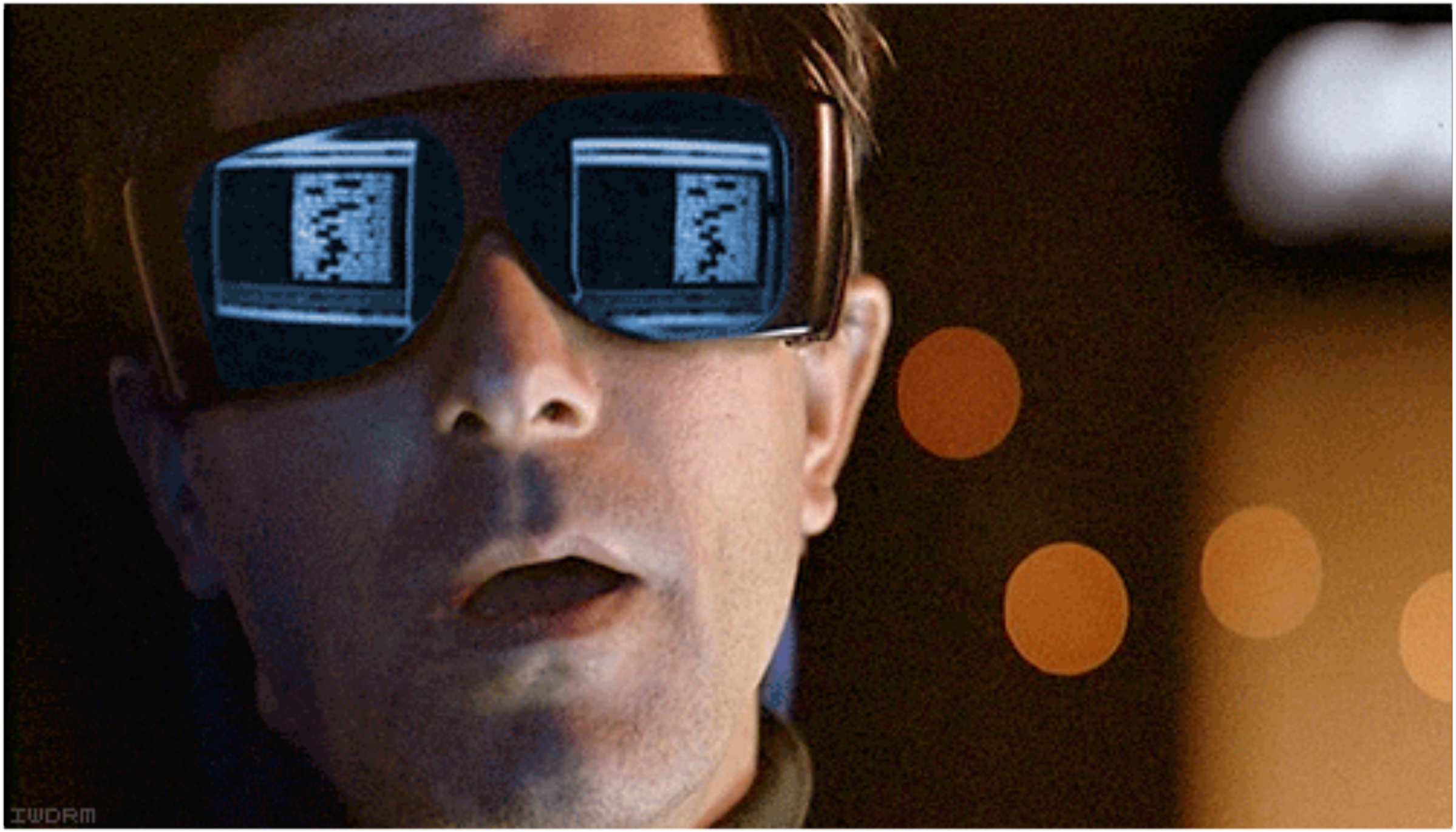
TAMING COMPLEXITY IN JAVASCRIPT WITH MACHINA.JS

JIM COWART / @IFANDELSE

WHO AM I?

- Developer Advocate @ Telerik
- @ifandelse
- OSS Author & Contributor (http://github.com/ifandelse)

I LOVE LOOKING FOR PATTERNS

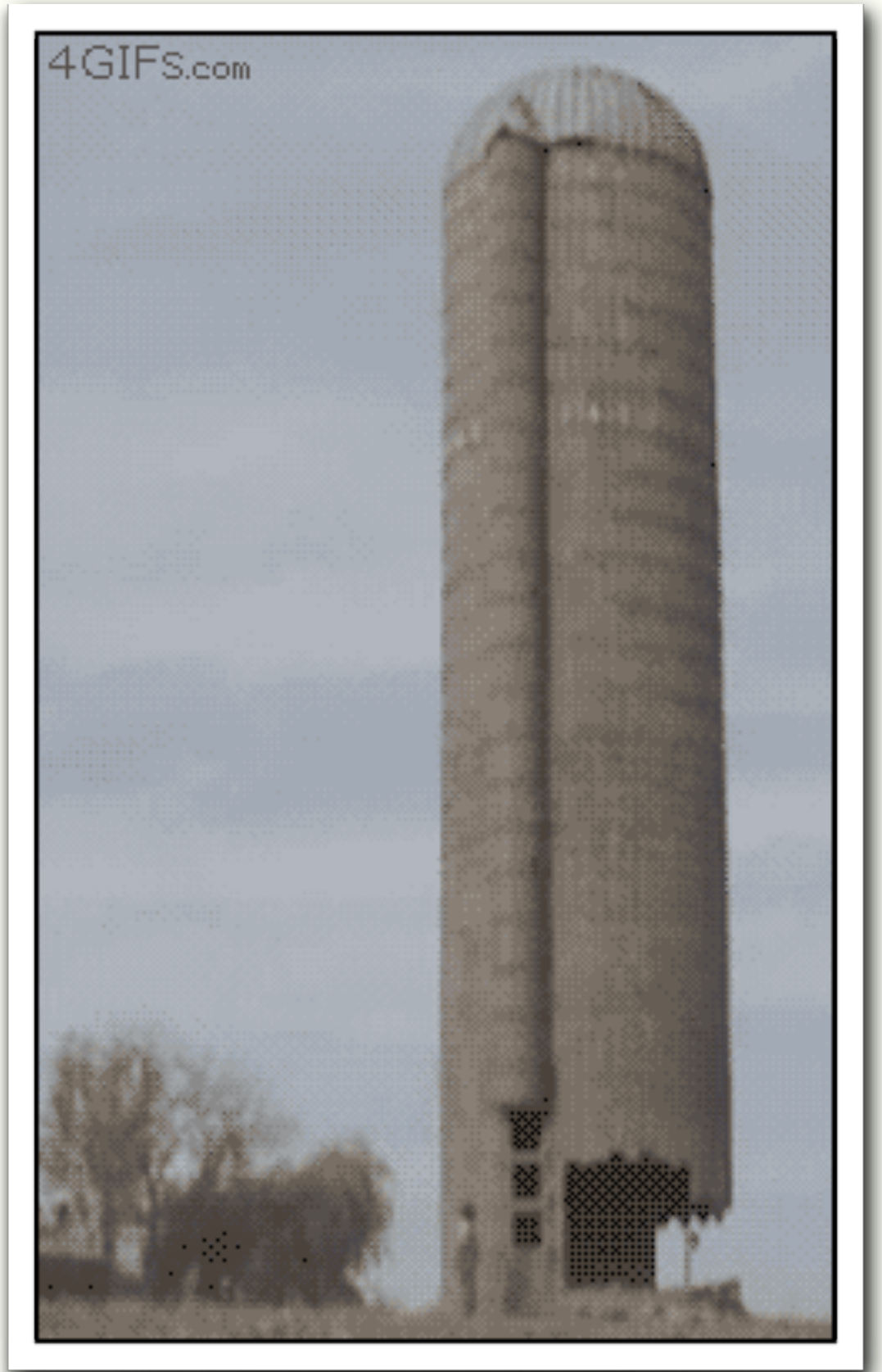


THEY TEND TO JUMP OUT AT ME

WHAT I WISH FOR

WHAT USUALLY HAPPENS

BUT IT'S OK...BECAUSE...REFACTORING



AND MORE REFACTORING

EVENTUALLY IT BECOMES...

WHAT I HOPE FOR YOU

AND

WHY ARE WE HERE?

- Workflow in JavaScript can be fun! How?

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- What are Finite State Machines?

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- What are Finite State Machines?
- What FSM behaviors are provided by machina.js?

WHY ARE WE HERE?

- Workflow in JavaScript can be fun! How?
- What are Finite State Machines?
- What FSM behaviors are provided by machina.js?
- How can we use this in the real world?

WHAT IS THE PROBLEM?

- How do you:
  - Manage online/offline state in your app?
  - Handle complex UI Workflow?
  - How do you structure order-dependent initialization?

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CONNECTIVITY DETECTION OPTIONS

- jQuery ajaxError event

```
$(document).ajaxError(
   function(event, req, opt) {
      //Wow- LOTS of assumptions
      //being made here...
      app.setStatus(“offline”);
   }
);
```

CONNECTIVITY DETECTION OPTIONS

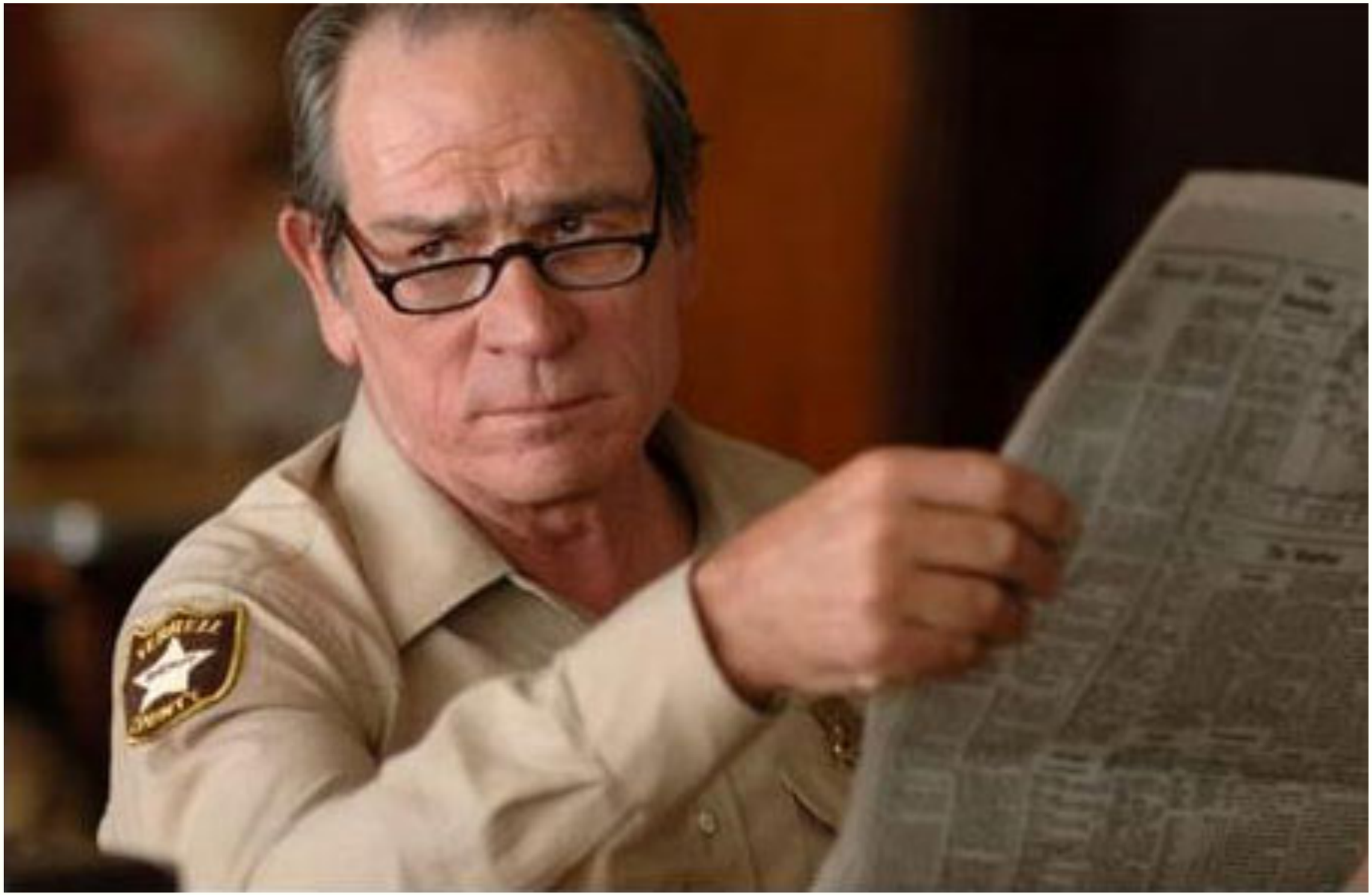
- jQuery ajaxError event
- navigator.onLine

A QUICK ASIDE ABOUT NAVIGATOR.ONLINE

“This attribute is inherently unreliable. A computer can be connected to a network without having Internet access.”

Hugs and Kisses,

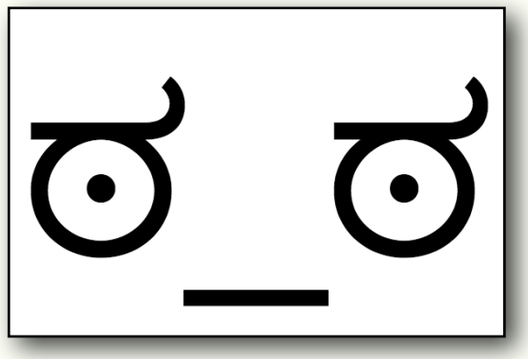
- the W3C



CONNECTIVITY DETECTION

```
1   if (navigator.onLine) {
2       save(customer);
3   } else {
4       queueUpForLater(customer);
5   }
```

CONNECTIVITY DETECTION



Who wants to have this all over the application?

```
1   if (navigator.onLine) {
2       save(customer);
3   } else {
4       queueUpForLater(customer);
5   }
```

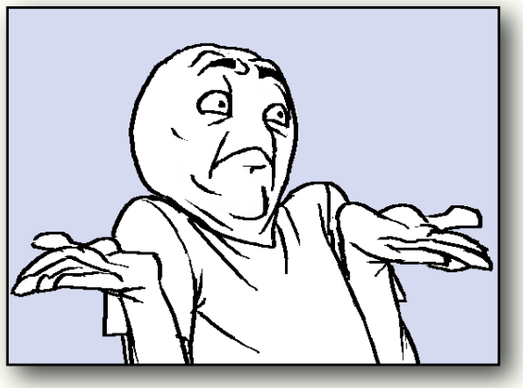
CONNECTIVITY DETECTION OPTIONS

- jQuery ajaxError event
- navigator.onLine
- addEventListener(“online”, handler);*

CONNECTIVITY DETECTION OPTIONS

- jQuery ajaxError event
- navigator.onLine
- addEventListener(“online”, handler);*
- window.applicationCache error

```
// assuming we have an app object
window.addEventListener("offline",function(){
    app.setStatus("offline");
});
window.addEventListener("online",function(){
    app.setStatus("online");
});
window.applicationCache.addEventListener(
    "error",
    function() {
        app.setStatus("offline");
    }
);
```



Is this better?

Than before, yes. Overall, NO.

```
1   // assuming we have an app object
2   window.addEventListener("offline",function(){
3     app.setStatus("offline");
4   });
5   window.addEventListener("online",function(){
6     app.setStatus("online");
7   });
8   window.applicationCache.addEventListener(
9     "error",
10    function() {
11      app.setStatus("offline");
12    }
13  );
```

CONNECTIVITY DETECTION OPTIONS

- jQuery ajaxError event
- navigator.onLine
- addEventListener(“online”, handler);*
- window.applicationCache error
- navigator.network.connection.type (Cordova/PhoneGap)

Sure...

Single Source of Application State

>

Peppered Spaghetti Branching

But What About...

- The Commuter Problem

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- False Negatives & Positives

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- Deliberate choice to go offline

But What About...

- The Commuter Problem
- False Negatives & Positives
- Deliberate choice to go offline
- Testability

We have lots of different abstractions for **similar** input

AN ABSTRACTION THAT....

Reacts differently to the same input depending on state

MAKE THIS EASY...

While We Are	And This Happens	Let's Do This
Online	http request	send request to server
	window.offline	set app to offline
Offline	http request	queue request up
	window.online	set app to online

FINITE STATE MACHINE

WHAT IS A FINITE STATE MACHINE?

?

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  - Has a finite number of states in which it can exist

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  - Can produce output determined by state &/ or input

WHAT IS A FINITE STATE MACHINE?

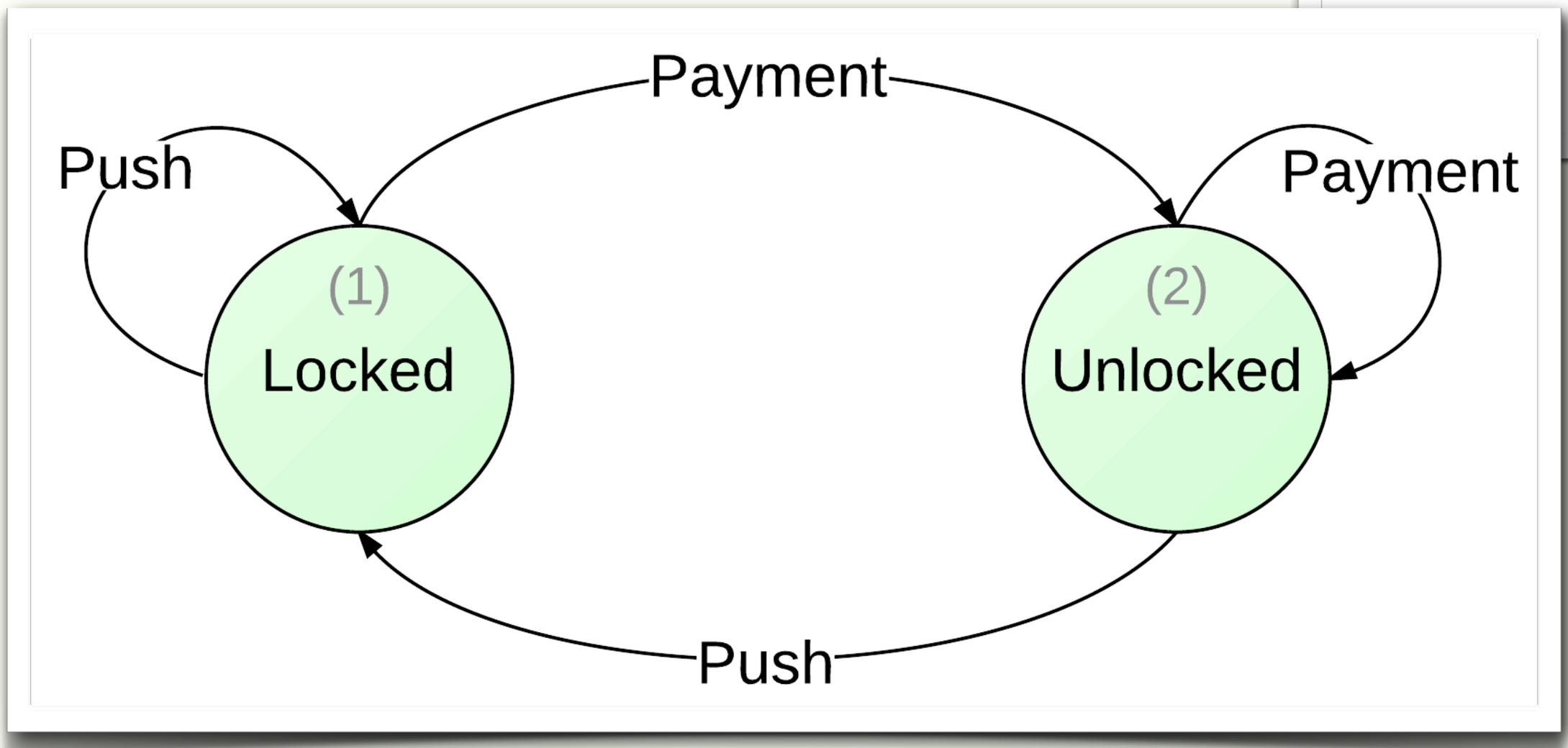
- A computational abstraction that:
  - Has a finite number of states in which it can exist
  - Can only be in one state at any time
  - Accepts input
  - Can produce output determined by state &/ or input
  - Can transition from one state to another*

THAT WAS A LOT OF TEXT ON ONE SCREEN

REAL WORLD EXAMPLE*

State	Input	Next State	Output
Locked	payment	Unlocked	turnstile released
	push	Locked	None
Unlocked	payment	Unlocked	None
	push	Locked	locks turnstile

DIAGRAMS FTW?



STILL AWAKE?

GOOD!

HERE'S SOME FINE

PRINT ON STATE

MACHINES

TWO BASIC TYPES

- Acceptor

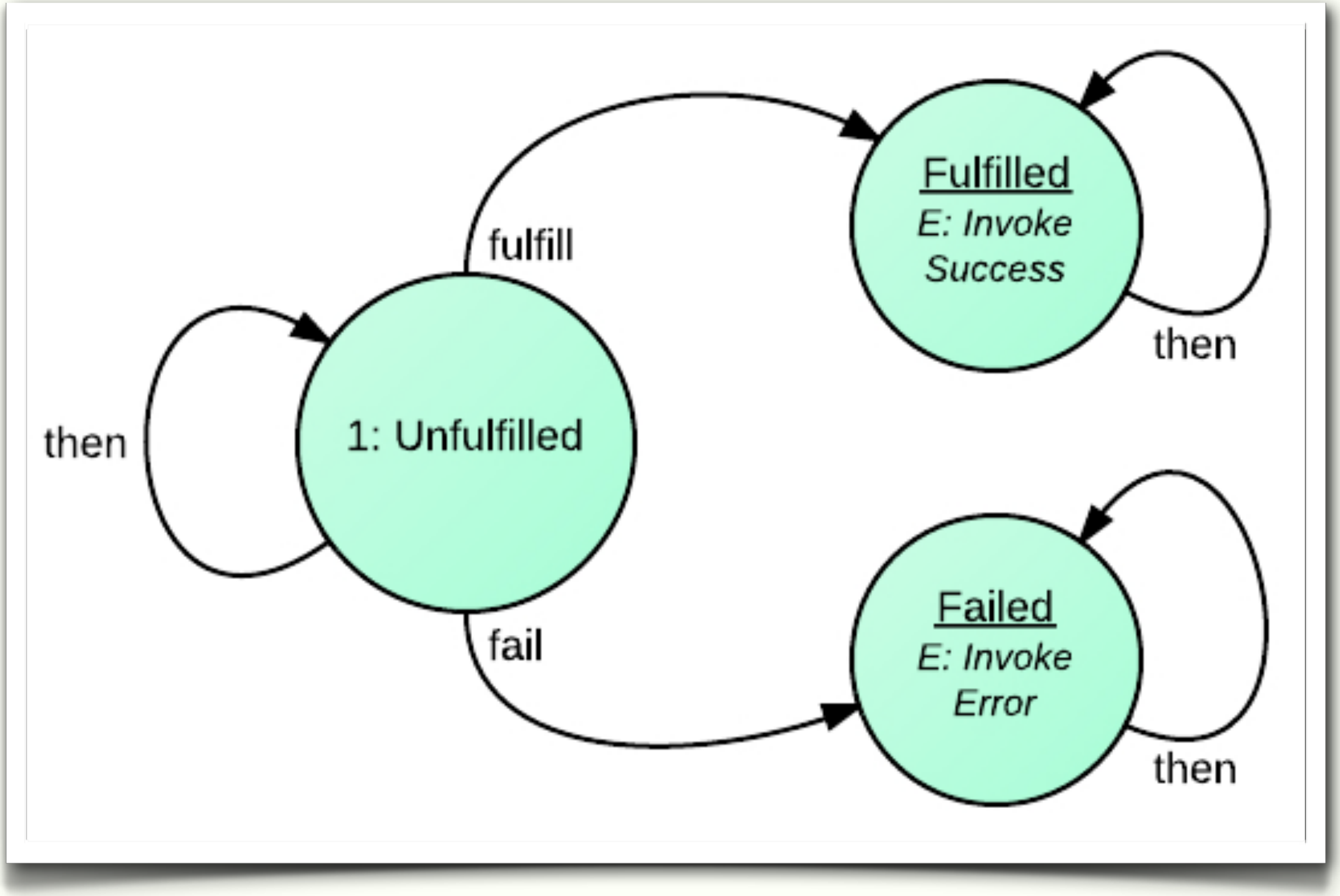
TWO BASIC TYPES

- Acceptor
- Transducer
  - Moore machine - output depends on state (entry actions)
  - Mealy machine - output depends on state and input

DETERMINISM

- Deterministic - only one transition possible for each input
- Non-deterministic - zero or more transitions possible from an input

PROMISES & FSMS



ENTER MACHINA.JS

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- STATES ARE ORGANIZED INTO A 'STATES' OBJECT ON THE FSM

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- EACH STATE OBJECT'S MEMBERS ARE FUNCTIONS* THAT RESPOND TO INPUT

ENTER MACHINA.JS

- STATES ARE ORGANIZED INTO A ‘STATES’ OBJECT ON THE FSM
- EACH OBJECT PROPERTY IS A STATE
- EACH STATE OBJECT’S MEMBERS ARE FUNCTIONS* THAT RESPOND TO INPUT
- CALLING “transition(stateName)” CHANGES STATE

ENTER MACHINA.JS

- FSM MAPS INPUT TO MATCHING HANDLER NAME:

  “handle(inputName, args*)”

ENTER MACHINA.JS

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- “_onEnter” & “_onExit” & “*”

ENTER MACHINA.JS

- FSM MAPS INPUT TO MATCHING HANDLER NAME:

  “handle(inputName, args*)”

- “_onEnter” & “_onExit” & “*”
- “deferUntilTransition([stateName])”

ENTER MACHINA.JS

- FSM MAPS INPUT TO MATCHING HANDLER NAME:

  “handle(inputName, args*)”

- “_onEnter” & “_onExit” & “*”
- “deferUntilTransition([stateName])”
- “deferUntilNextHandler()”

ENTER MACHINA.JS

- FSM MAPS INPUT TO MATCHING HANDLER NAME:

  “handle(inputName, args*)”

  - “_onEnter” & “_onExit” & “*”
  - “deferUntilTransition([stateName])”
  - “deferUntilNextHandler()”
  - BUILT-IN EVENT EMITTER


Sigh...so much API info... what if I need to *blink*?

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OMG CODE!

Instances and Constructors

```
var fsm = new machina.Fsm({ ... });
```

```
var Fsm = machina.Fsm.extend({ ... });
```

OMG CODE!

Instances and Constructors

```
var fsm = new machina.Fsm({ ... });
```

What goes here?

```
var Fsm = machina.Fsm.extend({ ... });
```

```
var turnstile = new machina.Fsm({
    initialState: “locked”,
    states: {
        locked: {
            payment: “unlocked”
        },
        unlocked: {
            push: “locked”
        }
    }
});
```

```
locked: {
  payment: “unlocked”
}
```

This is short for this:

```
locked: {
  payment: function() {
    this.transition(“unlocked”);
  }
}
```

```
var turnstile = new machina.Fsm({
    initialState: “locked”,
    states: {
        locked: {
            payment: “unlocked”
        },
        unlocked: {
            push: “locked”
        }
    }
});
```

OVERSIMPLIFIED USAGE

```
// you could do this
turnstile.handle(“push”); // sorry, not so much
turnstile.handle(“payment”); // trans.-> unlocked
turnstile.handle(“payment”); // oops, wasted лв
turnstile.handle(“push”); // yay, I get through
```

OVERSIMPLIFIED USAGE

```
// but you'll probably prefer to do this
// i.e. - top level methods wrapping handle()
turnstile.push(); // sorry, not so much
turnstile.pay(); // transition-> unlocked
turnstile.pay(); // oops, wasted money
turnstile.push(); // yay, I get through
```

HOW DO WE APPLY THIS?

HOW DOES IT HELP MANAGE CONNECTIVITY STATE?

CONNECTIVITY STATES

- Online
- Offline (the user said so!)

CONNECTIVITY STATES

- Online
- Offline (the user said so!)
- Disconnected (Oops, no connection)

CONNECTIVITY STATES

- Online
- Offline (the user said so!)
- Disconnected (Oops, no connection)
- Probing (detecting if we're online)

ONLINE STATE INPUT & TRANSITIONS

State	Input	Next State	Output
Online	window.offline	Probing	Emit Transition Event
	appCache.error	Probing	Emit Transition Event
	request.timeout	Probing	Emit Transition Event
	go.offline	Offline	Emit Transition Event

OFFLINE STATE INPUT & TRANSITIONS

State	Input	Next State	Output
Offline	go.online	Probing	Emit Transition Event

DISCONNECTED STATE INPUT & TRANSITIONS

State	Input	Next State	Output
Disconnected	go.online	Probing	Emit Transition Event
	go.offline	Offline	Emit Transition Event
	window.online	Probing	Emit Transition Event
	appCache. downloading	Probing	Emit Transition Event

PROBING STATE INPUT & TRANSITIONS

State	Input	Next State	Output
Probing	heartbeat	Online	Emit Transition Event
	no-heartbeat	Disconnected	Emit Transition Event
	go.offline	Offline	Emit Transition Event

State	Input	Next State	Output
Online	window.offline	Probing	Emit Transition Event
	appCache.error	Probing	Emit Transition Event
	request.timeout	Probing	Emit Transition Event
	go.offline	Offline	Emit Transition Event
Offline	go.online	Probing	Emit Transition Event
Disconnected	go.online	Probing	Emit Transition Event
	go.offline	Offline	Emit Transition Event
	window.online	Probing	Emit Transition Event
	appCache. downloading	Probing	Emit Transition Event
Probing	heartbeat	Online	Emit Transition Event
	no-heartbeat	Disconnected	Emit Transition Event
	go.offline	Offline	Emit Transition Event

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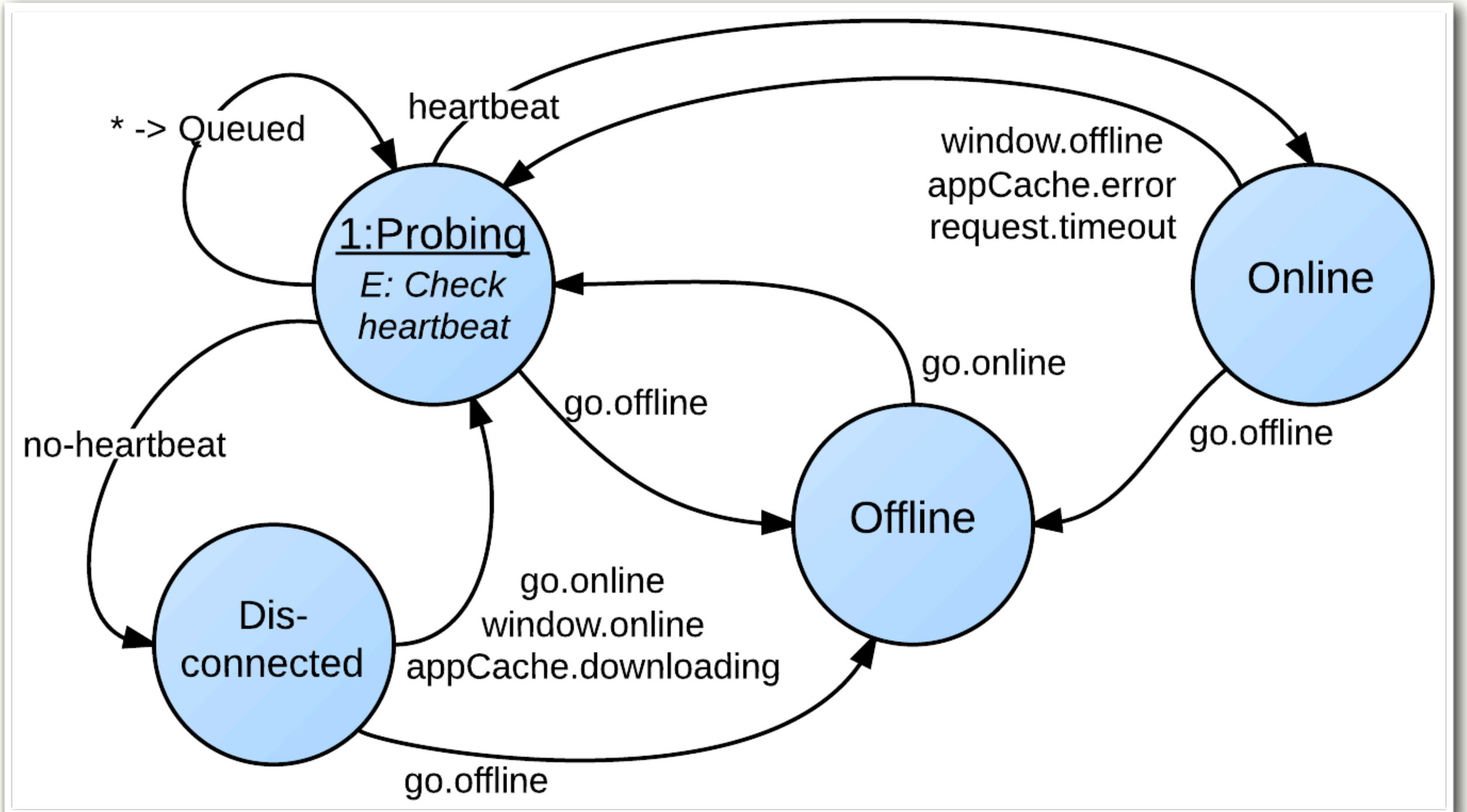
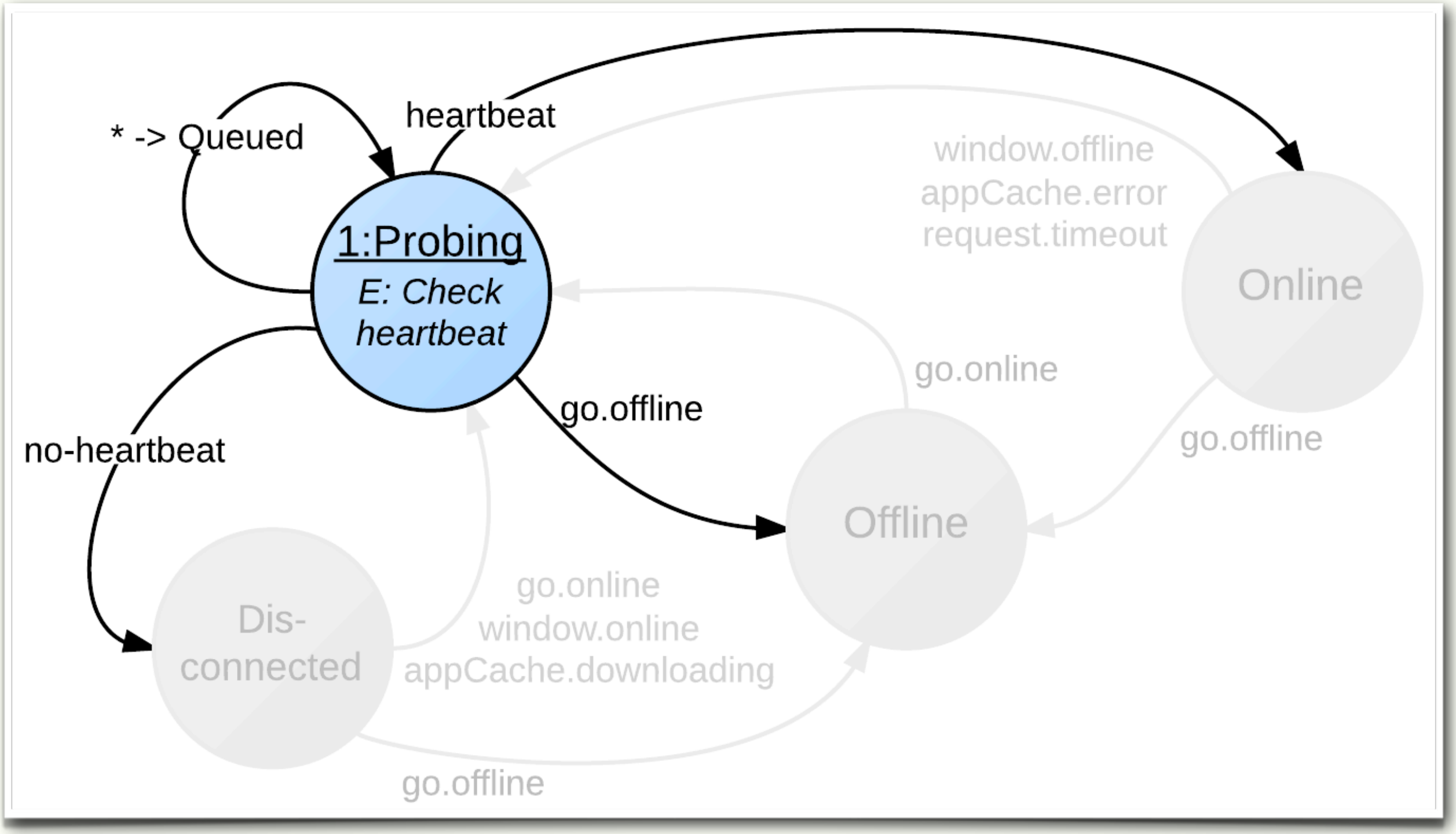
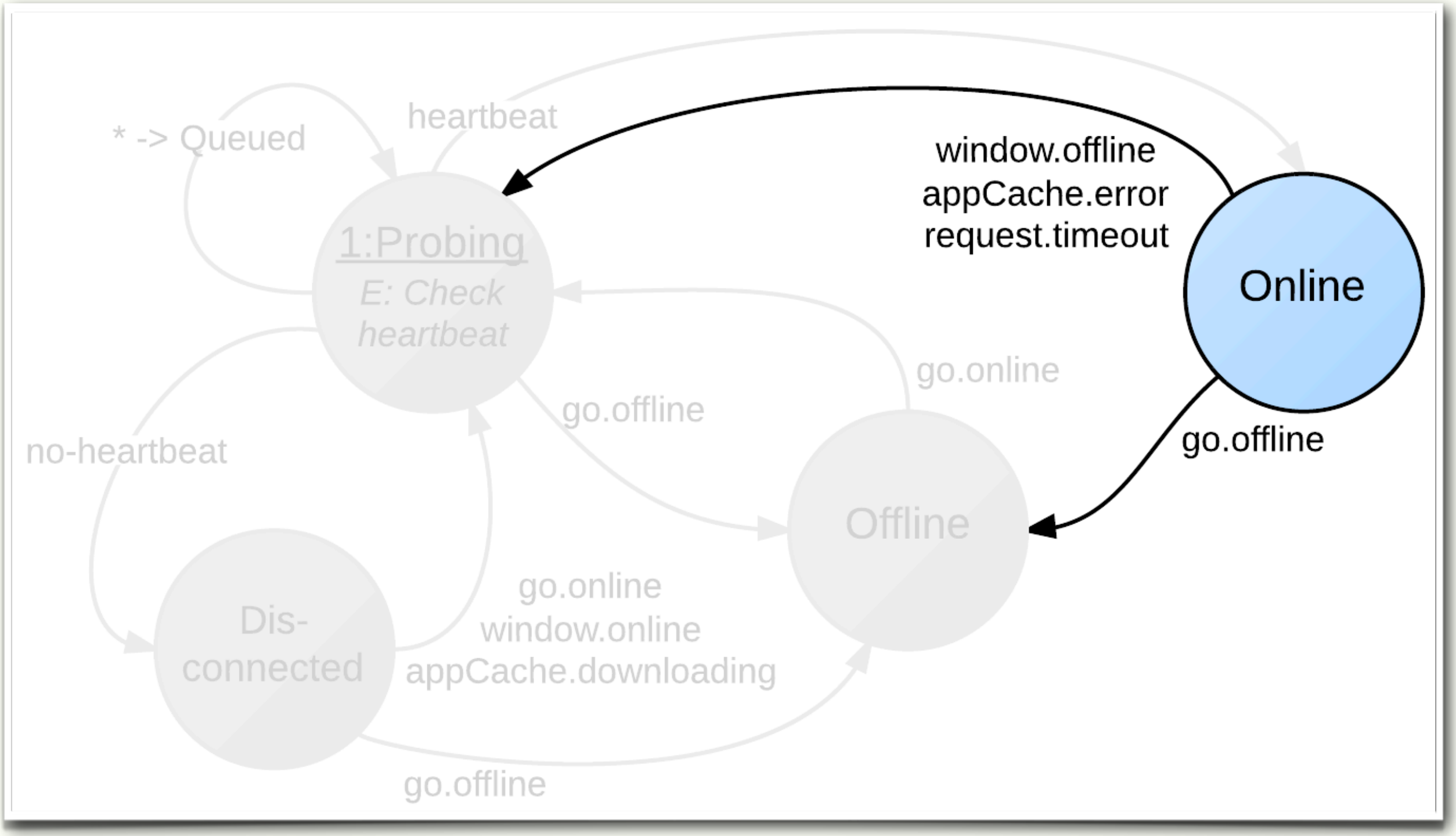
CONNECTIVITY STATE MACHINE



CONNECTIVITY STATE MACHINE



CONNECTIVITY STATE MACHINE



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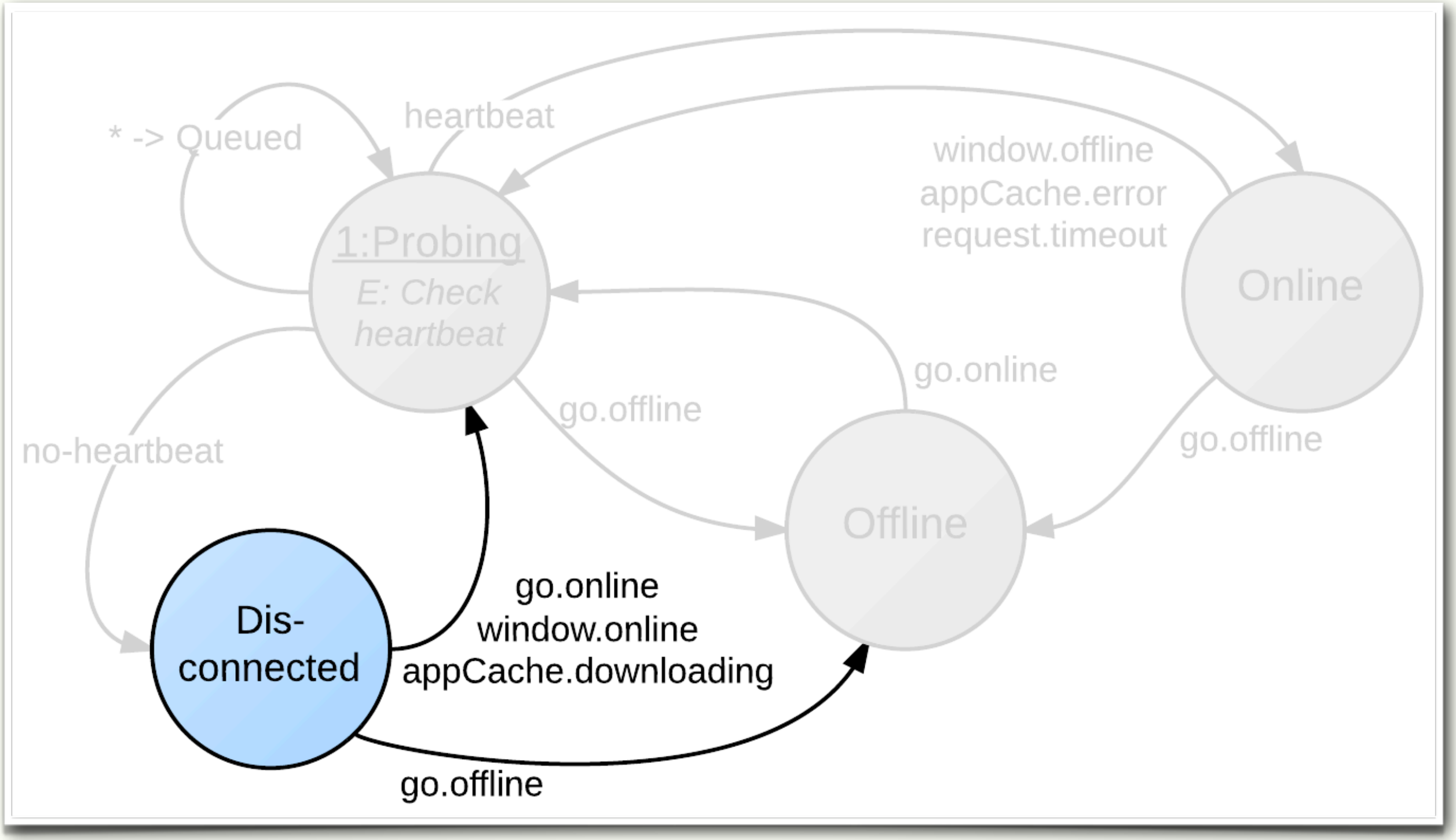

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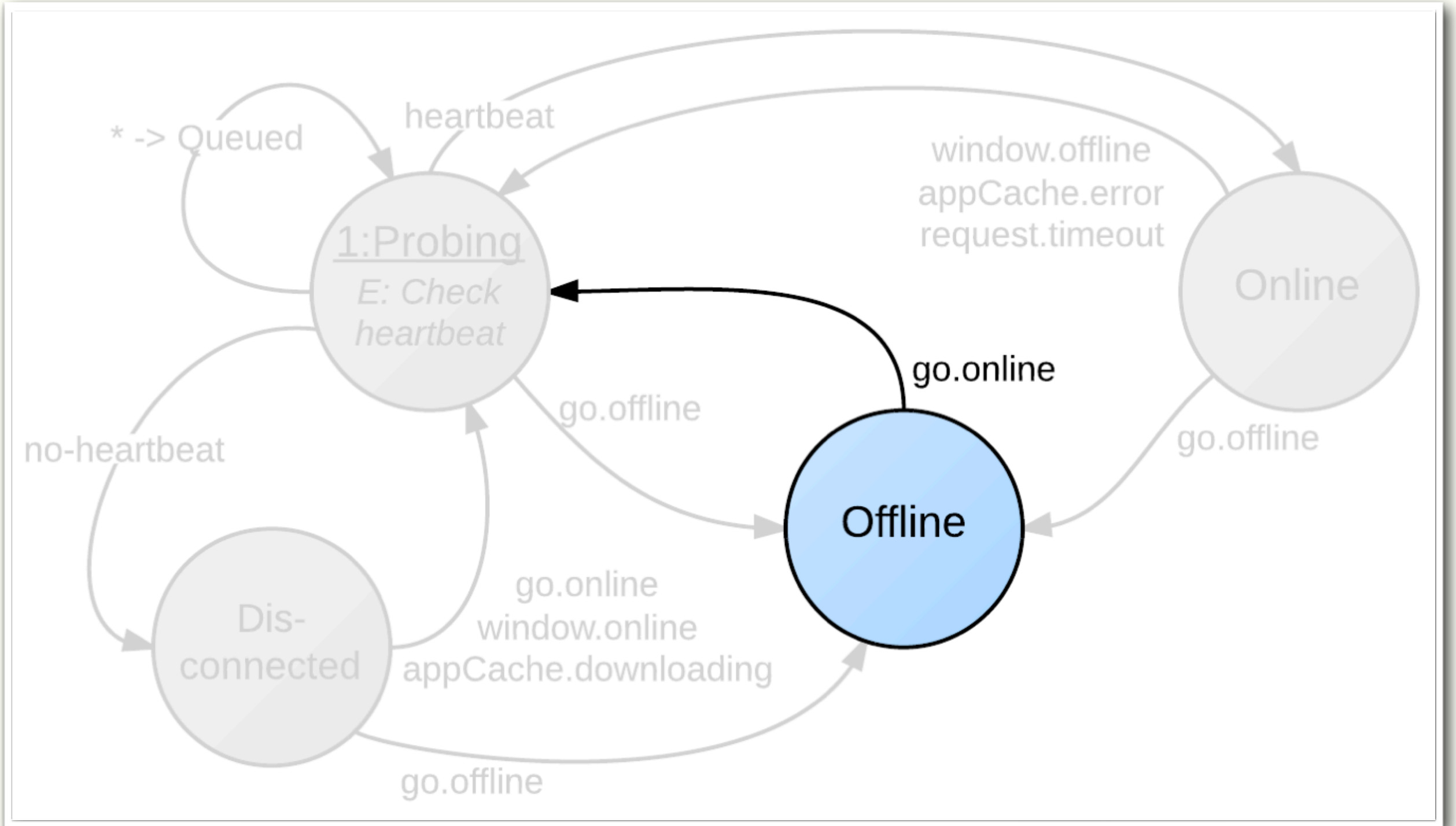

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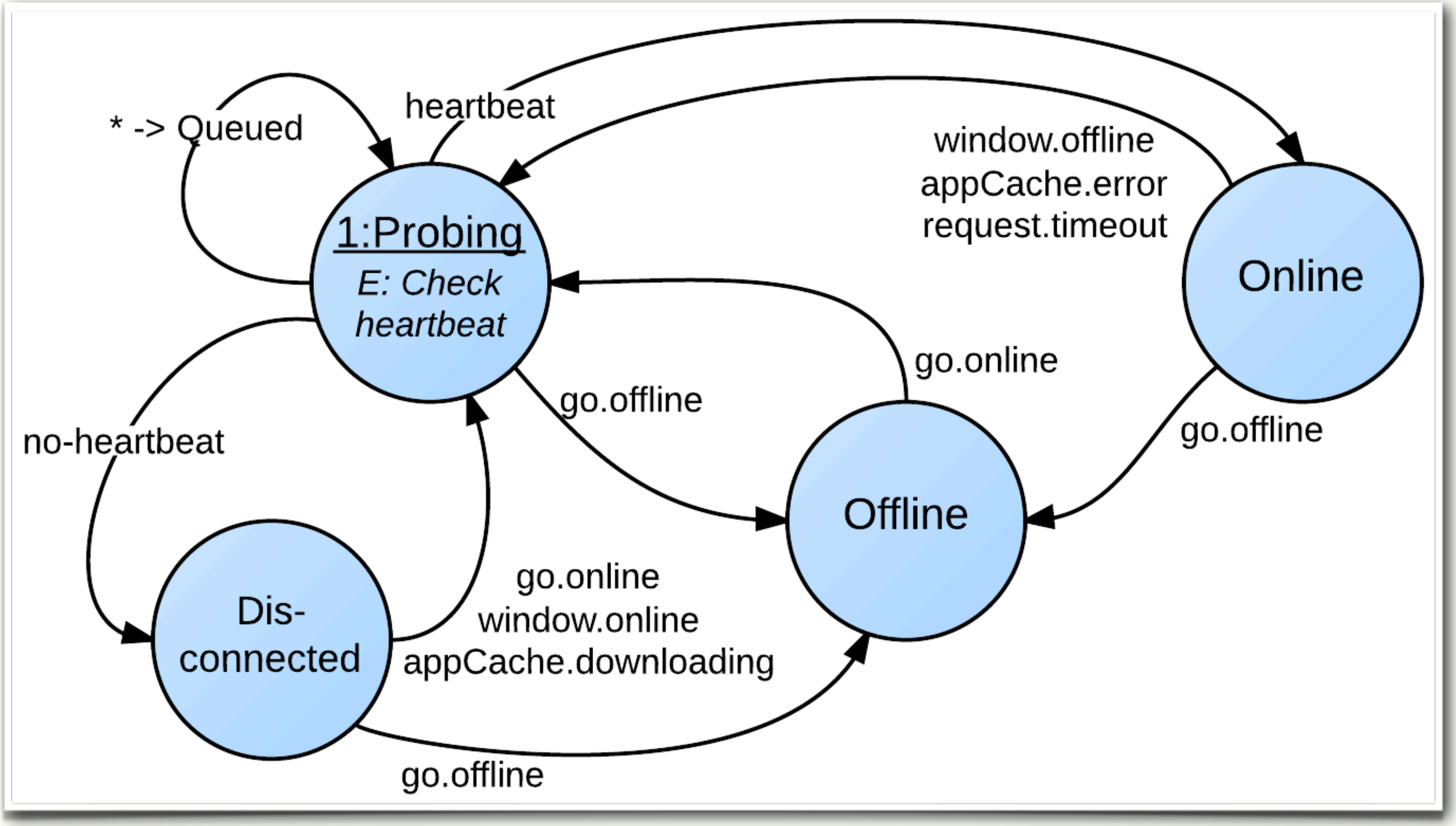


CODE

Child's Toy Simplicity

WAIT...WHAT HAPPENED TO THE HTTP BEHAVIOR?

SIBLING STATE MACHINES

Connectivity FSM

Communications FSM

State: Queuing

SIBLING STATE MACHINES

Connectivity FSM

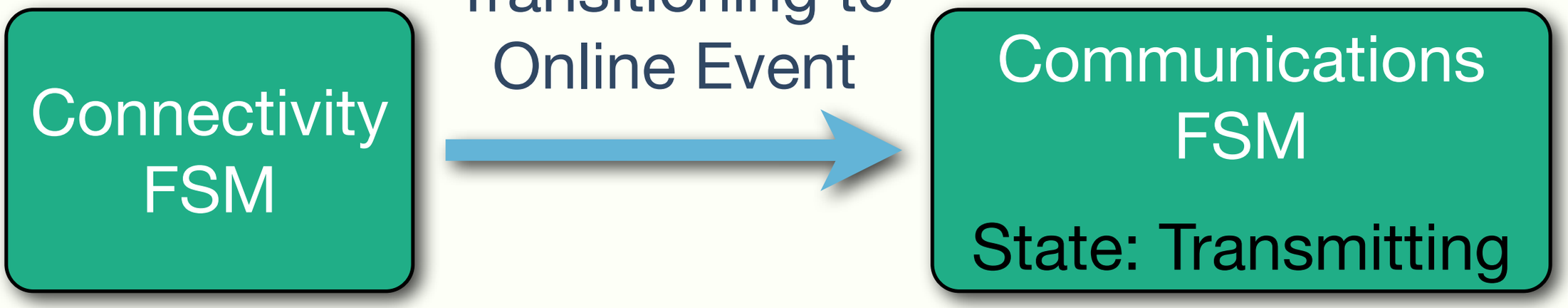
I emit events

Communications FSM

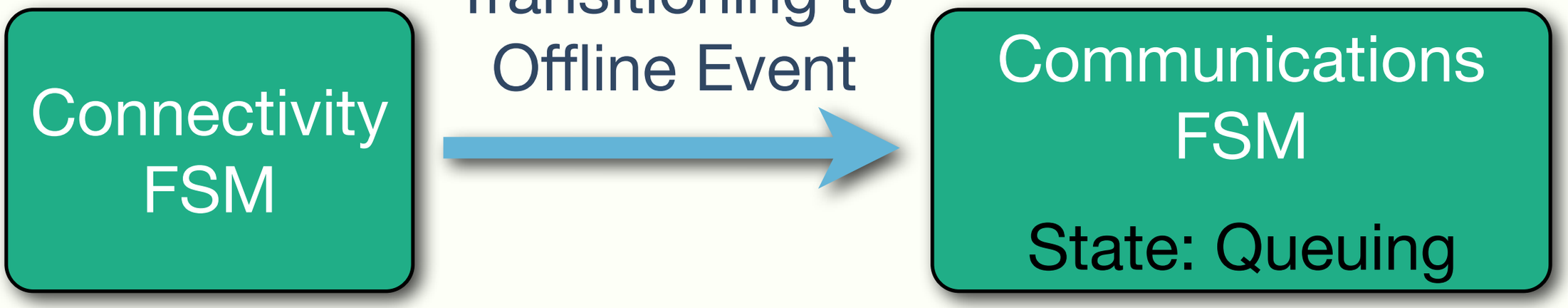
State: Queuing

Sweet. I'll listen...

SIBLING STATE MACHINES



SIBLING STATE MACHINES



FSMS WORKING TOGETHER: POWERFUL WAY TO MANAGE & ISOLATE COMPLEXITY

You, when they ask if you tackled the connectivity problem in an extensible way...

WHAT IS THE PROBLEM?

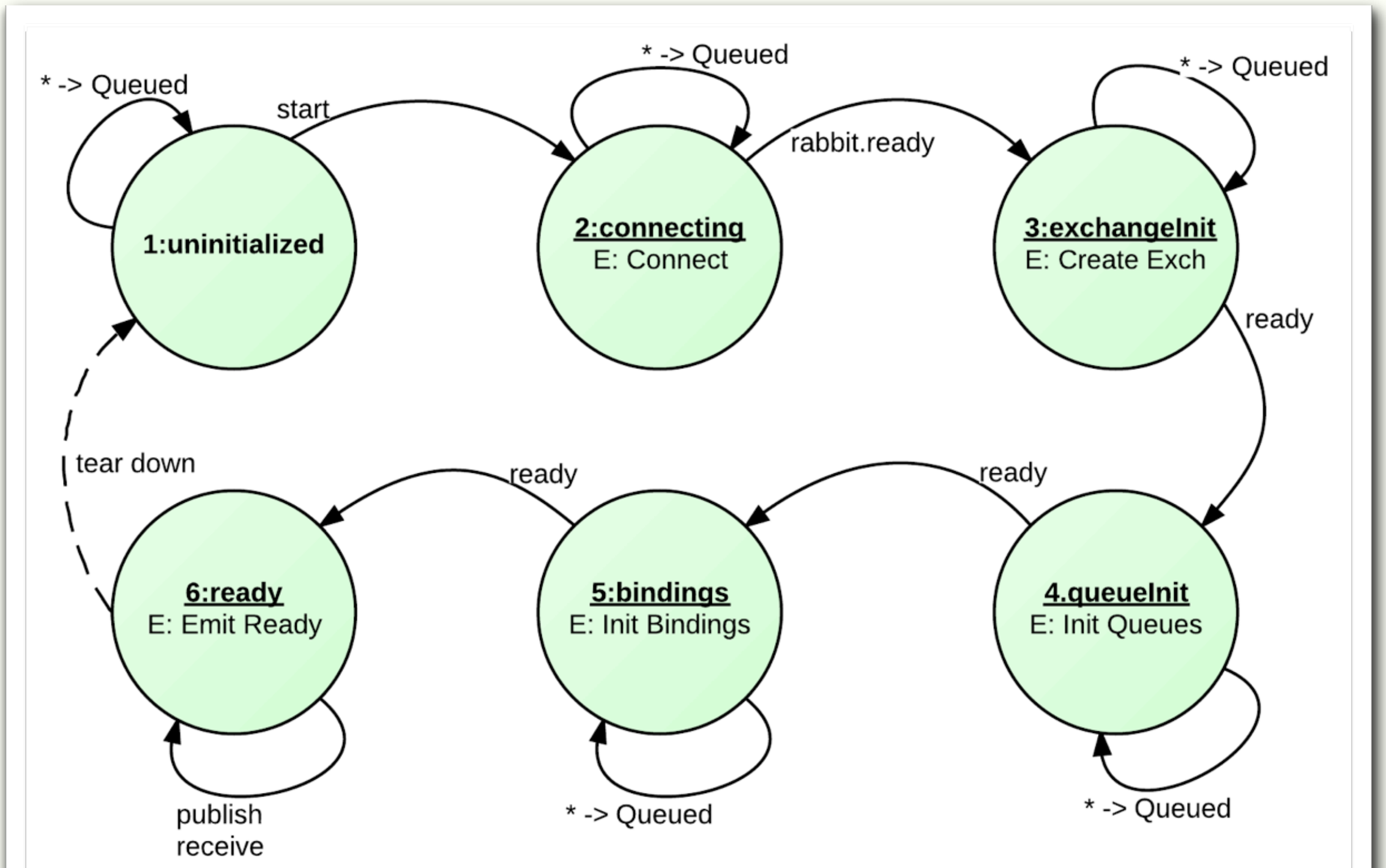
- How do you:
  - ~~Manage online/offline state in your app?~~
  - **Handle complex UI Workflow?**
  - How do you structure order-dependent initialization?

UI WORKFLOW

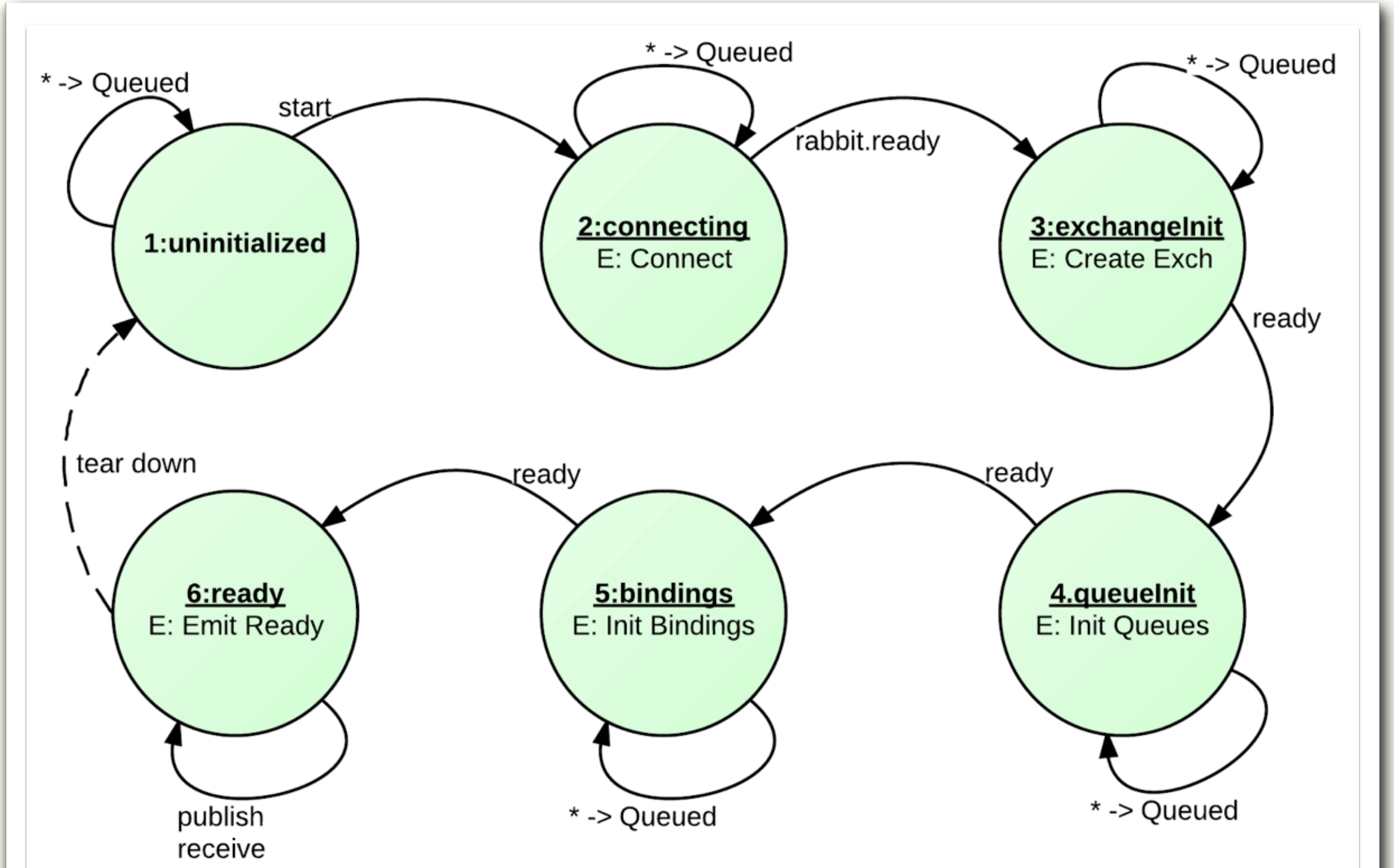
CODE

WHAT IS THE PROBLEM?

- How do you:
  - ~~Manage online/offline state in your app?~~
  - ~~Handle complex UI Workflow?~~
  - **How do you structure order-dependent initialization?**


* -> Queued
start
* -> Queued
rabbit.ready
* -> Queued
1:uninitialized
2:connecting
E: Connect
3:exchangeInit
E: Create Exch
ready
tear down
ready
ready
6:ready
E: Emit Ready
5:bindings
E: Init Bindings
4.queueInit
E: Init Queues
publish
receive
* -> Queued
* -> Queued

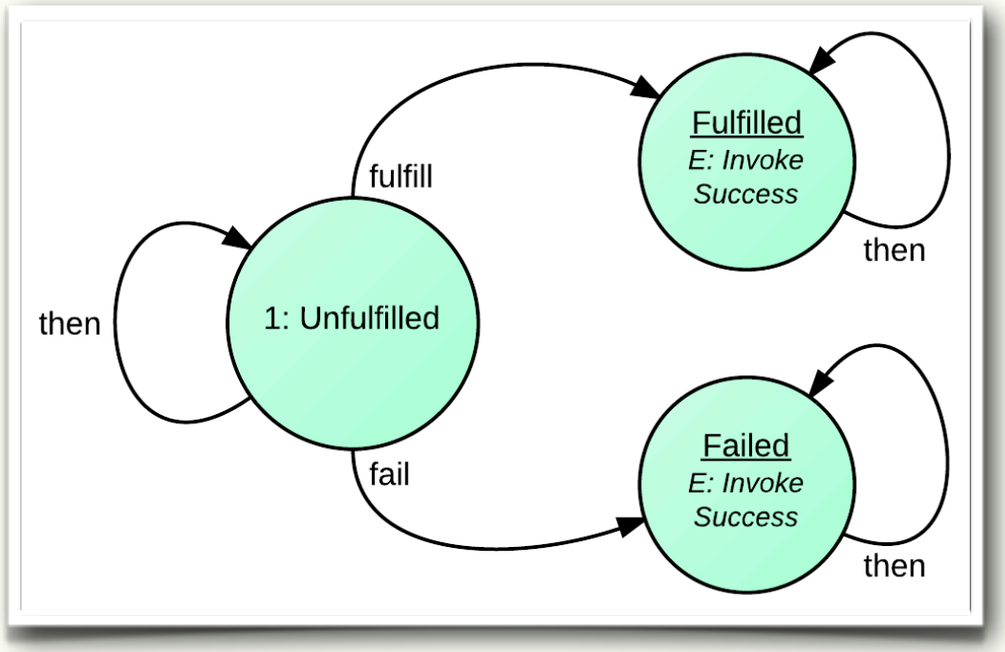
INITIALIZATION STATE MACHINE



CODE

See: https://github.com/a2labs/amqp-bootstrapper

PROMISES
& FSMS



CODE

(FEEL FREE TO CHECK THIS OUT ON YOUR OWN)

HTTPS://GITHUB.COM/A2LABS/MACHINA.PROMISE

PROS & CONS

- PROS
  - EXTREMELY VERSATILE
  - LENDS WELL TO GOOD SEPARATION OF CONCERNS
  - GREAT FOR LONG-RUNNING ASYNC WORKFLOWS
  - EXPRESSIVE

PROS & CONS

- CONS
  - MODELING COMPLEX/HIERARCHICAL FSMS IS “HARD”
  - LESS FAMILIAR PATTERN (FOR MANY)

FURTHER RESOURCES

- Finite State Machine - Wikipedia
- Taking Control With machina (Doug Neiner)
- Learn You Some Erlang - Finite State Machines
- machina.js on FreshBrewedCode
- machina.js on github
- "state" - cool FSM project by Nick Fargo
- Harvey Mudd CS paper on FSMs

Q & A