
UPnP+ for IoT

- UPnP+ (incl. UDA 2.0) released in September 2014
- UDA 2.X version in development

UPnP IoT is adding new protocols and architectural elements
  - In particular, existing APIs are being mapped to REST+JSON
    - SensorManagement is already RESTful, by means of SOAP actions
    - Will have a *pure* REST interface
  - CoAP is under consideration as one of the protocols for resource constrained devices.
UPnP Sensor Network Infrastructure

**UPnP Home Assistant Device**
- Bridged Network Device Abstractions
- AV Device Services
- Data Store Service (opt)

**UPnP Sensor Bridge Device**
- Bridged Network Access
- Sensor Connection Methods
- Sensor Data Forwarding
- Data Store Service (opt)

**Non-UPnP Networks**

**UPnP Mobile Devices**
- Sensor Data Forwarding
- Sensor Data Retrieval

**Service Provider Sensor Networks**

**Advanced Metering Infrastructure**

**Home AV Devices**

**Internet**

**Service Providers**
SensorManagement Overview

SensorManagement is a UPnP Device

- 2 Mandatory Services
  - ConfigurationManagement
  - SensorTransportGeneric

- 2 Optional Services
  - DataStore
  - DeviceProtection

Interfaces look like this ->
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 a generic data sources or sinks.

The UPnP Sensor Management Sensor DataModel 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-

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 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 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.
Typical UPnP Sensor Use Case

UPnP Home Assistant Device
- Data Store Service (opt)

Data Store Service(s) retains sensor data for UPnP Network clients

Sensor Bridge can be provisioned to push sensor data to one or more Data Store Services on the UPnP Network

UPnP Sensor Bridge

UPnP Mobile Device can push/pull sensor data from Data Store Services on UPnP Network from Anywhere

UPnP Mobile Device

UPnP Network

ZigBee™

Bluetooth™
• An IoT Sensor is defined as a set of SensorURNs
• Generic SensorURNs can be used by multiple devices
  • Standard SensorURNs
• Defining a set of sample devices that use those SensorURNs
  • Standard SensorTypes
• Manufacturers can create their own SensorTypes and keep interoperability
  • Just have to use standard SensorURNs
• SensorTypes and SensorURNs are like “interfaces”
Naming conventions

• Sensor URNs (DataItems)
  • List of UPnP defined sensors/actuators (features).
  • Generic list that every device can use
  • Units are defined

• List of standard modelled devices
  • Containing:
    • Mandatory SensorURN (features)
    • Optional SensorURN (features)
    • Vendor defined extensions

• Where a sensor is located
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
Sensor Management

• 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
Nodes can be:

- Created
  - CreateInstance()
- Read
  - GetValues()
- Updated
  - SetValues()
- Deleted
  - DeleteInstance()
- Notified
  - Alarming Feature: UPnP state variable event including the node & value of the node
DataModel Refrigerator

Refrigerator is a modelled device – can be generic or specific

Features are named collection of sensors/actuators

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DataModel Refrigerator (Cont)

Model continued from previous slide

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UPnP+ adds security for:

• In home by means of UPnP Device Protection

Access to the home is designed from ground up to include security which is incorporated in XMPP.
Device Protection

• Inside the home UPnP specified device protection as a backwards compatible mechanism

• When using device protection unsecured control points still can use the device

• However the functionality is then restricted to “open” actions

• Most actions are profiled so data can be read, but not modified
  • Example: an unsecure control point can browse AV-CDS content, but cannot delete or add content
• Uses TLS with self generated certificates
  • no trust authority involved
• Certificate identification is translated to a user role
  • e.g. admin, super user, regular user, guest,...
• DCPs define user roles they distinguish and the actions each role has access to
• Secured control points therefore use HTTPS for
  • device and service description downloads
  • invocation of actions allowed by their user role
• Hence this communication is secure
  • network traffic can still be observed when unsecured mode is used
• Any control point, including unsecured ones, can still register for events
  • e.g. see what state the device is in
• WPS based authentication
• Other scenarios described
Remote Access is using XMPP as transport mechanism.

Using UPnP Cloud means that one needs to log in to XMPP by having an account (JID).

• XMPP is using
  • SASL for authentication
  • TLS for encrypting the link

• UPnP specifications are silent about how you register the device/control point to your account.
• Using UPnP cloud also enables the local network to be more secure

• Share information by means of the cloud:

   *No need to exchange WiFi passwords with visitors*

• Create a virtual room, where you can share the TV
• Invite a visitor to that room to use the TV to display pictures
• The visitor can use a guest WiFi network or the 3/4G network on his mobile phone
• [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).