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BSI Standards Publication

Information technology — UPnP Device Architecture

Part 30-1: IoT management and control device control protocol
— IoT management and control architecture overview

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National foreword

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ISO/IEC 29341-30-1 was prepared by UPnP Forum and adopted, under the PAS procedure, by joint technical committee ISO/IEC JTC 1, *Information technology*, in parallel with its approval by national bodies of ISO and IEC.

The list of all currently available parts of ISO/IEC 29341 series, under the general title *Information technology — UPnP Device Architecture*, can be found on the ISO web site.

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Original UPnP Document

Reference may be made in this document to original UPnP documents. These references are retained in order to maintain consistency between the specifications as published by ISO/IEC and by UPnP Implementers Corporation and later by UPnP Forum. The following table indicates the original UPnP document titles and the corresponding part of ISO/IEC 29341:

UPnP Document Title	ISO/IEC 29341 Part
UPnP Device Architecture 1.0	ISO/IEC 29341-1:2008
UPnP Device Architecture Version 1.0	ISO/IEC 29341-1:2011
UPnP Device Architecture 1.1	ISO/IEC 29341-1-1:2011
UPnP Device Architecture 2.0	ISO/IEC 29341-1-2
UPnP Basic:1 Device	ISO/IEC 29341-2
UPnP AV Architecture:1	ISO/IEC 29341-3-1:2008
UPnP AV Architecture:1	ISO/IEC 29341-3-1:2011
UPnP AVTransport:1 Service	ISO/IEC 29341-3-10
UPnP ConnectionManager:1 Service	ISO/IEC 29341-3-11
UPnP ContentDirectory:1 Service	ISO/IEC 29341-3-12
UPnP RenderingControl:1 Service	ISO/IEC 29341-3-13
UPnP MediaRenderer:1 Device	ISO/IEC 29341-3-2
UPnP MediaRenderer:2 Device	ISO/IEC 29341-3-2:2011
UPnP MediaServer:1 Device	ISO/IEC 29341-3-3
UPnP AVTransport:2 Service	ISO/IEC 29341-4-10:2008
UPnP AVTransport:2 Service	ISO/IEC 29341-4-10:2011
UPnP ConnectionManager:2 Service	ISO/IEC 29341-4-11:2008
UPnP ConnectionManager:2 Service	ISO/IEC 29341-4-11:2011
UPnP ContentDirectory:2 Service	ISO/IEC 29341-4-12
UPnP RenderingControl:2 Service	ISO/IEC 29341-4-13:2008
UPnP RenderingControl:2 Service	ISO/IEC 29341-4-13:2011
UPnP ScheduledRecording:1	ISO/IEC 29341-4-14
UPnP ScheduledRecording:2	ISO/IEC 29341-4-14:2011
UPnP MediaRenderer:2 Device	ISO/IEC 29341-4-2
UPnP MediaServer:2 Device	ISO/IEC 29341-4-3
UPnP AV Datastructure Template:1	ISO/IEC 29341-4-4:2008
UPnP AV Datastructure Template:1	ISO/IEC 29341-4-4:2011
UPnP DigitalSecurityCamera:1 Device	ISO/IEC 29341-5-1
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UPnP DigitalSecurityCameraSettings:1 Service	ISO/IEC 29341-5-11
UPnP DigitalSecurityCameraStillImage:1 Service	ISO/IEC 29341-5-12
UPnP HVAC_System:1 Device	ISO/IEC 29341-6-1
UPnP ControlValve:1 Service	ISO/IEC 29341-6-10
UPnP HVAC_FanOperatingMode:1 Service	ISO/IEC 29341-6-11
UPnP FanSpeed:1 Service	ISO/IEC 29341-6-12
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UPnP HVAC_SetpointSchedule:1 Service	ISO/IEC 29341-6-14
UPnP TemperatureSensor:1 Service	ISO/IEC 29341-6-15
UPnP TemperatureSetpoint:1 Service	ISO/IEC 29341-6-16
UPnP HVAC_UserOperatingMode:1 Service	ISO/IEC 29341-6-17
UPnP HVAC_ZoneThermostat:1 Device	ISO/IEC 29341-6-2

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UPnP BinaryLight:1 Device	ISO/IEC 29341-7-1
UPnP Dimming:1 Service	ISO/IEC 29341-7-10
UPnP SwitchPower:1 Service	ISO/IEC 29341-7-11
UPnP DimmableLight:1 Device	ISO/IEC 29341-7-2
UPnP InternetGatewayDevice:1 Device	ISO/IEC 29341-8-1
UPnP LANHostConfigManagement:1 Service	ISO/IEC 29341-8-10
UPnP Layer3Forwarding:1 Service	ISO/IEC 29341-8-11
UPnP LinkAuthentication:1 Service	ISO/IEC 29341-8-12
UPnP RadiusClient:1 Service	ISO/IEC 29341-8-13
UPnP WANCableLinkConfig:1 Service	ISO/IEC 29341-8-14
UPnP WANCommonInterfaceConfig:1 Service	ISO/IEC 29341-8-15
UPnP WANDSLLinkConfig:1 Service	ISO/IEC 29341-8-16
UPnP WANEthernetLinkConfig:1 Service	ISO/IEC 29341-8-17
UPnP WANIPConnection:1 Service	ISO/IEC 29341-8-18
UPnP WANPOTSLinkConfig:1 Service	ISO/IEC 29341-8-19
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UPnP WANPPPConnection:1 Service	ISO/IEC 29341-8-20
UPnP WLANConfiguration:1 Service	ISO/IEC 29341-8-21
UPnP WANDevice:1 Device	ISO/IEC 29341-8-3
UPnP WANConnectionDevice:1 Device	ISO/IEC 29341-8-4
UPnP WLANAccessPointDevice:1 Device	ISO/IEC 29341-8-5
UPnP Printer:1 Device	ISO/IEC 29341-9-1
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UPnP PrintBasic:1 Service	ISO/IEC 29341-9-12
UPnP Scan:1 Service	ISO/IEC 29341-9-13
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UPnP QoS Architecture:1.0	ISO/IEC 29341-10-1
UPnP QosDevice:1 Service	ISO/IEC 29341-10-10
UPnP QosManager:1 Service	ISO/IEC 29341-10-11
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UPnP DeviceSecurity:1 Service	ISO/IEC 29341-13-10
UPnP SecurityConsole:1 Service	ISO/IEC 29341-13-11
UPnP ContentDirectory:3 Service	ISO/IEC 29341-14-12:2011
UPnP MediaServer:3 Device	ISO/IEC 29341-14-3:2011
UPnP ContentSync:1	ISO/IEC 29341-15-10:2011
UPnP Low Power Architecture:1	ISO/IEC 29341-16-1:2011
UPnP LowPowerProxy:1 Service	ISO/IEC 29341-16-10:2011

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UPnP LowPowerDevice:1 Service	ISO/IEC 29341-16-11:2011
UPnP QoS Architecture:3	ISO/IEC 29341-17-1:2011
UPnP QosDevice:3 Service	ISO/IEC 29341-17-10:2011
UPnP QosManager:3 Service	ISO/IEC 29341-17-11:2011
UPnP QosPolicyHolder:3 Service	ISO/IEC 29341-17-12:2011
UPnP QosDevice:3 Addendum	ISO/IEC 29341-17-13:2011
UPnP RemoteAccessArchitecture:1	ISO/IEC 29341-18-1:2011
UPnP InboundConnectionConfig:1 Service	ISO/IEC 29341-18-10:2011
UPnP RADAConfig:1 Service	ISO/IEC 29341-18-11:2011
UPnP RADASync:1 Service	ISO/IEC 29341-18-12:2011
UPnP RATAConfig:1 Service	ISO/IEC 29341-18-13:2011
UPnP RAClient:1 Device	ISO/IEC 29341-18-2:2011
UPnP RAServer:1 Device	ISO/IEC 29341-18-3:2011
UPnP RADiscoveryAgent:1 Device	ISO/IEC 29341-18-4:2011
UPnP SolarProtectionBlind:1 Device	ISO/IEC 29341-19-1:2011
UPnP TwoWayMotionMotor:1 Service	ISO/IEC 29341-19-10:2011
UPnP AV Architecture:2	ISO/IEC 29341-20-1
UPnP AVTransport:3 Service	ISO/IEC 29341-20-10
UPnP ConnectionManager:3 Service	ISO/IEC 29341-20-11
UPnP ContentDirectory:4 Device	ISO/IEC 29341-20-12
UPnP RenderingControl:3 Service	ISO/IEC 29341-20-13
UPnP ScheduledRecording:2 Service	ISO/IEC 29341-20-14
UPnP MediaRenderer:3 Service	ISO/IEC 29341-20-2
UPnP MediaServer:4 Device	ISO/IEC 29341-20-3
UPnP AV Datastructure Template:1	ISO/IEC 29341-20-4
UPnP InternetGatewayDevice:2 Device	ISO/IEC 29341-24-1
UPnP WANIPConnection:2 Service	ISO/IEC 29341-24-10
UPnP WANIPv6FirewallControl:1 Service	ISO/IEC 29341-24-11
UPnP WANConnectionDevice:2 Service	ISO/IEC 29341-24-2
UPnP WANDevice:2 Device	ISO/IEC 29341-24-3
UPnP Telephony Architecture:2	ISO/IEC 29341-26-1
UPnP CallManagement:2 Service	ISO/IEC 29341-26-10
UPnP MediaManagement:2 Service	ISO/IEC 29341-26-11
UPnP Messaging:2 Service	ISO/IEC 29341-26-12
UPnP PhoneManagement:2 Service	ISO/IEC 29341-26-13
UPnP AddressBook:1 Service	ISO/IEC 29341-26-14
UPnP Calendar:1 Service	ISO/IEC 29341-26-15
UPnP Presense:1 Service	ISO/IEC 29341-26-16
UPnP TelephonyClient:2 Device	ISO/IEC 29341-26-2
UPnP TelephonyServer:2 Device	ISO/IEC 29341-26-3
UPnP Friendly Info Update:1 Service	ISO/IEC 29341-27-1
UPnP MultiScreen MultiScreen Architecture:1	ISO/IEC 29341-28-1
UPnP MultiScreen Application Management:1 Service	ISO/IEC 29341-28-10
UPnP MultiScreen Screen:1 Device	ISO/IEC 29341-28-2
UPnP MultiScreen Application Management:2 Service	ISO/IEC 29341-29-10
UPnP MultiScreen Screen:2 Device	ISO/IEC 29341-29-2
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UPnP DataStore:1 Service	ISO/IEC 29341-30-10
UPnP IoT Management and Control Data Model:1 Service	ISO/IEC 29341-30-11
UPnP IoT Management and Control Transport Generic:1 Service	ISO/IEC 29341-30-12
UPnP IoT Management and Control:1 Device	ISO/IEC 29341-30-2
UPnP Energy Management:1 Service	ISO/IEC 29341-31-1

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1 Scope

1.1 Introduction

This document describes the overall UPnP IoTManagementAndControl Architecture, which forms the foundation for the UPnP IoTManagementAndControl device [11] and UPnP DataStore service [13] specifications. The IoTManagementAndControl device hosts services to bridge sensor devices connected to both UPnP networks as well as non-UPnP based networks. The DataStore service provides persistent retention and distribution of both sensor data as well as data from mobile devices which may leave the UPnP network at any time. This service can be hosted within the UPnP IoTManagementAndControl device as well as within other UPnP compliant devices.

1.2 Goals

The UPnP IoTManagementAndControl Architecture was explicitly defined to meet the following goals:

- Describe sensors and actuators residing on both UPnP and non-UPnP networks.
- Provide data transport services for sensors and actuators to UPnP network clients.
- Define a service to describe, retain and distribute data received from sensors as well as other non-persistent data sources.
- Define an allowed device protection model for both the sensor and data retention components.

1.3 Non-Goals

The following are not initial goals of the IoTManagementAndControl architecture:

- Low-level control of bridged networks

  The initial version of UPnP IoTManagementAndControl treats Sensors and Actuators as abstract data sources and sinks and does not expose details or provide direct access to bridging network protocols. Low-level control of selected bridged network protocols will be considered in subsequent versions of the architecture.

- Low-latency control of sensors and actuators

  The initial version of UPnP IoTManagementAndControl treats sensors and actuators as autonomous objects requiring relatively infrequent supervision from home-network clients. Closed loop control of sensor and actuator pairs is better accomplished directly within the internal vendor-device sensor/actuator architecture with UPnP home-network clients providing overall supervision. However, UPnP IoTManagementAndControl does support sensors which have substantial throughput requirements using transport connections.

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1.4 IoTManagementAndControl and DataStore Specification Map

IoTManagementAndControl Architecture Overview [10]

- Sensor Discovery and Description
  - IoTManagementAndControl Detail Overview
  - Sensor Protection Model
  - DataStore Detail Overview
  - DataStore Protection Model
  - DataItem Description and Semantics
  - Sample Implementation Theory of Operation

IoTManagementAndControl Device

IoTManagementAndControl Device Specification [11]

- Sensor Components High-Level Overview
- IoTManagementAndControl Required/Allowed Services

IoTManagementAndControl Sensor DataModel Service Specification [14]

- Sensor Discovery and Description
  - Sensor URN Description
  - Sensor Event Model Description
  - ConfigurationManagement service action(s)
  - Mandatory DataItem(s)
  - Common Sensor Collection types
  - Sensor Data Model
  - IEEE-11073 Medical Device Data Model

SensorTransportGeneric Service Specification [12]

- Sensor Transport (SOAP/HTTP)
  - Sensor Transport action(s)
  - Sensor Data Record(s)

DataStore Service Specification [13]

- Persistent Data Retention
  - DataStore URN Description
  - DataStore (LastChange) Event Model
  - DataStore action(s)
  - DataTable schema(s)

Device Protection Service Specification [15]

- Device Protection
  - Device Protection action(s)

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2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

[1] UPnP Device Architecture, version 1.0, UPnP Forum, June 13, 2000. Available at: http://upnp.org/specs/arch/UPnPDA10_20000613.pdf. Latest version available at: http://upnp.org/specs/arch/UPnP-arch-DeviceArchitecture-v1.0.pdf.

[2] ISO 8601 Data elements and interchange formats – Information interchange -- Representation of dates and times, International Standards Organization, December 21, 2000. Available at: ISO 8601:2000.

[3] IETF RFC 2119, Key words for use in RFCs to Indicate Requirement Levels, S. Bradner, 1997. Available at: http://www.faqs.org/rfcs/rfc2119.html.

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3 Terms, definitions and abbreviations

For initial readers of this document, it may be helpful to proceed to subclause 4, "Architectural Overview" and refer to this section for terms and definitions as needed.

3.1 IoTManagementAndControl terms and definitions

The following terms apply to the IoTManagementAndControl Device [11], IoTManagementAndControl Sensor DataModel Service [14], and IoTManagementAndControl SensorTransportGeneric Service [12] specifications.

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3.1.1
Sensor
A Sensor defines sets of named DataItem(s) (see subclause 3.2) which can be read and/or written via the SensorTransportGeneric service [12]. Access to Sensor DataItem(s) is provided by UPnP SOAP actions or via HTTP sensor transport connections. Discovery, control and status of Sensor(s) are provided through parameter(s) defined by the IoTManagementAndControl Sensor DataModel service [14]. Depending on the type of Sensor, additional sensor control and status parameters may also be defined by additional sensor ecosystem specific specifications.

3.1.2
SensorCollection
A SensorCollection contains zero or more Sensors. The Sensors enumerated within a SensorCollection typically relate to a real world device. In some instances the Sensors may be directly related to the operation of the device such as an IEEE-11073 Medical Device System [9], while in other instances, Sensors may indirectly assist in performing monitoring and possibly control operations on the device; such as sensors within a refrigerator or home thermostat. SensorCollections may identify other UPnP Devices which can provide additional command and control functionality.

3.1.3
SensorGroup
Sensors can be grouped using SensorGroup(s). An individual Sensor may participate (be a member of) zero or more SensorGroup(s). SensorGroup(s) may include Sensors from multiple SensorCollection(s). In addition to identifying related Sensors, SensorGroup(s) also can be assigned DeviceProtection permissions which can then be used as DeviceProtection Roles.

3.1.4
SensorID
A SensorID is an identifier which uniquely identifies a Sensor to SOAP actions implemented by the SensorTransportGeneric service [12]. SensorID values are provided by the IoTManagementAndControl Sensor DataModel service [14] *SensorID* parameter node.

3.1.5
SensorNode
A SensorNode is a set of IoTManagementAndControl Sensor DataModel [14] nodes which describe a Sensor and the DataItem(s) it supports. The required and allowed SensorNode parameters and corresponding syntax and semantics are detailed by IoTManagementAndControl Sensor DataModel service specification.

3.1.6
SensorPath
A PartialPath (see subclause 3.3) to a SensorNode.

3.1.7
SensorURN
A SensorURN(s) identifies sets of required and allowed DataItem(s) that a Sensor provides. The syntax and semantics of SensorURN(s) is detailed in the IoTManagementAndControl Sensor DataModel service specification [14], and subclause 5.2.6, "Sensor Normative Type Identifiers".

3.2 DataStore terms and definitions

The following terms apply to the DataStore Service specification [13],

3.2.1
DataItem
A DataItem identifies an output from a Sensor (or input to an Actuator). A DataItem is defined by a name, data type and encoding. See subclause 4.3, "DataItem Semantics" for a detailed description of DataItem(s).

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3.2.2
DataRecord
A DataRecord consists of a defined set of DataItem(s). DataRecord(s) may contain DataItem(s) from multiple sensor types as well as containing DataItem(s) from multiple sensors of the same type.

3.2.3
DataStore
A DataStore is a collection of DataTable(s).

3.2.4
DataStore Group
DataTable(s) within a DataStore shall be a member of one or more groups. Membership in a group indicates the participating DataTable(s) are related in some way. A given DataTable may participate in multiple groups. The DataStore service however, only defines membership in a group and access rights to a group. Additional ecosystem specific requirements may provide further rules and meaning attached to group membership.

3.2.5
DataTable
A DataTable consists of a collection of DataRecord(s) and a key/value Dictionary managed by a DataStore service. All DataRecord(s) in a DataTable share a common DataRecord format.

3.2.6
DataTable Dictionary
A DataTable provides a key/value data structure containing information about the DataTable. DataItem(s) stored in the DataTable records may refer to entries stored in the DataTable's Dictionary.

3.2.7
DataTable GUID
A globally unique identifier of a DataTable.

3.2.8
DataTableID
A UPnP action argument identifying a specific DataTable (see DataTable GUID).

3.2.9
DataTable URN
A uniform resource name (URN) which identifies the contents stored in a DataTable. See DataStore service [13], subclause 5.3.4, "DataTable URN" for further information.

3.3 Configuration Management terms and definitions

The following terms apply to the ConfigurationManagement Service [16]. The IoTManagementAndControl Sensor DataModel service [14] defines a profile of ConfigurationManagement service.

3.3.1
Leaf
A leaf element in the data model's logical tree.

3.3.2
Node
An element in the logical tree that represents the hierarchical structure of the data model.

3.3.3
Path
A string representation of the sequence of Node(s) starting with a Root Node and ending at the Node of interest. Specifically it's the concatenation of the Node names.

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3.3.4
PartialPath
A Path from the Root to a Node in the data model tree which is not a Leaf.

3.3.5
ParameterInitializationPath
A sequence of Node(s) starting from SingleInstance Node and ending to the Leaf Node.

3.3.6
Root
The root element of the data model's logical tree.

3.4 Device Protection terms and definitions

The following terms apply to the DeviceProtection service [15].

3.4.1
Device Protection Roles
The UPnP DeviceProtection service associates control points with device protection roles which define allowable operations a control point may perform on a UPnP service. UPnP DeviceProtection service roles are a union of basic roles defined by the UPnP DeviceProtection service and device protection roles defined by the UPnP service subject to device protection. See UPnP DeviceProtection service [15] and subclause 4.1.9, "Sensor Collection Protection Model" and subclause 4.2.6, "DataStore Protection Model" for further details.

3.4.2
Control Point Identity
The UPnP DeviceProtection service associates control point identities with device protection roles. A UPnP control point may have its own assigned roles as well as roles resulting from particular end-users being associated with the control point.

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