QUBES OS

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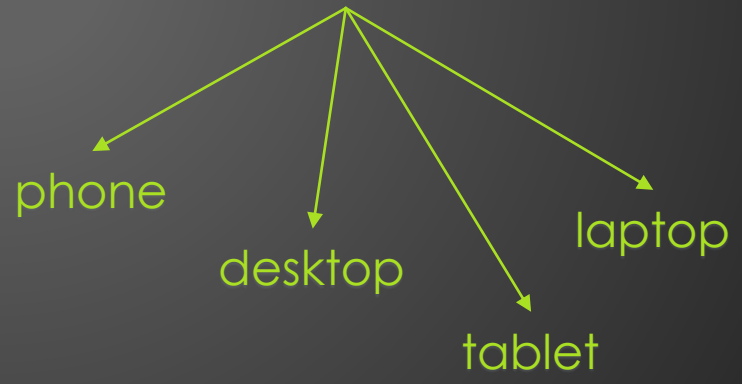
Qubes OS

- A reasonably secure desktop OS
- Security by Compartmentalization
- Qubes != Hypervisor/VMM (Qubes is a *user* of a VMM, presently Xen)
- Qubes != Linux Distro

Why?

Because we need secure *client* systems



We really need secure CLIENT systems

- Client systems are our Eyes, Ears, and Fingers!
- Nothing works when the client system is compromised
  - Crypto
  - (2-factor) authentication
  - VDI/thin terminals (“secure cloud” not secure)

Present client systems are… insecure

Problems with current (desktop) systems

- Attacks coming through (exploited) apps (Web browser, PDF readers, etc)
- Attacks coming from (malicious) apps (Spyware, Backdoors, etc)
- Attacks coming through (compromised) USB devices
- Attacks coming through networking stacks (DHCP client, WiFi driver/stacks)
- Attacks coming through (malformed) FS/Volume Metadata (USB Storage, CDs)
- Lack of GUI isolation (sniffing content & clipboard, sniffing & spoofing keystrokes)

Desktop systems != server systems

Monolithic systems are hard to secure
(especially desktop systems!)

Monolithic kernel is bad for security

- WiFi & NIC & BT drivers & stacks
- USB drivers & stacks
- Filesystem modules & other volume processing code
- All the various APIs (e.g. debug, VFS, sockets API, etc)
- Why should all these be **part of TCB**?

"Monolithic" is not only about the kernel...

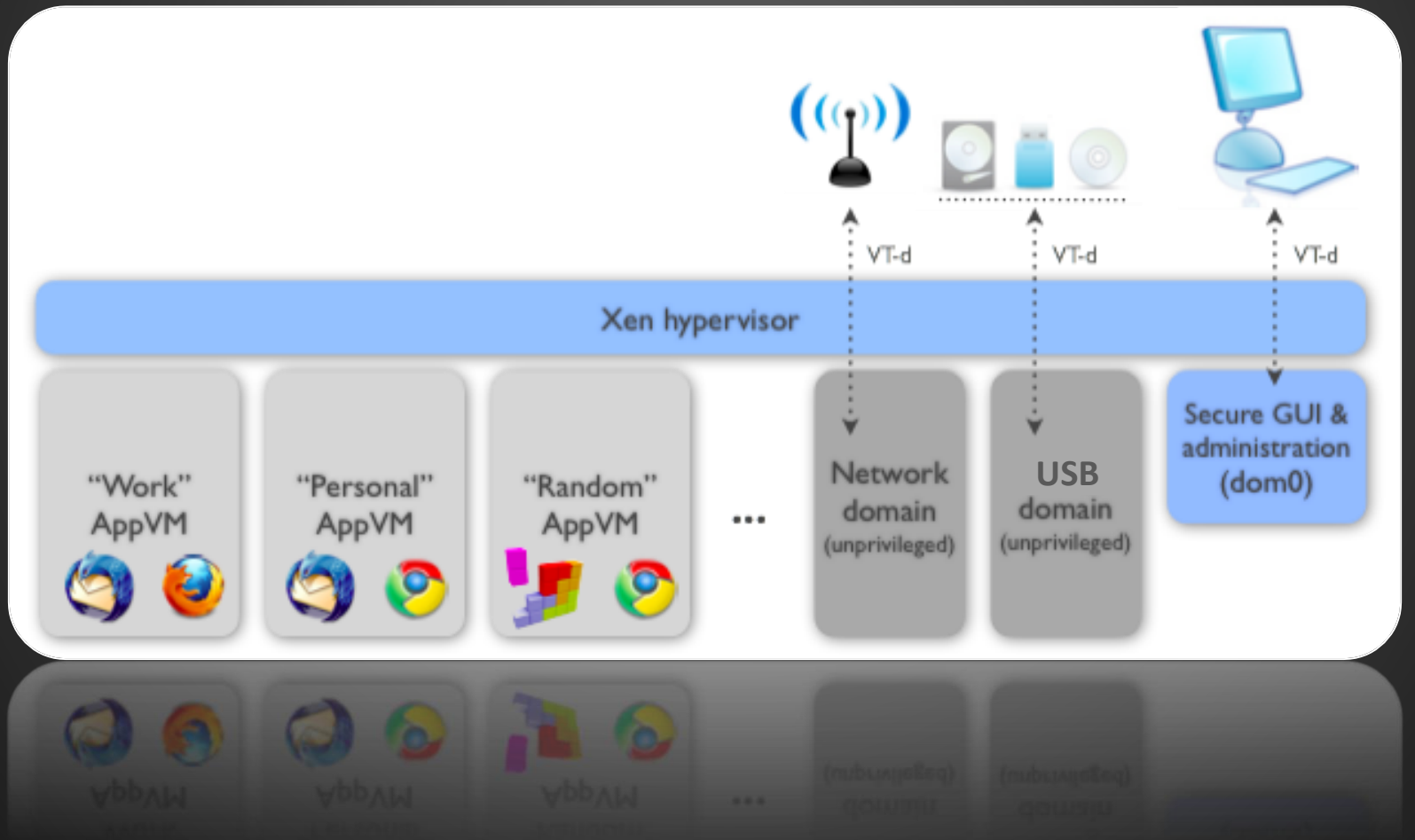
Monolithism beyond kernel

- GUI server (Xorg)
- Various system services
  - Network Manager and other D-Bus endpoints
  - udev services (e.g. block device mounting)
  - CUPS, desktop indexing, etc
- Not only root considered as “TCB” from user-data point of view
  - e.g. “root-less” Xorg not a big deal, really

Monolithic means: bloated, complex, difficult to understand, and manage

How?

Security by Compartmentalization


VT-d
VT-d
VT-d
Xen hypervisor
"Work" AppVM
"Personal" AppVM
"Random" AppVM
...
Network domain (unprivileged)
USB domain (unprivileged)
Secure GUI & administration (dom0)

Virtualization?

- Yes, we use virtualization (VMs) to isolate domains from each other...
- But why would VMs provide any better isolation than OS processes?
- Is there anything wrong with x86 good old MMU/page/ring separation?
- "Solving" problems by adding another layer of abstraction?

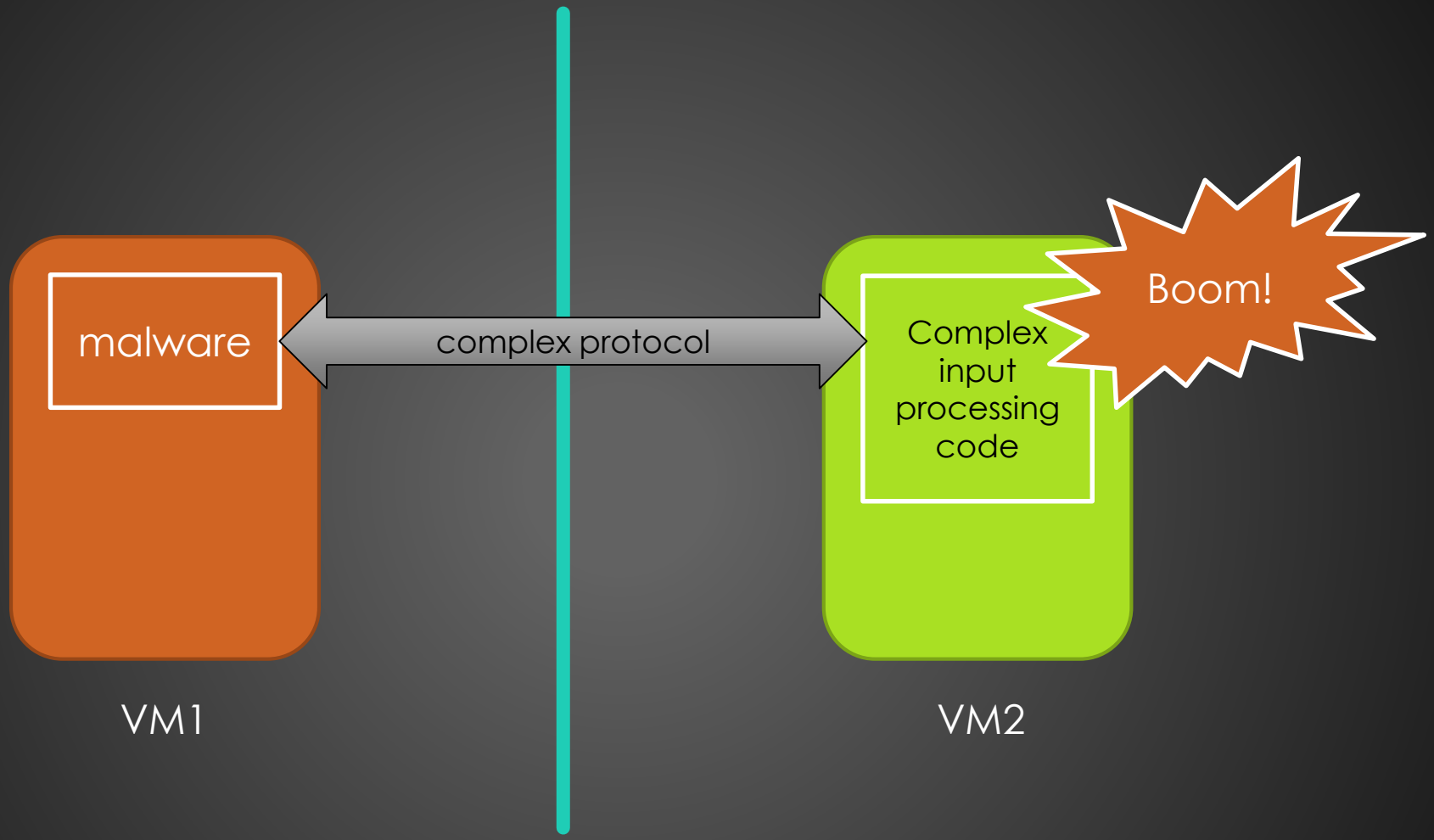
What so special about Virtualization?

- It allows to REDUCE the interfaces (VM-VM & VM-TCB)...
- ... and preserve compatibility with LEGACY apps & drivers at the same time

But before we get too excited...

VM<->hypervisor is not the only interface that is security critical...

Strong isolation “by virtualization”...



... not anymore!

Lesson:

- Don't get too excited about "hardware virtualization" isolation
  - Virtualization nothing magic, offers little more than traditional MMU isolation
  - (Except for IOMMU, but that's for devices, more later)
- Be careful about inter-VM interfaces and code that handles it!

Ask your hypervisor vendor if/how they DO:

- Device emulation (is qemu part of TCB?)
- Networking virtualization (is net backend part of TCB?)
- Storage virtualization (protocols used, any fancy & complex features?)
- USB virtualization (Is USB backend part of TCB?)
- GUI virtualization (also OpenGL/DirectX/GPU backend complexity?)
- Inter-VM communication framework?
- Inter-VM file & clipboard copy?

“Virtualization gold rush” brought some useful new h/w technology though...

IOMMU (AKA Intel VT-d)

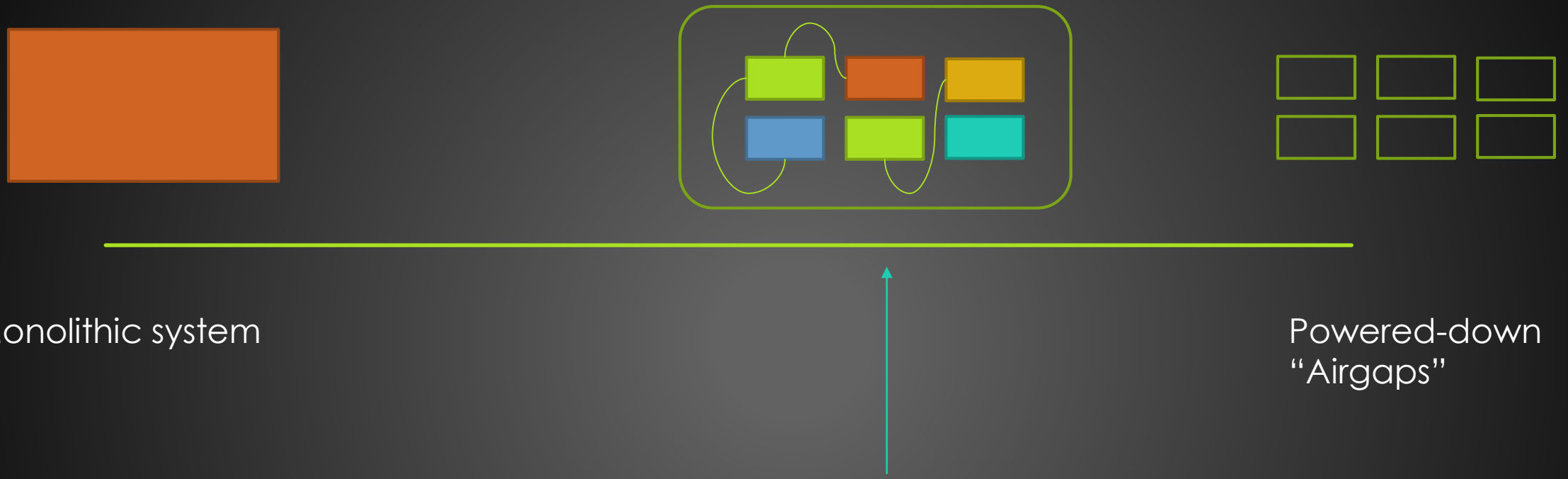
- Allows for truly de-privileged driver domains (Xen pioneer in using it)
- We can have NetVM, UsbVM :)
- BTW, microkernels without IOMMU made no sense from security point of view.

NetVM

- Ever used WiFi in an airport lounge or hotel?
- Ever wondered if your WiFi driver, stack or DHCP client could be exploited?
  - Remember Bashocalypse?
- How about sandboxing all these components?
- This is what a NetVM is about

USBVM

- How much code involved in processing when plugging in a USB device?
  - BadUSB?
- UsbVM can sandbox all the USB drivers and stacks
- Then we can carefully export select devices to other AppVMs



Monolithic system

Tradeoff between
usability & security?

Powered-down
“Airgaps”

Status

Qubes OS Releases

- Qubes OS R1
  - 2010-2012
- Qubes OS R2 (HVM & Windows support, gazillion other features)
  - 2012-2014
- Qubes OS R3 (Hypervisor Abstraction Layer, UX improvements, H/W compat)
  - 2013-

Qubes R2 implements everything we talked about so far (plus more!)

qubes-os.org

Use of Linux (and other OSes)

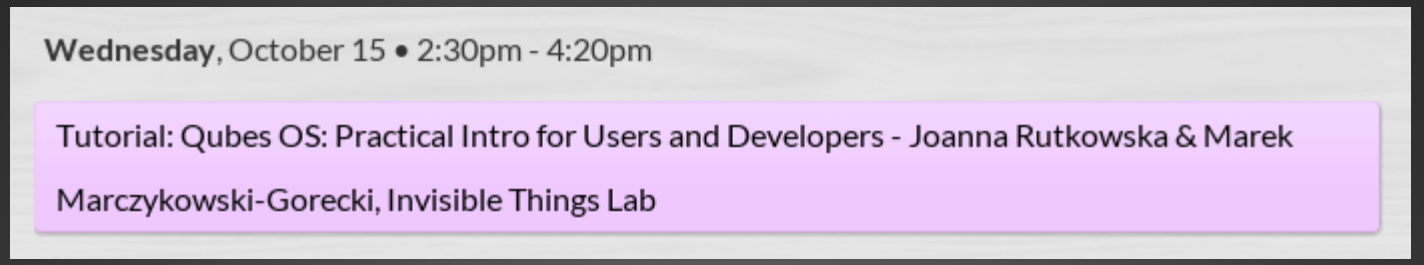
- Currently default template based on Fedora 20
- Debian and ArchLinux templates also available (community contribs)
- Also our Dom0 based on Fedora 20
  - But this mostly irrelevant to the user, as no user apps or data are in Dom0
  - (Think about Dom0 as of a thin and dumb terminal to work with AppVMs)
- Windows 7-based templates also supported
  - User must install Windows and provide licensing keys though

Qubes as a platform
for secure/privacy-oriented Apps

- Integration with Tor
  - TorVM since 2012
  - Currently on-going work to fully integrate Whonix
- Secure email
  - Open attachments in Disposable VMs
  - Split GPG to protect user private keys
  - PDF converter (make PDFs trusted)
- Secure networking
  - Isolated VPN VMs
- More coming!

Qubes OS R3 (“Odyssey”)

- Hypervisor Abstraction Layer (HAL)
  - Don’t like Xen?
  - No problem, use KVM, LXC, MS Hyper-V, [some academic u-kernel/hypervisor]
  - Allows for security-performance-compatibility tradeoffs
- Reworked architecture
  - More modular, even more decomposed
  - GUI domain != Admin domain (planned)
  - Qubes Admin API: semi-untrusted remote management VM(s) (planned)



QUBES-OS.ORG

427F 11FD 0FAA 4B08 0123 F01C DDFA 1A3E 3687 9494

Master Key Fingerprint

427F 11FD 0FAA 4B08 0123 F01C DDFA 1A3E 3687 9494

Thanks!