Microkernels:
The Last 15 Years in Retrospective

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Why Look Back on the Last 15 Years?

- **2012: Jakub Jermář started the Microkernel Devroom**
  - At each FOSDEM ever since
    (the name changed slightly over the years)
  - **146 talks** by **80 speakers** about **45 projects**
    (including unikernels and other friends)
- **It is already a substantial piece of history**
  - Kids graduating from high school, world order gradually changing …

What Has Not Changed since 2012

- **The significance of the microkernel architecture**
  - Different people / projects focus on different aspects / use cases
  - But there is one least common denominator:
    T**he microkernel architecture is *fundamentally* better than the flawed monolithic architecture**
    - There is nothing wrong with having many features
    - But it is not OK when all those features are a single point of failure
    - The *“Burgenschiff” analogy*, as described by Norman Feske in 2012

What Has Not Changed since 2012

- **The monolithic kernel architecture in perspective**
  - Approx. **150 MiB** of code and static data of the Linux kernel + necessary kernel modules on a typical x86-64 desktop
    - Comparable to the monolithic binary of AAA games, office suites (Microsoft Office, LibreOffice), modern web browsers (Firefox), modern 3D designers (Blender), modern video editors (Davinci Resolve), modern IDEs (Eclipse), information systems (SonarQube, Jira), ML runtimes (TensorFlow)
      - None of those run in kernel mode or directly access hardware

What Has Changed since 2012

- **Microkernels are the mainstream**
  - **seL4**, **HarmonyOS NEXT**, **L4Re**, etc., running in **millions of smart devices** as Trusted Execution Environments
  - **QNX**, **PikeOS**, **L4Re**, etc., running in **millions of cars** as hypervisors
  - **Google Fuchsia** running in **millions of smart appliances** as the **user-facing OS**
  - **HarmonyOS NEXT** running in **millions of smartphones and laptops** as the **user-facing OS**
- **People gradually leave ancient unfounded anxieties behind and embrace microkernels for their potential**


Tue, Jun 28
12:06
75°
33 AQI


20:15
20:15
Thursday, 2 October
Welcome to
Celia Suggestions
Instantly access your favorite features
Action required to show steps
Health
Celia Suggestions
Video
Music
14
Books
Themes
Wallet
VMALL
VMALL
App Gallery
AppGallery
MeeTime
Settings
Gallery

Highlights from the Previous 14 Microkernel Devrooms

2012

- **Detailed introductions of several microkernel projects**
  - NOVA, Genode, HelenOS
- **The agony of choice in Genode**
  - Broad diversity of supported microkernels
- **Panel discussion**
  - Jakub Jermář: “*HelenOS implements the MFS driver, thus there’s a migration path from MINIX 3.*”


GOOGLE
CODE-N

2013

- **GNU/Hurd is alive and well**
  - And it actually provides some surprisingly nice features
- **Talks on learning from past mistakes**
- **Talks about means to reach maturity**
  - Practical use cases, eating one's own dogfood

2014

- **Rump kernels are here**
- **Genode introduces base-hw**
- **HelenOS introduces sound stack**
- **L4Re goes commercial**
- **microkernel.info**
- **Vasily Sartakov makes the case for practical security measures**
  - NX, ASLR, stack canaries, etc.

2015

- **seL4 joins the community**
- **TORO, FLK**
  - New projects that provide interesting fresh perspectives
- **L4Re implements stack canaries**

2016

- **Genode supporting seL4**
- **GNU/Hurd gains usability features thanks to rump kernels**
  - Sound support, USB support
- **MH**
  - Fresh ideas on scheduling and execution contexts

2017

- **Redox OS**
  - It is never late to come to a party
- **HelenOS becoming more popular than MINIX 3**
  - By the number of downloads
- **Virtualization in GNU/Hurd**
  - Sub-hurds: How the microkernel architecture enables features for free

2018

- **Sculpt OS**
  - Genode (a framework for building custom operating systems) spawns a dynamically runtime-configurable operating system

2019

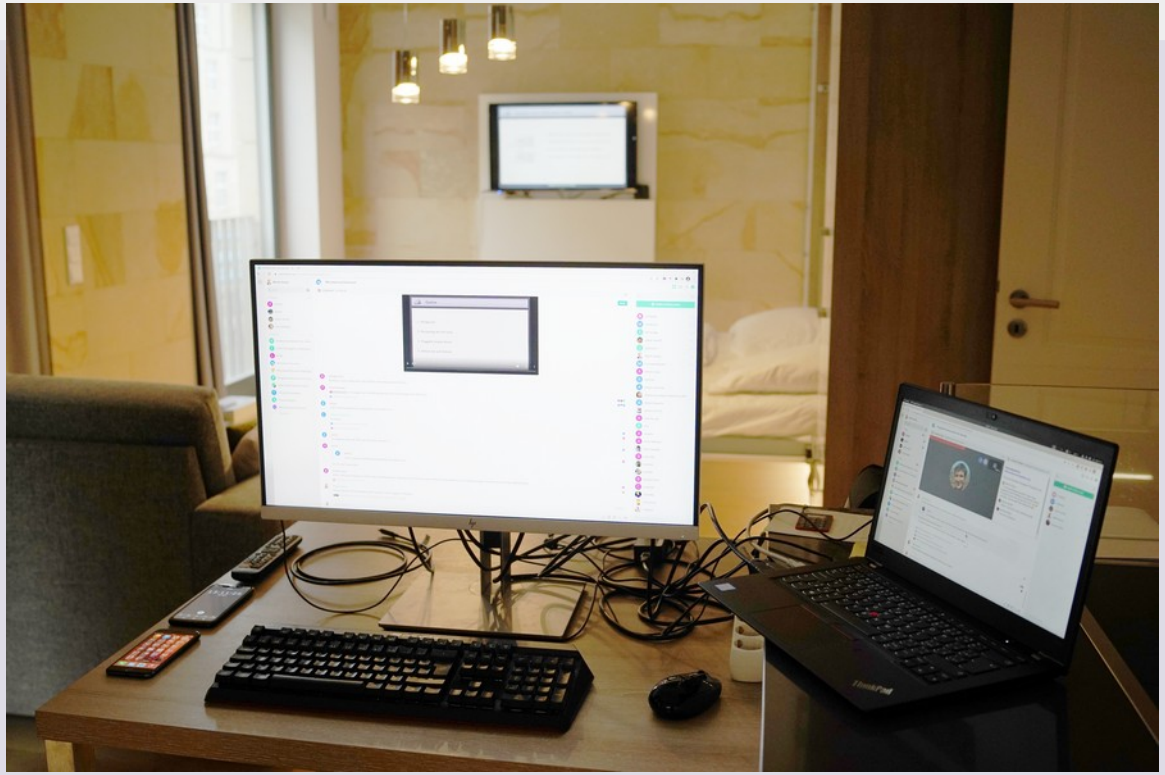
- **Genode kernel-agnostic VMM**
- **Unikernels getting stronger**
- **L4Re mitigating hardware blunders**
  - Spectre, Meltdown
  - Facing unpleasant reality is neither nice nor uplifting

2020

- **FOSDEM 2020 miraculously avoids becoming the world's largest superspreading event**
  - But it becomes the last in-person conference for several years to come
- **M^3**
  - Rethinking microkernels in terms of hardware-software co-design
- **The big resurrection of NOVA**
  - ARMv8 port, more news to come

2021

- FOSDEM is testing how scalable this Internet thing really is
- Genode pluggable device drivers



2022

- **Do not come to Brussels, Brussels comes to you**
- **Genode on Pinephone**
- **Managarm**
  - Fully asynchronous microkernel
  - Surprisingly large degree of GNU/Linux compatibility given the young age of the project

2023

- **Back to Brussels, in person!**
- **Genode's new approach of reusing Linux drivers**
  - Even a problem tackled dozens of times before can be tackled anew and more elegantly
- **Google Fuchsia and its deployment in the wild**
- **Ares (Helios)**
  - New microkernel-based OS in a new systems language

2024

- ***240 minutes of microkernel talks should be enough for everybody***
- **NOVA fully embraces trusted and confidential computing**
- **Genode's Goa build system**

2025

- **CMRX**
  - Real-time, embedded, MMU-less from the grounds up
- **L4Re certification**
  - Hard ways of getting into safety-critical systems
- **Managarm and Redox fighting ancient UNIX monsters**
  - Canceling POSIX syscalls and signals
- **Genode embraces trusted boot**

The Future is Bright!

Thank you!

Questions?

Acknowlegements

- **“Burgenschiff” by ChatGPT 5.2 image generation**
  - Inspired by: Hannes Hegen, Horst Boche, Egon Reitzl, Lona Rietschel, Gisela Zimmermann et al.: *Die schwimmende Burg*, Tessloff-Verlag & Tessloff-Verlag, 1964
- **Photo of Google Fuchsia running on Google Nest by Ben Patterson**
  - Source: https://www.techhive.com/article/579622/how-to-check-if-your-google-nest-hub-is-running-fuchsia.html