HelenOS: 20 Years of History, 20 Years of Future Vision

Martin Decky

About the Speaker



Charles University

- Researcher at the Department of Distributed and Dependable Systems (2008 2017)
- Co-author of the HelenOS microkernel multiserver operating system (since 2004)
- Huawei Technologies
 - Principal Research Engineer and co-founder at the Dresden Research Center (2019 2021)
 - Contributing to the HarmonyOS NEXT microkernel-based operating system
- Kernkonzept GmbH
 - Senior Software Engineer (since 2021)
 - Contributing to the L4Re microkernel-based operating system framework

HelenOS in a Nutshell

- Open source operating system
 - BSD
- Microkernel-based
 - 10 classes of kernel objects
- Multiserver
 - Avoiding monolithic components also in user space
- General-purpose
 - Policy decisions distributed among user space components

| - UI Demo - C | | | | | | | |
|---|------------------------------|---|---|------------------|---|--|--|
| Eile Edit Preferences Help | - | Havigator | | | | | |
| Basic Lists | File | | | | | | |
| Text label | ▲ app boot cfg data | | app boot cfg data | | 4 | | |
| OK Cancel | includ | dru includ Terminat | | | | | |
| | loc Ad | ∥ inet list-addr dr/Width | | Addr-Name Def-M1 | | | |
| Read only | src :: sru fe | 7.0.0.1/24 1/128 80::5054:ff:fe12:3 .0.2.15/24 | net/loopbac net/loopbac 456/64 net/eth1 net/eth1 | | | | |
| Center Bight | tnp vol Vo | # vol lume Name Resource | | Content | Auto Mounted at | | |
| | | | \hw\sys\00:01.0\at \hw\sys\00:01.0\at | |) Yes /vol/HelenOS-CD | | |
| Navigator Text Editor Command Line | logo.t prague | - | | - About | HelenOS | | |
| <u>Calculator</u> Image Viewer | Eite Ei | Calculator dit | | M | Helen 0S | | |
| Ul Demo GFX Demo Barber Pole | 7 | 89 | ~ | | 0.14.1 (Aladar) 1-2024 HelenOS project | | |
| Tetris | 4 | 5 6 | * | 10 0 | g on amd64 | | |
| Display Configuration Taskbar Configuration | 1 | 2 3 | - | | ок | | |
| Tas <u>k</u> Monitor (top) Edisk Disk Editor | 0 | C = | • | | | | |
| About HelenOS | ing without on se | | | | | | |
| Start Navigator | UI Demo | Calculator | GFX Demo | Terminal | About HelenOS 19:50:03 | | |

HelenOS in a Nutshell

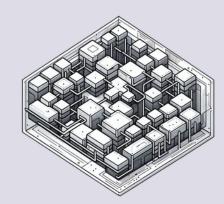
- Multiplatform
 - IA-32, AMD64, IA-64, ARM, AArch64, MIPS, PowerPC, SPARCv9
- Designed and implemented from scratch
 - Asynchronous IPC with memory sharing
 - Majority of native (non-ported) components
- Focusing on readability and maintainability
 - 30 % of comments in source code
- Integrated distribution

| UI Demo | - | | Navigator | | | | | |
|--|--|--|---------------------------------|--------------------|---|--|--|--|
| Basic Lists | File App boot cfg data | | il app ■ boot cfg data | | | | | |
| OK Cancel | The formation of the fo | includ Terminal 1ib / # inet list-addr 1oc Addr/Width Link-Mane 1og Iso Iso 1og Iso Iso 1c Iso Iso 1c Iso Iso src Iso Iso <t< th=""></t<> | | | | | | |
| Navigator Text Editor Command Line Ealculator Image Viewer | deno.x logo.t prague | Calculator | -× | - About | HetenOS IX | | | |
| UI Demo GFX Demo Barber Pole Tetris Display Configuration | | 8 9 5 6 | * | Copyright (c) 2004 | 0.14.1 (Aladar) -2024 HelenOS project g on amd64 | | | |
| Taskbar Configuration Task Monitor (top) Edisk Disk Editor | I I | 2 3 C = | - - | | ОК | | | |
| About HelenOS Start Navigator | UI Demo | Calculator | GFX Demo | Terminal | About HetenOS 19:50:0 | | | |

What Is New since 2020

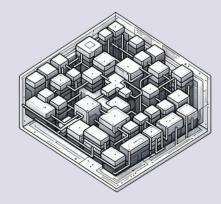
GUI reimplementation

- More flexible display server architecture
 - Support for accelerated direct and indirect rendering
 - Better performance in software rendering
 - Configurable double buffering
- Many widgets and dialogs
 - Text mode parity
 - Proportional fonts
- Text mode mouse & tablet support
- Raspberry Pi 3 HDMI support



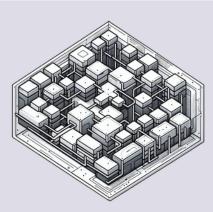
What Is New since 2020

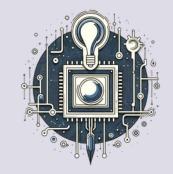
- Usability improvements
 - Font editor
 - 2-panel file manager
 - Taskbar with start button & start menu
 - Multiseat support
 - Terminal scrolling and resizing
 - Shutdown
- Up-to-date compiler toolchain
- Improved standards compliance



What Is New since 2020

- HiKey960 support
- Block device drivers performance improvements
- Kernel streamlining
 - DWARF support for better debugging experience
 - Reduction of synchronization (e.g. CPU-local structures, atomic accesses)
 - Abstraction improvements (e.g. semaphores instead of directly using wait queues)
 - Removal of unused "extension points"
 - Clever performance optimizations
- 4 public releases, 948 commits





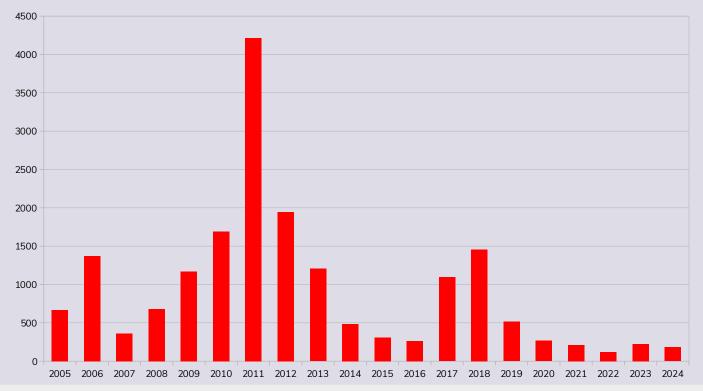
Qualitative Difference from 2004 – 2020

- We were used to news items such as ...
 - Itanium support, SPARCv9 support, AArch64 support
 - Device Driver Framework
 - Network subsystem with IPv6 support, sound subsystem
 - USB 3 support, Intel HD Audio support
 - Read-Copy-Update, lockless hash table
 - Dynamic linking
 - ext4 support, UDF support, installer



Overall Activity

Commits per year



Overall Activity



The "serene valley" of HelenOS in 2025

HelenOS is complete



Two Meanings of the Word "Complete"



This meaning **does not** apply to HelenOS



Two Meanings of the Word "Complete"



This meaning **does** apply to HelenOS

HelenOS in the Bigger Picture

- HelenOS is a "pure" open source project
 - Completely community driven
 - Individual interests
 - Academic research
 - Education (theses, etc.)
 - Some corporate sponsorship (GSoC, CZ.NIC)
 - But no real business or monetization plan
- No "major building blocks" missing anymore
 - Implementing thousands of device drivers, file systems, standard APIs and usability features is tedious and not rewarding

A Cautionary Tale?

- Do we remember MINIX 3?
- Do we remember GNU Hurd?
- Will we remember other major microkernel OS projects like this eventually?
- There is nothing wrong with the "serene valley" per se
 - Expect it and embrace it
 - If you do not like it, then have a plan to avoid it
 - Source of revenue that would cover the non-fun tasks

The Vision for HelenOS into 2030s

- Embracing the "serene valley" for now
 - Valuable tool for experimentation
 - Valuable code base to learn from
- Always on a lookout for future challenges
 - Asynchronicity more important than ever
 - Readily available functionality to be merged
 - Task checkpointing & migration
 - MMU-less operation

Summary

- HelenOS is alive and well
- HelenOS is complete
- There are still many ways to contribute
- HelenOS is here to stay
- There is nothing wrong with the "serene valley"
- If you do not like the "serene valley", have a plan



Thank you! Questions?