

Unikernel Technologies

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What are Unikernels?



What are Unikernels?

Specialized applications built with only the “Library OS” components they need.

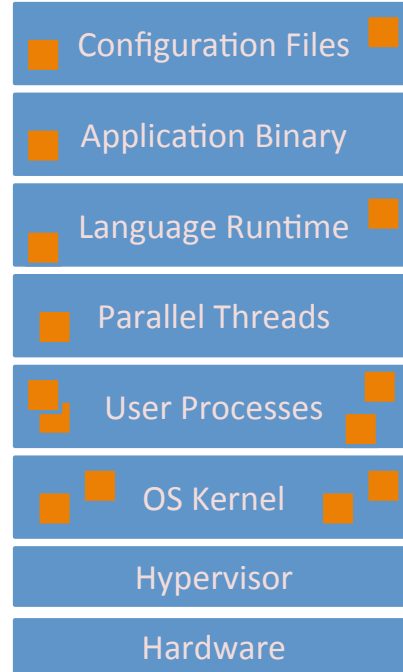
A Unikernel is a standalone machine image, it has no OS.

Compile in optional “Library OS” components such as

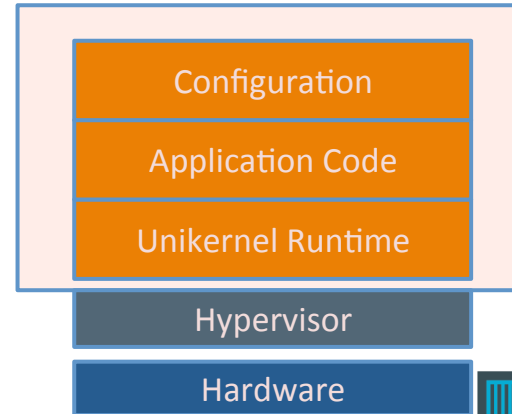
- Network stack
- File-system
- Device drivers

A typical application

Running above a
general purpose OS

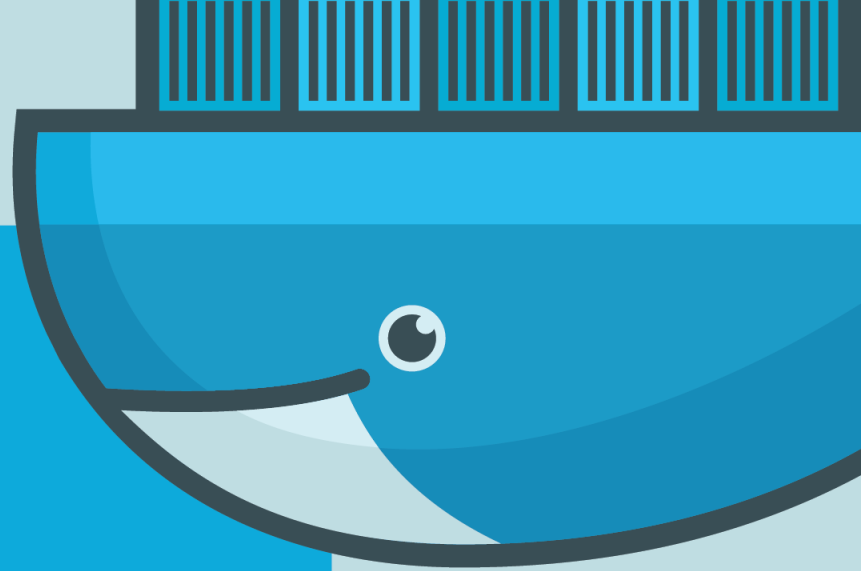



A Unikernel application
containing only selected
« Library OS » components



Contentious !


“VMs aren’t heavy, Oses are !”,
Alfred Bratterud, #includeOS



 **mattdm**
@mattdm [Follow](#)

"#Unikernels are not fit for production... they may be fit for getting your PhD.... " Mr. @rhatdan vs Dr. @TheSteve0

RETWEETS 4 LIKES 6

 <http://bit.ly/2o0Fxx0>

 **Bryan Cantrill**
@bcantrill [Follow](#)

@polvi @kelseyhightower Anyone caught advocating unikernels should be forced to smoke the whole pack!

RETWEETS 15 LIKES 30



1:09 PM - 22 Nov 2015 from Piedmont, CA

<http://bit.ly/2p4o59J>

[Unikernels are unfit for production](#)
January 22, 2016 - by Bryan Cantrill

[Hacker News Discussion](#)
January 22, 2016

[THE NEW STACK](#)
OCTOBER 24, 2016
Debunking Unikernel Criticisms

Why use Unikernels ?

Characteristics

- Single-user, Single-address space, Single-process
 - Performance: no user/kernel space context switches
 - Security: only needed features, few lines of code (small attack surface)
- Small immutable images, light on resources
 - On demand: fast to boot (100's ms)

Compared to containers?

- More secure: containers run directly on host OS kernel
- More efficient: better performance
- More difficult: to develop, debug
- A complimentary technology

Applications for Unikernels ?

Unikernels are still an active research area, with proof of concept or pilot deployments in areas of

- Cloud
 - PayGarden (MirageOS/GCE)
 - Deferpanic IaaS
 - NFV (Telco Cloud): Ericsson Research PoC
- IoT
- Networking Devices or appliances:
 - CyberChaff (HalVM)
 - ClickOS (NEC: Click Modular router)
- HPC

Unikernel Implementations

2 main families



Unikernel Implementations?

Clean-Slate

1. MirageOS (Ocaml)
2. HalVM (Haskell)
3. LING (Erlang)

Tools

1. Unik
2. Solo5 / ukvm

Legacy

1. Rumprun/*LKL* (Ruby,Go,Python...)
2. OSv (Java,Lua,Go)
3. IncludeOS (C/C++)
4. Many more ...

Runtimejs, Graphene, ClickOS,
HermitCore, Magnios, Vorteil, Clive

Ultibo 

MirageOS Unikernels: Clean-slate

[Xen incubator project] MirageOS v3 – Feb 2017

MirageOS v3 supports more backends inc. kvm & xhyve.

- MirageOS Unikernels – “Library OS” and app in Ocaml
- Jitsu project allows on demand “just in time spawning of unikernels”
- mirage tool creates build environment for backend (unix, xen, kvm, ...)

Build/run as Linux binary

```
mirage configure -t unix  
make depend  
make  
./binary
```

Build/run under kvm

```
mirage configure -t ukvm  
make depend  
make  
./ukvm-bin    unikernel-binary
```

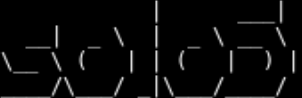
Demo: MirageOS

Clean-slate Unikernel

Let's build/run a unikernel on:

- Unix (Linux)
 - To run locally
- Ukvm
 - To run under ukvm locally
 - To run in the cloud

```
mjb@zBook ~/src/git/Unikernels/mirage-skeleton/applications/dns> sudo ./ukvm-bin --net=tap1
```



```
Solo5: Memory map: 512 MB addressable:
Solo5:   unused @ (0x0 - 0xffffffff)
Solo5:   text @ (0x100000 - 0x251fff)
Solo5:   rodata @ (0x252000 - 0x29efff)
Solo5:   data @ (0x29f000 - 0x37efff)
Solo5:   heap >= 0x37f000 < stack < 0x20000000
Solo5: Clock source: KVM paravirtualized clock
Solo5: new bindings
STUB: getenv() called
STUB: open() called
STUB: getpid() called
STUB: getppid() called
2017-04-04 00:12:22 -00:00: INF [netif] Plugging into 0 with mac 56:af:18:f4:00:ff
2017-04-04 00:12:22 -00:00: INF [ethif] Connected Ethernet interface 56:af:18:f4:00:ff
2017-04-04 00:12:22 -00:00: INF [arpv4] Connected arpv4 device on 56:af:18:f4:00:ff
2017-04-04 00:12:22 -00:00: INF [udp] UDP interface connected on 10.0.0.2
2017-04-04 00:12:22 -00:00: INF [tcpip-stack-direct] stack assembled: mac=56:af:18:f4:00:ff
2017-04-04 00:12:22 -00:00: INF [server] Loading 3107 bytes of zone data
Warning (<string> line 47): Converting MD to MX
Warning (<string> line 48): Converting MF to MX
2017-04-04 00:12:22 -00:00: INF [server] DNS server listening on UDP port 53
2017-04-04 00:12:25 -00:00: INF [client] Starting client resolver
```




Demo: DeferPanic

Unikernel IaaS

We can

- build a Unikernel online
 - Rumprun, IncludeOS or OSv
- Deploy online
- Pull the image and run locally
 - virgo pull myapp
 - virgo run myapp

 deferpanic

Images

Addons

Instances

Networks

Usage

Storage

Resources

DNS

Volumes

Source (github)

Command line parameters

Environment parameters

Script

```
version: 1
description: my project description
buildpack: rails
scripts:
  - name: clone redis client library
    command: git clone
```

Private Project? ☐ (won't be visible to anyone) - [upgrade](#) your account to access this

Mutable Volumes? ☐

Choose File

 No file chosen

ADD

ID	Name	Buildable	Filename	Language	Source	Build Status
466	mjb_javaexample	yes		Java	https://github.com/deferpanic/java_example	Success
465	mjb_snowcamp	yes		Python	https://github.com/mjbright/python_example	Success
464	mjb_python	yes		Python	https://github.com/deferpanic/python_example	Success



What's next ?

Here's my take

- Still research projects but many early adopters
 - More test and production deployments
- Better tooling through tools like Docker, Unik, OSv Capstan
- Increased collaboration across projects
- Increased Hypervisor support
- Different Unikernel technologies for different uses
 - Clean-slate for lightest, most secure needs – very specialized
 - Hybrid architectures with Unikernels and Containers
 - Legacy Unikernels for higher performance from existing apps, e.g. HPC



Thank You!

Questions?

@docker

#dockercon



Unikernels: General Resources

	URL
Unikernel.org	https://unikernel.org
Unikernel Forum	https://devel.unikernel.org/
Wikipedia	https://en.wikipedia.org/Unikernels
My Scoop.IT	https://scoop.it/Unikernels
LinkedIn Group	https://www.linkedin.com/groups/8469145
YouTube Playlist	http://bit.ly/2mJ6nfw

Unikernels: Project Resources

	Website	GitHub
MirageOS	mirage.io	mirage/mirage
HaLVM	galois.com	galoisInc/HaLVM
LING	erlangonxen.org	cloudozer/ling
IncludeOS	includeos.org	hioa-ca/IncludeOS
Rumprun	rumpkernel.org	rumpkernel/rumprun
Osv	osv.io	cloudius-systems/osv

Unikernels: Project Resources

	Website	GitHub
Runtime.js	runtimejs.org	runtimejs/runtime
Clive	lsub.org/lsub/clive.html	git.lsub.org/clive
ClickOS	cnp.neclab.eu/clickos	kohler/click
Unik		emc-advanced-dev/unik
Deferpanic IaaS	deferpanic.net	deferpanic/virgo