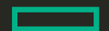
Unikernels - The next big little thing ?

Devconf.cz, Brno, Czech Republic, Jan 2017



Mike Bright, @mjbright

Unikernels

Overview

- What are Unikernels?
  - Why do we need them?
  - Domains of application
- Unikernel implementations
  - Clean-slate or legacy
  - Tooling
- Containers and Unikernels
- Demo
- Conclusions

Why this talk?

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Curiosity about

- What we can expect to see from Unikernels (and Docker …)
- Who the players are

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1990's: First unikernels - Exokernel and Nemesis (Univ. Cambr)

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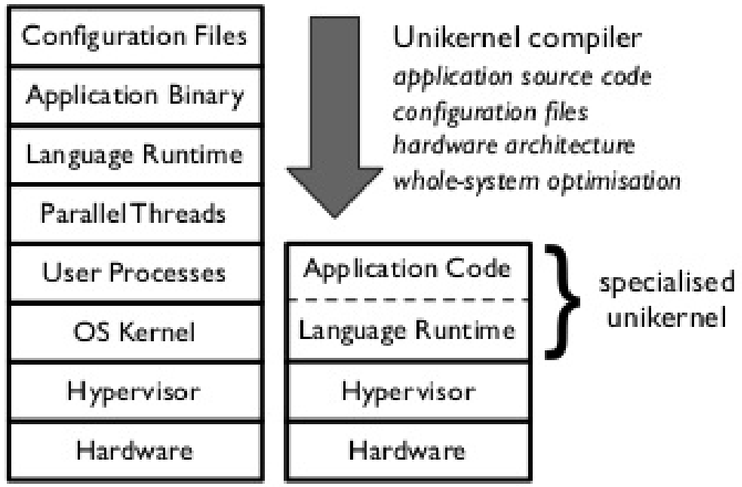
In 2017 ?

- MirageOS 3 will be released
- DockerCon US and EU

What are Unikernels? "Library OS"

Applications built with only the OS components they actually require, e.g. TCP Stack, DNS, DHCP, NAT, F/w, Disk access.



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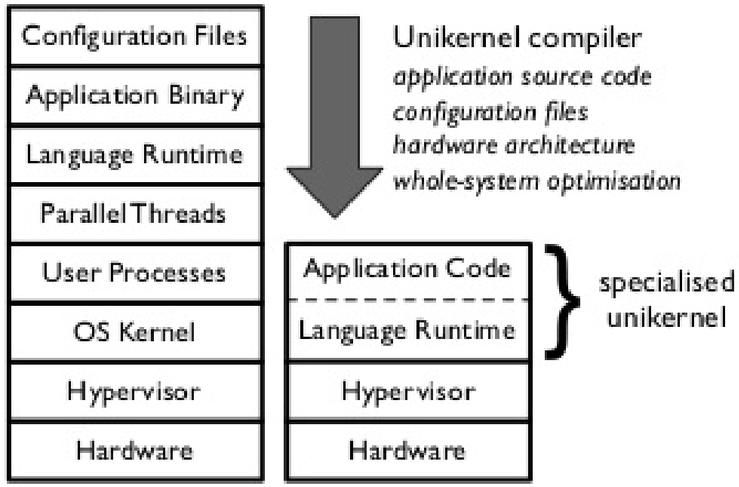

Single process(*) applications (no threads, forking or multi-user) (*)

Small size (few lines of code) and very fast to boot

Small attack surface (potentially secure)

High performance - no context switches!

No shell

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Think for a moment - What OS do you run?

On what hardware?

Modern OS provide amazing backwards compatibility and features

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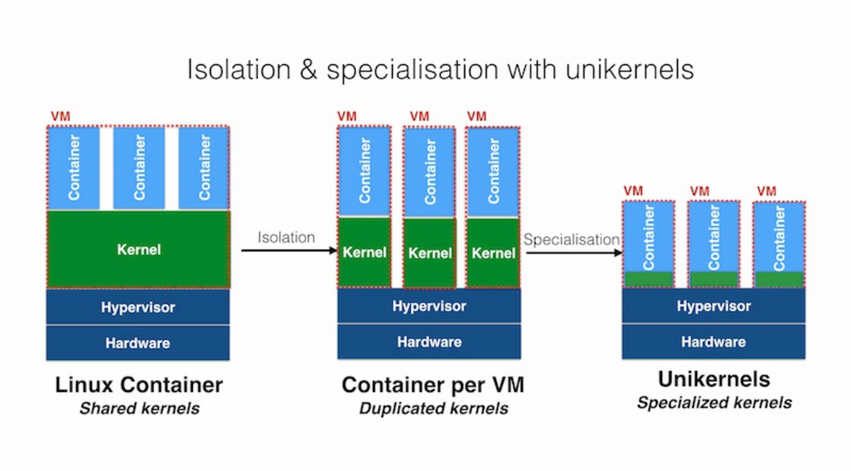

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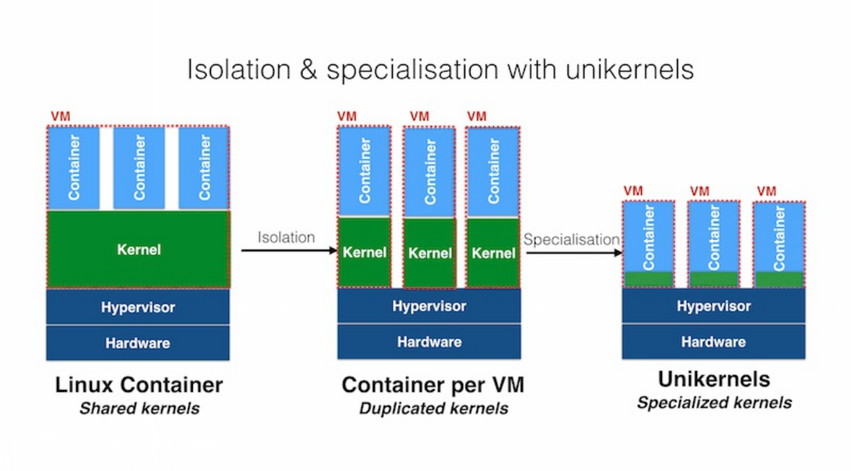

Unikernels provide an alternative

But are they a panacea?

In what domains might they be used?

Cloud Computing

- Small (kB/MB) immutable entities with fast boot times (100's ms).
- Possibility of on-demand servers, µ-services
- Potentially greater security (< LOC)

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IoT / Embedded

- For low-resource, potentially secure elements (baremetal or µ-vmm ?)
- Build up the "app" instead of stripping down the "OS"

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IoT / Embedded

- For low-resource, potentially secure elements (baremetal or µ-vmm ?)
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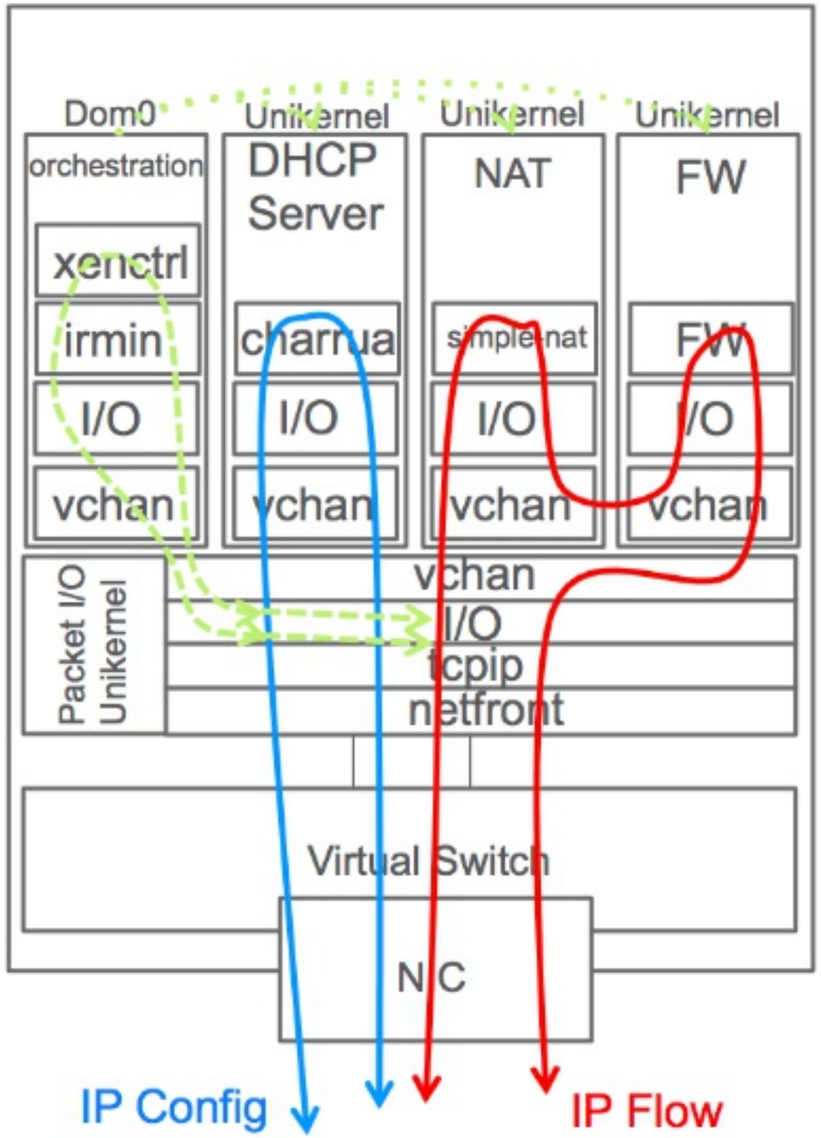
HPC

- Greater performance possible (but may be hard work)

In what domains might they be used? - NFV/SDN



Unikernel Implementations - 2 families

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The Clean-Slate approach emphasizes safety and security.
Same language for application and Library OS components.

- MirageOS (Ocaml)
- HalVM (Haskell)
- LING (Erlang)

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The Legacy approach favours backward compatibility of existing applications based on POSIX-compatibilities.

Many applications have been ported

- OSv (Tomcat, Jetty, Cassandra, OpenJDK, ...)
- Rumprun (MySQL, PHP, Nginx)
- Runtimejs
- Clive (Go)

Unikernel Implementations

Technology	Description
ClickOS cnp.neclab.eu	For embedded network h/w. ~5MB images, boots <20ms, 45 µs delay, 100 VMs => 10Gbps
Clive lsub.org	Written in Go. For distributed and cloud.
Drawbridge MS	Research prototype. Picoprocess/container with minimal kernel API surface, and Windows library OS.
Graphene graphene	Securing "multi-process" legacy apps - adds IPC.
HaLVM galois.com	Port of GHC (Glasgow Haskell Compiler) suite. Write apps in Haskell to run on Xen.
IncludeOS includeos.org	Research project for C++ code on virtual hardware.
LING erlangonxen.org	Erlang/OTP runs on Xen.
MirageOS mirage.io	Clean-slate library OS for secure, high-perf network apps. More than 100 MirageOS libraries plus OCaml ecosystem.
OSv osv.io Cloudius	Run Linux binaries (w. limitations), supports C/C++, JVM, Ruby, Node.js
Rumprun	FreeBSD - Runs POSIX s/w on BM or VM (Xen)

Unikernel implementations - MirageOS/Ocaml

Clean-Slate

MIRAGE OS

https://mirage.io/

OCaml-Based

MirageOS "Library OS" components are written in Ocaml .

ML-derived languages are best known for their static type systems and type-inferring compilers.

OCaml unifies functional, imperative, and object-oriented programming under an ML-like type system.

OCaml has extensive libraries available

(Unison utility)

Unikernel implementations - MirageOS-2

Clean-Slate

MIRAGE OS

https://mirage.io/

OCaml-Based

MirageOS Unikernels are based on the Mirage-OS Unikernel base (OS library).

The mirage tool is used to build Unikernels for various backends:

- Xen Hypervisor (PV)
- Unix (Linux or OS/X binaries)
- Browser (via Ocaml->JS compiler !!)
- MirageOS 3 (/Solo5) will support kvm (/ukvm)
- Even an experimental BM backend for Raspberry Pi

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Building applications for unix or xen

```
mirage configure -t unix
make
./mir-console
```

```
mirage configure -t xen
make
****xen create ./mir-console.xen
```

Unikernel implementations - MirageOS - Use Cases

Clean-Slate

MIRAGE OS

https://mirage.io/

- BNC Pinata: http://ownme.ipredator.se/
- Networking applications
  - e.g. CyberChaff "false network hosts"
- PayGarden, Sean Grove

  "Baby steps to unikernels in production"
  - Too painful to create/configure AMI images on AWS
  - Solo5 allows to create KVM images deployable on GCE

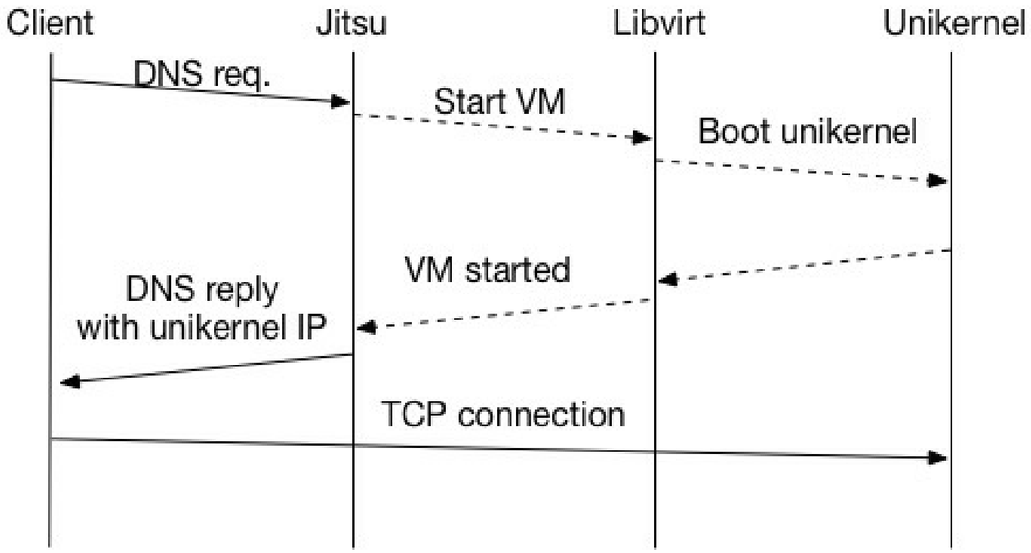
Unikernel Tooling

- Unik [EMC-Dell]: "The Unikernel Compilation and Deployment Platform" (+ image hub)
  - rumprun: Python, Node.js and Go
  - OSv: Java, Node.js, C and C++
  - IncludeOS: C++
  - MirageOS: OCaml
- Solo5 [IBM] : An alternative unikernel-base for MirageOS
  - Provides qemu/KVM support for MirageOS
  - Is currently being integrated into MirageOS 3 beta
- ukvm [IBM]: An alternative VM Monitor
  - a "library hypervisor"
- capstan : OSv build tool (+ image hub)

Unikernel Tooling

MirageOS jitsu : "Just-In-Time Summoning of Unikernels"

A DNS server that starts unikernels on demand.



Tested with MirageOS and Rumprun unikernels.

https://github.com/mirage/jitsu

Unikernels and Containers : My guess ...

So what about Containers? ... and why did Docker buy Unikernel Systems?

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- No-brainer: Provide build/ship/run tools for Unikernels
  - build:
    - tools to facilitate building Unikernels
    - test: run Unikernels in containers to faciltate testing https://github.com/mato/docker-unikernel-runner
  - ship: Docker registry extended to provide Unikernel images
  - run: Docker Swarm orchestrates tasks incl. Unikernels

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- Secure Container deployments through hybrid solutions
  - Secure front-ends made of unikernels
    - e.g. for OCaml MediaWiki (http2https, tlstunnel, ...)
  - Containers for backend
- Surprises? ...

Demo

DeferPanic - Unikernel IaaS - https://deferpanic.com/

runtime.js - Node.js Unikernel - https://github.com/runtimejs/example-web-server

4 unikernel demos - Look Ma, no OS! - https://github.com/technolo-g/lookma

Conclusions 

- Much work needs to be done
  - to make them easy to build, deploy, debug
  - We will see easier to use solutions
    - Whatever Docker plan to surprise us with
    - Unik will facilitate building, deploying multiple technologies
    - Solo5 will allow mixing of technologies
- Several disparate technologies today
  - but some efforts to synergize
- Unikernels are an interesting complimentary technology to containers
  - We can expect hybrid solutions
- 2017 will be an interesting year for Unikernels

Resources

Scoop.it Unikernels	www.scoop.it/t/unikernels
Youtube Playlist	youtube.com/.../unikernels
Wikipedia	en.wikipedia.org/wiki/Unikernel
unikernels.org	unikernels.org
mirageos.io	mirageos.io mirage.io/docs/papers
OReilly "Unikernels"	Free download
@unikernel	@unikernel
github.com/ocamllabs	ocamllabs
github.com/mirage	MirageOS

@mjbright

Thank you

Q&A