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INTERNATIONAL STANDARD

Information technology – UPnP Device Architecture – Part 8-11: Internet Gateway Device Control Protocol – Layer 3 Forwarding Service



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INFORMATION TECHNOLOGY – UPNP DEVICE ARCHITECTURE –

Part 8-11: Internet Gateway Device Control Protocol – Layer 3 Forwarding Service

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The list of all currently available parts of the ISO/IEC 29341 series, under the general title *Universal plug and play (UPnP) architecture*, can be found on the IEC web site.

This International Standard has been approved by vote of the member bodies, and the voting results may be obtained from the address given on the second title page.

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ORIGINAL UPNP DOCUMENTS
(informative)

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UPnP Document Title	**ISO/IEC 29341 Part**
UPnP Device Architecture 1.0	ISO/IEC 29341-1
UPnP Basic:1 Device	ISO/IEC 29341-2
UPnP AV Architecture:1	ISO/IEC 29341-3-1
UPnP MediaRenderer:1 Device	ISO/IEC 29341-3-2
UPnP MediaServer:1 Device	ISO/IEC 29341-3-3
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: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
UPnP AVTransport:2 Service	ISO/IEC 29341-4-10
UPnP ConnectionManager:2 Service	ISO/IEC 29341-4-11
UPnP ContentDirectory:2 Service	ISO/IEC 29341-4-12
UPnP RenderingControl:2 Service	ISO/IEC 29341-4-13
UPnP ScheduledRecording:1	ISO/IEC 29341-4-14
UPnP DigitalSecurityCamera:1 Device	ISO/IEC 29341-5-1
UPnP DigitalSecurityCameraMotionImage:1 Service	ISO/IEC 29341-5-10
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 HVAC_ZoneThermostat:1 Device	ISO/IEC 29341-6-2
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
UPnP HouseStatus:1 Service	ISO/IEC 29341-6-13
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 BinaryLight:1 Device	ISO/IEC 29341-7-1
UPnP DimmableLight:1 Device	ISO/IEC 29341-7-2
UPnP Dimming:1 Service	ISO/IEC 29341-7-10
UPnP SwitchPower:1 Service	ISO/IEC 29341-7-11
UPnP InternetGatewayDevice:1 Device	ISO/IEC 29341-8-1
UPnP LANDevice:1 Device	ISO/IEC 29341-8-2
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 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
UPnP WANPPPConnection:1 Service	ISO/IEC 29341-8-20
UPnP WLANConfiguration:1 Service	ISO/IEC 29341-8-21
UPnP Printer:1 Device	ISO/IEC 29341-9-1
UPnP Scanner:1.0 Device	ISO/IEC 29341-9-2
UPnP ExternalActivity:1 Service	ISO/IEC 29341-9-10
UPnP Feeder:1.0 Service	ISO/IEC 29341-9-11
UPnP PrintBasic:1 Service	ISO/IEC 29341-9-12
UPnP Scan:1 Service	ISO/IEC 29341-9-13
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
UPnP QosPolicyHolder:1 Service	ISO/IEC 29341-10-12
UPnP QoS Architecture:2	ISO/IEC 29341-11-1
UPnP QOS v2 Schema Files	ISO/IEC 29341-11-2

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UPnP Document Title	ISO/IEC 29341 Part
UPnP QosDevice:2 Service	ISO/IEC 29341-11-10
UPnP QosManager:2 Service	ISO/IEC 29341-11-11
UPnP QosPolicyHolder:2 Service	ISO/IEC 29341-11-12
UPnP RemoteUIClientDevice:1 Device	ISO/IEC 29341-12-1
UPnP RemoteUIServerDevice:1 Device	ISO/IEC 29341-12-2
UPnP RemoteUIClient:1 Service	ISO/IEC 29341-12-10
UPnP RemoteUIServer:1 Service	ISO/IEC 29341-12-11
UPnP DeviceSecurity:1 Service	ISO/IEC 29341-13-10
UPnP SecurityConsole:1 Service	ISO/IEC 29341-13-11

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1. Overview and Scope

This service definition is compliant with the UPnP Device Architecture version 1.0.

This OPTIONAL service models all layer-3 packet forwarding services applicable across all connection service instances of **urn:schemas-upnp-org:device:*WANDevice***

Generic Layer 3 packet forwarding services include all IP / layer-3 routing services. However, any such services that are configurable on a per connection instance basis, will be modeled in the context of the connection service itself. Network Address Translation (NAT) and Realm Specific IP (RSIP) are examples of such services.

The service is defined to be included under the root device
urn:schemas-upnp-org:device:*InternetGatewayDevice*

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2. Service Modeling Definitions

2.1. ServiceType

The following service type identifies a service that is compliant with this template:

urn:schemas-upnp-org:service:*Layer3Forwarding:1*.

2.2. State Variables

Table 1: State Variables

Variable Name	Req. or Opt.[1]	Data Type	Allowed Value	Default Value[2]	Eng. Units
`DefaultConnectionService`	R	string	Undefined	Empty string	N/A
Non-standard state variables implemented by an UPnP vendor go here.	*X*	*TBD*	*TBD*	*TBD*	*TBD*

[1] R = Required, O = Optional, X = Non-standard.

[2] Values listed in this column are required. To specify standard optional values or to delegate assignment of values to the vendor, you must reference a specific instance of an appropriate table below.

2.2.1. DefaultConnectionService

This variable specifies a connection service instance in a ***WANConnectionDevice,*** one or more of which could be defined in a ***WANDevice***. A comma-separated 2-tuple uniquely identifies the service:

uuid:*device-UUID*:*WANConnectionDevice*:*v* ,

urn:**upnp-org**:**serviceId**:*serviceID*

An example of a 2-tuple string follows:
"uuid:44f5824f- c57d-418c-a131-f22b34e14111:WANConnectionDevice:1,urn:upnp-org:serviceId:WANPPPConn1"

This is useful in the case of a dial-on-demand scenario where a client attempts to access Internet without explicitly initiating a connection (as would be the case for a legacy or non-UPnP networked device on the residential LAN). If multiple connections are configured, and a default connection is not set, the gateway selects a connection instance in an implementation dependent manner. **Only one instance of *WAN*Connection* service per *InternetGatewayDevice* (across multiple *WANDevice* and *WANConnectionDevice* instances) can be set as the default connection**. If a default connection is not set, and only one ***WAN*Connection*** instance is configured, it is automatically assumed to be the default connection. If the connection that is set as a default connection is not configured correctly on the gateway, then a dial-on-demand / implicit connection initiation attempt will fail.. If no connections are configured on the gateway and a client initiates an implicit dial-on-demand, the attempt to access the Internet will fail.

NOTE: In the case of bridged, relayed or spoofed connections, there is an implicit one-to-one correspondence between a control point and an active connection. In essence, the gateway performs source address based routing. Sharing of connections is not possible in these scenarios. Consequently, if the `DefaultConnectionService` points to an **active** connection service instance of one of the types listed above, dial-on-demand for a legacy or non-UPnP client will not work.

2.2.2. Relationships Between State Variables

None.

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2.3. Eventing and Moderation

Table 2: Event Moderation

Variable Name	Evented	Moderated Event	Max Event Rate[1]	Logical Combination	Min Delta per Event[2]
`DefaultConnectionService`	Yes	No	N/A	N/A	N/A
Non-standard state variables implemented by an UPnP vendor go here.	*TBD*	*TBD*	*TBD*	*TBD*	*TBD*

[1] Determined by N, where Rate = (Event)/(N secs).
[2] (N) * (allowedValueRange Step).

2.3.1. Event Model

`DefaultConnectionService` is evented whenever its value changes. Eventing is not moderated.

2.4. Actions

Immediately following this table is detailed information about these actions, including short descriptions of the actions, the effects of the actions on state variables, and error codes defined by the actions.

Table 3: Actions

Name	Req. or Opt. [1]
`SetDefaultConnectionService`	*R*
`GetDefaultConnectionService`	*R*
Non-standard actions implemented by an UPnP vendor go here.	X

[1] R = Required, O = Optional, X = Non-standard.

2.4.1. SetDefaultConnectionService

Action selects a connection service instance on one of the ***WANConnectionDevice*** instances to be the default connection. If this is not specified, the selection of the default gateway is implementation dependent. If the connection specified is not configured, dial-on-demand connection attempts to the Internet will fail.

2.4.1.1. Arguments

Table 4: Arguments for `SetDefaultConnectionService`

Argument	Direction	relatedStateVariable
`NewDefaultConnectionService`	*IN*	`DefaultConnectionService`

2.4.1.2. Dependency on State (if any)

2.4.1.3. Effect on State (if any)

Sets / changes the default connection for the gateway.

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2.4.1.4. Errors

errorCode	errorDescription	Description
402	Invalid Args	One of following: not enough IN arguments, too many IN arguments, no IN argument by that name, one or more IN arguments are of the wrong data type. See also the UPnP Device Architecture.
501	Action Failed	May be returned in current state if service prevents invoking of that action.
720	InvalidDeviceUUID	The UUID of a device specified in the action arguments is invalid
721	InvalidServiceID	The Service ID of a service specified in the action arguments is invalid
723	InvalidConnServiceSelection	The selected connection service instance cannot be set as a default connection

2.4.2. GetDefaultConnectionService

This action retrieves the 2-tuple string representing the default connection service in the gateway.

2.4.2.1. Arguments

Table 5: Arguments for `GetDefaultConnectionService`

Argument	Direction	relatedStateVariable
`NewDefaultConnectionService`	*OUT*	`DefaultConnectionService`

2.4.2.2. Dependency on State (if any)

2.4.2.3. Effect on State

None.

2.4.2.4. Errors

errorCode	errorDescription	Description
402	Invalid Args	One of following: not enough IN arguments, too many IN arguments, no IN argument by that name, one or more IN arguments are of the wrong data type. See also the UPnP Device Architecture.
501	Action Failed	May be returned in current state if service prevents invoking of that action.

2.4.3. Non-Standard Actions Implemented by a UPnP Vendor

To facilitate certification, non-standard actions implemented by UPnP vendors should be included in this service template. The UPnP Device Architecture lists naming requirements for non-standard actions (see the section on Description).

2.4.4. Relationships Between Actions

2.4.5. Common Error Codes

The following table lists error codes common to actions for this service type. If an action results in multiple errors, the most specific error should be returned.

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Table 6: Common Error Codes

errorCode	errorDescription	Description
401	Invalid Action	See UPnP Device Architecture section on Control.
402	Invalid Args	See UPnP Device Architecture section on Control.
404	Invalid Var	See UPnP Device Architecture section on Control.
501	Action Failed	See UPnP Device Architecture section on Control.
600-699	TBD	Common action errors. Defined by UPnP Forum Technical Committee.
701-799		Common action errors defined by the UPnP Forum working committees.
800-899	*TBD*	*(Specified by UPnP vendor.)*

2.5. Theory of Operation

A gateway could perform sophisticated routing functions, especially if it has multiple LAN and WAN interfaces. However, the IGD Working Committee decided to restrict the scope of the first version of gateway DCP to simpler usage scenarios. NAT functionality is configurable on a per connection basis and is consequently modeled in the appropriate connection service.

Per the current specification, the following precedence is implied in determining routes to a destination IP address on the WAN:

1. If a control point successfully invokes `RequestConnection`[1] on a connection service instance, subsequent IP packets from that control point MUST be routed on that connection instance.
2. If `RequestConnection` is not called, and if `DefaultConnectionService` points to a usable connection service instance, packets from a node on the residential LAN MUST be routed on that connection instance.
3. If `RequestConnection` is not called, and if `DefaultConnectionService` is not specified, packets MUST be routed based on the reachable route for the destination IP address in the packet..

[1] Refer to the ***WAN**Connection*** service definition for more information on `RequestConnection`.

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3. XML Service Description

```
<?xml version="1.0"?>
<scpd xmlns="urn:schemas-upnp-org:service-1-0">
  <specVersion>
    <major>1</major>
    <minor>0</minor>
  </specVersion>
  <actionList>
    <action>
    <name>SetDefaultConnectionService</name>
      <argumentList>
        <argument>
          <name>NewDefaultConnectionService</name>
          <direction>in</direction>
   <relatedStateVariable>DefaultConnectionService</relatedStateVariable>
        </argument>
      </argumentList>
    </action>
    <action>
    <name>GetDefaultConnectionService</name>
      <argumentList>
        <argument>
          <name>NewDefaultConnectionService</name>
          <direction>out</direction>
   <relatedStateVariable>DefaultConnectionService</relatedStateVariable>
        </argument>
      </argumentList>
    </action>
    <!-- Declarations for other actions added by UPnP vendor (if any) go
here -->
  </actionList>
  <serviceStateTable>
   <stateVariable sendEvents="yes">
      <name>DefaultConnectionService</name>
      <dataType>string</dataType>
   </stateVariable>
   <!-- Declarations for other state variables added by UPnP vendor (if
any) go here -->
  </serviceStateTable>
</scpd>
```

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4. Test

SetDefaultConnectionService / GetDefaultConnectionService

Test Sequence 1: To test success path
Semantic class: 2
Pre-conditions: None.

SetDefaultConnectionService Success = 200

In-Arg	Values	State Variables	Current State	Expected State
DefaultConnectionService	A string representing a valid connection service instance per semantics defined in the service description document			
Out-Arg	**Expected Value**			
		Error Code (if any)	NA	NA

GetDefaultConnectionService Success = 200

In-Arg	Values	State Variables	Current State	Expected State
Out-Arg	**Expected Value**			
DefaultConnectionService	String set in the preceding Set action	**Error Code (if any)**	NA	NA

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Test Sequence 2: To test error 720
Semantic class: 2
Pre-conditions: None.

GetDefaultConnectionService Success = 200

In-Arg	Values	State Variables	Current State	Expected State
Out-Arg	**Expected Value**			
DefaultConnectionService	A string representing a valid connection service instance per semantics defined in the service description document OR an empty string representing an uninitialized default connection	**Error Code (if any)**	NA	NA

SetDefaultConnectionService Success = 200

In-Arg	Values	State Variables	Current State	Expected State
DefaultConnectionService	A string representing a connection service instance per semantics defined in the service description document but with an invalid value for device container			
Out-Arg	**Expected Value**			
		Error Code (if any)	720	NA

GetDefaultConnectionService Success = 200

In-Arg	Values	State Variables	Current State	Expected State
Out-Arg	**Expected Value**			
DefaultConnectionService	String retrieved in preceding Get action	**Error Code (if any)**	NA	NA

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Test Sequence 3: To test error 721
Semantic class: 2
Pre-conditions: None.

GetDefaultConnectionService Success = 200

In-Arg	Values	State Variables	Current State	Expected State
Out-Arg	**Expected Value**			
DefaultConnectionService	A string representing a valid connection service instance per semantics defined in the service description document OR an empty string representing an uninitialized default connection	**Error Code (if any)**	NA	NA

SetDefaultConnectionService Success = 200

In-Arg	Values	State Variables	Current State	Expected State
DefaultConnectionService	A string representing a connection service instance per semantics defined in the service description document but with an invalid value for service instance			
Out-Arg	**Expected Value**			
		Error Code (if any)	721	NA

GetDefaultConnectionService Success = 200

In-Arg	Values	State Variables	Current State	Expected State
Out-Arg	**Expected Value**			
DefaultConnectionService	String retrieved in preceding Get action	**Error Code (if any)**	NA	NA

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