TFTP Provisioning for SPA and PAP2 Product Families

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1. Automatic In-House Pre-Provisioning

A newly manufactured SPA will automatically attempt to resync to a specific file on a TFTP server, whose IP address is offered as one of the DHCP provided parameters. Thus, if desired, a service provider can arrange to connect each new SPA to a LAN environment configured to pre-provision SPAs. Any new SPA connected to this LAN would automatically resync to the local TFTP server, initializing its internal state in preparation for deployment. Among other parameters, this pre-provisioning step will configure the URL of the unit's provisioning server.

Subsequently, when a new customer signs up for service, any pre-provisioned SPA can be simply bar-code scanned, to record its MAC address or serial number, before being shipped to the end-customer. Upon receiving the unit, the customer only needs to connect it to their broadband connection (possibly through a router). On power-up the SPA would already know which server to contact for its periodic resync update.

1.1. Fallback Options

The use of HTTPS with both server and client certificates for authentication provides the most straightforward means of provisioning and managing the Linksys voice end-points remotely. But in addition, the device firmware supports alternative means of remote provisioning. These may be useful in particular situations, depending on the specific requirements of the deployment.

1.1.1. HTTP with encrypted profiles

As an alternative to HTTPS, the SPA can resync to a configuration profile using HTTP. In this case, a separate explicit profile encryption can be used instead of SSL. The SPA supports 256-bit AES in CBC mode to pre-encrypt individual profiles. These can then be downloaded by the SPA "in the clear", using HTTP.

This resync mode may be useful to reduce the computational load on the provisioning server, with respect to using HTTPS for every resync request.

1.1.2. TFTP for LAN deployments

In a small deployment within a single LAN environment, it is often common to rely on a simple TFTP server for provisioning of network devices. Linksys voice devices support TFTP for both provisioning resync and firmware upgrade operations.

TFTP is especially useful for the in-house pre-provisioning of a large number of un-provisioned devices.

2. Tutorial

2.1. TFTP Resync

A Linksys voice device can be instructed to fetch a configuration profile from a provisioning server, and to update its internal configuration accordingly. Linksys voice products offer two profile formats, one based on an open published syntax, and one based on an unpublished binary definition. The open configuration profile format is based on text files, with a simple xml-like syntax.

The SPA supports multiple network protocols for retrieving configuration profiles. The most basic profile transfer protocol for an SPA is TFTP (RFC1350). TFTP is widely used for the provisioning of network devices within private LAN networks. Although not recommended for deployments of end-points across the internet, it can be convenient for deployment within small organizations, for in-house pre-provisioning, and for development.

The configuration profile format follows an xml-like syntax. Here's a basic self-contained configuration profile:

```
<flat-profile>
  <GPP_A> 12345678
  </GPP_A>
</flat-profile>
```

The `<flat-profile>` element tag encloses all parameter elements to be recognized by the SPA. The example above defines one parameter value, the first general purpose parameter (GPP_A), with a value of 12345678.

Exercise:

1. Within a LAN environment connect a PC and an SPA to a hub, switch, or small router. Connect an analog phone to the Phone 1 port of the SPA.
2. On the PC, install and activate a TFTP server.
3. Using a text editor, create the configuration profile displayed in the figure above, and save it with the name `basic.txt` in the virtual root directory of the installed TFTP server.
4. If possible, verify that the TFTP server is properly configured by requesting the basic.txt file using a TFTP client other than the SPA itself. Preferably, the TFTP client should be run on a separate host from the server.
5. Using the analog phone, obtain the local IP address of the SPA (IVR menu * * * * 1 1 0 #).
6. If the SPA's configuration has been modified since it was received, perform manufacturing reset on it via IVR (IVR menu option * * * * R E S E T #).
7. Open the PC's web browser and visit the SPA admin/advanced configuration page (for example, assuming the SPA IP address is 192.168.1.100):

   http://192.168.1.100/admin/advanced

8. The Provisioning tab in the admin/advanced page contains a number of configurable parameters specific to provisioning. Select the Provisioning tab, and inspect the values of the general purpose parameters GPP_A through GPP_P. They should be empty.
9. The SPA supports a resync url method for ease of development and testing. So, to resync the test SPA to the `basic.txt` configuration profile, visit the following url from the PC's web browser (for example, assuming the PC's IP address is 192.168.1.200):

http://192.168.1.100/admin/resync?tftp://192.168.1.200/basic.txt

10. With the above url-driven command, the SPA at address 192.168.1.100 will request the file `basic.txt` from the TFTP server at IP address 192.168.1.200. It will then parse the downloaded file, and accordingly update the GPP_A parameter, with the new value of 12345678.
11. Verify that the parameter was correctly updated, by refreshing the admin/advanced page on the PC's web browser, and selecting the Provisioning tab on that page. The GPP_A parameter should now contain the new value 12345678.

2.2. Syslog

Whenever the SPA is about to resync to a provisioning server, and once the resync has either completed or failed, the SPA generates a syslog message to a configured syslog server (SPA admin/advanced page, System tab, Syslog_Server parameter). Throughout this tutorial, it is convenient to program the syslog server ip address into the SPA, and observe the messages generated by the SPA.

Exercise:

12. Install and activate a syslog server on the local PC.
13. Program the PC's IP address into the Syslog_Server parameter, and submit the change.
14. Repeat the TFTP Resync operation described in the previous exercise.
15. The SPA will generate two syslog messages during the resync. The first indicates that a request is in progress. The second marks success or failure of the resync.

The messages will show text such as the following:

```
SPA-2000 00:0e:08:ab:cd:ef -- Requesting resync tftp://192.168.1.200/basic.txt
SPA-2000 00:0e:08:ab:cd:ef -- Successful resync tftp://192.168.1.200/basic.txt
```

More detailed messages are available by programming the Debug_Server parameter (instead of the Syslog_Server parameter) with the IP address of the syslog server, and setting the Debug_Level to a value between 0 and 3 (3 being the most verbose).

The contents of these messages can be configured via the parameters Log_Resync_Request_Msg, Log_Resync_Success_Msg, and Log_Resync_Failure_Msg. If any of these parameters is cleared, the corresponding syslog message will not be generated.

Occasionally, it may also be informative to capture an Ethernet packet trace of the interaction between the SPA and the provisioning server. An Ethernet packet sniffer can be run on the local PC for this purpose, provided the SPA is in the same subnet and a hub is used to connect them them.

2.3. Automatic Resync

When an SPA is deployed remotely, or else as part of an internal company deployment, it is desirable for it to resync periodically to the service provider's provisioning server, to ensure that any customer profile configuration changes made on the server are propagated to the end-point, without necessitating an explicit resync request to the end-point. To have the SPA resync periodically to a server automatically, a configuration profile url is programmed into the Profile_Rule parameter, and a resync period is programmed into the Resync_Periodic parameter.

Exercise:

16. Using the PC's web browser, open the SPA's admin/advanced page, Provisioning tab.
17. In the Profile_Rule parameter, program the following value (assuming the TFTP server is setup at ip address 192.168.1.200, as in the previous examples):

    tftp://192.168.1.200/basic.txt

18. In the Resync_Periodic parameter program a small value such as 30 (meaning 30 seconds). Then submit all changes.
19. With the new parameter settings, the SPA will now resync to the configuration file specified by the url twice a minute. The activity can be observed in the SPA's syslog trace, provided the Syslog_Server parameter is properly configured.

The SPA will also automatically resync to the provisioning server whenever it is power-cycled, provided that the Resync_On_Reset parameter is set to "yes".

If the resync operation fails (such as if the server is not responding), the unit will wait Resync_Error_Retry_Delay seconds before attempting to resync again. If Resync_Error_Retry_Delay is zero, the SPA will not try to resync again following a failed resync attempt.

2.4.   Unique Profiles and Macro Expansion

In a large deployment, each SPA needs to be configured with distinct values for certain parameters (such as User_ID or Display_Name). This requires the service provider to generate distinct profiles, one for each deployed SPA. Each SPA, in turn, must be configured to resync to its own profile, according to some predetermined profile naming convention.

The SPA profile url syntax can include identifying information specific to each SPA (such as MAC address and serial number) via macro expansion of built-in variables. This alleviates the need to specify such values individually within each SPA's distinct profile.

The SPA profile rule undergoes macro expansion internally before being applied. The macro expansion understands a number of values. Among them are the following:
- $MA expands to the unit's MAC address, using lower case hex digits, s.a. 000e08abcdef
- $SN expands to the unit's Serial Number, s.a. 88012BA01234

Exercise:

20. Obtain the MAC address of the test SPA from its product label (let's say this is 000e08aabbcc in lower case hex digits).
21. Copy the basic.txt configuration file to a new file named spa000e08aabbcc.cfg and place the new file in the virtual root directory of the TFTP server.
22. Open the SPA's admin/advanced page, Provisioning tab, and modify the Profile_Rule to the following (again, assuming the TFTP server is at 192.68.1.200):

    tftp://192.168.1.200/spa$MA.cfg

23. Submit the parameter change. When the next resync is due, the SPA will fetch the new file, by expanding the $MA macro expression above into its own MAC address of 000e08aabbcc.

Several more values can be macro expanded in this way, including all the general purpose parameters, GPP_A through GPP_P, which can be referenced as $A through $P respectively. Macro expansion is not limited to the url's file name, but can also be applied to any portion of the profile rule parameter.

A complete list of variables available for macro expansion is provided in the Feature Reference section of this Guide.

2.4.1. URL Resolution

The profile url can contain a provisioning server name, instead of an explicit IP address. In this case, the SPA performs a DNS lookup to resolve the name.

A non-standard server port can be specified in the url, using the standard syntax ":port" following the server name.

Also, the configuration profile can be stored in a subdirectory of the server's virtual root directory. Again, this is specified using standard URL notation.

Thus, for example, the following is a valid Profile_Rule. It would request the file spa2000.cfg, in the server subdirectory /Linksys/config, for the TFTP server running on host prov.telco.com, which listens for connection on port 6900.

```
tftp://prov.telco.com:6900/Linksys/config/spa2000.cfg
```

Again, macro expansion can be used anywhere in the url. This can be convenient in organizing a directory structure of profiles on the server for the deployed SPA devices. For example, a profile subdirectory name might be supplied for each SPA in a dedicated general purpose parameter, with its value referred within a common profile rule via macro expansion.

Thus, we might have a GPP_B with the following content:

```
Dj6Lmp23Q
```

And then a Profile_Rule with this content:

```
tftp://prov.telco.com/Linksys/$B/$MA.cfg
```

Then, when resyncing, this SPA (assuming a MAC address of 000e08012345) will request the profile at the following url:

```
tftp://prov.telco.com/Linksys/Dj6Lmp23Q/000e08012345.cfg
```

3. Server Configuration

This section provides basic information on configuring provisioning servers to interoperate with SPA units.

3.1. TFTP

The TFTP scheme is convenient for managing small deployments of SPA units within an office LAN environment. It is also useful for in-house pre-provisioning of SPAs in preparation for remote deployment. Once deployed remotely, though, http offers greater provisioning reliability, given its NAT traversal characteristics.

The SPA is able to obtain a TFTP server's IP address directly from the LAN's DHCP-server, which can supply this information. This is done by providing a TFTP server IP address as DHCP option 66. If this is done, then a Profile_Rule need only be configured with the profile filepath on that TFTP server. The manufacturing default rule does just that. Its Profile_Rule value is:

```
/spa$PSN.cfg
```

On an SPA-2000, this expands to "/spa2000.cfg", which means that (by manufacturing default) the unit will resync to this file on the local LAN's TFTP server, if one is specified via DHCP option 66.

Note that the specified filepath is relative to the TFTP server's virtual root directory.