Taking Ops & Infrastructure From Iterative To Functional

(Just Like Dev)

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Sr. Director of Technology
Pivotal

Me?

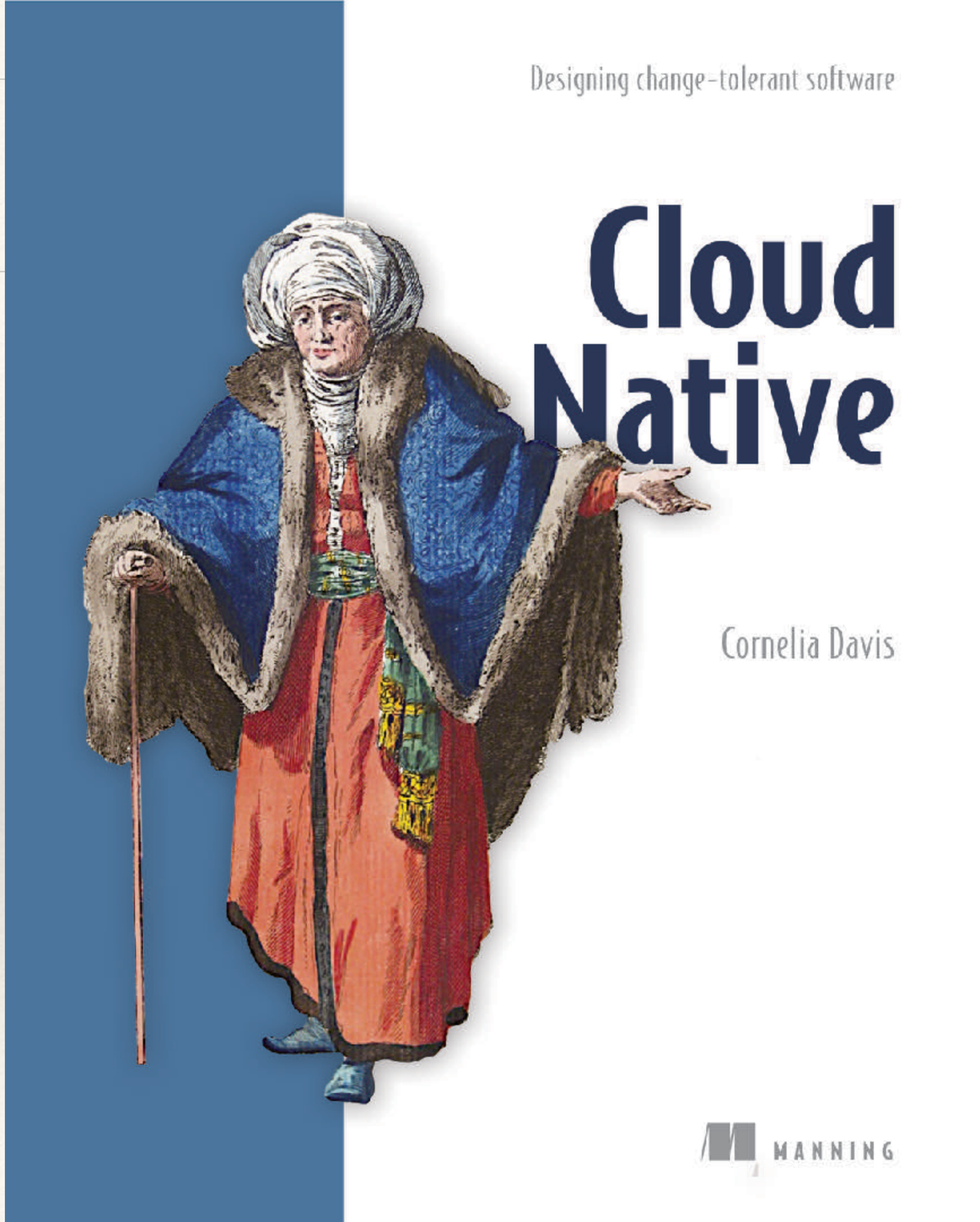
- Cal State Northridge: Computer Science
- Indiana University: Computer Science (ABD)
- Pivotal: Product Strategy (PCF, PCC, PKS)

Ops
as much as
Dev
now

- And …

Discount code 40% off!: 40cloudnat

https://www.manning.com/books/cloud-native



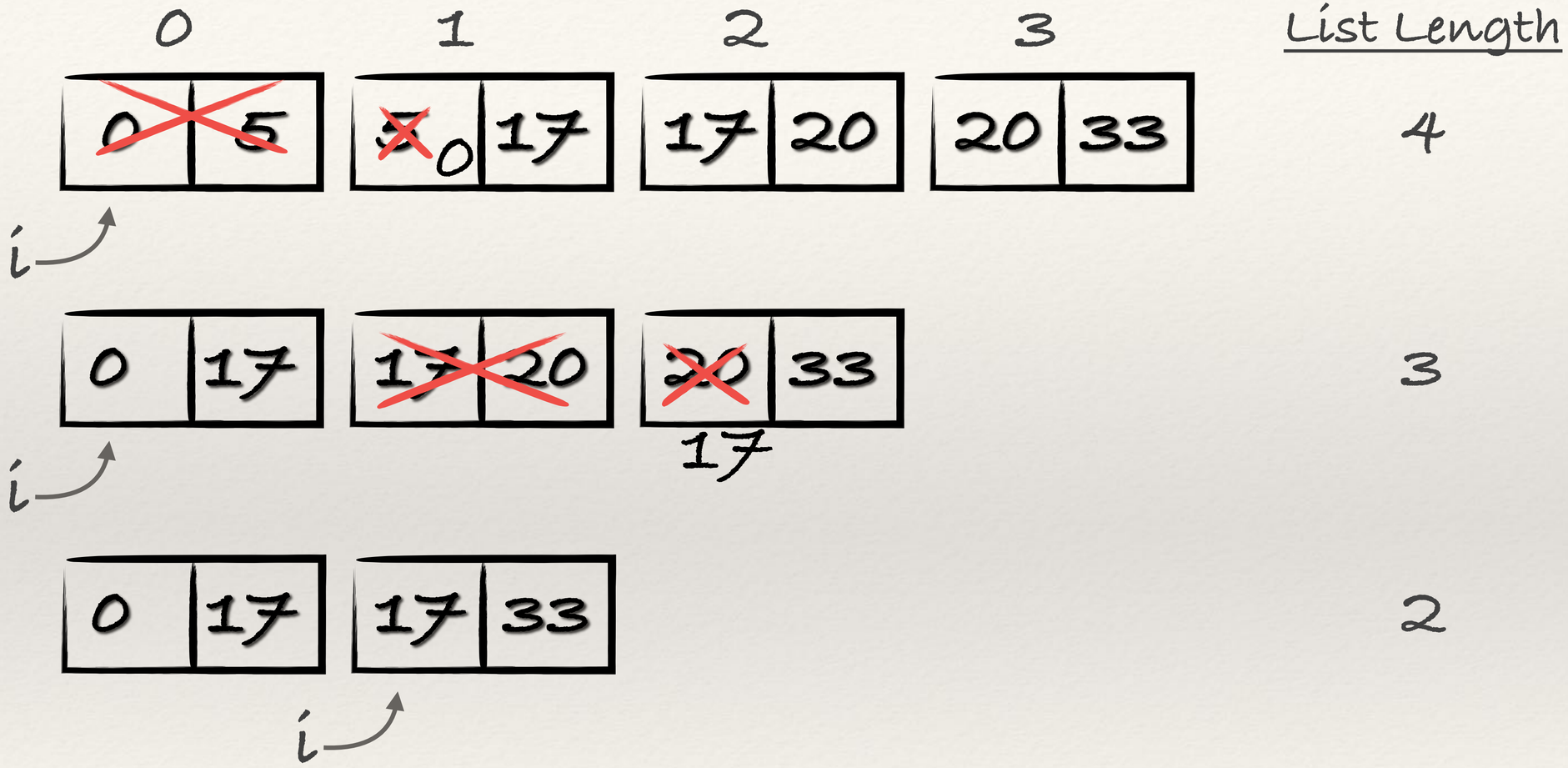
Let's cut some code…

```
[(0, 5), (5, 17), (17, 20), (20, 33)]
```

Merge short Segments together

```
[(0, 17), (17, 33)]
```

```
def mergeSegments(s_list, threshold):
  list_len = len(s_list)
  i = 0
  while i < list_len:
    seg_length = s_list[i][1]-s_list[i][0]
    if seg_length < threshold:
      s_list[i+1] =
            (s_list[i][0], s_list[i+1][1])
      del s_list[i]
      list_len -= 1
    else:
      i += 1
```

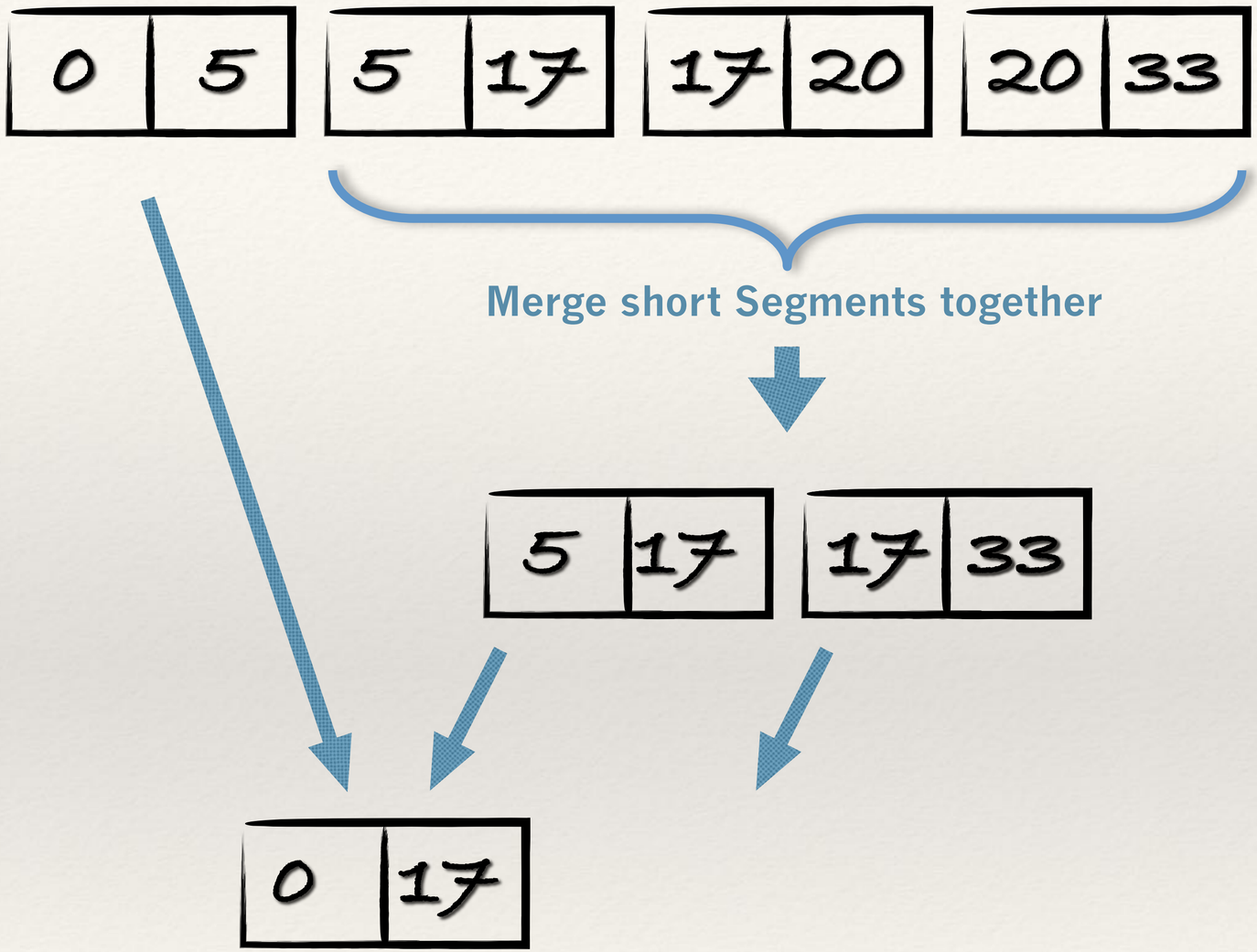

0
1
2
3
List Length
0 5
5 0 17
17 20
20 33
4
i
0 17
17 20
20 33
17
3
i
0 17
17 33
2
i

Hallmarks of Iterative Programs

- Sequential - we control every step in the process.
- Variables … with side effects

- Difficult to parallelize
- Hairy edge cases

```
(define (mergeSegments segs threshold)
  (if
    (or (null? segs) (null? (cdr segs)))
    segs
    (let
      ((rest (mergeSegments (cdr segs) threshold)))
      (if
        (< (currSegLen segs) threshold)
        (cons (cons (start segs) (end rest))
              (cdr rest))
        (cons (car segs) rest)))))
```


0
5
5
17
17
20
20
33
Merge short Segments together
5
17
17
33
0
17

Hallmarks of Functional Programs

- Declarative
- NO side effects
- Tail recursion (continuations!!!)

- Easier to program in a way that allows for parallelization
- Far fewer edge cases
- Provably correct

3000 Lines of Objective C

To

1500 Lines of Typescript & React

To

500 Lines of Clojure

“One of the hardest things I’ve ever learned, but one of the most rewarding. It’s the first time I’ve been able to write **code that doesn’t collapse on itself**.

It makes programming fun again!”

Gene Kim

The

Programming Primitives

have a

Marked impact

on the

Maintainability and Stability

of the

Application

Platform The

~~Programming~~ Primitives

have a

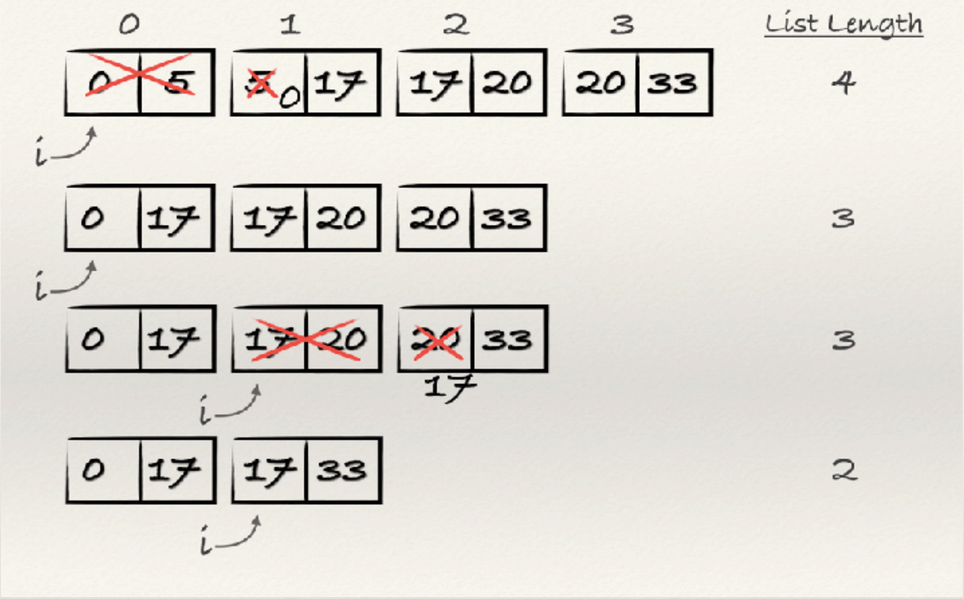
Marked impact

on the

Maintainability and Stability

of the

Application



What is our

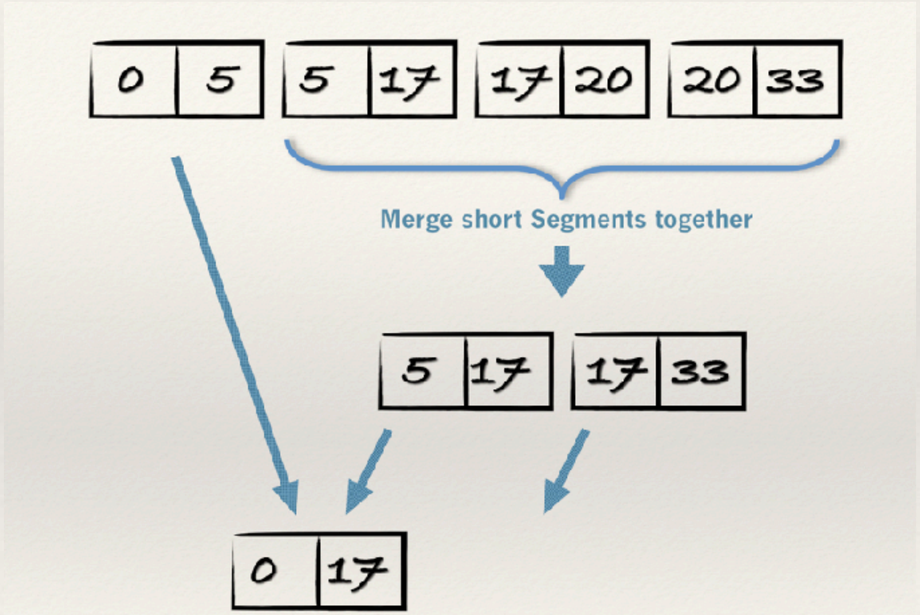
Iterative

For

Ops?

What could be our

Functional?



Iterative

```
function SumToN(n : INTEGER): INTEGER;
var
  i : INTEGER;
  s : INTEGER;
begin
  i := 0;
  s := 0;
  while (i <= n) do
    begin
      s := s + i;
      i := i + 1;
    end;
  SumToN := s;
end;
```

Functional

```
(define sumToN
  (lambda (n)
    (if (= n 1)
        1
        (+ n (sumToN (- n 1))))))
```

Base Case

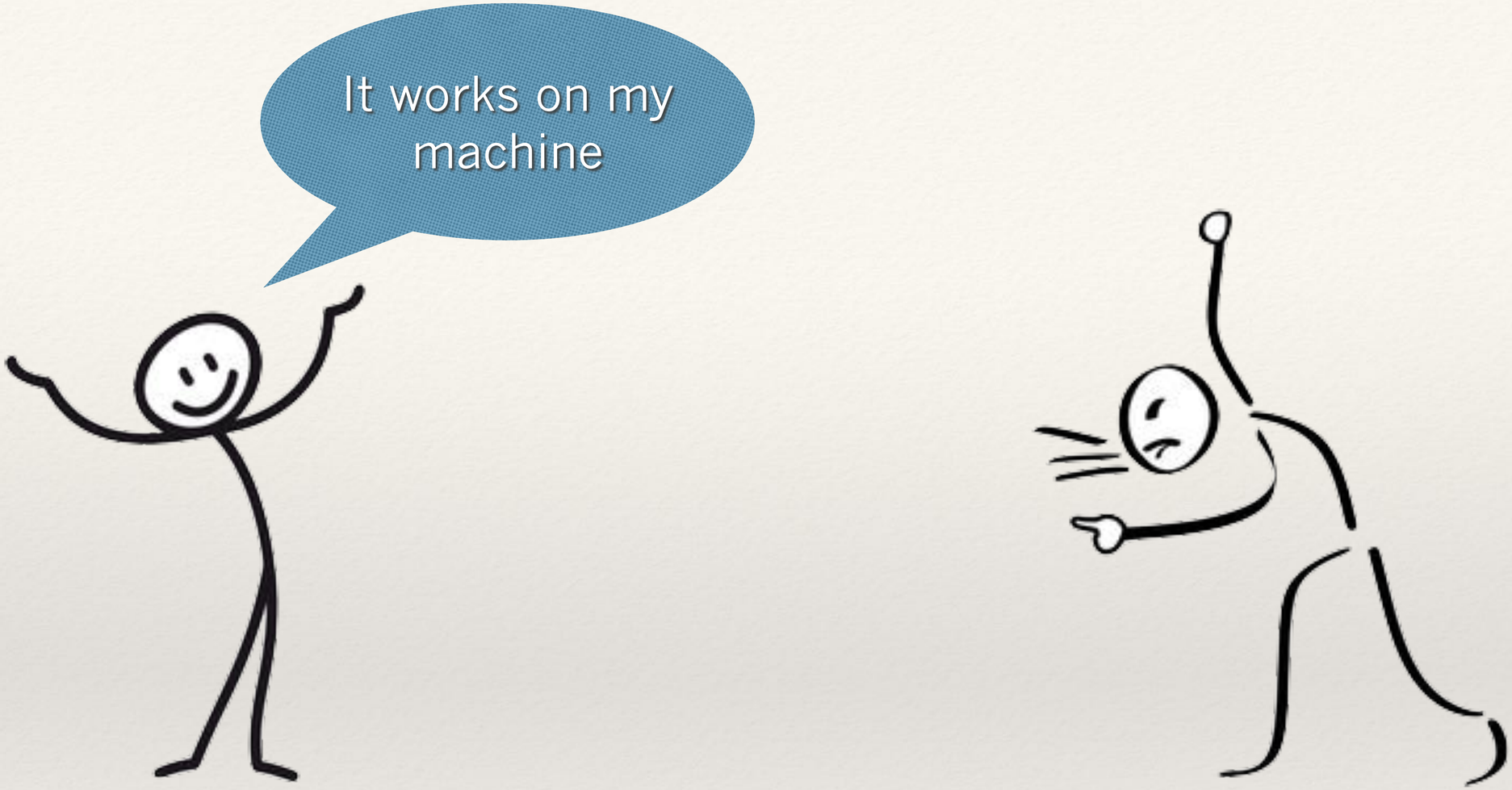
General Case
(Bit of a leap of faith)

Let something else do some of the work!

Ongoing Ops Challenges

- Snowflakes!!
- Security …
- … and Compliance
- Resilience

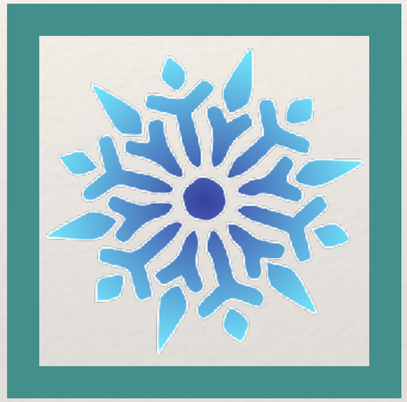
Snowflakes


It works on my machine

Dev

Test

UAT

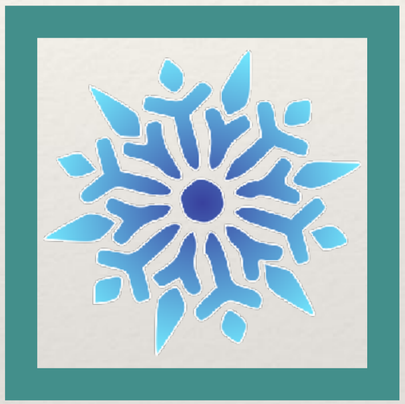


Prod

Dev

Test

UAT

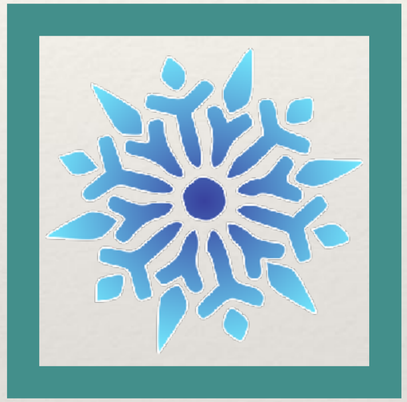


Prod

Dev

Test

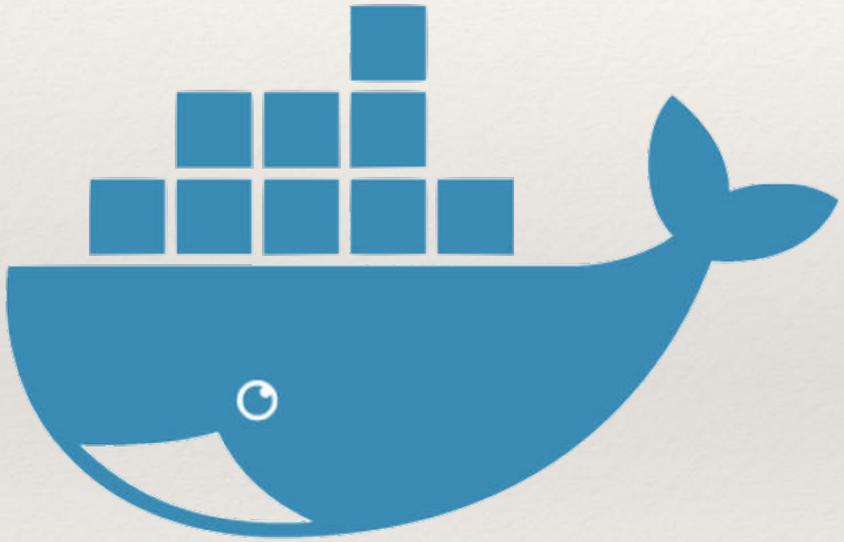
UAT



Prod

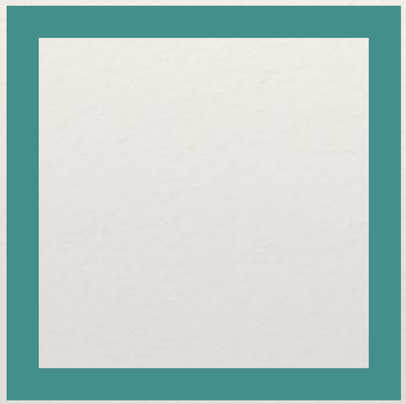
Single Deployable Artifact

Common theme: Immutability

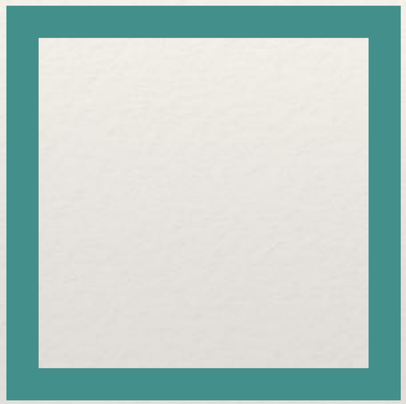


- Bundles all dependencies
- Properly parameterized

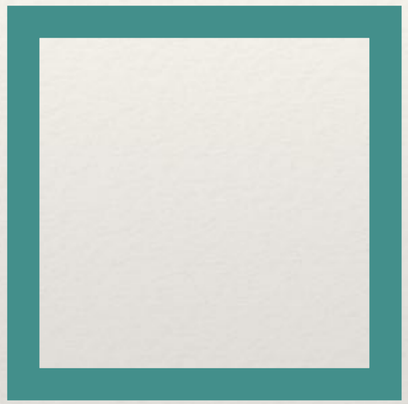
Security …



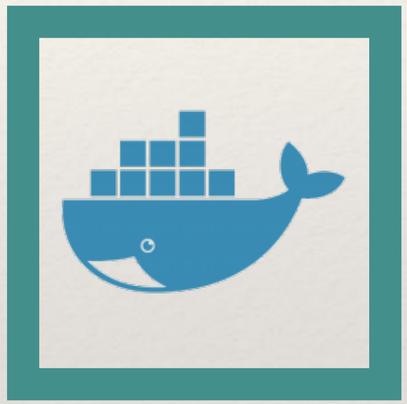
Dev



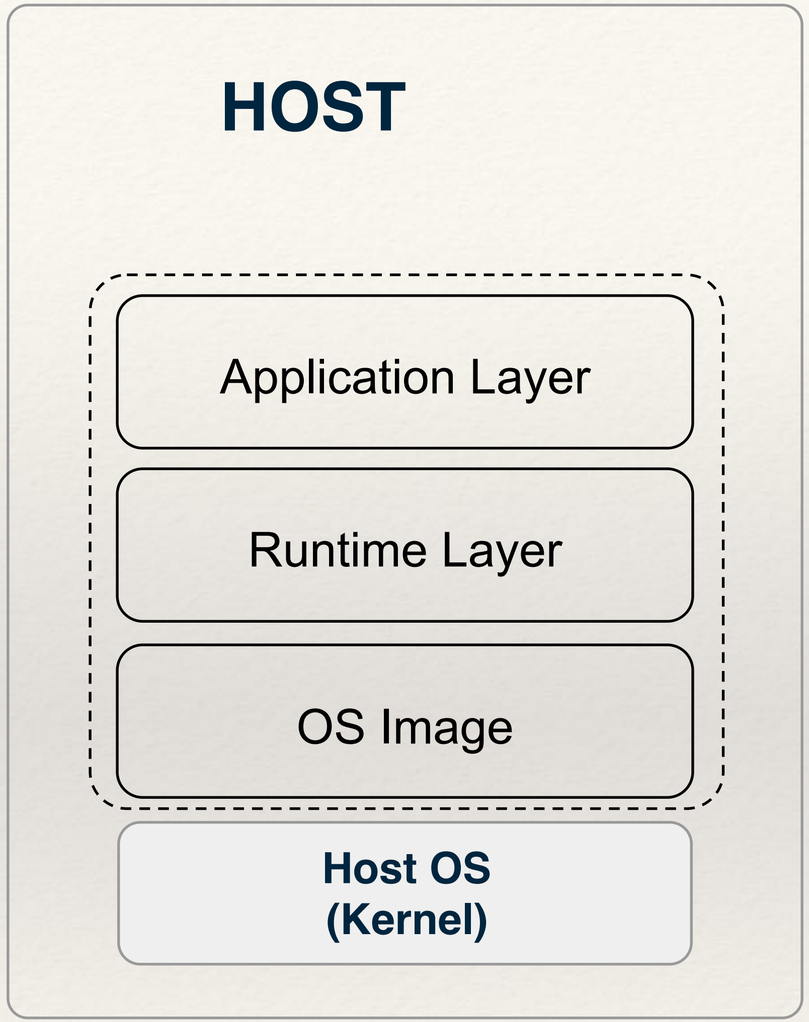
Test



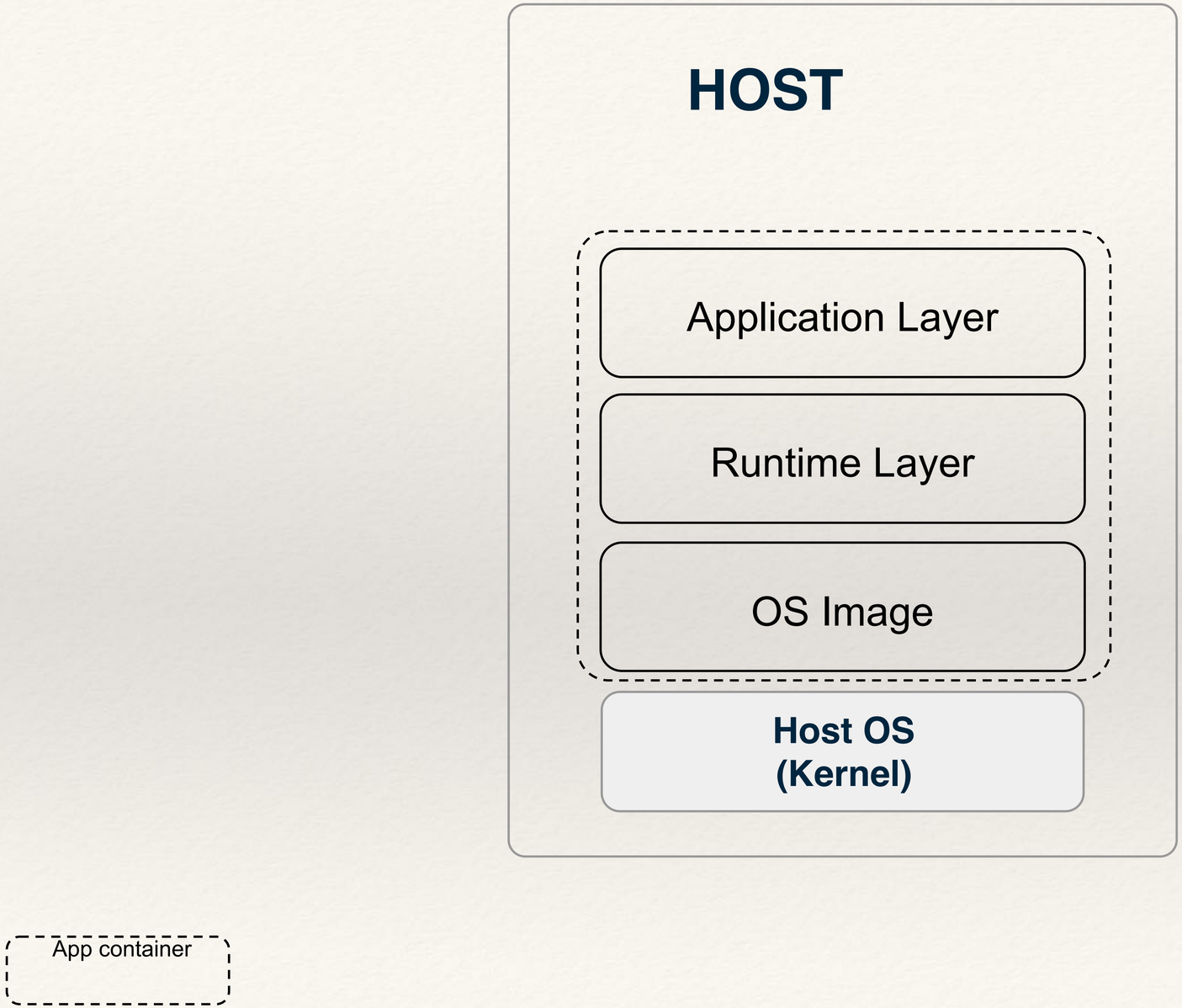
UAT

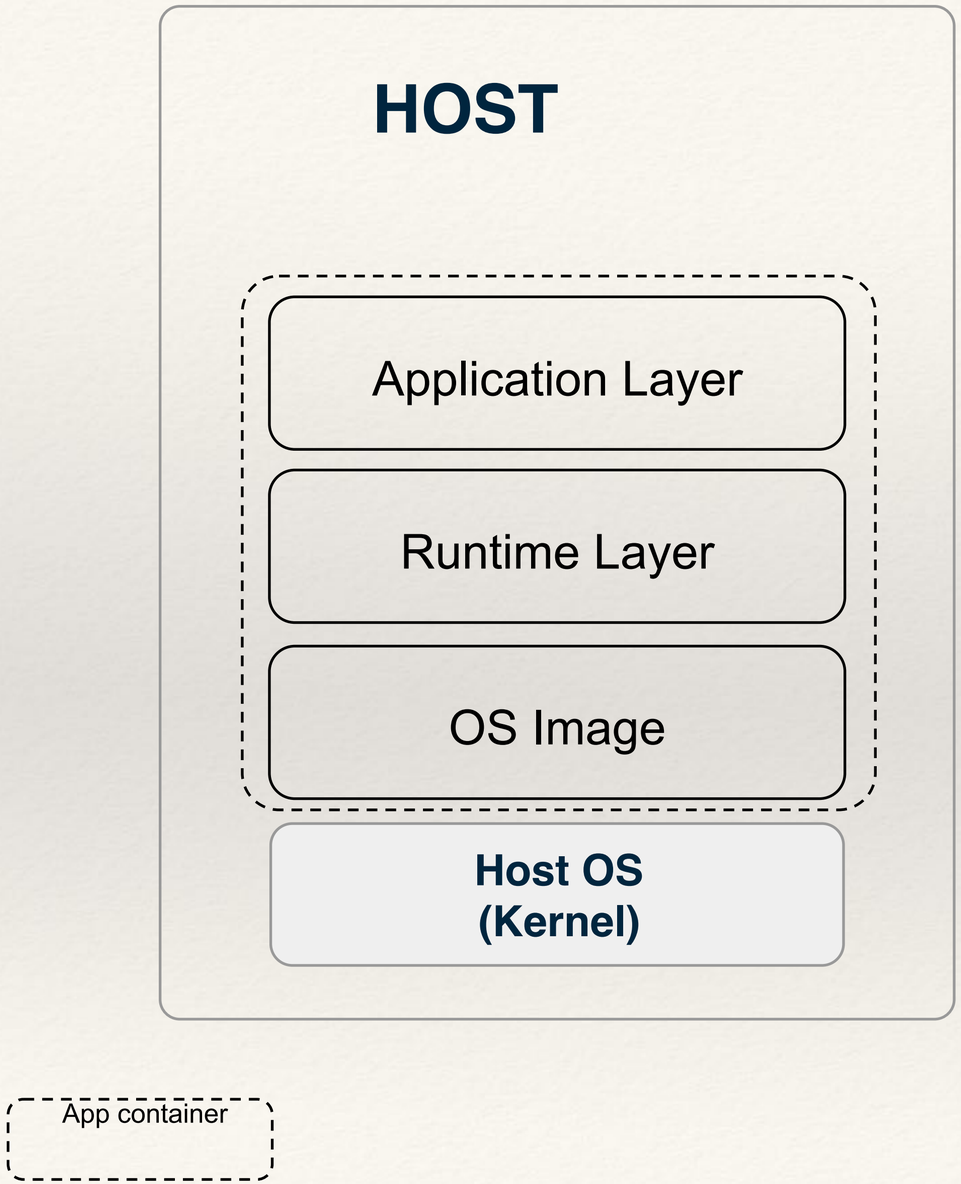


Prod



App container


HOST
Application Layer
Runtime Layer
OS Image
Host OS
(Kernel)
App container


HOST
Application Layer
Runtime Layer
OS Image
Host OS
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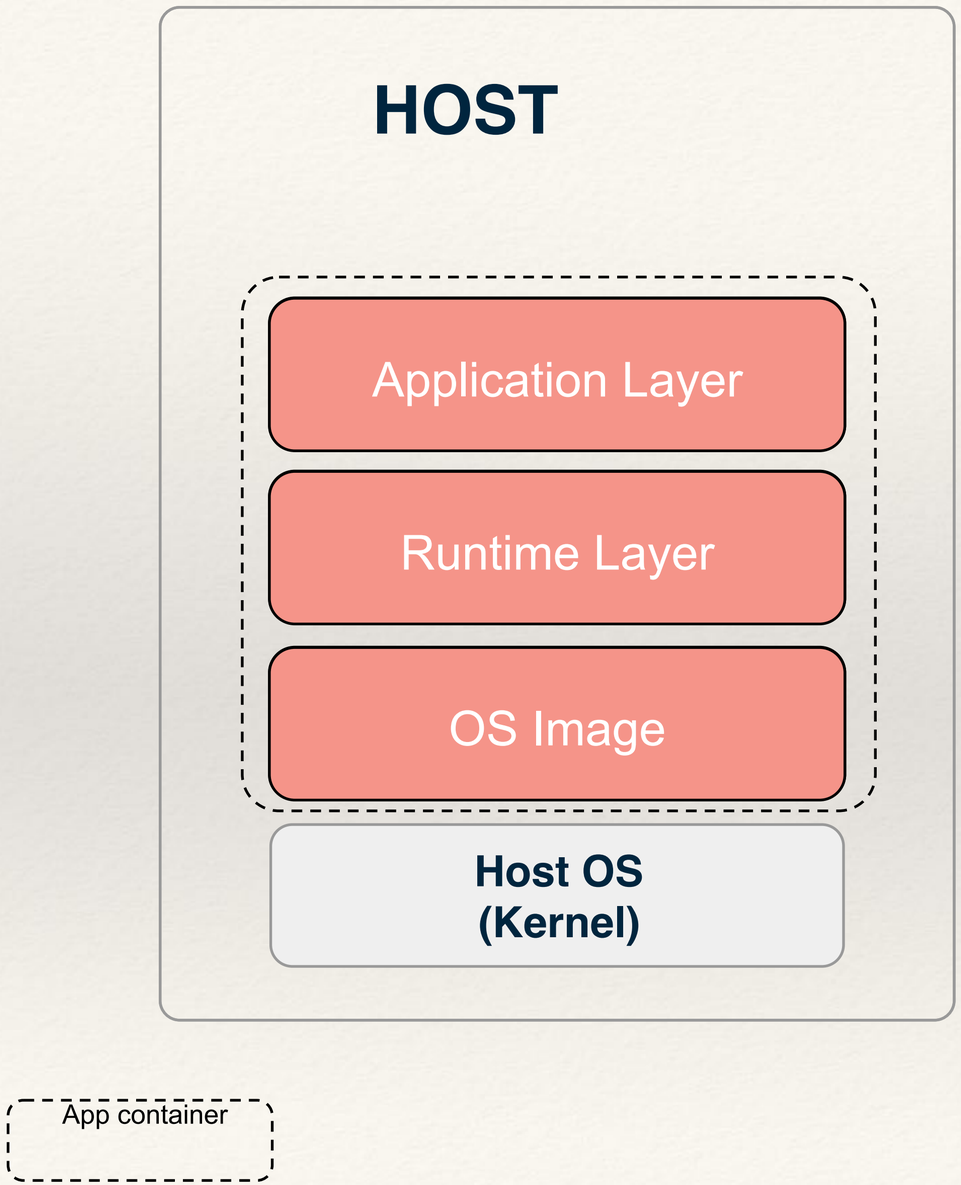
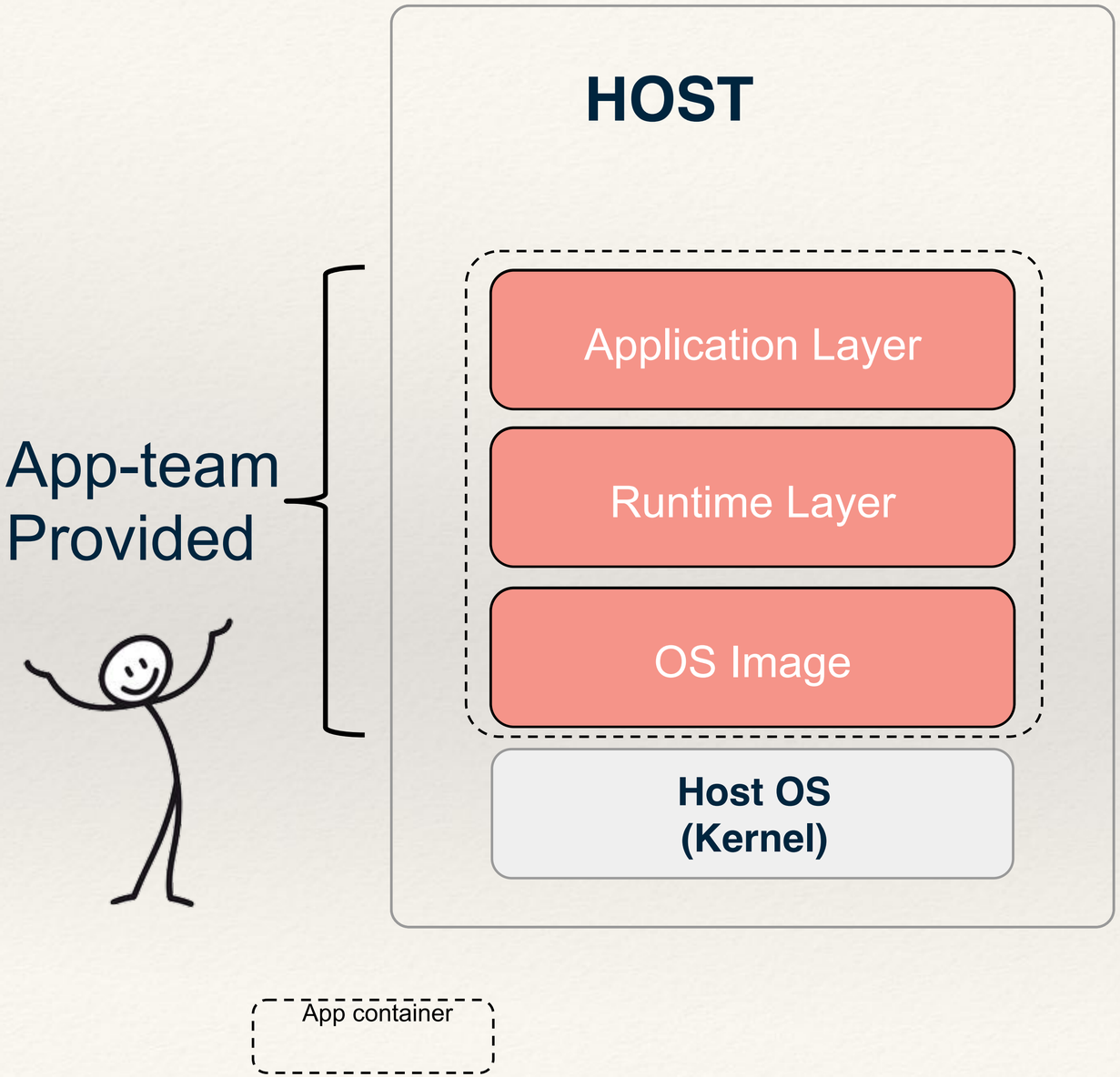
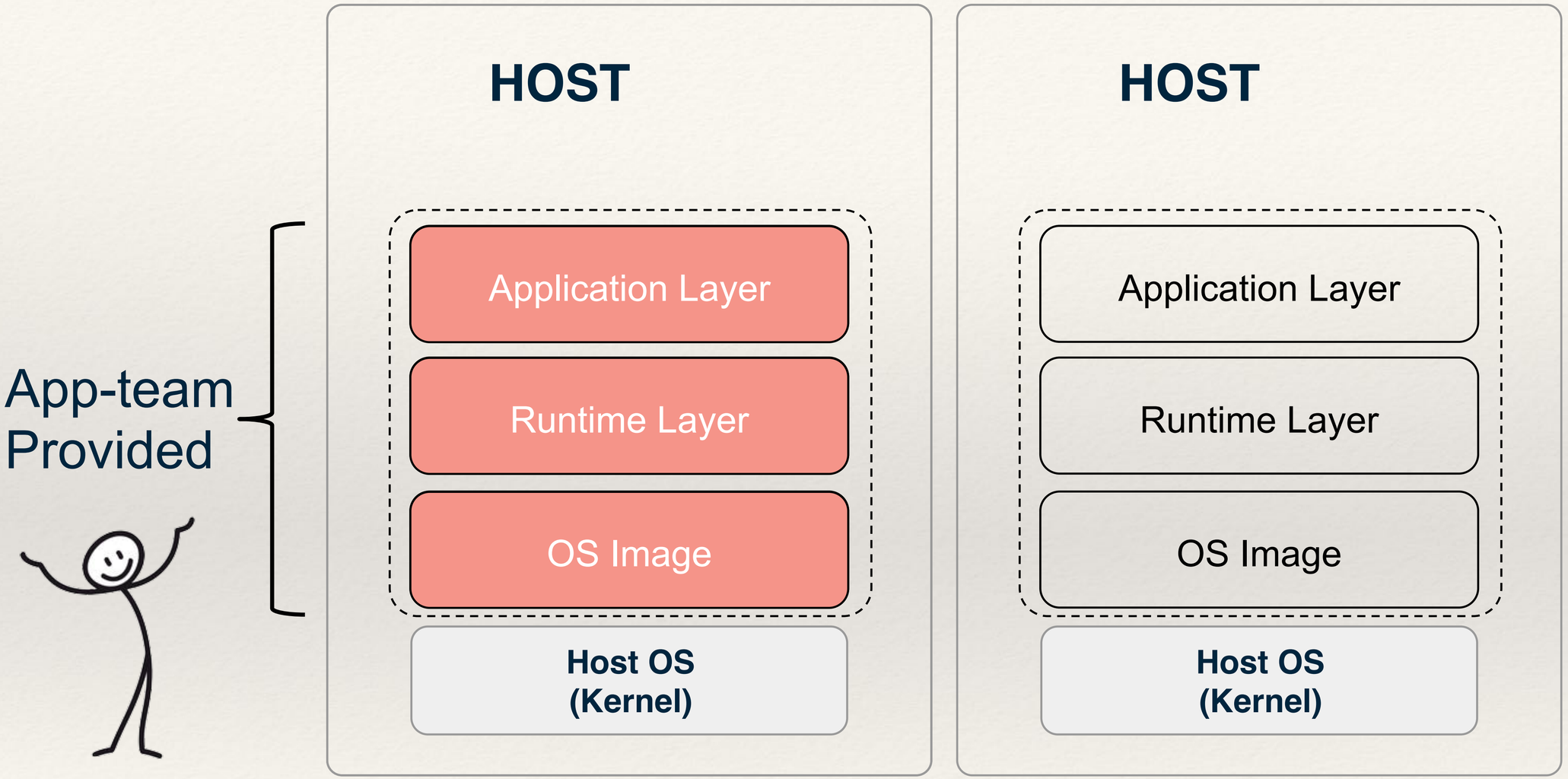
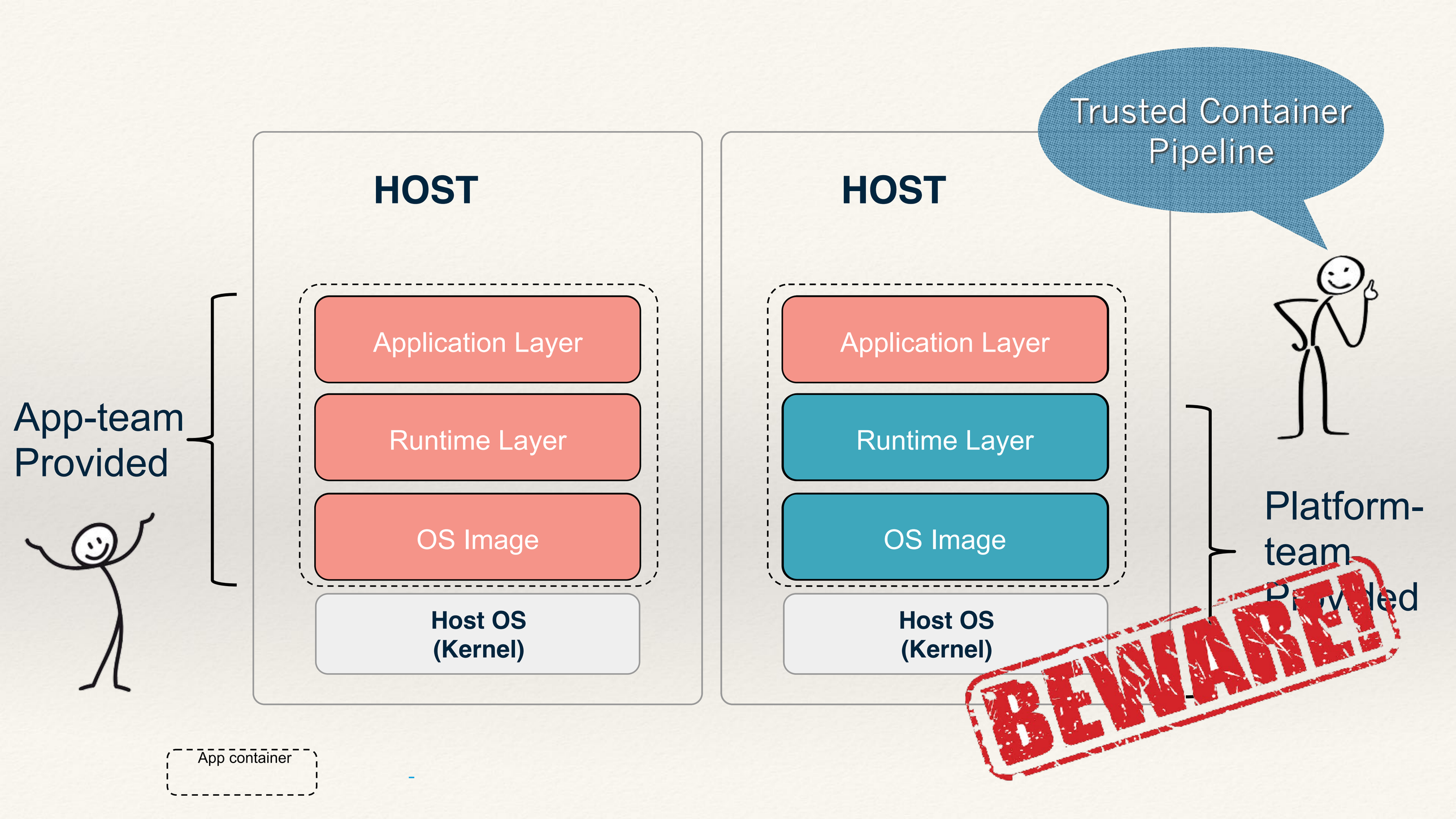
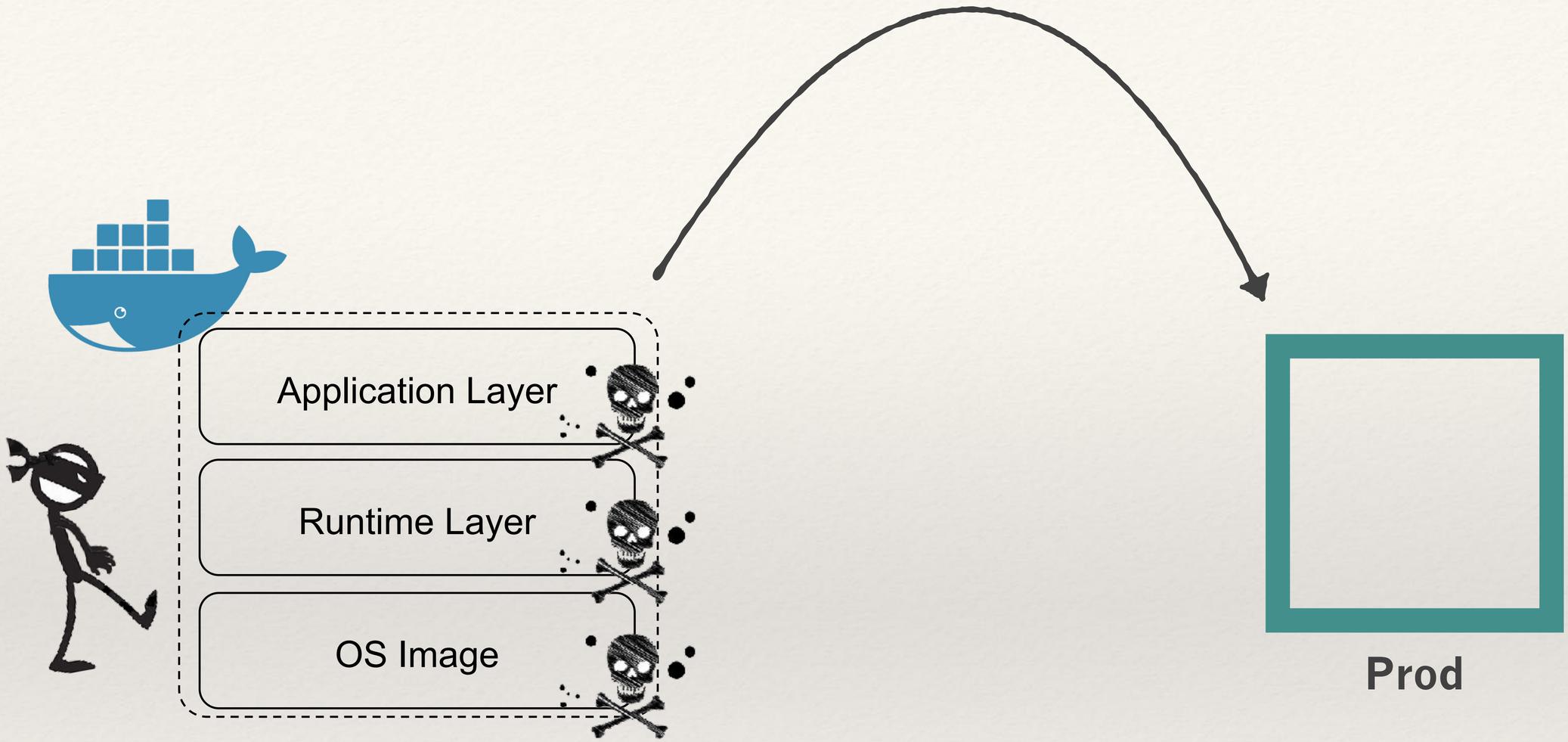
App container

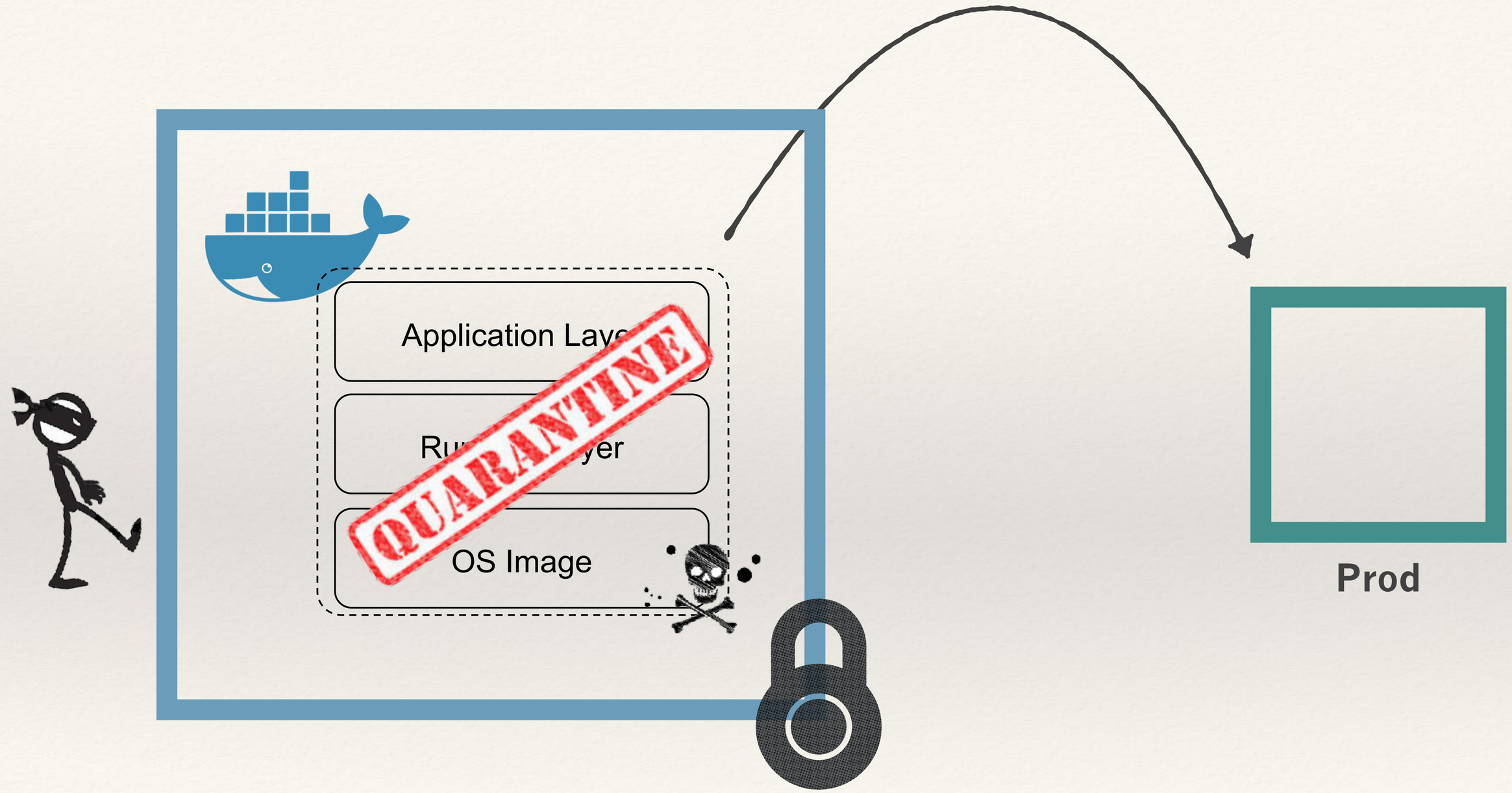

HOST
Application Layer
Runtime Layer
OS Image
Host OS
(Kernel)
App container


HOST
Application Layer
Runtime Layer
OS Image
Host OS
(Kernel)
App-team
Provided
App container

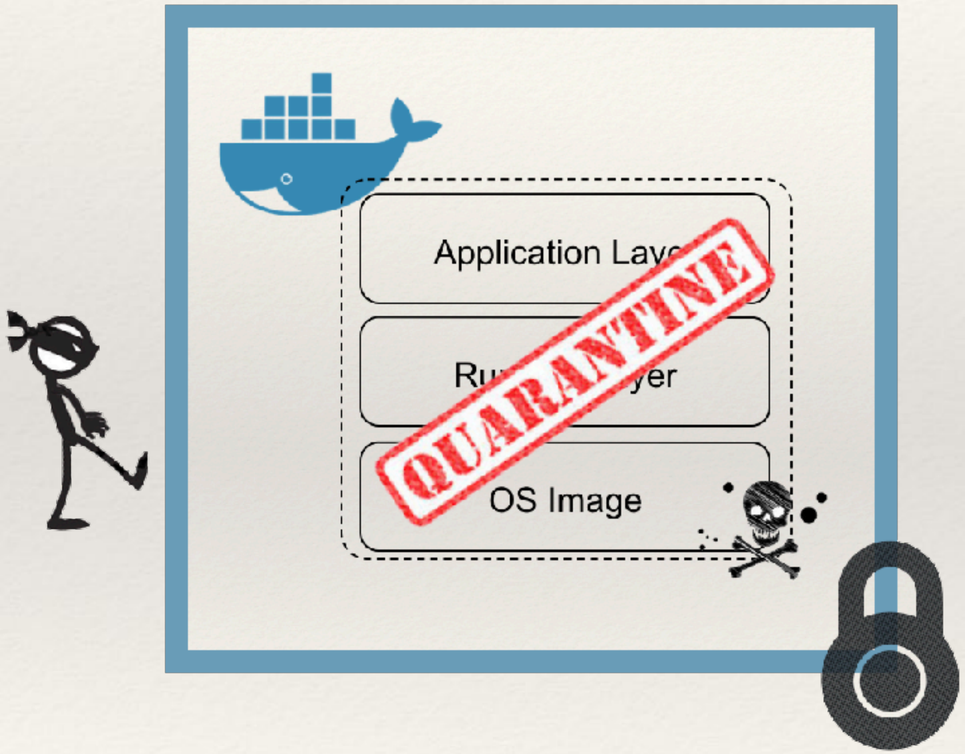

HOST
HOST
Application Layer
Runtime Layer
OS Image
Application Layer
Runtime Layer
OS Image
Host OS
(Kernel)
Host OS
(Kernel)
App-team
Provided
App container


Trusted Container Pipeline
HOST
HOST
Application Layer
Runtime Layer
OS Image
Application Layer
Runtime Layer
OS Image
Host OS (Kernel)
Host OS (Kernel)
App-team Provided
Platform-team Provided
BEWARE!
App container


Application Layer
Runtime Layer
OS Image
Prod


Application Lay
yer
QUARANTINE
OS Image
Prod

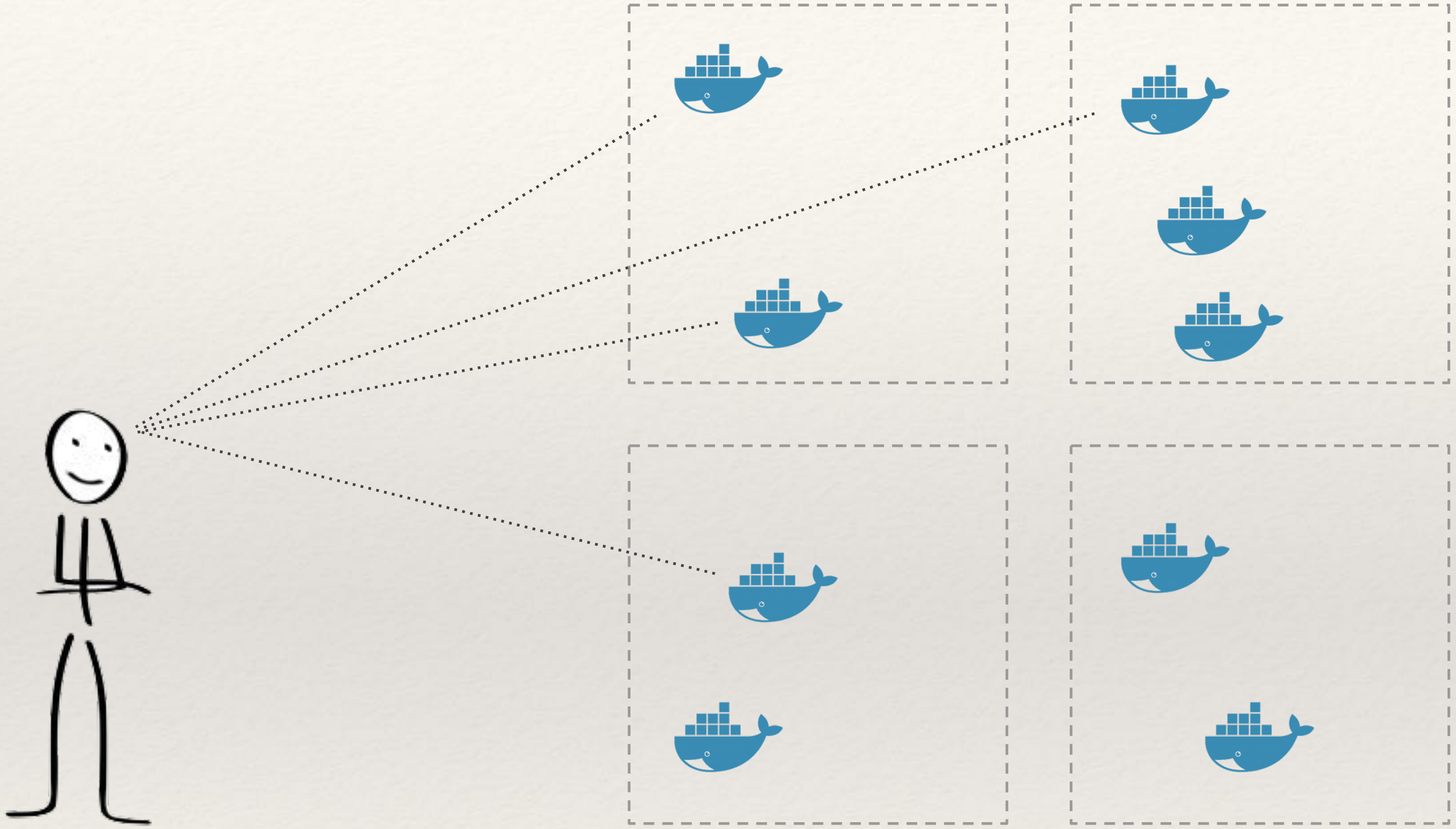
Artifact Management

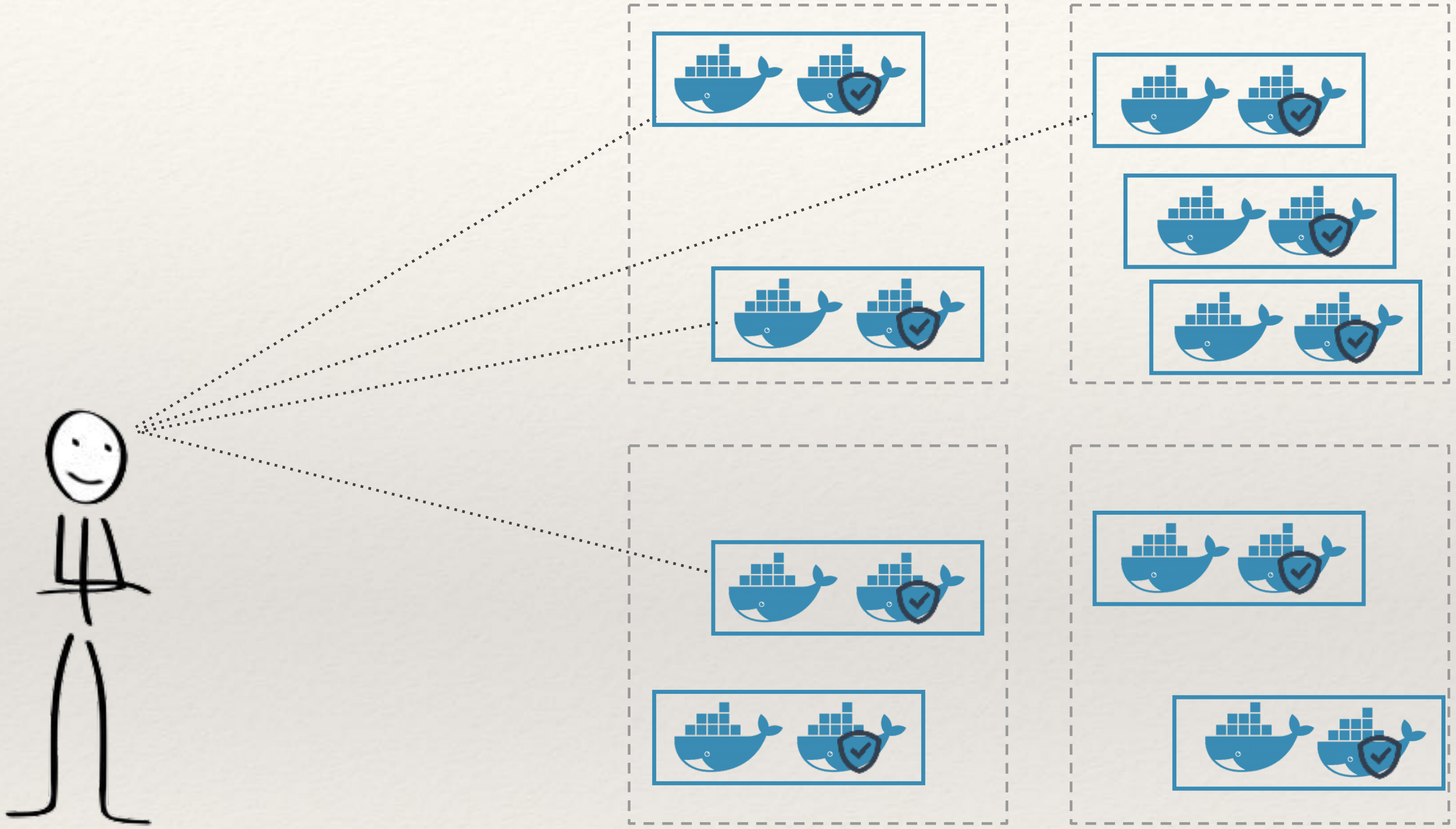


Common theme: Pipelines & SDLC

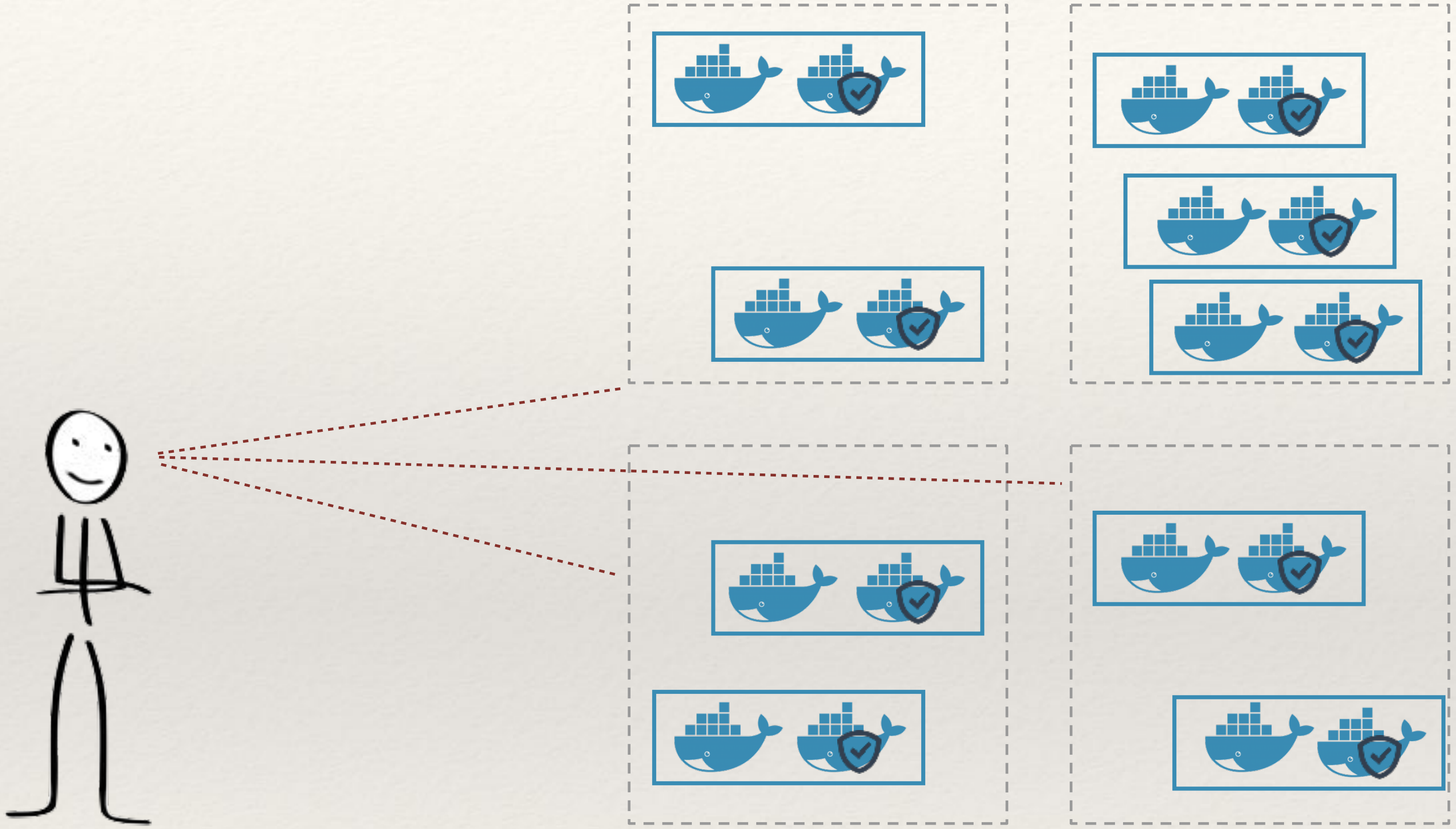
- Standard base images
- Approved runtimes
- Approved image build files
- Automated builds
- Image signing, scanning and quarantine
- ACLs

… and Compliance



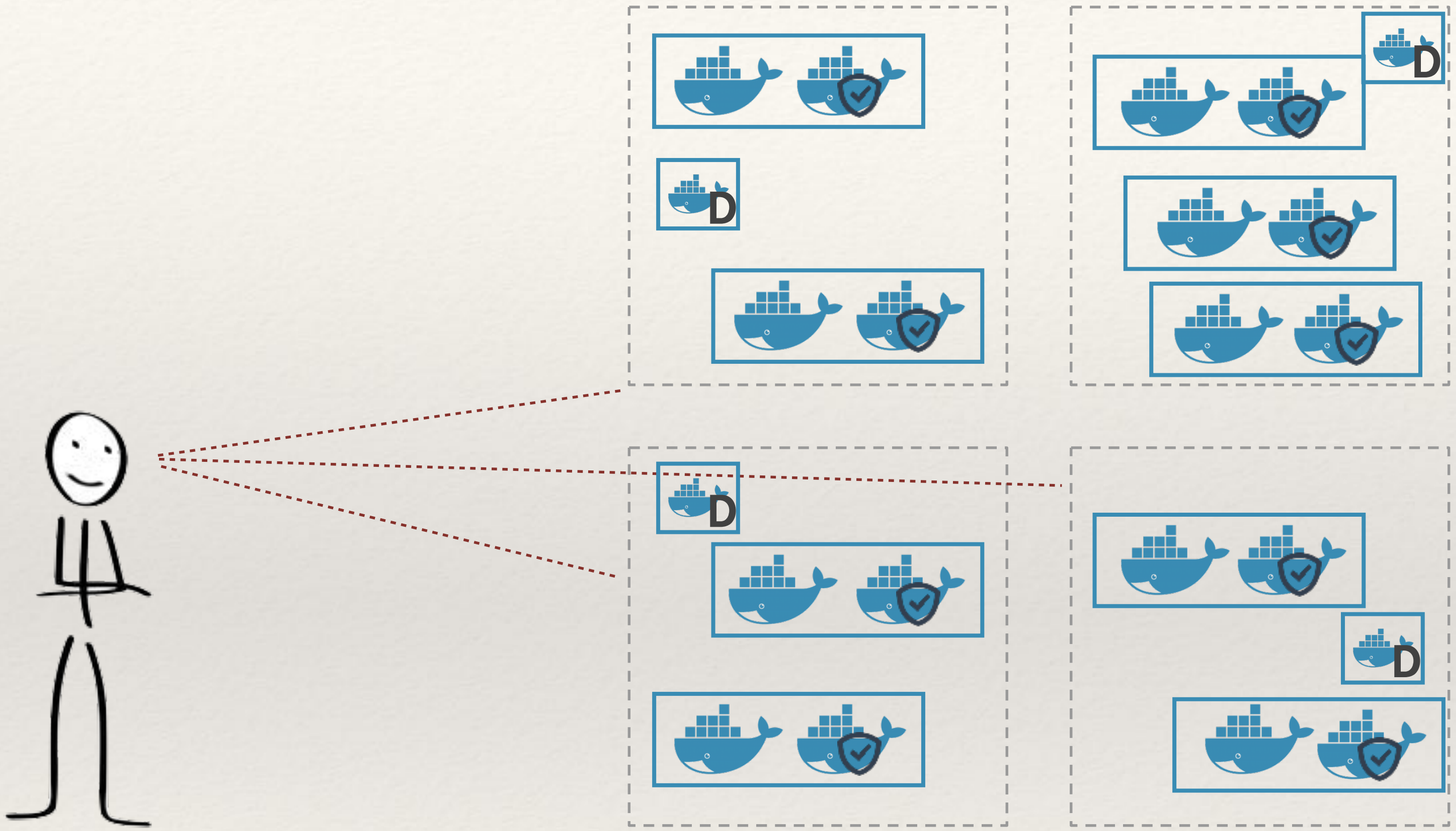


Cross-cutting Concerns…



Cross-cutting Concerns…

… both app and infrastructure



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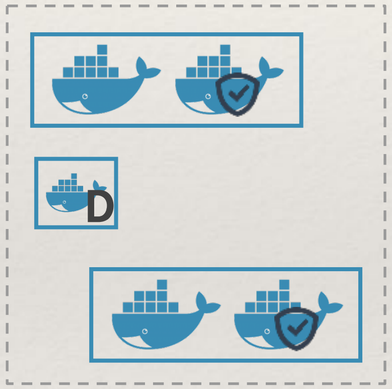
Cross-cutting Concerns

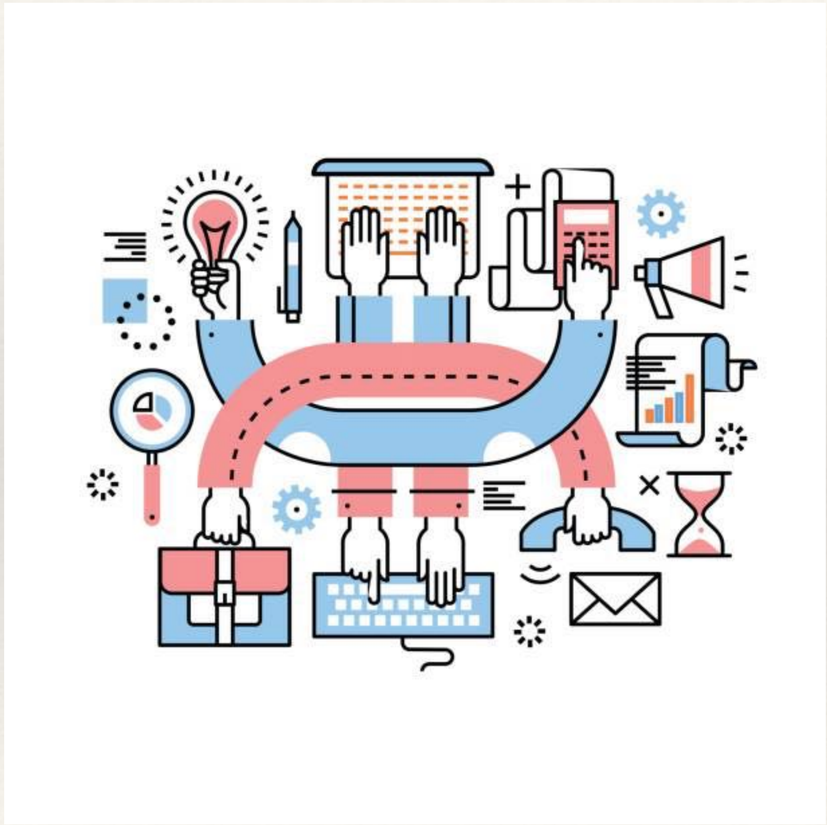


Common theme: Injection & Composition

- More than a container
- Aspect-oriented Programming
- App and Infra

Resilience

Imperative Deployments

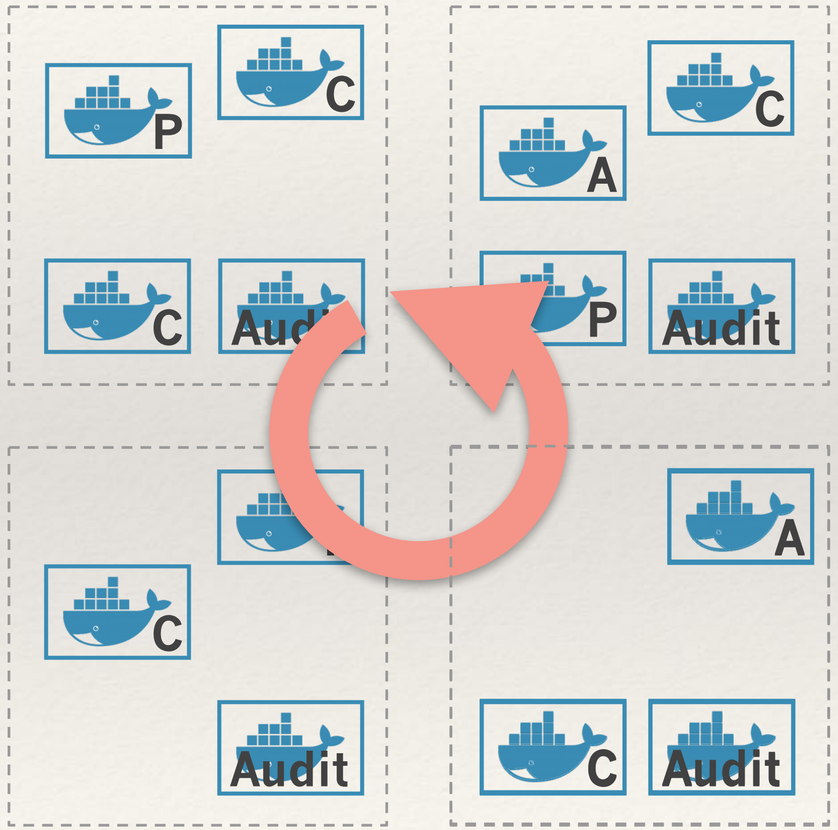


- Workflows:
  - Provision Machine
  - Install Operating System & Middleware
  - Install App
  - Configure Firewall
  - …
  - **Done!!!**

Functional Deployments

```
My app:
- image: posts
  type: pod
  replicas: 3
- image: connections
  type: pod
  replicas: 5
- image: aggregator
  type: pod
  replicas: 2
```

```
Compliance:
- image: audit
  type: daemonset
```



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```

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```

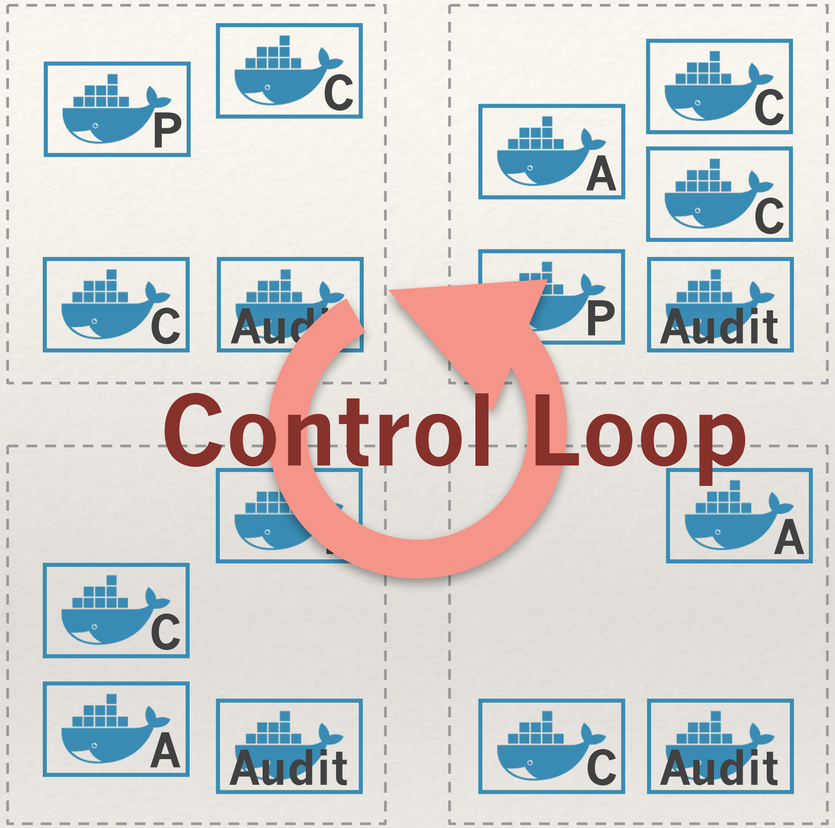

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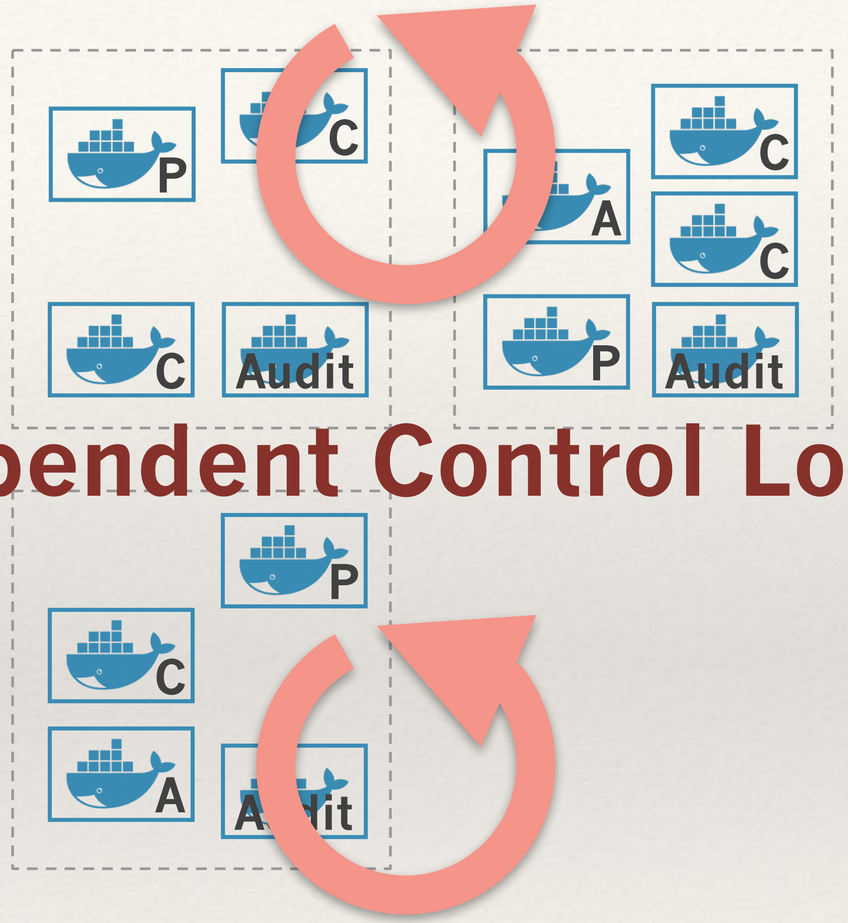
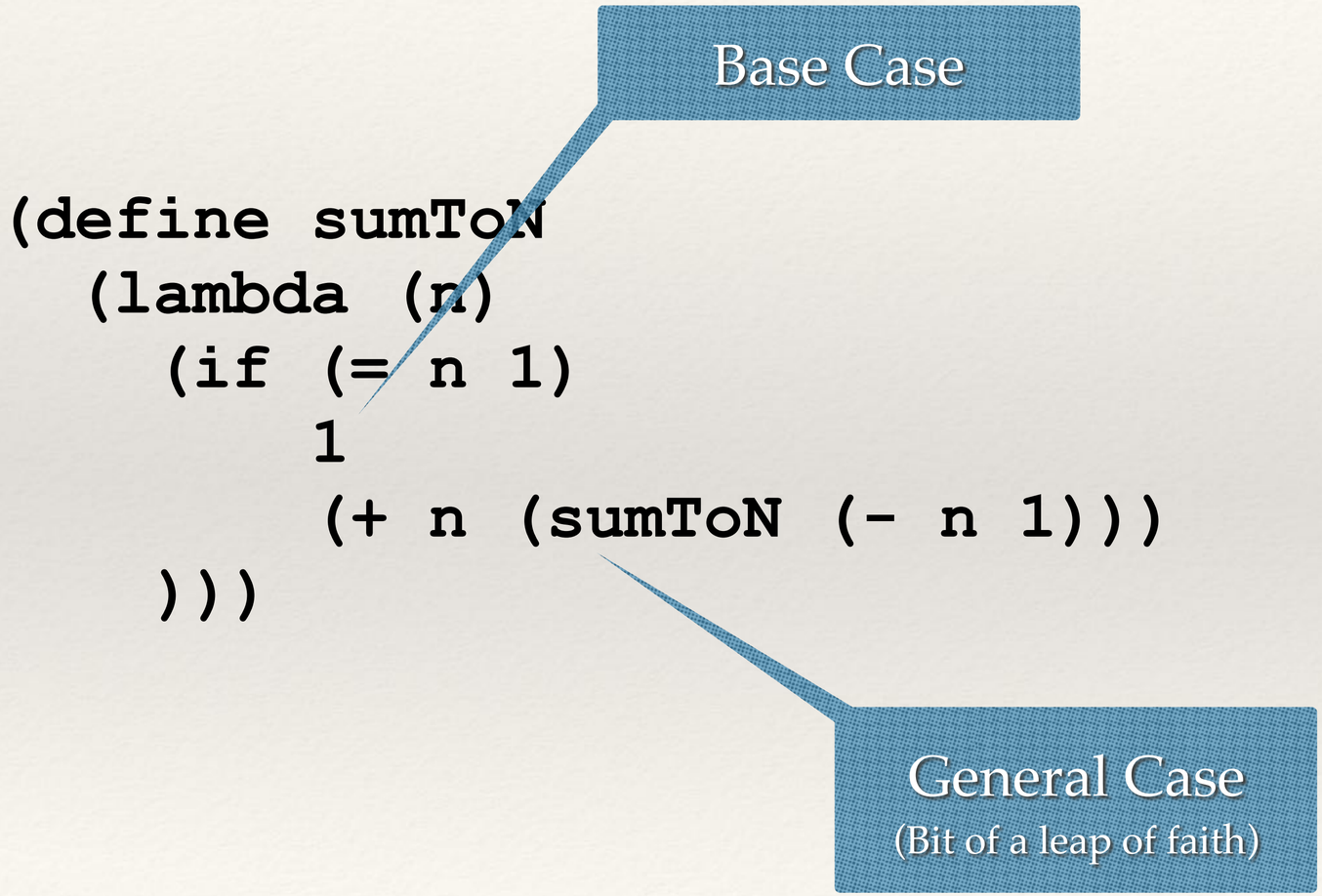


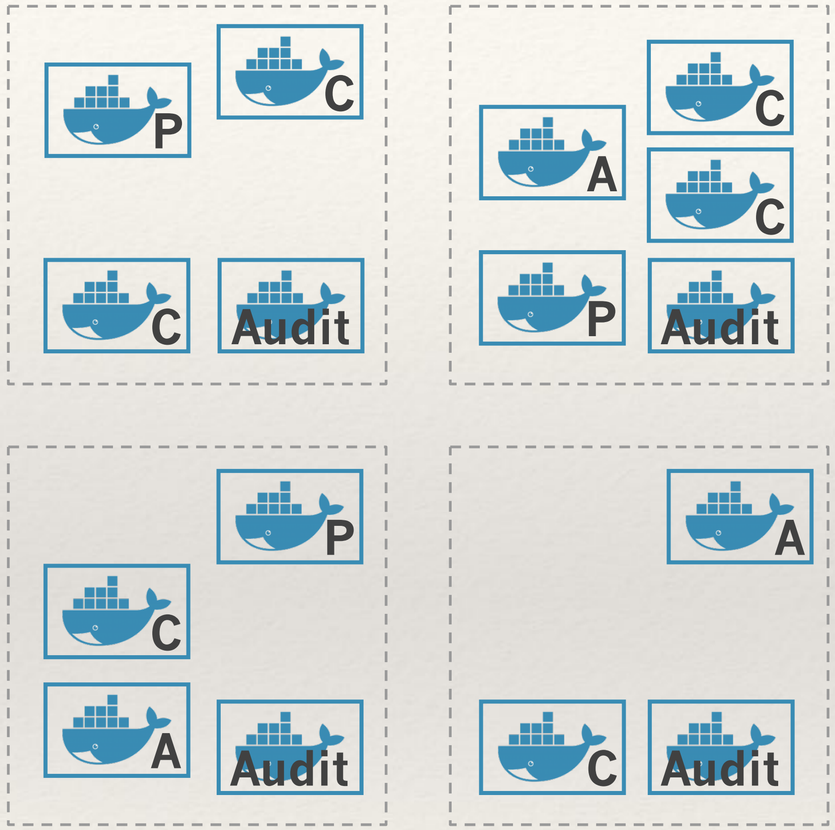
Independent Control Loops!!!

Functional Systems Management



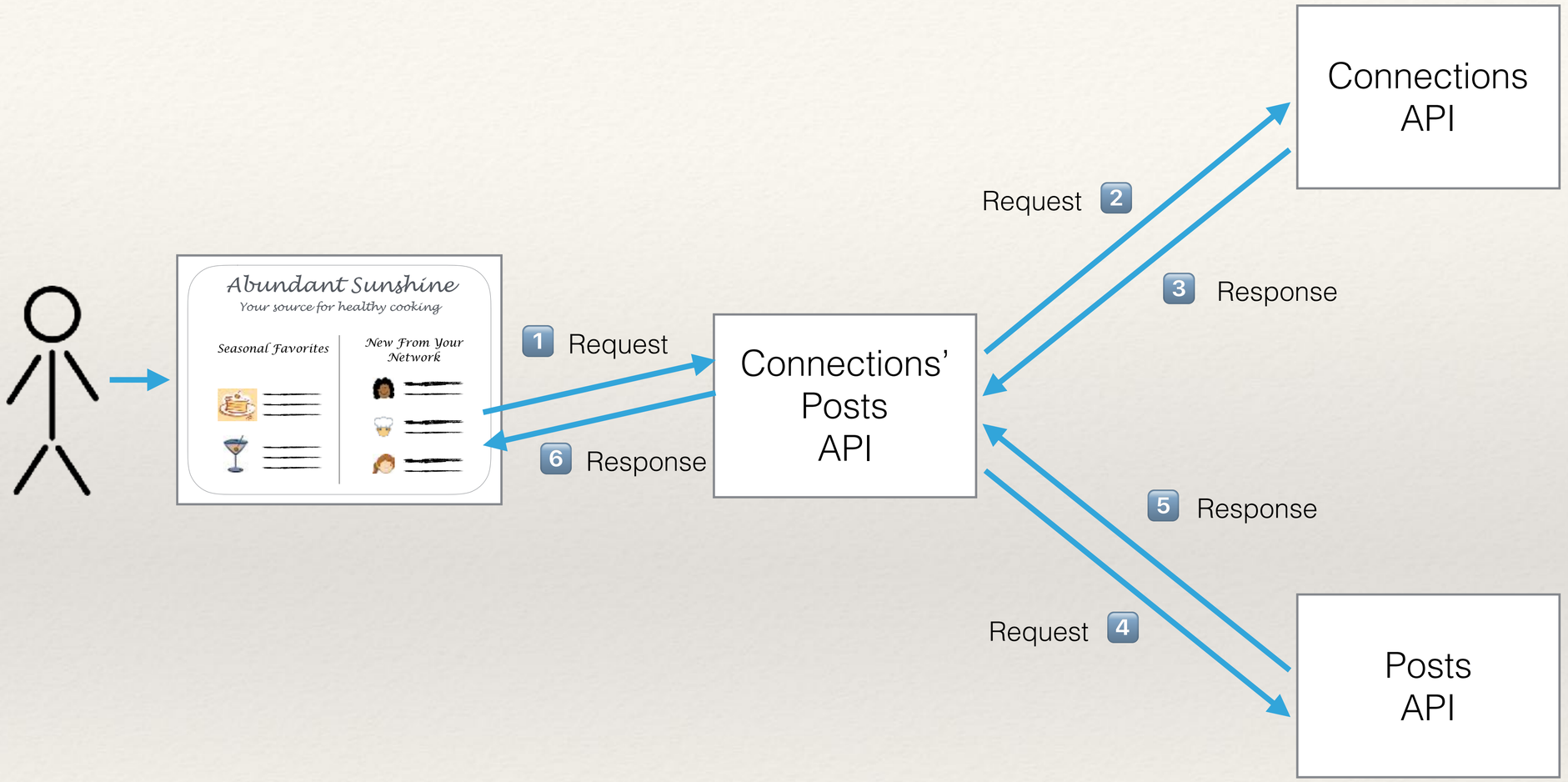
Common theme: Declarative & Strong Typing

- Eventual consistency
- Decoupled control loops

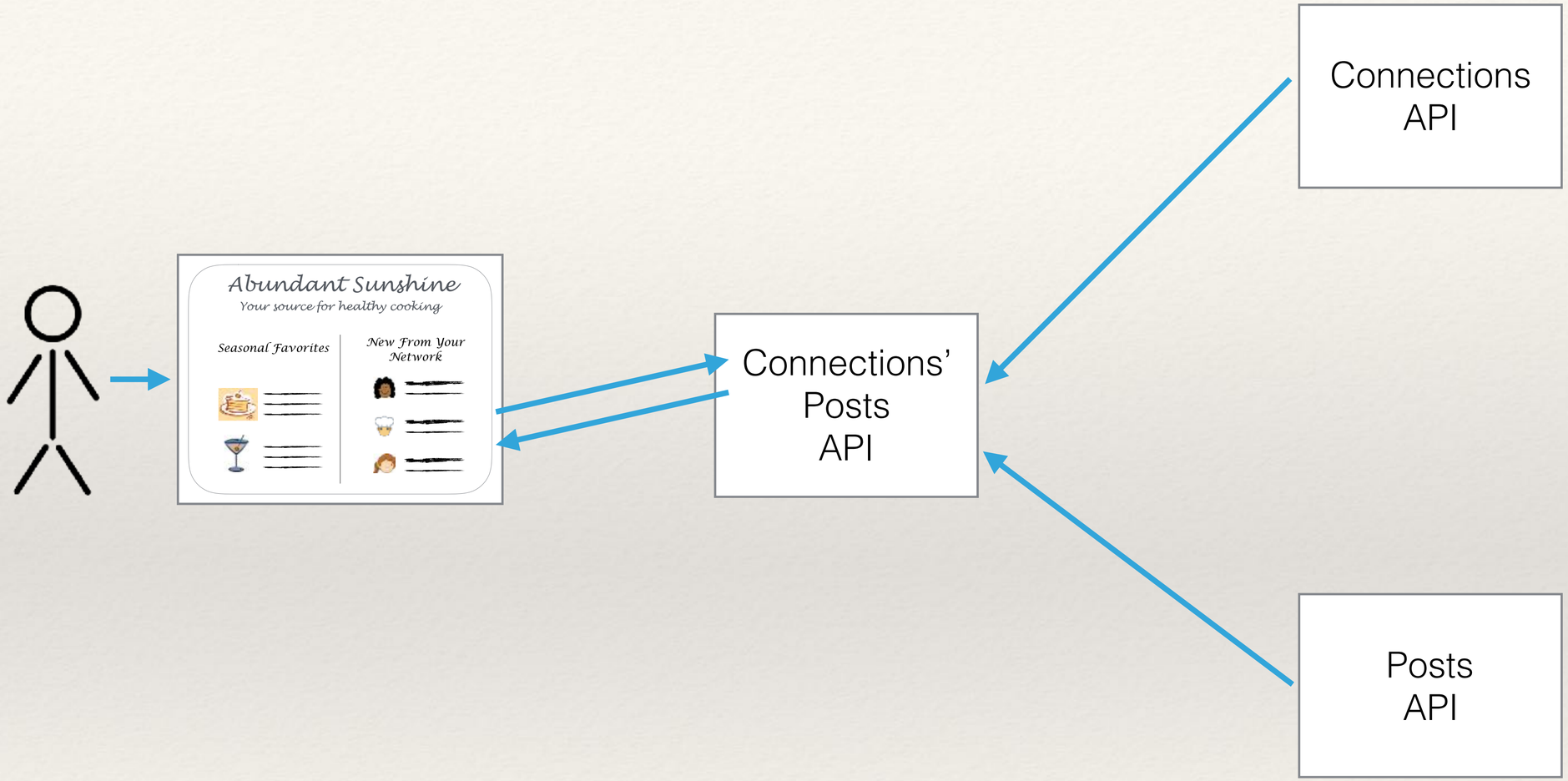


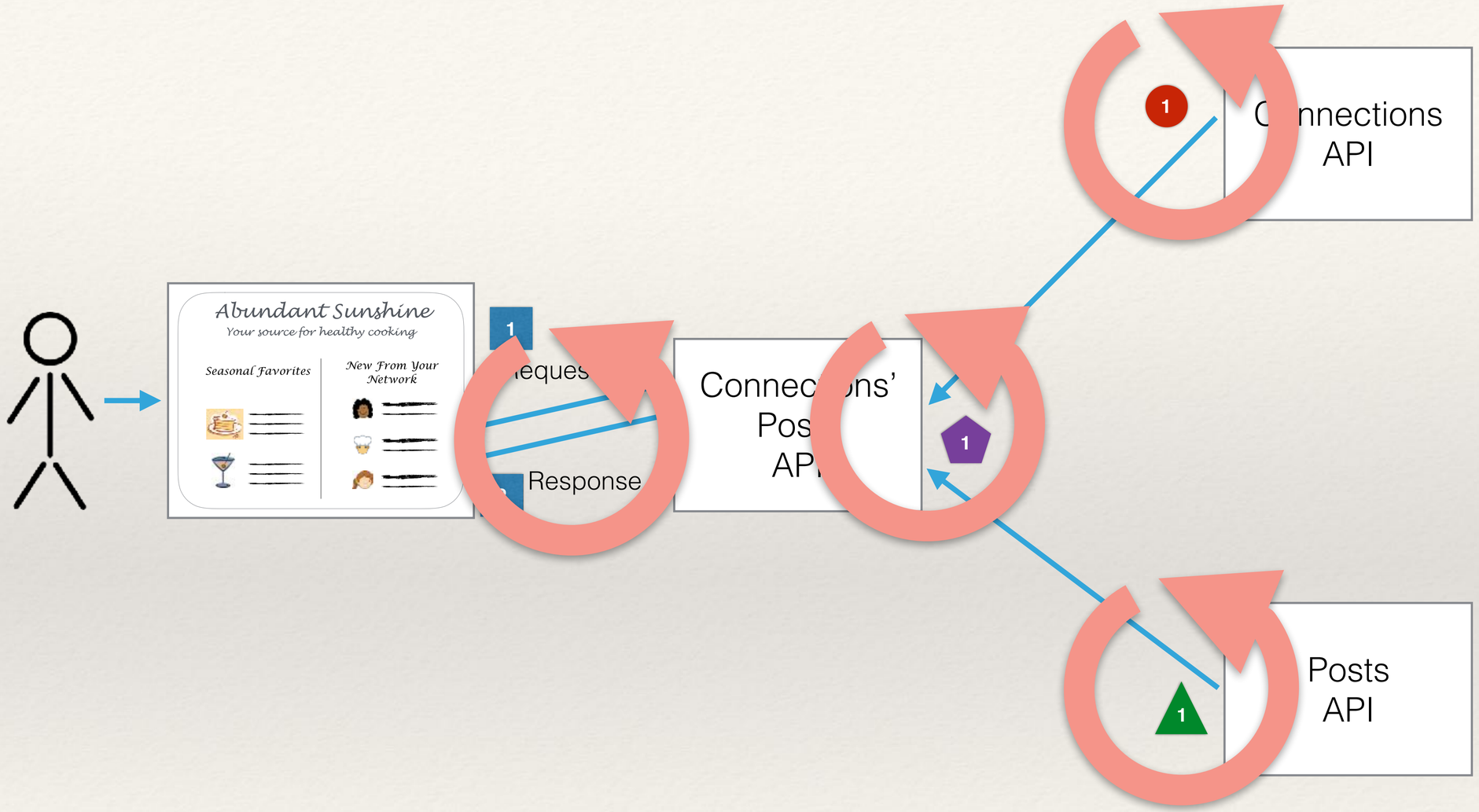
We're now operating

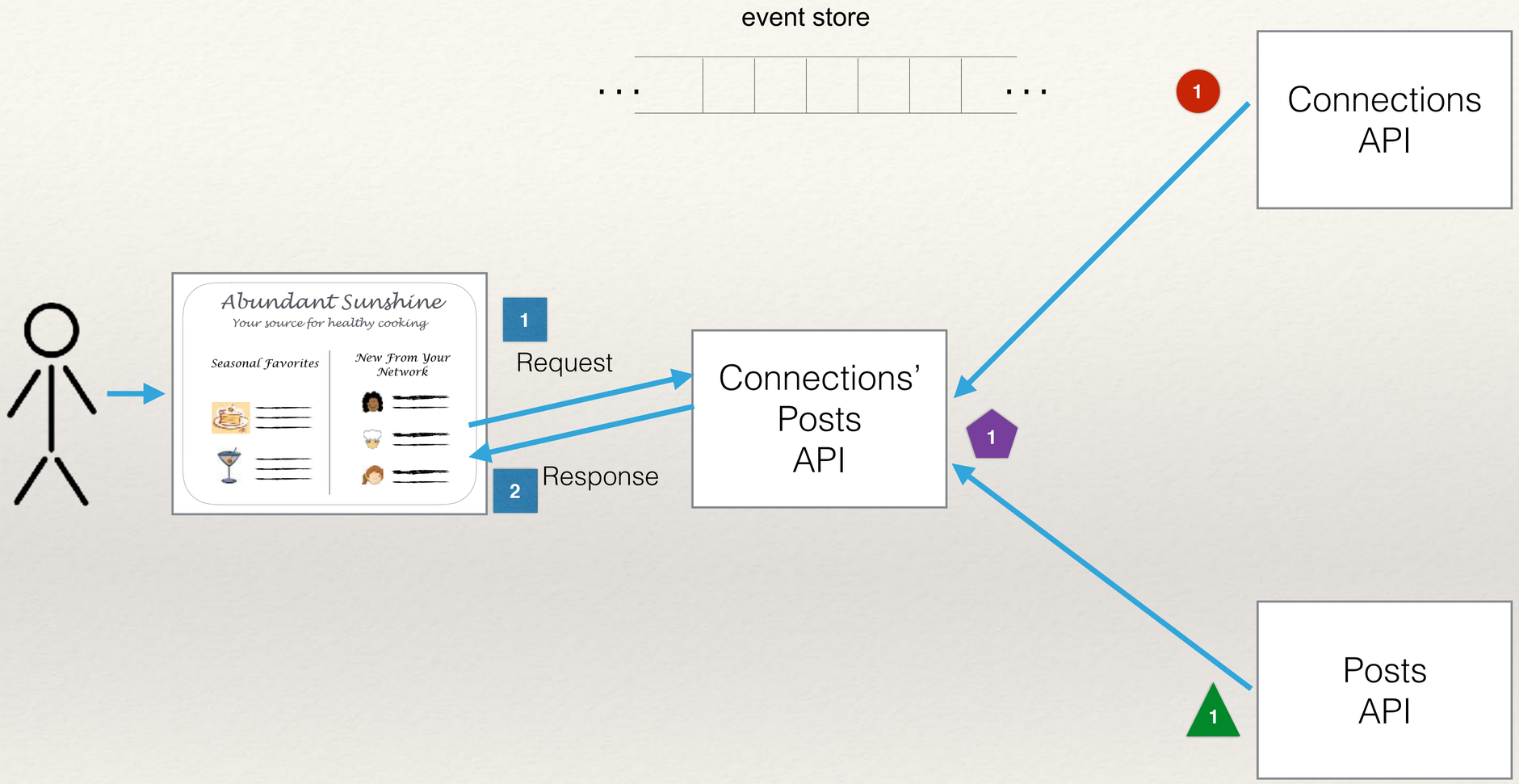
Distributed Systems

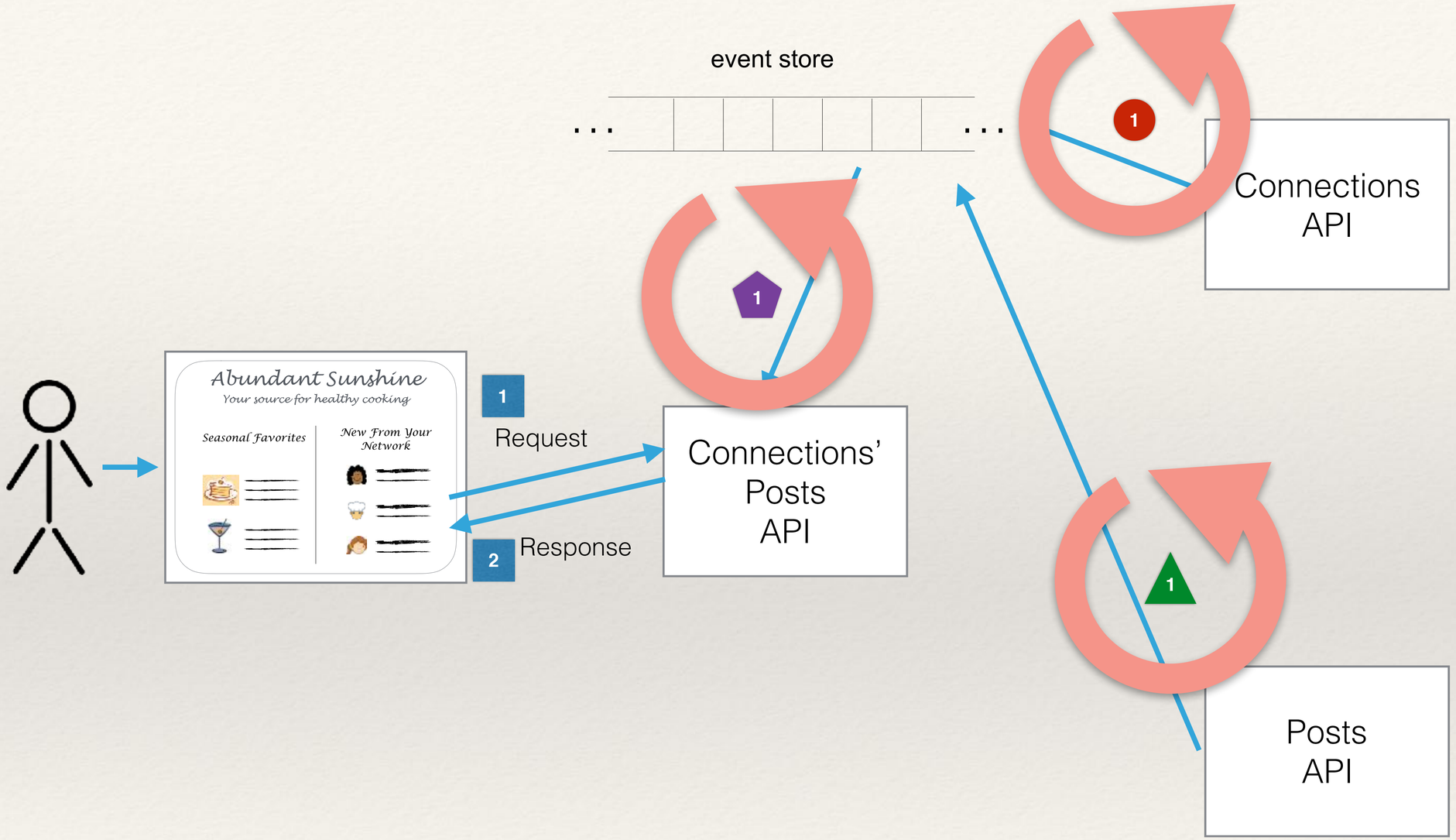

Abundant Sunshine
Your source for healthy cooking
Seasonal Favorites
New From Your Network
1 Request
6 Response
Connections' Posts API
Request 2
3 Response
Connections API
5 Response
Request 4
Posts API

Turning that on its head

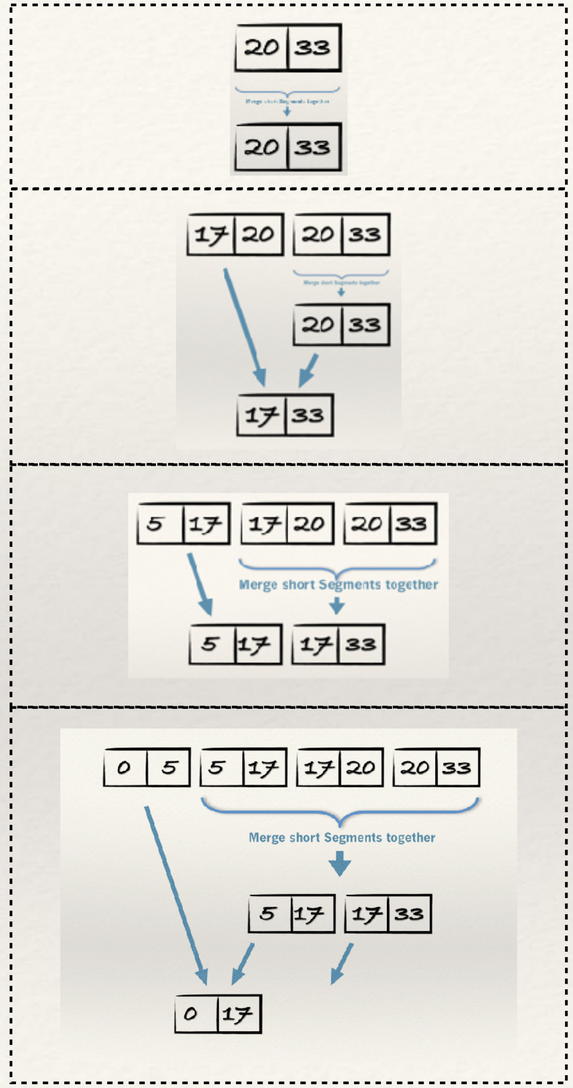



Abundant Sunshine
Your source for healthy cooking
Seasonal Favorites
New From Your Network
1
Response
Connections' Posts API
1
1
Connections API
1
Posts API


event store
Connections API
1
Abundant Sunshine
Your source for healthy cooking
Seasonal Favorites
New From Your Network
1
Request
2
Response
Connections' Posts API
1
Posts API
1


event store
Connections API
Posts API
Connections' Posts API
Abundant Sunshine
Your source for healthy cooking
Seasonal Favorites
New From Your Network
1
Request
2
Response
1
1
1

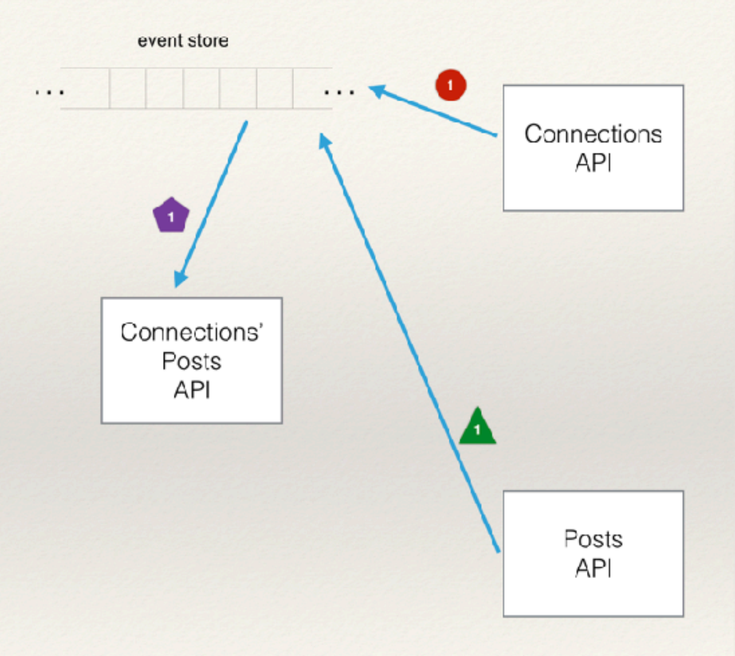
The call stack captures a series of events that result in state



Oh yeah!

Frames are <u>immutable</u>!

Event-driven, Distributed Systems



Common theme: Immutability & Continuations

- Independent Control loops
- Event log

Key Patterns

- Single deployable artifact **(immutability)**
- Trusted container pipeline and image management **(SDLC)**
- Aspect oriented programming **(composition)**
- Independent control loops **(declarative programming style & strong typing)**
- Event-driven architectures **(immutability & continuations)**


BEWARE!

```
(define (dontMergeSegmentsThisWayPlease segments threshold)
  (do ((listLen (vector-length segments))
       (i 0))
      ((>= i listLen))
      (if (< (segLen (vector-ref segments i)) threshold)
          (begin
            (vector-set! segments (+ i 1)
              (cons (car (vector-ref segments i))
                    (cdr (vector-ref segments (+ i 1)))))
            (set! segments (delVectorItem segments i))
            (set! listLen (- listLen 1)))
          (set! i (+ i 1))))
    segments)
```

What do I need help with?

Shifting from imperative to functional thinking can be hard.

Developers are getting it (or starting to).

How will we navigate this for ops-minded folks?

Thank you

@cdavisafc