UNIKERNELS
WHERE ARE THEY NOW?
AMIR CHAUDHRY
STATE OF THE UNIKERNEL

OVERVIEW

- Unikernel refresher
- Status updates:
  - MirageOS, IncludeOS, HaLVM, Solo5
- Summary
- Questions?
REFRESHER
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UNIKERNEL PHILOSOPHY

- Library OS
- Reusable components
- No separation between 'system' and app code
- Single-purpose appliances
- Minimalism all the way!
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BENEFITS

- Small, lean, appliances
- Immutable by default
- Reduced TCB
- Much rejoicing!
- Multiple deployment options
STATUS UPDATE:

MIRAGEOS
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MIRAGEOS

$ cat hello/unikernel.ml
open Lwt.Infix

module Hello (Time : Mirage_time_lwt.t) = struct

  let start _time =

    let rec loop = function
      | 0 -> Lwt.return_unit
      | n ->
        Logs.info (fun f -> f "hello");
        Time.sleep_ns (Duration.of_sec 1) >>= fun () ->
        loop (n-1)
    in
    loop 4

end

- Type-safety and correctness (in a pragmatic way)
- Multiple deployment targets (Unix, Xen, *BSD, ARM)
- Libs used in Docker products 🛳
- ISC Licensed
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```ocaml
type schoolPerson = Teacher | Director | Student string;

let greeting =
  switch stranger {
  | Teacher => "Hey professor!"
  | Director => "Hello director."
  | Student "Richard" => "Still here Ricky?"
  | Student anyOtherName => "Hey, " ^ anyOtherName ^ "."
  };
```
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MIRAGEOS 3.0!

- Improved cloud deployments
  Deploy onto GCP in ~70s!

- New targets:
  - virtio – QEMU (and GCP)
  - uvkm – KVM, FreeBSD, OpenBSD
  - qubes – QubesOS (on Xen)

- Much improved dev workflow
  Better versioning, logs system, error reporting, debugging
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**MIRAGEOS 3.0!**

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  - *virtio* — QEMU (and GCP)
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  - *qubes* — QubesOS (on Xen)
  - *hypervisor.framework* COMING SOON

- Much improved dev workflow
  Better versioning, logs system, error reporting, debugging
  gdb support COMING SOON
STATUS UPDATE:

INCLUDEOS
#include <os>

```c
int main() {
    printf("Hello world! No Linux here!");
}
```

**INCLUDEOS**

- **Focus on performance**
  
  C++ principle of "zero overhead"

- **Pragmatic approach to POSIX**
  
  expanding support as required

- **Multiple targets** (QEMU, ESXi, etc)

- **Apache Public License 2.0**
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INCLUDEOS — CURRENT WORK

- Very active project and growing quickly
  2k+ stars, ~200 forks, 35+ contributors

- Commercial company
  Based out of Oslo, Norway

- Broad support via libs
  Multicore virtual machines (SMP)
  Multiple network adapters

- LiveUpdate is a major feature
  In-place update of unikernels with zero downtime
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INCLUDEOS — LIVE UPDATE

Current application

Memory
STATE OF THE UNIKERNEL

INCLUDEOS — LIVE UPDATE

Current application  Upgraded application

Memory
INCLUDEOS — LIVE UPDATE

Current application

Upgraded application

State

Memory
STATE OF THE UNIKERNEL

INCLUDEOS — LIVE UPDATE

Current application -> Upgraded application

Memory

State
INCLUDEOS — LIVE UPDATE

Upgraded application

Memory
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INCLUDEOS — ROADMAP

- **Working on load balancers and firewall apps**
  Immutable VMs doing Network Function Virtualisation (NFV)

- **Expanding language support**
  NodeJS and Go are strongest contenders
STATUS UPDATE:

HALVM
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HALVM

- Haskell – type-safety and purity
- Evolved from internal uses e.g. prototyping OS design
- Targets Xen Hypervisor
- BSD-3 Licensed
HALVM / CYBERCHAFF

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- First project to generate revenue!
  NUC connected to network
  Can also run on EC2
  Looking into pure software option

- HaLVM 3 challenges
  How to write a minimal libc
  New targets
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  *Team distracted by money!! => => =>*

- **HaLVM 3 challenges**
  How to write a minimal *libc*
  New targets
STATUS UPDATE:

SOL05
STATUS UPDATE:

SOL05 ?
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**BENEFITS (A REMINDER)**

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BASE AND MONITOR

QEMU

App code
libs/runtime
base
monitor

LINUX / KVM
BASE AND MONITOR

- **Base defines:**
  - where unikernel can run,
  - how fast it boots,
  - what higher layers do.

- **Monitor provides:**
  - generic h/w abstractions
  - e.g. Mini-OS (Xen) or QEMU (KVM)
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BASE AND MONITOR

- Typically on a hypervisor
- Adds to the TCB!
- ‘General purpose’, so not very minimal!
- … what do we really need?
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INTRODUCING SOLO5/UKVM

- **Solo5**: a unikernel base
- **Ukvm**: a specialised monitor
- From folks at IBM Research
- Extends unikernel philosophy to the base and monitor
- Minimal interfaces (~5% code)
- Fast boot times (~10ms)
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SOLO5/UKVM — MILESTONES

- Major part of the MirageOS 3.0 release
- **Project is now multi-OS**
  Ported to run on FreeBSD and OpenBSD
- **Project is now multi-arch**
  Solo5 base ported to run on ARM64
  ukvm monitor ported to run Linux/KVM on ARM64
- **IncludeOS support**
  Mostly complete
SOLO5/UKVM — UPCOMING WORK

- ukvm is now a misnomer
  It’s grown way beyond just ‘kvm’

- More comms about Solo5/ukvm
  Less well known than the unikernel projects
  Work on Solo5 benefits all supported projects

- Refresh the Solo5 APIs

- Support for Muen SK as a monitor
  A formally verified microkernel
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SUMMARY

- Steady growth across projects
  Each growing in their own way

- Early signs of convergence
  Excellent time to get involved

- Revenue!

- Docker images to get started
  Tool chains still different though

- Find out more at unikernel.org
THANK YOU!
THANK YOU!
QUESTIONS?

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