Durable Workflows

with Effect Cluster

THANK YOU ORGANIZERS!

Ego Slide

- Push buttons
- Type things
- Break stuff
- Wear sweatshirt as cape
- This picture is not stack safe

Failures along the way

```
function chargeCreditCard(cardNumber, totalAmount): Effect<void, InsufficientFundsError | PaymentGatew
function createShippingTrackingCode(deliveryAddress): Effect<TrackingId, NoMoreApiCallQuotaError>
function sendConfirmationEmail(email, orderId, trackingId): Effect<void, SmtpFailureError>

const processPayment: Effect<
    void,
    InsufficientFundsError | PaymentGateway503Error | NoMoreApiCallQuotaError | SmtpFailureError
  > = ...
```

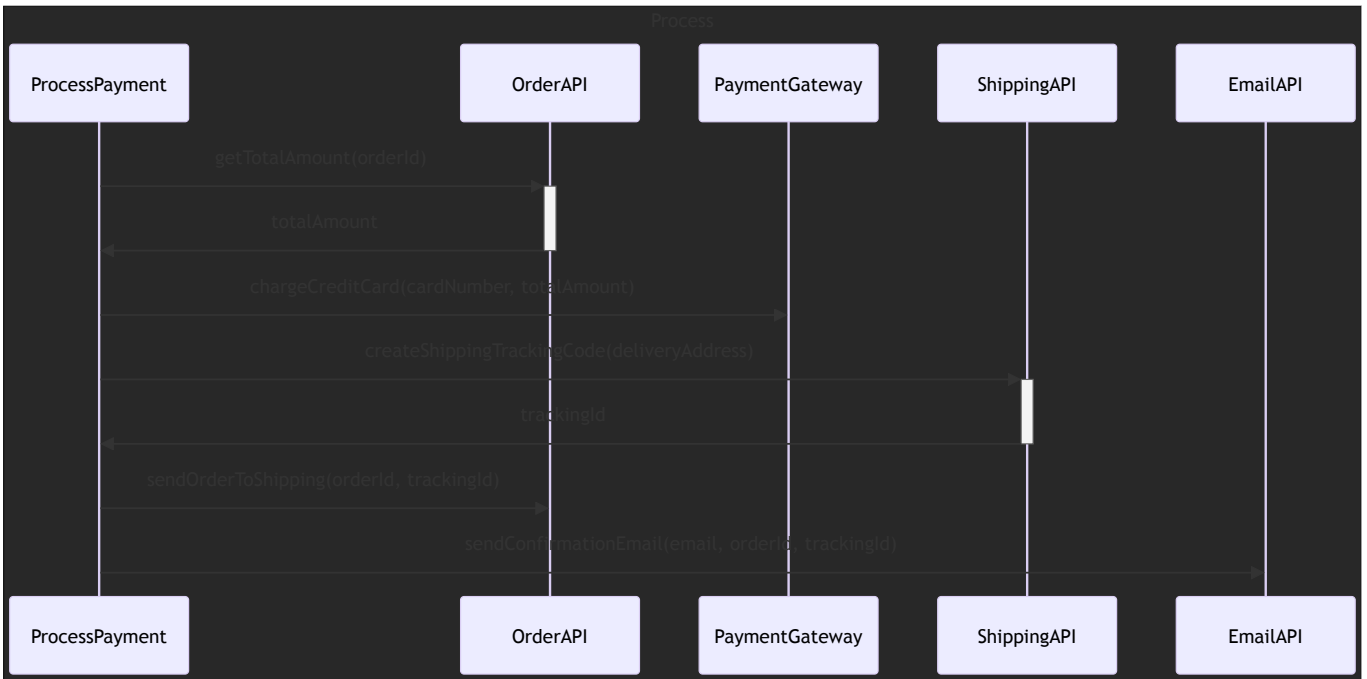
Log on failure

```
const processPayment =
  (cardNumber: CardNumber, deliveryAddress: DeliveryAddress,
  email: EmailAddress, orderId: OrderId) ⇒
    Effect.gen(function*($) {
      const totalAmount = yield* $(getTotalAmount(orderId))
      yield* $(chargeCreditCard(cardNumber, totalAmount))
      const trackingId = yield* $(createShippingTrackingCode(deliveryAddress))
      // ^- failure raised here!
      yield* $(sendOrderToShipping(orderId, trackingId)) // skipped
      yield* $(sendConfirmationEmail(email, orderId, trackingId)) // skipped
    })
```

Retrying everything

```
const processPayment =
  (cardNumber: CardNumber, deliveryAddress: DeliveryAddress,
  email: EmailAddress, orderId: OrderId) ⇒
    Effect.gen(function*($) {
      const totalAmount = yield* $(getTotalAmount(orderId))
      yield* $(chargeCreditCard(cardNumber, totalAmount))
      const trackingId = yield* $(createShippingTrackingCode(deliveryAddress))
      // ^- failure raised here!
      yield* $(sendOrderToShipping(orderId, trackingId)) // skipped
      yield* $(sendConfirmationEmail(email, orderId, trackingId)) // skipped
    }).pipe(
      Effect.retry({
        while: error ⇒ isTemporaryError(error)
      })
    )
```

Business Process



Transactions?

```
BEGIN TRANSACTION;
UPDATE card_balances SET balance = balance - 10 WHERE card_number = 42
UPDATE orders SET tracking_id = 'abc' WHERE order_id = 12
COMMIT TRANSACTION;
```

Distributed systems are everywhere

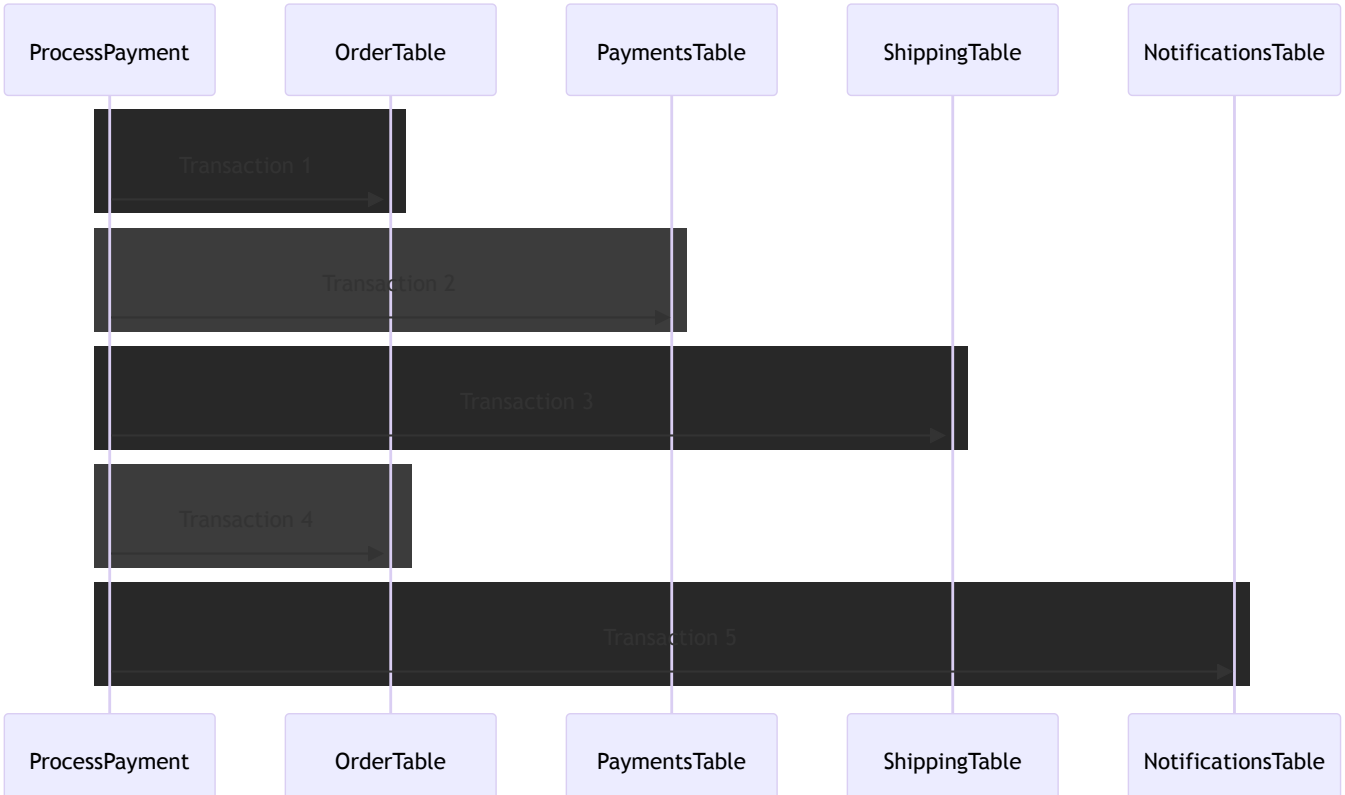
Distributed Workflows are everywhere

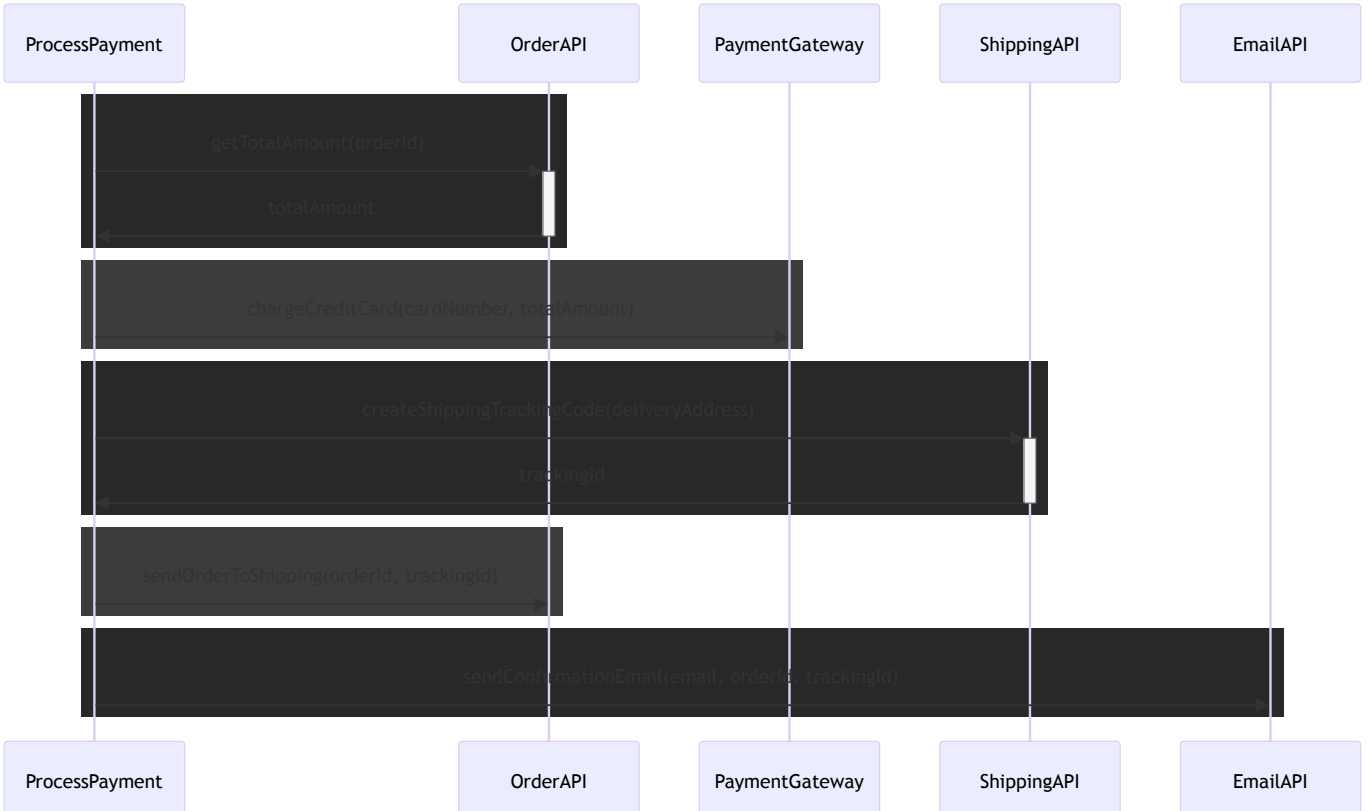
Welcome Effect Cluster

All the building blocks you need to deal with distributed workflows with ease!

…long lived transactions?

- Sagas!
- in 1987 they had computers!


ProcessPayment
OrderTable
PaymentsTable
ShippingTable
NotificationsTable
Transaction 1
Transaction 2
Transaction 3
Transaction 4
Transaction 5
ProcessPayment
OrderTable
PaymentsTable
ShippingTable
NotificationsTable


ProcessPayment
OrderAPI
PaymentGateway
ShippingAPI
EmailAPI
getTotalAmount(orderId)
totalAmount
chargeCreditCard(cardNumber, totalAmount)
createShippingTrackingCode(deliveryAddress)
trackingId
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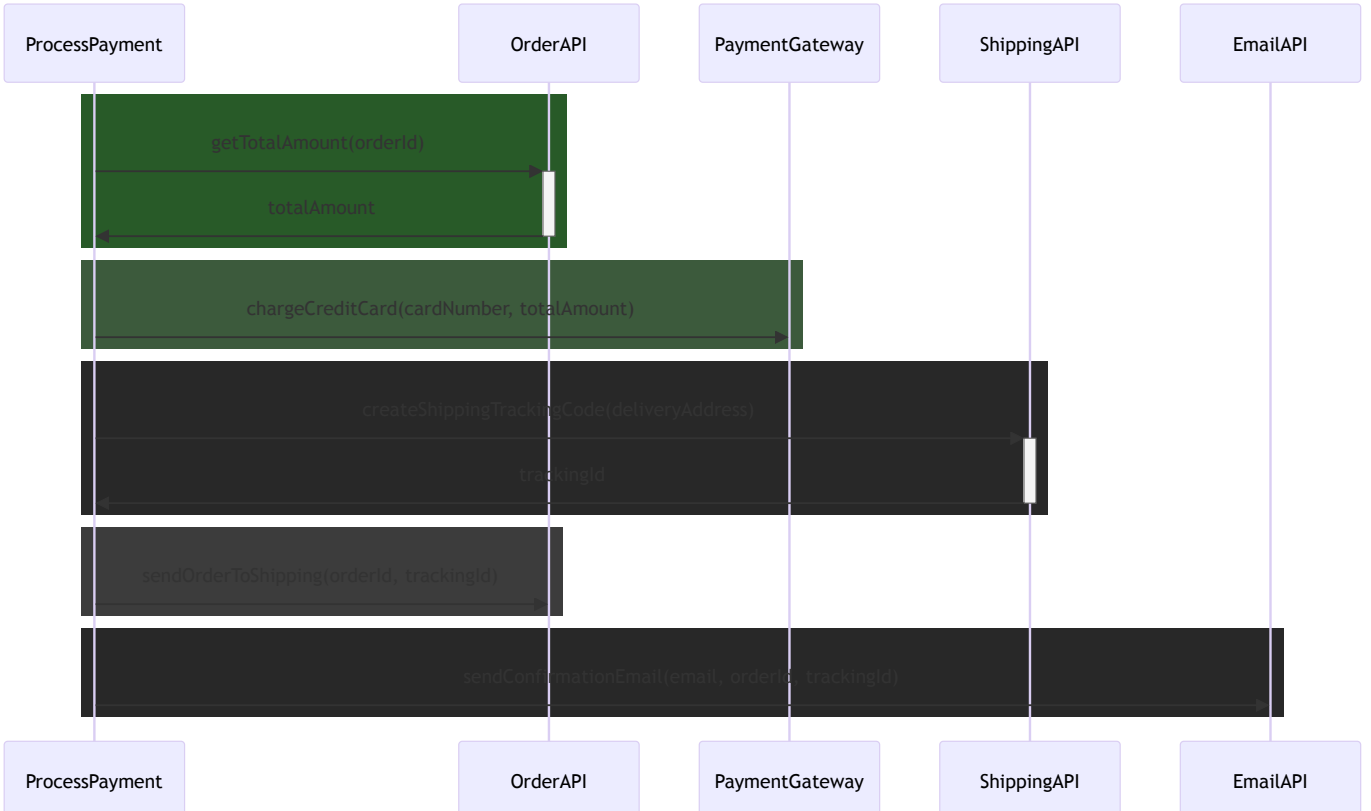
EmailAPI


ProcessPayment
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trackingId
sendOrderToShipping(orderId, trackingId)
sendConfirmationEmail(email, orderId, trackingId)
ProcessPayment
OrderAPI
PaymentGateway
ShippingAPI
EmailAPI

Defining an activity

- Work unit of a Workflow
- Can interact with external systems
- Executes an Effect
- Uniquely identified inside Workflow
- Requires schemas for success and failure

```
const getTotalAmount = (id: string) =>
Activity.make(
    `get-amount-due-${id}`, // identifier
    Schema.number, // success schema
    Schema.struct({ code: Schema.number,
      message: Schema.string }) // error schema
  )(
    pipe(
      Http.request.get(`/get-total-amount/${id}`)
      Http.client.fetchOk(),
      Effect.andThen((response) => response.json),
      Effect.mapError(() => ({
        code: 500,
        message: `API Fetch error`
        })
      )
    )
  )
```

Defining a workflow

- Is started by a Request
- Requires schemas for success and failure
- Has a payload of information

```
class ProcessPaymentRequest extends
  Schema.TaggedRequest<ProcessPaymentRequest>()(
  `ProcessPaymentRequest`, // tag
  Schema.never, // failure
  Schema.boolean, // success
  {
    orderId: Schema.string,
    cardNumber: Schema.string,
    email: Schema.string,
    deliveryAddress: Schema.string
  }
) {
}
```

Defining a workflow

```
const processPaymentWorkflow = Workflow.make(
  ProcessPaymentRequest,
  (_) => `ProcessPayment@${_.orderId}`,
  ({ cardNumber, deliveryAddress, email, orderId }) =>
    Effect.gen(function*($) {
      const totalAmount = yield* $(getTotalAmount(orderId))
      yield* $(chargeCreditCard(cardNumber, totalAmount))
      const trackingId = yield* $(createShippingTrackingCode(deliveryAddress))
      yield* $(sendOrderToShipping(orderId, trackingId))
      yield* $(sendConfirmationEmail(email, orderId, trackingId))
    })
)
```

- Coordinator of activities
- Durable execution
- Requires deterministic code

WTF is deterministic?

Given a set of input, the output of the function must be always the same and predictable, without triggering any side effects that may later affect the computation.

Deterministic

- Math & Logic ops
- Seed based random

Non-Deterministic

- Math.random()
- new Date()
- R/W Global Shared State (also DB)

Determinism & Workflows

```
const processPaymentWorkflow = Workflow.make(
  ProcessPaymentRequest,
  (_) ⇒ "ProcessPayment@" + _.orderId,
  ({ cardNumber, deliveryAddress, email, orderId }) ⇒
    Effect.gen(function*($) {
      const totalAmount = yield* $(Effect.succeed(42.1) /* getTotalAmount(orderId) */)
      yield* $(Effect.unit /* chargeCreditCard(cardNumber, totalAmount) */)
      const trackingId = yield* $(createShippingTrackingCode(deliveryAddress))
      yield* $(sendOrderToShipping(orderId, trackingId))
      yield* $(sendConfirmationEmail(email, orderId, trackingId))
    })
)
```

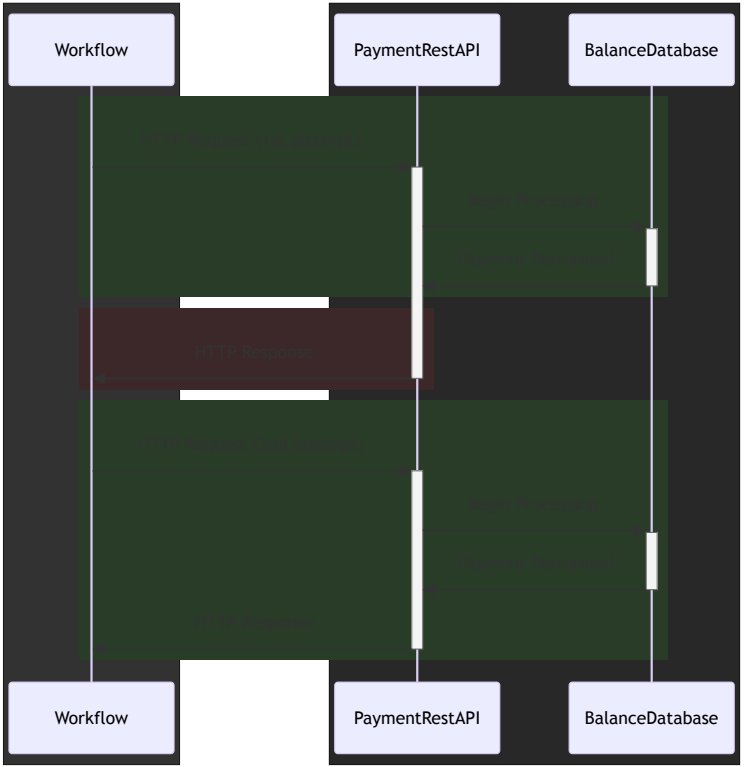
Running a Workflow

```
const main = Effect.gen(function*($) {
  const workflows = Workflow.union(processPaymentWorkflow, requestRefundWorkflow)
  const engine = yield* $(WorkflowEngine.makeScoped(workflows))
  yield* $(
    engine.sendDiscard(
      new ProcessPaymentRequest({
        orderId: "order-1",
        cardNumber: "my-card",
        deliveryAddress: "My address, 5, Italy",
        email: "my@email.com"
      })
    )
  )
})
runMain(
  pipe(
    main,
    Effect.provide(DurableExecutionJournalPostgres.DurableExecutionJournalPostgres)
  )
)
```

Activity is a Black Box

The double-payment problem

- Any transport may fail
- Not getting a response does not mean it has not been processed

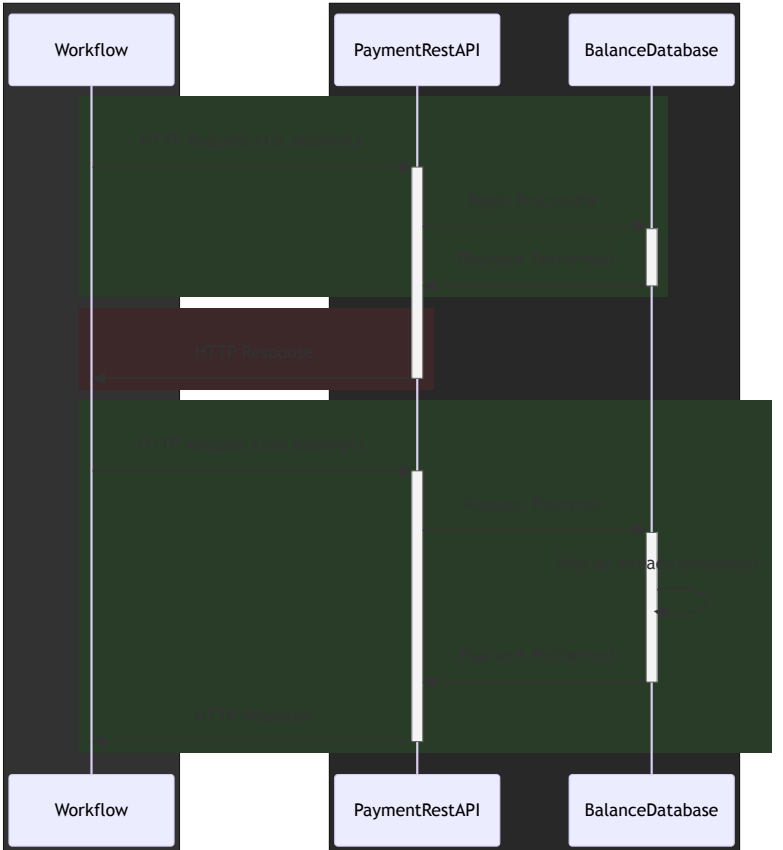


Idempotency

Multiple invocation of the same function, result on a state change as they were executed only the first time.

Idempotence using IDs

```
const chargeCreditCard =
 (cardNumber: string, amountDue: number) ⇒
  pipe(
    Activity.persistenceId,
    Effect.flatMap(
      (persistenceId) ⇒ callPaymentGateway(
        persistenceId,
        cardNumber,
        amountDue
      )
    ),
    Activity.make(
      "charge-credit-card",
      Schema.void,
      Schema.never
    )
  )
```



Yielding workflow execution

```
const getTotalAmount = (id: string) =>
  pipe(
    Http.request.get(`/get-total-amount/${id}`)
    .pipe(
      Http.client.fetchOk(),
      Effect.andThen((response) => response.json),
      Effect.retry(
        Schedule.exponential(1000).pipe(
          Schedule.compose(Schedule.recurs(32)),
        ),
      ),
      Effect.catchAllCause(() => pipe(
        Effect.logError("Something is wrong with the OrderAPI right now"),
        Effect.zipRight(Workflow.yieldExecution)
      ))
    ),
    Activity.make(`get-amount-due-${id}`, Schema.number, Schema.never)
  )
```

Fixing workflows

```
const processPaymentWorkflow = Workflow.make(
  ProcessPaymentRequest,
  (_) => `ProcessPayment@${_.orderId}`,
  ({ cardNumber, deliveryAddress, email, orderId }) =>
    Effect.gen(function*($) {
      const version = yield* $(getCurrentVersion(2))
      // ^- for already running WFs, will resolve with previous value (1)
      // ...
      if(version >= 2){
        yield* $(checkTrustedCardNumber(cardNumber))
      }
      yield* $(chargeCreditCard(cardNumber, totalAmount))
      // ...
    })
)

const getCurrentVersion = (definitionVersion: number) => pipe(
  Effect.succeed(definitionVersion),
  Activity.make("get-current-version", Schema.number, Schema.void)
)
```

All or Nothing

Compensating actions

```
const processPaymentWorkflow = Workflow.make(
  ProcessPaymentRequest,
  (_) => `ProcessPayment@${_.orderId}`,
  ({ cardNumber, deliveryAddress, email, orderId }) =>
    pipe(
      getTotalAmount(orderId),
      Effect.flatMap(totalAmount => pipe(
        chargeCreditCard(cardNumber, totalAmount),
        Effect.flatMap(() => createShippingTrackingCode(deliveryAddress)),
        Effect.tap(trackingId => sendOrderToShipping(orderId, trackingId)),
        Effect.tap(trackingId => sendConfirmationEmail(email, orderId, trackingId)),
        Effect.catchTag("OutOfStockError", () => refundCreditCard(cardNumber, totalAmount))
      ))
    )
)
```

Effect Cluster Workflows

Building durable and reliable Effects for your applications

Effect Cluster Sharding and Location Transparency

Safely distribute work and refer to entity without knowing their location

```ts
import * as RecipientType from "@effect/cluster/RecipientType"
import * as Schema from "@effect/schema/Schema"

export class Increment extends Schema.TaggedClass<Increment>()("Increment", {
  messageId: Schema.string
}) {}

export class Decrement extends Schema.TaggedClass<Decrement>()("Decrement", {
  messageId: Schema.string
}) {}

export class GetCurrent extends
  Schema.TaggedRequest<GetCurrent>()("GetCurrent", Schema.never, Schema.number, {
  messageId: Schema.string
}) {}

export const CounterMsg = Schema.union(Increment, Decrement, GetCurrent)
export type CounterMsg = Schema.Schema.To<typeof CounterMsg>

export const CounterEntity = RecipientType.makeEntityType("Counter", CounterMsg, (_) => _.messageId)
```

```
Sharding.registerEntity(
  CounterEntity
)(
  RecipientBehaviour.fromFunctionEffectStateful(
    () ⇒ Effect.succeed(0),
    (_, message, stateRef) ⇒ {
      switch (message._tag) {
        case "Increment":
          return pipe(Ref.update(stateRef, (count) ⇒ count + 1), Effect.as(MessageState.Processed(Opt
        case "Decrement":
          return pipe(Ref.update(stateRef, (count) ⇒ count - 1), Effect.as(MessageState.Processed(Opt
        case "GetCurrent":
          return pipe(
            Ref.get(stateRef),
            Effect.exit,
            Effect.map((result) ⇒ MessageState.Processed(Option.some(result)))
          )
      }
    }
  )
)
```

Today's Recap

Effect cluster provides all the basic building blocks you'll need to build distributed workflows and systems

`@effect/cluster`

- Sharding
- Shard Manager
- Messaging utilities

`@effect/cluster-node`

- Cluster specific utilities for NodeJS

`@effect/cluster-workflow`

- Activity
- Workflow
- WorkflowEngine

`@effect/cluster-pg`

- Postgres based persistency for Workflow and Sharding

Happy Effect-ing!

Thanks for your time!