



**Secure,
Multi-lateral Peering
with
SIP Express Router (SER)
Version 2.0.x**

Revision History

| Revision | Date of Issue | Changes |
|----------|---------------|---|
| 0.1 | 12 Aug 2005 | Initial Draft. |
| 0.2 | 23 Aug 2005 | Minor clarifications and edits |
| 0.3 | 4 Nov 2005 | Added Appendix 1 and other edits |
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| 0.10.0 | 6 Feb 2007 | Change OSP Toolkit site from SIPfoundry to SourceForge |
| 2.0.0 | 15 May 2007 | Update for SER 2.0.x |

E-mail support: <https://lists.sourceforge.net/lists/listinfo/osp-toolkit-client>
www.transnexus.com

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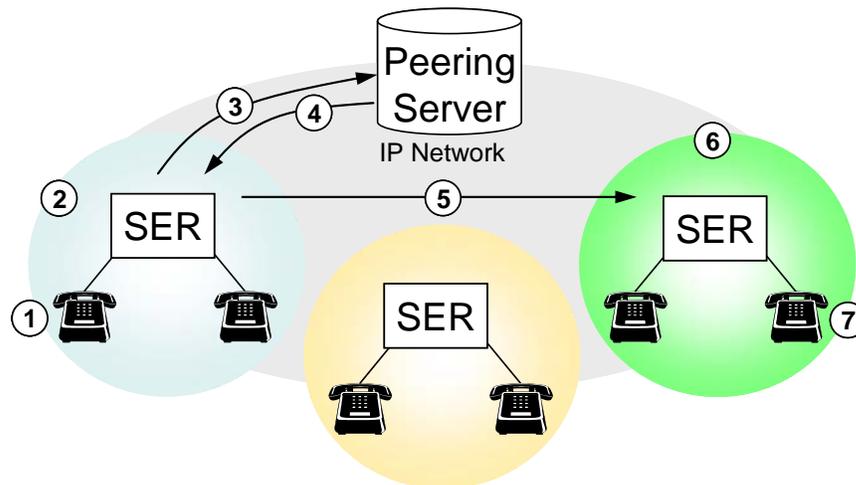
Introduction

Secure multi-lateral peering uses Public Key Infrastructure (PKI) services to secure, direct peering among an anonymous group of SIP peers. In a multi-lateral peering architecture, each peer trusts a common peering authority that enforces routing and access policies on behalf of each peer. The benefits of multi-lateral peering are increased peering security and the elimination of burdensome bilateral peering agreements and access control lists which are difficult to administer in a large peering network.

This document provides build instructions on how to build the OSP Toolkit with the SIP Express Router (SER). The OSP Toolkit, which is freely available from <https://sourceforge.net/projects/osp-toolkit/>, contains an implementation of the OSP standard defined by the European Telecommunications Standards Institute (ETSI TS 101 321) www.etsi.org. The OSP Toolkit enables the SIP Express Router for secure multi-lateral peering.

Multi-lateral SIP Peering

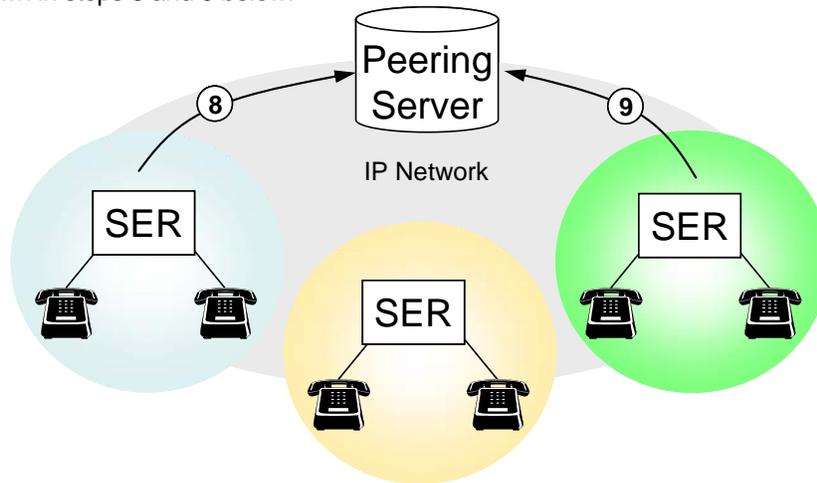
A peering server is a simple and efficient solution for managing routing, access control and CDR collection for VoIP calls among a network of SER devices. OSP can be used to securely manage wholesale VoIP peering among independent SIP networks, or by an enterprise to create a secure VoIP virtual private network for calling among branch offices using SIP PBXs. The diagram below illustrates a call scenario between SER networks using OSP peering. Each SER proxy manages calls within its own domain. However, when a call must be completed outside its own network, a SER proxy can query a peering server for routing and access information to a destination peer that can complete the call.



1. The calling party makes a call.
2. The source SER cannot complete the call within its domain.
3. Peering Request. The source SER queries the peering server for the IP addresses of other peers that can complete the call to the dialed number.
4. Peering Response. The peering server returns a list of IP addresses of destination peers and digitally signed peering tokens authorizing access to each destination peer.
5. The source SER routes the call to the destination SER returned by the peering server. Included in the SIP Invite message is the peering access token signed by the peering server.
6. The destination SER receives the call and validates the peering token. If the token is valid, the destination SER routes the call to the called telephone number.
7. The call is completed to calling party.

Call Detail Record Collection

When the call is over, both the source and destination peers send call detail records to the peering server as shown in steps 8 and 9 below.



Step 1. Build the OSP Toolkit

The OSP Toolkit, when compiled, is a library comprised of OSP client functions that simplify sending and receiving OSP peering messages. It is this library, which will be integrated into the SER. The OSP Toolkit uses third party software (by default OpenSSL) for cryptographic algorithms and for secure internet transactions (HTTPS). The OSP Toolkit also includes the application *Enroll* which enables the OSP client device to generate its own public-private key pair, get the public key from an OSP peering server, send a certificate request to a peering server and receive the resulting signed certificate from the peering server.

In order to successfully compile and use the OSP Toolkit, the following list of software is required:

OpenSSL (required) - Open Source SSL protocol and Cryptographic Algorithms (version 0.9.7g recommended) from www.openssl.org. Pre-compiled OpenSSL packages are not recommended because of the binary compatibility issue.

Perl (required) - A programming language used by OpenSSL for compilation. Any version of Perl will work. One version of Perl is available from www.activestate.com/ActivePerl. If pre-compiled OpenSSL packages are used, Perl package is not required.

C compiler (required) - Any C compiler should work. The GNU Compiler Collection from www.gnu.org is routinely used for building the OSP Toolkit for testing.

OSP Server (required for testing) - OpenOSP is an open source, reference implementation of an OSP server developed by Cisco Systems. The OpenOSP server is available from <http://www.vovida.org/applications/downloads/openosp/>. RAMS is a java based, open source OSP server available from <https://sourceforge.net/projects/rams/>. Also, a free version of the TransNexus commercial OSP peering server can be downloaded from www.transnexus.com/OSP%20Toolkit/Peering_Server/VoIP_Peering_Server.htm.

Unpacking the Toolkit

After downloading the OSP Toolkit, perform the following steps in order:

- 1) Copy the OSP Toolkit distribution into the directory where it will reside.

- 2) Unzip the tar file by executing the following command:

```
gunzip OSPToolkit-###.tar.gz
```

Where ### is the version number separated by underlines. For example, if the version is 2.5.4, then the above command would be:

```
gunzip OSPToolkit-2_5_4.tar.gz
```

A tar file will replace the *.gz file.

- 3) Untar the file by executing the following command:

```
tar -xvof OSPToolkit-###.tar
```

Where ### is the version number separated by underlines. For example, if the version is 2.5.4, then the above command would be: `tar -xvof OSPToolkit-2_5_4.tar`

A new directory (`osptoolkit`) will be created within the same directory as the tar file.

- 4) Go to the `osptoolkit` directory by running this command:

```
cd osptoolkit
```

Within this directory, you will find directories and files similar to what is listed below (if the command "`ls -F`" is executed):

```
> ls -F
enroll/
RelNotes.txt
README.txt
bin/
crypto/
include/
lib/
license.txt
src/
test/
```

Preparing to Build the OSP Toolkit

- 5) Compile OpenSSL according to the instructions provided with the OpenSSL distribution. **You would need to do this only if you don't have OpenSSL already.**
- 6) Copy the OpenSSL header files (ones with the *.h extension contained in `include/openssl` directory within the directory containing OpenSSL files into the `crypto/openssl` directory within the Toolkit. The OpenSSL header files are located under `include/openssl` directory.
- 7) Copy the OpenSSL library files (`libcrypto.a` and `libssl.a`) into the `lib` directory within the Toolkit. The OpenSSL library files are located within the `openssl` directory.

Building the OSP Toolkit

- 8) Open the makefile in the `src` directory. Look for the install path variable – `INSTALL_PATH`; edit it to be `/usr/local`.

```
cd src; vi Makefile
```

- 9) From within the OSP Toolkit directory, start the compilation script by executing the following commands:

```
cd src  
  
make clean; make build
```

The make script can also be used to install the toolkit header files and the toolkit library in the folder that the user wishes to install them in. The default path is: `/usr/local/`. The user can modify this to any path desired. Also, the “`make install`” command should be used to install the files.

Note: Please make sure you have the rights to access the `INSTALL_PATH` directory. For example, in order to access `/usr/local` directory, normally, you should be root.

Building the Enroll Utility

The Enroll program is a utility application for establishing a trusted relationship between the SER OSP client and an OSP peering server or certificate authority. This step will build the Enroll utility included with the OSP Toolkit.

- 10) From within the OSP Toolkit directory, execute the following commands at the Unix command prompt:

```
cd enroll  
  
make clean; make linux
```

Compilation is successful if there are no errors anywhere in the compiler output. The enroll program is now located in the OSP Toolkit "bin" directory. For more information on the Enroll utility, please http://www.transnexus.com/OSP%20Toolkit/OSP%20Toolkit%20Documents/Device_Enrollment.pdf.

Step 2. Enroll SER OSP Module with a Peering Server

Overview

To establish a secure relationship between an OSP peering server and the OSP module in SER requires three crypto files. These files are:

- `localcert.pem` - The local certificate for SER signed by the OSP server.
- `pkey.pem` - The private key generated by the Enroll utility for SER.
- `cacert_#.pem` - The Certificate Authority (CA) certificate from an OSP server. SER may enroll with multiple certificate authorities or peering servers. The # represents an integer indicating the CA certificate from different peering servers.

The Enroll utility automates the process of enrolling SER with a peering server and creating the three crypto files. By default, the OSP Module of SER will load the crypto files from the default configuration directory - /usr/local/etc/ser. If the files are not present, the OSP Module and SER will not start.

Using the Enroll script

The script 'enroll.sh' requires AT&T korn shell (ksh) or any of its compatible variants. The enroll.sh script should be run from the osptoolkit/bin directory, or the osptoolkit/bin directory should be in the PATH variable.

From the command line, type enroll.sh followed by the IP address or domain name of the peering server. Below is an example of the Enroll utility being used to enroll SER with a peering server named osptestserver.transnexus.com. The gray boxes indicate optional input which will be included in the SER's certificate. Error Code 0 indicates the operation was successful with no error.

```
# enroll.sh osptestserver.transnexus.com
Generating a 512 bit RSA private key
.....+++++
.+++++
writing new private key to 'pkey.pem'
-----
You are about to be asked to enter information that will be incorporated
into your certificate request.
What you are about to enter is what is called a Distinguished Name or a DN.
There are quite a few fields but you can leave some blank
For some fields there will be a default value,
If you enter '.', the field will be left blank.
-----
Country Name (2 letter code) [AU]: ██████████
State or Province Name (full name) [Some-State]: ██████████
Locality Name (eg, city) []: ██████████
Organization Name (eg, company) [Internet Widgits Pty Ltd]: ██████████
Organizational Unit Name (eg, section) []: ██████████
Common Name (eg, YOUR name) []: ██████████
Email Address []: ██████████

Please enter the following 'extra' attributes
to be sent with your certificate request
A challenge password []: ██████████
An optional company name []: ██████████

Error Code returned from openssl command : 0

CA certificate received
[SP: osptestserver.transnexus.com]Error Code returned from getcacert command : 0

output buffer after operation: operation=request
output buffer after nonce: operation=request&nonce=6096834216798074
X509 CertInfo context is null pointer
Unable to get Local Certificate
depth=0 /CN=osptestserver.transnexus.com/O=OSPServer
verify error:num=18:self signed certificate
verify return:1
depth=0 /CN=osptestserver.transnexus.com/O=OSPServer
verify return:1
The certificate request was successful.
Error Code returned from localcert command : 0
```

Note: The `localcert.pem`, `pkey.pem` and `cacert_#.pem` files generated by the Enroll utility must be copied to the `/usr/local/etc/ser` directory.

Step 3. Compile SER with OSP

Obtain the SER code

Download SER 2.0.x from <http://www.iptel.org> or directly from CVS repository.

```
Export CVSROOT=:pserver:anonymous@cvs.berlios.de:/cvsroot/ser

cvs login - for password simply press the Enter key.

cvs co -r rel_2_0_0 sip_router
```

It will create a sub-folder starting with `sip_router`. The distribution comes with a variety of modules (under “modules” folder), includes the OSP Module.

Compile SER with the OSP module

Build SER with the OSP Module. This release of SER default does not compile OSP module. You have to change the `sip_router/Makefile` file to remove `osp` from the `exclude_modules` list. After that, log in as root, go to the `ser_router` folder and run “`make install`”. It will build the SER with all modules (including OSP), and distribute executable and configuration files around the system.

```
make clean; make install
```

Step 4. Configure SER

`ser.cfg` is the main configuration file for SER. It includes instructions for configuring SER, loading external modules, configuring modules and CPL (call processing language) instructions. By default, the SER looks for the configuration file in `/usr/local/etc/ser`. SER includes a sample `ser.cfg` file, but it does not include instructions for using the OSP Module. Instead of using the default `ser.cfg`, use the sample config file `modules/osp/etc/sample-osp-ser.cfg`. Copy this file to overwrite the default configuration - `/usr/local/etc/ser/ser.cfg`.

```
cp modules/osp/etc/sample-osp-ser.cfg /usr/local/etc/ser/ser.cfg
```

The only parameter that must be configured in the `ser.cfg` is the location of a peering server. Edit the file and update the value of “`sp1_uri`” parameter to indicate the URL of the peering server. Configuring other `sp_uri` parameters to load share and add redundancy with other peering servers is recommended. Two other parameters which are recommended for editing are “`device_ip`” and “`token_format`”. More details on these parameters are provided in the `sample-osp-ser.cfg` file. Appendix 1 provides detail on all OSP Module parameters.

An additional tuning adjustment for optimizing SER is to decrease the number of TCP synchronization retries made by the Linux operating system when a TCP connection fails. Setting this parameter to 0 or 1 will decrease post dial delay when a TCP connection to a destination peer is not possible. Reducing TCP synchronization retries by the operating system will speed call fail-over to the next destination peer. To change this parameter, open the file `/etc/sysctl.conf` and add the entry `net.ipv4.tcp_syn_retries = 1`. Reboot the computer and check the parameter entry was accepted by typing `cat /proc/sys/net/ipv4/tcp_syn_retries`. It should display "1".

Step 5. Run SER

Running SER requires root privileges. To start the SER, use the following command

```
/usr/local/sbin/serctl start
```

Frequently Asked Questions

This section includes common questions about the OSP Module with SER along with answers. If your question was not answered here, please submit your question to the OSP mailing list at <https://lists.sourceforge.net/lists/listinfo/osp-toolkit-client>.

Where are OSP Module log messages written?

Log messages are sent to the sys-log application and will be logged according to the logger's configuration. Look for the messages in the `/var/log/messages` file.

Can multiple instances of SER be run on the same machine?

It is possible to run more than one SER on the same computer. The simplest way is to create a second `ser.cfg` and edit the port number from 5060 to a different port number. When starting the second SER, instead of using the `rpm/ser.init` script, explicitly specify where the configuration file is using the `-f config-file.ser` flag. If the second SER requires a different set of certificates, uncomment and update the "private_key", "local_certificate" and "ca_certificate" variables in the configuration file.

Can I use both TCP and UDP for communication?

SER supports both UDP and TCP. A peering response does not explicitly indicate which transport protocol to use for communicating to the terminating SIP proxy or user agent. By default, SER uses to UDP. Insure that the terminating proxy or UA is defined on the peering server as a SIP device. This will instruct the peering server to use a compressed peering token, small enough to fit into a single UDP packet.

How is OSP authentication different from password or access list authentication?

The OSP Module implements Public Key Infrastructure (PKI) services to securely authenticate and authorize peer to peer calling among SIP proxies. If the SIP INVITE received by SER includes a peering authorization token, the OSP Module will validate the peering token was digitally signed by the SER's peering authority. If the token is valid the SER will accept the call. If not, SER will reject the call.

The OSP Module uses the public key of its peering authority to verify that its peering authority signed the peering token (standard asymmetric cryptography). When compared to access lists or passwords for peer to peer authentication and authorization, PKI services offer improved security and scalability. Passwords, shared secrets or symmetric keys are prone to security breaches. Access lists have limited scalability. Managing an access list that contains hundreds of addresses and changes frequently is a major operations challenge. Secure peering using PKI services eliminates these limitations.

Why is time synchronization with the OSP peering server important?

Peering authorization tokens have a limited life – usually five minutes. If the time of day of SER differs by more than five minutes from its peering server, peering tokens from SIP INVITES received from other peers will be invalid and calls will be rejected. The simple solution is for all peers to use Network Time Protocol (ntp) to maintain time synchronization.

Appendix 1 - OSP Module Parameters

This Appendix provides a detailed explanation of all OSP Module parameters that may be included in the `ser.cfg` file. Information on OSP Module functions can be found in the "OSP Module for Secure, Multi-Lateral Peering" document located at: <http://www.iptel.org/views/moduledocs>.

sp1_uri, sp2_uri, ..., sp16_uri

These `sp_uri` (string) parameters define OSP peering servers which may be queried for peering authorization and routing information. At least one OSP peering server must be configured. Configuring additional OSP peering servers is recommended for reliability, but not required. Each peering server address takes the form of a standard URL, and consists of up to four components:

- An optional indication of the protocol to be used for communicating with the peering server. Both HTTP and HTTP secured with SSL/TLS are supported and are indicated by "http://" and "https://" respectively. If the protocol is not explicitly indicated, the SER defaults to HTTP secured with SSL.
- The Internet domain name for the peering server. An IP address may also be used, provided it is enclosed in square brackets such as [172.16.1.1].
- An optional TCP port number for communicating with the peering server. If the port number is omitted, the SER defaults to port 1080 (for HTTP) or port 1443 (for HTTP secured with SSL).
- The uniform resource identifier for requests to the peering server. This component is not optional and must be included.

Examples:

```
modparam("osp", "sp1_uri", "http://osptestserver.transnexus.com:1080/osp")
modparam("osp", "sp2_uri", "https://[1.2.3.4]:1443/osp")
```

device_ip

`device_ip` (string) is a recommended parameter that explicitly defines the IP address of SER in a peering request message (as SourceAlternate type=transport). The IP address must be in brackets as shown in the example below.

Example:

```
modparam("osp", "device_ip", "[1.1.1.1]")
```

token_format

When SER receives a SIP INVITE with a peering token, the OSP Module will validate the token to determine whether or not the call has been authorized by a peering server. Peering tokens may, or may not, be digitally signed. The `token_format` (integer) parameter defines if SER will validate signed or unsigned tokens or both. The values for `token_format` are defined below. The default value is 2.

- 0 - Validate only signed tokens. Calls with valid signed tokens are allowed.
- 1 - Validate only unsigned tokens. Calls with valid unsigned tokens are allowed.
- 2 - Validate both signed and unsigned tokens are allowed. Calls with valid tokens are allowed.

Example:

```
modparam("osp", "token_format", 2)
```

private_key
local_certificate
ca_certificates

These parameters identify crypto files are used for validating peering authorization tokens and establishing a secure channel between SER and a peering server using SSL. The files are generated using the 'Enroll' utility from the OSP Toolkit. By default, the proxy will look for `pkey.pem`, `localcert.pem`, and `cacert_0.pem` in the default configuration directory. The default config directory is set at compile time using `CFG_DIR` and defaults to `/usr/local/etc/ser/`. The files may be copied to the expected file location or the parameters below may be changed.

Example: If the default `CFG_DIR` value was used at compile time, the files will be loaded from:

```
modparam("osp", "private_key", "/usr/local/etc/ser/pkey.pem")
modparam("osp", "local_certificate", "/usr/local/etc/ser/localcert.pem")
modparam("osp", "ca_certificates", "/usr/local/etc/ser/cacert_0.pem")
```

sp1_weight, sp2_weight, ..., sp16_weight

These `sp_weight` (integer) parameters are used for load balancing peering requests to peering servers. These parameters are most effective when configured as factors of 1000. For example, if `sp1_uri` should manage twice the traffic load of `sp2_uri`, then set `sp1_weight` to 2000 and `sp2_weight` to 1000. Shared load balancing between peering servers is recommended. However, peering servers can be configured as primary and backup by assigning a `sp_weight` of 0 to the primary server and a non-zero `sp_weight` to the back-up server. The default values for `sp1_weight` and `sp2_weight` are 1000.

Example:

```
modparam ("osp", "sp1_weight", 1000)
```

device_port

The `device_port` (string) parameter is an optional field which includes the SIP port being used by SER in the peering request (as `SourceAlternate type=network`) to the peering server. If is not configured, this information is not included in the peering request. This field is useful if multiple SERs are running on the same Linux computer since it enables the peering server to administer different peering policies based on different SIP proxies. This parameter has not been implemented yet.

Example:

```
modparam ("osp", "device_port", "5060")
```

enable_crypto_hardware_support

The `enable_crypto_hardware_support` (integer) parameter is used to set the cryptographic hardware acceleration engine in the openssl library. The default value is 0 (no crypto hardware is present). If crypto hardware is used, the value should be set to 1.

Example:

```
modparam ("osp", "enable_crypto_hardware_support", 0)
```

ssl_lifetime

The `ssl_lifetime` (integer) parameter defines the lifetime, in seconds, of a single SSL session key. Once this time limit is exceeded, the OSP Module will negotiate a new session key. Communication exchanges in progress will not be interrupted when this time limit expires. This is an optional field with default value is 200 seconds.

Example:

```
modparam ("osp", "ssl_lifetime", 200)
```

persistence

The `persistence` (integer) parameter defines the time, in seconds, that an HTTP connection should be maintained after the completion of a communication exchange. The OSP Module will maintain the connection for this time period in anticipation of future communication exchanges to the same peering server.

Example:

```
modparam ("osp", "persistence", 1000)
```

retry_delay

The `retry_delay` (integer) parameter defines the time, in seconds, between retrying connection attempts to an OSP peering server. After exhausting all peering servers the OSP Module will delay for this amount of time before resuming connection attempts. This is an optional field with default value is 1 second.

Example:

```
modparam ("osp", "retry_delay", 1)
```

retry_limit

The `retry_limit` (integer) parameter defines the maximum number of retries for connection attempts to a peering server. If no connection is established after this many retry attempts to all peering servers, the OSP Module will cease connection attempts and return appropriate error codes. This number does not count the initial connection attempt, so that a `retry_limit` of 1 will result in a total of two connection attempts to every peering server. The default value is 2.

Example:

```
modparam ("osp", "retry_limit", 2)
```

timeout

The `timeout` (integer) parameter defines the maximum time in milliseconds, to wait for a response from a peering server. If no response is received within this time, the current connection is aborted and the OSP Module attempts to contact the next peering server. The default value is 10 seconds.

Example:

```
modparam ("osp", "timeout", 10)
```

max_destinations

The `max_destinations` (integer) parameter defines the maximum number of destinations that SER requests the peering server to return in a peering response. The default value is 5.

Example:

```
modparam ("osp", "max_destinations", 5)
```

validate_call_id

The `validate_call_id` (integer) parameter instructs the OSP module to validate call id in the peering token. If this value is set to 1, the OSP Module validates that the call id in the SIP INVITE message matches the call id in the peering token. If they do not match the INVITE is rejected. If this value is set to 0, the OSP Module will not validate the call id in the peering token. The default value is 1

Example:

```
modparam ("osp", "validate_call_id", 1)
```

use_rpid_for_calling_number

The `use_rpid_for_calling_number` (integer) parameter instructs the OSP module to use the calling number in the Remote-Party-ID of the SIP INVITE message. If this value is set to 1, the OSP Module uses the calling number in the Remote-Party-ID header of the INVITE message when a Remote-Party-ID exists. If this value is set to 0, the OSP Module will use the calling number in the From header of the INVITE message. The default value is 1

Example:

```
modparam ("osp", "use_rpid_for_calling_number", 1)
```