Everything is a device!

The MH microkernel and the MRG runtime.

What happens when you build a kernel based on a idea you had in a pub

Gianluca Guida
glguida@gmail.com

Bruxelles, 3 Feb 2018

whoami

Engineer at ZEDEDA, Inc. (stealth)

Past: Apple, Mimecast, Bromium, VUAmsterdam, Citrix, XenSource.

OS affiliations: MINIX3, GNU HURD, Xen

Personal projects for fun, curiosity, learning

- this is one of my projects
- building random kernels is my hobby since late ‘90s

outline

I. Introduction to MH/MRG
II. MH kernel architecture
III. NetBSD kernel components (rump)
IV. rumprun unikernels in MH/MRG
V. Conclusion + Q&A

Introduction to MH/MRG

intro MH

- Microkernel
- Complete name is **murgiahack**
  - **murgia**, the hills where I grew up (Apulia, Italy)
  - **hack**, not a compliment to my code
- Background personal project
- Timeline:
  - 2015: started
  - 2016: presented at FOSDEM2016 (this devroom)
  - mid 2016: on hold
  - late 2017: development restarted

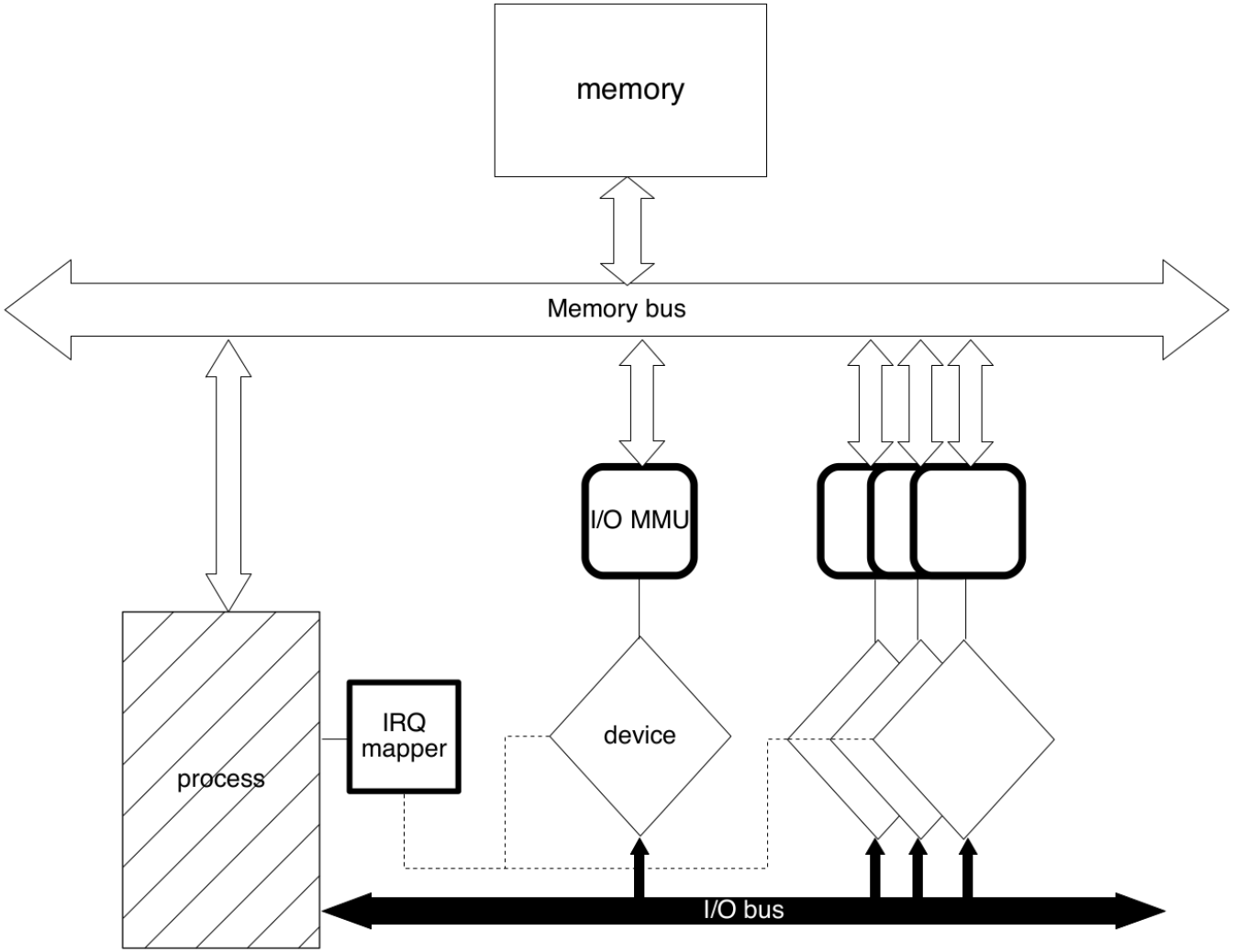
why MH

- Experiment with hardware
  - understanding the hardware I own
  - interacting with devices as directly as possible
- Experiment with software
  - create a modular system
  - use existing software in different ways
- Having fun
  - trying something *relatively* different
  - see faces of friends when you explain what it is

MH architecture

- Everything is a device(!):
  - An hardware device is exposed as a device
  - Kernel services (e.g., timers) are exposed as devices
  - A process may expose its services as devices
- The interface is low level:
  - Device are attached to a process bus
  - Memory is handled through user-level #PF
  - Syscall bus interface is hardware like: IRQs, IOMMUs, I/O ports
- The rest is UNIX-ish:
  - Fork to create new processes
  - UID/GID to handle resources

MH process interface

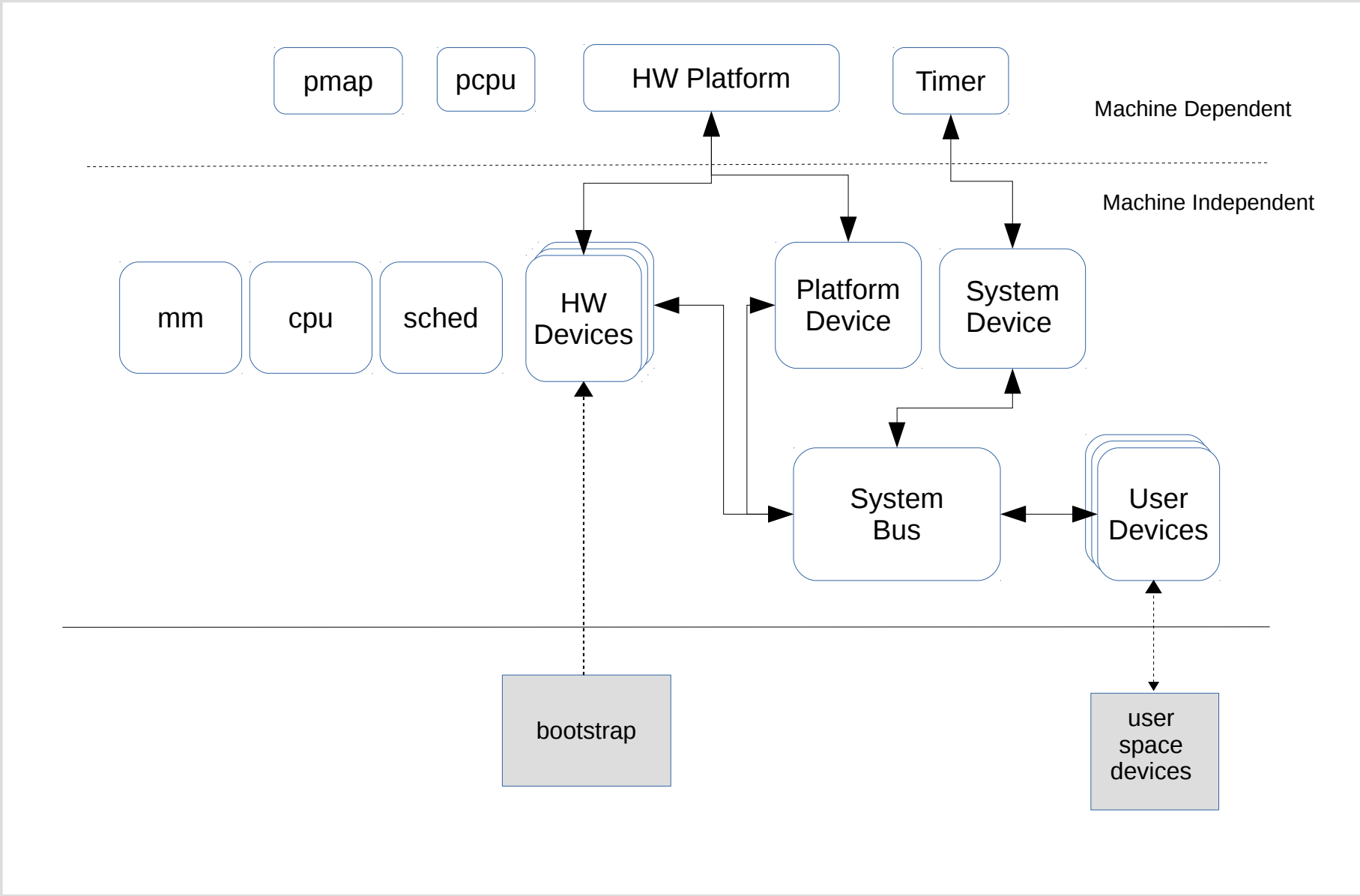


intro MRG

- Runtime library and basic services
- Basic primitives
  - Fibers
  - Event handling
  - Memory management
  - Device drivers libraries
- Basic system services
  - Bootstrap server
  - Console
- Native environment for MH processes
  - Exposes architecture of the kernel
  - Abstracts low level details of kernel interface

MH kernel architecture

MH kernel architecture



MH kernel architecture

- MD and MI code *relatively* traditional
- Different type of devices, same interface:
  - System Device
  - Platform and HW Devices
  - User Devices
- *bootstrap* creates HW Devices
- User space level devices are implemented in kernel by the *usrdev* device type.

NetBSD kernel components (rump)

rump kernels

- The *rump kernel* project has componentised the NetBSD kernel
  - When this happen, a lot of interesting thing can be done!
- MH interest is in reusing fileystem, network drivers and stack.
- **Porting rump to your system is *EASY***
  - Interface with the external world has been condensated in a sane, easily portable component called *librumpuser*
  - Writing librumpuser for mrg (called *librumpmrg)* and get it to an okay state took less than a day
    - Fear not, fighting the build system will entertain you for *weeks*!
- After linking a few librump modules, I can use MRG's own *libahci* to read and write ext4fs (or anything else supported by NetBSD) from real hardware. I am running *stable* file system code in a young OS!

rump + MRG = <3

- MRG building blocks are libraries, as it is for rump components.
- In a world where a everything is a device, device drivers are libraries in userspace. Rump gives us exactly that!
- I can create a single server that handles different devices based on *linking*.
  - Okay, it *is* a makefiles nightmare but cool!
- “Look ma’, network drivers!”

rumprun unikernels in MH/MRG (WIP)

rumprun unikernels

- *rumprun* is a set of tools and an build of a full rump kernel system.
- It allows to **run *unmodified* POSIX programs as unikernels** in a system that exposed a very simple and lowlevel interface.
- *rumprun-packages* is a repository of ready made unikernels (apache2, mysql, etc.)
- Xen and real hardware currently supported.
- *rumprun* implements its own *librumpuser*
- Porting interface is called *bmk*

rumprunmrg

- *rumprunmrg* is a port of *rumprun* for MRG.
- Implements its own *bmk* interface.
- **Porting the *bmk* interface to your system is easy!**
- The build system is a tad bit more complicated than rump.
- Took about two days to port rumprun to MRG.
- First result was MH booting into *mpg123*
  - *“I might not have a shell, but I can decode MP3s!”*

Conclusion and Q&A

- The goal of being fun has been reached
- Running *unikernels* as processes in a world where everything is abstracted into an hardware interface is strangely natural.
- Lots to do!
- Code all online (BSD license)
  - But it is a bit scattered, do ask me if you can’t find things.

Questions?

Thank you for listening!

Website:

mhsys.org

Github:

github.com/glguida/mh

Thank you!