Linux on RISC-V

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Agenda

- Introduction
- RISC-V support in Gentoo
- RISC-V support in other Linux distributions and mainstream applications

About

- Embedded Linux development and integration
- Open source contributions
  - Gentoo Linux

Introduction

RISC-V

- Open source ISA specification
- Stable (base and standard extensions are frozen)
- Modular design with extensions
- Led by RISC-V Foundation

RISC-V ISA

- Base ISA:
  - RV32I, RV32E: 32-bit
  - RV64I: 64-bit
  - RV128I: 128-bit

Name	Description
RV32I	Base Integer Instructions, 32 bit
RV32E	Base Integer Instructions, 32 bit, embedded
RV64I	Base Integer Instructions, 64 bit
RV128I	Base Integer Instructions, 128 bit
Q	Standard Extension Quad-precision Floating Point
L	Standard Extension Decimal Floating Point
C	Standard Extension Compressed Instructions
B	Standard Extension Bit Manipulation
M	Standard Extension Integer Multiply and Divide
A	Standard Extension Atomic Instructions
F	Standard Extension Single-precision Floating Point
D	Standard Extension Double-precision Floating Point
J	Standard Extension Dynamically Translated Languages
T	Standard Extension Transactional Memory
P	Standard Extension Packed SIMD Operations
V	Standard Extension Vector Operations
N	Standard Extension User Level Interrupts

RISC-V ISA

- Extensions:
  - M: integer multiplication and division
  - A: atomic operations
  - F, D, Q: single/double/quad precision floating point
  - G: general purpose ISA, shorthand for IMAFD
  - C: compressed instructions
- Linux distributions target RV64GC

RISC-V support in Gentoo

Gentoo

- Source-based distribution
- Package manager – Portage
- Users build their own systems
- Allows fine-grained system configuration
  - Profiles
  - USE flags

Supported architectures

- Stable: amd64, arm, arm64, hppa, ppc, ppc64,sparc, x86
- Unstable: alpha, ia64, loong, riscv
- Experimental: m68k, mips, s390

RISC-V port

- First working RISC-V profiles created by Andreas K. Hüttel in 2019
- Targets:
  - RV64GC (lp64d)
  - RV64IMAC (lp64)
- Today: 8000 packages (incl. tests), 10 000 packages supported on arm64

Why Gentoo?

- High degree of freedom and flexbility
- Latest software available
- Good platform for developing
  - Cross-compilation workflow using crossdev and QEMU

RISC-V stage archives

- https://www.gentoo.org/downloads

ABI	init	libc
lp64d	systemd	glibc
lp64d	systemd (merged-usr)	glibc
lp64d	openrc	glibc
lp64d	systemd	musl
lp64	systemd	glibc
lp64	systemd (merged-usr)	glibc
lp64	openrc	glibc
lp64	openrc	musl

RISC-V profiles

Attempted multilib support...

- Two level libdir paths
- lp64d
  - -march=rv64gc -mabi=lp64d
  - libdir = lib64/lp64d
- lp64
  - -march=rv64imac -mabi=lp64
  - libdir = lib64/lp64

Problems:

- Partially broken build systems (e.g. CMake)
- Important packages supporting only RV64GC/lp64d (e.g. Rust)

RISC-V 20.0 profile

- make.defaults

```
# Copyright 2019-2021 Gentoo Authors
# Distributed under the terms of the GNU General Public License v2

# RISC-V rv64gc/lp64d no-multilib profile

CHOST="riscv64-unknown-linux-gnu"

MULTILIB_ABIS="lp64d"
DEFAULT_ABI="lp64d"
ABI="lp64d"

LIBDIR_lp64d="lib64"

CFLAGS="-O2 -pipe -march=rv64gc -mabi=lp64d"
CXXFLAGS="${CFLAGS}"
FFLAGS="${CFLAGS}"
FCFLAGS="${CFLAGS}"
```

RISC-V 17.0 profile

```
# Flags for lp64d
LIBDIR_lp64d="lib64/lp64d"
CFLAGS_lp64d="-mabi=lp64d"
LDFLAGS_lp64d="-m elf64lriscv"
CHOST_lp64d="riscv64-unknown-linux-gnu"

# Flags for lp64
LIBDIR_lp64="lib64/lp64"
CFLAGS_lp64="-mabi=lp64"
LDFLAGS_lp64="-m elf64lriscv_lp64"
CHOST_lp64="riscv64-unknown-linux-gnu"
```

Repositories

- Main repository
  - https://github.com/gentoo/gentoo
  - 19 000 packages
- RISC-V overlay
  - https://github.com/gentoo/riscv
  - Contains experimental packages (valgrind, qtwebengine, thunderbird)

Calculate binary repository

- Calculate Linux
  - Gentoo-based distribution (backwards compatible)
  - Optimized for fast deployment
- Unofficial repository
  - https://mirror.onfoo.top/calculate/grp/riscv64
  - https://mirror.onfoo.top/images/calculate-unmatched-2022.05.18.rootfs.wic.xz

Future work

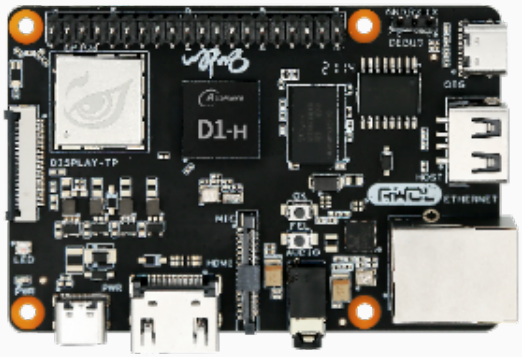
- Provide bootable images
- Support RISC-V as a stable architecture
- RV32 support?
  - glibc-2.33 gained RV32 support in 2021
  - Y2038 problem in distros - 14:30 @ Distributions devroom

Supported platforms

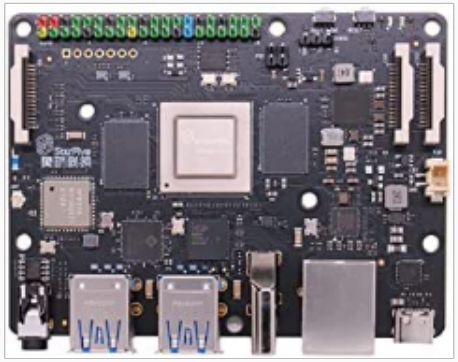
HiFive Unleashed

HiFive Unmatched

StarFive BeagleV



Allwinner NeZha D1



StarFive VisionFive 1

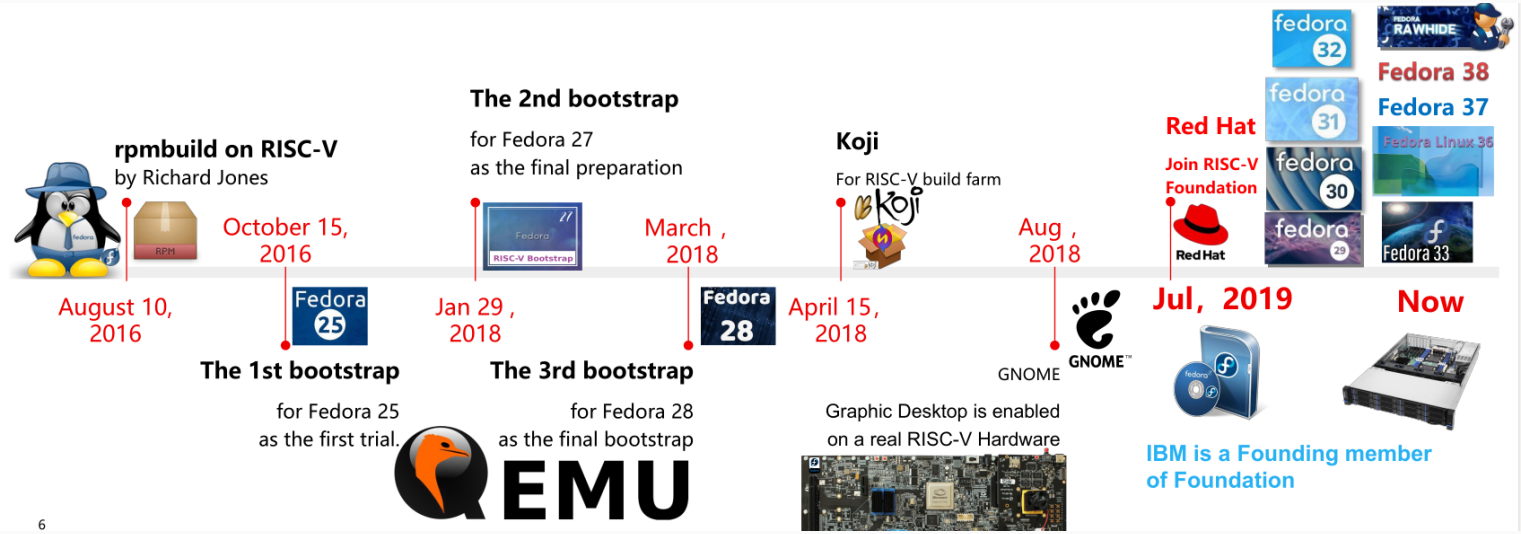
RISC-V support in other distributions

Debian

- Full RISC-V support
- 95% packages built for RISC-V
- Uses RV64GC as the hardware baseline and the lp64d ABI
- Supported hardware: HiFive Unleashed, HiFive Unmatched, StarFive VisionFive
- Karsten Merker - Porting Debian to RISC-V @FOSDEM 2019

Fedora

- Final bootstrap in 2018
- Pre-built images for virtual and physical targets
- David Abdurachmanov - Fedora on RISC-V 64-bit @FOSDEM 2019



FreeBSD

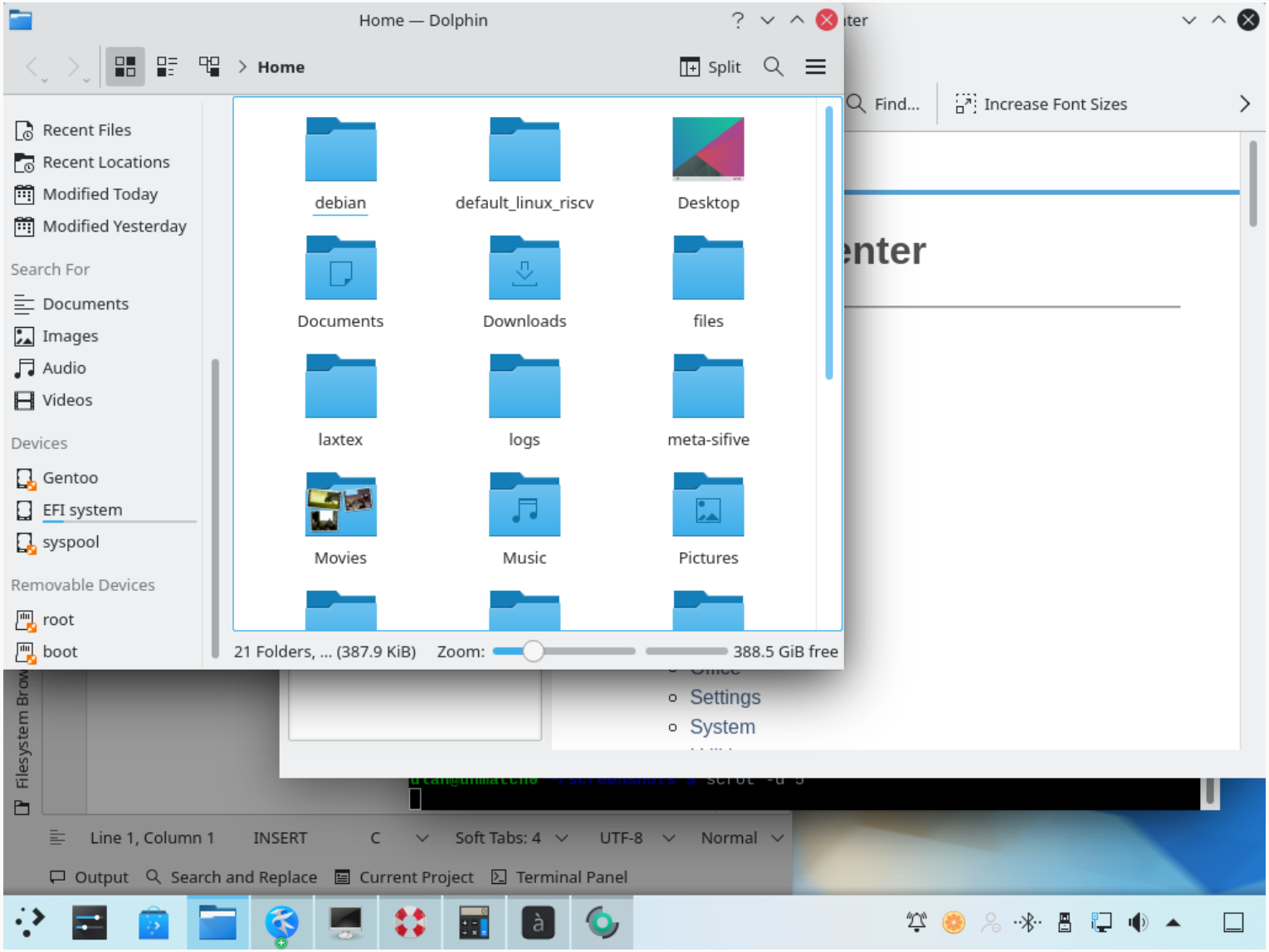
- RISC-V port released in January 2016
- First OS to have bootable in-tree support
- Tier-2 architecture
- Supported platforms: Spike, QEMU, BeagleV, Hifive Unmatched, HiFive Unleashed

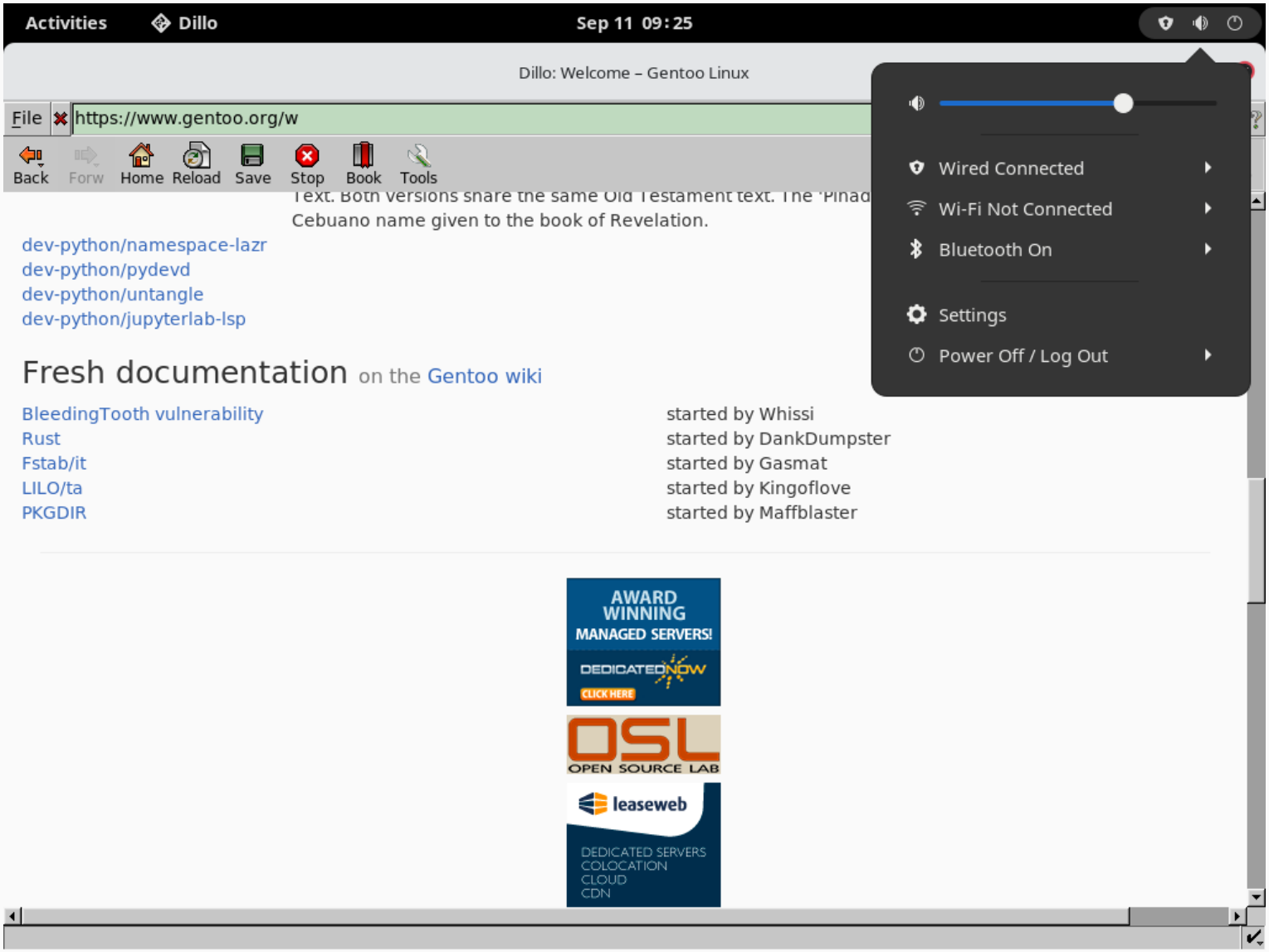
- OpenSUSE
  - Support for QEMU and physical hardware (HiFive Unmatched)
- Ubuntu
  - Supports RISC-V since 20.04 release
  - Bootable images for HiFive Unmatched, HiFive Unleashed, LicheeRV Dock and StarFive VisionFive

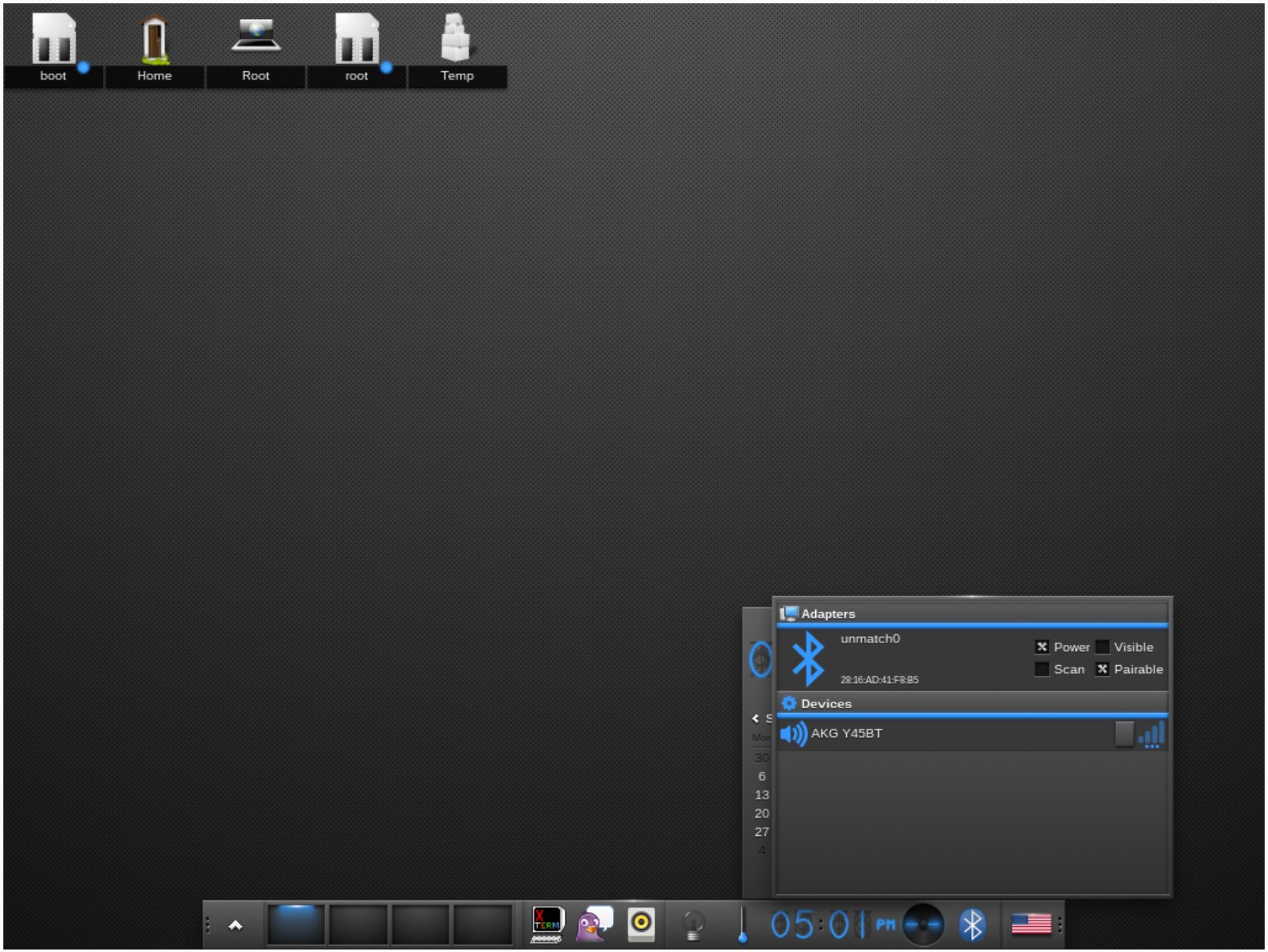
Desktop environments

- GNOME
- KDE
- XFCE
- Mate
- Cinnamon
- LXDE
- LXQT
- Enlightment

Gentoo in action




Activities
Dillo
Sep 11 09:25
Dillo: Welcome – Gentoo Linux
File
https://www.gentoo.org/w
Back
Forw
Home
Reload
Save
Stop
Book
Tools
Cebuano name given to the book of Revelation.
dev-python/namespace-lazr
dev-python/pydevd
dev-python/untangle
dev-python/jupyterlab-lsp
Fresh documentation on the Gentoo wiki
BleedingTooth vulnerability
started by Whissi
Rust
started by DankDumpster
Fstab/it
started by Gasmat
LILO/ta
started by Kingoflove
PKGDIR
started by Maffblaster
Wired Connected
Wi-Fi Not Connected
Bluetooth On
Settings
Power Off / Log Out
AWARD WINNING
MANAGED SERVERS!
DEDICATEDNOW
CLICK HERE
OSL
OPEN SOURCE LAB
leaseweb
DEDICATED SERVERS
COLOCATION
CLOUD
CDN


boot
Home
Root
root
Temp
Adapters
unmatch0
28:16:AD:41:F8:B5
Power
Visible
Scan
Pairable
Devices
AKG Y45BT
05:01 PM

Mainstream applications

- Firefox
- OpenJDK
- Chromium
- Libreoffice
- Nodejs

Ongoing ports

- Luajit - https://github.com/LuaJIT/LuaJIT/issues/628
- Valgrind - https://github.com/petrpavlu/valgrind-riscv64
- Mono

Questions, suggestions?

- https://wiki.gentoo.org/wiki/Project:RISC-V
- riscv@gentoo.org
- jsmolic@gentoo.org
- #gentoo-riscv on libera.chat