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Druid® Unified Communications Server (UCS)
Open Source Edition (OSE)

Technical Application Notes

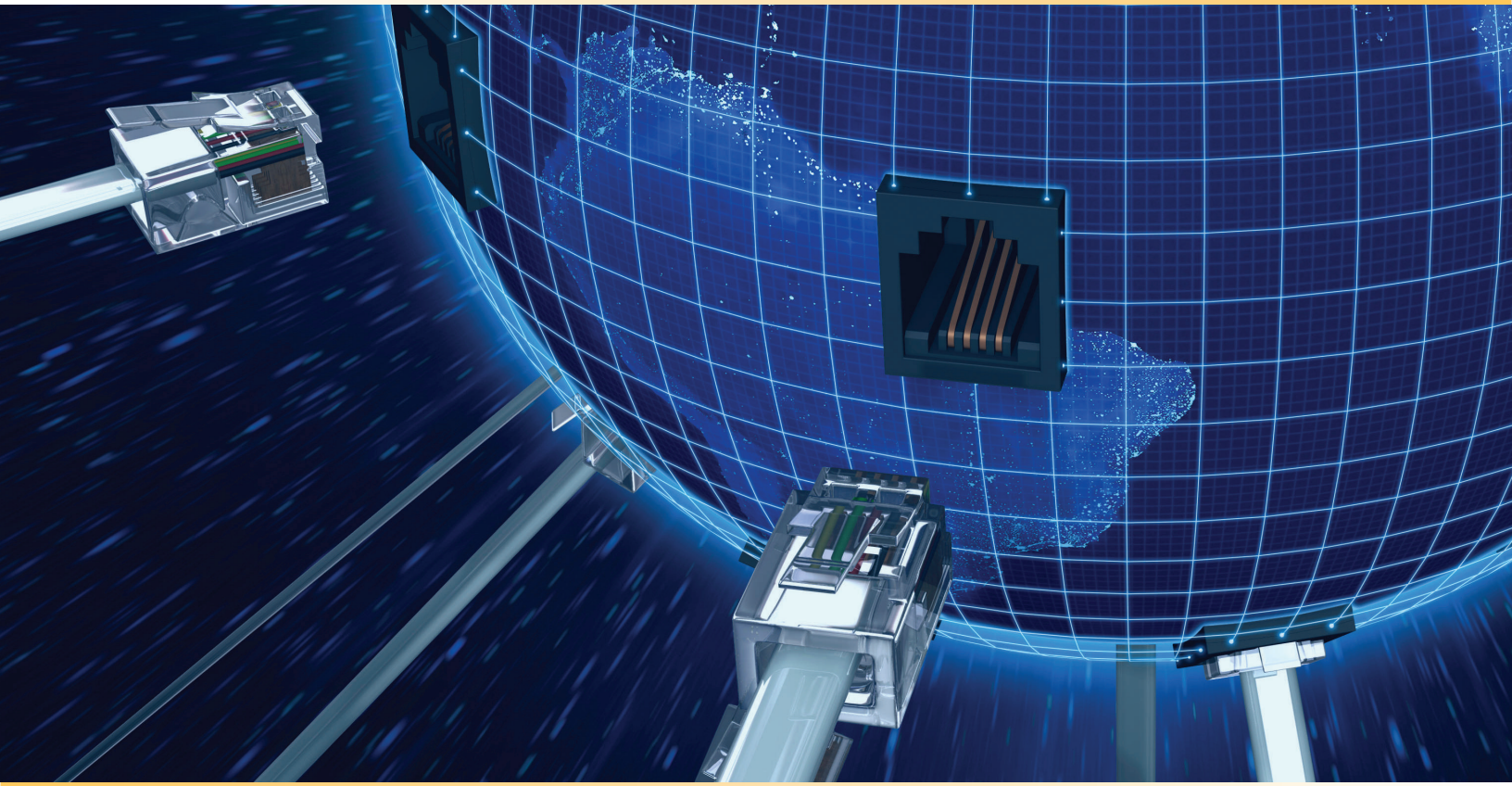

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Table of Contents

About Druid OSE

Voiceroute® created Druid® Unified Communications Server (UCS) Open Source Edition (OSE) and released it as open source software under the GNU General Public License (GPL). It is available free of charge as a download from the Internet for developing advanced communication solutions. Druid UCS can switch calls, manage call routing and connect calls over Internet Protocol (IP), Plain Old Telephone Service (POTS) and digital connections, to list just a few of its capabilities. It runs on Linux and can interoperate with almost all standards-based telephony equipment.

Druid UCS supports Session Initiation Protocol (SIP), making it an ideal choice for use in conjunction with Broadvox GO! SIP Trunking. For more information about Druid UCS OSE, visit www.voiceroute.org.

Purpose, Scope and Audience

This technical application note describes the configuration of Druid UCS OSE for the Broadvox GO! SIP Trunking service. This document is suitable for use by anyone deploying the Broadvox GO! SIP Trunking service in conjunction with Druid UCS OSE. This document has a technical audience in mind – specifically IT professionals skilled in Linux with some experience in PBX administration and familiarity with VoIP technologies. This document is not for business administrators or people in other non-technical careers. In order to successfully use this document to deploy Broadvox GO! SIP Trunking service, you will need to possess the following skills, or have access to professionals or consultants with the following skills:

- Understanding of UNIX or Linux operating systems, including:
  - Understanding of file and directory structure on target OS
  - Understanding of firewall configuration on target OS
  - Understanding of network configuration on target OS
  - Understanding of service configuration on target OS
- Familiarity with network troubleshooting tools, including:
  - Wireshark/Ethereal
  - dig/nslookup
  - ping
  - traceroute
- Familiarity with PBX systems, including:
  - Trunk configuration
  - Calling plan configuration
  - Extension configuration
  - Mailbox configuration
- Familiarity with Session Initiation Protocol (SIP)
- An understanding of all seven layers of the Open System Interconnection (OSI) model
- A complete understanding of your internal network structure, Network Address Translation (NAT) setup, and firewall setup
- A complete understanding of your public Internet connectivity

Broadvox can only provide support for Druid UCS OSE to the extent covered in this Technical Application Note and the included reference configuration, so if your level of technical expertise does not include the above skills, it is recommended that you obtain the services of a software professional.

Druid UCS OSE Deployment Information

Before you begin deploying Druid UCS OSE, please locate the following information. If you have questions about any item, refer to the descriptions and additional details provided on the pages that follow.

Druid UCS External IP Address: _____._____._____._____

Max Calls For GO!Local: 6 12 18 Other: _____

Preferred Codec: ulaw g729

Alternate Codec: ulaw g729

Is Druid UCS NATd: Yes No

Is Druid UCS Behind a Firewall: Yes No

Is There a Local Firewall: Yes No

Druid UCS OSE External IP Address

Your Druid UCS OSE server will either use a public IP address or a private IP address. If the IP address on your Druid UCS OSE server is of the form 192.168.x.x, 172.16.x.x – 172.31.x.x, or 10.x.x.x, then your Druid UCS OSE server uses an internal, private IP address. This internal address is not routable on the public Internet. In order for your Druid UCS OSE server to connect to the Broadvox Session Border Controller (SBC), you must either have a public IP address on your Druid UCS OSE server or you must translate your private IP address into a public IP address using a Network Address Translator (NAT).

If your Druid UCS OSE server is behind a NAT, your public IP address will typically be the public IP address of your NAT. You may also have a static, one-to-one mapping of a public IP address to your private IP address. In this case, your public IP address will not match the IP address of your NAT, but you can look up the correct public IP address in your NAT configuration. If in doubt, you can perform a network packet capture using Wireshark (previously called Ethereal) on the public side of your NAT while simultaneously issuing some form of Internet request on your Druid UCS OSE server.

Choosing the SIP Trunk Version

Broadvox offers two versions of SIP Trunking to meet your requirements. By default, Broadvox places most new customers on Version N. Version N supports dynamic IP addresses using registration, offers NAT Traversal, and offers automatic fall-back forwarding to PSTN numbers, either on a per-trunk basis, or a per-number basis.

If you anticipate using more than 1,000 simultaneous calls you should consider using Version S. The Version S trunks do not support registration, NAT Traversal, or automatic fall-back forwarding to PSTN numbers. However, Broadvox can offer up to four separate gateways across three cities to which you may send calls and from which you may receive calls (by default, Broadvox offers connectivity to two, but for very large customer implementations, can offer additional gateways). In addition, the Version S gateways are rated for a much higher call capacity than the Version N gateways, and offer more granular control of the specific signaling and media profiles for your trunk. The more granular control allows Broadvox to be more flexible in accommodating any special requirements you may have.

Sending Calls to Broadvox

In your Welcome letter, Broadvox provides IP addresses to which you may send calls, and from which you should be prepared to receive calls. Druid UCS OSE supports DNS A records, DNS SRV records, and IP addresses. Broadvox recommends that you use IP addresses in Druid UCS OSE. Broadvox uses two Welcome letters depending on which version of services you are on. Version S uses two entirely separate servers to provide high availability. Version N uses a cluster and a virtual IP address to provide high availability. In the figure below, you can see the three main sections for Version S.

Allow These Media IPs - UDP Ports Up To 65535			
64.158.162.71	64.158.162.100	64.152.60.71	64.152.60.164

Trunk Number	Turn-up Ticket	Trunk Type	BTN	Source IP
1234567	23456	GO!Anywhere	5551234567	127.0.0.1
2345678	23456	GO!Domestic	NA	127.0.0.1

Trunk Number	DNS A Record	DNS SRV Record	IP Addr 1	IP Addr 2
2345678	east.gd.broadvox.net	psrveast.gd.broadvox.net	64.158.162.76	64.152.60.76
1234567	east.ga.broadvox.net	psrveast.ga.broadvox.net	64.158.162.75	64.152.60.75
	east1.ga.broadvox.net	psrveast1.ga.broadvox.net	64.158.162.101	64.152.60.165
	east2.ga.broadvox.net	psrveast2.ga.broadvox.net	64.158.162.102	64.152.60.166
	east3.ga.broadvox.net	psrveast3.ga.broadvox.net	64.158.162.103	64.152.60.167
	east4.ga.broadvox.net	psrveast4.ga.broadvox.net	64.158.162.104	64.152.60.168

Figure 1: Version S Welcome Letter

The first section lists the IP addresses from which you will receive media. These IP addresses must be allowed through your firewall. You may receive media from any UDP port from 1024 up to 65535 from any of these addresses.

The second section lists each of your trunks, the service ticket number which contains your turn-up information, the type of the trunk, the BTN for the trunk, if

any, and the source IP address Broadvox has configured on our end from which it is expected to receive your calls and to which calls are directed to your numbers. The Source IP that Broadvox has listed **must** match the Druid UCS OSE External IP Address you listed on the previous page.

In the third section, Broadvox has provided signaling addresses to you for each trunk group. You will notice that the trunk group number listed matches the trunk group number from the second section. This tells you which trunk sends to which IP address. If you input the incorrect IP address for the trunk, you may end up paying much more for your calls than anticipated. For instance, if you swap the two IPs (send your GO!Domestic traffic to the .75 address listed for your GO!Local trunk, and your GO!Local traffic to the .76 address listed for your GO!Domestic trunk) then your GO!Domestic calls will be rated as LD from the GO!Local trunk LD minutes, if you have them. (If you do not have a bundle of LD minutes on the GO!Local trunk there is typically a charge of 3.5 cents per minute), and your GO!Local local calls will be rated as LD calls from the LD bundle you purchased for the GO!Domestic trunk. Obviously, this could result in much higher expenses than you anticipated, so be certain you send traffic to the correct address! If you utilize different IP addresses for each trunk on your end, then the calls will fail if you send them to the incorrect location.

In the Version N Welcome letter, the media IP addresses are different, and there is only one signaling IP address for each trunk instead of two, as you can see in the image below. Also, you will notice that Version N contains a Password field for each trunk. This field will contain a password for your trunk if you are using registration. If you are not using registration, the Source IP field will be filled out instead. When utilizing registration, Broadvox obtains the IP address from your register request.

Trunk Number	Turn-up Ticket	Trunk Type	BTN	Source IP	Password

Trunk Number	DNS A Record	DNS SRV Record	IP Addr 1
	dfwnx01gd.pa.broadvox.net	dfwnx01gd.psrv.broadvox.net	209.249.3.57
	dfwnx01ga1.pa.broadvox.net	dfwnx01ga1.psrv.broadvox.net	209.249.3.59
	dfwnx01ga2.pa.broadvox.net	dfwnx01ga2.psrv.broadvox.net	209.249.3.100
	dfwnx01ga3.pa.broadvox.net	dfwnx01ga3.psrv.broadvox.net	209.249.3.101
	dfwnx01ga4.pa.broadvox.net	dfwnx01ga4.psrv.broadvox.net	209.249.3.102

Figure 2: Version N Welcome Letter

SRV Records

Service records (SRV) are a form of Domain Name System (DNS) record. They contain information about where to send requests for a particular service offered at a specific domain. In the case of Broadvox GO! SIP Trunking, they provide the IP addresses, port numbers, and preferences to use for sending SIP calls over UDP to Broadvox. The SRV location to use for sending calls to Broadvox for each of your trunk groups is in your Welcome letter.

Choose the correct server on page 5 based on the information in your Welcome letter. There is one caveat with using DNS records on Druid UCS OSE. Druid UCS OSE, by design, performs the DNS query on initial startup (or reload) and uses only one IP address for signaling to/from a peer. To configure Druid UC OSE to provide proper redundancy, you must use IP addresses instead of DNS. If you use IP addresses instead of DNS and remove one of the servers from DNS to perform a scheduled maintenance, your Druid UCS OSE server will continue to try to target that IP. This will add a small amount of post dial delay to your calls. Post dial delay (PDD) is the period of time between when you finish dialing a number and you start to receive ringing. Typically, the added delay will be less than 3 seconds but usually will be under 1 second.

Testing SRV Records

Most Broadvox GO! SIP Trunking customers like to ensure the DNS entries are functioning or they like to look up the actual IP addresses, however, performing a standard DNS query on the SRV records will fail. In a Windows environment, you can perform the query using the **`nslookup`** command at a command prompt, as shown in Figure 1.

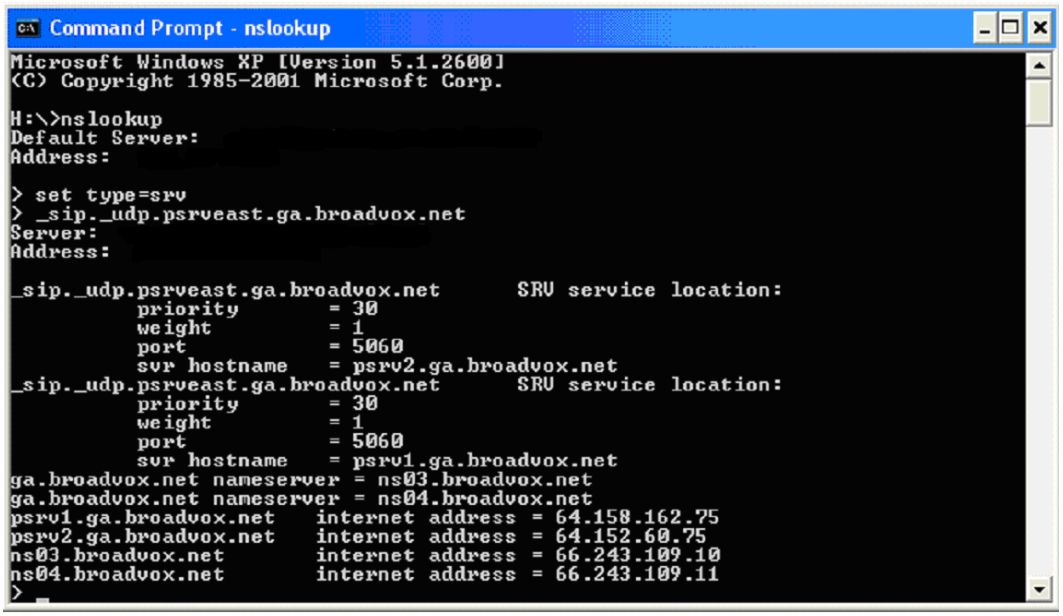

Figure 3: SRV Lookup in Windows XP

As you can see, a SRV record consists of a service type definition (_sip), a transport definition (_udp), and the domain (psrveast.ga.broadvox.net). Druid OSE will automatically add the service and transport definitions as a prefix to the domain before performing the query. The query returns a priority, weight, port and hostname for each entry. The query also returns the “A record” entries for each hostname, which provides the IP address for each host.

In a UNIX or Linux environment, you can perform a query on our SRV records using the **`dig`** command:

```
$ dig SRV  sip. udp.psrveast.ga.broadvox.net

; <<>> DiG 9.3.3 <<>> SRV  sip. udp.psrveast.ga.broadvox.net
;; global options:  printcmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 16950
;; flags: qr aa rd ra; QUERY: 1, ANSWER: 2, AUTHORITY: 2, ADDITIONAL: 4

;; QUESTION SECTION:
; sip. udp.psrveast.ga.broadvox.net. IN SRV

;; ANSWER SECTION:
 sip. udp.psrveast.ga.broadvox.net. 600 IN SRV  30 1 5060
psrv2.ga.broadvox.net.
 sip. udp.psrveast.ga.broadvox.net. 600 IN SRV  30 1 5060
psrv1.ga.broadvox.net.

;; AUTHORITY SECTION:
ga.broadvox.net.        600     IN      NS      ns04.broadvox.net.
ga.broadvox.net.        600     IN      NS      ns03.broadvox.net.

;; ADDITIONAL SECTION:
psrv1.ga.broadvox.net.  600     IN      A       64.158.162.75
psrv2.ga.broadvox.net.  600     IN      A       64.152.60.75
ns03.broadvox.net.      7200    IN      A       66.243.109.10
ns04.broadvox.net.      7200    IN      A       66.243.109.11

;; Query time: 2 msec
;; SERVER: 66.243.109.10#53(66.243.109.10)
;; WHEN: Wed Nov  7 12:30:24 2007
;; MSG SIZE  rcvd: 236
```

Max Calls For GO!Local

Broadvox offers three pre-defined options for maximum simultaneous calls on GO!Local trunks. In addition, custom pricing allows you to define your own number of maximum simultaneous calls. While Broadvox controls the maximum simultaneous call limits on our side, it is recommend that you configure your Druid UCS OSE server to limit calls locally.

Preferred and Alternate Codecs

Broadvox allows you to select preferred and alternate codecs to simultaneously meet your bandwidth requirements and provide greater end-to-end support. In the event that your destination party or your destination party's carrier cannot support your preferred codec or alternate codecs, Broadvox will automatically transcode your call to a supported codec.

When configuring codecs, please keep in mind that G.711 µLaw (ulaw) consumes approximately 87.2 Kbps of bandwidth per simultaneous call. G.729 Annex B (g729) will consume approximately 31.2 Kbps of bandwidth per

simultaneous call. Also, keep in mind that G.711 offers superior call quality when compared to G.729, but only if you have enough bandwidth to support all of your simultaneous calls.

Is Druid UCS OSE NATd

If your Druid UCS OSE server uses an Internet-facing IP address of the form 192.168.x.x, 172.16.x.x – 172.31.x.x, or 10.x.x.x, then it is almost certainly behind a Network Address Translation (NAT) device. If your server uses an address of that form and is not behind a NAT, then it has no connectivity to the Internet. Even if your server uses an IP address that does not match the forms above, it is still possible (though very unlikely) that it is behind a NAT. If Druid UCS OSE is behind a NAT, you may need to perform *port forwarding*, set up a *DMZ host* or configure a *one-to-one static IP map*.

Is Druid UCS OSE Behind a Firewall

If Druid UCS OSE is behind a NAT, then it is almost certainly behind a firewall. It is also possible that Druid UCS OSE uses a public IP address but is still behind a firewall. If you use a Cisco PIX, SonicWALL, Shorewall, Firebox, or any other brand of firewall, you may need to perform additional configuration steps on the firewall device to allow Druid UCS OSE to function properly. Additionally, you may be using an Application Gateway such as an Ingate SIParator. These devices will also need additional configuration to allow Druid UCS OSE to function properly. Configuring your firewall or application gateway is beyond the scope of this document. In general, you will need to allow UDP port 5060 in both directions, as well as UDP ports 10000 to 20000 for RTP. However, you may need a larger range of ports for RTP. Broadvox recommends allowing traffic on all UDP ports equal to or greater than 5060.

Is There a Local Firewall

In addition to being behind a firewall, it is also possible that the Druid UCS OSE server itself utilizes a local firewall. Typically, a UNIX or Linux operating system deploys Druid UCS OSE. These systems usually come with a firewall program installed, like **`iptables`**. If your server uses **`iptables`**, you can check to see if there are any rules in place by issuing the following commands:

```
$ iptables -L -v -n

Chain INPUT (policy ACCEPT 3549M packets, 4907G bytes)
 pkts bytes target     prot opt in     out     source
destination

Chain FORWARD (policy ACCEPT 0 packets, 0 bytes)
 pkts bytes target     prot opt in     out     source
destination

Chain OUTPUT (policy ACCEPT 688M packets, 51G bytes)
```

```
 pkts bytes target     prot opt in     out     source
destination

$ iptables -L -v -n -t nat

Chain PREROUTING (policy ACCEPT 1836K packets, 118M bytes)
 pkts bytes target     prot opt in     out     source
destination

Chain POSTROUTING (policy ACCEPT 2247K packets, 136M bytes)
 pkts bytes target     prot opt in     out     source
destination

Chain OUTPUT (policy ACCEPT 2247K packets, 136M bytes)
 pkts bytes target     prot opt in     out     source
destination

$ iptables -L -v -n -t mangle

Chain PREROUTING (policy ACCEPT 3551M packets, 4907G bytes)
 pkts bytes target     prot opt in     out     source
destination

Chain INPUT (policy ACCEPT 3549M packets, 4907G bytes)
 pkts bytes target     prot opt in     out     source
destination

Chain FORWARD (policy ACCEPT 0 packets, 0 bytes)
 pkts bytes target     prot opt in     out     source
destination

Chain OUTPUT (policy ACCEPT 688M packets, 51G bytes)
 pkts bytes target     prot opt in     out     source
destination

Chain POSTROUTING (policy ACCEPT 688M packets, 51G bytes)
 pkts bytes target     prot opt in     out     source
destination
```

The output shown above indicates that there are no firewall rules configured on this server. If you are using a different type of firewall software on your Druid UCS OSE server, you will need to consult the documentation for that software to learn how to check whether it is enabled. If you have a local firewall enabled, you will need to configure it to allow the appropriate ports, as described in “Is Druid UCS OSE Behind a Firewall”.

If you are using a standard iptables firewall setup, such as that used by a typical, modern Linux system, these rules may be of use to you in allowing the appropriate traffic from our Version N platform:

```
iptables -I INPUT -p udp --dport 5060 -s 209.249.3.59 -j ACCEPT
iptables -I INPUT -p udp --dport 1024:65535 -s 209.249.3.58 -j ACCEPT
iptables -I INPUT -p udp --dport 1024:65535 -s 209.249.3.60 -j ACCEPT
```

Please note, you may not be able to copy and paste these directly into a terminal program like SecureCRT, PuTTY, ZOC, etc. You may need to paste into Notepad or a similar text-only editor, and then copy and paste from there into the terminal program. This extra step should eliminate any hidden formatting characters that get copied along with the text (typically only applies when performing the copy and paste on a Microsoft platform).

Any rules you insert into iptables must be loaded each time the Druid UCS OSE server restarts. There are typically two methods to accomplish this. The first, and preferred method is to use the iptables save and restore functionality. On most platforms, you can simply issue one of these two commands:

```
/etc/init.d/iptables save
/etc/rc.d/iptables save
```

The second method is to use a start-up script to re-issue the commands that add the rules. Generally, you would create a file in `/etc/init.d` or the appropriate `/etc/rc.d` directory (based on your individual platform) that contains the commands to create the rules. You would then **`chmod`** the file so that it is executable. Next, you would either create a symbolic link in the appropriate `/etc/rc.d` directory, or you would add it to your '`local`' script which is responsible for executing any custom start-up commands.

If you require any further assistance in modifying your local firewall, please consult the documentation appropriate for your OS distribution and firewall program.

Configuring Druid for Version N SIP Trunking

First, log in to the Druid GUI using a web browser. You should see the home page depicted in Figure 4. Follow the instructions below to set up your system.

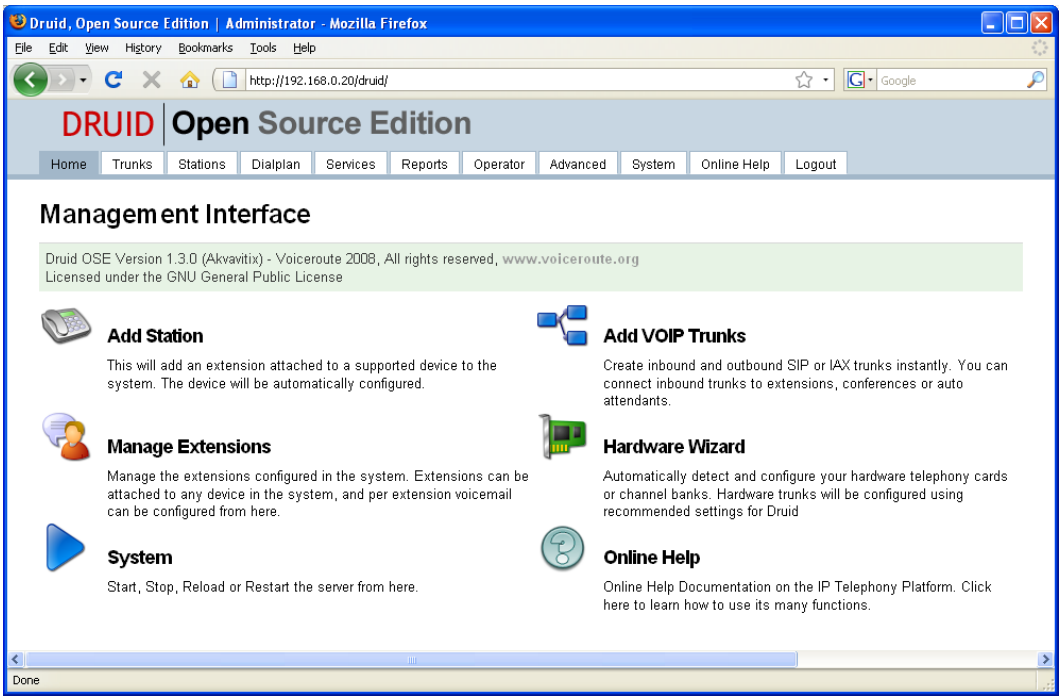

Figure 4: Druid Home

1. Click "Add Station"
2. A "New Extension Wizard" will open and allow you to choose a type of phone. Click on your phone type.

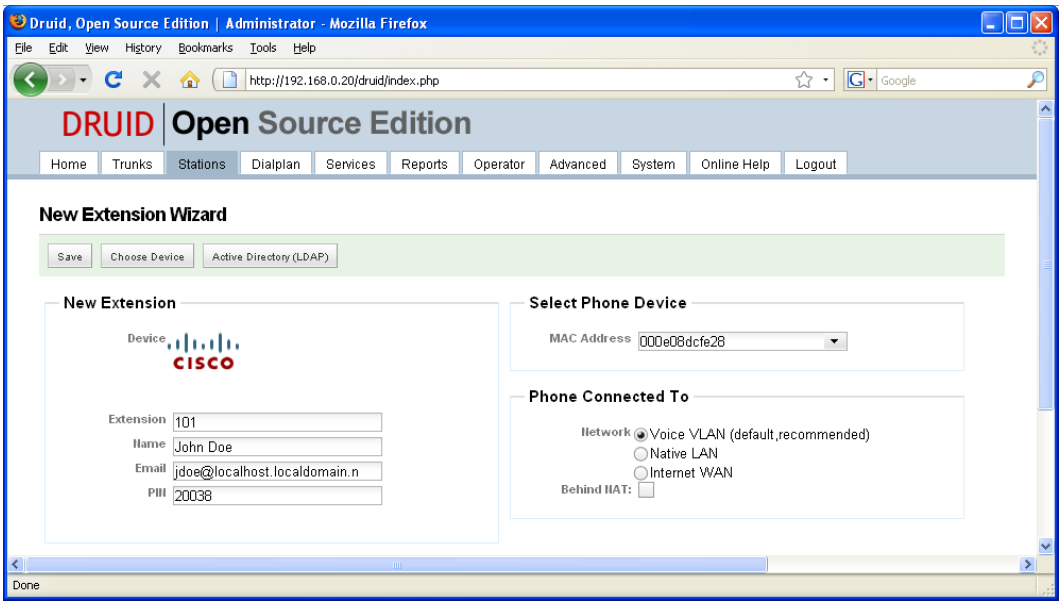

Figure 5: New Extension Wizard

3. Fill out the extension, name, E-mail, PIN, and MAC address for the new phone.
4. Click "Save".
5. On the "Trunks" menu, click "VoIP Trunk Wizard".

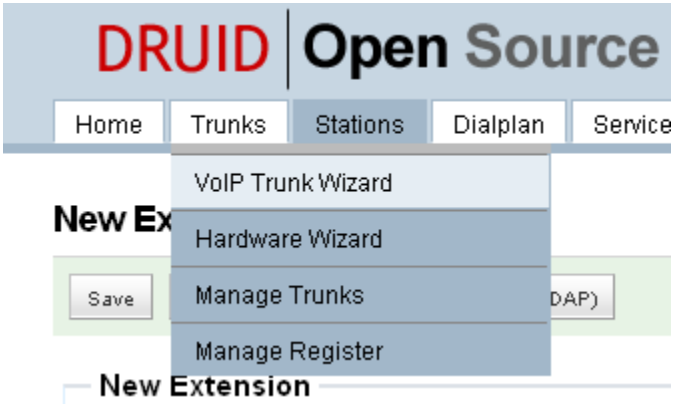

Figure 6: VoIP Trunk Wizard Menu

6. Fill out the Trunk Definition as detailed in Figure 7. This assumes that 5551234567 is your BTN and "mypassword" is your password.

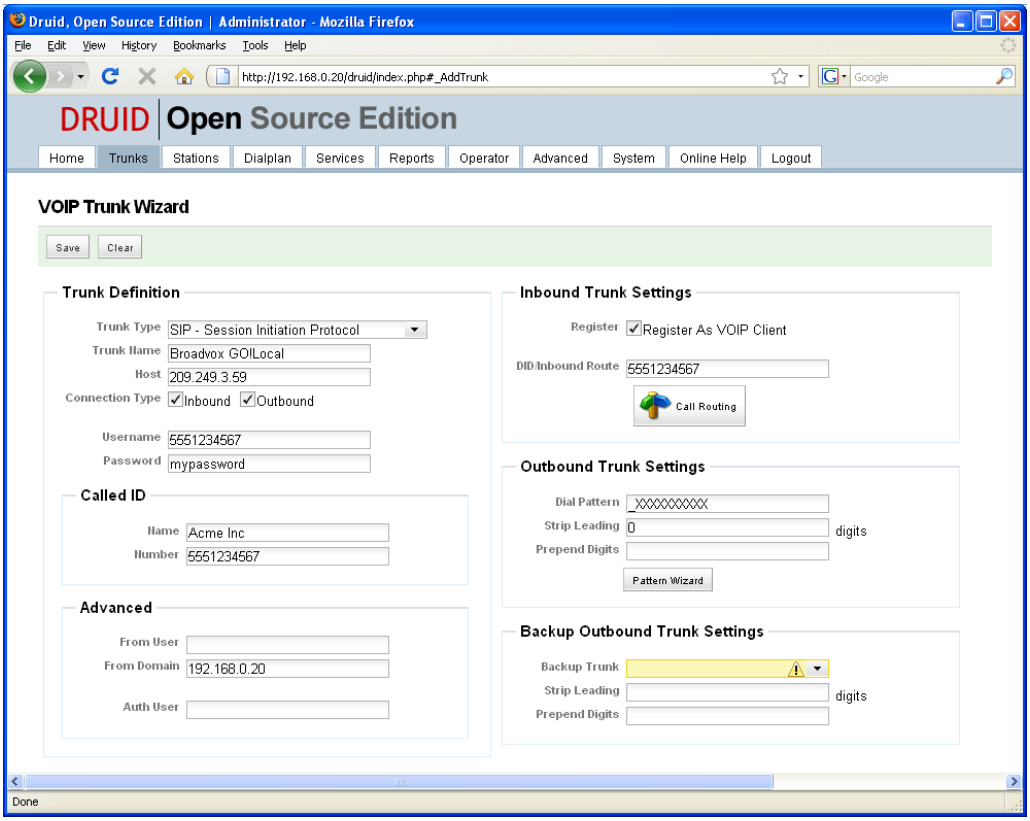

Figure 7: Trunk Definition

This information is contained in your welcome letter, as depicted in Figure 1 in the section titled *Sending Calls to Broadvox*. Make sure you enter the correct IP address for your GO!Local trunk, or you may incur additional charges.

7. Enter your BTN in the "DID/Inbound Route" box.
8. Click the "Call Routing" button.
9. In the blue "Default Call Route" section, select "Extension" and then the extension you configured previously.

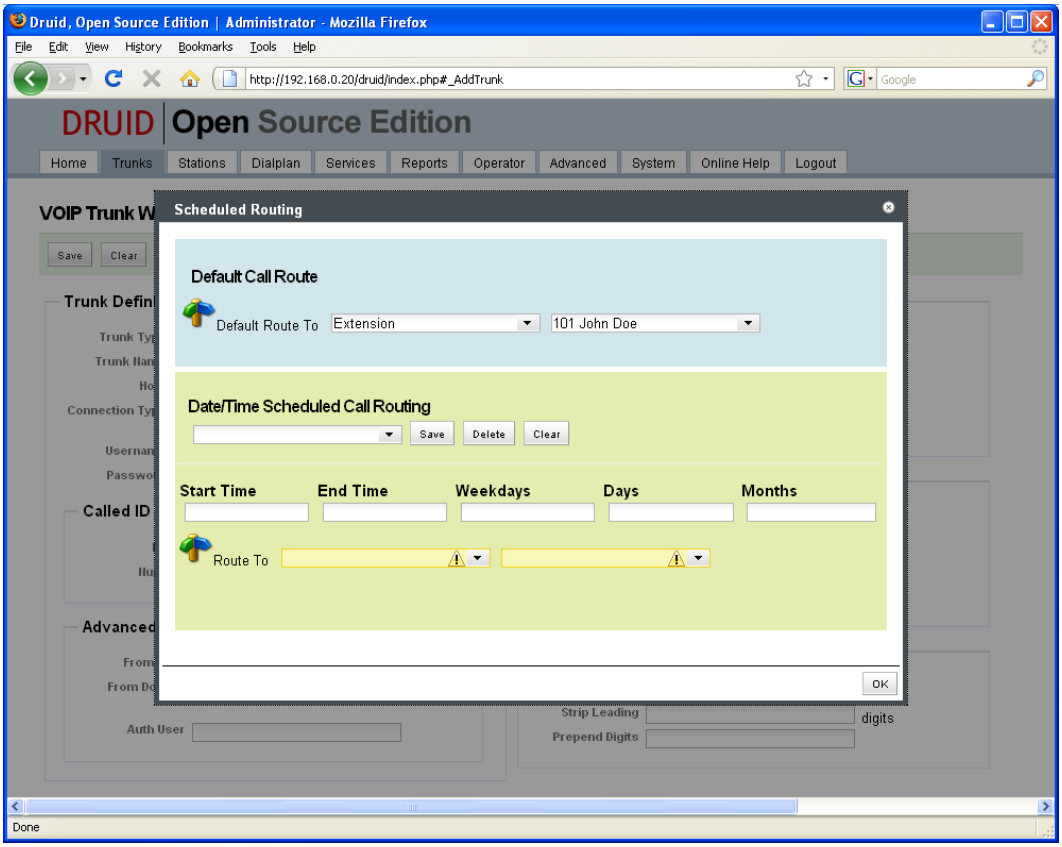

Figure 8: Default Call Route for BTN

10. Click the "OK" button.
11. Click the "Pattern Wizard" button.
12. Enter a name for your pattern at the top. For example, "GO!Local Calling Pattern".
13. In field #1, clear any entries (make the field blank).
14. In field #2, select "fixed" and "10". This will matched all 10-digit dialed numbers.
15. In field #3, enter a zero (0).
16. In field #4, make sure it is blank.
17. Click the "Save" button.
18. Click the "OK" button.

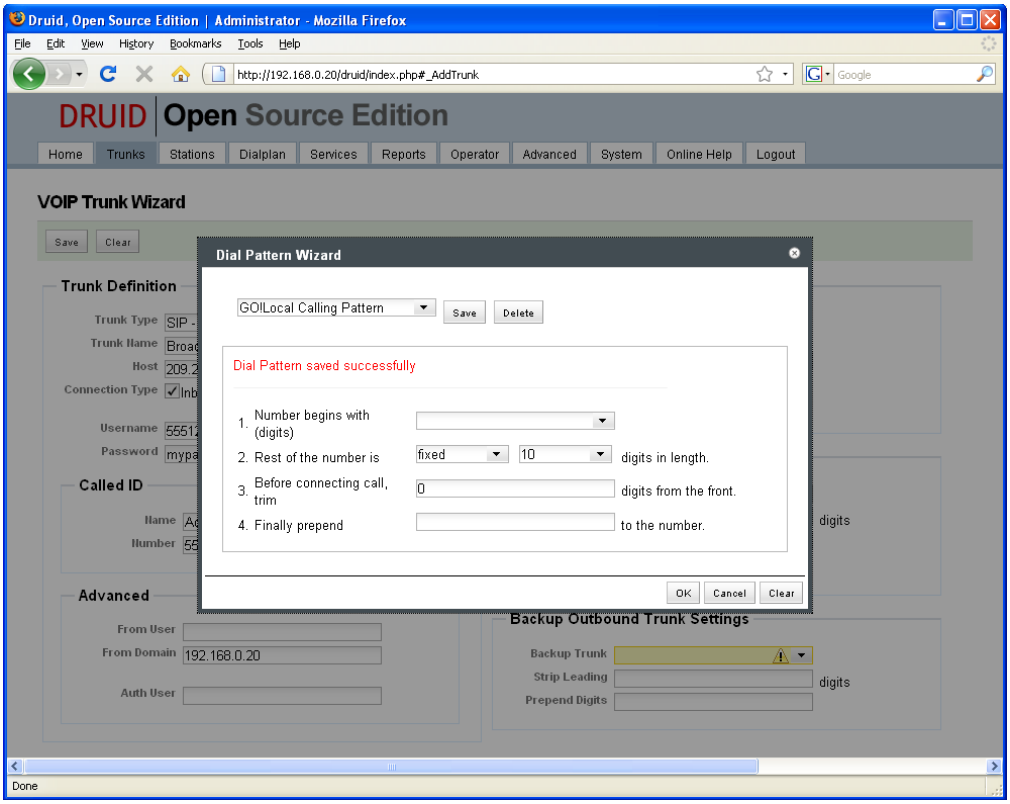

Figure 9: GO!Local Calling Pattern

19. Finally, click the "Save" button on the VoIP Trunk Wizard.
20. Under the "Trunks" menu tab, click on "Manage Register."
21. Click on "Edit" next to the entry for your BTN.
22. Remove the local extension.

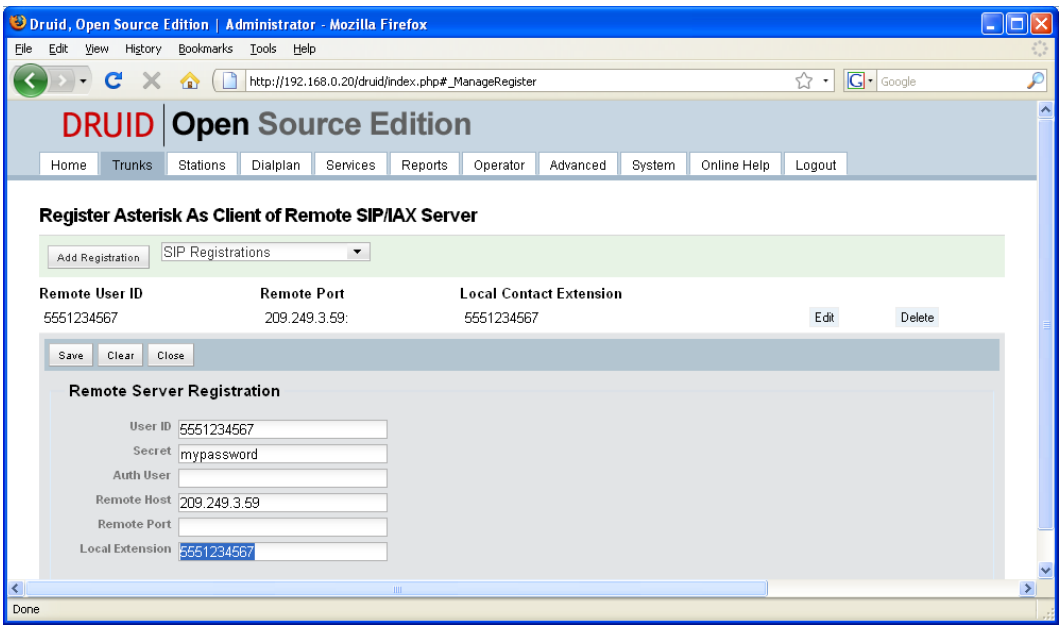

Figure 10: Manage Register

23. Click "Save."

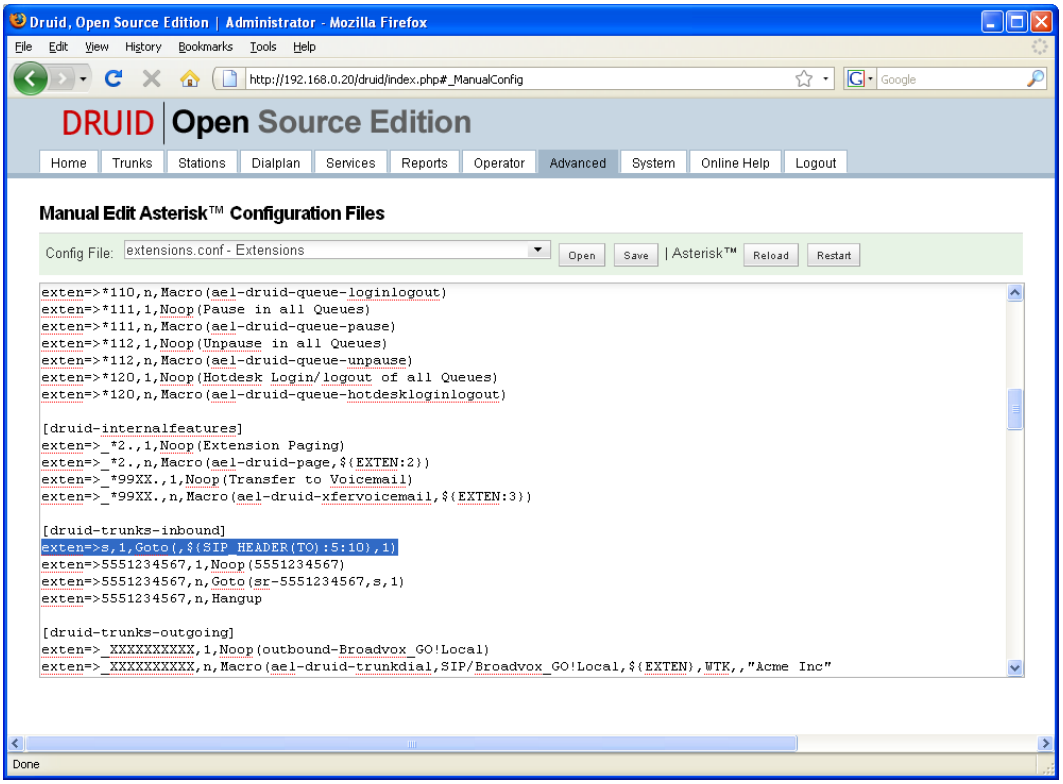

Figure 11: Manual Edit Extensions.conf

24. Under the "Advanced" tab, click on "Manual Edit Configs."
25. Select the "extensions.conf - Extensions" in the drop-down and click "Open."
26. Locate the section called "[druid-trunks-inbound]".
27. Immediately below the start header for this section, enter "exten=>s,1,Goto(,${SIP_HEADER(TO):5:10},1)", as shown in the highlighted text in Figure 11. This forces Druid to route calls based on the "To:" header field instead of the Request-URI.
28. Under the "Trunks" tab, click "Manage Trunks."

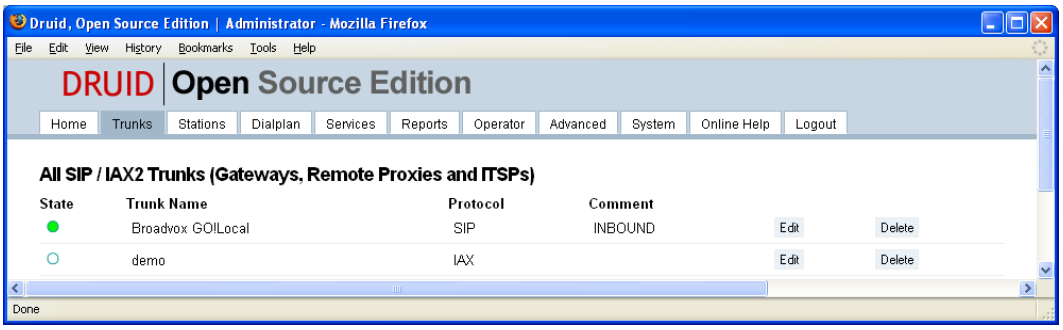

Figure 12: Manage Trunks

29. You should see a green dot next to the GO!Local trunk you created.
30. Delete the demo trunk.
31. Just to make certain everything worked correctly, go to the "Reports" tab and click on "Asterisk Log."

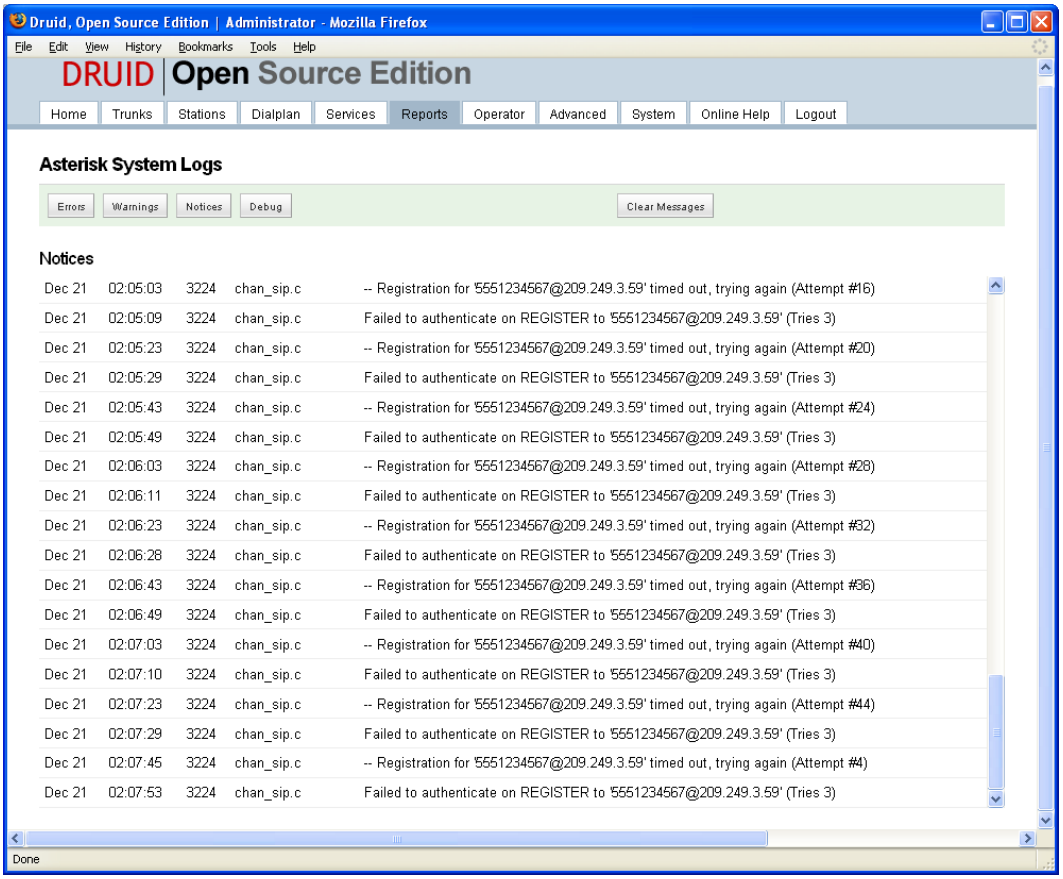

Figure 13: Asterisk Logs

32. Ensure you do not see any "Failed to authenticate" messages similar to those shown in Figure 13.

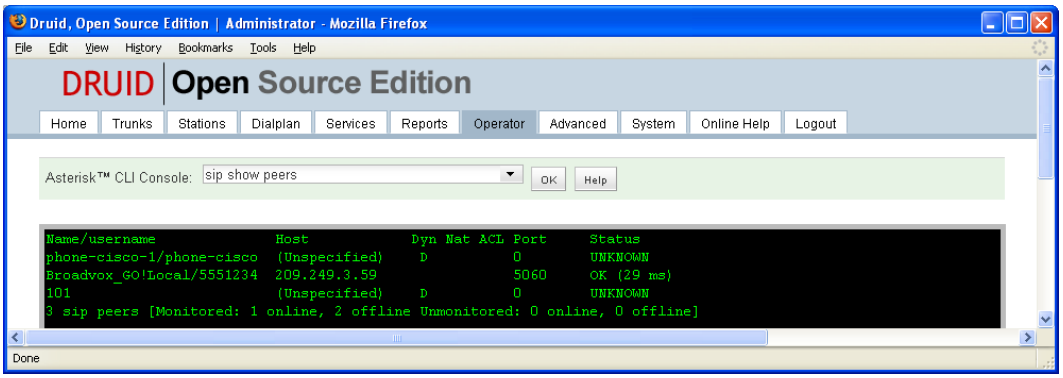

Figure 14: CLI Console

33. You may also go to the "Operator" tab and select "CLI Console."
34. Enter the command "sip show peers."
35. This output should verify that the trunk is registered. In addition, you can see if your phone is registered.

This concludes configuration of the Druid UCS OSE platform for Broadvox Version N SIP Trunking based on a single, GO!Local trunk group.

You may wish to configure a route for long distance calls dialed with a "1" in front of the number. You may do this under the "Dial Plan" tab using "Outbound Dialing Rules". If you ordered a GO!Domestic trunk along with your GO!Local trunk, you should run through this process again from step 5 through step 23. This time, in step 13, enter a "1" and in step 14, enter "11". This will point long distance calls (calls dialed with a "1" in front of them) to the GO!Domestic trunk.

You may optionally enable 7-digit dialing by entering "7" in step 14 and entering your area code (NPA) in step 15. This will take any 7-digit dialed numbers and prepend them with your area code prior to sending them to Broadvox.

If you plan to use 911, 411, or 711, be sure to create outbound dialing rules for them and point them to your GO!Local trunk. Also, be certain you are sending the correct calling number on calls to 911!

Illustrations