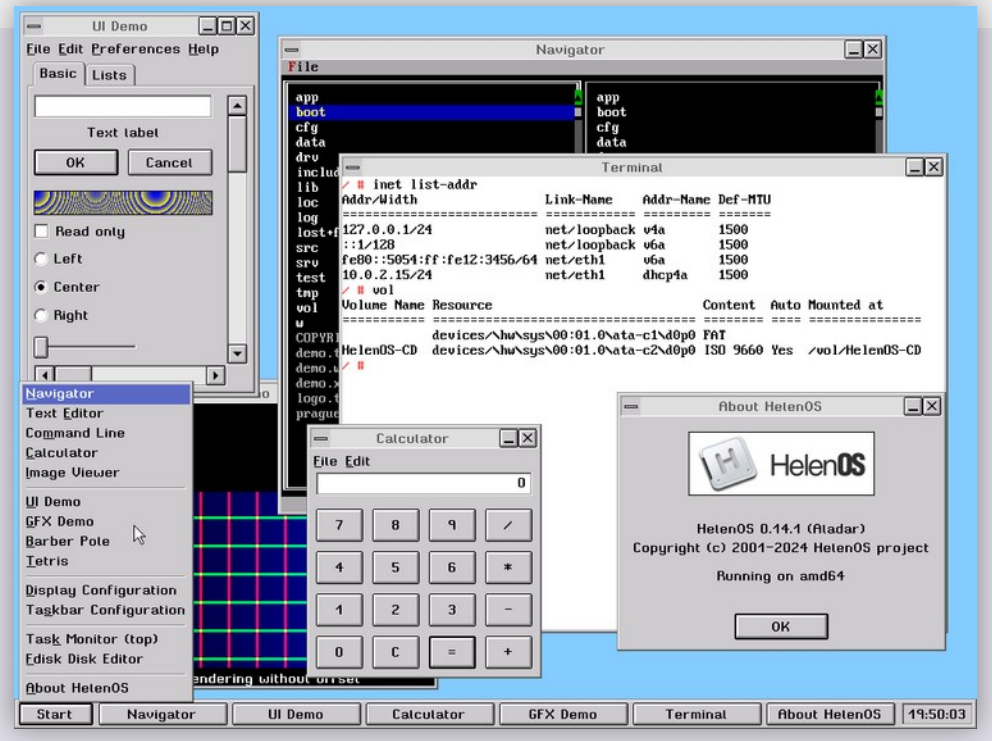
# HelenOS:
## 20 Years of History, 20 Years of Future Vision

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

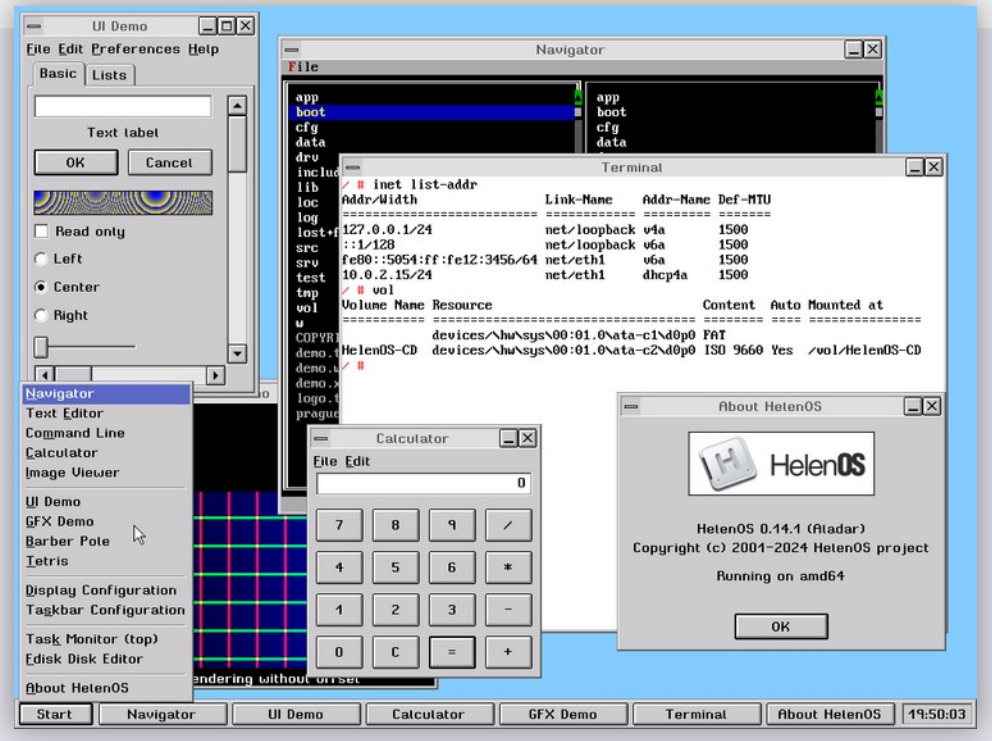
# HelenOS in a Nutshell



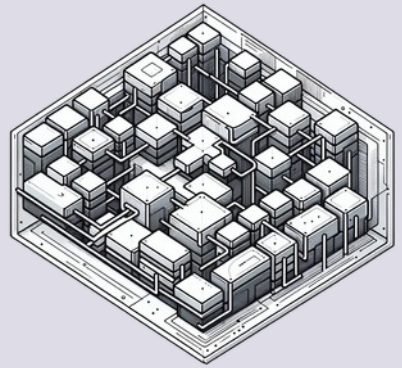

- **Open source operating system**
  - BSD
- **Microkernel-based**
  - 10 classes of kernel objects
- **Multiserver**
  - Avoiding monolithic components also in user space
- **General-purpose**
  - Policy decisions distributed among user space components

# 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**

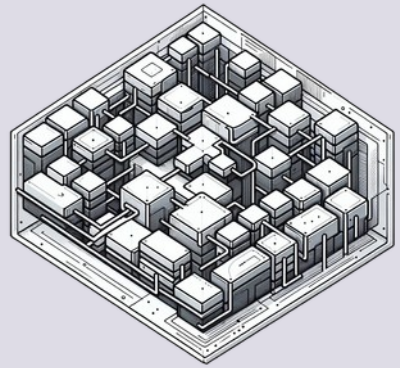


# What Is New since 2020



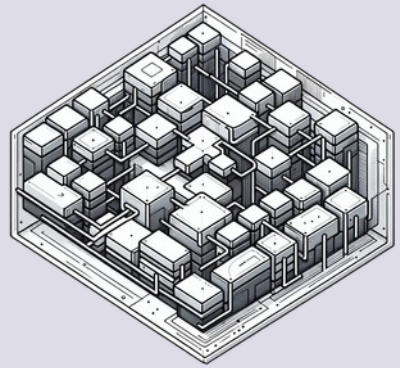
- **GUI reimplementation**
  - More flexible display server architecture
    - Support for accelerated direct and indirect rendering
    - Better performance in software rendering
    - Configurable double buffering
  - Many widgets and dialogs
    - Text mode parity
    - Proportional fonts
  - Text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

# What Is New since 2020



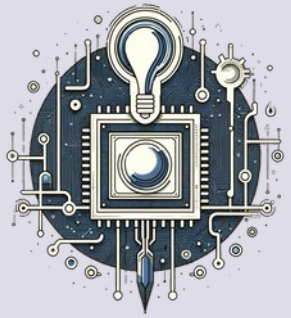
- **Usability improvements**
  - Font editor
  - 2-panel file manager
  - Taskbar with start button & start menu
  - Multiseat support
  - Terminal scrolling and resizing
  - Shutdown
- **Up-to-date compiler toolchain**
- **Improved standards compliance**

# 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**

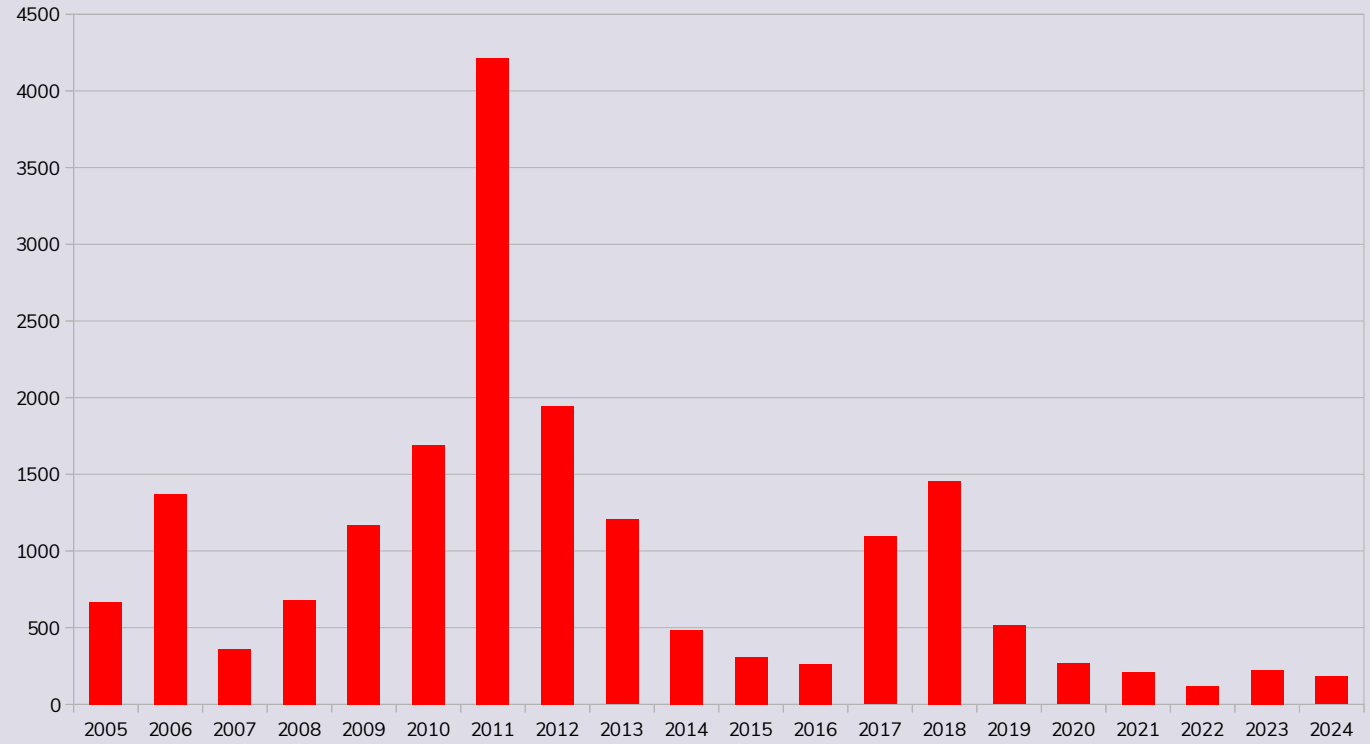
# Qualitative Difference from 2004 – 2020



- **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

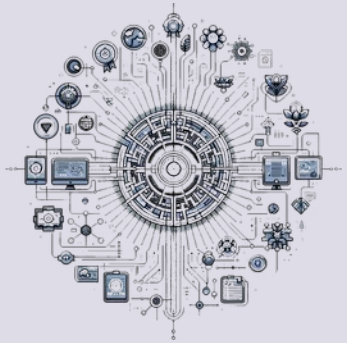
# A Cautionary Tale?


- **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?