Multi-Tier Security in WasmCloud:

From Developer Constraints to Platform Extensibility

Brooks Townsend

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Introduction

- Senior Software Engineer @ Cosmonic
- CNCF wasmCloud maintainer
- Rustacean 🦀
- Demo enthusiast
- Developer Developer Developer

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Agenda

- Open Source Security for Platforms
- wasmCloud Introduction
- Basic Demo
- wasmCloud Multi-tiered Security Platform
- Deep Dive Demo
- wasmCloud Secrets & Extensibility
- Secrets Demo

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“74% of codebases contained high risk open source vulnerabilities.”

2024 "Open Source Security and Risk Analysis" (OSSRA) report
https://investor.synopsys.com/news/news-details/2024/New-Synopsys-Report-Finds-74-of-Codebases-Contained-High-Risk-Open-Source-Vulnerabilities-Surging-54-Since-Last-Year/default.aspx

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Platform Eng. today has a problem

1 **Build**

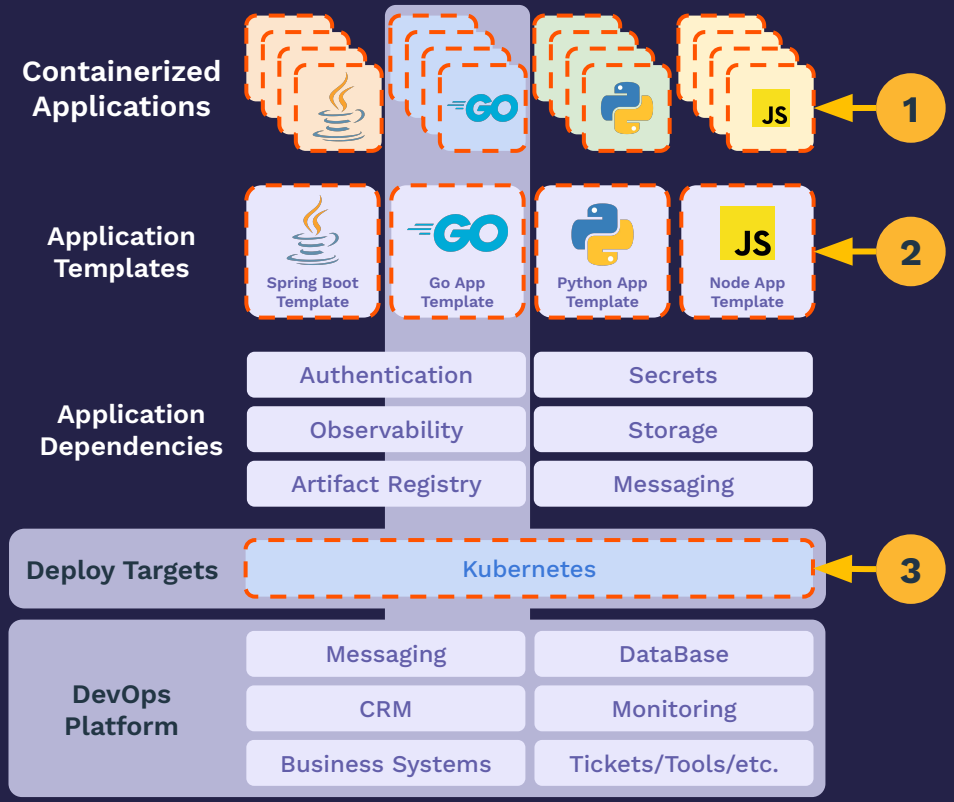
Developers tightly couple application code with OSS libraries, vulnerabilities, & boilerplate.

2 **Compose**

Enterprises integrate apps into ***blessed, required platforms***.

3 **Run**

Platform Engineers operate apps across many unique control planes.



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Strategy: Reduce Per App (team) Responsibilities

Containers

Per Application (x1000)

- App Code
- Maintain Dependencies
- Manage Capabilities
- Run Ops

Developer Experience Gap

Per Platform (x1)

- Compute
- Storage
- Observability
- Networking
- Orchestration
- Secrets

WasmCloud

Per Application (x1000)

- App Code

Per Platform (x1)

- Maintain Dependencies
- Compute
- Storage
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- Manage Capabilities
- Run Ops
- Networking
- Orchestration
- Secrets

Wasm-native Orchestration

Deploy and manage Wasm applications
on any device, server or cloud

even your own!

wasmcloud

Build: Components | Wasm-Native Application Platform

Faster Development Cycles

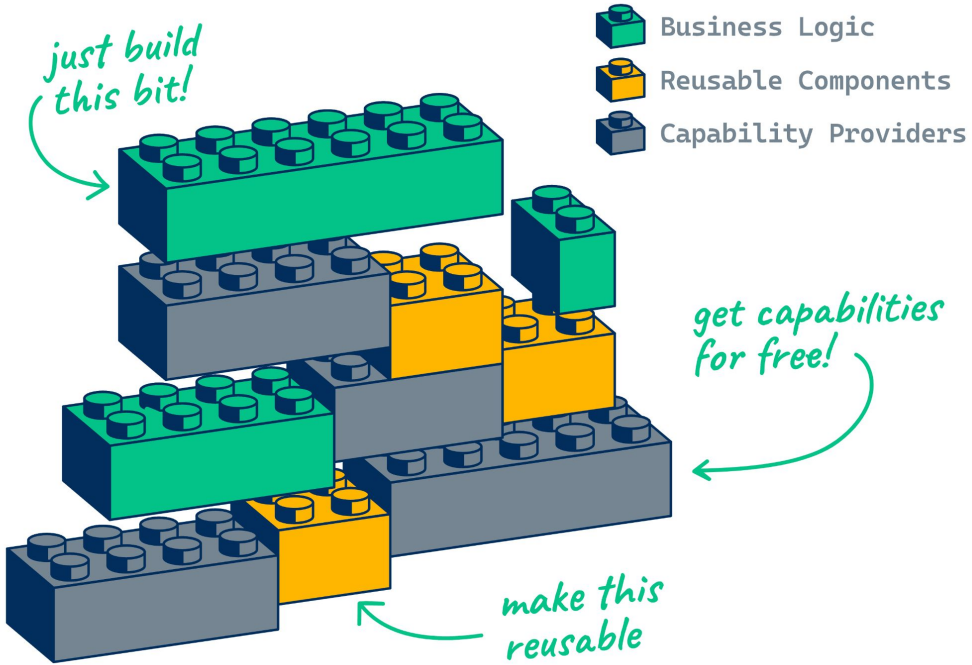
- Make code reuse simple
- Write less boilerplate

Maintainable Apps

- Simple dependency updates

Integrate with Existing Stacks

- Wasm-native works with cloud native



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Compose: Applications with Open Standards

Development Without Lock-In

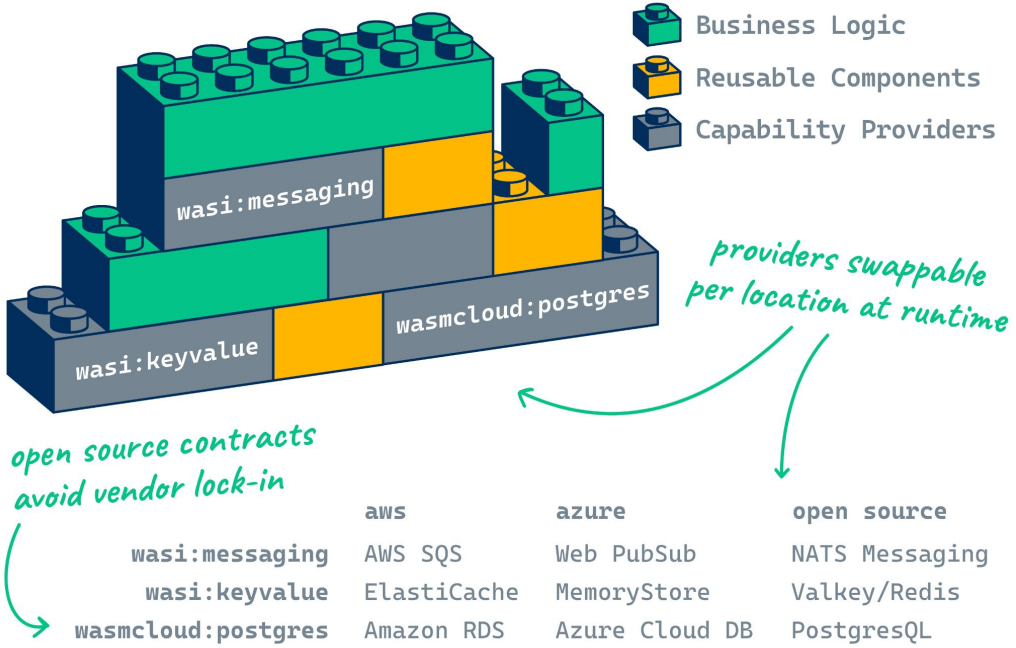
- Interface driven development
- Swap capabilities at runtime

Truly Portable Apps

- Compile once
- Run on any architecture

Custom Capabilities

- Interfaces for native hardware
- Custom-built capabilities



	aws	azure	open source
wasi:messaging	AWS SQS	Web PubSub	NATS Messaging
wasi:keyvalue	ElastiCache	MemoryStore	Valkey/Redis
wasmcloud:postgres	Amazon RDS	Azure Cloud DB	PostgresQL

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Run: Wasm apps on any device, server or cloud

Scale-to-Zero with Zero Cold Starts

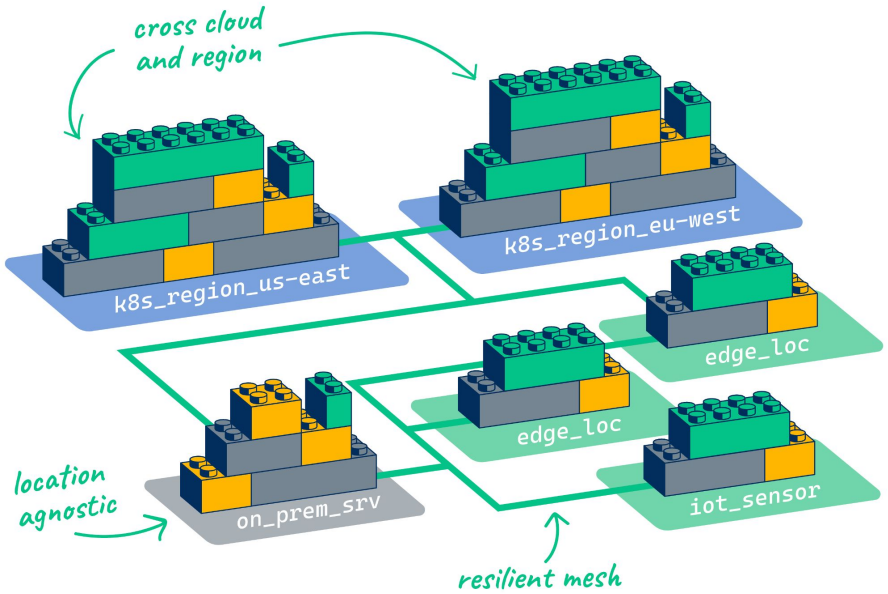
- Sub-millisecond start times
- Vertical auto scaling

Reliable, Fault-Tolerant Apps

- Horizontal scaling with failover
- Capability-level resiliency, reliability, and scalability

Deploy Across Clouds

- Local-first routing
- Cross region, cloud, and edge resiliency



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Demo time

Build and run a Wasm component, introspect for runtime behavior

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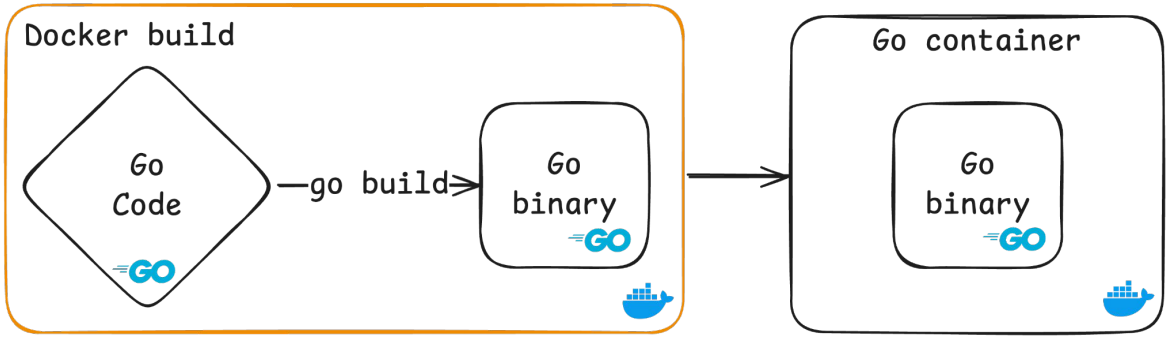
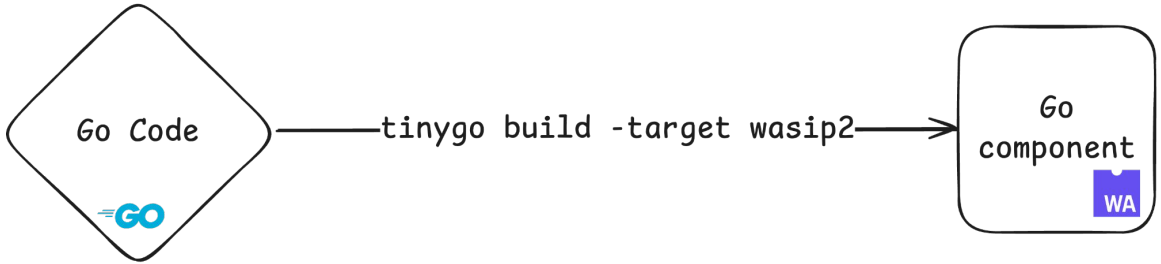
Build

Containerized



Componentized



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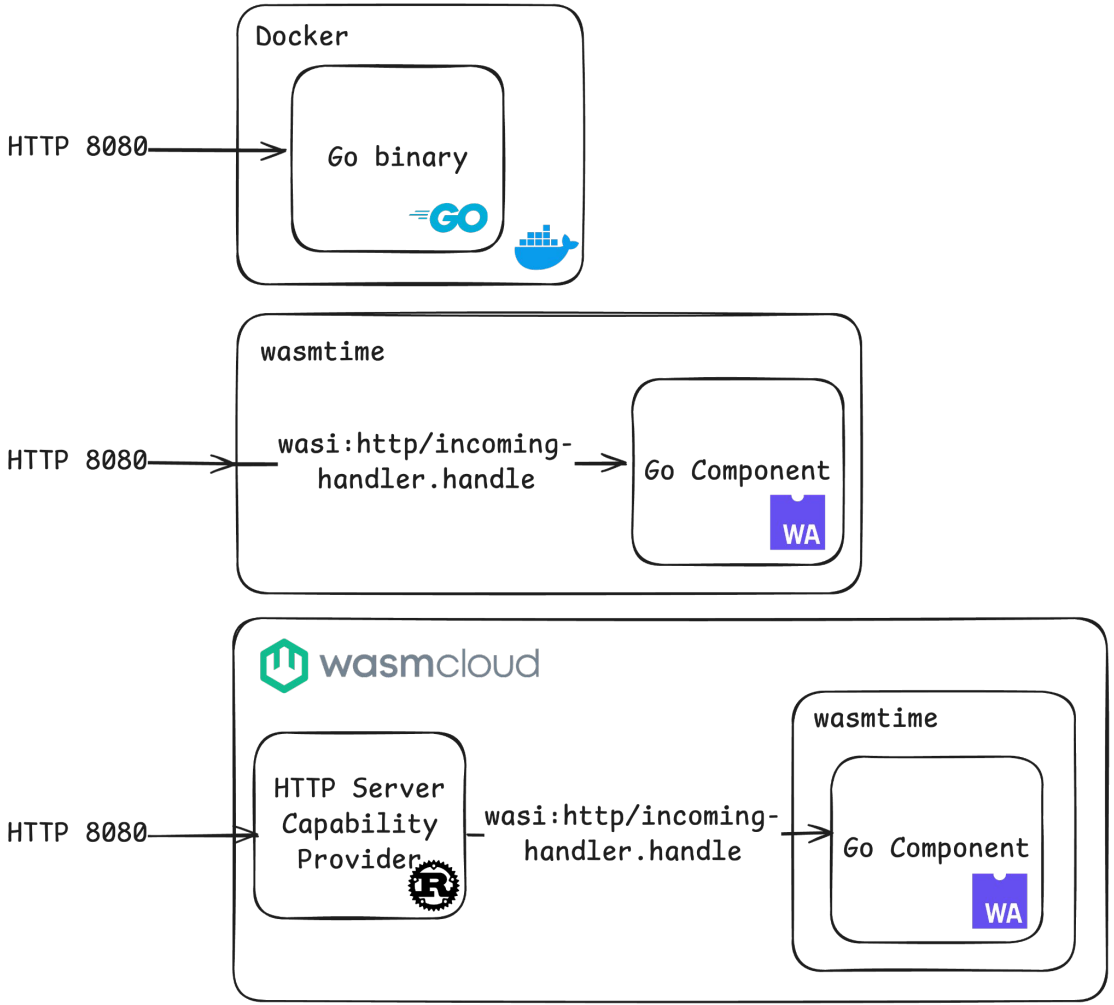
Run



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Demo Takeaways

- Wasm is a compile target
- Wasm can be interpreted for runtime behavior at build time
- Capability driven permissions create a deny-by-default sandbox execution environment

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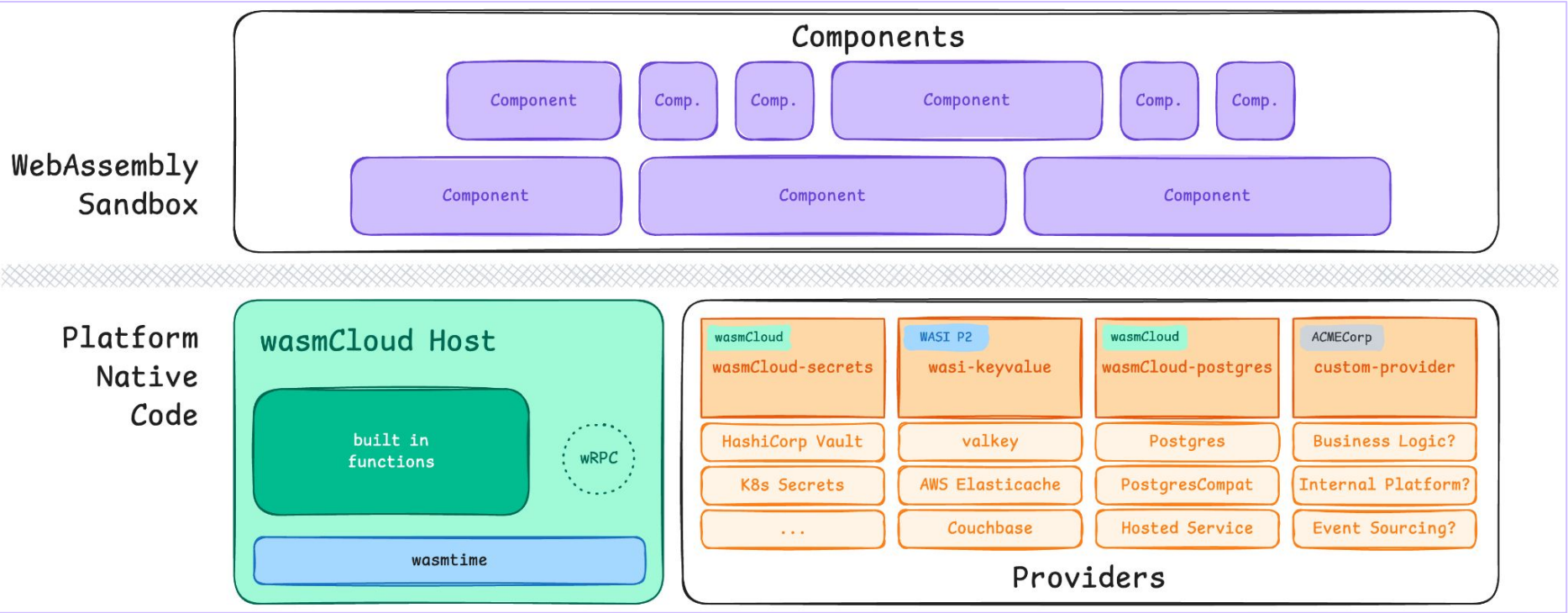
Extensibility of the wasmCloud platform



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Extensibility of the wasmCloud

```
package root:component;

world root {
    import wasi:logging/logging;
    import wasmcloud:postgres/types@0.1.1-draft;
    import wasmcloud:postgres/query@0.1.1-draft;
    import wasmcloud: task-manager/types;
    import wasi:cli/environment@0.2.0;
    import wasi:io/error@0.2.0;
    import wasi:io/streams@0.2.0;
    import wasi:cli/stdin@0.2.0;
    import wasi:cli/stdout@0.2.0;
    import wasi:cli/stderr@0.2.0;
    import wasi:clocks/monotonic-clock@0.2.0;
    import wasi:clocks/wall-clock@0.2.0;
    import wasi:filesystem/types@0.2.0;
    import wasi:filesystem/preopens@0.2.0;

    export wasmcloud:task-manager/tracker;
}
```

WebAssembly Sandbox

Component

Comp.

Comp.

Component

Component

Platform Native Code

wasmCloud Host

built in functions

wRPC

wasmtime

wasmCloud	WASI P2	wasmCloud	ACMECorp
wasmCloud-secrets	wasi-keyvalue	wasmCloud-postgres	custom-provider
HashiCorp Vault	valkey	Postgres	Business Logic?
K8s Secrets	AWS Elasticache	PostgresCompat	Internal Platform?
...	Couchbase	Hosted Service	Event Sourcing?

Providers

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Extensibility of the wasmCloud

```
package root:component;

world root {
    import wasi:logging/logging;
    import wasmcloud:postgres/types@0.1.1-draft;
    import wasmcloud:postgres/query@0.1.1-draft;
    import wasmcloud: task-manager/types;
    import wasi:cli/environment@0.2.0;
    import wasi:io/error@0.2.0;
    import wasi:io/streams@0.2.0;
    import wasi:cli/stdin@0.2.0;
    import wasi:cli/stdout@0.2.0;
    import wasi:cli/stderr@0.2.0;
    import wasi:clocks/monotonic-clock@0.2.0;
    import wasi:clocks/wall-clock@0.2.0;
    import wasi:filesystem/types@0.2.0;
    import wasi:filesystem/preopens@0.2.0;

    export wasmcloud:task-manager/tracker;
}
```

WebAssembly Sandbox

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WRPC

wasmtime

wasmCloud	WASI P2	wasmCloud	ACMECorp
wasmCloud-secrets	wasi-keyvalue	wasmCloud-postgres	custom-provider
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Providers

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Demo time

Platform engineers provide capabilities with wasmCloud host plugins, developers don’t know nor care.

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Demo takeaways

- Capability driven permissions create a deny-by-default sandbox execution environment
- CNCF wasmCloud as a platform lets developers write features, and platform engineers to provide capabilities at runtime.

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Platform Security is like an Onion

Onion

?

Platform Security

?

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Platform Security is like an Onion

Onion

They stink

Platform Security

Makes you want to cry

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Platform Security is like an Onion

Onion

There’s a lot of layers to it

Platform Security

There’s a lot of layers to it

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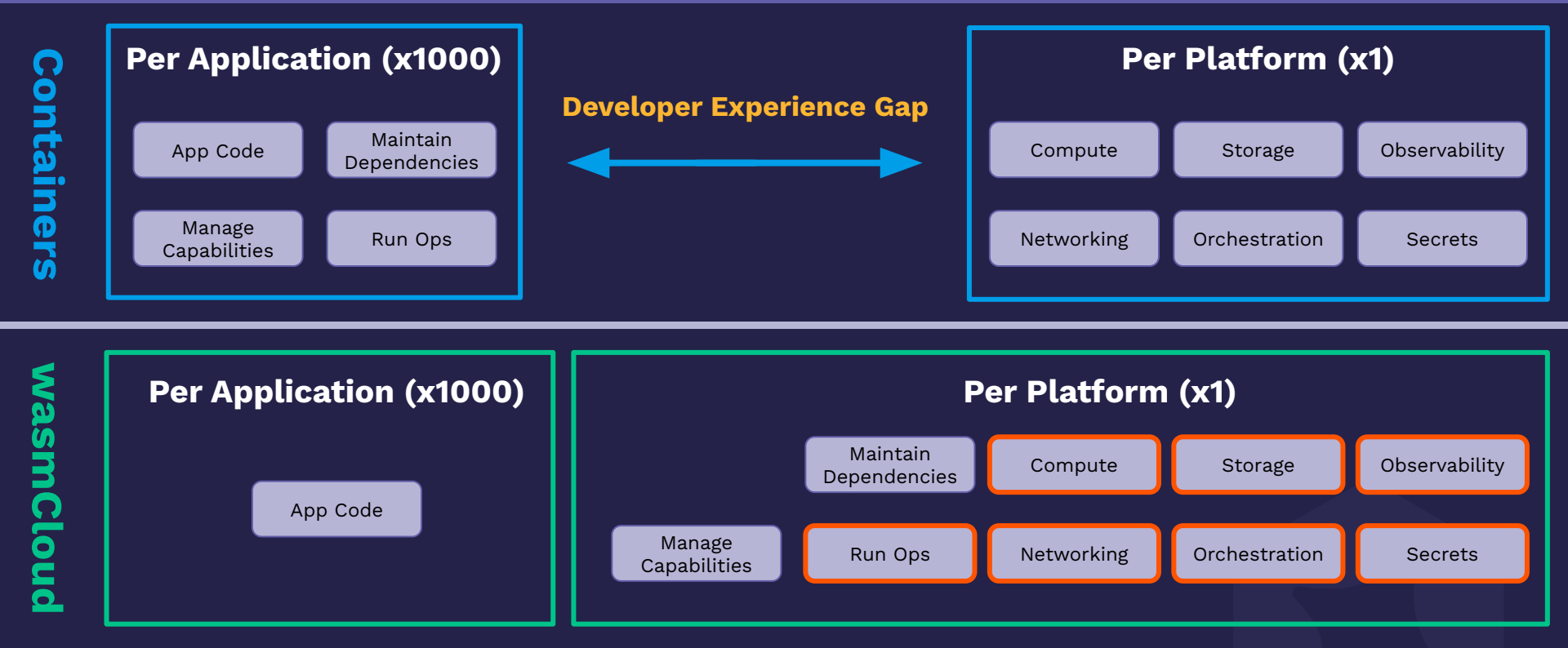
Strategy: Reduce Per App (team) Responsibilities



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wasmCloud Platform Layers

- Sandbox & Runtime: **wasmtime**
- Application artifact: **WebAssembly Component**
- wasmCloud itself distributed using Wolfi base images
- Multi-tier pluggable security
  - Signed components
  - Fine-grained capability providers
  - **Policy service**
  - **Secrets backends**

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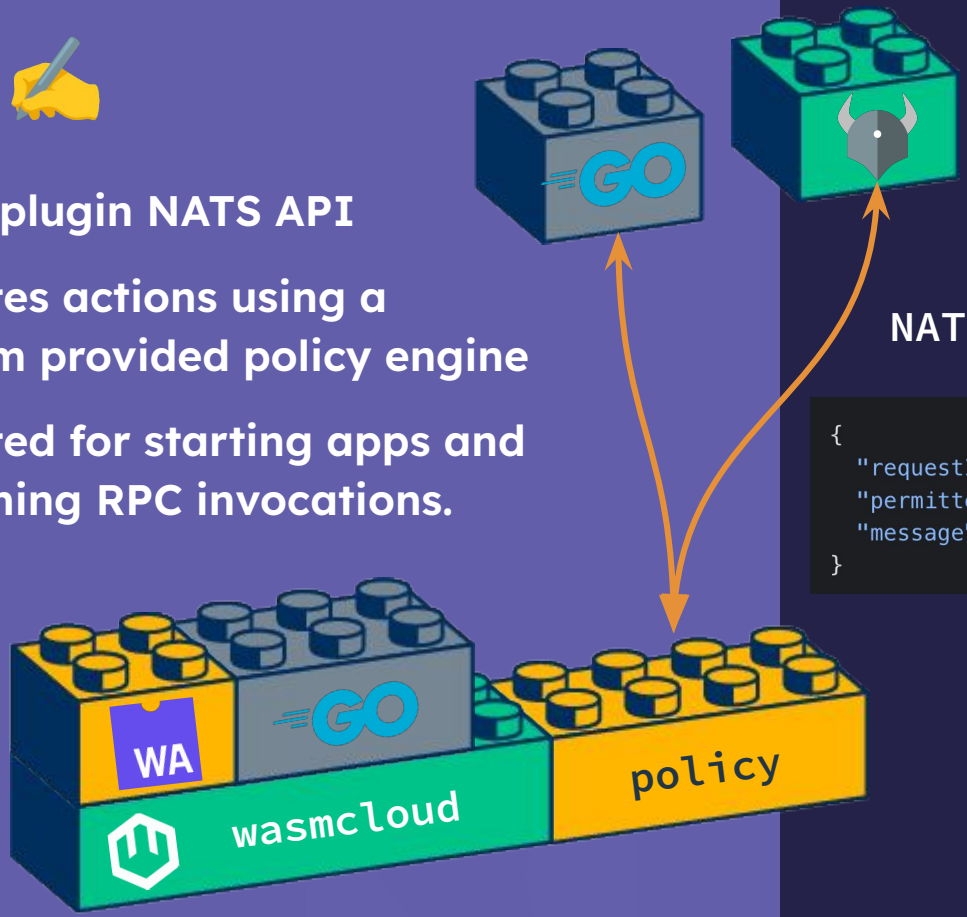
Policy ✍️

- Simple plugin NATS API
- Evaluates actions using a platform provided policy engine
- Evaluated for starting apps and performing RPC invocations.




```
{
  "requestId": "... unique ID used for correlation ...",
  "permitted": true|false,
  "message": "... optional detailed message ..."
}
```

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Secrets 🤫

- Extensible NATS API, can be integrated into any secrets service
- Implementations
  - NATS KV
  - Vault
  - Kubernetes Secrets

```yaml
apiVersion: core.oam.dev/v1beta1
kind: Application
metadata:
  name: http-with-secret
  annotations:
    version: v0.0.1
    description: Application with component secret
spec:
  policies:
    - name: vault-policy
      type: policy.secret.wasmcloud.dev/v1alpha1
      properties:
        backend: vault
  components:
    - name: http-component
      type: component
      properties:
        image: ghcr.io/wasmcloud/component-http-hello-world:0.1.0
        secrets:
          - name: api_key
            properties:
              policy: vault-policy
              key: component_api_key
              field: key
              version: v1
```

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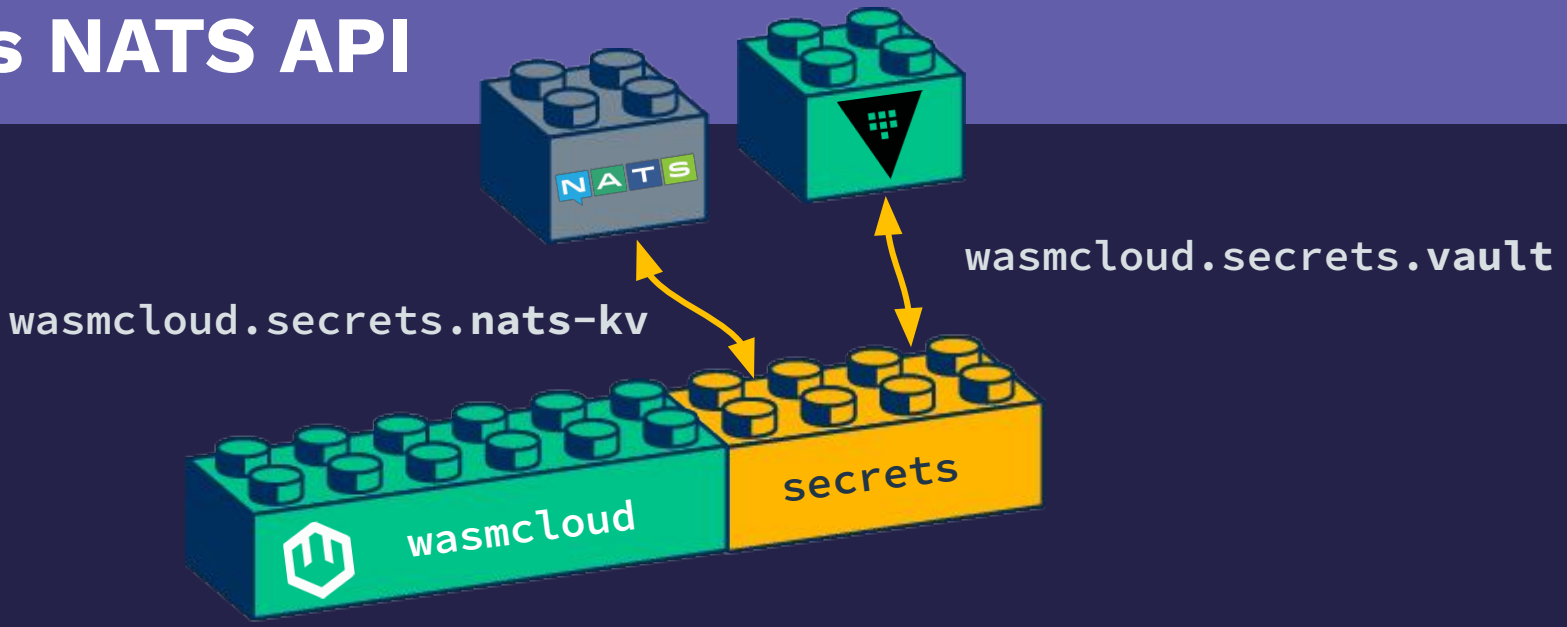
Secrets NATS API



Name	Subject	Return Payload
get	wasmcloud.secrets.nats-kv.v1alpha1.get	Encrypted SecretResponse
server_xkey	wasmcloud.secrets.vault.v1alpha1.server_xkey	Unencrypted String

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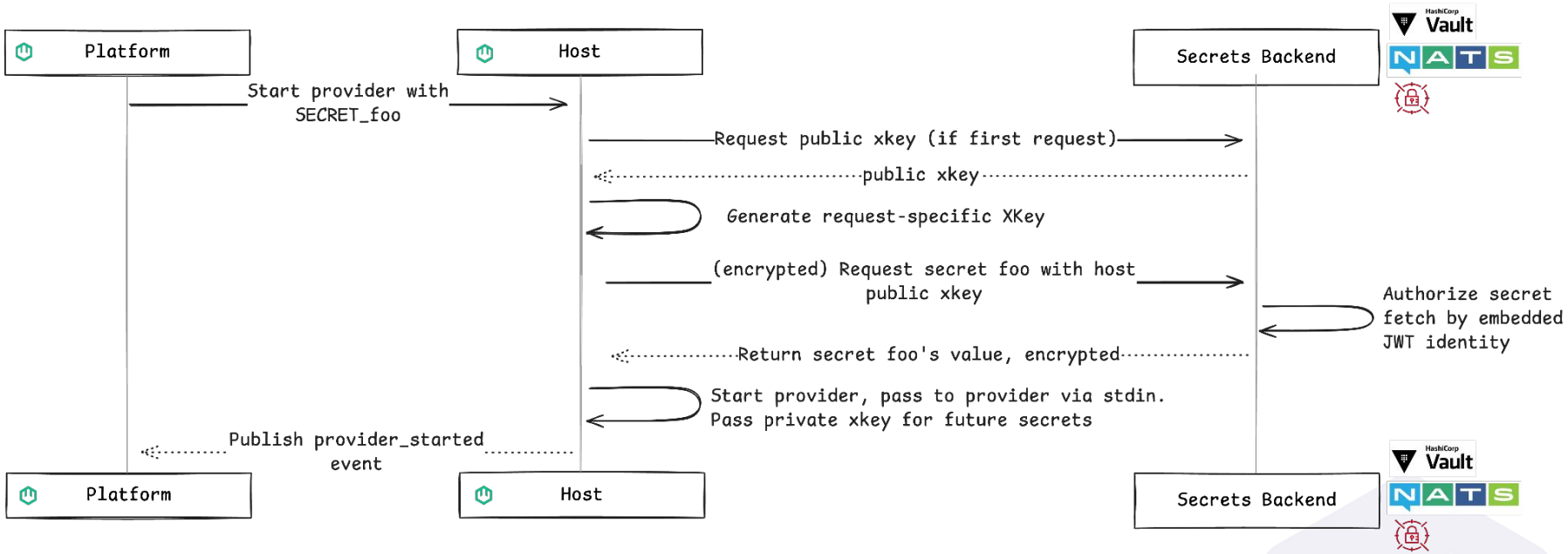
Requesting secrets secretly



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Demo time

Secrets locked away,

“Don’t hardcode,” they always say,

sandbox saves the day.

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Demo takeaways

- CNCF wasmCloud has a multi-tiered security model
- Pluggable security is a fantastic way to extend the security of a platform

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Looking Forward

- Signing is done with NATS ed25519 NKeys, would be great to implement workload identity by conforming to SPIFFE
- Out-of-the-box net/http support in TinyGo enables direct compilation to Wasm
- Golang wasip2 target support enables direct Go toolchain compilation to Wasm
- Pluggable policy as WebAssembly components would be much more powerful than our existing plugin model (NATS API)

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Get Involved!

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wasmcloud.com

Star us on GitHub

github.com/wasmcloud

Join us on Slack

slack.wasmcloud.com