



POWER9 Functional Simulator

User's Guide

Version 1.0
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IBM Systems
294 Route 100, Building SOM4
Somers, NY 10589-3216

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Revision Log

Each release of this document supersedes all previously released versions. The revision log lists all significant changes made to the document since its initial release. In the rest of the document, change bars in the margin indicate that the adjacent text was modified from the previous release of this document.

Revision Date	Pages	Description
11 October 2016	—	Initial release (1.0).



POWER9 Functional Simulator

About this Document

The IBM® POWER9® Functional Simulator has been developed and refined in conjunction with several design projects built upon the IBM Power Architecture®. The POWER9 Functional Simulator enables hardware and software developers to simulate a POWER9 processor-based system to develop and enhance application support for this platform.

The *IBM POWER9 Functional Simulator User's Guide* describes the basic structure and operation of the POWER9 Functional Simulator and its command-line user interface.

Intended Audience

This document is intended for designers and programmers who are developing and testing applications that are designed to run on systems based on the POWER9 processor. Potential users include:

- System and software designers
- Hardware and software tool developers
- Application and product engineers

Using this Guide

The guide is organized into topics that cover concepts and procedures for initiating and running a functional simulation of a POWER9 system. This book includes the following chapters:

- *Section 1 Introduction to the POWER9 Functional Simulator* describes the POWER9 Functional Simulator and introduces the POWER9 platform modeled by the POWER9 Functional Simulator.
- *Section 2 Command Syntax and Usage* describes the POWER9 Functional Simulator command framework and introduces the structure, format, and usage of simulator commands.
- *Section 3 Accessing the Host Environment* describes several mechanisms that are provided to allow interactions between the host and simulated systems.

Conventions

This guide provides screen captures to illustrate example interface elements and uses code samples to represent example implementations. Your software interface or development environment might vary from these examples depending on your system and product environment.

The typographical conventions shown in the following table are used to indicate the command syntax and to clarify meaning.

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Typographical Conventions

Convention	Description
Bold typeface	Represents information and controls displayed on screen, including menu options, application pages, windows, dialogs, and field names.
<i>Italics</i> typeface	Used to emphasize new concepts and terms, and to stress important ideas.
Bookmaster Gothic typeface	Represents example code, such as XML output or C/C++ code examples. When referenced in the main text, it also represents information such as: <ul style="list-style-type: none"> • Commands, file names, and directories • In-line programming elements, such as function names and XML elements <i>Italic Bookmaster Gothic</i> in code and commands represent values for variables that you must supply, such as arguments to commands or path names for your particular system. For example: <code>cd /users/<i>your_name</i></code>
... . . . (Horizontal or Vertical ellipsis)	In format and syntax descriptions, an ellipsis indicates that some material has been omitted to simplify a discussion.
{ } (Braces)	Enclose a list from which you must choose an item or information in syntax descriptions.
[] (Brackets)	Enclose optional items in format and syntax descriptions. For example, in the statement SELECT [DISTINCT], DISTINCT is an optional keyword.
(Vertical rule)	Separates items in a list of choices enclosed in { } (braces) in format and syntax descriptions.
UPPERCASE	Indicates keys or key combinations that you can use. For example, press CTRL + ALT + DEL.
Hyperlink	URLs are displayed in blue text to denote a virtual link to an external site. For example: http://www.ibm.com
Note: This is note text.	"Note:" denotes information that emphasizes a concept or provides peripheral information.

Related Documents

The simulator's command interface is implemented as an extension of the Tool Control Language (Tcl). Information about Tcl syntax and features can be found in:

- *Practical Programming in Tcl and Tk* by Brent B. Welch. Prentice Hall, Inc.

For detailed information about the commands, see the *POWER9 Functional Simulator Command Reference User's Manual*. It is available on the POWER9 Functional Simulator download site under the [Install & Use](#) tab.

Among the documents available in [OpenPOWER Connect](#), an IBM online technical library, the following are particularly helpful in understanding the operation of the POWER9 Functional Simulator:

- *Power ISA User Instruction Set Architecture - Book I (Version 3.0)*
- *Power ISA Virtual Environment Architecture - Book II (Version 3.0)*
- *Power ISA Operating Environment Architecture (Server Environment) - Book III-S (Version 3.0)*

Help and Support

For questions or to request technical support:

1. Go to IBM [Customer Connect \(https://www.ibm.com/technologyconnect/tgcm/login.jsp\)](https://www.ibm.com/technologyconnect/tgcm/login.jsp).
2. Sign in with your IBM ID.
(New users must register first. Click "Registration" in the right navigation panel.)
3. Click on "Help and support" in the left navigation panel.
4. Scroll down to the section for POWER9 Functional Simulator Support.
5. Select either "Open a new Customer Connect support request" or "Manage existing Customer Connect support requests."

Note: If the Customer Connect support channel for the POWER9 Functional Simulator is not established, use the POWER8 Functional Simulator channel.

To provide additional feedback, contact OpenPOWER@us.ibm.com.



1. Introduction to the POWER9 Functional Simulator

This chapter provides an overview of the POWER9 Functional Simulator, also referred to in this document as `systemsim-p9`. It provides concepts and procedures for using the simulator for the POWER9 processor. It also describes configuration parameters for setting up and running the simulation environment in standalone and Linux mode. Topics in this chapter include:

- Simulator Overview
- Installing and Invoking the Simulator
- Simulator Basics

1.1 Simulator Overview

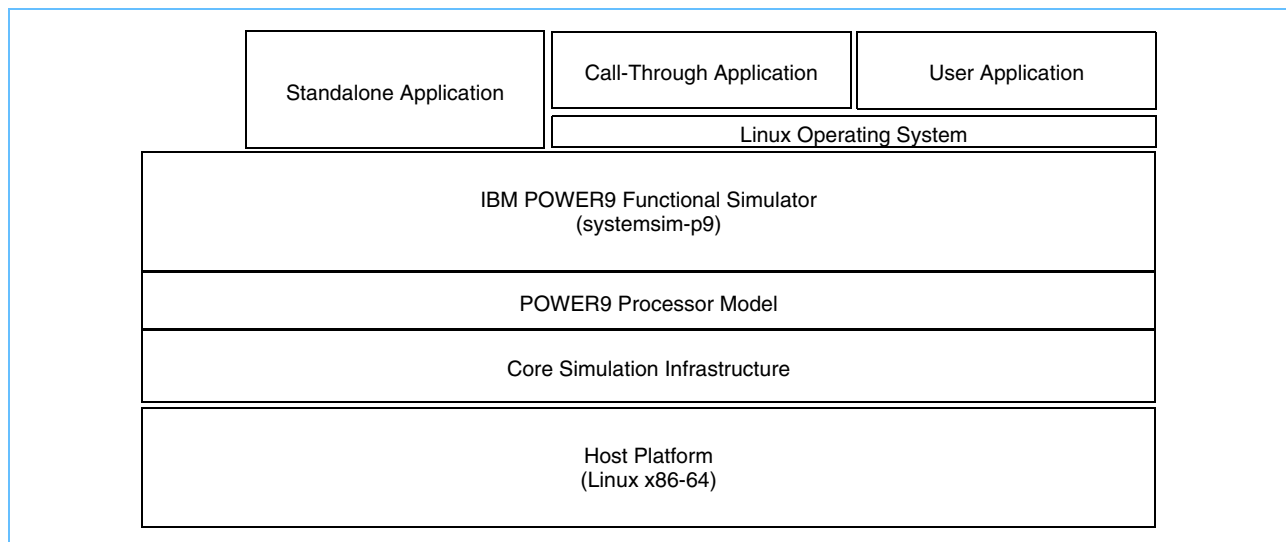
The POWER9 Functional Simulator for the POWER9 processor is a software enablement tool that runs on a `x86_64` Linux host system and allows users to develop and debug software for POWER9 processors. It simulates the architectural behavior of the system to test the features and functions of a software program developed for, or ported to, the POWER9 platform. It includes generalized simulation of the memory, disk, network, and system console. Some simulator configurations are extensible. They can be modified using Tool Command Language (Tcl) commands to produce customized run scripts for booting operating systems and loading and running user application code for debug or analysis.

Figure 1-1 shows the simulation stack. The simulator can be run as part of the software development kit (SDK) for Linux on Power, which is available at:

<http://www-304.ibm.com/webapp/set2/sas/f/lopdiags/sdklop.html>

It can also be run outside of this environment with the user interacting directly with the simulator. This document focuses on the latter usage method.

Figure 1-1. Simulator Stack for the POWER9 Processor



1.2 Installing and Invoking the Simulator

To install the simulator, first download the installation package from <http://www14.software.ibm.com/webapp/set2/sas/f/pwrfs/pwr9/home/html>.

There are three x86_64 installation packages.

- **RPM**: RHEL 7.2, Centos 7 and SuSE 12.1. (TCL 8.5 requirement for this RPM)
- **RPM**: Fedora 22 (TCL 8.6 requirement for this RPM)
- **DEB**: Ubuntu14.04 and Ubuntu 16.04.

To do an initial install of the system, use the following commands:

```
$ sudo rpm -ivh systemsim-p9-<version>.x86_64.rpm  
or  
$ sudo dpkg -i systemsim-p9-<version>.amd64.deb
```

To update the simulator if you already have a version installed, use the following commands:

```
$ sudo rpm -Uvh ./systemsim-p9-<version>.x86_64.rpm  
or  
$ sudo dpkg -i ./systemsim-p9-<version>.amd64.deb
```

Follow the instructions under the [Install & Use](#) tab on the POWER9 Functional Simulator download site.

By default, the simulator is installed in the `/opt/ibm/systemsim-p9` directory. This directory is used in all the examples shown in this document.

The simulator is invoked by using the `power9` shell script, which is located in the `/opt/ibm/systemsim-p9/run/p9` directory.

When the simulator starts, it loads an initial run script, which typically configures and initializes the simulated machine. The name of the initial run script can be passed to the `power9` script with the `-f` option. When not specified on the command line, the simulator uses the `lib/p9/systemsim.tcl` file, which is provided as part of the `systemsim-p9` release.

When specified using the `-f` option, the name of the initial run script can contain an absolute or relative path. The simulator searches for initial run scripts with a relative path by first looking in the current directory, and then in the `lib/p9` directory of the `systemsim-p9` release. If the simulator fails to find the initial run script specified with the `-f` option, it issues an error message and exits.

It is generally the task of the initial run script to locate the operating-system and file-system images to be used by the simulated machine. For booting a little-endian Linux kernel, the default run script is `boot-linux-le-skiboot.tcl`. This script is installed in the `/opt/ibm/systemsim-p9/run/p9/linux` directory. The script searches for a Linux kernel named `vmlinux`, a skiboot firmware binary named `skiboot.lid`, and a file-system image named `disk.img`. The script looks in the current directory. If it fails to find either of these components, it prints an error message and terminates the simulator.

Users who are working with `systemsim-p9` in the [SDK](#) Eclipse development environment do not need to be concerned about this because the SDK handles it for them. Users running the simulator without the SDK must follow the instructions in `/opt/ibm/systemsim-p9/examples/linux/README` to obtain `vmlinux`, `disk.img`, and `skiboot.lid`. They then edit the `boot-linux-le-skiboot.tcl` script to point to the location of these files.

The following examples illustrate various ways to invoke the simulator. These examples assume that the simulator was installed into `/opt/ibm/systemsim-p9`.

Note: By default, the Tcl shell and command line interpreter do not support history recall. To add this feature install the "rlwrap" package and use the "-rl" option when invoking the simulator with the power9 script.

1. To run the simulator and boot Linux, change to the `run/p9/linux` directory and issue:

```
../power9 -f boot-linux-le-skiboot.tcl
```

2. To run the simulator without a console window (-n) using the `run/p9/linux` directory and the user-created script, `myrun.tcl`, issue:

```
../power9 -n -f myrun.tcl
```

When the simulator starts, the window in which it was started becomes the simulator command window where you can enter simulator commands. The simulator also creates the console window (unless this was disabled with -n) which is initially labeled UART0 in the window's title bar.

1.3 Simulator Basics

1.3.1 Interacting with the Simulator

There are two ways to interact with the simulator:

- Issuing commands to the simulated system
- Issuing commands to the simulator

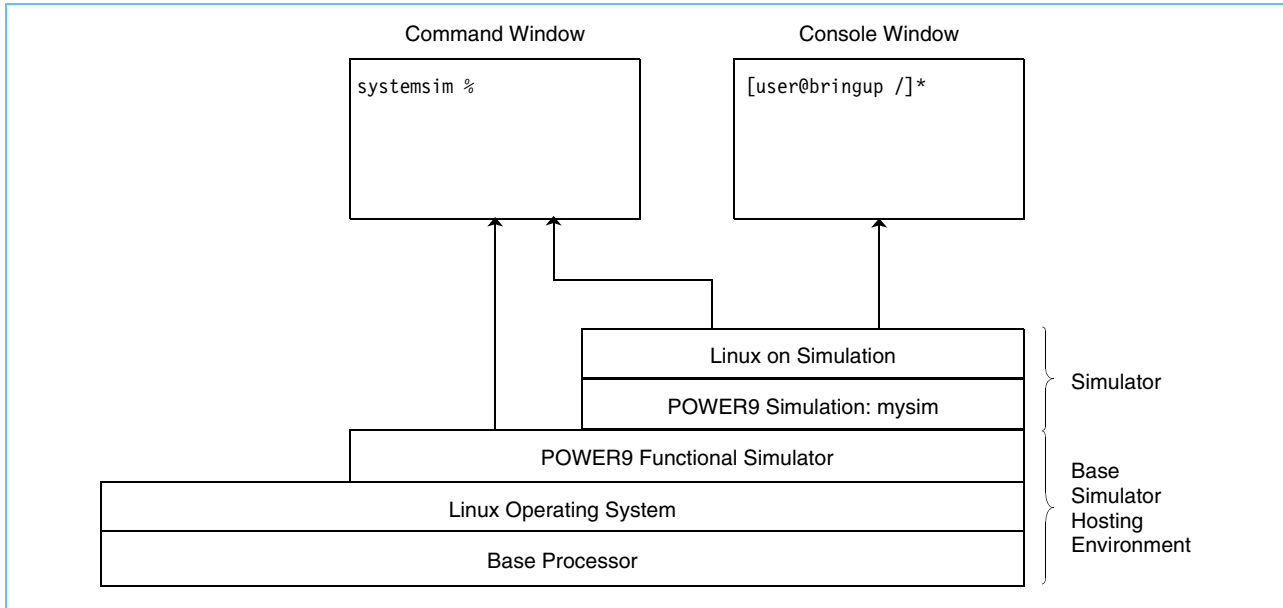
The simulated system is the Linux environment on top of the simulated POWER9, where you run and debug programs. You interact with it by entering commands at the Linux command prompt in the console window. The console window is a Linux shell of the simulated Linux operating system.

You can also control the simulator itself, configuring it to do such tasks as setting breakpoints in code. These commands are entered at the simulator command line in the simulator command window.

Figure 1-2 on page 18 shows the simulator windows and the layers with which they communicate.

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Figure 1-2. Simulator Structure



All simulator commands must be entered at the prompt in the command window (that is, in the window in which the simulator was started). *Table 1-1* shows some important commands.

Table 1-1. Basic User Commands

Simulator Command	Description
quit	Closes the simulation and exits the simulator.
help	Displays a list of the available simulator commands.
mysim go	Starts or continues the simulation. The first time the command is issued, the simulator boots the Linux operating system on the simulation.
mysim cpu 0 help	Shows a list of the simulator commands available for each CPU. For example: mysim cpu 0 step (number of instructions)

The simulator prompt is displayed in the command window when the simulation is stopped or paused. When the simulation is running, the command window also displays a copy of the output to the console window and simulation-cycle information every few seconds, and the prompt is not available. To stop the simulation and get back the prompt, use the Ctrl-C key sequence. This stops the simulation, and the prompt reappears.

1.3.2 Operating-System Modes

A key attribute of the POWER9 Functional Simulator is its ability to boot and run a complete POWER9 system. By booting an operating system, such as Linux, the POWER9 Functional Simulator can execute many typical application programs that use standard operating-system functions. Alternatively, applications can be run in standalone mode, in which all operating-system functions are supplied by the simulator and normal operating-system effects, such as paging and scheduling, do not occur. These two approaches to running applications on the simulator are referred to as Linux mode and standalone mode.

Linux Mode

In Linux mode, after the simulator is configured and loaded, the simulator boots the Linux operating system on the simulated system. At runtime, the operating system is simulated along with the running programs. The simulated operating system takes care of all the system calls, just as it would in a nonsimulation (real) environment.

Standalone Mode

In standalone mode, the application is loaded without an operating system. Standalone applications are user-mode applications that are normally run on an operating system. On a real system, these applications rely on the operating system to perform certain tasks, including loading the program, address translation, and system-call support. In standalone mode, the simulator provides some of this support, allowing applications to run without having to first boot an operating system on the simulator.

There are limitations that apply when building an application to be loaded and run by the simulator without an operating system. For example, applications must be linked statically with any libraries they require because the standard operating system shared libraries are not available in standalone mode. Another example is support for virtual memory address translation. Typically, the operating system provides address-translation support. Since an operating system is not present in standalone mode, the simulator loads executables without address translation, so that the effective address is the same as the real address. Therefore, all addresses referenced in the executable must be valid real addresses. If the simulator has been configured with 64 MB of memory, all addresses must fit in the range `x'0' - x'3FFFFFF'`.

1.3.3 Modifying the Root File System

The details of creating a sysroot disk file can be rather complicated. The sysroot disk provided for use with the IBM SDK for PowerLinux contains a minimal set of build tools and libraries to limit the size of the disk image file. This disk should be sufficient for running most simple applications, but in some cases users will want additional packages installed into the sysroot disk. To modify the contents of the sysroot disk:

1. Start the simulator with the `boot-linux-le-skiiboot.tcl` startup script.
2. Wait for the shell prompt to appear in the console window.
3. To copy normal files to the sysroot, use the `call thru source` command from the console window to copy the files into place from the host file system.
4. To install rpm, first copy the rpm file to the simulator file system with the `call thru source`. Then install the package with `sudo rpm -Uvh <package>.rpm`. After the package is installed, you can delete the rpm file to preserve space in the simulated file system.

To install deb, follow the same procedure using `sudo dpkg -i <package>.amd64.deb`.

5. When all packages are installed, be sure to properly shutdown the simulated system with `"shutdown -h now"` to ensure the integrity of the file system:

```
$ shutdown -h now
```

6. Exit the simulator.



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2. Command Syntax and Usage

This chapter describes the POWER9 Functional Simulator command framework and introduces the structure, format, and usage of simulator commands. Topics in this chapter include:

- Understanding and Using Simulator Commands
- Defining and Managing a Simulated Machine
- Summary of Top-Level Simulator Commands

2.1 Understanding and Using Simulator Commands

The POWER9 Functional Simulator provides a unified, cross-platform interface that enables users to easily set up the simulation environment, manage simulated architecture components, and write debugging and user application routines. The POWER9 Functional Simulator harnesses the power of Tcl to develop a simple and programmable text-oriented syntax that is easily extended. It minimizes the need for proprietary and difficult programming grammar and usage. By extending Tcl with exported functions, data types, and numerous predefined interfaces that are used for all interobject communication, the simulator provides a rapid, cross-platform development environment that enables users to quickly start working in the simulation environment.

The POWER9 Functional Simulator command framework provides a set of commands for simulating processors. Each component in a system is configured by using commands that not only define the component's run-time behavior and characteristics, but govern its relationships and interactions with surrounding components in the system. The *POWER9 Functional Simulator Command Reference* provides syntax and usage information for Tcl commands that are used in the simulator environment.

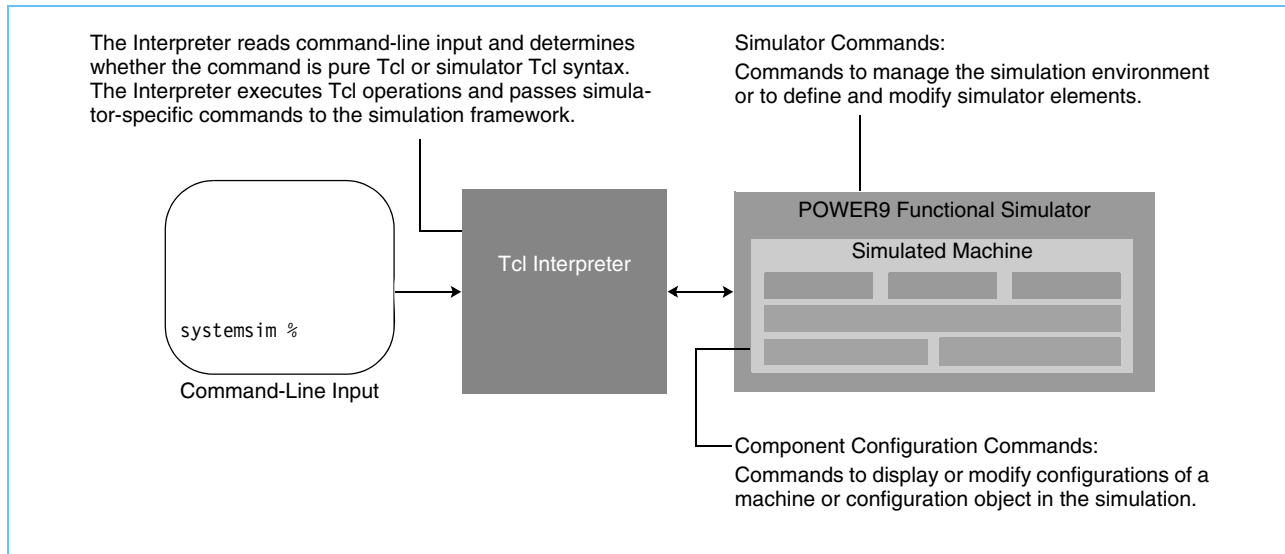
Commands in the POWER9 Functional Simulator are organized into a hierarchy of operations based on the command function. At the top level, commands perform general sets of operations in the simulation environment, such as defining and displaying machine properties and system configurations, modifying configurable parameters, or managing the simulation environment.

The command-line interface can also be used to perform a number of operations on the simulator itself, such as to control a simulation, start debugger tools, and define and load virtual devices and disk images.

Figure 2-1 on page 22 illustrates how commands are processed in the simulation environment and describes the different categories of commands that are available.

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Figure 2-1. Categories of Simulator Commands



Once the simulator is started, commands can be entered at the simulator command line or through simulation Tcl scripts. *Figure 2-2* on page 23 illustrates the simulator command line at startup and the output that is displayed in response to typing "help" at the command prompt.

Figure 2-2. POWER9 Functional Simulator Command Line

```
Mambo internal commands
=====
Available Commands
  alias ->
  define ->
  display ->
  helprecursive
  modify ->
  quit
  simdebug ->
  simstop
  version ->

Simulators
=====
  mysim

Tcl procedures
=====
  BogusDisk::init      - Initialize the bogus disk
  help                  - Displays this help information

Use 'help' or 'helprecursive' after a command for more help.
Command name abbreviations are allowed if unambiguous.
```

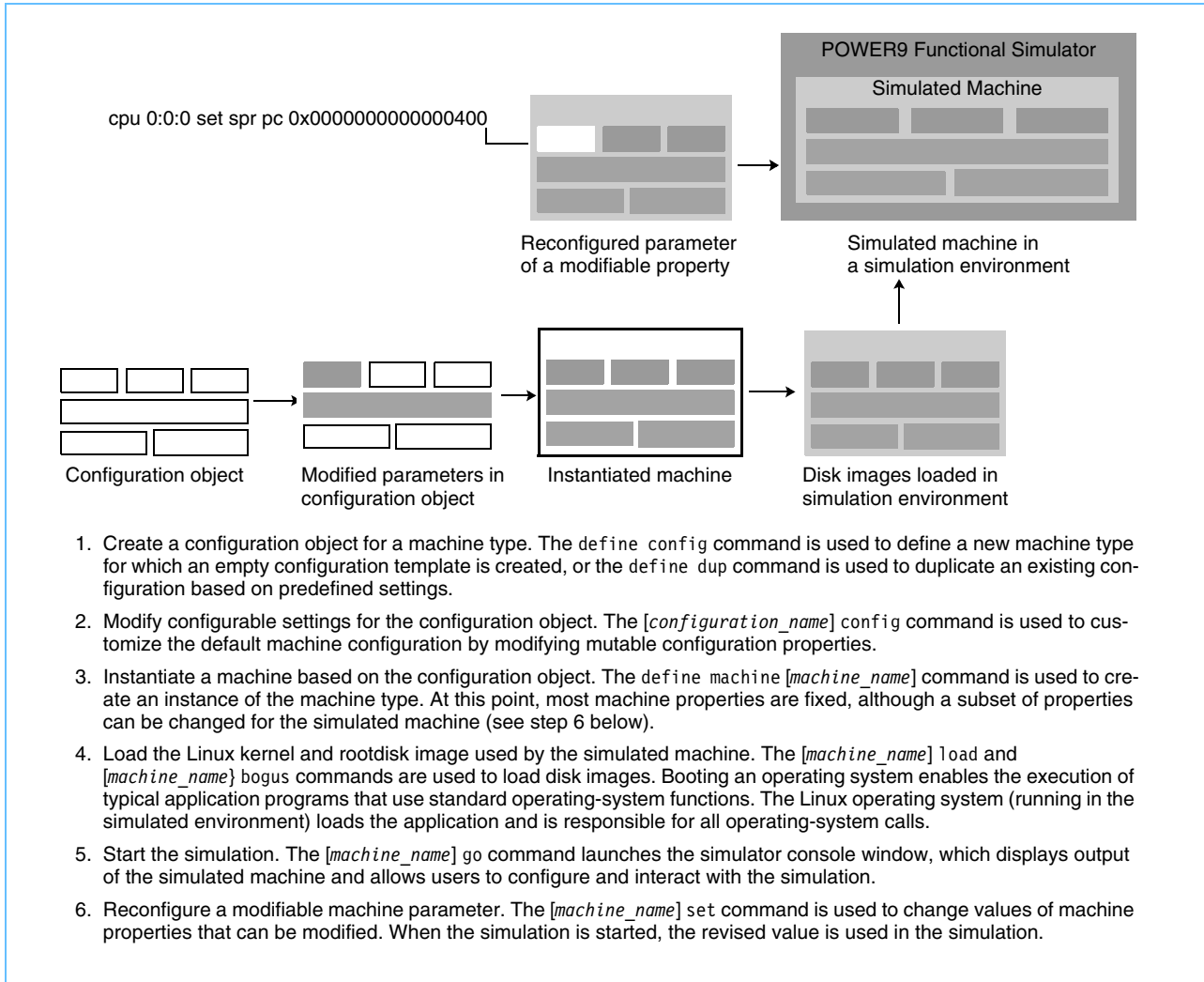
2.2 Defining and Managing a Simulated Machine

The POWER9 Functional Simulator delivers default configurations for the POWER9 processor that it is modeling. Using this configuration, users can instantiate a simulated machine based on a default configuration object to simulate the functionality of a baseline system.

Figure 2-3 on page 24 describes the general sequence of commands that is used to define a machine in the simulation environment.

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Figure 2-3. Defining, Creating, and Starting a Simulated Machine



Commands to configure and initialize a simulated machine are typically provided to the simulator with a Tcl configuration and start-up file, called an initial run script, that is loaded when the simulator starts. The initial run script specifies commands to:

- Create a machine configuration and a machine instance using this configuration
- Locate and load the operating-system and file-system image files
- Prepare the machine to begin execution

The name of the initial run script can be passed to `systemsim-p9` with the `-f` option. If there is no initial run script specified when the simulator is started, the simulator uses the default initial run script provided with the release.

A typical initial run script

The specific commands in an initial run script vary slightly for various machine configurations, but all follow the basic procedure described previously. The following command sequence might be found in a typical initial run script:

1. Set up configuration and utility routines to be used later for booting an operating system. These utilities reside in the `/opt/ibm/systemsim-p9/lib/common` directory. They are brought in with the `tc1` source command.

```
source $env(LIB_DIR)/common/openfirmware_utils.tc1
```

2. The `lib/common` and `lib/p9` directories also contain standard configuration files that can be used in run scripts to create a simulator named `mysim` for a machine with the configuration `myconf`, based on the default POWER9 configuration.

```
proc config_hook { conf } {  
    $conf config processor/number_of_threads 1  
    $conf config memory_size 2048M  
}
```

```
source $env(LIB_DIR)/p9/systemsim.tc1
```

```
source $env(RUN_DIR)/p9/p9-devtree.tc1
```

3. Specify a file containing the root file-system (`sysroot`) image:

```
# bogus disk  
mysim bogus disk init 0 disk.img rw
```

The initial run script typically uses a standard search order to locate the `sysroot_disk` file starting with the current directory. The `rw` parameter indicates that the disk image has an access type of `rw` (for read-write), which indicates that modifications to the root file system during the simulation must be stored back into the `sysroot_disk` file. When the `sysroot_disk` is accessed read-write, the user must issue the `sync` command before exiting the simulator to ensure consistency of the file-system image. If the parameter used is `cow` (copy on write), it indicates that changes will be stored in `<cowfile>`. This method treats the contents of the `sysroot_disk` file as read-only, so that subsequent simulations can be performed with repeatable results.

4. Set up the simulated network (for more information, see *Section 3 Accessing the Host Environment* on page 33):

```
# networking with IRQ off  
# need this locally:  
# sudo tunc1 -u $USER -t tap0  
# sudo ifconfig tap0 172.19.98.108 netmask 255.255.255.254  
# in sim this:  
# ifconfig eth0 172.19.98.109 netmask 255.255.255.254  
mysim bogus net init 0 d0:d0:d0:da:da:da tap0 0 0
```

5. Load the operating system kernel into memory:

```
mysim load vmlinux <path_to_vmlinux_file> 0x0
```

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In hardware, this is generally performed by the system firmware. However, the simulator is typically configured without firmware installed. Therefore, a simulator command is used to load the kernel into memory.

In many cases, the initial run script uses a standard search order to locate the `vmlinux` file, starting with the current directory and then the `images` directory under the simulator root directory. The `0x0` parameter in this command specifies the address at which to load the kernel file:

```
# Load vmlinux
mysim load vmlinux vmlinux 0x0
```

6. Start the simulation with the `mysim go` command:

```
mysim mode fastest
mysim go
```

7. After the operating system has completed boot, you can execute POWER9 applications by entering commands at the Linux console (see *Figure 2-4* on page 27). To automate console input from within a script, use the `mysim console create` command. This command automates the interactions that are typically performed by manually typing commands in the simulator console window:

```
mysim console create input in string <console_input>
```

where `console_input` specifies a string containing console commands to execute. The string contents are identical to any commands that are typed in the console window, including new lines (which can be entered with the escape sequence `\n`). Typically, the last command of the console input is `callthru exit` to return control to the simulation Tcl command script. For example:

```
mysim console create UART0 in string "\n"
mysim console create UART0 in string "ls -l /"
mysim console create UART0 in string "cat /proc/cpuinfo"
mysim console create UART0 in string "callthru exit"
```

Figure 2-4. Linux Console and Command Line Screen

```

File Edit View Search Terminal Help
.
3481601208: (1447295077): Debian GNU/Linux jessie/sid debian-ppc64el-2-0 hvc0
3481712651: (1447406520): debian-ppc64el-2-0 login: mambo^H ^H^H ^H^H ^H^H ^H^H
^Hroot
61036243565: (1663335773): Password:
66896767493: (1688554313): Last login: Thu Jun 13 22:29:04 UTC 2002 on hvc0
66936422093: (1728208942): Linux debian-ppc64el-2-0 3.16.3-systemsim #2 SMP Fri
Sep 26 13:56:21 UTC 2014 ppc64le

66936714824: (1728501673): The programs included with the Debian GNU/Linux syste
m are free software;
66936743456: (1728530305): the exact distribution terms for each program are des
cribed in the
66936769045: (1728555894): individual files in /usr/share/doc/*/copyright.

66936788746: (1728575595):
o the extent
66936817458: (1728604307):
66973648985: (1745055729):
s initialized

2068126571325: (8486412121)

```

DefaultConsole

```

[ OK ] Started Serial Getty on hvc0.
[ OK ] Reached target Login Prompts.
[FAILED] Failed to start Login Service.
See 'systemctl status systemd-logind.service' for details.
[ OK ] Reached target Multi-User System.
[ OK ] Reached target Graphical Interface.

Debian GNU/Linux jessie/sid debian-ppc64el-2-0 hvc0

debian-ppc64el-2-0 login: root
Password:
Last login: Thu Jun 13 22:29:04 UTC 2002 on hvc0
Linux debian-ppc64el-2-0 3.16.3-systemsim #2 SMP Fri Sep 26 13:56:21 UTC 2014 pp
c64le

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
root@debian-ppc64el-2-0:~# random: nonblocking pool is initialized

root@debian-ppc64el-2-0:~#

```

2.3 Simulator Commands

For a list of the top-level commands that are used to define, modify, and use the simulator, see the *POWER9 Functional Simulator Command Reference*. That document provides the complete command-line syntax and usage of each command or class of commands.

Simulator commands are prefaced with “mysim.” *Table 2-1* on page 28 provides a complete list of all the available simulator commands and subcommands. To generate this list at any time, type:

```
mysim helprecursive
```

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At any time, users can type the help command at the command line to retrieve a list of command choices that are available from that point in the syntax statement. In most cases, you can also just type a partial command sequence and hit return. For example, at the top level, help displays a list of top-level commands. An arrow indicates that a subsequent level of command functionality is available for this command.

Table 2-1. POWER9 Functional Simulator Commands (Page 1 of 5)

systemsim % mysim helprecursive
config_on
cycle {number}
dtranslate
exit
go
itranslate
mode {turbo turbo_perflfast simple warmup simple_warmup cycle}
quit
setargs [args list]
stall
start_thread {PC_address}
step {number of instructions}
stop_thread
tick {number}
to_cycle {number}
bogus ->
disk ->
cleanup
display
init {minor} {imagepath} {rlw rw cow newcow} [{cowpath} {hashsize}]
stat
sync {minor}
net ->
cleanup
init {minor} {macaddr} {socket_file} [IRQ IRQ_offset]
bogushalt ->
delay
disable
display
enable
console ->

Table 2-1. POWER9 Functional Simulator Commands (Page 2 of 5)

destroy {console-id}
disable {console-id}
enable {console-id}
list
create {console-id} ->
in ->
file {file-name}
listen {port} [max_attempts] [time_limit]
program {program-name}
socket {host:port}
string {input-string}
inout ->
file {file-name}
listen {port} [max_attempts] [time_limit]
program {program-name}
socket {host:port}
string {input-string}
out ->
file {file-name}
listen {port} [max_attempts] [time_limit]
program {program-name}
socket {host:port}
string {input-string}
display ->
buffered
set ->
buffered {on/off}
cpu {cpu-number} ->
display ->
cycles
features
fpr {number}
fpr_as_fp {number}
fprs
gpr {number/values}
gprs
instruction_count

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Table 2-1. POWER9 Functional Simulator Commands (Page 3 of 5)

loader_high_mem
memory_size
memorymap [listformat]
mode
name
nfpr
ngpr
number_of_MCMS
number_of_threads
slb {number valid all}
spr {name list values}
vmx {reg-num} {size}
vmxr {reg-num}
vsxr {reg-num}
interrupt ->
AlignmentException {Load Store}
DataStoragePageFault {Load Store}
DataStorageProtection {Load Store}
DataStorageReservationWithWriteThrough {dar_value} {Load Store}
DataStorageSegmentFault {dar_value} {Load Store}
Decrementer
External {ms raiselower} <interrupt_source_number>
FPUavailable
HMI
HV_Decrementer
HV_Virtualization
HvSystemCall
IllegalInstruction
InstStorageG1
IPI
MachineCheck
MER
PerfMonitor
PreciseMachineCheck
PrivilegedInstruction
SystemCall
SystemError

Table 2-1. POWER9 Functional Simulator Commands (Page 4 of 5)

SystemReset
TrapInstruction
VMX_Assist
VMXUnavailable
load ->
elf {filename}
linux {filename}
vmlinux {filename} {address}
xcoff {filename} {entry point}
mcm {mcm-number} ->
memory ->
display {address} {unit-size} [repeat_count]
fread {address} {bytes-to-read} {filename}
freadcmp {address} {bytes-to-read} {compressed-filename}
freadgz {address} {bytes-to-read} {compressed-filename}
fwrite {address} {bytes-to-write} {filename} {append}
fwritecmp {address} {bytes-to-write} {compressed-filename}
fwritegz {address} {bytes-to-write} {compressed-filename}
set {address} {unit-size} {64-bit value}
use_swap
of ->
addchild {parent-handle} {driver-name} {unit-address}
child {parent-handle}
clear
enuminfo {enum-func-name}
find_device {device-spec}
getprop {package-handle} {prop-name}
getpropflen {package-handle} {prop-name}
getproptype {package-handle} {prop-name}
machineinfo
mmapinfo {map-name}
nextprop {package-handle} [previous-prop]
package_to_path {package-handle}
peer {sibling-handle}
print
rtasinfo {rtas-func-name}
setprop {package-handle} {property-name} {property-value}

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Table 2-1. POWER9 Functional Simulator Commands (Page 5 of 5)

test {service-name}
thread {thread-number} ->
util ->
dtranslate
dtranslate_wimg
itranslate
itranslate_wimg
ppc_disasm {instruction} {address}
stuff {instruction}

3. Accessing the Host Environment

This chapter describes several mechanisms that are provided to allow interactions between the host and simulated systems. Topics in this chapter include:

- The Callthru Utility
- Bogus Network Support
- Bogus Disk Driver Support

3.1 The Callthru Utility

There are two callthru utilities, one for use with big-endian kernels and one for use with little-endian kernels. They are installed as a binary applications in the simulator system in the `/opt/ibm/systemsim-p9/examples` directory. The callthru utilities allow you to copy files between the host system and the simulated system while it is running. These utilities run within the simulated system and access files in the host system using special call-through functions of the simulator. The callthru utilities support the following options:

- To write standard input into `<filename>` on the host system, issue:

```
callthru sink <filename>
```

- To write the contents of `<filename>` on the host system to standard output, issue:

```
callthru source <filename>
```

Redirecting appropriately lets you copy files between the host and the simulated system. For example, to copy the `/tmp/matrix_mul` application from the host into the simulated system and then run it, issue the following commands in the console window of the simulated system:

```
callthru source /tmp/matrix_mul > matrix_mul
chmod +x matrix_mul
./matrix_mul
```

Another commonly used feature of the callthru utilities is the `exit` option, which stops the simulation and is initiated by the callthru utility inside the simulator. This is especially useful for constructing “scripted” executions of the simulator that involve alternating steps in the simulator and the simulated system.

- To stop the simulator and return control back to the currently active run script, issue:

```
callthru exit <filename>
```

3.2 Bogus Network Support

Bogus network support enables network communications with reasonable performance between the simulated system and other systems. This is accomplished by using a special Ethernet device that uses call-through functions of the simulator to send and receive network packets to the host system. To enable communication with other systems, the host system must be configured to relay packets from the simulated system out to the real network.

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The bogus network facility can be configured and used in a variety of ways. A detailed description of the Linux and `systemsim-p9` commands to set up and manage bogus network communications follows. For user convenience, the most common approach to using the bogus network has been automated using Tcl procedures. These are described first because most users should find these sufficient for simple network communication between the host and the simulated system.

3.2.1 Extended Description of Bogus Network Support

There are three key components to bogus network communications:

1. A facility on the host system that provides `systemsim-p9` with a path to the network. The `TUN/TAP` support available for Linux is a good choice for this component, and we assume `TUN/TAP` in the remainder of this description.
2. The `systemsim-p9` support for the bogus network. This support is not enabled by default. Simulator commands are used to enable the bogus network support.
3. An operating-system kernel with a bogus network driver.

3.2.2 Setting up TUN/TAP on the Host System

You must have root privileges on your system to set up bogus network operation. Execute the following commands:

```
sudo tuncctl -u $USER -t tap0
sudo ifconfig tap0 172.19.98.108 netmask 255.255.255.254
```

3.2.3 Configuring `systemsim-p9` Support for the Bogus Network

To enable bogus network support, issue simulator commands that configure and initialize the bogus network. These commands must be issued before booting the Linux kernel on the simulator so that Linux recognizes the bogus network device during its boot process. The general form of the command to initialize the bogus network is:

```
mysim bogus net init 0 <mac address> <interface name> <irq>
```

The `<mac address>` parameter is the media access control (MAC) hardware address that you want the emulated Ethernet to use. It must be unique on your network (that is, not used by any other emulated hosts or by any host network adapter). The `<interface name>` parameter is the name of the interface to be used, typically "tap0". The `<irq>` parameter specifies the interrupt request queue ID to be used by the bogus network device; use 0 0 for the POWER9 Functional Simulator.

3.2.4 The Bogus Network Device Driver

The final component required for bogus network communication is an operating-system kernel with the bogus network device driver. A precompiled little-endian Linux kernel that has been patched with support for bogus net and bogus disk device drivers can be downloaded from the unicamp file FTP site. Instructions can be found in the readme file in the `/opt/ibm/systemsim-p9/examples/linux` directory.

3.2.5 Connecting to the Simulation Host

After these components are in place, you are ready to use the bogus network for network communications with the simulated system. Start the simulation. At the Linux prompt, enter the following commands on the simulated console (UART):

```
% mount /proc # if /proc is not already mounted
% ifconfig eth0 172.19.98.109 netmask 255.255.254.0
```

You can then ping the host system from the simulated system (and vice versa)

```
% ping -c 1 172.19.98.108
```

3.2.6 Troubleshooting the Bogus Network

Ping of system host from simulated host results in ping icmp open socket: Operation not permitted:

First, check to see if you can ping the simulated host from the system host. If this is working, the bogus network traffic is flowing in both directions. The problem is probably with the kernel or root disk, most likely the latter.

Operations seems to hang:

Beware of firewalls, ipchains, and iptables. A firewall of some sort is probably blocking the port. Either disable the firewall or open up the specific port.

3.3 Bogus Disk Driver Support

To enable bogus disk support, issue simulator commands that configure and initialize the bogus disk system. These commands must be issued before booting the Linux kernel on the simulator so that Linux recognizes the bogus disk device during its boot process. The general form of the command to initialize bogus disk is:

```
mysim bogus disk init 0 disk.img rw
```

This configures the disk support for read/write operations.

You can find examples of how to configure both bogus disk and bogus network support in the example Linux boot script, `boot-linux-le-skiboot.tcl`.