Hardware, Languages, and Architectures for Defense Against Hostile Operating Systems (DHOSA)

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http://www.dhosa.org/

The Problem

Can we defend applications from buggy and even malicious host operating systems?

- OS's contain ~50M lines of code.
  1 bug/Kloc $\Rightarrow$ ~50K bugs?

Reality: must assume OS will be compromised.

Exploring New Territory

- Conventional wisdom: If the OS is malicious or subverted, you are hosed.
- Our goal: Survive a malicious OS, perhaps with degraded functionality or availability.

The Approach

Advances that cut across traditional disciplines:

- new hardware architectures
- new techniques for binary rewriting
- new OS and software architectures
- new advances in formal methods
- new cryptographic techniques

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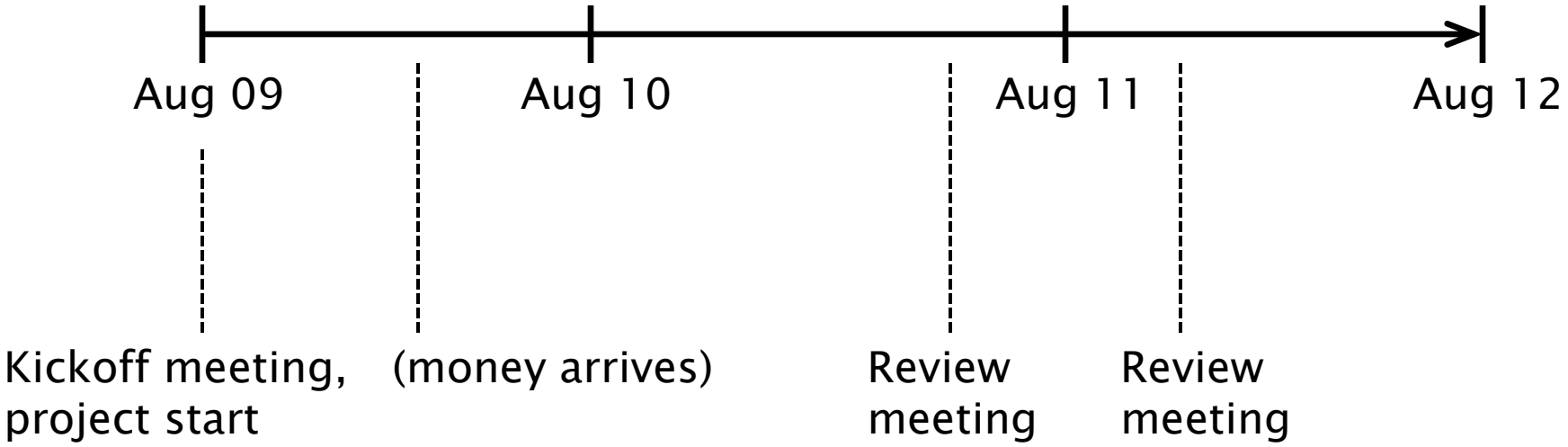
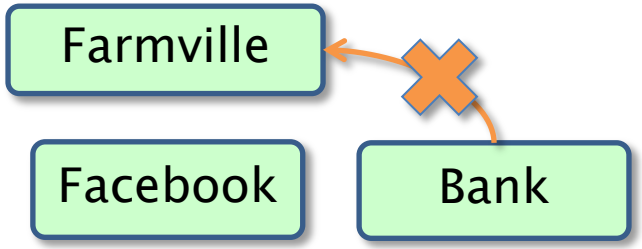
Timeline


Aug 09
Aug 10
Aug 11
Aug 12
Kickoff meeting, project start
(money arrives)
Review meeting
Review meeting



What must you trust to prevent unwanted flows?

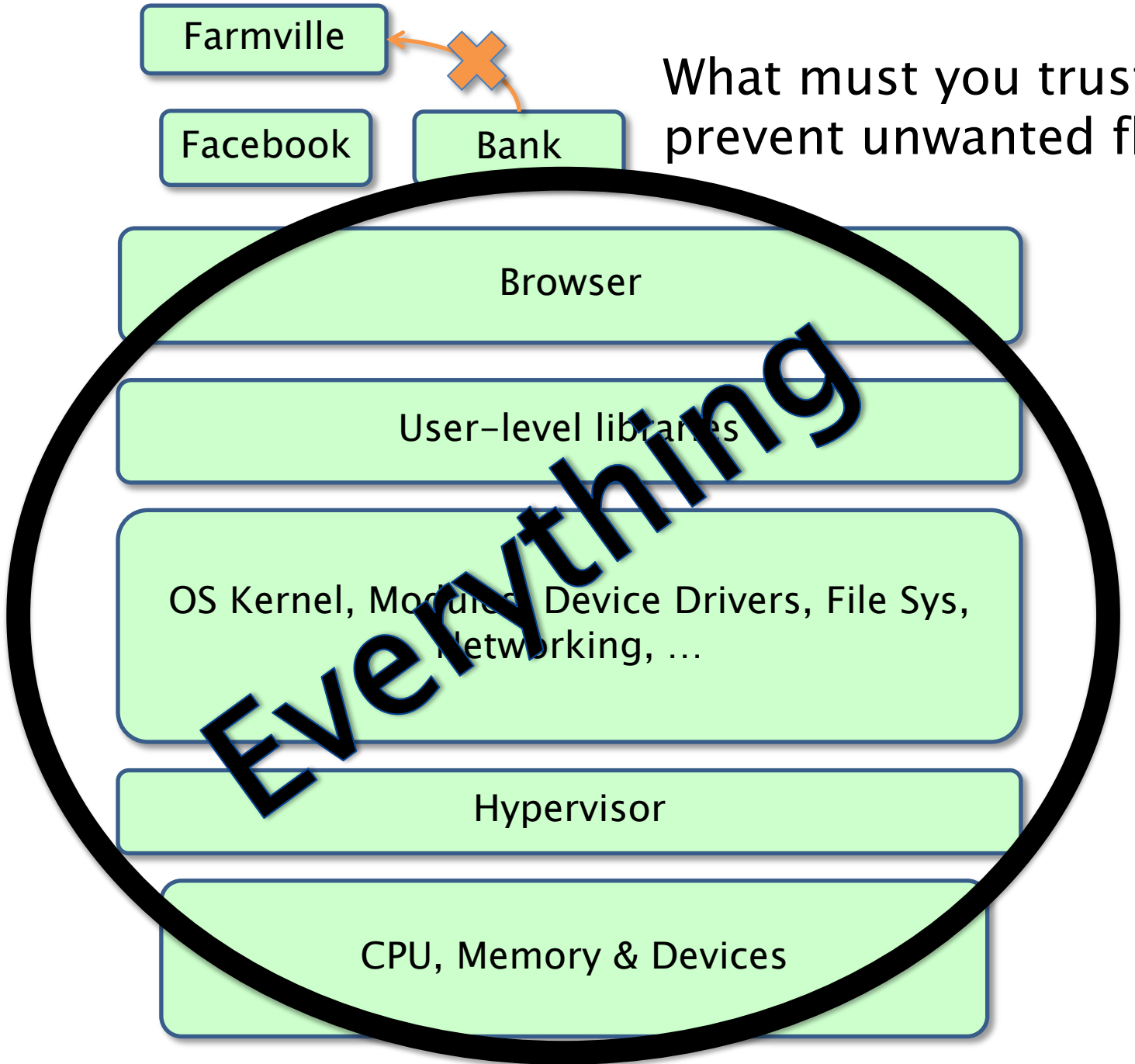
Browser

User-level libraries

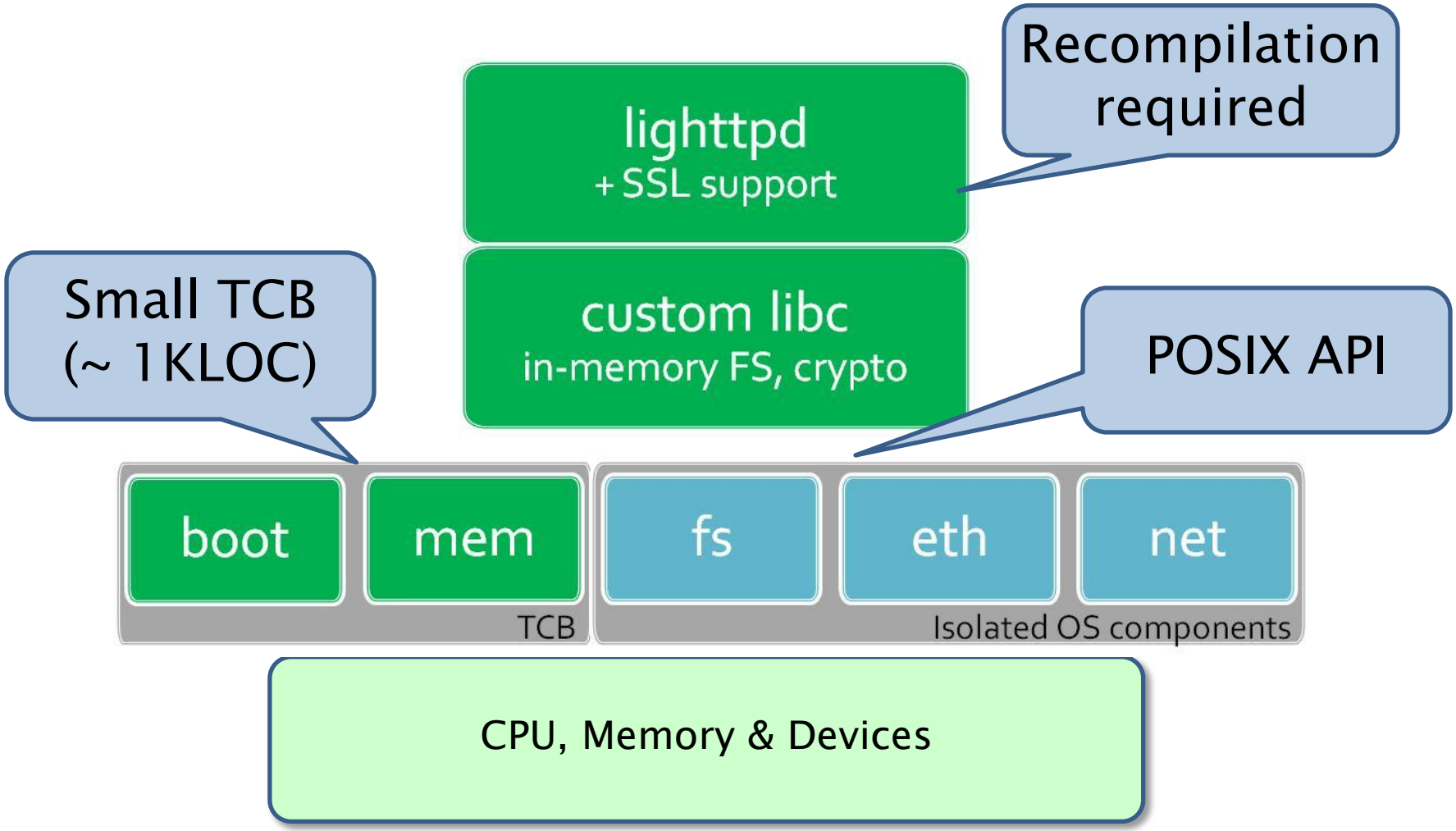
OS Kernel, Modules, Device Drivers, File Sys, Networking, …

Hypervisor

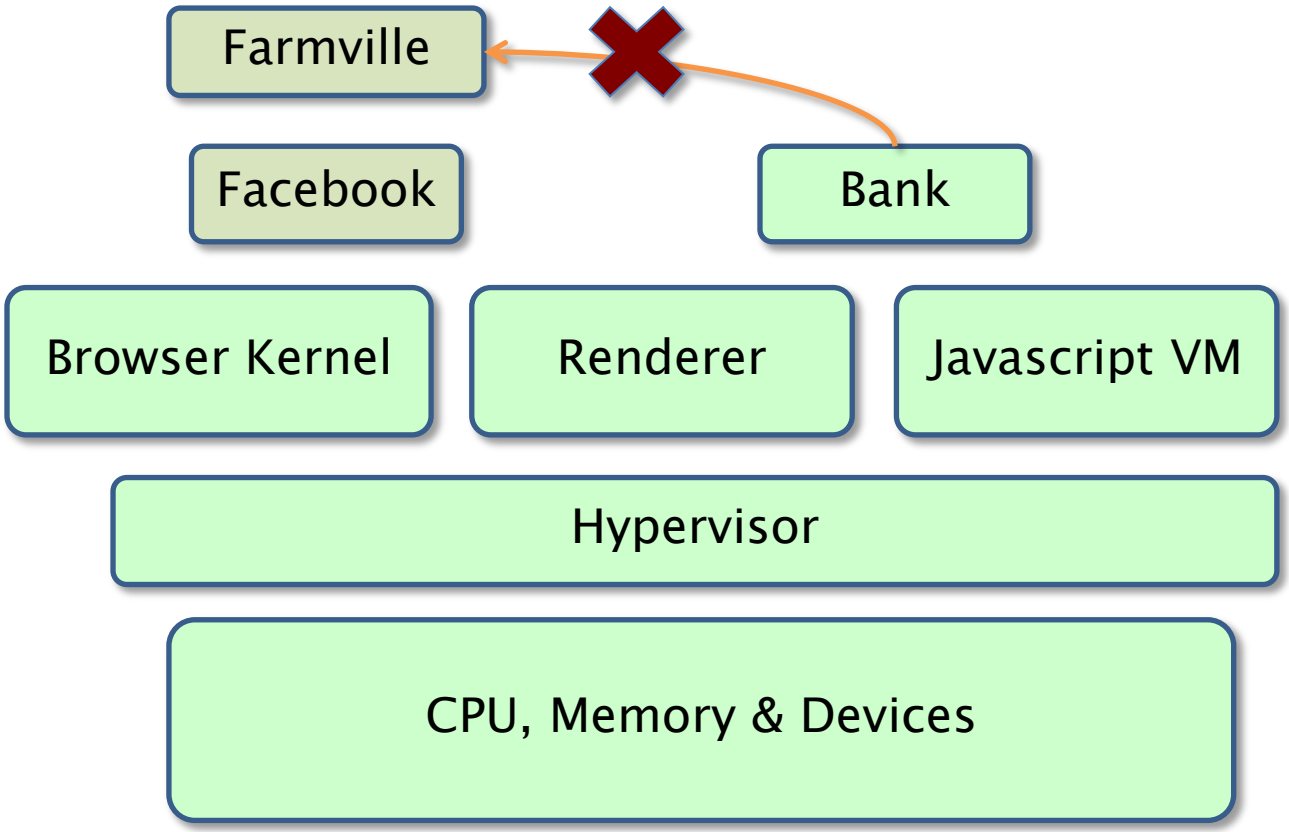
CPU, Memory & Devices


Farmville
Facebook
Bank
What must you trust to prevent unwanted flows?
Browser
User-level libraries
OS Kernel, Modules, Device Drivers, File Sys, Networking, …
Hypervisor
CPU, Memory & Devices
Everything

An alternative world?



Another alternative world?

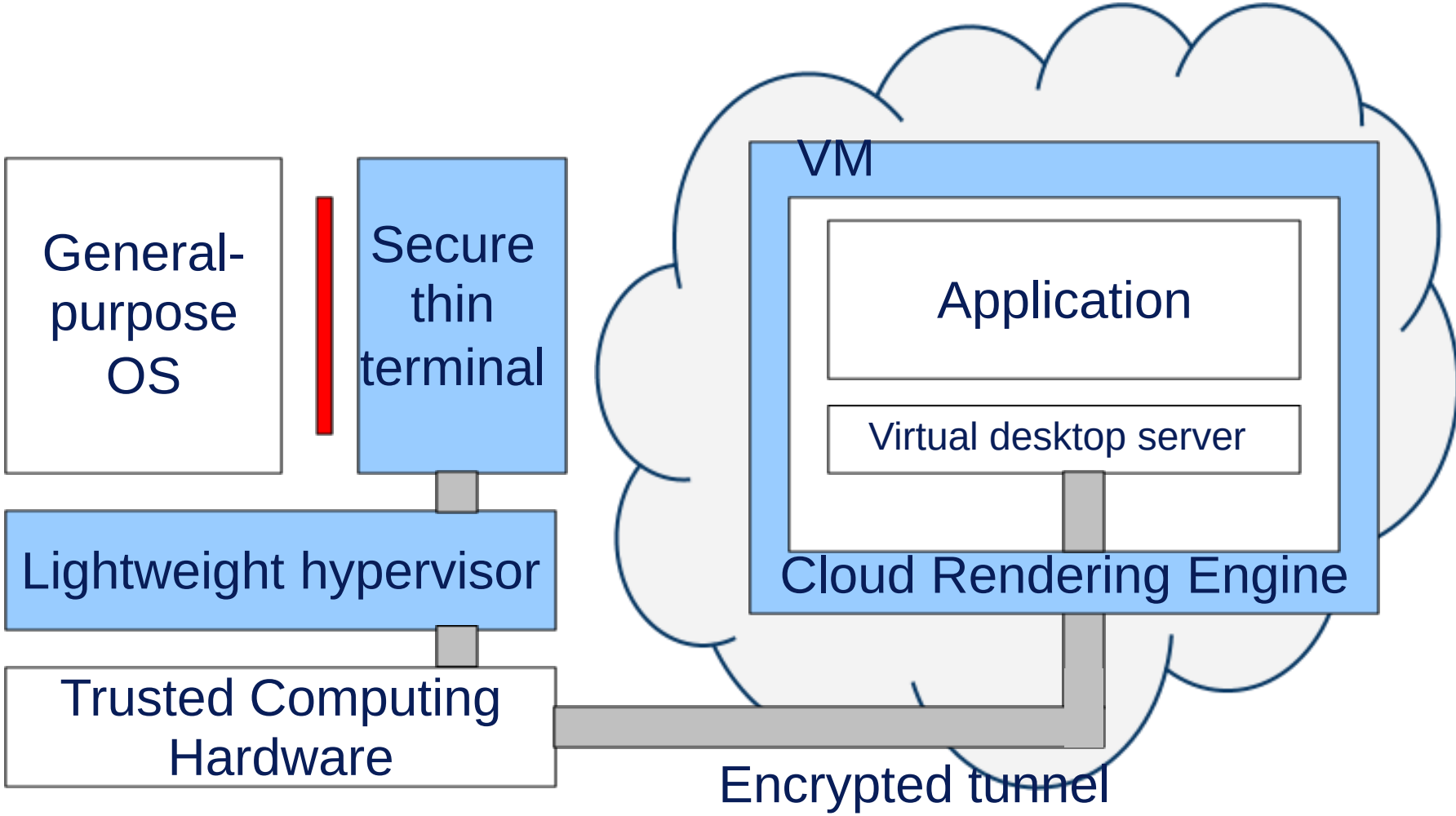


Illinois Browser Operating System (IBOS)

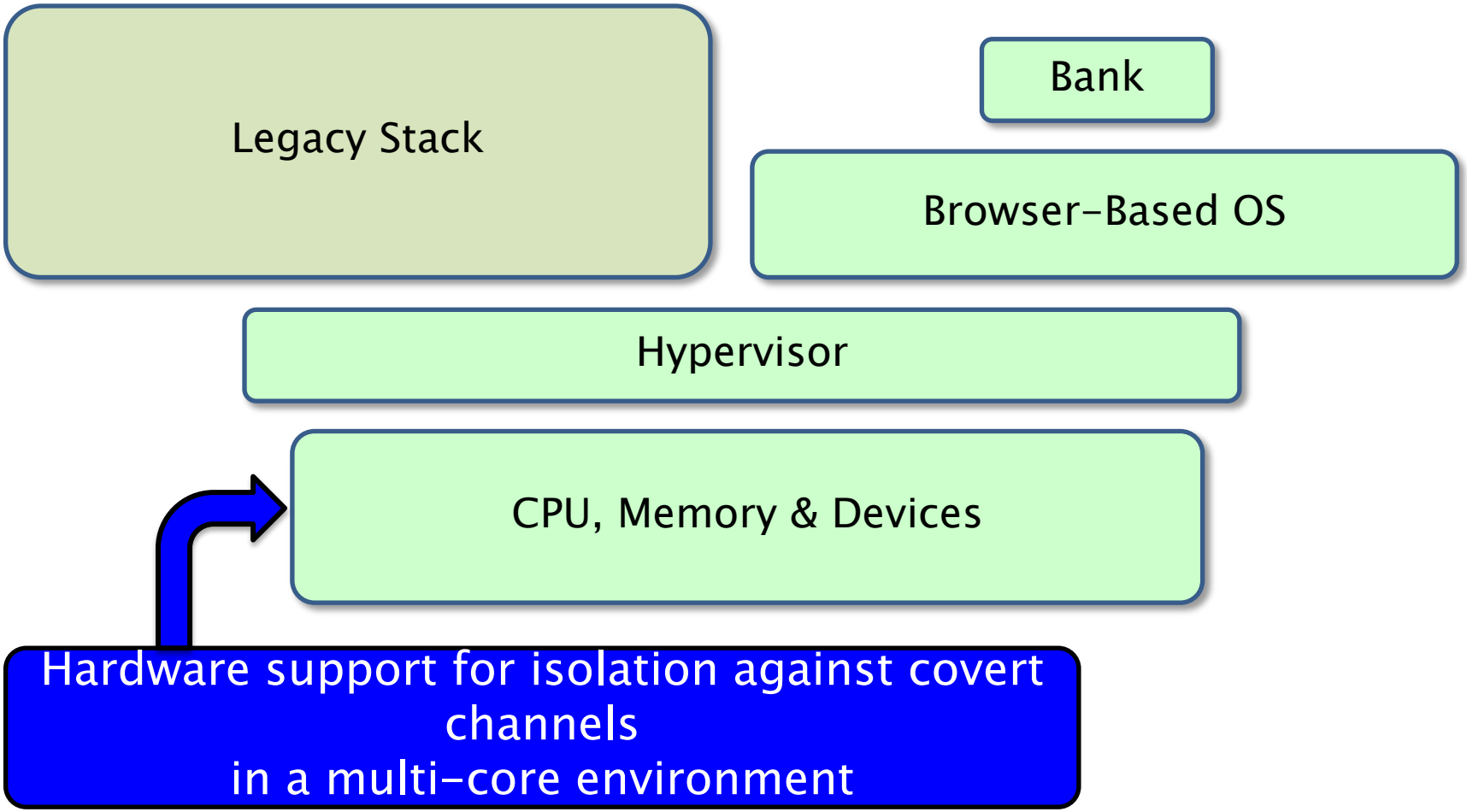
Data-centric Security

- Protect the data directly instead of network or host-based protection
- Three examples:
  - Cloud-terminal: providing trusted input/output
  - Platform for private data
  - Secure web applications: Guardrails

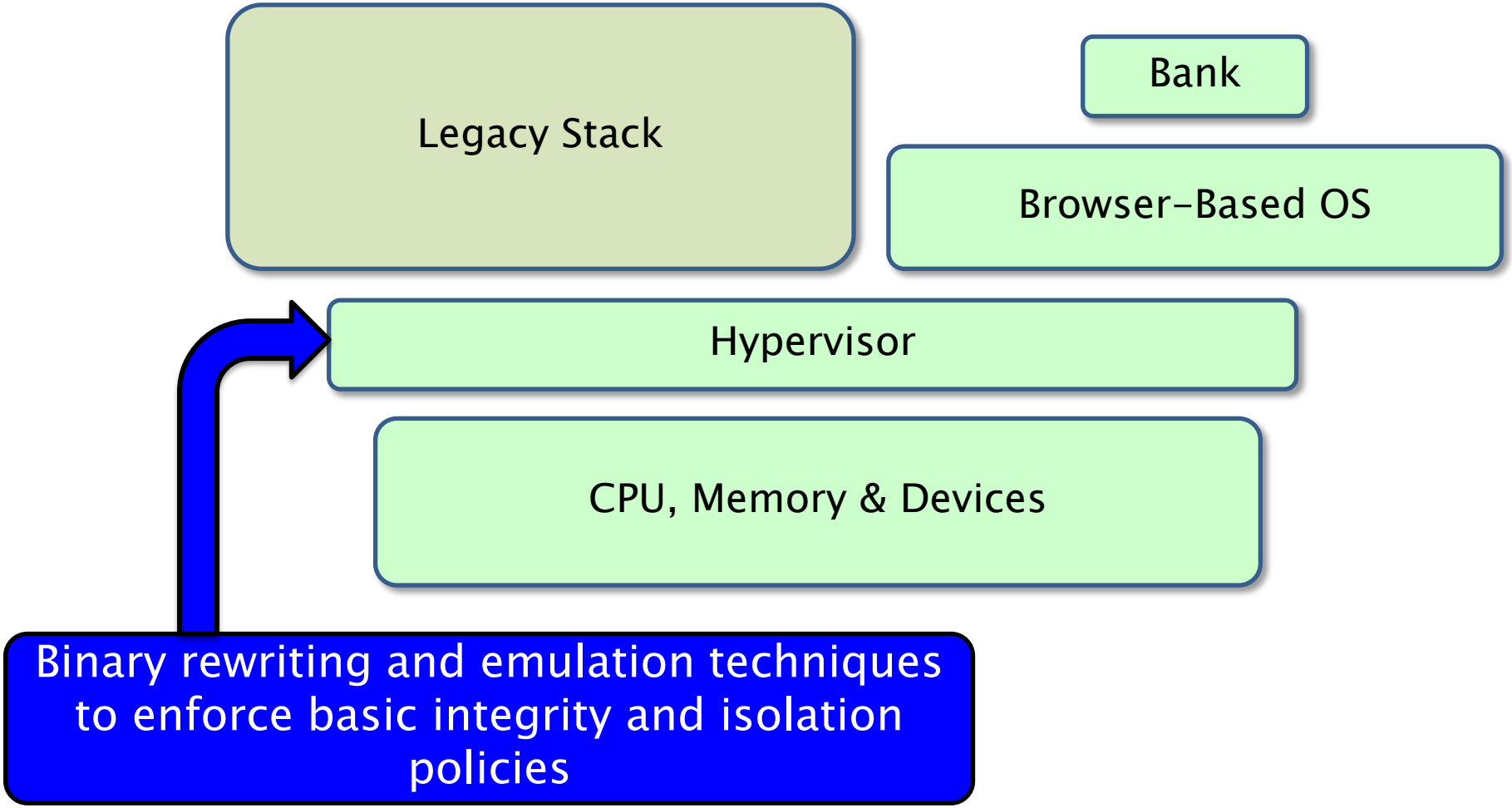
Cloud-terminal architecture



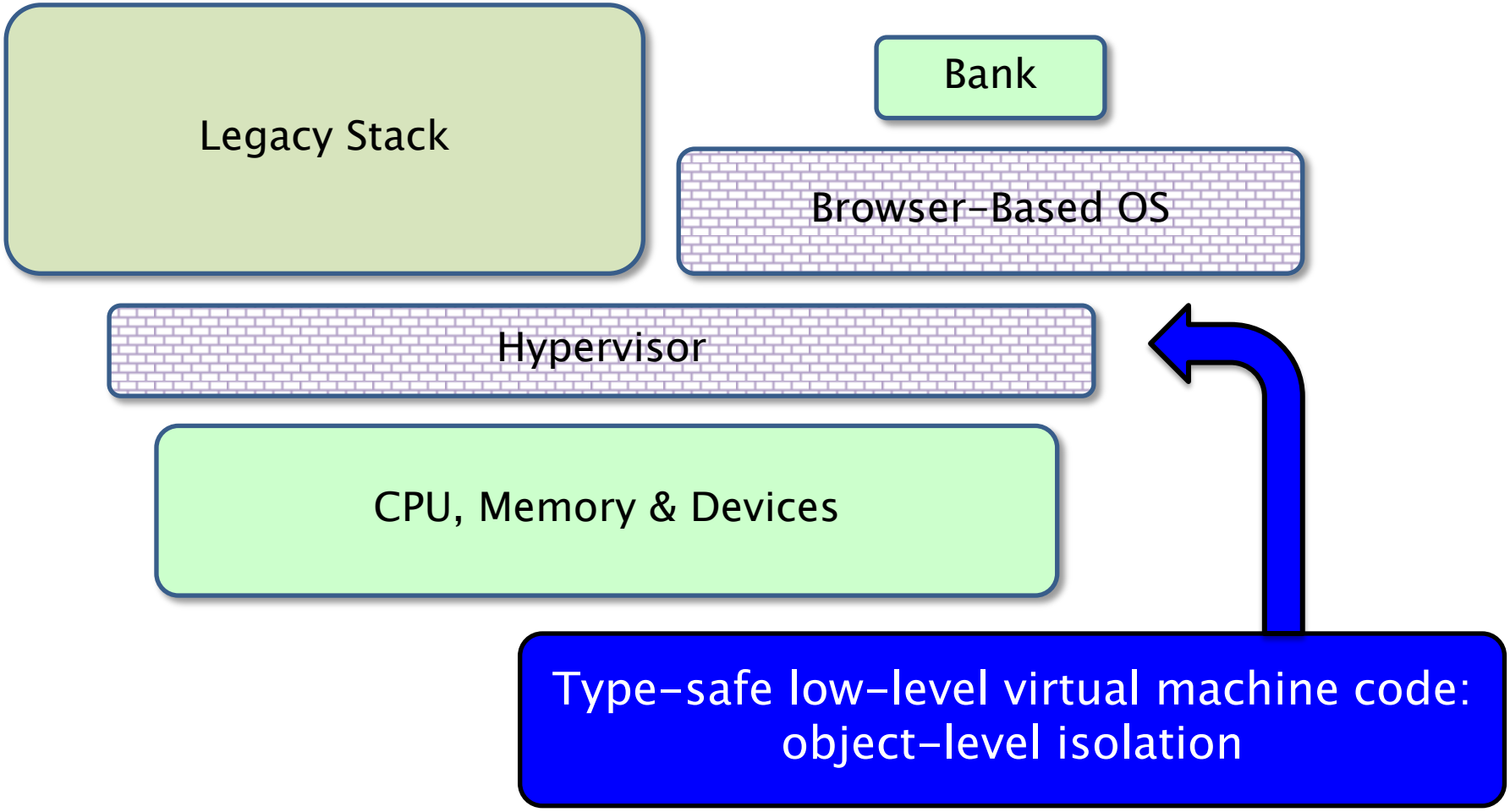
Hardware


Legacy Stack
Bank
Browser-Based OS
Hypervisor
CPU, Memory & Devices
Hardware support for isolation against covert channels
in a multi-core environment

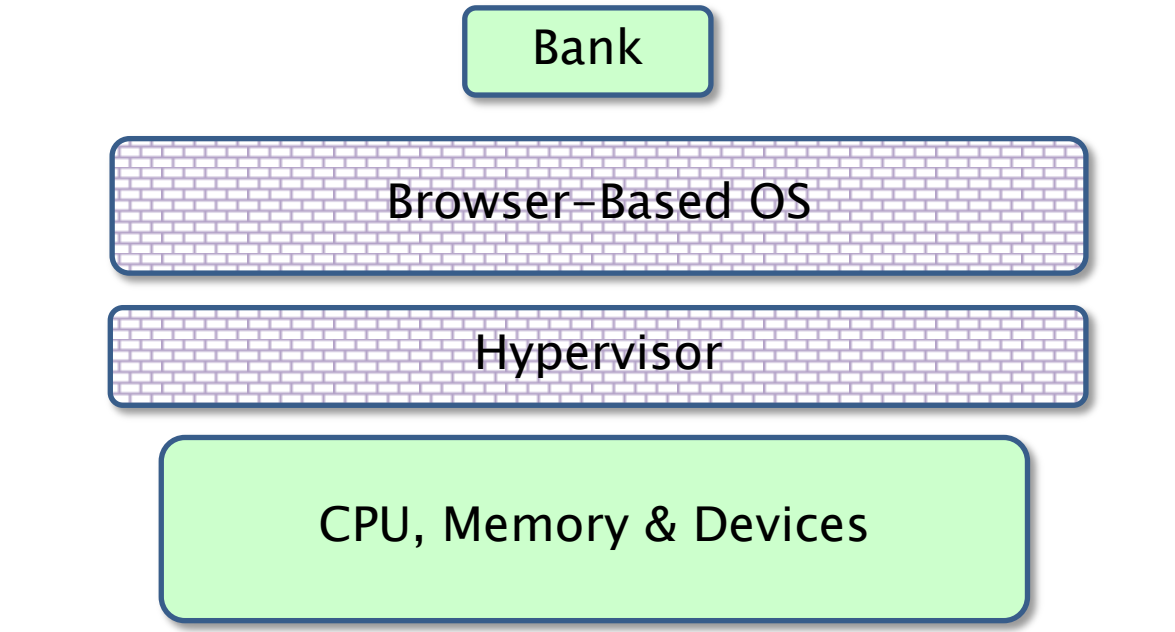
Binary rewriting



Language-based safety

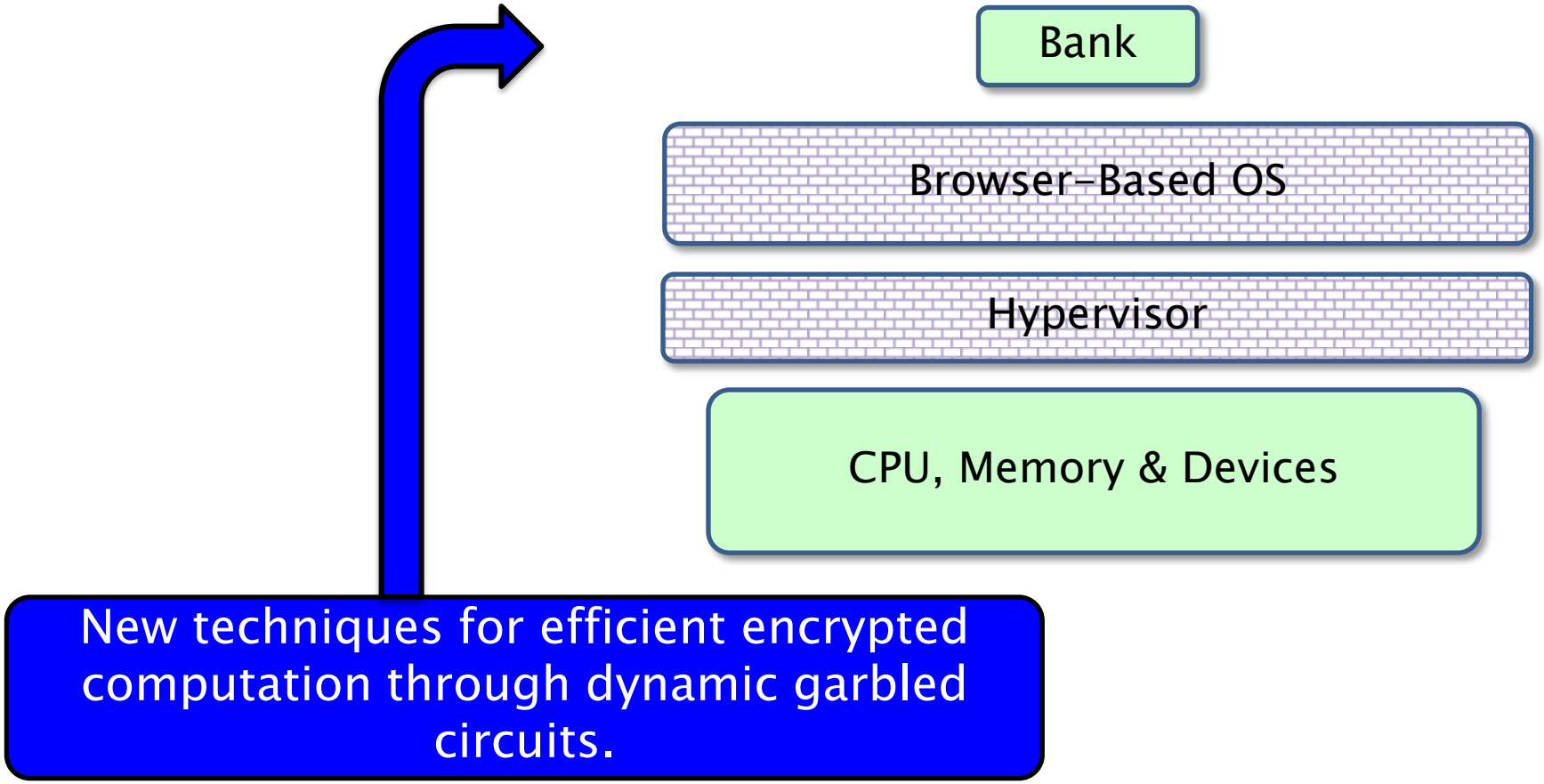


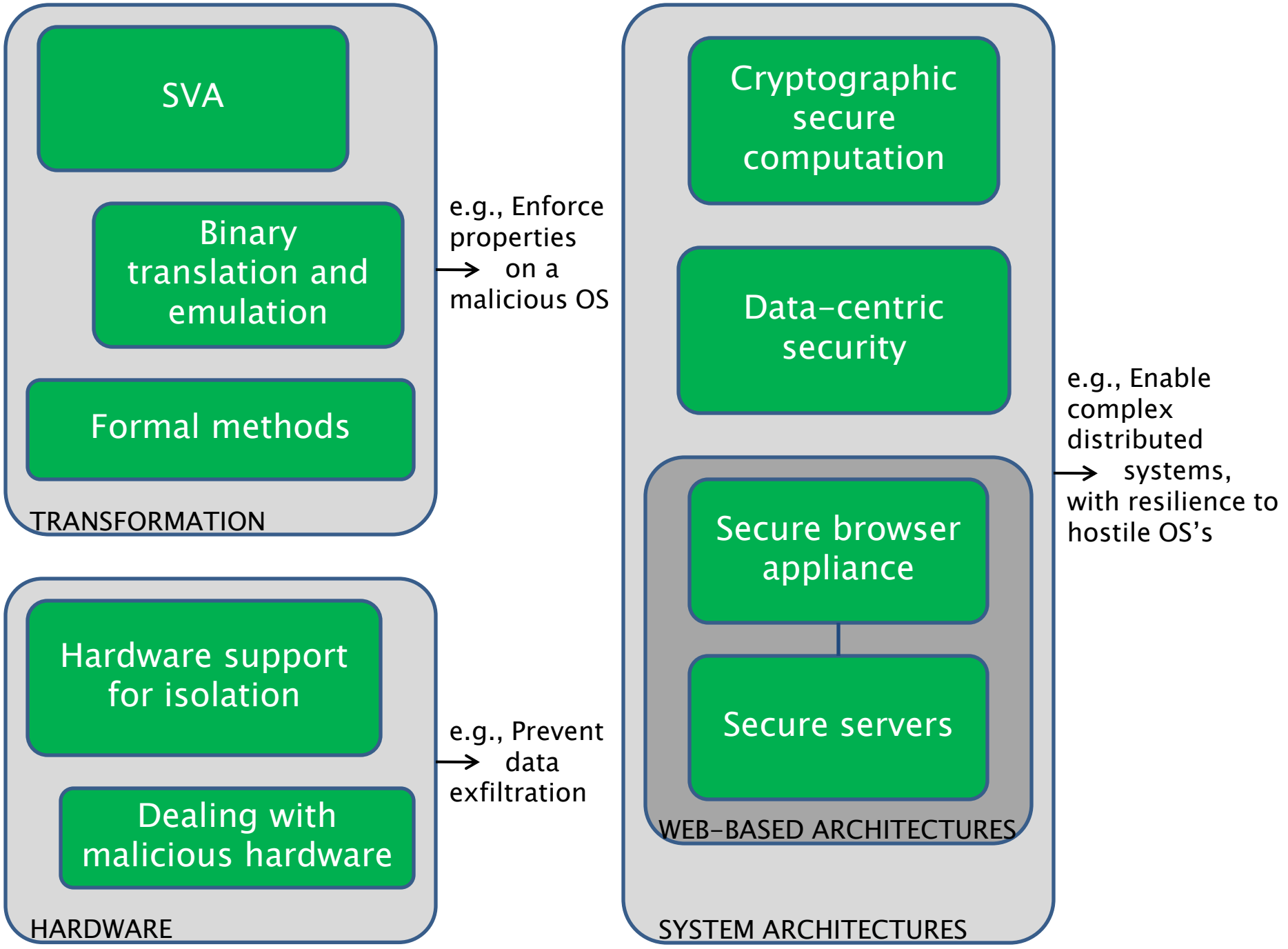
Formal methods



New techniques for scalable verification of enforcement technologies.

Cryptographic techniques




SVA
Binary translation and emulation
Formal methods
TRANSFORMATION
e.g., Enforce properties on a malicious OS
Hardware support for isolation
Dealing with malicious hardware
HARDWARE
e.g., Prevent data exfiltration
Cryptographic secure computation
Data-centric security
Secure browser appliance
Secure servers
WEB-BASED ARCHITECTURES
SYSTEM ARCHITECTURES
e.g., Enable complex distributed systems, with resilience to hostile OS's

Agenda

9:30- 9:45	Welcome + Overview
9:45-10:10	CPU emulators: improving their assurance
10:10-10:35	Formal modeling of x86 binaries
10:35-11:00	Data-centric security: Platform for Private Data
11:15-11:35	Binary rewriting
11:35-12:00	Secure Virtual Architecture
12:00- 1:00	Lunch
1:00- 1:25	Trust, protection, & performance with Valkyrie
1:25- 1:50	When semi-honest is only semi-good-enough
1:50- 2:30	Visitor feedback

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