BROCHURE

Lumen Technologies guide to the LEVEL3 Internet Routing Registry

Updated April 2021

LUMEN® TECHNOLOGIES

Introduction

This document is a reference guide to the Lumen Technologies-operated, *LEVEL3 Internet Routing Registry* (LEVEL3 IRR). Level 3 Communications was acquired by CenturyLink in November 2017, and in September 2020 CenturyLink renamed itself to Lumen Technologies. Despite the above listed merger and acquisition history, the "LEVEL3" name for the Internet Routing Registry (IRR) has remained due to the globally connected nature of the network and impracticality of changing it.

This guide helps to document the contents and interfaces that are publicly available to the LEVEL3 IRR as operated by Lumen Technologies. Throughout the guide, any reference to "Level3 Internet Route Registry" will be abbreviated as "LEVEL3 IRR". And any reference to Internet Routing Registries in general (not specific to the LEVEL 3 IRR) will be abbreviated as "IRR".

This guide is not intended as a complete review of internet routing registries' use or the syntax employed in the objects of a registry. Instead, it presents an overview of registry objects as used for Lumen's BGP peering purposes and provides basic information on how to register these objects. See the links below under Further Reading to learn more about Internet Routing Registries. This guide is not intended as a complete review of routing registry use or object syntax. Instead, it presents an overview of registry objects as used by Lumen for BGP peering purposes and provides basic information on how to register these objects. Interested readers may wish to review Routing Policy Specification Language (RFC 2622, http://www.ietf.org/rfc/rfc2622.txt) and Using RPSL in Practice (RFC 2650, http://www.ietf.org/rfc/rfc2650.txt).

Further Reading

Overview of the IRR: http://www.irr.net/docs/overview.html

Routing Policy Specification Language (RPSL): http://www.irr.net/docs/rpsl.html

Internet Routing Registry

Customers who wish to advertise routing information to Lumen's ASN 3356 via BGP must register that information with a routing registry. Our systems will build automated filters based on the IRR objects containing that information and will apply these filters to the customer peering session. These filters will be updated daily as IRR information changes.

Customers may register routes in the LEVEL3 IRR operated by Lumen or in any other registry that we mirror. As of January 2021, the below table indicates the IRR's that Lumen mirrors:

AFRINIC	ALTDB	APNIC	ARIN	ARIN-	BBOI
BELL	CANARIE	HOST	IDNIC	JPIRR	LACNIC
NESTEGG	NTTCOM	OPENFACE	PANIX	RADB	REACH
RGNET	RIPE	RIPE-	TC		

Other registries may be supported in the future based on customer requests and technical feasibility. Mirroring of any registry may be discontinued if ongoing technical difficulties cannot be resolved. Lumen's mirroring process of these registries is initiated daily at 20:40 UTC.

The first step to register routes in a registry is to create a maintainer object and its subordinate person and/or role objects. The person and/or role objects contain administrative and technical contact information. A maintainer object links that contact information with security information to control/protect other registry objects. Since maintainer objects contain security information, they can only be created by Lumen personnel. Other object types may generally be created and/or maintained by anyone with proper credentials as specified in the maintainer object to do so. The methods for doing so are discussed later in this document. In addition to maintainer, person and role objects, Lumen BGP filters make use of route, route6 (IPv6 route), route-set, and as-set objects.

The *import policy*, that is, the policy that describes the filter Lumen implements to control the BGP route-advertisements on customer facing routers, is made up of references to IRR objects. There is a separate import policy for each customer connection on these Lumen edge routers. Those references may be direct, that is, explicitly naming a route-set or an as-set; or they may be indirect, that is, specifying an ASN which indicates a reference to all route (or route6) objects whose origin ASN is the one specified. Import policies are specified by the customer at the time of connection creation and may be changed by contacting the Lumen NOC or TSC representatives. See the section below on *Import Policy.*

Internet Route Registry Objects

RPSL defines object classes. The table below is broken out into those RPSL classes that are utilized by Lumen (left-hand column) which will be discussed later in this document. The right-hand column of the below table is for those Object classes that are not utilized by Lumen in BGP route filtering. Please see RFC 2622 for additional information regarding these objects.

Utilized by Lumen in BGP Route Filtering	Not Utilized by Lumen in BGP Route Filtering
maintainer (mntner)	rtr-set
person	filter
role	filter-set
route	peering-set
route6	aut-num
route-set	
as-set	

Each of these object classes have attributes. The following attributes are common to all IRR object classes:

Attribute and Type	Definition
descr [mandatory] [single]	A free-form, clear-text description of this maintainer object.
admin-c [optional] [multiple]	The business or administrative contact. This attribute should contain the NIC-handle of a *person* or *role* object contained in this routing registry. Multiple lines may be used to specify multiple contacts.
tech-c [mandatory] [multiple]	The contact for technical problems (e.g. incorrect configuration). This attribute should contain the NIC-handle of a *person* or *role* object contained in this routing registry. Multiple lines may be used to specify multiple contacts.
remarks [optional] [multiple]	A free-form clear-text explanation or description. Multiple lines may be used to accommodate extended remarks.
notify [optional] [multiple]	An e-mail address to which notifications of a change or deletion of this maintainer object are sent. The use of role email addresses is recommended. Multiple lines may be used to specify multiple e-mail addresses.

mnt-by **[mandatory]** **[multiple]**	A registered maintainer object name from this IRR.
changed **[mandatory]** **[multiple]**	An email address and a date used to identify the creator or each subsequent modifier of an object and the date the creation or modification occurred (e.g. "jqpublic@ispx.tld yyyymmdd"). *Role* email addresses should not be used as they are less easily tied to the individual making the change. The convention is to add a new *changed* line for each modification, leaving previous *changed* lines as an audit trail (user's discretion). Use the current date in the format: yyyymmdd (no spaces, dashes, or slashes).
Source **[mandatory]** **[single]**	Always set to **LEVEL3** in the LEVEL3 IRR

The objects utilized by Lumen in BGP route filtering are described in the following sections.

Maintainer Object

Maintainer objects specify the authorization required to make updates to objects in a given registry. Since all other objects in a registry will reference a maintainer object in that same registry, the maintainer object must be created first. Maintainer objects are generally created via manual intervention on the part of the registry owner. If you choose or need to use the LEVEL3 IRR, your provisioning team will create a maintainer for you from the information you provide in the BGP Questionnaire. Other registries have their own procedures, which are not outlined in this document.

Maintainer objects also generally contain technical and administrative contact information, which often reference person objects.

The table below contains the maintainer object attributes, attribute types, and definitions. Some attributes allow you to supply multiple values.

Attribute and Type	Definition
mntner **[mandatory]** **[single]**	A unique name that identifies the object. A customer may have multiple maintainer objects, each with different attributes. The maintainer object describes which entities can create, delete, and update other objects. This object is referenced by all other registry objects for the customer needing the same security. The maintainer object naming convention is to use the company name or an abbreviation followed by **-MNT**. For example, a Lumen maintainer object might be named **LUMEN-MNT**.
upd-to **[mandatory]** **[multiple]**	An e-mail address to which notification of an unauthorized attempt to add, change, or delete an object keyed to this maintainer is sent. A role account (e.g. "rradmin@ispx.tld") is preferred. Multiple lines may be used to specify multiple e-mail addresses.
mnt-nfy **[optional]** **[multiple]**	This field is an e-mail address to which notification of a successful attempt to add, change or delete an object keyed to this maintainer should be sent. A role account (e.g. "rradmin@ispx.tld") is preferred. Multiple lines may be used to specify multiple e-mail
auth **[mandatory]** **[multiple]**	This field specifies the scheme for authenticating update requests to objects keyed to this maintainer. Currently, the LEVEL3 IRR supports either the *CRYPT PW* or *MAILFROM* authentication methods. CRYPT-PW is more secure and is preferred. When multiple "auth" lines are specified, any one of the authentication methods maybe be used.

Auth examples:

auth: MAIL-FROM rradmin@ispx.tld

Emails with a *From* address of "rradmin@ispx.tld will be allowed.

auth: MAIL-FROM .*@ispx.tld

Emails with any *From* address at ispx.tld will be allowed, (eg: max@ispx.tld, abc@ispx.tld, etc).

From addresses are easily spoofed, so the use of *CRYPT PW* authentication is recommended. When *CRYPT PW* is specified with an encrypted password in a maintainer object, attempts to add, delete, or change an object referencing the maintainer object may be authenticated by use of the un-encrypted password. Lumen can help users generate an encrypted password string matching a customer-specified plain-text password for customers who do not have access to software that can generate these strings.

Here is a sample maintainer object:

```
mntner:     FOO-MNT
descr:      LEVEL3 maintainer for Foo, Inc.
admin-c:    JC1-LEVEL3
tech-c:     NC5-LEVEL3
upd-to:     noc@foo.tld
mnt-nfy:    noc@foo.tlddummy
auth:       CRYPT-PW g5kCkiHFBMVl2
remarks:    The moon is yellow tonight.
notify:     noc@foo.tld
mnt-by:     FOO-MNT
changed:    somebody@foo.tld 20010522
source:     LEVEL3
```

If you have forgotten your password referenced in the CRYPT-PW authentication or cannot send email with the proper return address for MAIL-FROM authentication you will need to contact Lumen at 877-453-8353.

Person Object

Objects such as the maintainer object contain admin-c or tech-c fields which often reference other objects (by NIC-handle) with contact information. These can be person objects for individuals, or role objects for groups of individuals who jointly perform a function. The table below contains the person object attributes, attribute types, and definitions.

Attribute and Type	Definition
person [mandatory] [single]	The name of the individual.
address [mandatory] [multiple]	The full address of the individual or organization. Multiple lines may be used to specify multi-line addresses.
phone [mandatory] [multiple]	The individual's phone number. The desired phone number format is: +country_code city subscriber [ext. extension]. A U.S.A phone number would look like this: +1 123 456 7890 ext. 123 Multiple lines may be used to specify multiple phone numbers.
fax-no [optional] [multiple]	The individual's fax number (e.g. +1 123 456 7890).
e-mail [optional] [multiple]	The e-mail address for the individual. Multiple lines may be used to specify multiple e-mail addresses.

nic-hdl [optional] [single]	This is a unique "handle" in the format first_initial last_initial digits routing_registry (e.g. "JC1-LEVEL3"), where the digits start at 1 and increment if a conflict is found. You can identify an available nic-hdl by querying the registry to see if the desired handle is taken, or an inquiry can be sent to the LEVEL3 IRR administrators to find an available handle.

Here is a sample person object corresponding to the sample maintainer object shown in the previous section:

```
person:     Joe College
address:    Foo, Inc.
address:    1 Foo Dr
address:    Fooville AK 87654
phone:      +1 800 123 4567
e-mail:     noc@foo.tld
nic-hdl:    JC1-LEVEL3
remarks:    Good man in a storm.
notify:     noc@foo.tld
mnt-by:     FOO-MNT
changed:    somebody@foo.tld 20010522
source:     LEVEL3
```

Role Object

The role object is similar to the person object. However, instead of describing a human being, it describes a role performed by one or more human beings. Examples include help desks, network operations centers, systems administrators, etc. Role objects are particularly useful since often the person performing a role may change, but the role itself remains. The table below contains the role object attributes, attribute types, and definitions.

Attribute and Type	Definition
role [mandatory] [single]	A name or description of the role account.
address [mandatory] [multiple]	The full address of the role or organization. Multiple lines may be used to specify multi-line addresses.
phone [mandatory] [multiple]	The role's phone number. The desired phone number format is: +country-code city subscriber [ext. extension]. A U.S.A. phone number would look like:+1 123 456 7890 ext. 123. Multiple lines may be used to specify multiple phone numbers.
fax-no [optional] [multiple]	The role's fax number (e.g. +1 123 456 7890).
e-mail [optional] [multiple]	The e-mail address for the role account. Multiple lines may be used to specify multiple e-mail addresses.
trouble [optional] [multiple]	Additional contact information to be used when a problem arises with any object referencing this role object. Multiple lines may be used to specify multiple contacts.
nic-hdl [optional] [single]	This is a unique "handle" in the format XX digits- routing registry (e.g. "HD1- LEVEL3"), where the digits start at 1 and increment if a conflict is found. You can identify an available nic-hdl by querying the registry to see if the desired handle is taken, or an inquiry can be sent to the LEVEL3 IRR administrators to find an available handle.

Here is a sample role object corresponding to the sample maintainer object:

```
role:       Foo, Inc. Network Operations Center
address:    Foo, Inc.
address:    1 Foo Dr
address:    Fooville AK 87654
phone:      +1 234 567 8901
e-mail:     noc@foo.tld
nic-hdl:          NC5-LEVEL3
admin-c:    JC1-LEVEL3
tech-c:     NC5-LEVEL3
remarks:    Fooville Ops.
notify:     noc@foo.tld
mnt-by:     FOO-MNT
changed:    somebody@foo.tld 20010522
source:     LEVEL3
```

Route-Set Object

The most straightforward and simple method to maintain a list of routes is to use a route-set object. It is suggested customers use a route-set object to register their routes, unless they are particularly comfortable with the various other means of registering routes or have some other compelling reason to use them.

The route-set object defines a set of routes. The route-set attribute is the name of the set and is an RPSL name beginning with "RS-." The members and mp-members attributes provide a list of address prefixes or other route names.

The table below shows route-set object attributes, attribute types, and definitions.

Attribute and	Definition
route-set* [mandatory] [single]	A unique name beginning with "RS-".
members* [optional] [multiple	A comma-separated list of routes in the format address/prefix-length and/or route-set object names.
mp-members* [optional] [multiple	A comma-separated list of IPv6 routes in the format address/prefix-length and/or route-set object names.
mbrs-by-ref* [optional] [multiple	A list of maintainer names or the keyword "ANY". If this attribute is used, the route-set will include route objects which are keyed to one of these maintainers, and whose member-of attribute refers to this route-set object. If the value of a mbrsby- ref attribute is ANY, any route object referring to this route-set is a member. If the mbrs-by-ref attribute is missing, only the routes listed in the members attribute will be part of the route-set. This is not a commonly used attribute and can be safely ignored by most users.

* attributes which are used by the automated BGP filter generation system.

Here is a sample route-set object:

```
route-set:      RS-FOO
descr:          Routes announced to Lumen by Foo, Inc.
members:        10.1.2.0/24, 172.16.0.0/16
members:        192.168.4.128/25
mp-members:     FC00:0::/32
remarks:        Checked and double-checked.
```

admin-c: JC1-LEVEL3
tech-c: NC5-LEVEL3
notify: noc@foo.tld
mnt-by: FOO-MNT
changed: somebody@foo.tld 20010522
source: LEVEL3

A customer using a route-set object like the one above to maintain their list of advertised routes would simply ask Lumen to use an import policy of "LEVEL3::RS-FOO" to build their filter.

Route Object

Another method of maintaining a list of routes is to use route objects. Unlike route-set objects, which define multiple routes, a route object defines one and only one IPv4 route. Multiple route objects are indicated as a group by specifying a particular routing registry and origin AS (e.g. "LEVEL3::AS65000"). The specified registry is searched for all route objects matching the specified origin AS, and those routes are used to build the filter.

The table below contains the route object attributes, attribute types, and definitions.

Attribute and Type	Definition
route* [mandatory] [single]	The route in address/prefix-length format.
origin* [mandatory] [single]	The AS announcing (or "originating") the route into the Internet. The format is ASASN (e.g. "AS65000").
holes [optional] [single]	This attribute is rarely used and is primarily informational in nature. See RFC 2622 for details.
member-of* [optional] [single]	This attribute may contain a comma-separated list of route-sets to which this route should belong. Using the member-of attribute is an alternative to explicitly listing routes in the members attribute of the route-set objects. As long as the mbrsby- ref attribute of these route-sets includes the maintainer name listed in the mnt-by attribute of this route object (or the keyword "ANY"), this route is considered to be a member of that route-set. This is not a commonly used attribute and can be safely ignored by most users.
inject [optional] [multiple]	This attribute is rarely used and is primarily informational in nature. See RFC 2622 for details.
components, aggr-bndry, and export-comps	These attributes are rarely used and are primarily informational in nature. See RFC 2622 for details.

* attributes which are used by Lumen's automated BGP filter generation system.

Here are some example route objects:

route: 10.1.2.0/24
descr: Foo, Inc. network 1.
origin: AS65000
mnt-by: FOO-MNT
changed: somebody@foo.tld 20010522
source: LEVEL3

route: 172.16.0.0/16

```
descr:      Foo, Inc. network 2.
origin:     AS65000
mnt-by:     FOO-MNT
changed:    somebody@foo.tld 20010522
source:     LEVEL3

route:      192.168.4.128/25
descr:      Foo, Inc. network 3.
origin:     AS65000
mnt-by:     FOO-MNT
changed:    somebody@foo.tld 20010522
source:     LEVEL3
```

A customer using route objects like the ones above to maintain their list of advertised routes would simply ask Lumen to use an import policy based on the origin attribute of these route objects (e.g. "LEVEL3::AS65000").

Route6 Object

Route6 objects are route objects for IPv6 routes and are otherwise the same as route object. Here is an example:

```
route:      FC00:0::/32
descr:      Foo, Inc. network 3.
origin:     AS57000
mnt-by:     FOO-MNT
changed:    somebody@foo.tld 20010522
source:     LEVEL3
```

AS-Set Object

Customers sometimes have multiple ASNs, or they have their own downstream customers with their own ASNs. In such cases, specifying an export policy is made easier using as-sets.

An as-set object specifies a list of ASNs (or other as-sets). These as-sets are expanded to a list of ASNs, which in turn are used to find corresponding route or route6 objects. The list of routes to be used to build an import filter is obtained by searching the registry for all route objects matching any origin AS in the list derived by expanding the as-sets, and those routes are used to build the filter.

Using as-set objects gives the customer the flexibility and control of maintaining the list of ASNs themselves. Without the use of as-sets, the customer would have to ask Lumen to change the routing policy from which their import filters are built every time they add or delete an ASN. With the use of as-sets the customer can add or delete ASNs at will, and the import filters are built automatically, quickly, and without errors.

The table below contains the as-set object attributes, attribute types, and definitions.

Attribute and Type	Definition
as-set* [mandatory] [single]	A unique name with an "AS-" prefix.
descr [mandatory] [single]	A free-form clear-text description of this as-set object.

members* **[optional]** **[multiple]**	A comma-separated list of ASNs in the format ASASN and/or as-set object names (e.g. "AS65000, AS65001, AS-CDNY").
mbrs-by-ref* **[optional]** **[multiple]**	A list of maintainer names, or the keyword ANY. If this attribute is used, the as-set will include aut-num objects, which are keyed to one of these maintainers, and whose member-of attribute refers to this as-set object. If the value is "ANY" for a mbrs-by-ref attribute, then any aut-num object referring to the as-set is a member. If the mbrs-by-ref attribute is missing, only the ASNs listed in the members attribute will be part of the as-set. This is not a commonly used attribute and can be safely ignored by most users.

* Attributes which are used by Lumen's automated BGP filter generation system.

As an example, assume a customer wants their export policy to include the following route objects:

```
route:      10.1.2.0/24
descr:      Foo, Inc. network 1.
origin:     AS65000
mnt-by:     FOO-MNT
changed:    somebody@foo.tld 20010522
source:     LEVEL3

route:      172.16.0.0/16
descr:      Lectroid, LLC - downstream cust. of Foo, Inc.
origin:     AS65001
mnt-by:      LECTROID-MNT
changed:    somebody@lectroid.tld 20010522
source:     LEVEL3

route:      192.168.4.128/25
descr:      Yoyodyne Industries – downstream customer of Foo, Inc.
origin:     AS65002
mnt-by:     YOYODYNE-MNT
changed:    somebody@yoyodyne.tld 20010522
source:     LEVEL3
```

The customer could create an as-set object resembling this:

```
as-set:     AS-FOO
descr:      Foo, Inc. and downstream customer ASNs.
members:    AS65000, AS65001, AS65002
tech-c:     NC5-LEVEL3
mnt-by:     FOO-MNT
changed:    somebody@foo.tld 20010522
source:     LEVEL3
```

The customer would specify an export policy of "LEVEL3::AS-FOO" in order to reference all of the route objects with these differing origin AS's. As downstream customers come and go, the administrators of Foo, Inc., can simply modify AS-FOO to add or delete their ASNs accordingly.

Cross-Registry Expansion of Set Objects

Some customers wish to register objects in multiple routing registries. For example, a customer may register in one routing registry, but their downstream customers may register in other routing registries. Other customers are global in nature and different semi-autonomous regional organizations may register their routes in different registries.

For example, a company with a presence in the U.S. and Europe may choose to register U.S. routes in the RADB registry, and European routes in the RIPE registry. There is no method defined in the RPSL specification to allow explicit specification of a source registry for objects, so it is impossible to create set objects which reference objects in other registries.

We have implemented semi-private extensions to RPSL route-set and as-set objects to allow for explicit registry specification within these objects. The syntax chosen is like that discussed and proposed as an extension to the standard. However, currently, these extensions remain private.

Within the remarks attribute of route-set and as-set objects, the user may enter one or more lines of text resembling:

remarks: Level3 members: member_list

The remarks version of the members list will take precedence over the normal members list within the route-set or as-set object.

Within this new members list, the user may specify an explicit registry source using the syntax registry_name::object_name. For example:

remarks: Level3 members: RADB::AS-FOO-US, RIPE::AS-FOO-EU

This extension may also be used for the mbrs-by-ref attribute of route-set and as-set objects.

Customers who are registering as-macro objects in RIPE-181- based registries may also override the as-list attribute in this same fashion. (RIPE-181 is the syntactical predecessor of RPSL, and RIPE-181 as-macro objects perform the same basic function as RPSL as-set objects.)

Import Policy

An import policy is used by Lumen to build a filter for BGP advertisements from a peer. This policy is simply a list of origin ASs, as-sets, as-macros (for RIPE-181 registries) and/or route-sets. Any route found in any member of this list will be included in the BGP filter applied to the advertisements of the customer peering session.

This import policy is created during the initial customer design stage of the Internet service based on the information provided during the BGP information gathering process. Updates may be made to the import policy by submitting a BGP Change Request via the Control Center portal.

Lumen hosts a public *whois* server to its filter generation process. Users may query the filter generator specifying their import policy. For example:

whois -h filtergen.level3.com ‘AS-FOO RADB::RS-BAR AS123456’

See the next section ("Querying the Routing Registry") for more details.

Please note that there is special handling of the "remarks" field in as-set and as-macro objects. If an as-set object is found to have remarks field lines containing "Level3 members:" or "Level3 mbrsby-ref:" then those fields will take precedence over any "members" or "mbrs-by-ref" fields in the object. Likewise, if an as-macro object has “remarks” field lines containing "Level3 as-list:" then those fields will take precedence over any "as-list" field in the object. These special case “remarks” fields can be used to denote "source" for the expanded policy components, which are not supported in the general syntax definition of these fields.

Querying the Routing Registry

Users will often need to query the routing registry to look at their registered objects, or to see if a given object

already exists. For example, a user may want to create an as-set object called "AS-MINEALLMINE", but before submitting a request to create this object, the user should first check to see if the name is already in use.

The routing registry has a public whois server to answer object queries:

whois -h rr.level3.com 'AS-MINEALLMINE'

If the there is a "AS-MINEALLMINE" as-set in the LEVEL3 IRR (or any other registry that LUMEN mirrors), that (those) registry object(s) will be returned.

Likewise, the user may query the filter generator by replacing "rr.level3.com" with "filtergen.level3.com":

whois -h filtergen.level3.com "LEVEL3::AS-MINEALLMINE"

The resulting set of prefixes defined by AS-MINEALLMINE and any other referenced objects will be returned. If the user is interested in IPv6 routes, the qualifier "-v6" may be added to the query string to so indicate. There are more qualifier options that are beyond the scope of this document.

Whois clients are available on most versions of Unix. Versions for Windows machines can be downloaded free from the Internet. There are two main flavors of whois clients, each with differing command-line syntax. The "RIPE" style clients use the following syntax:

whois -h server _options query
eg: whois -h rr.level3.net AS-FOO

Another whois client popular on Linux distributions uses this syntax:

whois 'options query@server'
whois 'AS-FOO@rr.level3.net'

Consult the documentation on your server for details.

Submitting Objects to the Routing Registry

Any request to add, change or delete an object must be submitted via e-mail to rpsl@lumen.com. E-mails sent to this address are handled by an automated system which will attempt to authorize and fulfill the request.

E-mail messages should contain the desired objects as outlined in the previous sections. The objects must be submitted as plain ASCII text (i.e. not as a MIME-embedded attachment or as base-64-encoded content, etc.). Some e-mail clients mangle messages in ways transparent to the user, so problems may be encountered even when the user believes they are sending messages in the correct format.

Multiple requests (adds, changes and deletions) may be sent in a single e-mail by separating the objects with one or more blank lines. Entries submitted to rpsl@lumen.com will be checked for syntax, authenticated, and then processed if the syntax check and authorization succeed. A response is always returned to the sender indicating one of three things:

1. The object was successfully added, changed, or deleted.
2. Some small error was fixed, and the object was then successfully added, changed, or deleted.
3. An unfixable error was encountered, and the object has not been added, changed, or deleted.

To learn more about what these response emails will look like, please see below section "Email Response to Object Change Request".

Adding an Object

To create an object, simply review the object description as outlined in the earlier sections of this document. Populate all fields with the desired data, making sure that all mandatory attributes are present. Example:

```
as-set:         AS-FOO
descr:          Foo, Inc. and downstream customer ASNs.
members:        AS65000
mbrs-by-ref:    ANY
tech-c:         NC5-LEVEL3
mnt-by:         FOO-MNT
changed:        somebody@foo.tld 20010522
source:         LEVEL3
```

If the as-set "AS-FOO" does not already exist, then it will be created. If it already exists, it will be modified to reflect the new data.

For CRYPT-PW authentication, the user must add a pseudo-attribute called "password" to each object being added, modified, or deleted in the e-mail message. Example:

```
as-set:         AS-FOO
descr:          Foo, Inc. and downstream customer ASNs.
members:        AS65000
mbrs-by-ref:    ANY
tech-c:         NC5-LEVEL3
mnt-by:         FOO-MNT
changed:        somebody@foo.tld 20010522
source:         LEVEL3
password:       ItsASecret
```

Changing an Object

To change an object, you should first perform a whois query to fetch the current object, and then change the fields as needed. The *changed* line should be modified, or a new *changed* line added, to specify the e-mail address of the person submitting the change and the current date. Example:

```
as-set:         AS-FOO
descr:          FooBar, Inc. and downstream customer ASNs.
members:        AS65001
mbrs-by-ref:    ANY
tech-c:         NC5-LEVEL3
mnt-by:         FOO-MNT
changed:        somebody@foo.tld 20010522
changed:        somebodynew@foobar.tld 20010523
source:         LEVEL3
(remember to add the password field if needed for CRYPT PW authentication)
```

If AS-FOO does not exist, it will be added. If it already exists, it will be modified to reflect the new data.

Deleting an Object

To delete an object, you should first perform a whois query to pull the current object. An attribute called delete should be appended to the object, leaving all other attributes unchanged. The delete attribute should contain your e-mail address. In the following example, the underlined lines are the lines added to the information fetched with the whois query:

```
as-set:         AS-FOO
descr:          Foo, Inc. and downstream customer ASNs.
members:        AS65000
mbrs-by-ref:    ANY
tech-c:         NC5-LEVEL3
mnt-by:         FOO-MNT
changed:        somebody@foo.tld 20010522
source:         LEVEL3
delete:         somebody@foo.tld 20010522
password:       ItsASecret
```

APPENDIX

Email Response to Object Change Requests

Every request to add, change or delete an object that is submitted via e-mail to rpsl@lumen.com will receive a response. Below are examples of these email responses:

When you specify an object that exists, but you specify no changes, you get a response email similar to the below:

> Your update was SUCCESSFUL
>
> > From: joesmith@foo.tld (Joe Smith)
> > Subject:
> > Date: Thu, 04 Feb 2021 14:59:23 -0700
> > Msg-Id: <20210204215924.513A1601CF12@tdhc7.Joe.Smith>
>
> The following objects were processed:
>
> Update **NOOP**: [person] SMITH-LEVEL3 (Joe Smith)

When you specify an object that exists, but you specify it differently than it exists, you get a reply email similar to the below:

> Your update was SUCCESSFUL
>
> > From: Joe Smith <smith@tikasys.com>
> > Subject:
> > Date: Thu, 4 Feb 2021 15:13:07 -0700 (MST)
> > Msg-Id: <20210204221307.33A282140089@anywhere.tetrapyloctomy.org>
>
> The following objects were processed:
>
> Update **OK**: [person] SMITH-LEVEL3 (Joe Smith)

And the address in the notify line of the maintainer gets a message similar to the below:

> Dear Colleague,
>
> This is to notify you that some object(s) in the Level 3 RR database
> which you either maintain or are listed as to-be-notified have
> been added, deleted or changed.
>
> The objects below are the old and new entries for these objects
> in the database. In case of DELETIONS, the deleted object is
> displayed. NOOPs are not reported.
>
> The update causing these changes had the following mail headers:
>
> - From: Joe Smith <smith@tikasys.com>
> - Subject:
> - Date: Thu, 4 Feb 2021 15:13:07 -0700 (MST)
> - Msg-Id: <20210204221307.33A282140089@anywhere.tetrapyloctomy.org>
>
> Level 3 Routing Registry Notification Department
>
> ---
> PREVIOUS OBJECT:
>
> person: Joe Smith
> address: Lumen Technologies
> address: Broomfield, CO

phone:	+1-720-888-1000
e-mail:	joe.smith@lumen.com
nic-hdl:	SMITH-LEVEL3
notify:	joe.smith@lumen.com
mnt-by:	SMITH-MNT
changed:	joe.smith@lumen.com 20190523
source:	LEVEL3

REPLACED BY:

person:	Joe Smith
address:	Lumen Technologies
address:	Broomfield, CO
phone:	+1-720-888-1000
e-mail:	joe.smith@lumen.com
nic-hdl:	SMITH-LEVEL3
notify:	joe.smith@lumen.com
notify:	smith@tikasys.com
mnt-by:	SMITH-MNT
changed:	joe.smith@lumen.com 20190523
changed:	joe.smith@lumen.com 20210204
source:	LEVEL3