SlimLinux

Linux for IoT and embedded applications

A Guide

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What is SlimLinux

SlimLinux is a Linux server development kit for the purpose of developing small lightweight, secure Linux based network-aware embedded applications – both physical & virtual. The base installation takes 16Mb of disk space and uses 20Mb of RAM to run.

An "embedded application" means any Linux system that is intended to run "headless" (no standard UI) with almost exclusively unattended operation. So this includes, but is not limited to, IoT, network applications (Routers, Firewalls etc), Internet servers (real or VM), industrial applications, automotive applications, intelligent devices, home & industrial automation, basically anywhere you want to be able to put in a relatively sophisticated network capable computer that will run continuously without the need for human intervention.

SlimLinux is not a distribution, in itself, but is an operating system design that uses other Linux distributions as its base. This means you can copy binaries and libraries directly from the base distribution and they will run on your SlimLinux.

Because SlimLinux is a very cut-down operating system, if you do copy binaries from other distributions, you may also need to copy libraries and static configuration files that are required to support the binary you have copied over.

Our design philosophy has been to copy over as little as possible. All you need for a minimal Linux system is a kernel, some basic libs, and busybox – so that's about all you get in our base O/S.

Current binary base distributions supported are

- Slackware x64 v14.2
- Redhat x64 v7.5

When you look at the "Redhat" or "Slackware" SlimLinux you will **not** see is an operating system that looks like the one it is based on. The base gives the SlimLinux full binary compatibility with the base, but the structure of the operating system and what utilities are available will be different.

We have been running public facing internet server applications, based on Slackware SlimLinux, on both physical & virtual servers for over 10 years, and would expect an "uptime" of between 3 & 4 years – i.e. running 3 to 4 years between reboots.

Because SlimLinux is so small, it enables you to run each of your server applications on a different physical or virtual machine – a technique called "network appliance" – this improves security without being as wasteful of resources as using a full standard install.

Getting Started

```
$ git clone https://github.com/james-stevens/SlimLinux.git

$ cd SlimLinux

$ ./configure

$ make
```

This will create a bootable ISO image that, when booted in a target machine, will install the SlinLinux, with the options you have chosen.

If you are not sure what to do with an ISO image, I recommend you google "boot iso image".

The ISO image is "hybrid", which means it should boot from either a CD/DVD (real or virtual) or a USB stick.

If you change the "mkiso.cfg" file, or run "./configure" again, you then need to run :-

```
$ make clean all
```

The "configure" utility checks you have the programs "mkisofs" and "isohybrid" that are needed for creating the ISO. If you do not have these you will have to refer to your documentation to add them.

Or google "add mkisofo <name>" - where "<name>" is the name of the operating system you are using.

Design

SlimLinux is designed using a basic set of libraries and binaries that is close to the minimum required to support a network-capable Linux server. The base system includes the server processes "sshd" and a range of basic operating system utilities, but not much else – so the total is about 16Mb. However, this still enough to build a useful firewall or NTP server!

The operating system utilities are largely provided by "busybox" (https://www.busybox.net/) and the kernel is an unpatched version of one of the most recent stable "longterm maintenance" development trees. The "config" file required to build the kernel and "busybox" are included in the "build_files" subdirectory.

Currently SlimLinux is available based on **Slackware x64 v14.2** and **Redhat Enterprise Linux x64 v7.5**. Slackware is not widely know, but is incredibly reliable. A SlimLinux server based on Slackware should give you an uptime in the region of 3 to 4 years between reboots. Both sets of binaries use the same kernel (built using the provided "config") which is also the same kernel used for the CD boot/install.

On top of the "base" operating system you can add "overlays", these are extremely similar to packages provided by other distributions, but the intention is that they represent application groups, instead of program groups. For example, you might add a "LAMP" overlay, which includes Apache, MySQL & PHP - or a "Mail Server" overlay which includes an SMTP, POP3 and IMAP4 server.

One significant difference is that with SlimLinux you always build a custom install ISO that only includes those parts that you want. You can also include configuration & application data on the ISO that installed alongside the operating system.

Some of the binaries that are in the RedHat base are *not* a direct copy of the binary from the RedHat distribution, but the binary has been built fresh from its source code. This has two advantages

1) It enables us to reduce the number of libraries the binary is dependant on, and so reduce the overall size of SlimLinux

2) We can ensure the same version is run whether you are using the RedHat or Slackware binary base – this ensures all the scripts that control the system will be 100% compatible, no matter which binary base you choose.

We have tried to keep things as simple as possible. All binaries that may need to be run from the command like are in "/sbin" ("/bin" is just a sym-link to "/sbin"). All libraries are in "/lib64". Binaries that do not need to run from the command line (like daemon processes), are in "/usr/sbin". "/etc/rc.d/boot.d/<files>" are the file run at start-up. "/usr/scripts" contains the operating system scripts.

The Control Process and Run Levels

There are many great and sophisticated "init" (process control) daemons, like "systemd", but its more complex than what we were looking for, where as the "init" in "busybox" was just too simple! So we've gone with the "sysvinit". Its only major drawback is that it does not support supervising process that fork into the background. This offers run levels 2 to 5 for managing system processes. Here's how we've used the different run levels.

Run Level 2	Console login only, unless that's been disabled, in which case only Ctrl-Alt-Del will work! The DHCP client also runs at this level
Run Level 3	"sshd", "ntpd" (optional) and "crond" running – so basic remote access
Run Level 4	Recommend for bringing up user processes, so you can test the system, but the system's external services are not running
Run Level 5	Full external services running

If the server has a fixed IP Address, its default run level will be 5.

If the server has a DHCP assigned IP Address, it will start at run level 2 until it has obtained an IP Address, then it will transition to run level 5.

All processes that run at a lower level will also (usually) be running at levels above that. This may not always be true, but it is usually.

Sysvinit's behaviour is specified by the file "/etc/inittab" and controlled by the command line utility "telinit". "telinit" is just a symbolic link to "init", so you can use "init" instead to change the live run levels.

If you are connected by "ssh" and you run "init 2" you will not loose your connection, but you will have terminated the "sshd" login daemon - so make sure you bring the server back to level-3, or above, before logging out!

"init 0" will shut the system down and "init 6" will reboot it. The utilities "halt", "shutdown" & "poweroff" do the same as "init 0" and "reboot" does the same as "init 6". Once the system reaches run level-0 (halt/shutdown) it will always try and power-off.

License Terms

SlimLinux is released as open source under the license GPLv3.

You are free to do whatever you like with the software, but all modifications, enhancements, bug fixes to any part of the works must be made public as well as any additional features / binary bases / overlays that depend on, or make use of, the open source code.

All projects that are based on SlimLinux, or use any parts of SlimLinux, must be fully open source and made free under GPLv3.

If you wish to use SlimLinux as part of a proprietary product, and so do not wish to publish the source code to that product, other license terms are available. Closed source projects based on SlimLinux are not permitted under the terms of this open source license.

Developers that submit changes, updates, enhancements etc, agree that their code will always be released as open source under GPLv3, as well as being included in alternative closed source license terms offered to third parties.

We totally respect all developers who do not wish to agree to this but, due to pre-existing agreements, we can not integrate their code in the Primary branch.

This is commonly referred to "selling exceptions" and there are mixed feelings about it in the open source community. However, where it enables businesses to sustain open source projects it will probably continue to be part of the industry.

Partition Structure

SlimLinux uses is own, very simple, partition structure. This starts with a basic design philosophy that divides an operating system's files into three types

1) Binaries, Libraries and static files, partition-1

2) Configuration files that rarely change, partition-2

3) Application data that may be constantly changing, partition-4

Each data type is put into a separate partition, with different "`mount`" options (set in "`/etc/fstab`"). There is also a swap partition (partition-3) which defaults to 8Gb.

This means the minimum disk size for a *default* install is about 10Gb. However, you can change the partition sizes by providing a file called "`sfdisk.cfg`" in the top level of the "`iso`" directory. The file is piped to "`sfdisk`" to partition the disk. The default is:-

```
label: gpt
,512000,L,*
,21000,L
,16700000,S
,,L
```

This makes Partition-1 (ROOT) 250Mb, Partition-2 "`/opt/config`" 10Mb, Partition-3 (swap) 8Gb and Partition-4 "`/opt/data`" the remaining disk space.

If you are using "*server instance*" or "*server application*" overlays (see below), you can include an "`sfdisk.cfg`" file in the overlay directory to change the partitioning for that server.

1 … Binaries, Libraries and static configuration files

Binaries & Libraries are kept in the ROOT partition and it is mounted read-only & execute allowed. Therefore, if you wish to add files to it, you must remount it writeable, make the changes you want, then mount it read-only again.

We provide the user "`root`" with three helpful shell aliases to do this, they are

"`rw`" - make the ROOT file system writeable, with write-cache <u>disabled</u>
"`rwr`" - make the ROOT file system writeable, with write-cache <u>enabled</u>
"`ro`" - make the ROOT file system read-only.

"`rw`" is useful if you are making a small change, e.g. editing a script file. "`rwr`" is useful if you are uploading a large number of binaries / libraries. You can upload a lot of files with write-cache disabled, but it will be a lot slower.

If returning the ROOT file system to read-only status fails, usually with a message saying its busy, this usually means you have replaced a binary / library that is currently running. The running process will be running the old copy, until you restart it, so the file-delete of the old copy is still pending, until the process is restarted. So just kill the process you have replaced and try again.

If you have replaced a library, you will need to kill <u>all</u> the processes that are using that library. If you can't get the ROOT file system to return to read-only, you can always just reboot.

If you add binaries from the standard distributions your SlimLinux is based on, you may also need to adjust their start-up options in order for them to be happy to run in a read-only ROOT partition. This is usually not too difficult and is both necessary and worth doing.

Having the ROOT partition read-only has two big advantages. Firstly, it will never become corrupt in the event of a crash – this vastly improves the likely hood your server will be able to restart and automatically recover. Secondly, it makes it more difficult for malicious agents to make changes.

By default the ROOT partition is formatted EXT2. Its does not need to be a journaling file systems as it does not change.

2 ... Configuration Data

Configuration data are the configuration files that differentiate one instance of the same server type from another and it is stored in "/opt/config". Two servers of the same type should have identical contents in their ROOT file system, unless changes have been made by hand.

This is partition 2 of the disk and is mounted with write-cache disabled and execute permission denied (sync,noexec). This means changes made to files in this partition are immediately written to the physical disk.

In a traditional operating system, these files are generally scattered all over the disk in various different directories & partitions. This can make it very difficult for a sysadmin to identify and back-up the system's config.

You can think of the contents of this directory as being the "personality" of an instance of the server. If you copy the entire contents of this directory from one machine, of the same type, to another, then reboot the target machine, it will have adopted the entire personality of the source machine. You can even switch the ROOT partition's binary base and reboot, and the new machine will behave the same as the previous binary base.

Where, on a tradition distribution, the same configuration value may appear multiple times in different places, on SlimLinux the value appears once (usually in the "system.cfg" file) and any configuration files that need this value are than dynamically constructed. A good example might the the server's IP Address.

By default the config partition is 10Mb in size and formatted EXT2 – because there is no write-caching, it does not need to use a journaling format.

3 ... Application Data

Application Data is stored in "/opt/data" which is partition four. It takes up all the rest of the disk (except for 8Gb of swap in partition 3), and is formatted ReiserFS. Everybody has their preferred filesystem – if you are not happy with ReiserFS, its not difficult to change. The kernel we provide also has built-in support for EXT4, but adding (say) XFS would be trivial.

"/opt/data" is mounted with write-cache enabled (for improved performance), execute-denied and "noatime,nodiratime" - very few applications make use of "atime", so the performance hit of having it is usually not worth it and by minimising changes to the filesystem metadata, you minimise the risk of catastrophic corruption in the event of a crash.

Building Your ISO

To build your bootable install ISO (which can be booted from either a CD / DVD or USB stick), you simply run "make". This will prompt you to create a configuration file called "mkiso.cfg" this has the following options

binary	The base operating system binary platform – either **slackware_x64_v14.2** or **rhel_x64_v7.5** – the directory "baseos/rootfs" will contain one directory for each possible base operating system, excluding "common". There is no default, so this option is mandatory.
overlays	A space separated list of overlays to add on top of the base operating system. You can see the list of possible ones in the directory "overlays". More overlays may be added in automatically, if there are dependencies. With no overlays, only the base O/S will be installed.
upload_ip	IP Address to upload the finished ISO to
upload_dir	Remote directory on the server identified by "upload_ip" to place the ISO image in.
kernel	The file name of an alternative kernel to use for both the operating system and install. The default is "kernel" The file you specify must be in the "kernel" subdirectory.

If either "upload_*" option is missing, the upload stage is skipped. The "upload" stage runs a "tar" over "ssh", so assumes you have "ssh" access to the target IP Address.

Supported "make" Options

clean	Remove all files & directories that were created in the process of making the ISO, excluding the "mkiso.cfg"
all / iso / default	make anything that needs making to build the ISO
rootfs	Recreate the SlimLinux ROOT file system image, config & data, then recreate the ISO
initrd	Recreate the installation operating systems (run by booting the ISO), then recreate the ISO
config	Remove and re-prompt for the configuration, then rebuild the ISO

Note: the "make" is not really a "makefile" in the true sense – in that it does not automatically rebuild only what needs to be rebuilt when certain files change. It is simply a "make" interface to the "mkiso" & "configure" scripts, which are what do the real work.

If you change the "mkiso.cfg" file, the "makefile" will **not** correctly rebuild the ISO, you need to rebuilt it manually using "make clean all".

To install the SlimLinux operating system you have specified, you simply boot the ISO in the target machine. If the hard disk on the target machine is already partitioned, you will be asked to confirm you wish to repartition and reformat the disk.

At this prompt you can answer …

Stop	No repartitioning or formatting is done and the target machine will switch itself off.
Continue	The install will proceed as if the disk had been completely blank – the disk will be repartitioned and the partitions will be reformatted.
Update	Only the ROOT partition is reformatted and reinstalled – this replaces the kernel & operating system, but will **not** touch the config or data. This can be used to update the server to different code or to switch the server to a different binary base.

Once you have finished the install, the ISO will prompt you before ejecting the CD and rebooting. We **highly** recommend that you reboot before powering down, as this ensures all data is flushed to the disk.

By default the SlimLinux kernel includes the "virtio" drivers for Ethernet and SCSI hard disks and we have tested SlimLinux on physical hardware as well as running as a Linux/KVM guest. We have no reason to believe it will no run under other hyper-visors – although we can not guarantee all the required hardware drivers are present.

The Kernel is an unmodified standard kernel and we have provided the config file we used to create it. The main difference between the way we build a kernel and the way a standard distribution might is that we disable dynamically loadable modules and include all the drivers in the kernel. For more information see the Kernel section, below.

Build Tree's Directory Structure

The directory structure of the <u>build environment</u> is as follows

`baseos/rootfs/common`	Contains files that are common to all binary platforms – typically this means script files, static config files and symbolics links.
`baseos/rootfs/<platform>`	Contains the binaries & libraries that belong to the corresponding binary platform. If you wish to add your own binary platform, create a subdirectory here and place the files as if they were in the ROOT file system of a running system
`build_files`	Contains the config files we used to build the kernel & busybox as well as the list of files the `install_cd` operating system needs copied from the `baseos/rootfs` directory.
`install_cd`	Files & scripts to run the create the operating system for the installation ISO – becomes an "`initrd`"
`kernel`	The kernel for the install & operating system
`overlays/<name>`	One subdirectory for each overlay
`source`	The source code for minor utilities that are included in the installation process

There are also some scripts

`configure`	Prompts you to build your "mkiso.cfg"
`mkiso`	The script that reads the "`mkiso.cfg`" file and builds the bootable install ISO image
`Makefile`	A "make" interface to the options available in "`mkiso`"
`tstroot`	After you have built an ISO image, you will have a directory called "ROOT", which is a copy of what your root file system will be if you run an install of the ISO. This script uses "`chroot`" to emulate running the "ROOT" directory structure as a root file system. This allows you to test out development code without having to actually install it. This is especially useful for testing out library dependencies.

Overlay's Directory Structure

Within each overlay there is:-

`rootfs/common`	Directory containing the files & directories needed by this overlay that are common to all binary platforms
`rootfs/<platform>`	Directory containing the files & directories needed by this overlay that are exclusive to a particular binary platform
`config`	Directory containing files to go into "/opt/config"
`data`	Directory containing files to go into "/opt/data"
`<platform>.cfg`	Additional install options this overlay needs for a specific binary platform
`common.cfg`	Additional install options this overlay needs for all binary platforms

Currently supported additional install options, for "`common.cfg`" or "`<platform>.cfg`" are

`depends`	Space separated list of other overlays this overlay requires to be installed in order to work correctly. If the overlay is selected, the dependant overlays will be automatically added in.

You can also include any configuration options that are valid in the "`mkiso.cfg`" file. For example, this allows you to specify an alternative kernel for a specific overlay.

We have ensured that no one file is included more than once across all the overlays. This makes maintenance easier, as it only needs to be replaced in one place. However, it is perfectly valid for the same file to appear in the same place in multiple overlays.

The overlays are added-in in the order you list them in the "`mkiso.cfg`". If there are dependant overlays that are not included in "`mkiso.cfg`", they will be added to the end of the list you have given.

Please note: ALL files ending ".`cfg`" are treated as shell-script include files. Therefore, if you need to include special characters (including white space) in your configuration data, you must put the value in quotes.

Server Instance & Server Application Overlays

You can create your own custom overlays to build specific server instances – these are called *server instance overlays*.

This *can* include additional operating system files, but often all you will want is a custom configuration file and a list of overlays to include.

To achieve this all you need is a "`common.cfg`" (in the top level directory of your server instance overlay) which lists which overlays this server instances requires and a "`config/system.cfg`" which contains that server's specific configuration.

Then, in your "`mkiso.cfg`" the only overlay you need to specify is the server instance overlay and the "`mkiso`" script will recursively bring in all the overlays it needs.

If you have different configurations for different binary distributions you can rename the file "common.cfg" file as "`<binary>.cfg`" – e.g. "`slackware_x64_v14.2.cfg`" - for example, this allows you to specify different overlay dependencies for different binary platforms.

You can also create *server application overlays* that pull-in existing overlays, but add more functionality, e.g. by adding your own code and scripts. The server application overlay should also list all the pre-existing overlays it depends on.

You can then create *server instance overlays* that only needs to depend on one of your server application overlays in order to create an instance of that application server type.

For example, lets say I'm setting up two servers that are going to do web and email forwarding. I might create an *application* overlay called "`forwarder`" that depends on overlays like "`dns apache sendmail`" as well as adding a few scripts and custom binaries to make the whole thing hang together, but the application overlay would probably not contain any configuration data, but might contain some user data.

I could then create two server *instances* called "fwd1" and "fwd2" that both depend on the "`forwarder`" overlay, but also include configuration files that are specific to each server *instance* – e.g. static IP Addresses, host names etc.

So "`forwarder`" is the *server application overlay* and "fwd1" & "fwd2" are the *server instance overlays.*

Adding Your Own Overlay

To create your own overlay, simply create a subdirectory in the "overlays" directory and start adding files by copying them into the correct sub-structure from an installation of the appropriate binary base.

Before you build your ISO, remember to edit the "mkiso.cfg" file and add your overlay into the list of overlays to be included.

When the "rootfs" for the ISO is built, you will see a new directory called "ROOT" appear at the top level of the SlimLinux build tree. This is what will become the root partition of your SlimLinux. If you wish to test out your new overlay, you can use the "tstroot" script.

"tstroot" mounts ram-disks & virtual file systems (like "/proc" & "/sys"), as well as running some basic set-up scripts, then puts you into a "chroot" shell in the "ROOT" directory, so you can do as much testing as possible. Whatever is mounted, is then unmounted when you exit the shell.

If you are having real problems getting your binary to work, or if you want to use a binary from a different Linux distribution, and you have access to that binary's source code, a reasonably fool-proof way to get it working is to statically link the binary.

This means, so long as it doesn't dynamically load executable code at run time (like Apache's modules), all the libraries needed by your binary will be bound into the binary itself. This, of course, makes the binary a lot bigger, but may be useful to help your solve problems.

Adding Your Own Binary Base O/S

Adding a new binary base for Linux distributions that are based on a 64-bit PC architecture is relatively trivial. Just create a new directory in "baseos/rootfs" and start copying the files from an installation of that distribution.

You will probably find the utility "ldd" extremely useful for finding out what libraries also need to be brought across – but you can also refer to the binaries & libraries that are present in the existing binary bases.

Where we have listed a specific item of open source code, we strongly recommend that you build a fresh binary from that code, to ensure compatibility with all the existing scripts and config files.

You will also need to build, from the source code provided, binaries for the overlays you want to use.

Once you have built as much as you think you need, edit the "mkiso.cfg" file and change the "binary=" option to point to your new binary base, then run "make rootfs"

Once you have created a fresh "ROOT" directory, you can also use the "tstroot" command to run some basic testing on your new binary base.

It is our intention to continue to focus on 64-bit platforms, with 64-bit ARM as one of our higher priorities.

Adding a new binary base that is not based on a PC architecture is going to be more complicated. We've not done it yet, so we'll let you know how it goes.

Replacing the Kernel

The kernel we selected (v4.14.x) was the latest version with "longterm maintenance" support - https://www.kernel.org/category/releases.html – it was first released in Nov-2017 and the "projected EOL" is Jan-2020

There are lots of reasons why you might want to use a different kernel, than the one we have provided, the most common might be you need a newer kernel with newer hardware drivers, or you may just want to enable a missing hardware driver in the current kernel.

Replacing the kernel with a newer one is relatively trivial.

1) Download and unpack the kernel you want to use

2) Copy the build_files/kernel_config_x64_4.14.43B file from the SlimLinux directory to your kernel's source tree as the file ".config"

3) Run "make olddefconfig" - this will read the kernel config values from the ".config" file you have copied over, and use standard default values if an option is missing.

If, at this point, you simply run "make" you should end up with a kernel that is pretty much 100% compatible with the one we have provided. If the kernel source code you downloaded is also v4.14.43, then the binary kernel you have created will be nearly identical to the one we provided.

If all you wanted to do was update to a newer release of v4.14, then that should be everything you need to do. If you wish to alter the kernel options, run "make menuconfig", do your changes, quite & save, then run "make" again.

Now copy your new kernel into the "kernel" subdirectory of the "SlimLinux" build tree, giving it a new name – e.g. "mykernel"

Edit the "mkiso.cfg" file to add a line specifying your new kernel – e.g. "kernel=mykernel". Now run "make clean all" in the SlimLinux build directory.

You can also follow this procedure if all you want to do is keep the same kernel version, but alter some of the configuration options. If you know what platform you are developing for, you can probably remove quite a few hardware drivers you do not need.

If you want to build a kernel completely from scratch, the you should be OK, so long as you ensure the following options are enabled – CONFIG_DEVTMPFS, CONFIG_DEVTMPFS_MOUNT, CONFIG_TMPFS, CONFIG_BLK_DEV_INITRD – and to boot from a CD you will need hardware support for the CD drive and CONFIG_ISO9660_FS enabled.

SlimLinux is designed to use a kernel with dynamic loadable modules disabled. This means all the drivers you need must be built into the kernel itself. On a general purpose distribution this can make the kernel excessively large but, because of the lightweight nature of SlimLinux this is generally not a problem.

This also means that any drivers that require dynamically loaded firmware will also need to have that firmware linked into the kernel. The most common drivers that require this are the Broadcom Ethernet chips used by Dell. Our default kernel does not include support for these chips. Adding it is not hard, but it is also not trivial!

Configuring a System

SlimLinux keeps all its configuration files in "/opt/config" - the core options are in the file "system.cfg", but most of the processes support you adding an individual custom configuration file into this directory, so you have complete control over how they run.

If you have not added a custom configuration file for a particular process, the system will usually build a useful basic configuration for you, which can often be controlled using options in the "system.cfg" file.

If you create a fresh install of the same overlays, copy the entire contents of this directory onto the new machine and reboot it, it will take over all aspects of the configuration of the original machine. There is nothing about the configuration of the server that is not kept in this directory.

When adding your own overlays, you should follow this principal.

Base Operating System Options

`rootPassword`	Password for the user "root", pre-encrypted (as seen in "/etc/shadow") – the default is "aa" (encrypted)
`allowRootSSH`	Boolean (Y/N) - Allow "root" to ssh directly to the server – if you disable this you will either have to login on the console (assuming that is not disabled) or login as an ordinary user, then use "su" to get root privileges.
`allowConsoleLogin`	Boolean (Y/N) - Run login prompts on the console (Alt-F2/3/4)
`runningSSHd`	Boolean (Y/N) - Add "sshd" into inittab – if you disable **both** `allowConsoleLogin` and `runningSSHd` you will have locked yourself out and you will have to boot the ISO to recover.
`serverHostname`	Host name for this server
`serverAdmin`	E-Mail address of the server admin
`syslogToDisk`	Boolean (Y/N) – syslog to disk (Y) or RAM (N) – syslog to RAM can be read with the command line utility "`logread`". Syslog to disk goes into "/var/log/messages".
`syslogSize`	File size to allow the syslog to grow to before rolling the log files
`ntpServers`	Space separated list of NTP servers to correct the system clock to – if this is present an "`ntp`" daemon will run, which you can also choose to have act as a server as well as a client by setting the "ntpAllow" option
`ntpAllow`	Space separated list of IPv4/v6 addresses or subnets which are allowed to access this as an NTP Server. We *strongly* recommend, if you enable this option, you make it as restrictive as possible.
`rdateServers`	Space separated list of rdate servers to correct the clock to
`sshRemoteAllow`	Space separated list of IPv4/v6 addresses or subnets which are allowed to "ssh" to the server
`firewallLogging`	Boolean (Y/N) – syslog firewall blocks. This should be enabled for debugging only, otherwise it can become an attack vector
`keyboardMap`	Console's keyboard layout – currently only "uk" or "us" supported
`static4IP`	<IP>/<netmask> (in bit count) of static IPv4 addresses to assign to the server. This option can appear multiple times. If not present, the server will run a DHCP client on "eth0"
`static4GW`	IPv4 default route / gateway
`static6IP`	<IP>/<netmask> (in bit count) of static IPv6 addresses to assign to the server – this option can appear multiple times
`static6GW`	IPv6 default route / gateway – if you are running "zebra" from the "bgp" overlay, it can obtain the IPv6 gateway from the LAN.
`staticResolvers`	Space separated list of IPs (v4 or v6) of DNS resolvers. If this is blank, sensible defaults will be used. If DHCP is running the resolvers will be taken from the DHCP.
`extraUser`	"<user>[:<group] <password> <uid>" If no "uid" is present, one will be assign starting from 100. This can cause issues as it can mean a user's Id could change after a reboot. If <group> is specified, the GID will be the same as the UID. If a

	group is not specified, the group "users" is used. The <password> must be pre-encrypted. If the password field is just a hypen/dash "-", then this user can not login
staticRoute	"<ip>[/<mask>] <gateway>" - this option can appear more than once and specifies that the IP or subnet specified is routed via the gateway given. IPv4 & IPv6 are both supported.
pingAllow	Space separated list of IPv4/v6 addresses or subnets which are allowed to ping the server. If not present ,or left blank, then any IP Address can ping this server.
root_keys	SSH keys to put into the "root" user's ".ssh/authorized_keys" file
user_keys	SSH keys to put into every non-root user's ".ssh/authorized_keys" file
auth_keys	SSH keys to put into both "root" and non-root user's ".ssh/authorized_keys" file
<username>_keys	SSH keys to put into the specified user's ".ssh/authorized_keys" file – e.g. "dns_keys=..."

All "keys" options can occur more than once. Only users that have a password field, that is not dash/hyphen ("-"), will have a home directory, and so only those users can have the keys set up. If you want a user to be able to login, but **not** by password, only using ssh keys, then set the user's encrypted password to "x".

The system will try and keep the "system.cfg" file owned by "root" and permissions "600" (read & write by owner only).

The "snmp" Overlay

Adding the "snmp" over will allow you to do basic SNMP monitoring of your server. This can be useful as quite a wide range of monitoring systems support SNMP polling.

You can provide your own SNMP configuration file at "/opt/config/snmp.conf". If you do not provide one, a basic configuration will be created for you.

The "snmpd" process will run at run levels 4 & 5.

Snmp Specific Options (in system.cfg)

runningSnmpd	Boolean (Y/N) – Add "snmpd" into inittab
serverFacility	Descriptive text of this server's Facility
serverLocDesc	Descriptive text of this server's physical location
serverLocation	Geographic co-ordinates of this server's location
snmpRemoteAllow	Space separated list of IPv4/v6 addresses or subnets which are allowed to poll this server over snmp

The "bgp" Overlay

The "bgp" overlay adds the "bgp" & "zebra" daemons from the quagga network package.

If you provide a BGP configuration file at "/opt/config/bgpd.conf", this will be used, otherwise a basic BGP configuration file will be made for you. Because BGP can be quite complex to get right, it is highly likely that making your own BGP configuration file will be the best option.

Note – the "bgp" overlay <u>requires</u> a user called "quagga" - this should be specified as an "extraUser" in the "system.cfg" file. For example,

        extraUser="quagga:quagga – 98"

This creates the user called "quagga" in the group "quagga", both with the Id "98", and no password – i.e. this user is unable to login – the user is for owning files and running processes only – its home directory will be "/tmp" and its shell will be "/sbin/false".

The "bgpd" process will run at run level 5 only. The helper process called "zebra", which communicates with the kernel, will run at levels 4 & 5.

Both "bgpd" and "zebra" support remote access via ports 2605 & 2601 respectively. "bgpd" config file and command line syntax is reasonably compatible with Cisco router commands. To get remote access, you simply "telnet" to the appropriate port and enter the password when prompted. As the connection is not encrypted, we recommend instead, you "ssh" to the server, then use "telnet 127.0.0.1 260[1|5]".

With the addition of just the "bgp" overlay, SlimLinux can become a route server for an IX, and adding the "snmp" overlay would allow monitoring of its traffic flow.

"bgp" Specific Configuration Options (in system.cfg)

extraUser	"quagga:quagga – 98" - This extra user must not be removed for "bgp" to work correctly, although the user Id could be changed.
runningBGPd	Boolean (Y/N) – add "bgpd" & "zebra" into inittab
bgpPassword	Plain text password for read-only access to the configuration and status of "bgpd" & "zebra" on ports 260[1|5]
bgpEditPassword	Plain text password to upgrade to be able to modify the configuration of "bgpd" and "zebra".
bgpRemoteAllow	Space separated list of IPv4/v6 addresses or subnets which are allowed to access port 2601 & 2605
bgpWithAS112	Set up BGP for running as an AS112 anycast node
bgpMyASN	AS number to use, if you are not using AS 112
bgpPeers	Peers to connect to by BGP – this makes the appropriate changes to the firewall and adds them into the "bgpd.conf" file.

The "dns" Overlay

The "dns" overlay adds ISC's "bind" dns server. This can be used a DNS Primary, DNS Secondary or recursive resolver. If you add the "bgp" Overlay, it can also be used as an anycast node, and has specific support for running as an AS112 anycast node.

It comes with the utilities "named-checkconf", "names-checkzone", "dig" and "rndc". If you provide an RNDC key, rndc support will be added to the default configuration.

You can provide your own configuration as "/opt/config/dns.conf" or a reasonable one will be build using the configuration options provided in "system.cfg".

Note – because of the security model under which the DNS server runs, if you have provided your own configuration file, when the DNS server starts up it will **copy** your file into its runtime directory structure. This means there are now **two** copies of your "dns.conf", one that the server is running from and the original in "/opt/config/dns.conf". If you make changes to the one the server is running from, make sure you copy those changes into the one in the config directory.

"dns" Specific Configuration Options (in system.cfg)

dnsLogging	Boolean (Y/N) – Enable / Disable logging of every DNS query – should be used for debugging only, or it can become an attack vector
dnsDNSSEC	Boolean (Y/N) - Enabled DNSSEC Support
dnsWithAS112	Boolean (Y/N) – add all AS112 zones into the DNS configuration
dnsResolver	Boolean (Y/N) – Enable this DNS server as a recursive resolver
dnsResolverAllowed	Space separated list of IPv4/v6 addresses / subnets which are allowed to use this recursive resolver (default = any)
firewallBlockRD1	Y/N or number – use the kernel firewall to block UDP DNS queries with RD bit on (RD=1). "Y" = block, "N"=don't block, number=allow this number of queries per second with RD=1 Authoritative DNS servers (Primary/Secondary) should **not** receive queries with RD=1, only resolvers. Sources listed in "dnsResolverAllowed" are not blocked or throttled.
FirewallBlockResp	Boolean (Y/N) – Use the kernel firewall to block UDP DNS responses sent to port 53. ISC's bind should **never** see incoming responses to port 53.
dnsRndcKey	Key to use for "rndc" authentication
dnsRndcAllow	Space separated list of IPv4/v6 addresses or subnets which are allowed to query the DNS server by "rndc"
dnsSecondary	"<zone> <ip> <ip>...." - Act as a Secondary DNS for this zone. Followed by any number of Primary IP (v4 or v6) addresses to retrieve the zone from. This option can appear multiple times.
dnsPrimary	"<zone> <ip> <ip>...." - Act as Primary for this zone, followed by a list of IP (v4 or v6) Addresses / Subnets allowed to XFR the zone. The default is to block all zone transfers. If "<ip>" is an IP Address, and not a subnet, it will also be explicitly sent a NOTIFY. This option can appear multiple times