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Routing Registry

Customers who wish to advertise routing information to Level 3 via BGP must register into a routing registry the routes they wish Level 3 to accept. Level 3 will build automated filters based on these registrations and will apply these filters to the customer peering session. These filters will be updated periodically as routes are registered or deleted by the customer.

Customers may register routes in the Level 3 routing registry or in any registry mirrored by Level 3. Currently, Level 3 mirrors 32 routing registries:

<table>
<thead>
<tr>
<th>Registry</th>
<th>Registry</th>
<th>Registry</th>
<th>Registry</th>
<th>Registry</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIGITALREALM</td>
<td>REACH</td>
<td>WCGDB</td>
<td>APNIC</td>
<td>ARIN</td>
</tr>
<tr>
<td>BCNET</td>
<td>BBOI</td>
<td>BELL</td>
<td>DERU</td>
<td>LEVEL3</td>
</tr>
<tr>
<td>EASYNET</td>
<td>EPOCH</td>
<td>GT</td>
<td>GW</td>
<td>HOST</td>
</tr>
<tr>
<td>NESTEGG</td>
<td>OPENFACE</td>
<td>OTTIX</td>
<td>PANIX</td>
<td>AOLTW</td>
</tr>
<tr>
<td>NTTCOM</td>
<td>RADB</td>
<td>RGNET</td>
<td>RISQ</td>
<td>ROGERS</td>
</tr>
<tr>
<td>MTO</td>
<td>RIPE</td>
<td>JPIRR</td>
<td>SAVVIS</td>
<td></td>
</tr>
</tbody>
</table>

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.

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 Level 3 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).

There are two basic steps to register routes in a registry. You must first obtain a maintainer object in the registry. This step generally includes the creation of person or role objects, which contain administrative and technical contact information for the maintainer object. Next, you can register route-set, route, or AS-set objects (or combinations thereof) which reference the routes to be advertised.

Once you have registered your routes in a routing registry, you will also need to communicate your desired export policy to Level 3. We will use your specified export policy to find these objects and use them to generate the incoming route filters on our customer-facing routers.

Maintainer Object

Maintainer objects specify who is allowed to make updates to objects in a given registry. All other objects in the registry will reference a maintainer object, so the maintainer object must be created first. Maintainer objects are generally created via manual intervention on the part of the registry maintainer. If you choose or need to use the Level 3 routing registry, your Level 3 provisioning team will create a maintainer for you from the information you provide in the BGP Questionnaire (see Appendix D). 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 that follows contains the maintainer object attributes, attribute types, and definitions. For each attribute, it is important to note whether the attribute is mandatory or optional. It is also useful to note which attributes allow you to supply multiple values. This is useful when you want to specify multiple contacts.
<table>
<thead>
<tr>
<th>Attribute and Type</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>mntner</td>
<td>The unique name by which the registry knows the customer. The maintainer object describes which entities can create, delete, and update objects. This name is used in all registry objects maintained by this customer. The preferred convention for labeling your maintainer object in the LEVEL3 registry is company-MNT where company is a short form of your company's name.</td>
</tr>
<tr>
<td>descr</td>
<td>A free-form, clear-text description of this maintainer object.</td>
</tr>
<tr>
<td>admin-c</td>
<td>The business or administrative contact for the customer identified by this maintainer. This attribute should contain the name of a person or role object in this routing registry, which contains the relevant contact information. Multiple lines are allowed to specify multiple contacts.</td>
</tr>
<tr>
<td>tech-c</td>
<td>The person to be contacted for technical problems (e.g. incorrect configuration). This attribute should contain the name of a person or role object in this routing registry which contains the relevant contact information. Multiple lines are allowed to specify multiple contacts.</td>
</tr>
<tr>
<td>upd-to</td>
<td>This field is an e-mail address to which notification of an unauthorized attempt to add, change, or delete an object keyed to this maintainer should be sent. A role account (e.g. &quot;<a href="mailto:rradmin@ispx.tld">rradmin@ispx.tld</a>&quot;) is preferred. Multiple lines are allowed to specify multiple e-mail addresses.</td>
</tr>
<tr>
<td>mnt-nty</td>
<td>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. &quot;<a href="mailto:rradmin@ispx.tld">rradmin@ispx.tld</a>&quot;) is preferred. Multiple lines are allowed to specify multiple e-mail addresses.</td>
</tr>
<tr>
<td>auth</td>
<td>This field specifies the scheme for authenticating update requests to objects keyed to this maintainer. Currently, Level 3 supports either the CRYPT-PW or MAILFROM authentication methods. CRYPT-PW is more secure and is preferred. When using the MAIL-FROM authentication method, adding, changing, or deleting via e-mail any object keyed to this maintainer must be performed using the account listed. The e-mail &quot;From:&quot; address must exactly match the e-mail address in the Auth field, or attempts to add, change, or delete objects keyed to this maintainer will be rejected. A role account (e.g. &quot;MAIL-FROM <a href="mailto:rradmin@ispx.tld">rradmin@ispx.tld</a>&quot;) is preferred. Multiple lines are allowed to specify multiple crypt passwords or e-mail addresses.</td>
</tr>
<tr>
<td>remarks</td>
<td>A free-form clear-text explanation or description. Multiple lines are allowed to accommodate extended remarks.</td>
</tr>
<tr>
<td>notify</td>
<td>This field is an e-mail address to which notification of a change to or deletion of this maintainer object should be sent. A role account (e.g. &quot;<a href="mailto:rradmin@ispx.tld">rradmin@ispx.tld</a>&quot;) is preferred. Multiple lines are allowed to specify multiple e-mail addresses.</td>
</tr>
<tr>
<td>mnt-by</td>
<td>A registered maintainer name, which should be the same name used in the &quot;mntner&quot; field in this case.</td>
</tr>
<tr>
<td>changed</td>
<td>This field is the e-mail address of the individual creating, changing, or deleting this maintainer object, along with the date of the change (e.g. &quot;<a href="mailto:jqpublic@ispx.tld">jqpublic@ispx.tld</a> yyyymmdd&quot;). This cannot be a role e-mail address, but must be the address of the individual making the change. You must use the current date, i.e., the date you are filling out the request. The date must be in the following format: yyyymmdd (four-digit year followed by two-digit month followed by two-digit day, with no spaces, dashes or slashes).</td>
</tr>
<tr>
<td>source</td>
<td>The routing registry in which this maintainer object will be stored. The source is &quot;LEVEL3&quot; for objects in the LEVEL3 routing registry.</td>
</tr>
</tbody>
</table>
For the Level 3 routing registry, contact information in the maintainer objects should reference only person or role objects, which are also in the Level 3 routing registry. The auth field in the maintainer object may contain multiple entries. Each entry may be a "CRYPT-PW" or a "MAIL-FROM" type. The "MAIL-FROM" entries allow for the specification of a matching mail address as a regular expression. For example:

Auth: MAIL-FROM rradmin@ispx.tld

This would allow updates submitted via e-mail if the e-mail has a "From:" address of rradmin@ispx.tld matching case exactly. An entry resembling:

Auth: MAIL-FROM *@ispx.tld

This would allow updates submitted via e-mail if the e-mail has a "From:" address of anything@ispx.tld. Return addresses are easily spoofed, so it is preferable to use "CRYPT-PW" authorization entries, which require that the submitted object contain password information. "CRYPT-PW" authorization entries contain an encrypted representation of a plain-text password. Level 3 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 g5kCkiHFBMVi2
remarks: The moon is yellow tonight.
notify: noc@foo.tld
mnt-by: FOO-MNT
changed: somebody@foo.tld 20010522
source: LEVEL3

Person Object

Objects such as the maintainer object contain admin-c or techc fields which often reference other objects 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. For each attribute, it is important to note whether the attribute is mandatory or optional. It is also useful to note which attributes allow you to supply multiple values. This is useful when you want to specify multiple contacts.

<table>
<thead>
<tr>
<th>Attribute and Type</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>person [mandatory] [single]</td>
<td>The name of the individual.</td>
</tr>
<tr>
<td>address [mandatory] [multiple]</td>
<td>The full address of the individual or organization. Multiple lines are allowed to specify multi-line addresses.</td>
</tr>
<tr>
<td>phone [mandatory] [multiple]</td>
<td>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 are allowed to specify multiple phone numbers.</td>
</tr>
<tr>
<td>fax-no [optional] [multiple]</td>
<td>The individual's fax number (e.g. +1 123 456 7890).</td>
</tr>
<tr>
<td><strong>e-mail</strong> [optional] [multiple]</td>
<td>The e-mail address for the individual or role account. Multiple lines are allowed to specify multiple e-mail addresses.</td>
</tr>
<tr>
<td><strong>nic-hdl</strong> [optional] [single]</td>
<td>This is a unique &quot;handle&quot; in the format first_initial last_initial digitsrouting_registry (e.g. &quot;JC1-LEVEL3&quot;), 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 routing registry administrators to find an available handle.</td>
</tr>
<tr>
<td><strong>remarks</strong> [optional] [multiple]</td>
<td>A free-form clear-text explanation or description. Multiple lines are allowed to accommodate extended remarks.</td>
</tr>
<tr>
<td><strong>notify</strong> [optional] [multiple]</td>
<td>This field is an e-mail address to which notification of a change to or deletion of this maintainer object should be sent. A role account (e.g. &quot;<a href="mailto:rradmin@ispx.tld">rradmin@ispx.tld</a>&quot;) is preferred. Multiple lines are allowed to specify multiple e-mail addresses.</td>
</tr>
<tr>
<td><strong>mnt-by</strong> [mandatory] [multiple]</td>
<td>The maintainer name under which this object is to be registered.</td>
</tr>
<tr>
<td><strong>changed</strong> [mandatory] [multiple]</td>
<td>This field is the e-mail address of the individual creating, changing, or deleting this maintainer object, along with the date of the change (e.g. &quot;<a href="mailto:jqpublic@ispx.tld">jqpublic@ispx.tld</a> yyyyymmdd&quot;). This cannot be a role e-mail address, but must be the address of the individual making the change. You must use the current date, i.e., the date you are filling out the request. The date must be in the following format: yyyyymmdd (four-digit year followed by two-digit month followed by two-digit day, with no spaces, dashes, or slashes).</td>
</tr>
<tr>
<td><strong>source</strong> [mandatory] [single]</td>
<td>The routing registry in which this maintainer object will be stored. The source is &quot;LEVEL3&quot; for objects in the LEVEL3 routing registry.</td>
</tr>
</tbody>
</table>

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

```
person: Joe College
description: Foo, Inc.
description: 1 Foo Dr
description: 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. For each attribute, it is important to note whether the attribute is mandatory or optional. It is also useful to note which attributes allow you to supply multiple values. This is useful when you want to specify multiple contacts.
<table>
<thead>
<tr>
<th>Attribute and Type</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>role [mandatory] [single]</td>
<td>A name or description of the role account.</td>
</tr>
<tr>
<td>address [mandatory] [multiple]</td>
<td>The full address of the role or organization. Multiple lines are allowed to specify multi-line addresses.</td>
</tr>
<tr>
<td>phone [mandatory] [multiple]</td>
<td>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 this: +1 123 456 7890 ext. 123. Multiple lines are allowed to specify multiple phone numbers.</td>
</tr>
<tr>
<td>fax-no [optional] [multiple]</td>
<td>The role's fax number (e.g. +1 123 456 7890).</td>
</tr>
<tr>
<td>e-mail [optional] [multiple]</td>
<td>The e-mail address for the role account. Multiple lines are allowed to specify multiple e-mail addresses.</td>
</tr>
<tr>
<td>trouble [optional] [multiple]</td>
<td>Additional contact information to be used when a problem arises with any object referencing this role object. Multiple lines are allowed to specify multiple contacts.</td>
</tr>
<tr>
<td>nic-hdl [optional] [single]</td>
<td>This is a unique &quot;handle&quot; in the format XX digits- routing registry (e.g. &quot;HD1- LEVEL3&quot;), 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 routing registry administrators to find an available handle.</td>
</tr>
<tr>
<td>admin-c [optional] [multiple]</td>
<td>The business or administrative contact for the role identified by this object. This attribute should contain the name of a person object in this routing registry, which contains the relevant contact information. Multiple lines are allowed to specify multiple contacts.</td>
</tr>
<tr>
<td>tech-c [mandatory] [multiple]</td>
<td>The person to be contacted for technical problems with this role (e.g. incorrect information). This attribute should contain the name of a person object in this routing registry which contains the relevant contact information. Multiple lines are allowed to specify multiple contacts.</td>
</tr>
<tr>
<td>remarks [optional] [multiple]</td>
<td>A free-form clear-text explanation or description. Multiple lines are allowed to accommodate extended remarks.</td>
</tr>
<tr>
<td>notify [optional] [multiple]</td>
<td>This field is an e-mail address to which notification of a change to or deletion of this object should be sent. A role account (e.g. &quot;<a href="mailto:rradmin@ispx.tld">rradmin@ispx.tld</a>&quot;) is preferred. Multiple lines are allowed to specify multiple e-mail addresses.</td>
</tr>
<tr>
<td>mnt-by [mandatory] [multiple]</td>
<td>The maintainer name under which this object is to be registered.</td>
</tr>
<tr>
<td>changed [mandatory] [multiple]</td>
<td>This field is the e-mail address of the individual creating, changing or deleting this object, along with the date of the change (e.g. &quot;<a href="mailto:jqpublic@ispx.tld">jqpublic@ispx.tld</a> yyyyymmdd&quot;). This cannot be a role e-mail address, but must be the address of the individual making the change. You must use the current date, i.e., the date you are filling out the request. The date must be in the following format: yyyyymmdd (four-digit year followed by two-digit month followed by two-digit day, with no spaces, dashes or slashes).</td>
</tr>
<tr>
<td>source [mandatory] [single]</td>
<td>The routing registry in which this object will be stored. The source is &quot;LEVEL3&quot; for objects in the LEVEL3 routing registry.</td>
</tr>
</tbody>
</table>
Here's 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. Level 3 suggests 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 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. For each attribute, it is important to note whether the attribute is mandatory or optional. It is also useful to note which attributes allow you to supply multiple values. This is useful when you want to specify multiple contacts.

<table>
<thead>
<tr>
<th>Attribute and Type</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>route-set* [mandatory]</td>
<td>A unique name beginning with &quot;RS-&quot;.</td>
</tr>
<tr>
<td>descr [mandatory]</td>
<td>A free-form clear-text description of this route-set object.</td>
</tr>
<tr>
<td>members* [optional]</td>
<td>A comma-separated list of routes in the format address/prefix-length and/or</td>
</tr>
<tr>
<td></td>
<td>routeset object names.</td>
</tr>
<tr>
<td>mp-members* [optional]</td>
<td>A comma-separated list of IPv6 routes in the format address/prefix-length</td>
</tr>
<tr>
<td></td>
<td>and/or routeset object names.</td>
</tr>
<tr>
<td>mbrs-by-ref* [optional]</td>
<td>A list of maintainer names or the keyword &quot;ANY&quot;. If this attribute is used,</td>
</tr>
<tr>
<td></td>
<td>the routeset will include route objects which are keyed to one of these</td>
</tr>
<tr>
<td></td>
<td>maintainers, and whose member-of attribute refers to this route-set object.</td>
</tr>
<tr>
<td></td>
<td>If the value of a mbrs-by-ref attribute is ANY, any route object referring</td>
</tr>
<tr>
<td></td>
<td>to this route-set is a member. If the mbrs-by-ref attribute is missing,</td>
</tr>
<tr>
<td></td>
<td>only the routes listed in the members attribute will be part of the</td>
</tr>
<tr>
<td></td>
<td>route-set. This is not a commonly-used attribute and can be safely ignored</td>
</tr>
<tr>
<td></td>
<td>by most users.</td>
</tr>
<tr>
<td>remarks [optional]</td>
<td>A free-form clear-text explanation or description. Multiple lines are allowed</td>
</tr>
<tr>
<td></td>
<td>to accommodate extended remarks.</td>
</tr>
<tr>
<td>admin-c [optional]</td>
<td>The business or administrative contact for the routes identified by this</td>
</tr>
<tr>
<td></td>
<td>object. This attribute should contain the name of a person or role object in</td>
</tr>
<tr>
<td></td>
<td>this routing registry which contains the relevant contact information.</td>
</tr>
<tr>
<td></td>
<td>Multiple lines are allowed to specify multiple contacts.</td>
</tr>
</tbody>
</table>
**tech-c**
[mandatory]
[multiple]

The person to be contacted for technical problems with this object (e.g. incorrect configuration). This attribute should contain the name of a person or role object in this routing registry, which contains the relevant contact information. Multiple lines are allowed to specify multiple contacts.

**notify**
[optional]
[multiple]

This field is an e-mail address to which notification of a change to or deletion of this object should be sent. A role account (e.g. "rradmin@ispx.tld") is preferred. Multiple lines are allowed to specify multiple e-mail addresses.

**mnt-by**
[mandatory]
[multiple]

The maintainer name under which this object is to be registered.

**changed**
[mandatory]
[multiple]

The e-mail address of the person who most recently changed the object along with the date of the change (yyyyymmdd). This field is the e-mail address of the individual creating, changing or deleting this object, along with the date of the change (e.g. "jqpublic@ispx.tld yyyyymmdd"). This cannot be a role e-mail address, but must be the address of the individual making the change. You must use the current date, i.e. the date you are filling out the request. The date must be in the following format: yyyyymmdd (four-digit year followed by two-digit month followed by two-digit day, with no spaces, dashes or slashes).

**source**
[mandatory]
[single]

The routing registry in which this object will be stored. The source is "LEVEL3" for objects in the LEVEL3 routing registry.

* attributes which are used by the Level 3 automated BGP filter generation system

Here's a sample route-set object:

```plaintext
route-set: RS-FOO
descr: Routes announced to Level 3 by Foo, Inc.
members: 10.1.2.0/24, 172.16.0.0/16, 192.168.4.128/25
mp-members: FC00::/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 Level 3 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 route. A list of routes to be used in building an import filter is generally obtained 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. For each attribute, it is important to note whether the attribute is mandatory or optional. It is also useful to note which attributes allow you to supply multiple values. This is useful when you want to specify multiple contacts.

<table>
<thead>
<tr>
<th>Attribute and Type</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>route* [mandatory] [single]</td>
<td>The route in address/prefix-length format.</td>
</tr>
<tr>
<td>descr</td>
<td>A free-form clear-text description of this route object</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------------------------------------</td>
</tr>
<tr>
<td>admin-c</td>
<td>The business or administrative contact for the route identified by this object. This attribute should contain the name of a person or role object in this routing registry, which contains the relevant contact information. Multiple lines are allowed to specify multiple contacts.</td>
</tr>
<tr>
<td>tech-c</td>
<td>The person to be contacted for technical problems with this object (e.g. incorrect configuration). This attribute should contain the name of a person or role object in this routing registry which contains the relevant contact information. Multiple lines are allowed to specify multiple contacts.</td>
</tr>
<tr>
<td>origin</td>
<td>The AS announcing (or &quot;originating&quot;) the route into the Internet. The format is ASASN (e.g. &quot;AS65000&quot;).</td>
</tr>
<tr>
<td>holes</td>
<td>This attribute is rarely used and is primarily informational in nature. See RFC 2622 for details.</td>
</tr>
<tr>
<td>member-of</td>
<td>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 &quot;ANY&quot;), 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.</td>
</tr>
<tr>
<td>inject</td>
<td>This attribute is rarely used and is primarily informational in nature. See RFC 2622 for details.</td>
</tr>
<tr>
<td>components, aggr-bndry, and export-comps</td>
<td>These attributes are rarely used and are primarily informational in nature. See RFC 2622 for details.</td>
</tr>
<tr>
<td>remarks</td>
<td>A free-form clear-text explanation or description. Multiple lines are allowed to accommodate extended remarks.</td>
</tr>
<tr>
<td>notify</td>
<td>The maintainer name under which this object is to be registered.</td>
</tr>
<tr>
<td>changed</td>
<td>The e-mail address of the person who most recently changed the object along with the date of the change (yyyymmd). This field is the e-mail address of the individual creating, changing, or deleting this object, along with the date of the change (e.g. &quot;<a href="mailto:jqpublic@isp.x.tld">jqpublic@isp.x.tld</a> yyyymmd&quot;). This cannot be a role e-mail address, but must be the address of the individual making the change. You must use the current date, i.e., the date you are filling out the request. The date must be in the following format: yyyymmd (four-digit year followed by two-digit month followed by two-digit day, with no spaces, dashes or slashes).</td>
</tr>
<tr>
<td>source</td>
<td>The routing registry in which this object will be stored. The source is &quot;LEVEL3&quot; for objects in the LEVEL3 routing registry.</td>
</tr>
</tbody>
</table>

* attributes which are used by the Level 3 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 Level 3 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. Here’s 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 by the use of 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 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 Level 3 Technical Customer Account Management (TCAM) 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. For each attribute, it is important to note whether the attribute is mandatory or optional. It is also useful to note which attributes allow you to supply multiple values. This is useful when you want to specify multiple contacts.

<table>
<thead>
<tr>
<th>Attribute and Type</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS-set* [mandatory] [single]</td>
<td>A unique name with an “AS-” prefix.</td>
</tr>
<tr>
<td>descr [mandatory] [single]</td>
<td>A free-form clear-text description of this AS-set object.</td>
</tr>
<tr>
<td>members* [optional] [multiple]</td>
<td>A comma-separated list of ASNs in the format ASASN and/or AS-set object names (e.g. &quot;AS65000, AS65001, AS-CDNY&quot;).</td>
</tr>
<tr>
<td>Attribute</td>
<td>Description</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>mbrs-by-ref*</td>
<td>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 &quot;ANY&quot; 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.</td>
</tr>
<tr>
<td>remarks</td>
<td>A free-form clear-text explanation or description. Multiple lines are allowed to accommodate extended remarks.</td>
</tr>
<tr>
<td>admin-c</td>
<td>The business or administrative contact for the AS-set identified by this object. This attribute should contain the name of a person or role object in this routing registry, which contains the relevant contact information. Multiple lines are allowed to specify multiple contacts.</td>
</tr>
<tr>
<td>tech-c</td>
<td>The person to be contacted for technical problems with this object (e.g. incorrect configuration). This attribute should contain the name of a person or role object in this routing registry, which contains the relevant contact information. Multiple lines are allowed to specify multiple contacts.</td>
</tr>
<tr>
<td>notify</td>
<td>This field is an e-mail address to which notification of a change to or deletion of this object should be sent. A role account (e.g. &quot;<a href="mailto:rradmin@ispx.tld">rradmin@ispx.tld</a>&quot;) is preferred. Multiple lines are allowed to specify multiple e-mail addresses.</td>
</tr>
<tr>
<td>mnt-by*</td>
<td>The maintainer name under which this object is to be registered.</td>
</tr>
<tr>
<td>changed</td>
<td>The e-mail address of the person who most recently changed the object along with the date of the change (yyyyMMdd). This field is the e-mail address of the individual creating, changing or deleting this object, along with the date of the change (e.g. &quot;<a href="mailto:jqpublic@ispx.tld">jqpublic@ispx.tld</a> yyyyMMdd&quot;). This cannot be a role e-mail address, but must be the address of the individual making the change. You must use the current date, i.e., the date you are filling out the request. The date must be in the following format: yyyyMMdd (four-digit year followed by two-digit month followed by two-digit day, with no spaces, dashes or slashes).</td>
</tr>
<tr>
<td>source*</td>
<td>The routing registry in which this object will be stored. The source is &quot;LEVEL3&quot; for objects in the LEVEL3 routing registry.</td>
</tr>
</tbody>
</table>

* Attributes which are used by the Level 3 automated BGP filter generation system

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

<table>
<thead>
<tr>
<th>route</th>
<th>descr</th>
<th>origin</th>
<th>mnt-by</th>
<th>changed</th>
<th>source</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1.2.0/24</td>
<td>Foo, Inc. network 1.</td>
<td>AS65000</td>
<td>FOO-MNT</td>
<td><a href="mailto:somebody@foo.tld">somebody@foo.tld</a> 20010522</td>
<td>LEVEL3</td>
</tr>
<tr>
<td>172.16.0.0/16</td>
<td>Lectroid, LLC - downstream cust. of Foo, Inc.</td>
<td>AS65001</td>
<td>LECTROID-MNT</td>
<td><a href="mailto:somebody@lectroid.tld">somebody@lectroid.tld</a> 20010522</td>
<td>LEVEL3</td>
</tr>
</tbody>
</table>
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  
technical-contact: 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.

**Aut-Num Object**

Aut-num (autonomous system number) objects are intended to document the routing policy for a given ASN. Level 3 does not use the import or export policies listed in these objects for anything other than informational purposes at this time. Within the scope of the Level 3 automated BGP filter generation process, aut-num objects are only interesting if they reference AS-set objects.

The table below contains the aut-num object attributes, attribute types, and definitions. For each attribute, it is important to note whether the attribute is mandatory or optional. It is also useful to note which attributes allow you to supply multiple values. This is useful when you want to specify multiple contacts.

<table>
<thead>
<tr>
<th>Attribute and Type</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>aut-num* [mandatory] [single]</td>
<td>The unique ASN, in the format ASnumber (e.g. &quot;AS65000&quot;).</td>
</tr>
<tr>
<td>as-name [optional] [single]</td>
<td>A name for this AS.</td>
</tr>
<tr>
<td>descr [mandatory] [single]</td>
<td>A free-form, clear-text description of this aut-num object.</td>
</tr>
<tr>
<td>admin-contact [optional] [multiple]</td>
<td>The business or administrative contact for the aut-num identified by this object. This attribute should contain the name of a person or role object in this routing registry, which contains the relevant contact information. Multiple lines are allowed to specify multiple contacts.</td>
</tr>
<tr>
<td>technical-contact [mandatory] [multiple]</td>
<td>The person to be contacted for technical problems with this object (e.g. incorrect configuration). This attribute should contain the name of a person or role object in this routing registry, which contains the relevant contact information. Multiple lines are allowed to specify multiple contacts.</td>
</tr>
<tr>
<td>member-of* [optional] [multiple]</td>
<td>This attribute may contain a comma-separated list of AS-sets to which this aut-num should belong. Using the member-of attribute is an alternative to explicitly listing ASNs in the members attribute of the AS-set objects. As long as the mbrs-by-ref attribute of these AS-sets includes the maintainer name listed in the mnt-by attribute of this aut-num object (or the keyword &quot;ANY&quot;), this ASN is considered to be a member of that AS-set. This is not a commonly-used attribute and can be safely ignored by most users.</td>
</tr>
<tr>
<td>import [optional] [multiple]</td>
<td>The import policy for this AS. See RFC 2622 for details.</td>
</tr>
<tr>
<td>export [optional] [multiple]</td>
<td>The export policy for this AS. See RFC 2622 for details.</td>
</tr>
</tbody>
</table>
**default [optional] [multiple]**  The default routing policy for this AS. See RFC 2622 for details.

**remarks [optional] [multiple]**  A free-form clear-text explanation or description. Multiple lines are allowed to accommodate extended remarks.

**notify [optional] [multiple]**  This field is an e-mail address to which notification of a change to or deletion of this object should be sent. A role account (e.g. "rradmin@ispx.tld") is preferred. Multiple lines are allowed to specify multiple e-mail addresses.

**mnt-by* [optional] [multiple]**  The maintainer name under which this object is to be registered.

**changed [mandatory] [multiple]**  The e-mail address of the person who most recently changed the object along with the date of the change (yyyymmdd). This field is the e-mail address of the individual creating, changing or deleting this object, along with the date of the change (e.g. "jqpublic@ispx.tld yyyy-mm-dd"). This cannot be a role e-mail address but must be the address of the individual making the change. You must use the current date, i.e., the date you are filling out the request. The date must be in the following format: yyyy-mm-dd (four-digit year followed by two-digit month followed by two-digit day, with no spaces, dashes or slashes).

**source* [mandatory] [single]**  The routing registry in which this object will be stored. The source is "LEVEL3" for objects in the LEVEL3 routing registry.

As an example, a customer might create an AS-set object resembling:

```
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
```

Their downstream customers could join this AS-set by creating aut-num objects resembling:

```
aut-num: AS65001
as-name: LECTROID
descr: Lectroid, LLC - downstream customer of Foo, Inc.
admin-c: FD3-LEVEL3
tech-c: RR7-LEVEL3
member-of: AS-FOO
mnt-by: LECTROID-MNT
changed: somebody@lectroid.tld 20010522
source: LEVEL3
```

This would cause AS65001 to be considered a member of the "AS-FOO" AS-set. This type of configuration is not used often. It is generally preferred to explicitly list the ASNs that belong to an AS-set in the AS-set's members' field.

**Other Objects**

There are other RPSL objects such as filter-set, rtr-set, peering-set, dictionary and inet-rtr, but these are not used by Level 3 in the automated maintenance of customer BGP filters and are thus of informational value only as far as Level 3 is concerned. These objects will not be discussed in this document. Please see RFC 2622 for additional information regarding these objects.
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.

Level 3 has implemented semi-private extensions to RPSL routeset and AS-set objects to allow for explicit registry specification within these objects. The syntax chosen is similar to that discussed and proposed as an extension to the standard. However, at this time, 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
```

This 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
```

The next section ("Policy Syntax") contains additional information about this source-specification syntax - in particular, the use of parentheses in making associations. 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.)

Policy Syntax

Level 3 has extended the standard RPSL syntax. This extended syntax can be used to specify your export policy. Level 3 will automatically generate BGP input filters from the export policy you specify and apply them to your peering session. You specify your policy on new connections in Section 3 of the BGP Questionnaire. To change your policy on existing connections, contact TCAM at 1-877-4LEVEL3 or http://3enabled.portallogin.net. The extended syntax does not strictly pertain to the LEVEL 3 routing registry. It pertains to a system dubbed "filtergen," which automatically creates the BGP input filters each night.

An import policy as defined within the scope of the Level 3 automated filter generation process is simply a list of origin ASs, AS-sets, AS-macros (for RIPE-181 registries), and/or route-sets. Any object found in any member of this list will be included in the BGP input filter applied to the customer peering session.

If multiple objects in a routing policy come from the same registry, the object names may be enclosed in parentheses. For example, if you want Level 3 to build a BGP input filter allowing all routes registered in the Level 3 routing registry with an origin AS of AS65000, you would specify your routing policy as:

```
LEVEL3::AS65000
```

If you want the filter built to allow all routes with origin ASs listed in either the AS-FOO AS-set in the Level 3 registry or in the AS-FOO AS-set in the RADB routing registry, you would specify your routing policy as:

```
(LEVEL3 RADB)::AS-FOO
```
To expand AS-FOO and AS-BAR AS-sets from each registry, you would specify your routing policy as:

\[(LEVEL3\ RADB)::(AS\ -FOO\ AS\ -BAR)\]

Of course, you could simply list the elements of your routing policy without using parentheses. For example, the following policies are all identical:

\[(LEVEL3\ RADB)::(AS\ -FOO\ AS\ -BAR)\]
\[LEVEL3::(AS\ -FOO\ AS\ -BAR)\]
\[RADB::(AS\ -FOO\ AS\ -BAR)\]
\[LEVEL3::AS\ -FOO\ LEVEL3::AS\ -BAR\]
\[RADB::AS\ -FOO\ RADB::AS\ -BAR\]

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. Similarly, 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 aren't supported in the general syntax definition of these fields.

The Level 3 filtergen process hosts a public whois server, which may be queried at any time to see the Level 3 view of how to expand any given routing policy. See the next section ("Querying the Routing Registry") for more details.

**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 "ASMINEALLMINE", but before submitting a request to create this object, the user should first check to see if the name is already in use.

The Level 3 routing registry has a public whois server to answer object queries. The Level 3 filtergen server has a public whois server to answer policy queries.

A simple way to query the Level 3 routing registry is by using a Web browser and a public Web-to-whois gateway. Level 3 operates one of these gateways at http://www.level3.com/LookingGlass/. A user may connect to this URL and then follow the "Whois query" link. On that page the user may enter "rr.level3.net" in the "Whois server" field, and an object name (e.g. "AS-MINEALLMINE") in the "Query" box. A user could do this to check whether an object name is already in use, or to check the status of an existing object. Please note that rr.level3.net is the whois server for object queries.

Likewise, the user may enter "filtergen.level3.net" in the "Whois server" field and a policy specification (e.g. "LEVEL3::AS-FOO") in the "Query" box. This would expand the list of routes associated with the AS-FOO AS-set. A user could do this to determine the routes associated with their current routing policy, or to test a new policy before implementing it. Please note that filtergen.level3.net is the whois server for policy queries.

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
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 local documentation 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@level3.com. E-mail sent to this address is handled by an automated system which will attempt to authorize and fulfill the request. The primary exception to this automated process is the creation of the initial maintainer object, to which all other objects are keyed. This requires human intervention. Please note that you need one and only one maintainer object in each routing registry you use.

If you are using the Level 3 routing registry, Level 3 will create your maintainer object as part of the provisioning process. Level 3 Technical Customer Account Management (TCAM) can assist you in the creation of your routing objects, if necessary. TCAM can be contacted at 1-877-4LEVEL3 or http://3enabled.portallogin.net. Another exception to the automated process is if a customer cannot remember the password referenced in CRYPT-PW authentication or cannot send e-mail with the proper return address for MAIL-FROM authentication.

E-mail messages to rpsl@level3.com 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@level3.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.

**Adding an Object**

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

For CRYPT-PW authentication, the user must add a pseudoattribute called "password" to each object in the e-mail message. For example:

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

This attribute must be appended to each object included in the e-mail message.
Changing an Object

To change an object, you should first perform a whois query to pull the current object, and then change the fields as needed. The changed field should be modified to include the e-mail address of the person submitting the change and the current date (yyyyymmdd). This cannot be a role e-mail address but must be the address of the individual making the change. You must use the current date, i.e., the date you are e-mailing the request. The date must be in the following format: yyyyymmdd (four-digit year followed by two-digit month followed by two-digit day, with no spaces, dashes or slashes).

changed: somebody@foo.tld 20010522

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. For 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
delete: somebody@foo.tld 20010522
password: ItsASecret