ECE 5984 Virtualization Technologies

Project Presentation

Pierre Olivier

Outline

1) Brief presentation of unikernels

2) HermitCore

3) Problem statement

4) Project organization

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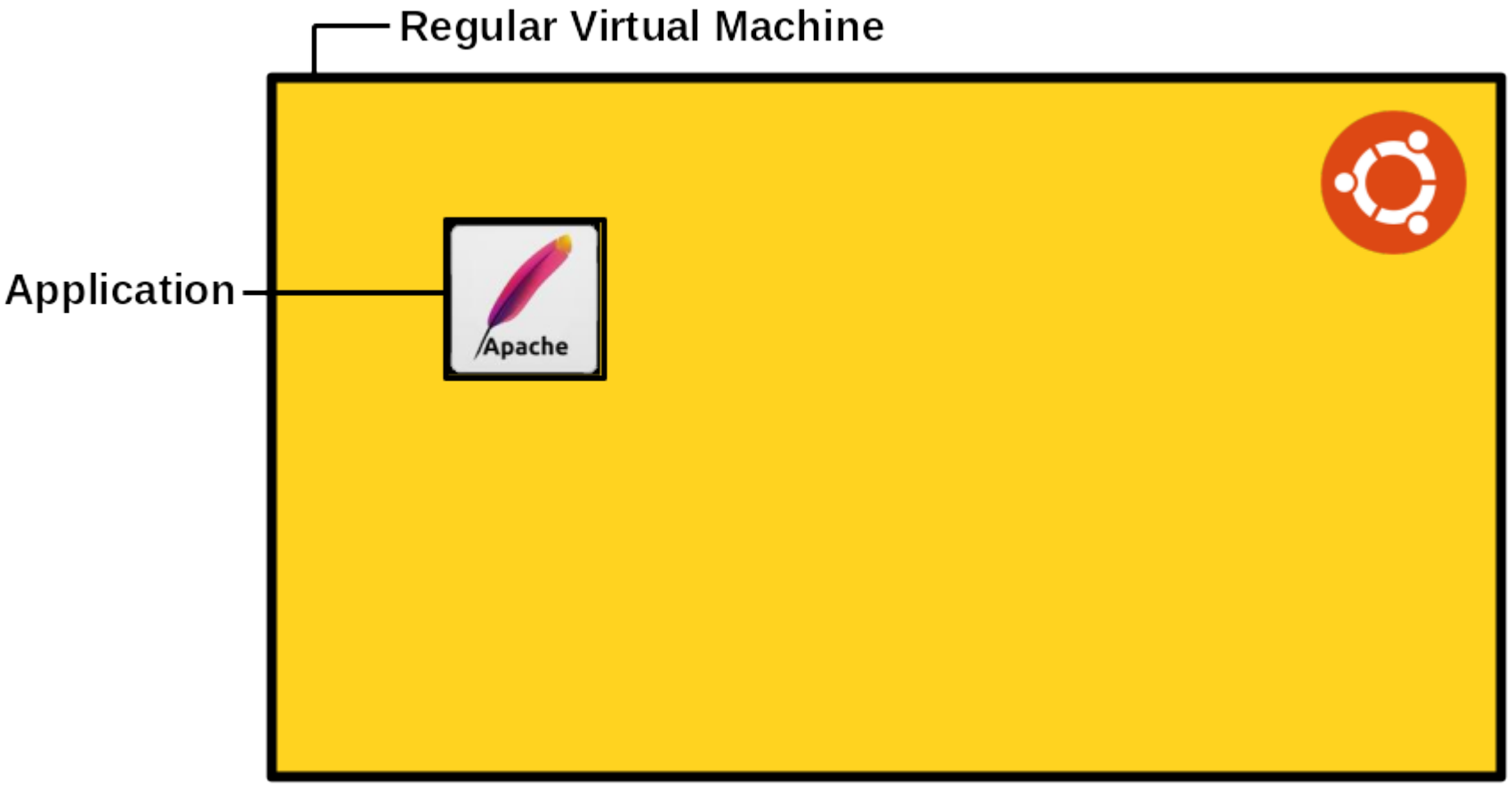
Unikernels

- Motivation: my website in the cloud



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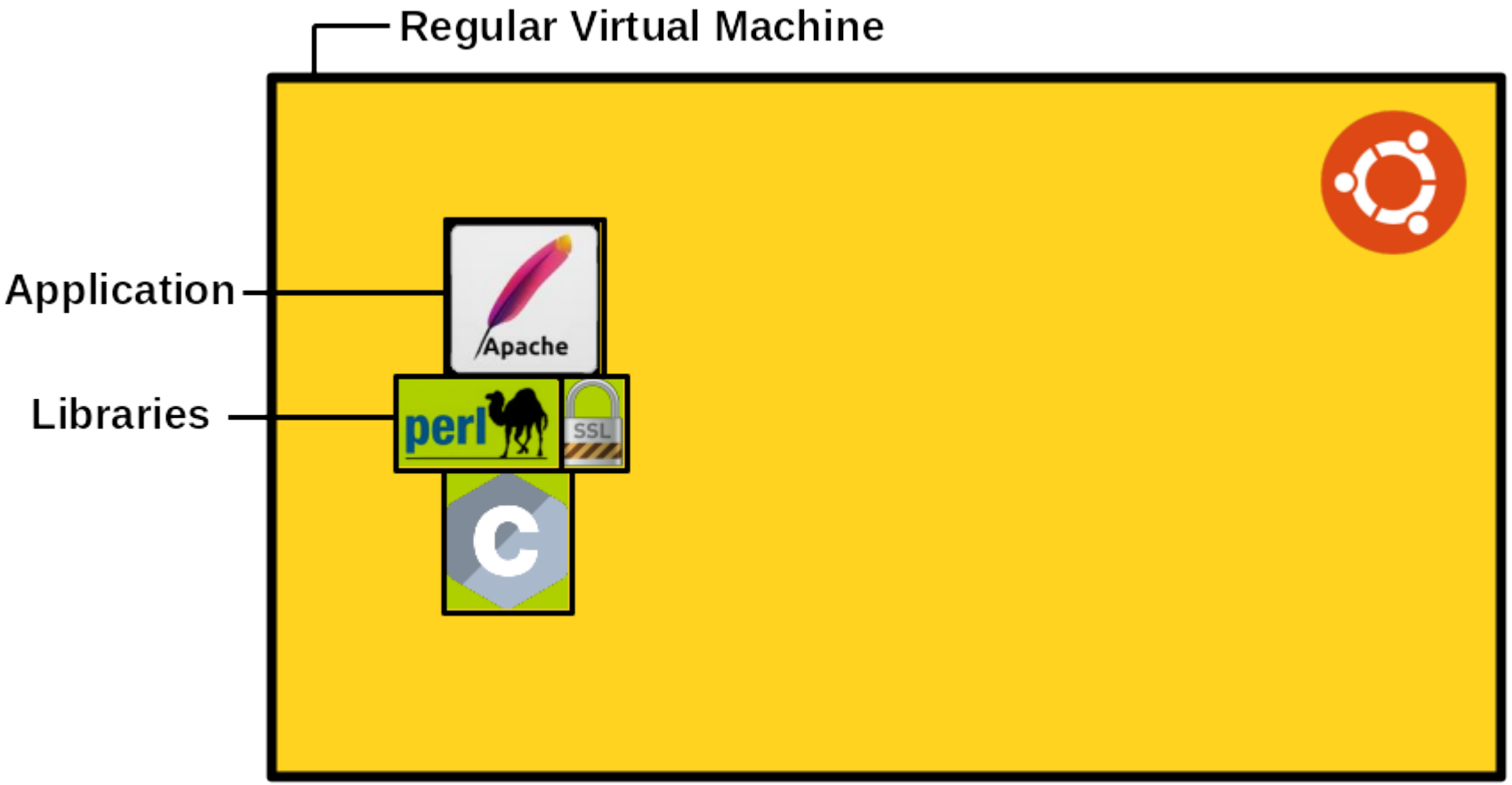

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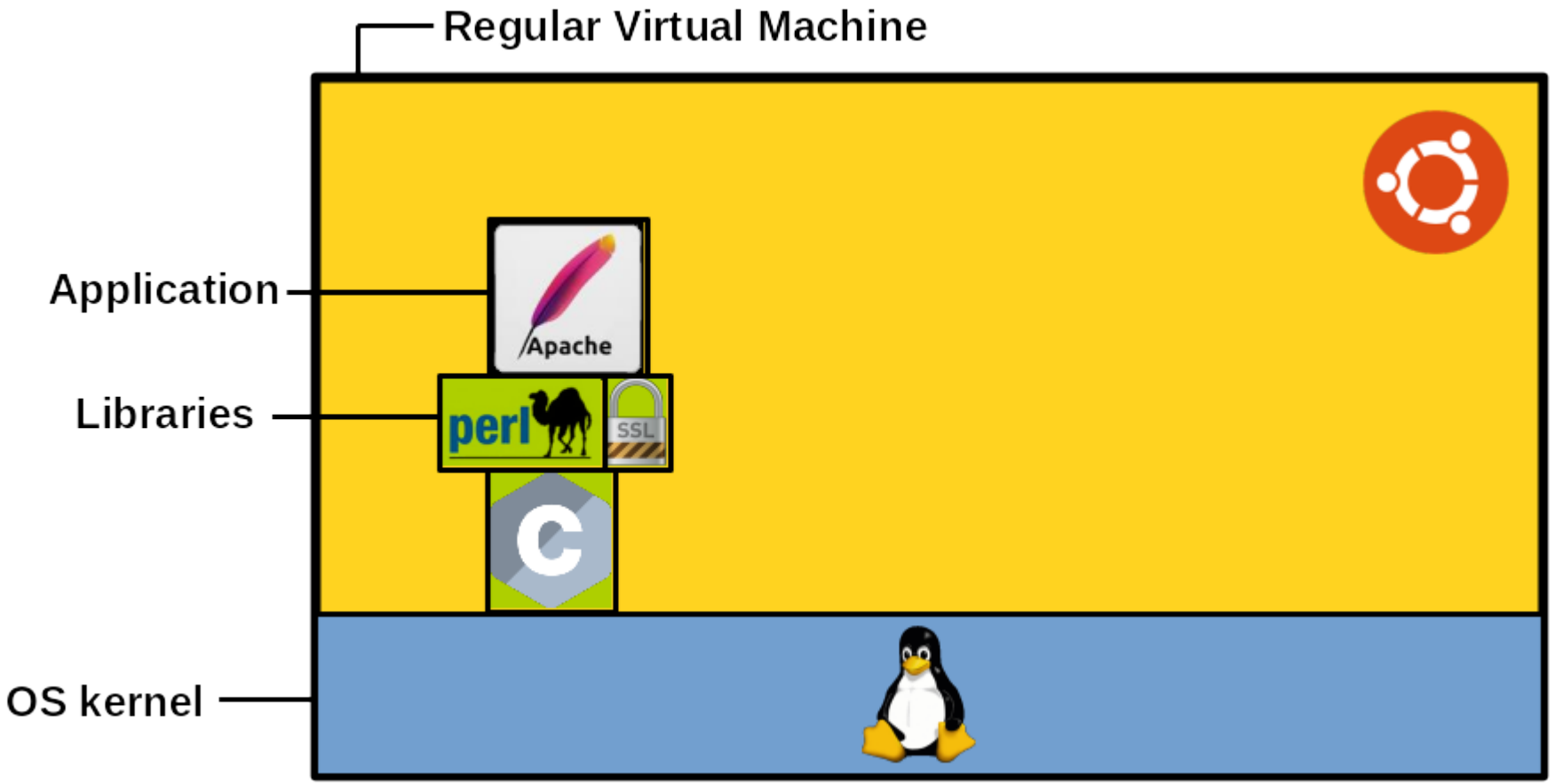

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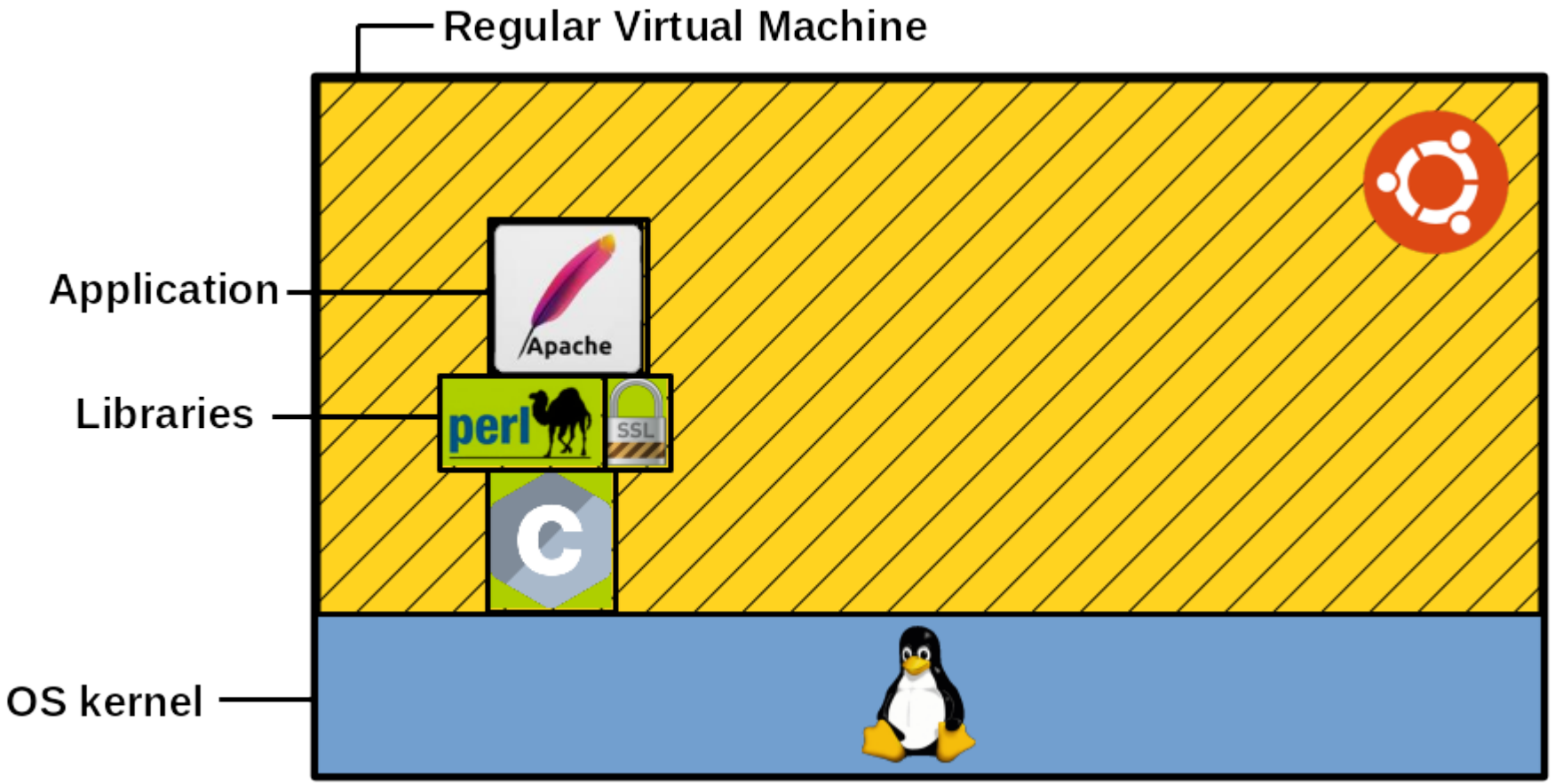

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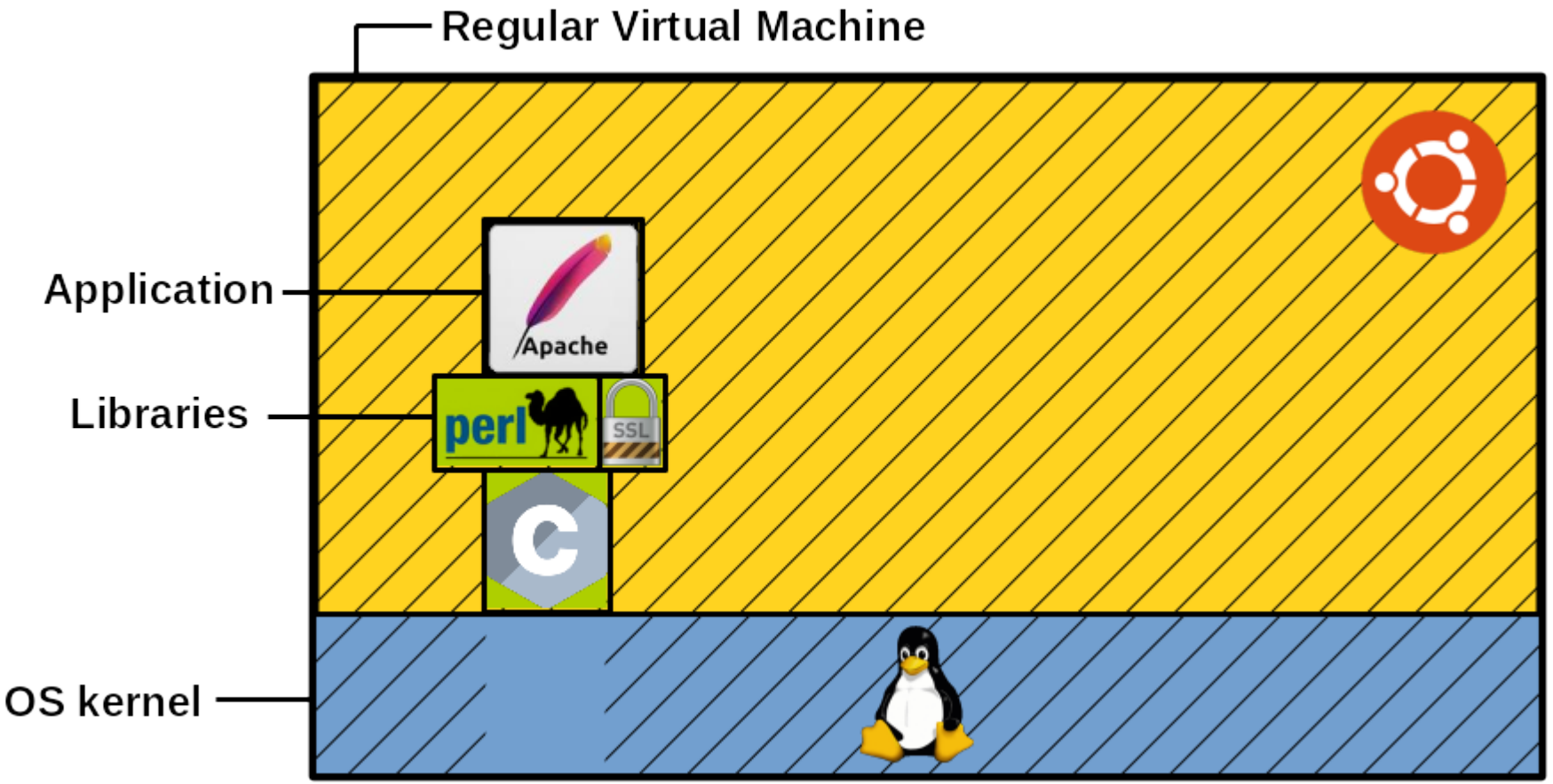

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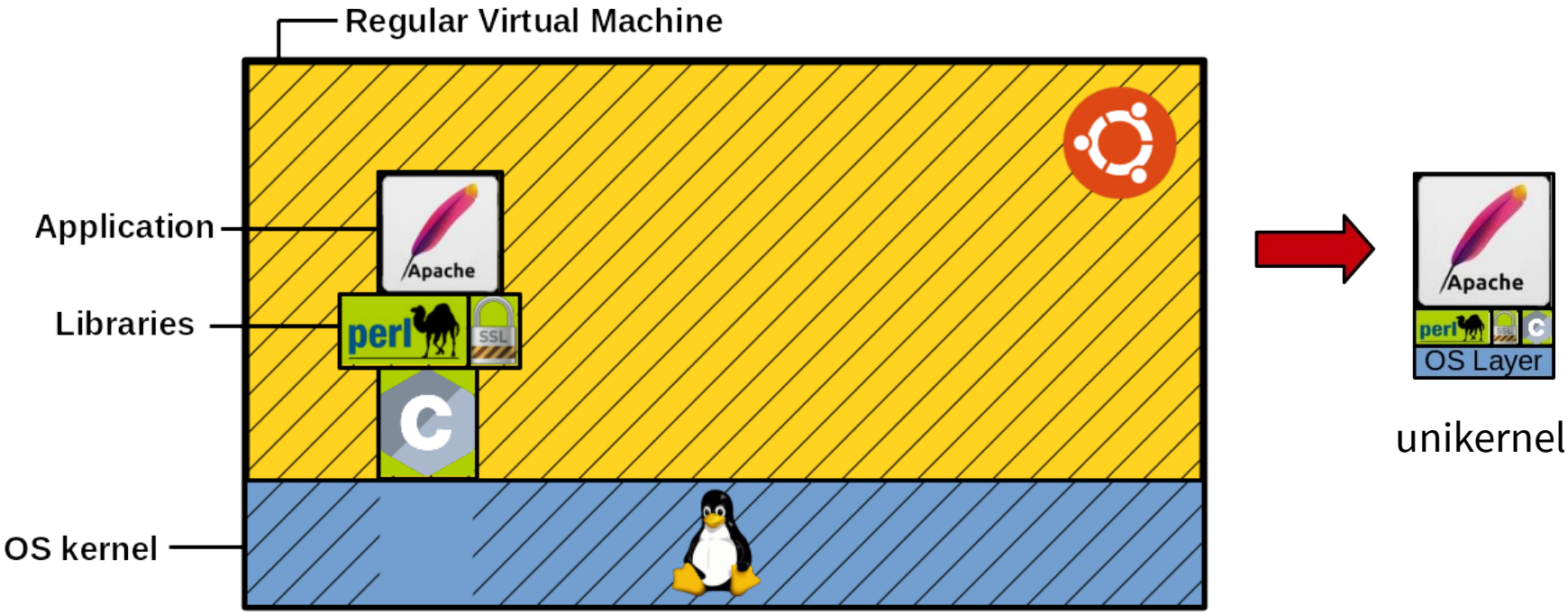

Unikernels

- **Unikernel:**
  - Statically compiled **application + libraries + thin OS layer** running as a guest on top of an hypervisor
  - Single purpose: 1 application
  - Single binary
  - Single address space
    - Shared by the application and the kernel, no privilege separation, system calls are function calls
  - More info:
    - http://unikernel.org/
    - http://unikernel.org/files/2014-cacm-unikernels.pdf
    - https://www.youtube.com/watch?v=24rvIB4_v4U&t=607s
- **Interesting benefits in terms of security, cost reduction, and performance**

Unikernels

- **One claim made by unikernel supporters is that systems calls are fast**
  - Common function calls
  - No ‘world switch’ between user space and kernel
- **Interesting paper studying the cost of system calls:**
  - Soares, Livio, and Michael Stumm. "**FlexSC: Flexible system call scheduling with exception-less system calls.**" Proceedings of the 9th *USENIX conference on Operating systems design and implementation* (OSDI). USENIX Association, 2010.

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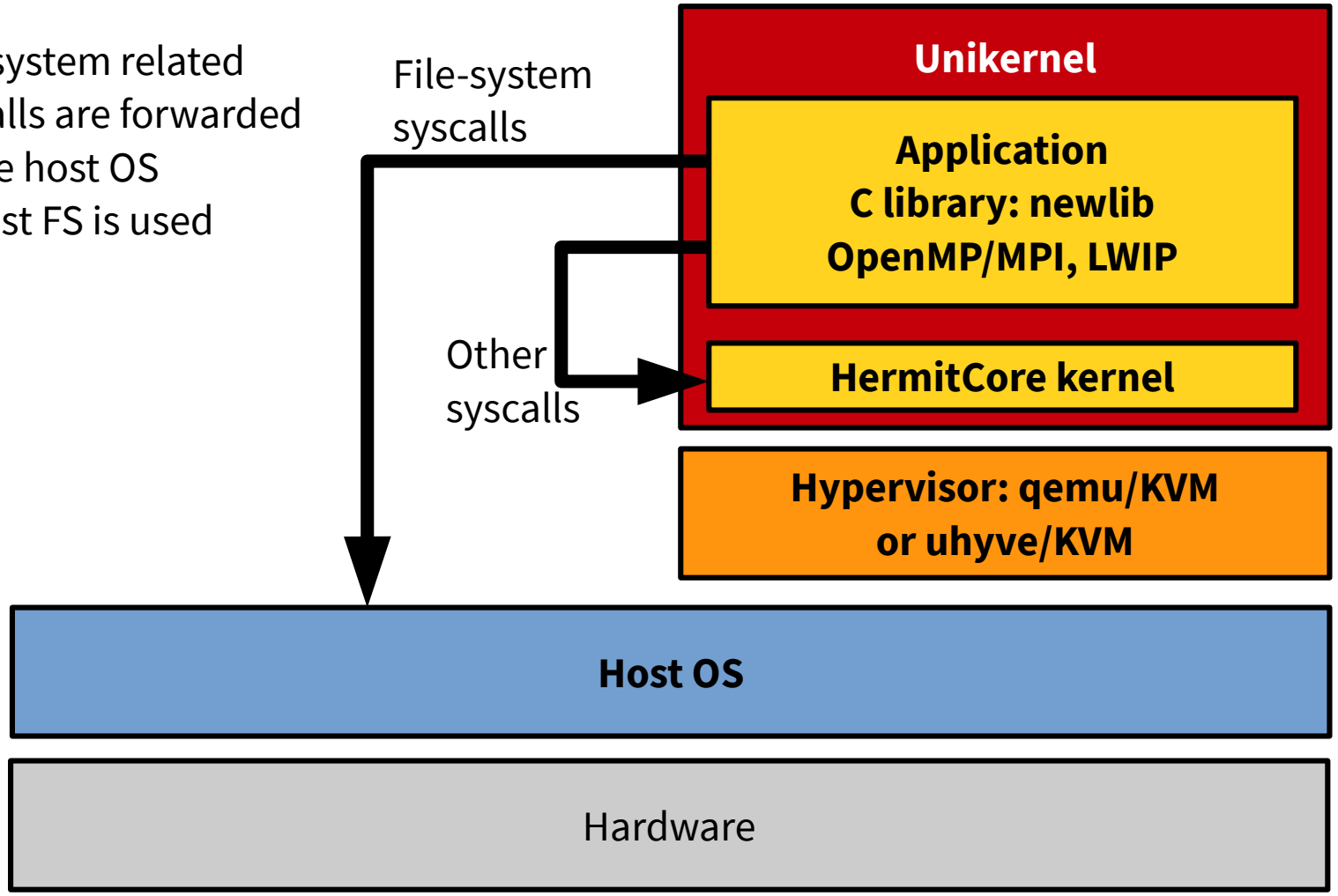
HermitCore

- **Unikernel originally dedicated to HPC**
  - Described in this paper:
    - Lankes, Stefan, Simon Pickartz, and Jens Breitbart. "HermitCore: a unikernel for extreme scale computing." *Proceedings of the 6th International Workshop on Runtime and Operating Systems for Supercomputers*. ACM, 2016.
    - http://www.hermitcore.org
  - Written in C, very simple codebase:
    - ~10KLOC
    - Good candidate for a project
  - Supports running on top of the following hypervisors:
    - Qemu (and Qemu/KVM)
    - Uhyve
      - ➔ Custom minimal hypervisor ~2KLOC

HermitCore

- File-system related syscalls are forwarded to the host OS
  - Host FS is used



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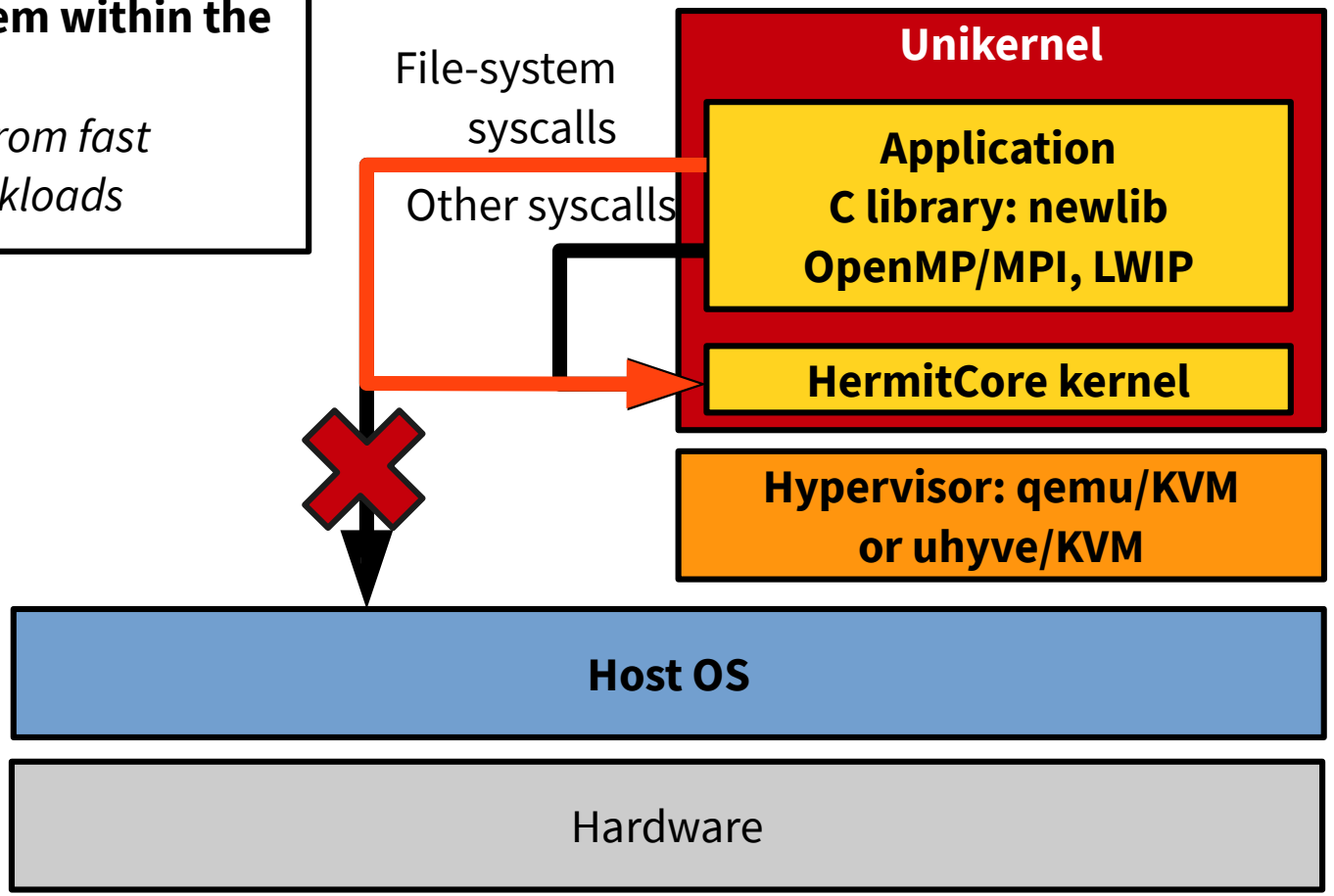
Problem statement

- **Unikernels system calls are fast**
  - Common function calls, no world switch
  - Was never clearly demonstrated
- **Most syscall intensive macro-benchmarks are file-system and network intensive**
  - We will not consider network (LWIP is pretty slow by itself)
  - HermitCore file system calls are forwarded to the host:
    - The bottleneck is this forwarding process, will not see any performance improvement from running a benchmark as a unikernel!

Problem statement

Project objective:
Implement a *simple* file-system within the HermitCore unikernel
- To explore potential benefits from fast system calls in FS intensive workloads



Solution design

What does *implementing a FS within HermitCore* means?

- Implement the FS syscall interface and define how files are stored, organized and retrieved in/from the backing store
- Backing store (storage medium)?
  - Strong advice: Implement the FS as a **ramdisk**
    - ➔ No driver to write, no need to virtualize the Host HDD
- Interface with the application
  - HermitCore redirects the following syscalls to the host:
    - ➔ open, read, write, lseek, close
    - ➔ **Change that to internal processing in HermitCore**
  - **Add new system calls**
    - ➔ creat, mkdir, rename, readlink, etc.

Recommended project steps

1) Being able to run a simple program

- Write a unikernel that opens a single file with O_CREAT, write something, read it, then close

2) Add directories

- Write a unikernel creating a directory with a few files in it then list the content of the directory

3) Scale up

- Create and access thousands of files and directories

4) Macro-benchmarks & performance evaluation

- Port postmark to HermitCore
- Compare your file-system performance (postmark & micro-benchmarks) to
  1) Regular HermitCore and/or
  2) Native Linux

5) Additional functionalities

- Pre-charge the ramdisk before application execution
- Other ideas?

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Project organization

- **Group work: can be accomplished in groups of 2 students max**
- **Timeline:**
  - Project assignment PDF released tomorrow
  - 'Getting started with HermitCore' technical guide released today
  - For next monday
    - Reproduce all the items in the technical guide on your own
    - Come up with a FS design
      - ➔ What are the system calls you will support, and a draft of what happen under the hood when each is executed
    - We'll review the designs together
- **Results to hand by *2018-02-20 11:59PM*:**
  - Source code, tests & performance evaluation programs
  - Project report: 7 pages minimum
  - 1 archive per group (i.e. 1 report & set of source files)