THANK YOU ORGANIZERS!

Ego Slide

- Push buttons
- Type things
- Break stuff
- Wear sweatshirt as cape

Processes, StateCharts and WorkFlows

...and React?

React Slide

```
export function Counter(){
  const [count, setCount] = React.useState(0);
  return <button onClick={() => setCount(previous => previous + 1)}>
    Count: {count}
  </button>
}
```

💪 Italian Restaurant 💪

- Customer is seated to a table
- The customer places his order
- The kitchen cooks the food
- The customer eats the food
- The customer pays

…gotta go Fast!

/api/process

```
export function postProcess(payload){
  seatPeople(payload.tableId, payload.seatCount)
  placeOrder(payload.tableId, payload.menuItemId, payload.amount)
  const amountDue = askForBill(payload.tableId)
  removeFromBalance(payload.cartNumber, amountDue)
  markAsPayed(payload.tableId)
  sendThankYouEmail(payload.email)
}
```

A tale of Success

Modeling software around the Real World

- People arrive and seat
- Choose what to eat (lot of time!)
- The waiter takes the order (and brings it to kitchen)
- The chef cooks (time again!)
- Food is served and people eat (guess what? time!)
- Customer request the bill and pay

We have been LIED

- Everything takes time to happen
- The waiter waited for us to choose
- The owner waited before placing the bill

Long Running Process

/api/seat

```
export function postSeat(payload){
  seatPeople(payload.tableId, payload.seatCount)
}
```

/api/order

```
export function postOrder(payload){
  placeOrder(payload.tableId, payload.menuItemId, payload.amount)
```

/api/checkout

```
export function postCheckout(payload){
  const amountDue = askForBill(payload.tableId)
  removeFromBalance(payload.cartNumber, amountDue)
  markAsPayed(payload.tableId)
  sendThankYouEmail(payload.email)
}
```

API names

/api/checkout

/api/order

/api/seat

Execution Flow

```
export function postProcess(/* ... */){
  seatPeople(tableId, seatCount)
  placeOrder(tableId, menuItemId, amount)
  const amountDue = askForBill(tableId)
  removeFromBalance(cartNumber, amountDue)
  markAsPayed(tableId)
  sendThankYouEmail(email)
}
```

How the Real World works: interleaved interactions

- Customer A is seated to a table
- Customer B is seated to another table next to Customer A
- The waiter takes Customer A order
- The waiter takes Customer B order
- The kitchen receives both orders and cooks them
- The customers eats the food
- The customers pays only upon finishing their food

Is human interaction the only problem?

/api/checkout

```
export function postCheckout(payload){
  const amountDue = askForBill(payload.tableId)
  removeFromBalance(payload.cartNumber, amountDue)
  markAsPayed(payload.tableId)
  sendThankYouEmail(payload.email)
}
```

Transactions are a LIE too

```
BEGIN TRANSACTION;
UPDATE card_balances SET balance = balance - 10 WHERE card_number = 42
UPDATE orders SET payed = 1 WHERE table_id = 1
COMMIT TRANSACTION;
```

And what do we do today?

```
export function postProcess(payload){
  // ...
  fetch('http://payment.processor/?card=' + payload.cartNumber +
      + '&amount=' + amountDue)
  markAsPayed(payload.tableId) // goes BOOM! 🤯
  sendThankYouEmail(payload.email)
  // ...
}
```

…is it fixed now?

```
export function postProcess(payload){
  try{
    beginTransaction();
    fetch('http://payment.processor/?card=' + payload.cartNumber +
        + '&amount=' + amountDue)
    markAsPayed(payload.tableId) // goes BOOM! 🤯
    sendThankYouEmail(payload.email)
    commitTransaction();
  }catch(e){
    rollbackTrasaction();
  }
}
```

Real World Problems

- Customer is seated to a table
- The customer places his order for a steak
- The kitchen finds out it’s out of steak
- …BOOM! 🤯

Upfront checks aren’t an option

What about possible downstream problems?

Long Running Process involve different systems

User is an external service too

- Input: screen
- Output: key presses and clicks

Beer slide

- Everyone else had one
- So why should’nt I
- Please send me free beer
- Man, I love lists.

ACID may exist only locally

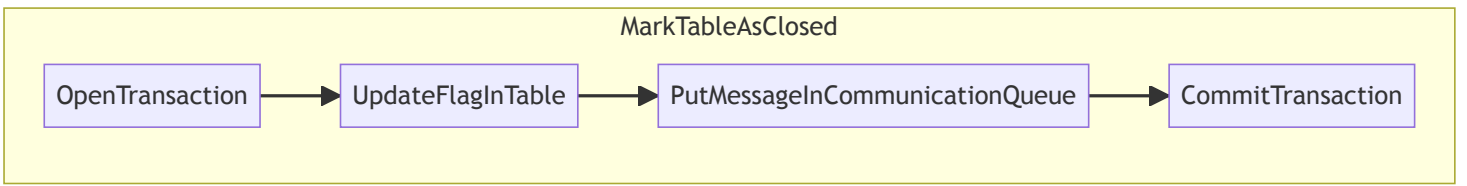
…long lived transactions?

- Sagas!
- in 1987 they had computers!

/api/checkout

A communication layer

- Is needed in order to connect each transaction
- Communication becomes part of the transaction as well



Two kinds of coordination: choreography

```
module Payment
  on "BillRequested"
    processPayment()
    raise event PaymentProcessed()
end module

module Table
  on "PaymentProcessed"
    closeTable()
    raise event TableClosed()
end module

module Satisfaction
  on "TableClosed"
    sendThankYouEmail()
    raise event ThankYouSent()
end module
```

Two kinds of coordination: orchestration

```
module Payment
  on "ProcessPaymentRequest"
    processPayment()
    raise event PaymentProcessed()
end module

module Table
  on "CloseTableRequest"
    closeTable()
    raise event TableClosed()
end module

module Satisfaction
  on "SendThankYouEmailRequest"
    sendThankYouEmail()
    raise event ThankYouSent()
end module
```

```
module CloseTableFlow
  raise event ProcessPaymentRequest()
  await PaymentProcessed()
  raise event CloseTableRequest()
  await TableClosed()
  raise event SendThankYouEmailRequest()
end module
```

Introducing new flows in our application

```
module OfferLiquorFlow
  const liquorId = ProductId(42)
  const [tableId, numberOfGuest] = await event GuestSeated()
  await PaymentRequested()
  raise event PlaceOrder(tableId, liquorId, numberOfGuest)
end module
```

Events as a whole

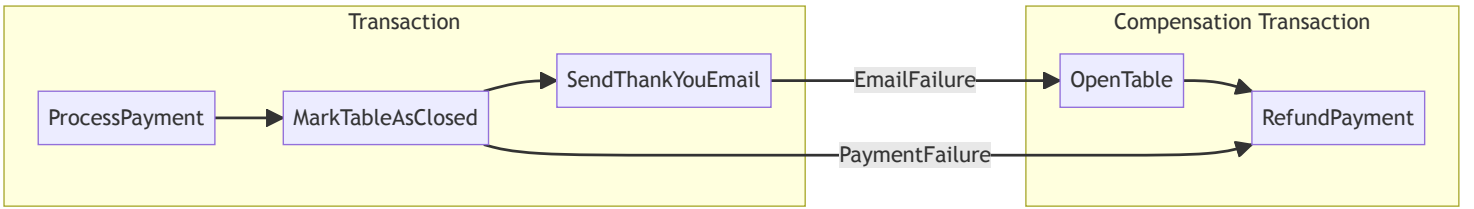
```
module ProductsOrderedReport
  state totalAmount = 0

  on "ProductOrdered"
    totalAmount += event.amount

  on "OrderCancelled"
    totalAmount -= event.amount
end module
```

What happens with failures?

Compensate all the things!



Three kind of transactions: Compensable

- Define both the transaction and the compensating transaction
- Should not rely on "just setting the old value back"
- Should be commutative
- WareHouse and Accounting systems are great scenarios were you can find these

Three kind of transactions: Retriable

- Can’t fail but instead may be retried infinitely

Three kind of transactions: Pivot

- Not compensable in any way
- Once committed, there is no more going back

Asynchronous checkout in plain JavaScript

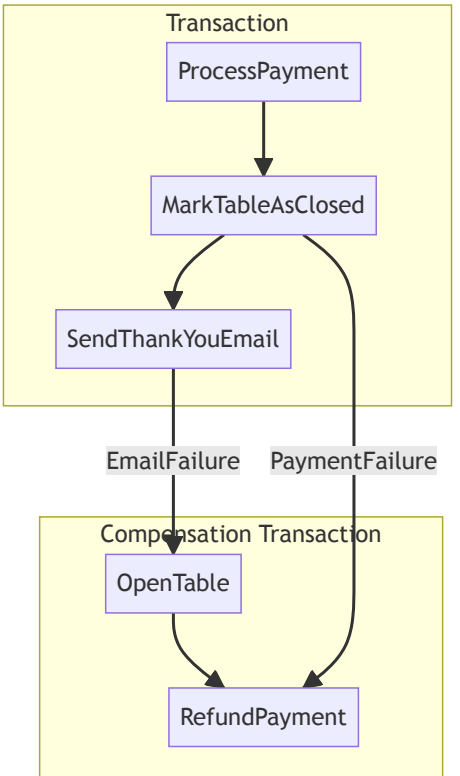
```
async function checkout(tableId: number, cardNumber: string, email: string) {
  const tableDue = await getAmountDue(tableId);
  await processPayment(cardNumber, tableDue);
  await markTableAsPaid(tableId);
  await sendThankYouEmail(email);
  console.log("Table closed successfully!");
}
```

```ts
export const checkoutDistributed = (
  tableId: number,
  cardNumber: string,
  email: string
) =>
  saga(async (step) => {
    const tableDue =
      await step(() => getAmountDue(tableId));
    await step(
      () => processPayment(cardNumber, tableDue),
      () => refundAmount(cardNumber, tableDue)
    );
    await step(
      () => markTableAsPaid(tableId),
      () => openTable(tableId)
    );
    await step(() => sendThankYouEmail(email));
    console.log("Table closed successfully!");
  });
```

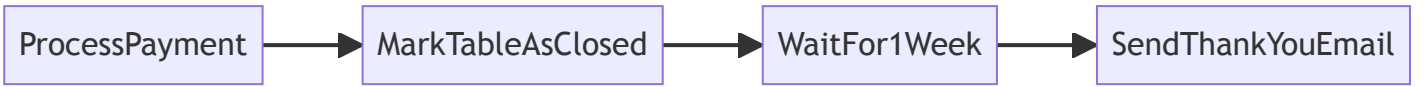
Simple implementation

```
async function saga<R>(definition: (step: StepFn) ⇒ Promise<R>) {
  const compensations = [];
  const step = async (transaction, compensate) ⇒ {
    const result = await transaction();
    if (compensate) compensations.push(compensate);
    return result;
  }
  try {
    return await definition(step);
  } catch (e) {
    for (const compensation of compensations) {
      await compensation();
    }
    throw e;
  }
}
```

Compensation handling



Waiting is part of the business process



What happens if the process stops?

Adding a persistence identifier

```
const checkout = (tableId: number, cardNumber: string, email: string) =>
  saga(async (step) => {
    const tableDue = await step("get-amount", () => getAmountDue(tableId));
    await step(
      "payout",
      () => processPayment(cardNumber, tableDue),
      () => refundAmount(cardNumber, tableDue)
    );
    await step(
      "mark-as-paid",
      () => markTableAsPaid(tableId),
      () => openTable(tableId)
    );
    await step("thankyou", () => sendThankYouEmail(email));
    console.log("Table closed successfully!");
  });
```

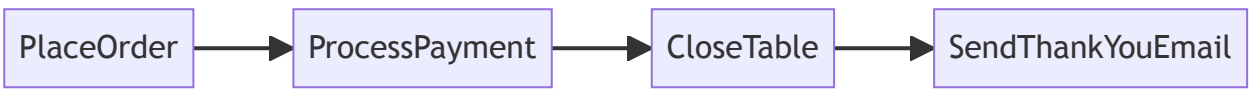
```
const step: StepFn =
  async (persistenceId, transaction, compensate) => {
  if (!persistence.has(persistenceId)) {
    try {
      const result = await transaction();
      persistence.set(persistenceId, { ok: true, result
    } catch (error) {
      persistence.set(persistenceId, { ok: false, error
    }
  }
  const persisted = persistence.get(persistenceId);
  if (persisted.ok) {
    if (compensate) compensations.push(compensate);
    return persisted.result;
  } else {
    throw persisted.error;
  }
};
```

…ACID maybe?

- Atomic: all transactions or compensating transactions will be executed
- Consistent: integrity in each transaction and eventually consistent across services
- Durable: each step commits its internal data
- Isolation: ???

Lack of isolation

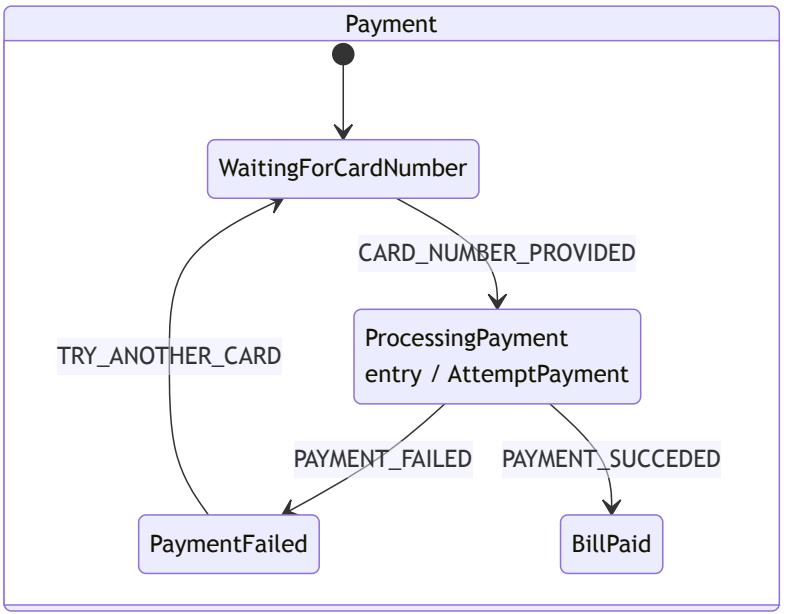
- Potential inconsistent reads
- Potential writes in between other flows



StateCharts

`(state, event) ⇒ state + effects[]`

Payment flow using State Machines



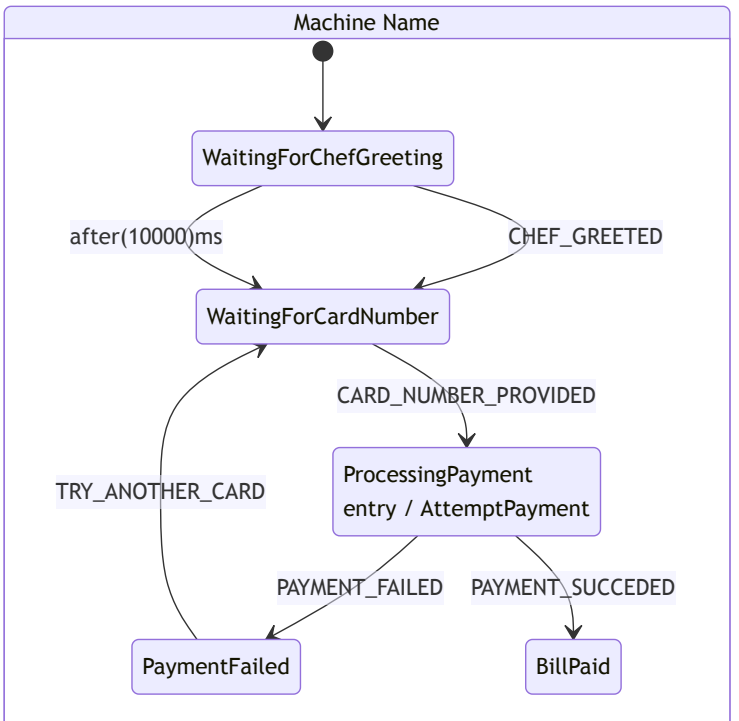
StateCharts are a DSL rather than Code

- Can be visually shown
- Can be understood by domain experts
- Creates a shared language between devs and experts

StateCharts are fully serializable

```
{
  "id": "Machine Name",
  "initial": "WaitingForCardNumber",
  "states": {
    "WaitingForCardNumber": {
      "on": {
        "CARD_NUMBER_PROVIDED": {
          "target": "ProcessingPayment"
        }
      }
    },
    "ProcessingPayment": {
      "entry": {
        "type": "AttemptPayment"
      },
      "on": {
        "PAYMENT_FAILED": {
          "target": "PaymentFailed"
        },
        "PAYMENT_SUCCEDED": {
```

Evolving flows



Evolving flows: I do not care!

- Short lived flows
- I Expect to have a consistent UX

Evolving flows: Restore machine state!

- Work for connections changes or new state added
- What to do when we delete states?

Evolving flows: Replay events

- Load the new definition with the default state
- Replay all the events that occurred before
- What to do with side effects?
- Works as long your entire machine is deterministic

Evolving flows: Upgrade events

- Do not delete previous state node
- Restore machine state with the new definition
- Trigger upgrade event
- Send new incoming events

Concurrent Executions

- The waiter comes to the table of 3 people
- The customer order 2 beers and a coke
- The waiter brings the order to kitchen
- Another waiter comes
- The confused customer order 1 beer and 2 coke
- The table receives 2 times the order

Concurrent execution: Real world

- The boss assigns ranges of tables to each waiter
- Each waiter will pick up only orders of the range od tables it got assigned to

Concurrent execution: Sharding

- A shard manager will assign range of entities to each worker
- Each worker gets a range of entities to manage and will care only about that
- We ensured that only one worker will process each entity

LRP means… long to reply APIs?

When should we reply to our request? Or should we wait for the completion?

Long Running Process: The challenges

- *Communication*: they can be orchestration or choreography
- *Distributed transactions*: data may be "dirty" between step
- *Persistent*: because the process may last forever even server restarts
- *Evolving*: because business requirements may change during application lifetime
- *Single executor per workflow*: you do not want concurrency issues right?

Thanks for your time!

- Twitter/X: @mattiamanzati