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Information technology – UPnP Device Architecture – Part 8-14: Internet Gateway Device Control Protocol – Wide Area Network Cable Link Configuration Service



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Part 8-14: Internet Gateway Device Control Protocol – Wide Area Network Cable Link Configuration 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 service-type encapsulates physical and link layer properties that are specific to a cable connection used for Internet access. These properties are specific to a cable interface but are common across the different instances of ***WANIPConnection*** service. Please see the Deployment Scenario section for more detail.

The service is OPTIONAL if there is a cable modem WAN interface in the Internet Gateway.
It is specified in
urn:schemas-upnp-org:device:*WANConnectionDevice* in
urn:schemas-upnp-org:device:*WANDevice* under the root device
urn:schemas-upnp-org:device:*InternetGatewayDevice.*

The ***WANDevice*** also provides a ***WANCommonInterfaceConfig*** service that encapsulates Internet access properties common to a WAN Interface.

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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:*WANCableLinkConfig:1*.

2.2. State Variables

Table 1: State Variables

Variable Name	Req. or Opt.[1]	Data Type	Allowed Value[1]	Default Value[2]	Eng. Units
CableLinkConfigState	R	string	See Table 1.1	Not specified	N/A
LinkType	R	string	See Table 1.2	Not specified	N/A
DownstreamFrequency	O	ui4	>=0	Undefined - Depends on Service Provider	N/A
DownstreamModulation	O	string	See Table 1.3	Empty string (Depends on Service Provider)	N/A
UpstreamFrequency	O	ui4	>=0	Empty string (Depends on Service Provider)	N/A
UpstreamModulation	O	string	See Table 1.4	Empty string (Depends on Service Provider)	N/A
UpstreamChannelID	O	ui4	>=0	Undefined - Depends on Service Provider	N/A
UpstreamPowerLevel	O	ui4	>=0	Undefined - Depends on Service Provider	N/A
BPIEncryptionEnabled	O	boolean	1, 0	Not specified	N/A
ConfigFile	O	string	N/A	Empty string	N/A
TFTPServer	O	string	N/A	Empty string	N/A
Non-standard state variables implemented by a 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.

NOTE: Default values are not specified in the DCP. A vendor may however choose to provide default values for SST variables where appropriate.

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Table 1.1: AllowedValueList for `CableLinkConfigState`

Value	Req. or Opt.
notReady	*R*
dsSyncComplete	*R*
usParamAcquired	*R*
rangingComplete	*R*
ipComplete	*R*
todEstablished	*R*
paramTransferComplete	*R*
registrationComplete	*R*
operational	*R*
accessDenied	*R*

Table 1.2: AllowedValueList for `LinkType`

Value	Req. or Opt.
Ethernet	*R*

Table 1.3: AllowedValueList for `DownstreamModulation`

Value	Req. or Opt.
64QAM	*R*
256QAM	*R*

Table 1.4: AllowedValueList for `UpstreamModulation`

Value	Req. or Opt.
QPSK	*R*
16QAM	*R*

2.2.1. CableLinkConfigState

This variable represents the current status of the DOCSIS cable connection. Possible string values are:

- ***notReady***: This is the default value and indicates that other variables in the service table are not in a valid state.
- ***dsSyncComplete***: The cable interface of the Internet Gateway has successfully locked on to the downstream channel.
- ***usParamAcquired***: The upstream parameters have been received by the cable interface.
- ***rangingComplete***: The cable interface has completed ranging and all automatic adjustments.
- ***ipComplete***: The cable interface has received its IP address from the DHCP server.
- ***todEstablished***: The cable interface has received the IP address for the TOD server.

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- ***paramTransferComplete***: The cable interface has downloaded its operational parameters
- ***registrationComplete***: The cable interface has registered with the CMTS.
- ***operational***: The cable interface is now operational.
- ***accessDenied***: The cable interface of the Internet Gateway has been set in a deny state by the ISP.

2.2.2. LinkType

This variable indicates the type of Cable Link used for connection to the Internet. It cannot be set by a UPnP control point and is a read-only variable.

2.2.3. DownstreamFrequency

This variable specifies the center frequency for the downstream channel to be used by the modem. It cannot be set by a UPnP control point and is a read-only variable.

2.2.4. DownstreamModulation

This variable indicates the modulation type associated with the downstream channel. It cannot be set by a UPnP control point and is a read-only variable.

2.2.5. UpstreamFrequency

This variable specifies the center frequency for the upstream channel to be used by the modem. It cannot be set by a UPnP control point and is a read-only variable.

2.2.6. UpstreamModulation

This variable indicates the modulation type associated with the upstream channel. It cannot be set by a UPnP control point and is a read-only variable.

2.2.7. UpstreamChannelID

This variable specifies channel ID for the upstream channel to be used by the modem. It cannot be set by a UPnP control point and is a read-only variable.

2.2.8. UpstreamPowerLevel

This variable indicates the upstream power level used by the modem in dBmV. It cannot be set by a UPnP control point and is a read-only variable.

2.2.9. BPIEncryptionEnabled

This variable indicates whether BPI encryption is enabled on the cable interface. It cannot be set by a UPnP control point and is a read-only variable.

2.2.10. ConfigFile

This variable indicates the name of the configuration file used.

2.2.11. TFTPServer

This variable indicates the IP Address of the TFTP server.

2.2.12.Relationships Between State Variables

The variables in the SST have no dependencies or relationship other than what is mandated by relevant Cable modem standards and protocols.

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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]
CableLinkConfigState	No	No	N/A	N/A	N/A
LinkType	No	No	N/A	N/A	N/A
DownstreamFrequency	No	No	N/A	N/A	N/A
DownstreamModulation	No	No	N/A	N/A	N/A
UpstreamFrequency	No	No	N/A	N/A	N/A
UpstreamModulation	No	No	N/A	N/A	N/A
UpstreamChannelID	No	No	N/A	N/A	N/A
UpstreamPowerLevel	No	No	N/A	N/A	N/A
TFTPServer	No	No	N/A	N/A	N/A
ConfigFile	No	No	N/A	N/A	N/A
BPIEncryptionEnabled	No	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

None of the variables are evented.

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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]
GetCableLinkConfigInfo	R
GetDownstreamFrequency	O
GetDownstreamModulation	O
GetUpstreamFrequency	O
GetUpstreamModulation	O
GetUpstreamChannelID	O
GetUpstreamPowerLevel	O
GetBPIEncryptionEnabled	O
GetConfigFile	O
GetTFTPServer	O
Non-standard actions implemented by an UPnP vendor go here.	X

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

2.4.1. GetCableLinkConfigInfo

This action retrieves the status of the cable interface, including the Link Type.

2.4.1.1. Arguments

Table 4: Arguments for GetCableLinkConfigInfo

Argument	Direction	relatedStateVariable
NewCableLinkConfigState	OUT	CableLinkConfigState
NewLinkType	OUT	LinkType

2.4.1.2. Dependency on State (if any)

2.4.1.3. Effect on State (if any)

None

2.4.1.4. Errors

errorCode	errorDescription	Description
402	Invalid args	See Table 2.4.13

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2.4.2. GetDownstreamFrequency

This action retrieves the center frequency associated with downstream channel.

2.4.2.1. Arguments

Table 5: Arguments for `Get GetDownstreamFrequency`

Argument	Direction	relatedStateVariable
NewDownstreamFrequency	*OUT*	DownstreamFrequency

2.4.2.2. Dependency on State (if any)

2.4.2.3. Effect on State (if any)

None

2.4.2.4. Errors

errorCode	errorDescription	Description
402	Invalid args	See Table 2.4.13
501	Action Failed	See Table 2.4.13

2.4.3. GetDownstreamModulation

This action retrieves the modulation type associated with downstream channel.

2.4.3.1. Arguments

Table 6: Arguments for `GetDownstreamModulation`

Argument	Direction	relatedStateVariable
NewDownstreamModulation	*OUT*	DownstreamModulation

2.4.3.2. Dependency on State (if any)

2.4.3.3. Effect on State

None

2.4.3.4. Errors

errorCode	errorDescription	Description
402	Invalid args	See Table 2.4.13
501	Action Failed	See Table 2.4.13

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2.4.4. GetUpstreamFrequency

This action retrieves the center frequency associated with the upstream channel.

2.4.4.1. Arguments

Table 7: Arguments for `GetUpstreamFrequency`

Argument	Direction	relatedStateVariable
NewUpstreamFrequency	*OUT*	UpstreamFrequency

2.4.4.2. Dependency on State (if any)

2.4.4.3. Effect on State

None

2.4.4.4. Errors

errorCode	errorDescription	Description
402	Invalid args	See Table 2.4.13
501	Action Failed	See Table 2.4.13

2.4.5. GetUpstreamModulation

This action retrieves the modulation type associated with the upstream channel.

2.4.5.1. Arguments

Table 8: Arguments for `GetUpstreamModulation`

Argument	Direction	relatedStateVariable
NewUpstreamModulation	*OUT*	UpstreamModulation

2.4.5.2. Dependency on State (if any)

2.4.5.3. Effect on State

None

2.4.5.4. Errors

errorCode	errorDescription	Description
402	Invalid args	See Table 2.4.13
501	Action Failed	See Table 2.4.13

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2.4.6. GetUpstreamChannelID

This action retrieves the channel ID associated with the upstream channel.

2.4.6.1. Arguments

Table 9: Arguments for `GetUpstreamChannelID`

Argument	Direction	relatedStateVariable
NewUpstreamChannelID	*OUT*	UpstreamChannelID

2.4.6.2. Dependency on State (if any)

2.4.6.3. Effect on State

None

2.4.6.4. Errors

errorCode	errorDescription	Description
402	Invalid args	See Table 2.4.13
501	Action Failed	See Table 2.4.13

2.4.7. GetUpstreamPowerLevel

This action retrieves the power level associated with the upstream channel.

2.4.7.1. Arguments

Table 10: Arguments for `GetUpstreamPowerLevel`

Argument	Direction	relatedStateVariable
NewUpstreamPowerLevel	*OUT*	UpstreamPowerLevel

2.4.7.2. Dependency on State (if any)

2.4.7.3. Effect on State

None

2.4.7.4. Errors

errorCode	errorDescription	Description
402	Invalid args	See Table 2.4.13
501	Action Failed	See Table 2.4.13

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2.4.8. GetBPIEncryptionEnabled

This action retrieves a value that indicates whether BPI encryption is currently enabled on the cable interface.

2.4.8.1. Arguments

Table 11: Arguments for `GetBPIEncryptionEnabled`

Argument	Direction	relatedStateVariable
NewBPIEncryptionEnabled	*OUT*	BPIEncryptionEnabled

2.4.8.2. Dependency on State (if any)

2.4.8.3. Effect on State

None

2.4.8.4. Errors

errorCode	errorDescription	Description
402	Invalid args	See Table 2.4.13
501	Action Failed	See Table 2.4.13

2.4.9. GetConfigFile

This action retrieves the name of the configuration file used for the gateway by the CMTS.

2.4.9.1. Arguments

Table 12: Arguments for `GetConfigFile`

Argument	Direction	relatedStateVariable
NewConfigFile	*OUT*	ConfigFile

2.4.9.2. Dependency on State (if any)

2.4.9.3. Effect on State

None

2.4.9.4. Errors

errorCode	errorDescription	Description
402	Invalid args	See Table 2.4.13
501	Action Failed	See Table 2.4.13

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2.4.10.GetTFTPServer

This action retrieves IP Address of the TFTP server used for the Gateway by the CMTS.

2.4.10.1. Arguments

Table 13: Arguments for `GetTFTPServer`

Argument	Direction	relatedStateVariable
`NewTFTPServer`	*OUT*	`TFTPServer`

2.4.10.2.Dependency on State (if any)

2.4.10.3.Effect on State

None

2.4.10.4.Errors

errorCode	errorDescription	Description
402	Invalid args	See Table 2.4.13
501	Action Failed	See Table 2.4.13

2.4.11.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).

2.4.12.Relationships Between Actions

All actions defined are for querying state variables, and have no specific relationship between them.

2.4.13.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.

Table 14: Common Error Codes

errorCode	errorDescription	Description
401	Invalid Action	See UPnP Device Architecture section on Control.
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 UPnP Device Architecture section on Control.
404	Invalid Var	See UPnP Device Architecture section on Control.
501	Action Failed	May be returned in current state if service prevents invoking of that action. 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.)*

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2.5. Theory of Operation

There are certain minimum requirements that a gateway device with a cable interface needs to support to be able to be UPnP compliant. This also applies to a cable modem that acts as a gateway device. The device needs to expose an IP address to the in-home LAN. Therefore the gateway should be reachable to the control point from the in-home LAN before, during and after initialization and connection procedures are completed with the Cable Modem Termination System (CMTS).

A ***WANDevice*** that has a cable interface MUST implement a ***WANConnectionDevice*** device and optionally the ***WANCableLinkConfig*** service. The SST variables in this service give information on specific properties of a Cable modem used for WAN Internet access.

Please refer to the DOCSIS specifications (http://www.docsis.org/) for more details on the physical and link layer operation of DOCSIS-compliant cable interfaces.

When a ***WANDevice*** and a ***WANConnectionDevice*** is initialized, one instance of ***WANCableLinkConfig*** service (if implemented) will be initialized. In addition, one or more instances of ***WANIPConnection*** service will be initialized depending on the number of configurations supported on the ***WANDevice***. The gateway implementation may choose to initialize more than one instance of ***WANIPConnection*** service even though the cable interface may support only one connection at a time.

The state variables in this service are DOCSIS oriented. However with the exception of `CableLinkConfigState` and `LinkType`, all the other states are optional. `CableLinkConfigState` values are taken from DOCSIS initialization states but it is expected that non-DOCSIS cable modems would have similar states. Non-DOCSIS cable interfaces can also be supported in UPnP through a combination of these variables and other optional states and use of vendor extensions means that non-DOCSIS cable interfaces can also be supported in UPnP.

2.5.1. Connection Initiation

When an Internet Gateway has a cable interface, the connection is considered "always on." But each time the Internet Gateway is powered on, the cable interface has to go through an initial configuration and registration. The cable interface has a number of parameters that are passed to it by the CMTS. These parameters and the initialization process are detailed in the DOCSIS standard [1]. Please refer to it for a more detailed theory of operation. At the end of the DOCSIS initialization process the cable interface of the Internet Gateway is online and operational in the basic DOCSIS bridging ("plug and play") mode.

The outline of the DOCSIS initialization process is shown in Figure 1 with brief description provided below:

1. *Scan for a downstream channel and establish synchronization with the CMTS.*
The cable interface of an Internet Gateway acquires a downstream channel by matching the clock sync signal that is regularly sent out by the CMTS on the downstream channel. The cable interface of the Internet Gateway saves the last operational frequency in non-volatile memory and tries to reacquire the saved downstream channel the next time a request is made.

2. *Obtain upstream channel parameters.*
The cable interface of the Internet Gateway waits for a message from the CMTS and configures itself for the upstream frequency specified in that message.

3. *Start ranging for power adjustments.*
As needed, the cable interface adjusts its transmit power levels using the power increment value given by the CMTS in its ranging response message.

Note At this point, the cable interface of the Internet Gateway has established connectivity with the CMTS but is not yet online. The next steps are the configuration required for IP network connectivity. In the future it is assumed that there will be different IP connectivity providers so the architecture is created so that there could be multiple ***WANIPConnection***.

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4. Establish IP connectivity.
The cable interface invokes the Dynamic Host Configuration Protocol (DHCP) to establish IP connectivity with the TCP/IP network at the headend. The DHCP server sends a response containing the cable interface's IP address as well as the IP addresses for the default gateway, time of day (TOD) server, and Trivial File Transfer Protocol (TFTP) server, and the DOCSIS configuration file to be downloaded.

5. Establish the time of day.
The cable interface accesses the TOD server for the current date and time, which is used to create time stamps for logged events.

6. Transfer operational parameters.
Using TFTP, the cable interface downloads the specified DOCSIS configuration file and configures itself for the appropriate parameters. The DOCSIS configuration file defines the operating mode of the cable interface, such as the provisioned downstream and upstream service assignments, including assigned frequencies, data rates, modulation schemes, Class of Service, Quality of Service and other parameters.

7. Perform registration.
The cable interface completes its secondary ranging and is then online, passing data between the HFC network and the PCs and other CPE devices that are connected to the Internet Gateway.

8. Comply with baseline privacy.
If baseline privacy (BPI) is configured and enabled on both the cable interface and CMTS, the cable interface and CMTS negotiate the appropriate encryption/decryption parameters and exchange keys for privacy. After encryption is enabled, all information sent within Ethernet packets is encrypted to prevent interception or modification by an unauthorized party.

9. Enter in operational state.
As soon as the cable interface has successfully completed the above sequence, it enters operational state.

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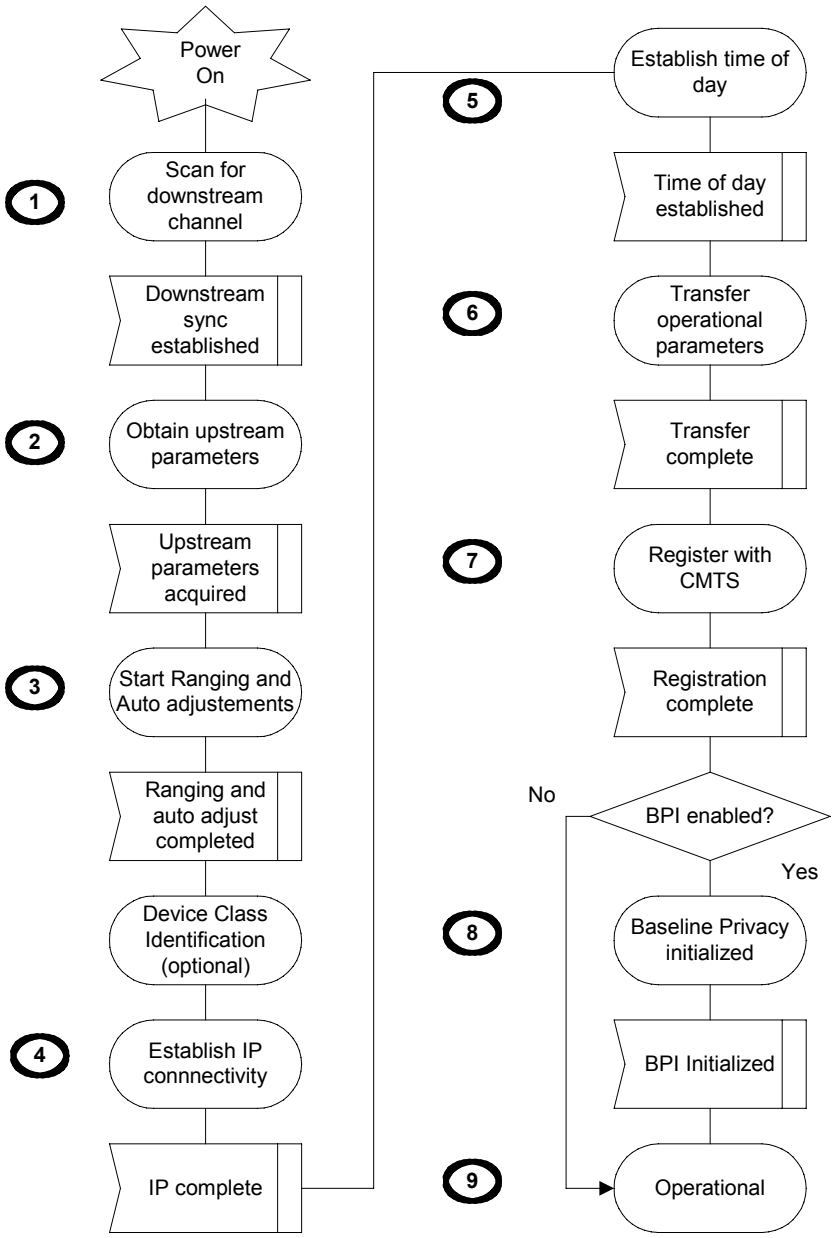


Figure 1: Cable interface initialization overview

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2.5.2. Deployment Scenarios

The following is a guide to implementers on how to model a UPnP Internet Gateway device that involves a cable interface. Only the WAN modeling will be elaborated since the others should be straightforward. Three cases will be elaborated here.

- A Gateway with CM interface

This is a gateway capable of routing with multiple LAN interfaces as well as one or more WAN interfaces, one of which is a cable interface. It will need the following devices and services to model the just the WAN cable interface:

- ***WANDevice*** – one for the cable interface
  - ***WANCommonInterfaceConfig*** service – one corresponding to the ***WANDevice*** above
  - ***WANConnectionDevice*** – for the cable interface
    - ***WANCableLinkConfig*** service (optional) – within the ***WANConnectionDevice***
    - ***WANIPConnection*** service – one within the ***WANConnectionDevice***

- Cable Modem as the Internet Gateway

This is a regular cable modem, most probably DOCSIS compliant. It does Ethernet bridging and has to have an IP stack to be UPnP compliant. It has to expose an IP address to the in-home LAN. Cable modem implementation vary, so it is important to have a mechanism for the control point on the in-home LAN to talk to the cable modem both before and after connecting to the CMTS, in order for the cable modem to be UPnP compliant. If this is present, the Internet Gateway WAN model is exactly the same as the first case.

- Cable modem connected to an Internet Gateway PC

In this case, the PC is acting as the Internet Gateway which is using its Ethernet interface to connect to the CM and hence to the Internet. The cable modem plays no part in the PC's Internet Gateway implementation. The PC is using its Ethernet interface as the WAN connection and so it should be modeled as:

- ***WANDevice*** – one for the Ethernet interface
  - ***WANCommonInterfaceConfig*** service – one corresponding to the ***WANDevice*** above
  - ***WANConnectionDevice*** – for the Ethernet interface
    - ***WANEthernetLinkConfig*** service (optional) – within the ***WANConnectionDevice***
    - ***WANIPConnection*** service – one within the ***WANConnectionDevice***

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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>GetCableLinkConfigInfo</name>
      <argumentList>
        <argument>
          <name>NewCableLinkConfigState</name>
          <direction>out</direction>
       <relatedStateVariable>CableLinkConfigState</relatedStateVariable>
        </argument>
        <argument>
          <name>NewLinkType</name>
          <direction>out</direction>
          <relatedStateVariable>LinkType</relatedStateVariable>
        </argument>
      </argumentList>
    </action>
    <action>
    <name>GetDownstreamFrequency</name>
      <argumentList>
        <argument>
          <name>NewDownstreamFrequency</name>
          <direction>out</direction>
        <relatedStateVariable>DownstreamFrequency</relatedStateVariable>
        </argument>
      </argumentList>
    </action>
    <action>
    <name>GetDownstreamModulation</name>
      <argumentList>
        <argument>
          <name>NewDownstreamModulation</name>
          <direction>out </direction>
       <relatedStateVariable>DownstreamModulation</relatedStateVariable>
        </argument>
      </argumentList>
    </action>
    <action>
    <name>GetUpstreamFrequency</name>
      <argumentList>
        <argument>
          <name>NewUpstreamFrequency</name>
          <direction>out</direction>
          <relatedStateVariable>UpstreamFrequency</relatedStateVariable>
        </argument>
      </argumentList>
    </action>
    <action>
    <name>GetUpstreamModulation</name>
      <argumentList>
        <argument>
          <name>NewUpstreamModulation</name>
          <direction>out</direction>
         <relatedStateVariable>UpstreamModulation</relatedStateVariable>
        </argument>
      </argumentList>
```

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```
    </action>
    <action>
    <name>GetUpstreamChannelID</name>
      <argumentList>
        <argument>
          <name>NewUpstreamChannelID</name>
          <direction>out</direction>
          <relatedStateVariable>UpstreamChannelID</relatedStateVariable>
        </argument>
      </argumentList>
    </action>
    <action>
    <name>GetUpstreamPowerLevel</name>
      <argumentList>
        <argument>
          <name>NewUpstreamPowerLevel</name>
          <direction>out</direction>
         <relatedStateVariable>UpstreamPowerLevel</relatedStateVariable>
        </argument>
      </argumentList>
    </action>
    <action>
    <name>GetBPIEncryptionEnabled</name>
      <argumentList>
        <argument>
          <name>NewBPIEncryptionEnabled</name>
          <direction>out</direction>
        <relatedStateVariable>BPIEncryptionEnabled</relatedStateVariable>
        </argument>
      </argumentList>
    </action>
    <action>
    <name>GetConfigFile</name>
      <argumentList>
        <argument>
          <name>NewConfigFile</name>
          <direction>out</direction>
          <relatedStateVariable>ConfigFile</relatedStateVariable>
        </argument>
       </argumentList>
    </action>
    <action>
    <name>GetTFTPServer</name>
      <argumentList>
        <argument>
          <name>NewTFTPServer</name>
          <direction>out</direction>
          <relatedStateVariable>TFTPServer</relatedStateVariable>
        </argument>
       </argumentList>
    </action>
    <!-- Declarations for other actions added by UPnP vendor (if any) go
here -->
  </actionList>
  <serviceStateTable>
  <stateVariable sendEvents="no">
      <name>CableLinkConfigState</name>
      <dataType>string</dataType>
      <allowedValueList>
        <allowedValue>notReady</allowedValue>
        <allowedValue>dsSyncComplete</allowedValue>
        <allowedValue>usParamAcquired</allowedValue>
        <allowedValue>rangingComplete</allowedValue>
        <allowedValue>ipComplete</allowedValue>
```

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```
        <allowedValue>todEstablished</allowedValue>
        <allowedValue>paramTransferComplete</allowedValue>
        <allowedValue>registrationComplete</allowedValue>
        <allowedValue>operational</allowedValue>
        <allowedValue>accessDenied</allowedValue>
      </allowedValueList>
    </stateVariable>
    <stateVariable sendEvents="no">
      <name>LinkType</name>
      <dataType>string</dataType>
      <allowedValueList>
        <allowedValue>Ethernet</allowedValue>
      </allowedValueList>
    </stateVariable>
    <stateVariable sendEvents="no">
      <name>DownstreamFrequency</name>
      <dataType>ui4</dataType>
    </stateVariable>
    <stateVariable sendEvents="no">
      <name>DownstreamModulation</name>
      <dataType>string</dataType>
      <allowedValueList>
        <allowedValue>64QAM</allowedValue>
        <allowedValue>256QAM</allowedValue>
      </allowedValueList>
    </stateVariable>
    <stateVariable sendEvents="no">
      <name>UpstreamFrequency</name>
      <dataType>ui4</dataType>
    </stateVariable>
    <stateVariable sendEvents="no">
      <name>UpstreamModulation</name>
      <dataType>string</dataType>
      <allowedValueList>
        <allowedValue>QPSK</allowedValue>
        <allowedValue>16QAM</allowedValue>
      </allowedValueList>
    </stateVariable>
    <stateVariable sendEvents="no">
      <name>UpstreamChannelID</name>
      <dataType>ui4</dataType>
    </stateVariable>
    <stateVariable sendEvents="no">
      <name>UpstreamPowerLevel</name>
      <dataType>ui4</dataType>

    </stateVariable>
    <stateVariable sendEvents="no">
      <name>ConfigFile</name>
      <dataType>string</dataType>
    </stateVariable>
    <stateVariable sendEvents="no">
      <name>TFTPServer</name>
      <dataType>string</dataType>
    </stateVariable>
    <stateVariable sendEvents="yes">
      <name>BPIEncryptionEnabled</name>
      <dataType>boolean</dataType>
    </stateVariable>
    <!-- Declarations for other state variables added by UPnP vendor (if
any) go here -->
  </serviceStateTable>
</scpd>
```

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4. Test

No semantic tests have been defined for this service.

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