Towards Highly Specialized, POSIX-Compliant Software Stacks with Unikraft

Linaro Connect Virtual 2020

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The Difficult Choice

General Purpose OSes

Support lots of devs and applications

Familiar development environm

POSIX

Hard to

Large a

Large memory footprint, image size, memory consumption

Expensive to certify

Embedded OSes

Resource efficient

Smaller attack surface

ant

equires

effort

Unfamiliar development environment

Is it possible to have the best from both worlds?

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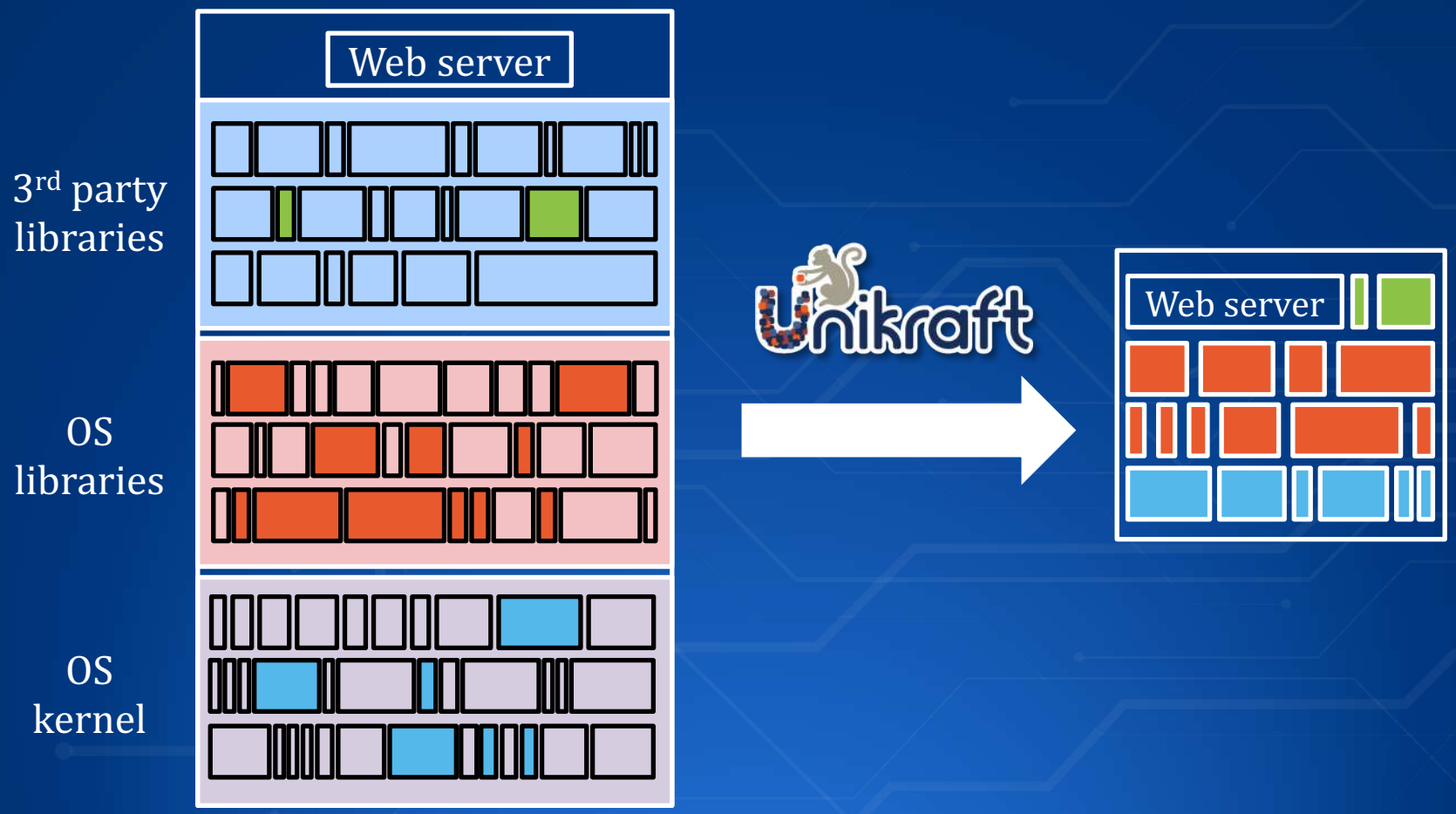
A New OS Paradigm - Requirements

- Easy configuration and customization
- Efficient
- Minimal attack surface
- Low certification costs
- Easy to port/use existing application

Unikraft's Optimization



Unikraft is a highly **modular** library pool and build system allowing users to **seamlessly** build extremely specialized and efficient images (VMs, containers, bare metal) targeting particular applications.

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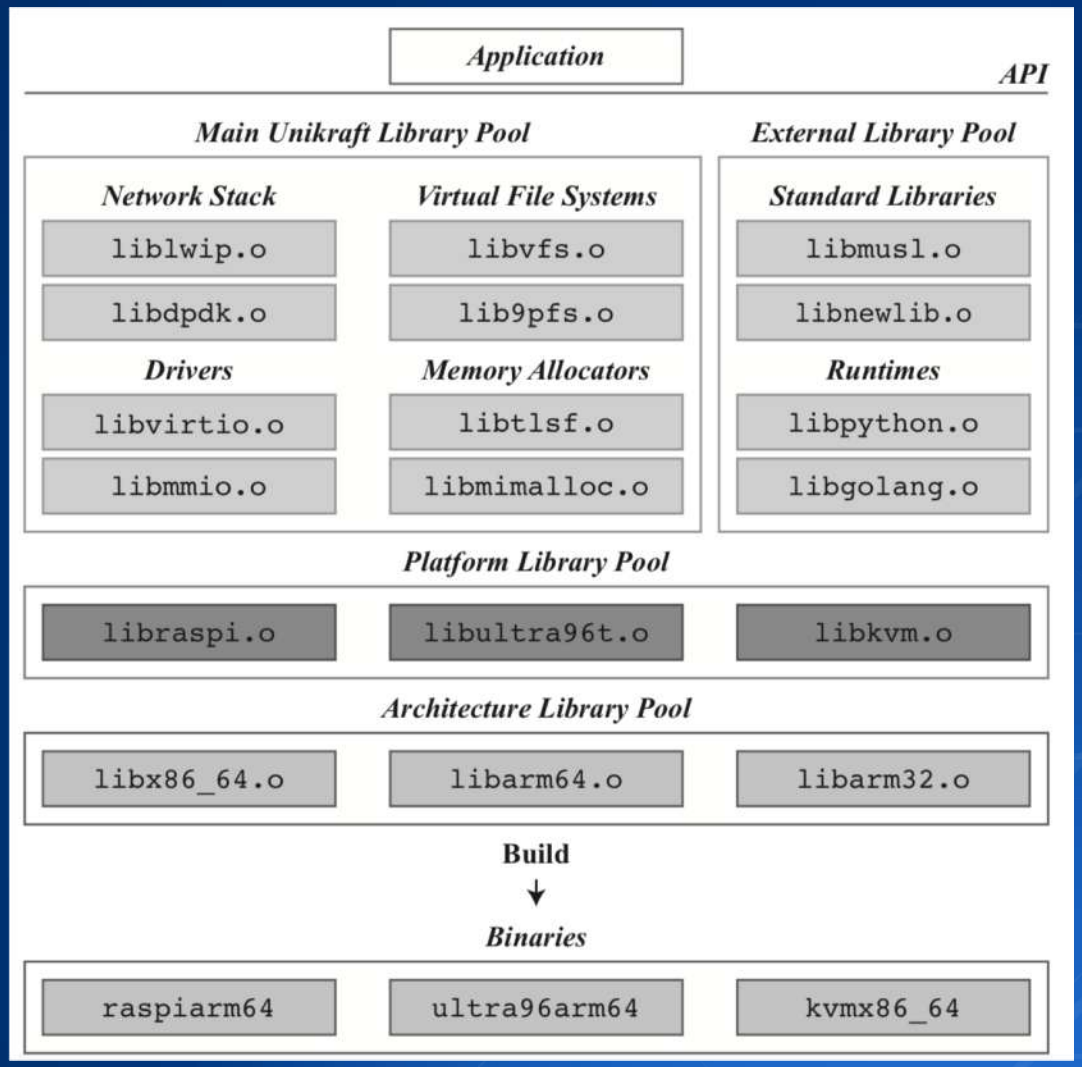
A Fully Librarized OS



- OS primitives as libraries
  - Schedulers
  - Memory allocators
  - Network stack
- Customizable via Kconfig
- Language support
  - Compiled: C/C++, Go, Java, Rust
  - Interpreted: Python, Ruby, Lua, WASM
- Targets POSIX compatibility
  - Tools for easy porting, musl support
  - Standard app support (e.g., NGINX, SQLite, Redis)
- Minimal TCB
- Multi-platform support (bare metal, virtual machine)

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Unikraft Security Features

- Stack protection
- Page protection
- ASLR
- Security hardening via fuzzing
- Secure memory allocator
- Immutable images
- Minimal attack surface
- Strong isolation (in case of VMs, containers)

Quick Demo (RPI)

Unikraft on the RaspberryPi

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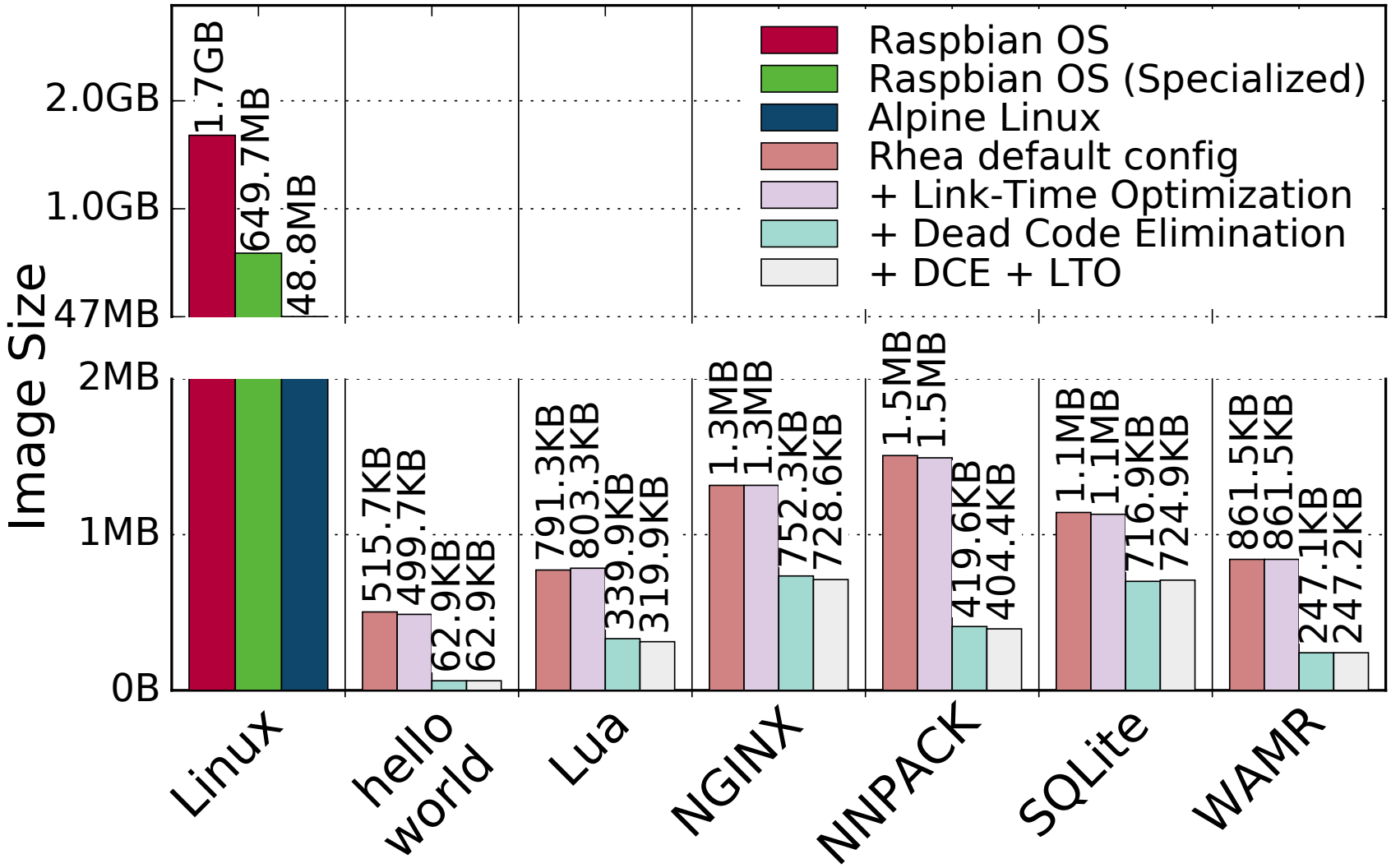
Performance Results

Image Sizes



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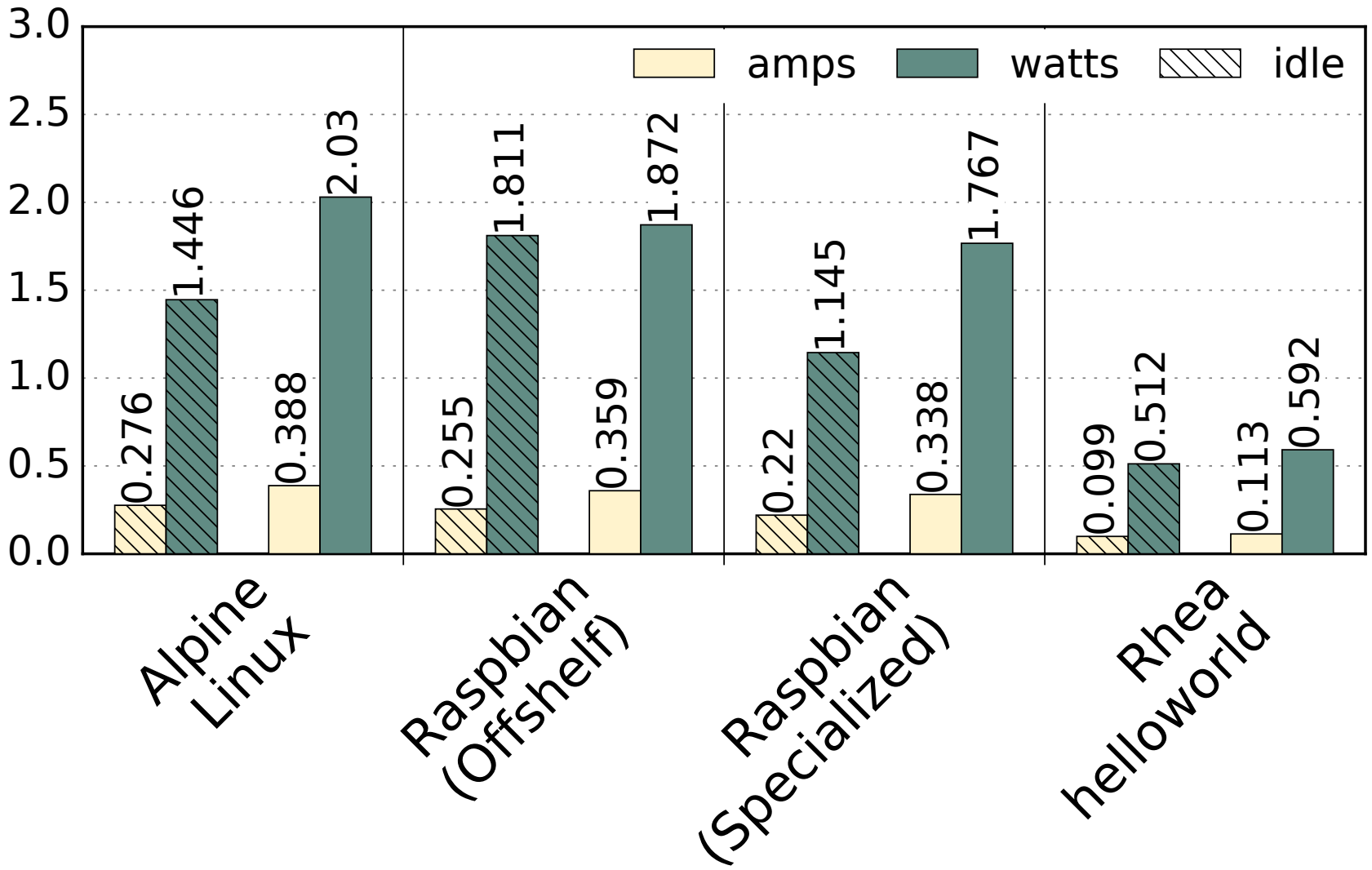
Power Consumption



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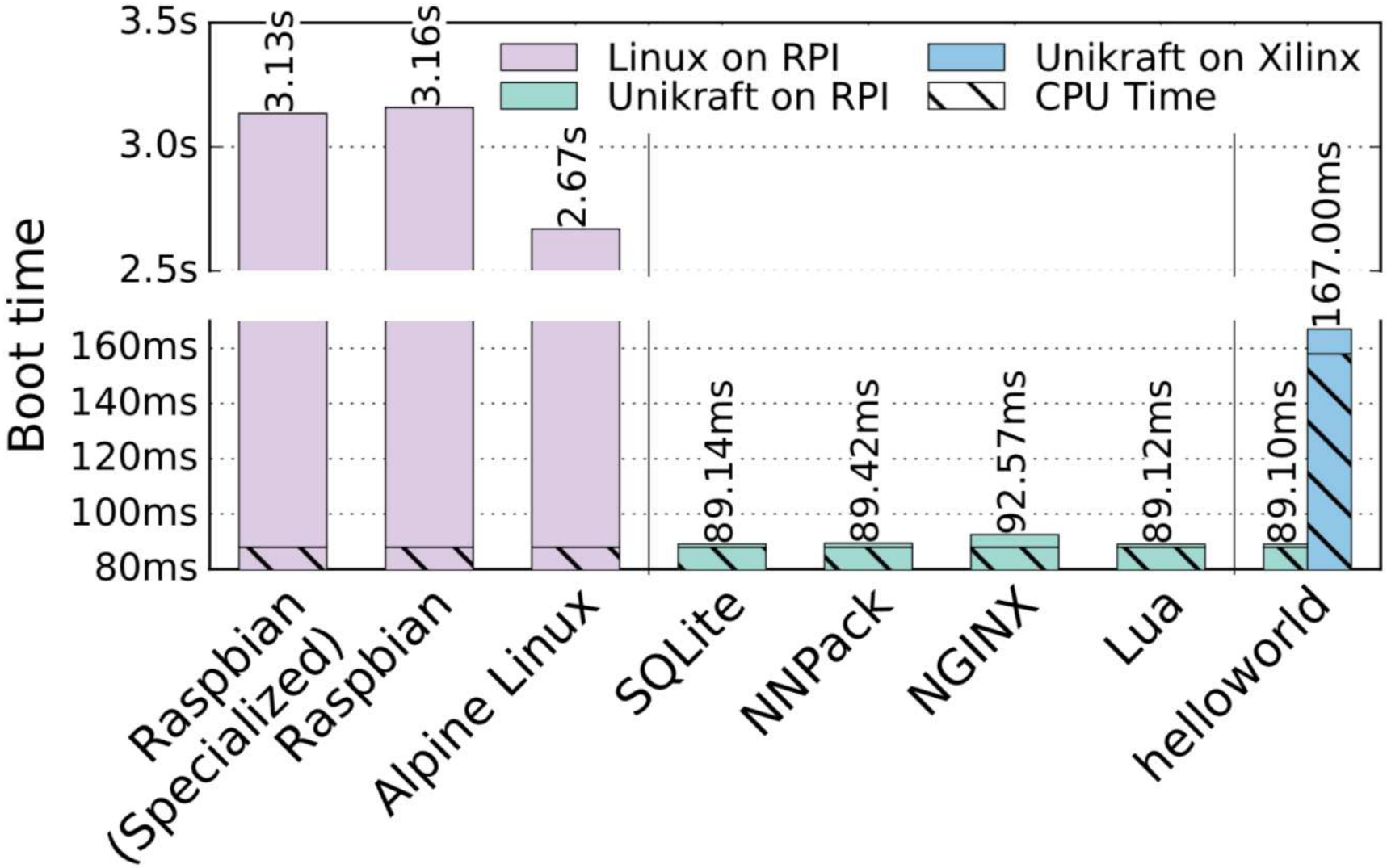
Boot Times



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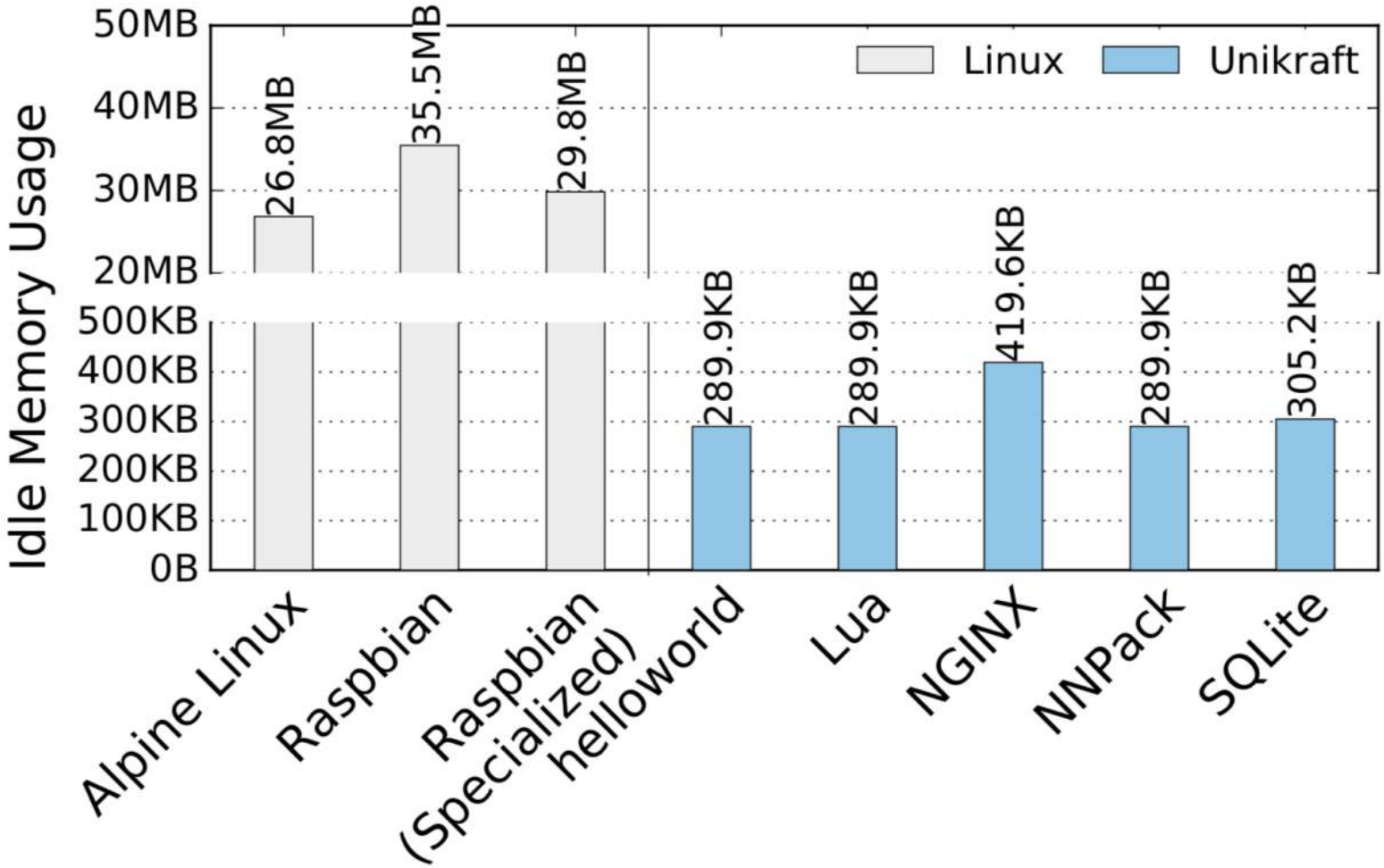
Memory Usage



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Tools & Ecosystem

Unikraft is now even easier to use!

kraft: companion tool!

- Improves user & developer experience
- Lists and clones available Unikraft libraries from GitHub organization
- Building and inital configuration
- Testing und Benchmarking

- Get https://github.com/unikraft/kraft/
- ..and start building your Unikernel:

```
> kraft update

> kraft list

> kraft init -a APPNAME
> kraft build

> kraft run -p kvm
```

```
skuenzer@d0: ~ (ssh)
root@c431:~# kraft list
CORE                    RELEASE         LAST UPDATED    LAST CHECKED
unikraft                a952768c        16 hours ago    02 Feb 20

ARCHITECTURES           RELEASE         LAST UPDATED    LAST CHECKED
x86_64                  94e6454e        Never           02 Feb 20
arm64                   94e6454e        Never           02 Feb 20
arm                     94e6454e        Never           02 Feb 20

PLATFORMS               RELEASE         LAST UPDATED    LAST CHECKED
gcp                     39b5c8e7        17 Oct 19       02 Feb 20
kvm                     94e6454e        Never           02 Feb 20
digitalocean            99af973b        17 Oct 19       02 Feb 20
aws                     82e7e4ea        17 Oct 19       02 Feb 20
xen                     94e6454e        Never           02 Feb 20
linuxu                  94e6454e        Never           02 Feb 20
solo5                   81b9e716        04 Nov 19       02 Feb 20

LIBRARIES               RELEASE         LAST UPDATED    LAST CHECKED
lwip                    06bd023d        28 Nov 19       02 Feb 20
axtls                   20c79304        24 Sep 19       02 Feb 20
pthread-embedded        1888b189        08 Jan 20       02 Feb 20
python3                 572aab3b        22 hours ago    02 Feb 20
http-parser             174bef89        04 Oct 19       02 Feb 20
```

Future Work and Challenges (Bare Metal)

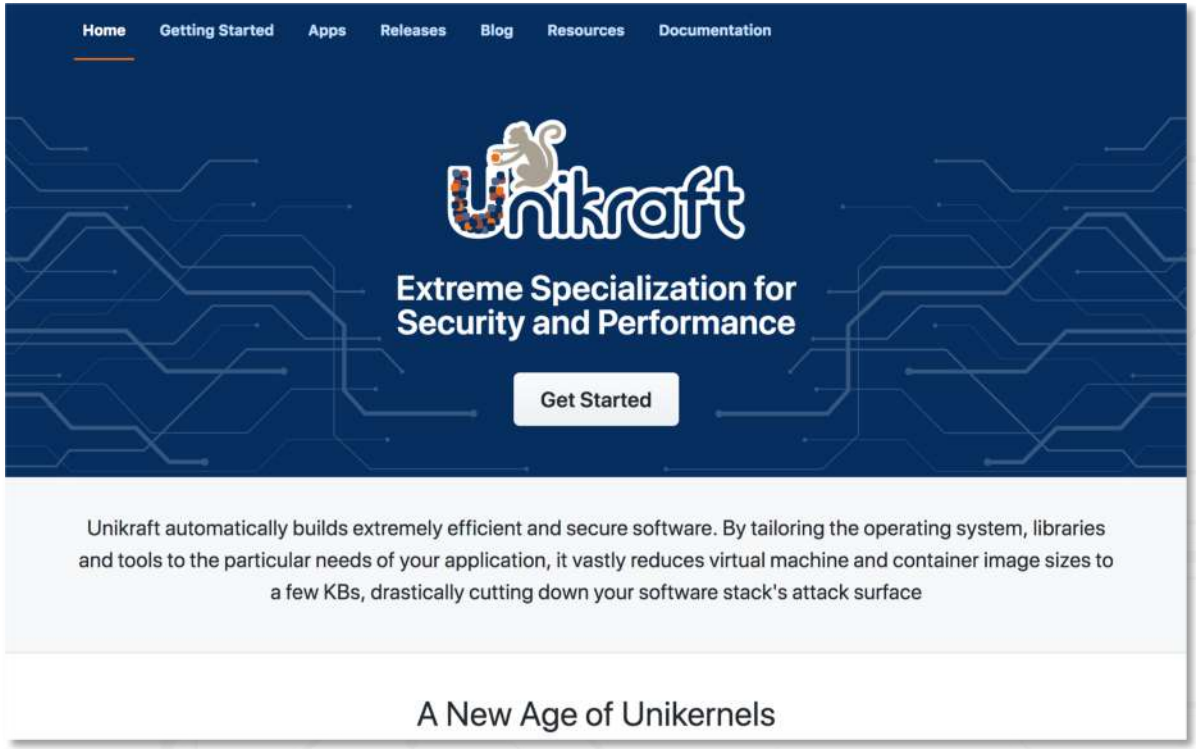
Drivers support

- Provide compatibility layer to be able to re-use existing drivers (e.g., from FreeRTOS)

Device Support

- RPI and Xilinx/Avnet Ultra96-v2 supported
- What other devices should we add? Possibility: support 96 boards

Website



http://unikraft.org

- Blog
- Getting started
- Pointers to repositories
- Pointer to documentation

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Join us!

Project page

- www.unikraft.org

Documentation

- docs.unikraft.org

Sources

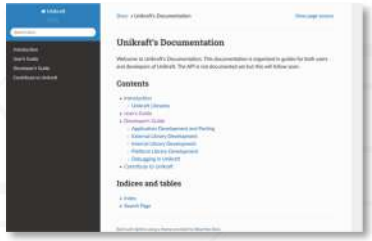
- github.com/unikraft

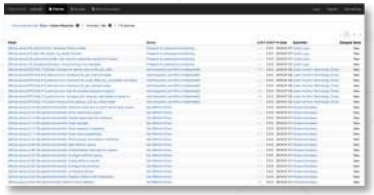
Kraft tool

- github.com/unikraft/kraft

Contributing

- minios-devel@lists.xen.org





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