A Love Letter to Isolation

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Cloud Native Wasm Day 2023

Isolation is the unsung hero of computing.

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Isolation is a core design element for how we sustain resilience against failures of all kinds

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But we don’t love isolation the way we should

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This is a love letter to isolation as we take the next big step in our relationship: Wasm

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Isolation in
Complex Systems

Isolation is literally the basis of life.

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“The necessity of thermodynamically isolating a subsystem is an irreducible condition of life.”

– Harold Morowitz

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Nature was the original architect of nested isolation, long before we made the transistor.

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Proteins and genes, cells, organs, ecosystems...

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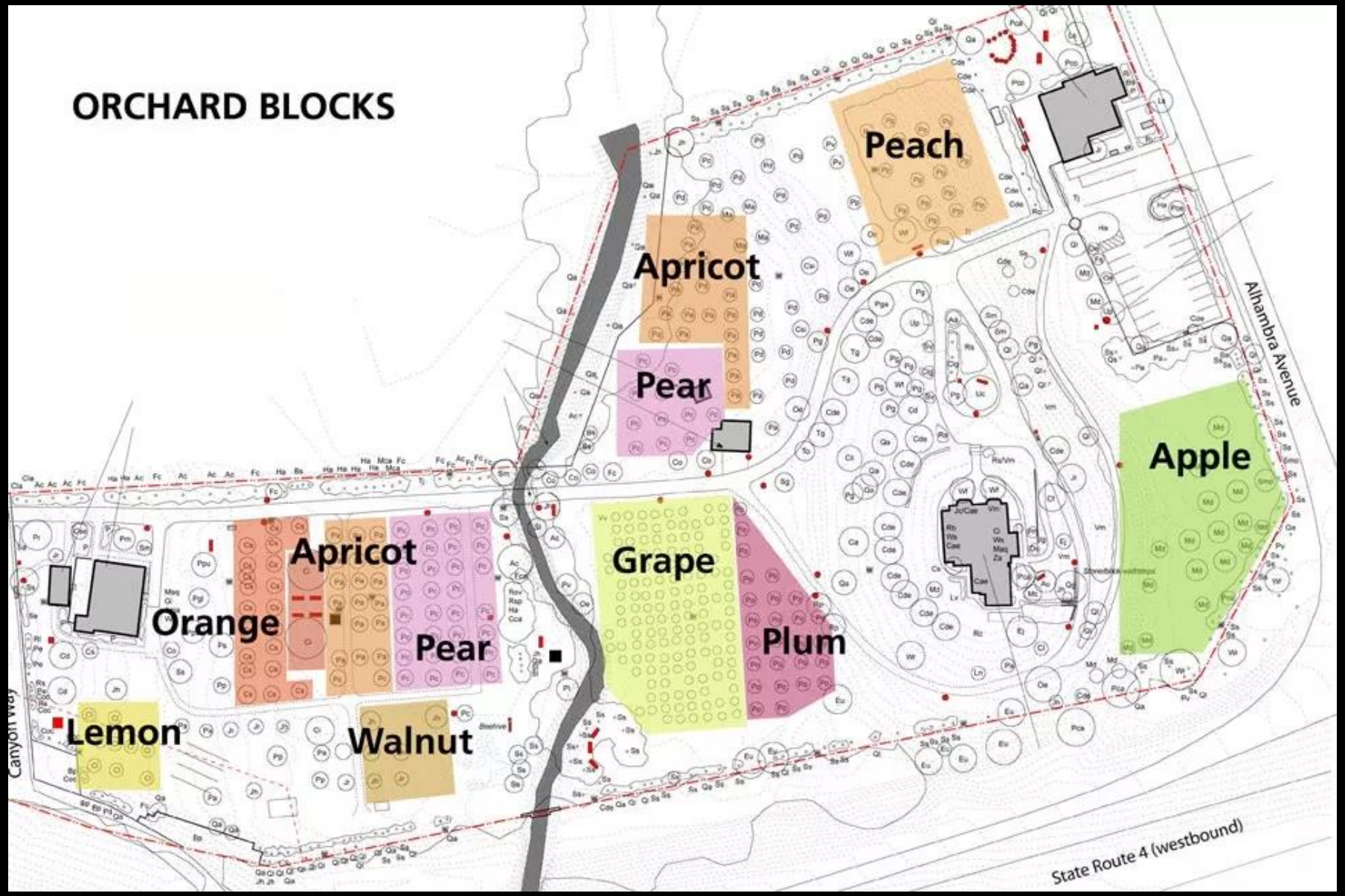

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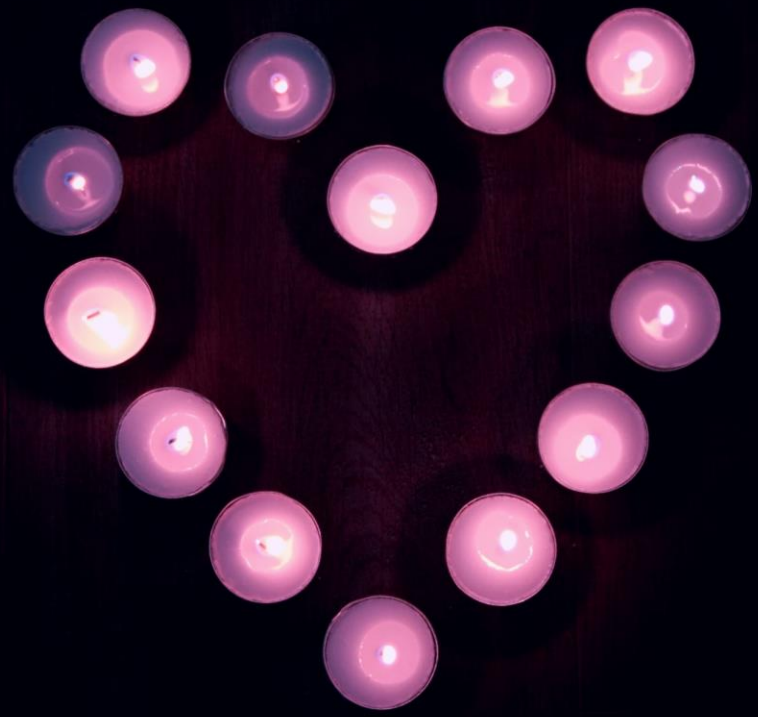
Modularity



Isolation is the modularity superpower

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Modularity is a system property reflecting the degree to which components can be decoupled

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Modularity: allows structurally or functionally distinct parts to retain autonomy during periods of stress & allows for easier recovery from loss

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Modularity directly enhances evolvability

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Unless components can fail independently, you don't have modularity in the resilience sense.

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Modularity enables iterative evolution; the system can “save its work” and still change

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Modularity allows for basic encapsulation and separation of concerns, which enables isolation

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Modularity minimizes incident impact

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Aesop's Fable: "The Oak & the Reeds"

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Where real world systems bend, software systems tend to break

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Software isn't forgiving to crashes, exceptions, and attacks – which is why isolation is our hero

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In software, we're lucky that we can isolate failure to handle unexpected interactions

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Software Isolation

Isolation makes computers usable

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Isolation allows us to wrap specific software components in a membrane

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But adding each layer or dimension of isolation is a hard-fought battle, a great upheaval

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Process isolation

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User isolation

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App / site isolation

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Network isolation

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Browser isolation

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Cryptography

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All of this innovation supports modularity; we should embrace isolation and deepen it.

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WebAssembly & the Component Model

Wasm is the latest in a long history of trying to provide convenient and cheap isolation

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Wasm's existing isolation model lets you build services and programs that are completely isolated from the underlying system

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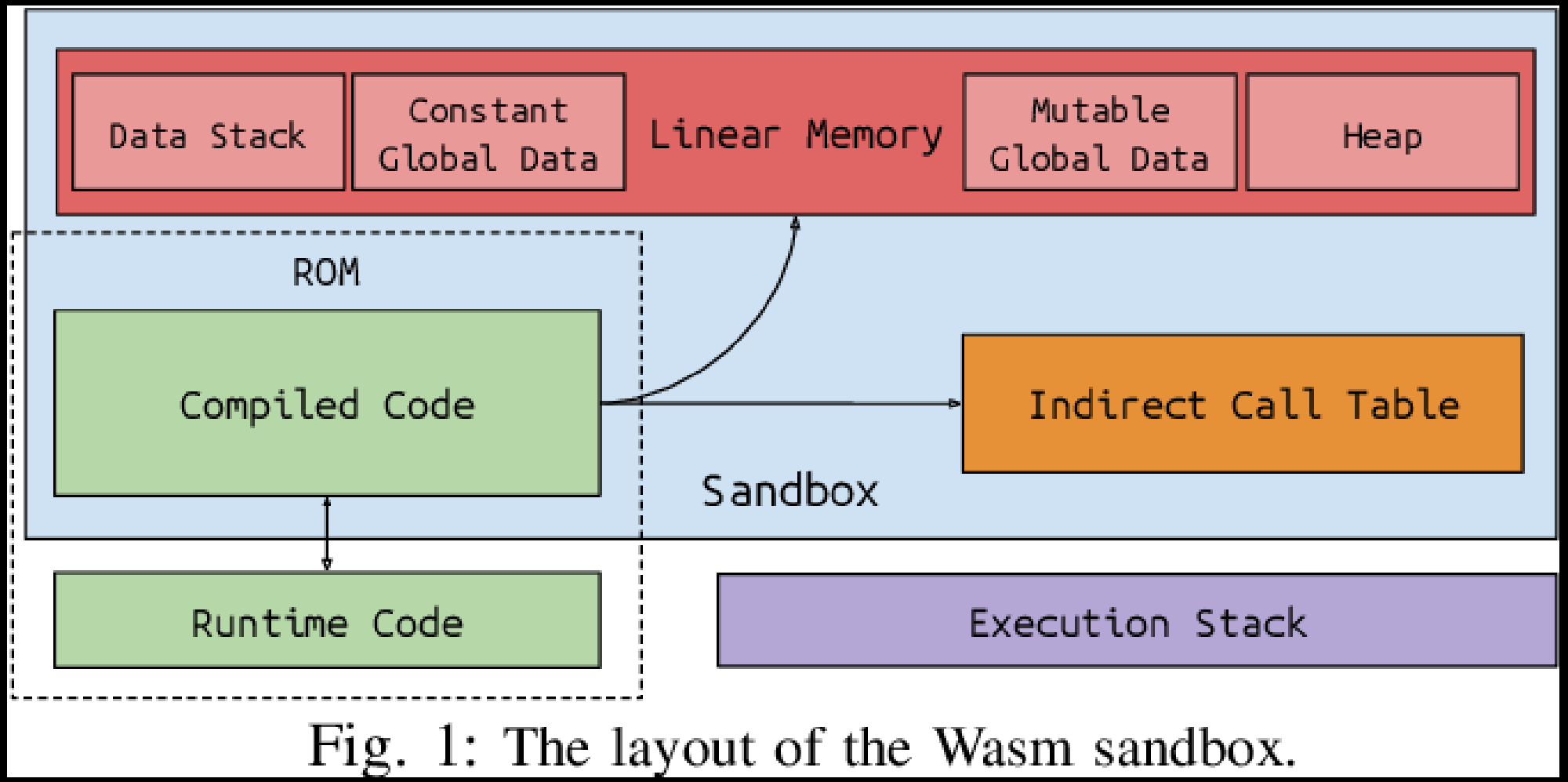

Fig. 1: The layout of the Wasm sandbox.

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This is an improvement – but hazards remain, and it isn't the easiest thing to set up, either

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We can do more to solve for a “strong isolation by default” world: the Component Model

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Devs don’t want to think about isolation; they want some layer underneath to handle it

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The Component Model adds the same safety benefits *between* components (like libraries)

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Decompose apps into a modular architecture to get loose coupling with near-native speeds

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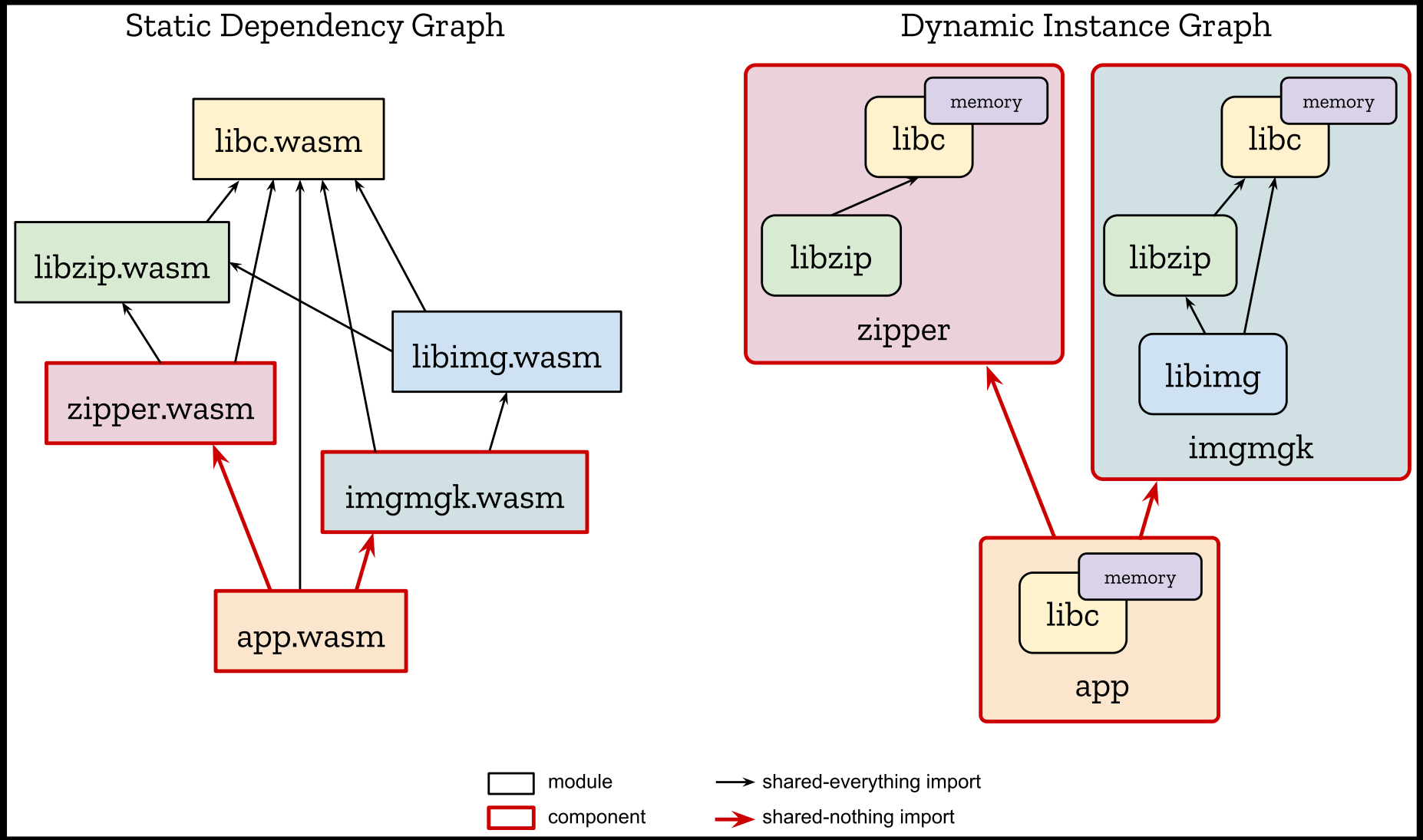

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These boundaries enforce “shared-nothing”

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WCM gives us the ability to stitch isolated units together in a transparent, performant way

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WCM is “modularity without microservices”

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We gain isolation through a simple FFI call

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Carrot: using libraries from other ecosystems via automatic binding generation

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The Wasm CM will be the more productive and safe way to build and assemble software

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The Wasm Component Model offers some of the most powerful security outcomes I've seen

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It gets us closer to nature's nested isolation

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Being able to split components arbitrarily and recursively to an infinite depth is basically:

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CM means Wasm runtimes can implement stronger *temporal* isolation, not just logical

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Create component instances on-demand, destroying them once they complete their task

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This is HUGE in solving “supply chain security”

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Can now isolate failures between dependencies

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Attackers can compromise the dependency's instance state but can't access anything else

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Reduce “attack surface” even more by defining each dependency-as-components capabilities

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These properties benefit resilience to all sorts of failures, not just cyberattacks

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Instead of “turtles all the way down,” with WMC it’s perhaps “isolation all the way down”

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We can densely pack services together — even malicious ones — into a single process, safely

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We could implement the “airlock approach” – yeeting a failing component out the airlock

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Platforms could offer full observability between cross-component messages, too

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Or migrate components around and scale them independently in respond to demand

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All of this gets us closer to the ancient dream of software integrated circuits (SICs)

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The Wasm Component model can revolutionize what resilience means in software

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But to become *the* future of software dev & delivery, devs must actually use it...

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DX is a core problem area Wasm must solve

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Riding off into the sunset

Isolation is the key to modern life, and life itself

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Software is usable because of isolation

The Wasm Component Model is the next upheaval – a software resilience revolution

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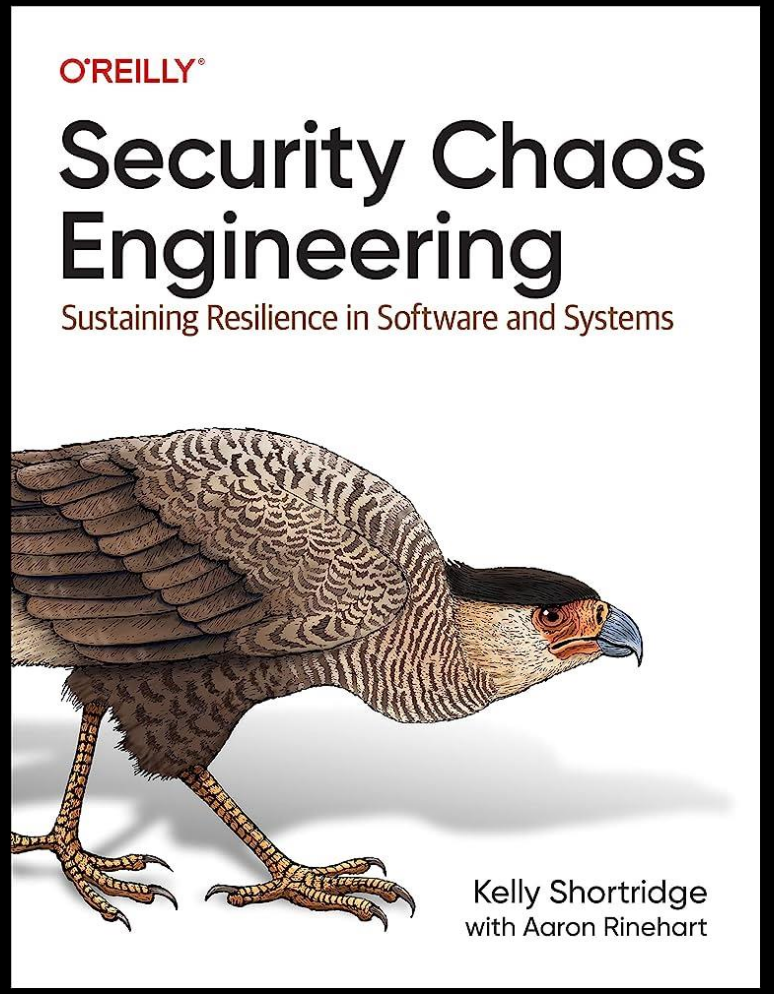

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