

# **TR-131**

## **ACS Northbound Interface Requirements**

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**Executive Summary**

This Technical Report specifies requirements for the ACS Northbound Interface (NBI), which enables an integration of the Operational and Business Support Systems with the ACS to provision and manage devices.

This Technical Report specifies the use cases and functional requirements for the NBI, but does not specify the interface itself.

This Technical Report includes requirements for architecture, provisioning devices, device operations, file management, device grouping, and events.

# 1 Purpose and Scope

## 1.1 Purpose

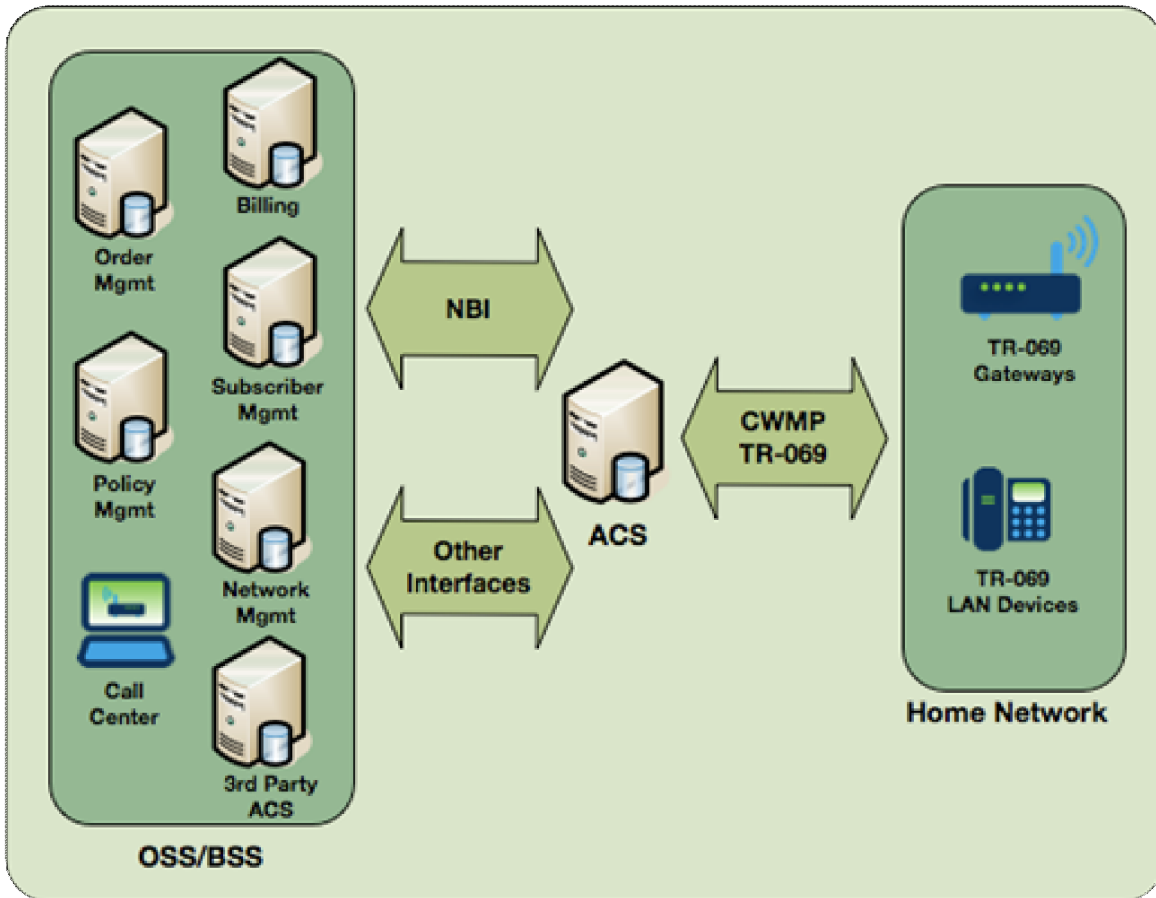
This Technical Report defines requirements for an ACS Northbound Interface (NBI) that allows Operational and Business Support Systems to access ACS functionality. These requirements are derived from a set of device management and service management use cases. Sections 1 through 5 of this Technical Report, which includes this introduction, use cases and key concepts, are non-normative and are provided as context for the rest of the Technical Report. Section 6 is normative and provides requirements.

The ACS is assumed to have the ability to support the functions outlined in Section 1.1/TR-069 [2]:

- auto-configuration and dynamic service provisioning,
- software/firmware image management,
- status and performance monitoring, and
- diagnostics

It is not assumed that the ACS itself implements features which are likely to be found in other Operational and Business Support Systems, including order fulfillment, billing, subscriber management, change management, manufacturing management, performance analytics, or service level agreement management. The ACS is likely to integrate with these systems via the NBI. Note that this is not intended to mandate that an ACS cannot implement these other functions should a company choose to build them into their product, but that their presence is not assumed. ACSes may also integrate with each other via the NBI.

The following figure illustrates the relationship between the ACS and other systems.



**Figure 1 – ACS to OSS/BSS Relationships**

## 1.2 Scope

The primary purpose of the NBI is to provide an interface for northbound Operational and Business Support Systems into the ACS for provisioning and managing any devices implementing the CWMP protocol as defined in TR-069 [2]. It also provides a messaging infrastructure to enable the communication of various Events to Operational and Business Support Systems. Devices under management by the ACS could include both those implementing InternetGatewayDevice (IGD) as defined in TR-098 [3], and/or Device as defined in TR-106 [4], including any embedded service objects.

An ACS may also implement alternate or proprietary southbound protocols for device management and none of the requirements expressed in this Technical Report are intended to preclude that possibility.



The NBI requirements are not intended to cover all interfaces between Operational and Business Support Systems and the ACS. For example, static configuration of ACS systems or ACS GUI definition is considered out of scope for this Technical Report.

This Technical Report specifies the use cases and functional requirements for the NBI, but does not specify the interface itself.

## 2 References and Terminology

### 2.1 Conventions

In this Technical Report, several words are used to signify the requirements of the specification. These words are always capitalized. More information can be found in RFC 2119 [1].

|                   |  |
|-------------------|--|
| <b>MUST</b>       | This word, or the terms “REQUIRED” or “SHALL”, mean that the definition is an absolute requirement of the specification.   |
| <b>MUST NOT</b>   | This phrase, or the phrase “SHALL NOT”, means that the definition is an absolute prohibition of the specification.   |
| <b>SHOULD</b>     | This word, or the adjective “RECOMMENDED”, means that there may exist valid reasons in particular circumstances to ignore this item, but the full implications must be understood and carefully weighed before choosing a different course.  |
| <b>SHOULD NOT</b> | This phrase, or the phrase “NOT RECOMMENDED” means that there may exist valid reasons in particular circumstances when the particular behavior is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behavior described with this label. |
| <b>MAY</b>        | This word, or the adjective “OPTIONAL”, means that this item is one of an allowed set of alternatives. An implementation that does not include this option <b>MUST</b> be prepared to inter-operate with another implementation that does include the option.  |

## 2.2 References

The following references are of relevance to this Technical Report. At the time of publication, the editions indicated were valid. All references are subject to revision; users of this Technical Report are therefore encouraged to investigate the possibility of applying the most recent edition of the references listed below.

A list of currently valid Broadband Forum Technical Reports is published at [www.broadband-forum.org](http://www.broadband-forum.org).

- |     |                          |   |                 |      |
|-----|--------------------------|---|-----------------|------|
| [1] | <a href="#">RFC 2119</a> | <i>Key words for use in RFCs to Indicate Requirement Levels</i> | IETF            | 1997 |
| [2] | TR-069<br>Amendment 2    | <i>CPE WAN Management Protocol v1.1</i>                         | Broadband Forum | 2007 |
| [3] | TR-098<br>Amendment 2    | <i>Internet Gateway Device Data Model for TR-069</i>            | Broadband Forum | 2008 |
| [4] | TR-106<br>Amendment 3    | <i>Data Model Template for TR-069 Enabled Devices</i>           | Broadband Forum | 2009 |

## 2.3 Definitions

The following terminology is used throughout this Technical Report.

|                           |  |
|---------------------------|--|
| ACS                       | Auto-Configuration Server; component in the broadband network responsible for auto-configuration and management of devices.  |
| Association               | A logical link between two objects, e.g. between a subscriber and a device or between a file and a device.   |
| BSS                       | Business Support System(s); this is one kind of an NBI client.   |
| Device                    | Customer Premises Equipment; refers to any TR-069-enabled device and therefore covers both Internet Gateways and LAN-side end devices.   |
| Device Group              | The ACS uses the Device Group concept to reference a set of devices that share something in common. Device Group membership is based on data discovered from the device, data pre-provisioned via NBI or data derived from lookups in external systems.      |
| Device Record             | The information that the ACS stores about a device.  |
| NBI                       | Northbound Interface; this Technical Report specifies requirements for a standard NBI between OSS/BSS and the ACS; there may be other, non-standard, NBI between the same or other OSS/BSS and the ACS.  |
| Next Contact              | The next time at which a device will contact the ACS due to any trigger such as periodic/scheduled Inform, reboot, active notification or connection request from ACS.   |
| Operation                 | Method exposed by the NBI to enable interaction with one or more devices.  |
| OSS                       | Operational Support System(s); this is one kind of an NBI client.  |
| Service                   | A collection of settings, firmware and/or software versions applied to a device to enable the delivery of some business functionality as defined by the operator.  |
| Subscriber ID             | A unique value that is chosen by the OSS/BSS system to be able to group devices to a subscriber. This is an opaque string to the ACS and represents a billing entity rather than individual users within a subscriber's household.                           |
| Vendor Specific Operation | Vendor-specific device operations are those operations supported by a particular device that are not defined by TR-069 Amendment 2 and adhere to the naming conventions for vendor-specific CWMP methods as dictated by Appendix A.3.1.1/TR-069 Amendment 2. |

### **3 Technical Report Impact**

#### **3.1 Energy Efficiency**

TR-131 has no impact on energy efficiency.

#### **3.2 IPv6**

TR-131 has no impact on IPv6 support and compatibility.

#### **3.3 Security**

There are no relevant security issues relating to TR-131.

## 4 NBI Use Cases

The following NBI use cases are provided to help in the understanding of how the ACS provided NBI can be used. It is not necessarily assumed that each use case will generate a set of requirements for the standardized NBI.

### 4.1 Initial Device Provisioning

In this use case, a subscriber installs a device and connects it to the network for the first time. When the device is provisioned, the ACS will notify all registered OSS/BSS informing them that a particular device has been provisioned.

Before the device contacts the ACS, the OSS/BSS may add devices to the ACS data store by adding device identifiers connected to the initial desired configuration. This use case calls for the ACS to configure or re-configure the device upon bootstrap, which may involve upgrading the device firmware as well as configuring various parameters.

In addition to adding device information to the ACS, there also needs to be a clean-up feature to be able to remove unused devices.

The device management functionality can also be used by an inventory system.

#### 4.1.1 Pre-registered Device and Unregistered Subscriber

In this use case, the subscriber installs the device before registering for service with the service provider. The ACS is pre-provisioned with sufficient data to be able to authenticate the device when it appears on the network and provide it with basic configuration. In one example usage, this basic configuration may configure the device for limited service that enables the subscriber to register for fuller service. Once the subscriber registers for service, the ACS is updated by the OSS/BSS with sufficient information to re-configure the device for the appropriate service(s).

#### 4.1.2 Pre-registered Device and Pre-Registered Subscriber

In this use case, the subscriber registers for service before the device is installed. The ACS is pre-provisioned with sufficient data to be able to authenticate the device and configure it for a given service. The configuration of the device may involve upgrading device firmware as well as configuring various parameters.

### 4.2 Subscription to New Service

In this use case, a subscriber who has previously installed and configured their device subscribes to a new service. In this scenario, it is assumed that an order management or other OSS/BSS has already validated the subscriber's access to the particular service. The OSS/BSS may use the ACS to determine the device's capability to support the new service.

The OSS/BSS then instructs the ACS to execute any required changes that enable that service for the device. The ACS may change the device configuration parameters, upgrade firmware, or install new software as appropriate. It then reports the results of the operation to the OSS/BSS.

### **4.3 Firmware/Software Management**

This use case covers a couple of different firmware/software management use cases. These use cases apply to managing any software or firmware images on the device.

#### **4.3.1 Pass-Through Firmware Management**

In this use case the ACS functions as a pass-through proxy to force an upgrade of a particular device's firmware. This enables OSS/BSS to take direct control over firmware management as opposed to delegating such responsibilities to the ACS.

#### **4.3.2 Firmware Reporting**

In this use case, the OSS/BSS needs to determine the firmware currently used by a given device. The OSS/BSS contacts the ACS, which can query the device for its current firmware version.

#### **4.3.3 Pass-Through Software Management**

In this use case the ACS functions as a pass-through proxy to perform software management of a particular device's modular software. This enables OSS/BSS to take direct control over software management as opposed to delegating such responsibilities to the ACS.

#### **4.3.4 Software Reporting**

In this use case, the OSS/BSS needs to determine the software currently used by a given device. The OSS/BSS contacts the ACS, which can query the device for its currently installed software.

### **4.4 Device and Service Diagnostics**

In this use case, a subscriber has some problem with their service and contacts the service provider's help desk to diagnose and repair the issue.

Upon the subscriber reaching the help desk, the operator identifies the customer's Subscriber ID. The tech support OSS/BSS then retrieves a list of devices stored in the ACS for this Subscriber ID. The OSS/BSS then retrieves information about each or a particular device from the ACS. This information may include data pre-provisioned into the ACS, data discovered from the device during prior interaction and stored by the ACS, and real-time data retrieved from the device if it is reachable. Additionally, the OSS/BSS may instruct the ACS to execute diagnostics tests supported by both the ACS and the device, and report the results. The ACS might support diagnostics tests that operate on more than one device, e.g. on all of a subscriber's devices.

Using these results the OSS/BSS determines the root cause of the fault and any repairs to be executed on the device or whether the problem is due to some other issue (e.g. subscriber account fault, network problem). If the problem requires changes to the device, the ACS makes the necessary changes, validates the new settings, and reports the results to the OSS/BSS. The OSS/BSS then validates that the subscriber problem has been solved.

### **4.5 Device Management**

In this use case, the service provider wants to manage various aspects of the service provided by the device and uses the ACS to assist in collecting the necessary information. The ACS assists the OSS/BSS in collecting any of the following information from the devices:

- Performance and error statistics reported by the device
- Device log files
- Results of running diagnostics tests
- Device parameters configured by the LAN-side protocols
- Any other data exposed in the device parameter model

The OSS/BSS may request that the data be retrieved from a given device in real-time if the device is reachable or it may request that the data be retrieved upon the next connection established by the device.

The ACS also enables the OSS/BSS to register for and receive any notifications supported by the device.

Finally, the ACS exposes to the OSS/BSS any data that has been pre-provisioned into the ACS as well as any data that the ACS discovered from the device and stored in its database.

#### **4.6 Replacement of a Device**

In this use case, a subscriber needs to return a faulty device to the service provider. The replacement device that is provided to the customer may be the same or a different model produced by the same or different manufacturer. The ACS is updated with the information about the new device. The ACS then configures the new device as in the initial installation use case. In a more advanced version of this use case, the user-modified settings stored on the device are automatically restored on the new device to the extent possible given the new device's capabilities.



## 5 Key Concepts

This section provides non-normative description of key NBI concepts.

The NBI provides the means for OSS/BSS entities to interact with devices under an ACS's management purview. NBI clients may learn device state, configure and troubleshoot it in order to enable services or satisfy management policies.

### 5.1 Device Groups

Because an ACS manages millions of devices, service providers are likely to wish to manage groups of devices in many scenarios rather than attempt to configure and monitor each device individually.

Device groups can be based on search criteria, which might use information discovered from the device itself. Some of this information might be static, such as make and model or device capabilities, or it might be dynamic information such as firmware version or enabled interfaces. Grouping can also use other information associated with the device, such as subscriber information.

Device groups can also consist of named collections of devices, for example a group of all devices within a specific geographic location, or devices identified as requiring enhanced monitoring. The methods by which these named groups are created or maintained is implementation specific, although the NBI provides a means to discover the available named groups as well as a way to associate a device to a group and dissociate a device from a group.

Note: This Technical Report does NOT attempt to standardize the mechanisms for defining, adding and removing device groups via the NBI. This task is best accomplished via specialized UIs provided by the ACS, which provides a key point of differentiation for ACS vendors.

### 5.2 Device Operations

Device operations allow any number of OSS/BSS to instruct the ACS to perform operations on the device.

Device operations are designed to mimic the RPCs supported by CWMP. These operations allow OSS/BSS to retrieve data from the device, reboot it, set parameters, etc.

Device operations may be targeted at a single device or at any of the types of device groups.

### 5.3 Device Connectivity

In order to execute CWMP operations against the device, the ACS must have connectivity with the device. TR-069 [2] describes multiple options for establishing the CWMP session.

If the device is reachable by the ACS, the ACS may issue a connection request to the device causing it to contact the ACS. The device, however, may not be reachable from the ACS if it is behind a NAT-enabled device, does not have an active connection or is simply not powered up.

In these situations, the ACS has to rely on the device establishing a connection on its own (or, even when the device is contactable, the ACS may choose to wait for the device to contact it). The device may establish a connection based on a variety of events such as reboot, notification, scheduled periodic contact, etc.

In order to support these situations, the NBI contains concepts both of timeliness of the operations and time span of the operations. Timeliness refers to allowing the NBI client to specify whether the ACS should wait for the device's connection trigger, contact the device to establish a connection immediately, or arrange for a connection to be established at some time in the future, e.g. so that an operation will take place within a maintenance window determined by the NBI client. Time span refers to the length of time it takes to reach the device, set up a session, perform the desired actions, validate their success, and report back results to the NBI client. These device connection issues affect operations, responses, errors, and session timeouts throughout the NBI.

## 6 Interface Requirements

This section contains the normative requirements of the NBI as guided by the use cases and key concepts described above.

### 6.1 Architecture (A)

| Identifier | Requirement  |
|------------|--|
| A 1        | The NBI MUST accommodate transactional updates of the ACS data store. This means that all data store updates MUST be done atomically, in an all-or-nothing fashion, for a single NBI method call.  |
| A 2        | The NBI MUST enable the NBI client to issue an NBI operation that can lead to multiple Device Operations.  |
| A 3        | The NBI MUST document the exact transaction isolation between different operations. For example, whether or not large queries lock data. Note: this is not a run-time requirement.   |
| A 4        | Device operations MUST be designed to provide support for the full functionality of the underlying TR-069 [2] mechanisms. For example, this means that the all-or-nothing property of SetParameterValues also applies to NBI device operations. Note, though, that this all-or-nothing property applies only to a single device and, as within TR-069 [2], within the context of a single RPC; if operations are requested against multiple devices, they may succeed in one device and fail in other devices. |
| A 5        | The NBI MUST define mechanisms to support triggering immediate updates to device configuration (when the device is available) as well as updates on device next contact. This addresses the environments in which the device cannot be contacted on demand.  |
| A 6        | The NBI MUST provide a transport binding which is based on standard technology with widely available tooling and which is programming language- and platform-neutral.  |
| A 7        | The NBI MUST provide support for standards-based security. This includes authentication of both Server and Client, authorization, link security so that it can be verified that the content has been sent from the appropriate sender and was not modified while in transit. Information should also be confidential (encryption).   |

| Identifier | Requirement   |
|------------|---|
| A 8        | <p>The NBI MUST support both Point-to-Point and Publish/Subscribe notification mechanisms.</p> <p>A Point-to-Point notification mechanism uses a direct connection between each client and the server. A Publish/Subscribe mechanism allows the server to publish messages and each client can subscribe to the messages that it is interested in.</p>  |
| A 9        | <p>All NBI functions that act upon a specific device MUST use a unique device identifier to address the device. This identifier MUST be unique across all devices (under ACS management) of all vendors.</p>  |
| A 10       | <p>The NBI MUST be machine-readable, i.e. it MUST be possible for NBI clients to determine which NBI functions are implemented by the ACS, and details of their arguments and returned values.</p>  |
| A 11       | <p>The NBI MUST maintain a version number that contains both a major and minor version. The NBI MUST maintain backwards compatibility between different minor versions, except in the rare cases of known problems (errata) which MAY be corrected through a non-backwards compatible minor version. Backwards compatibility is achieved by only allowing the addition of new NBI functions and not altering or removing existing NBI functions. In the case that the NBI is changed, the current version of the NBI SHOULD be discoverable via the NBI itself.</p> |
| A 12       | <p>The NBI SHOULD scale to returning millions of records in various searching and enumeration calls. The NBI MUST gracefully fail in the situations in which a particular call leads to the return of more records than the NBI can provide.</p>  |

## 6.2 Device Data Pre-Provisioning (DDPP)

| Identifier | Requirement   |
|------------|---|
| DDPP 1     | The NBI MUST provide a primary unique identifier for each device, which includes: <ul style="list-style-type: none"><li>* Serial number</li><li>* Manufacturer OUI</li><li>* Product class (could be an empty string)</li></ul> |
| DDPP 2     | The NBI MUST provide a mechanism to add a device record to the ACS data store.  |
| DDPP 3     | The NBI MUST provide a mechanism to manipulate (add, modify, retrieve, and delete) device data that has been provisioned into the ACS related to a specific device record.  |
| DDPP 4     | The NBI MUST allow the assignment of pre-provisioned data to a specific device by using its unique identifier.  |
| DDPP5      | The NBI MUST provide a mechanism to remove a device record from the ACS data store.   |

### 6.3 Subscriber to Device Association (SDA)

| Identifier | Requirement  |
|------------|--|
| SDA 1      | <p>The NBI MUST provide a mechanism to associate a Subscriber ID with one or more devices. A device's association MUST NOT span more than one Subscriber ID.</p> <p>The NBI MAY provide a mechanism to add a Subscriber ID without an association to a device.</p> |
| SDA 2      | The NBI MUST provide a mechanism to dissociate a Subscriber ID from a device.  |
| SDA 3      | The NBI MUST provide a mechanism for returning the Subscriber ID for a given device identifier.  |
| SDA 4      | The NBI MUST provide a mechanism for returning a list of device identifiers for all devices that are associated with a particular Subscriber ID.   |
| SDA 5      | The NBI MUST provide a mechanism to return a list of all Subscriber IDs.   |
| SDA 6      | The NBI MUST support the use of search filters/constraints when searching for a list of Subscriber IDs.  |

#### 6.4 Device Data Retrieval (DDR)

| Identifier | Requirement  |
|------------|--|
| DDR 1      | The NBI MUST be able to differentiate between live device data and cached data from the ACS data store.  |
| DDR 2      | The NBI MUST allow the retrieval of live device state for parameters and objects, that is names, current values, and attribute settings.   |
| DDR 3      | The NBI MUST support the retrieval of data previously discovered from the device through device/ACS interactions and saved within the ACS data store. The type and quantity of data stored within the ACS is a matter of ACS implementation and Service Provider policy. |
| DDR 4      | The NBI MUST allow the retrieval of all device identifiers.  |
| DDR 5      | The NBI MUST support the use of search filters/constraints when searching for a list of device identifiers.  |

## 6.5 Device Operations (DO)

| Identifier | Requirement  |
|------------|--|
| DO 1       | The NBI MUST allow the retrieval of TR-069 [2] device operations supported by the ACS.   |
| DO 2       | The NBI MUST support delegating device operations to the NBI client. The NBI MUST support delegating the REQUIRED CPE methods as defined in TR-069 [2]. The NBI MAY support delegating the OPTIONAL CPE methods as defined in TR-069 [2].  |
| DO 3       | The NBI MAY support delegating vendor-specific device operations.  |
| DO 4       | The NBI MUST support making the results of individual device operations available upon completion. Note: this is not a synchronous requirement.  |
| DO 5       | The NBI MUST support the execution of device operations (both those defined in TR-069 [2] and vendor-defined RPCs) on an individual or group of devices governed by the execution criteria.  |
| DO 6       | The NBI MUST support making available the results of group device operations. Available results MUST include the overall success/failure for the group, individual device status, and any errors.  |
| DO 7       | Execution criteria determine when a device operation will be executed. Execution criteria MAY include <ul style="list-style-type: none"> <li>• When to execute: <ul style="list-style-type: none"> <li>○ Immediate execution</li> <li>○ Execution on "next device contact"</li> <li>○ Day/time window execution</li> </ul> </li> <li>• Retry policy</li> <li>• Time out</li> </ul> |
| DO 8       | The NBI MUST allow the retrieval of all pending (not started) and running device operations for a specified device   |
| DO 9       | The NBI MUST allow the retrieval of pending (not started) and running operations for a group of devices  |
| DO 10      | The NBI MUST allow the retrieval of the status (at a summary level) of all pending (not started) and running individual and group device operations  |



| Identifier | Requirement   |
|------------|---|
| DO 11      | <p>The NBI MUST allow the removal of all pending (not started) individual and group device operations.</p> <p>Note: Only scheduled operations that have not been started are allowed to be removed.</p>                     |
| DO 12      | <p>The NBI MUST allow the removal of a specified pending (not started operation) device operation from a specified device.</p> <p>Note: Only scheduled operations that have not been started are allowed to be removed.</p> |
| DO 13      | <p>The NBI MUST allow the removal of a specified pending (not started) device operation from a specified group of devices.</p> <p>Note: Only scheduled operations that have not been started are allowed to be removed.</p> |

## 6.6 File Management (FM)

| Identifier | Requirement  |
|------------|--|
| FM 1       | The NBI MUST provide a mechanism to manage device files using device pass-through operations corresponding to Download and Upload RPCs (this is really just a subset of DO2 as these 2 RPCs are already covered with that requirement). Files could be based on the File Types as defined in Section A.3.2.8 Download and Section A.4.1.5 Upload of TR-069 [2].  |
| FM 2       | The NBI MUST provide an optional mechanism to add files to the ACS. A file consists of metadata (e.g., manufacturer, model, type, file description, version, owner, link to file location) and optionally, file contents.  |
| FM 3       | The NBI MUST provide an optional mechanism for scheduling (might be immediate) the association of a file of any file type with a specified device or group of devices with the same triggering requirements as those outlined in DO7. An association means that it becomes a relation between the device and the file, the file will eventually be downloaded to the device.                                   |
| FM 4       | The NBI MUST provide an optional mechanism for deleting files from the ACS. A file consists of metadata (e.g., manufacturer, model, type, file description, version, owner, link to file location) and, optionally, file contents. Only files that have no associations can be removed.  |
| FM 5       | The NBI MUST provide an optional mechanism for updating files in the ACS. A file consists of metadata (e.g., manufacturer, model, type, file description, version, owner, link to file location) and, optionally, file contents. It is the responsibility of the NBI client to ensure that file metadata and contents are in sync.   |
| FM 6       | The NBI MUST provide an optional mechanism for searching files in the ACS. A file consists of metadata (e.g. manufacturer, model, type, file description, version owner, link to file location) and, optionally, file contents. Searching can, for instance, be based on which files are associated to a given device, or which files are associated to a given device type, as well as other similar queries. |

| Identifier | Requirement  |
|------------|--|
| FM 7       | The NBI MUST provide an optional mechanism for retrieving files in the ACS. A file consists of metadata (e.g., manufacturer, model, type, file description, version, owner, link to file location) and, optionally, file contents. |

### 6.7 Events (E)

| Identifier | Requirement  |
|------------|--|
| E 1        | The NBI MUST provide a mechanism for northbound clients to subscribe to events.  |
| E 2        | The NBI MUST provide a list of events for which a northbound client can subscribe  |
| E 3        | The NBI MUST provide a mechanism for northbound clients to unsubscribe from events.  |
| E 4        | The NBI MUST provide a list of any event filters that it supports  |
| E 5        | The NBI MUST provide an event delivery mechanism.  |
| E 6        | The minimum set of events to be included in the event delivery filters MUST include: <ol style="list-style-type: none"> <li>1. CWMP event code</li> <li>2. Specific parameters changing value</li> <li>3. By device</li> <li>4. By any combination of the above</li> </ol> |

## 6.8 Device Grouping (DG)

| Identifier | Requirement   |
|------------|---|
| DG 1       | The NBI MUST provide a mechanism to enable northbound systems to perform operations on collections of CPE.  |
| DG 2       | The NBI MUST allow for the targeting of groups of devices based on search criteria.   |
| DG 3       | The NBI MUST support the use of search filters/constraints when searching for groups, returning a list of currently available group names and the name of any required input arguments. |
| DG 4       | The NBI MUST enable operations to be performed on a named group of CPEs.  |
| DG 5       | The NBI is NOT REQUIRED to provide a mechanism to create, update (except for group membership), or delete groups.   |
| DG 6       | The NBI MUST provide a mechanism to get a list of all device identifiers that are members of a given named group.   |
| DG 7       | The NBI MUST provide a mechanism to manage the membership of named groups.  |
| DG 8       | The NBI MUST provide a mechanism to remove a device from a named group, but only if the group is not constrained by search criteria.  |
| DG 9       | The NBI MUST provide the list of groups to which a specific device is a member of.  |
| DG 10      | The NBI MUST provide an optional mechanism to change a device from one named group to another named group.  |

## 6.9 Error Management (EM)

| Identifier | Requirement  |
|------------|--|
| EM 1       | The NBI MUST support returning an error result when an NBI client makes a request with an invalid function, or invalid parameters. |

End of Broadband Forum Technical Report TR-131