REDISCONF 2016

BACKGROUND TASKS IN NODE.JS

@EVANTAHLER

WARNING

MOST OF THE IDEAS IN THIS PRESENTATION ARE ACTUALLY VERY BAD IDEAS.

TRY THESE AT ~, NOT ON PRODUCTION

node
JS®

HI. I'M EVAN

- Director of Technology @ TaskRabbit
- Founder of ActionHero, node.js framework
- Node-Resque Author

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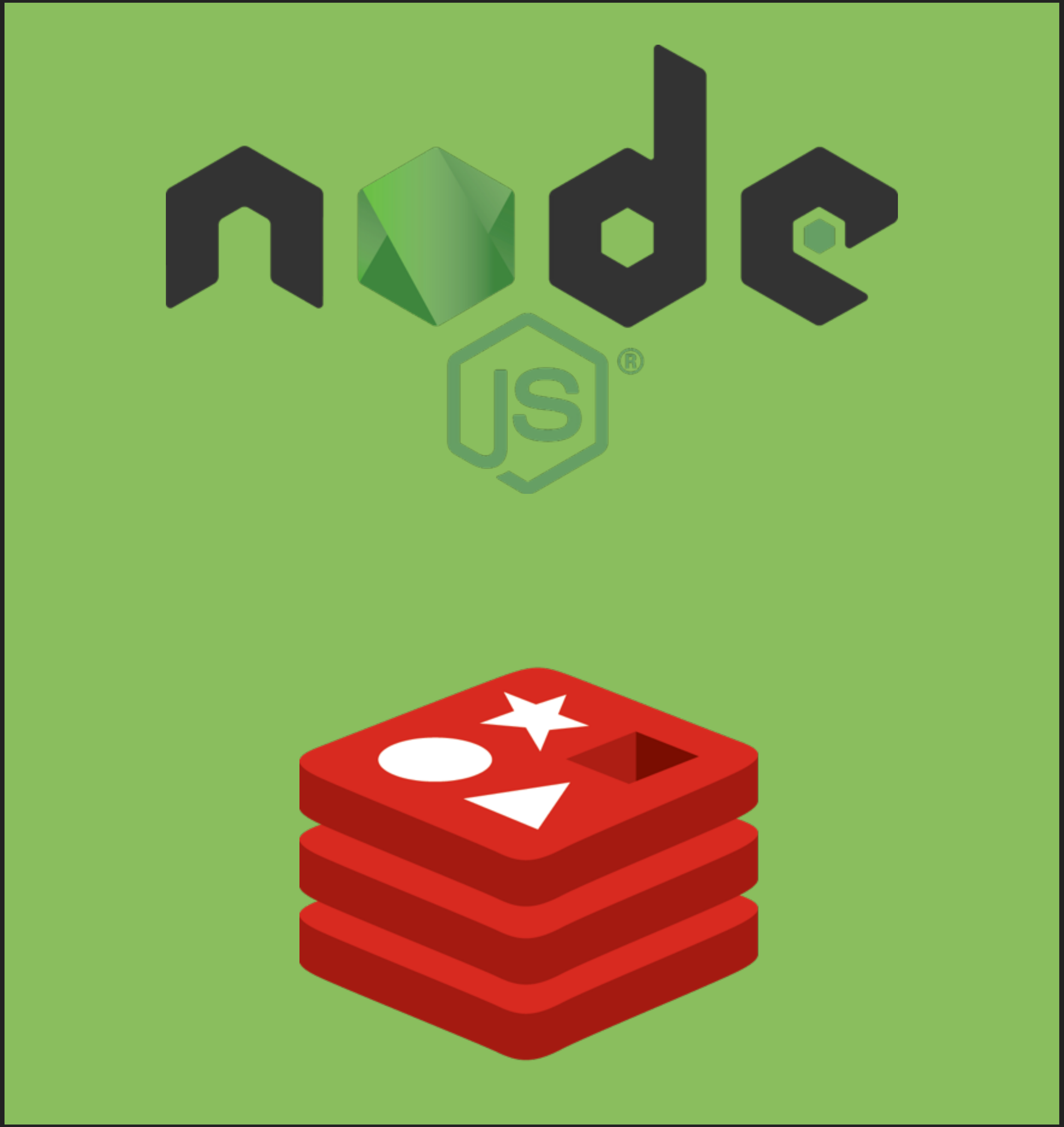
WHAT IS NODE.JS

- Server-side Framework, uses JS
- Async
- Fast

WHAT IS REDIS

- In-memory database
- Structured data
- Fast

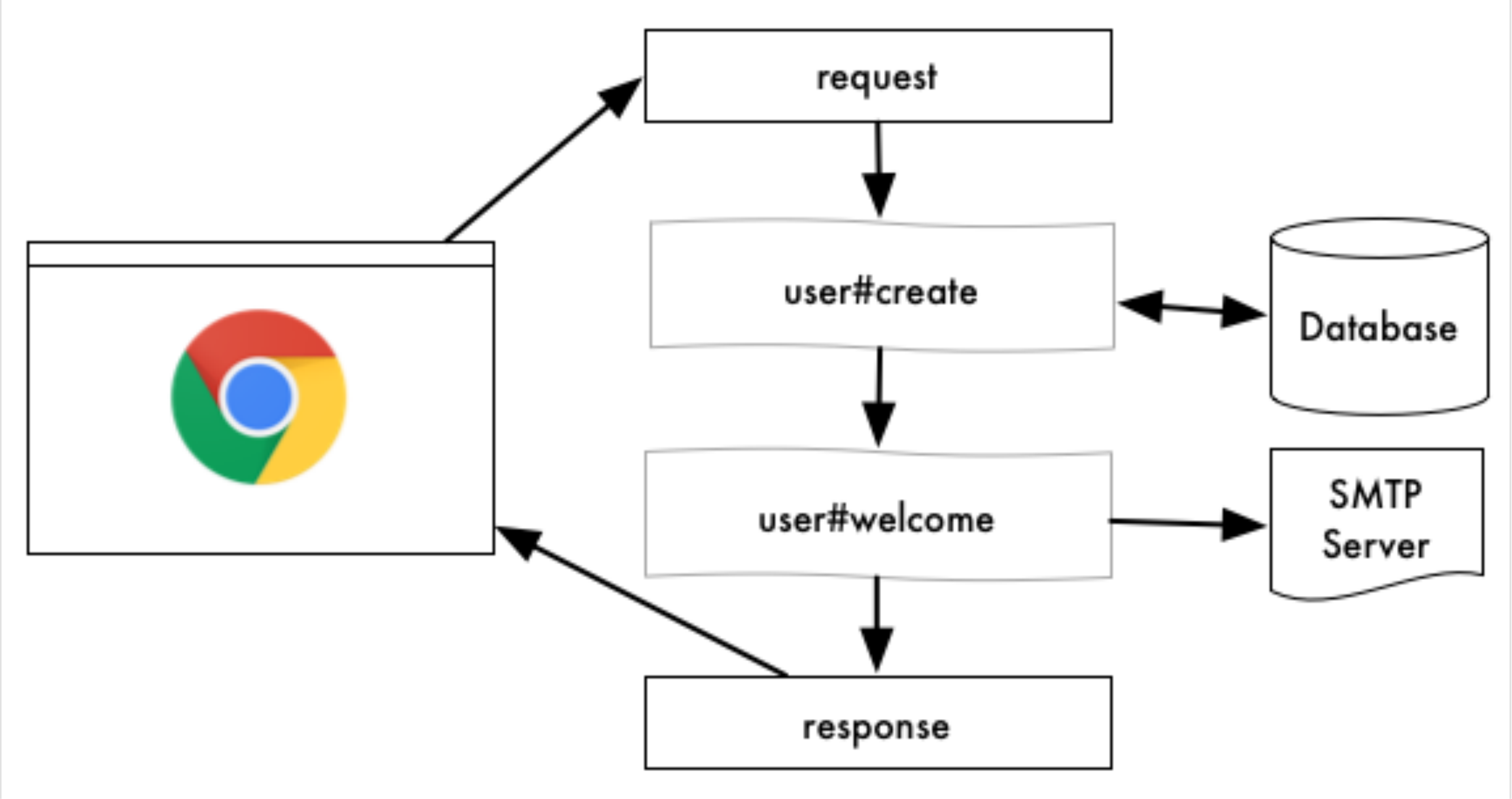


WHAT ARE WE GOING TO TALK ABOUT?

> EVERYTHING IS FASTER IN NODE…
> ESPECIALLY THE BAD IDEAS

Me (Evan)

WHAT ARE WE GOING TO TALK ABOUT?



POSSIBLE TASK STRATEGIES:

FOREGROUND (IN-LINE)

PARALLEL (THREAD-ISH)

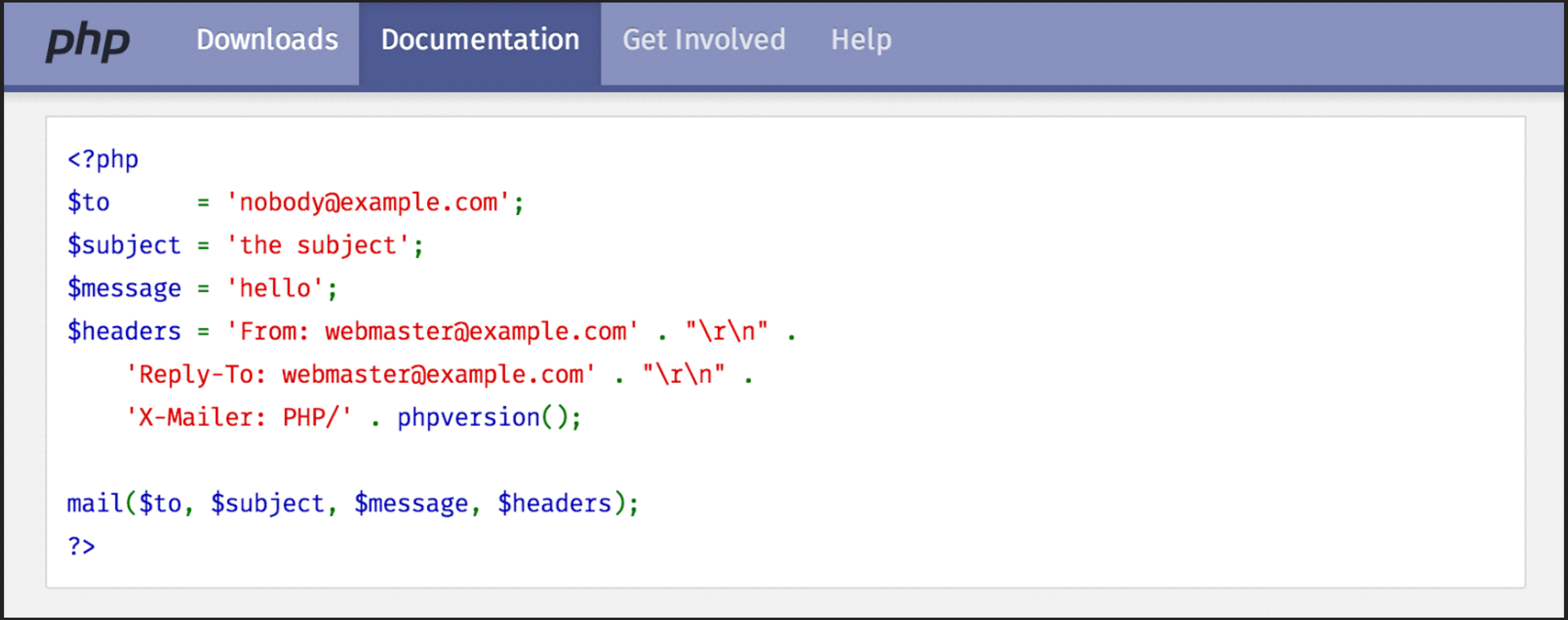
LOCAL MESSAGES (FORK-ISH)

REMOTE MESSAGES (*MQ-ISH)

REMOTE QUEUE (REDIS + RESQUE)

IMMUTABLE EVENT BUS (KAFKA-ISH)

1) FOREGROUND TASKS



```php
<?php
$to      = 'nobody@example.com';
$subject = 'the subject';
$message = 'hello';
$headers = 'From: webmaster@example.com' . "\r\n" .
    'Reply-To: webmaster@example.com' . "\r\n" .
    'X-Mailer: PHP/' . phpversion();

mail($to, $subject, $message, $headers);
?>
```

SENDING EMAILS

```
var http          = require('http');
var nodemailer    = require('nodemailer');
var httpPort      = process.env.PORT || 8080;
var httpHost      = process.env.HOST || '127.0.0.1';

var transporter = nodemailer.createTransport({
    service: 'gmail',
    auth: {
      user: require('./.emailUsername'),
      pass: require('./.emailPassword')
    }
});
```

```
var sendEmail = function(req, callback){
  var urlParts     = req.url.split('/');
  var email        = {
    from:    require('./.emailUsername'),
    to:      decodeURI(urlParts[1]),
    subject: decodeURI(urlParts[2]),
    text:    decodeURI(urlParts[3]),
  };
  transporter.sendMail(email, function(error, info){
    callback(error, email);
  });
};
```

THE SERVER

```
var server = function(req, res){
  var start = Date.now();
  var responseCode = 200;
  var response     = {};

  sendEmail(req, function(error, email){
    response.email = email;

    if(error){
      console.log(error);
      responseCode = 500;
      response.error = error;
    }

    res.writeHead(responseCode, {'Content-Type': 'application/json'});
    res.end(JSON.stringify(response, null, 2));
    var delta = Date.now() - start;
    console.log('Sent an email to ' + email.to + ' in ' + delta + 'ms');
  });

};

http.createServer(server).listen(httpPort, httpHost);
```

Async and non-blocking!

DEMO TIME

STRATEGY SUMMARY

- **Why it is better in node:**
  - The client still needs to wait for the message to send, but you won't block any other client's requests
  - Avg response time of ~2 seconds from my couch
- **Why it is still a bad idea:**
  - Slow for the client
  - Spending "web server" resources on sending email
  - Error / Timeout to the client for "partial success"
    - IE: Account created but email not sent
    - Confusing to the user, dangerous for the DB

2) PARALLEL TASKS

IMPROVEMENT IDEAS

- In any other language this would be called “threading”
  - But if it were real threading, the client would still have to wait
  - I guess this might help you catch errors…
  - _*note: do not get into a discussion about threads in node…_
- Lets get crazy:
  - Ignore the Callback

IGNORE THE CALLBACK

```
var sendEmail = function(req, callback){
  var urlParts     = req.url.split('/');
  var email        = {
    from:    require('./.emailUsername'),
    to:      decodeURI(urlParts[1]),
    subject: decodeURI(urlParts[2]),
    text:    decodeURI(urlParts[3]),
  };
  transporter.sendMail(email, function(error, info){
    if(typeof callback === 'function'){
      callback(error, email);
    }
  });
};
```

```
var server = function(req, res){
  var start = Date.now();
  var responseCode = 200;
  var response     = {};
  sendEmail(req);
  res.writeHead(responseCode, {'Content-Type': 'application/json'});
  res.end(JSON.stringify(response, null, 2));
  console.log('Sent an email');
};


http.createServer(server).listen(httpPort, httpHost);
```

DEMO TIME

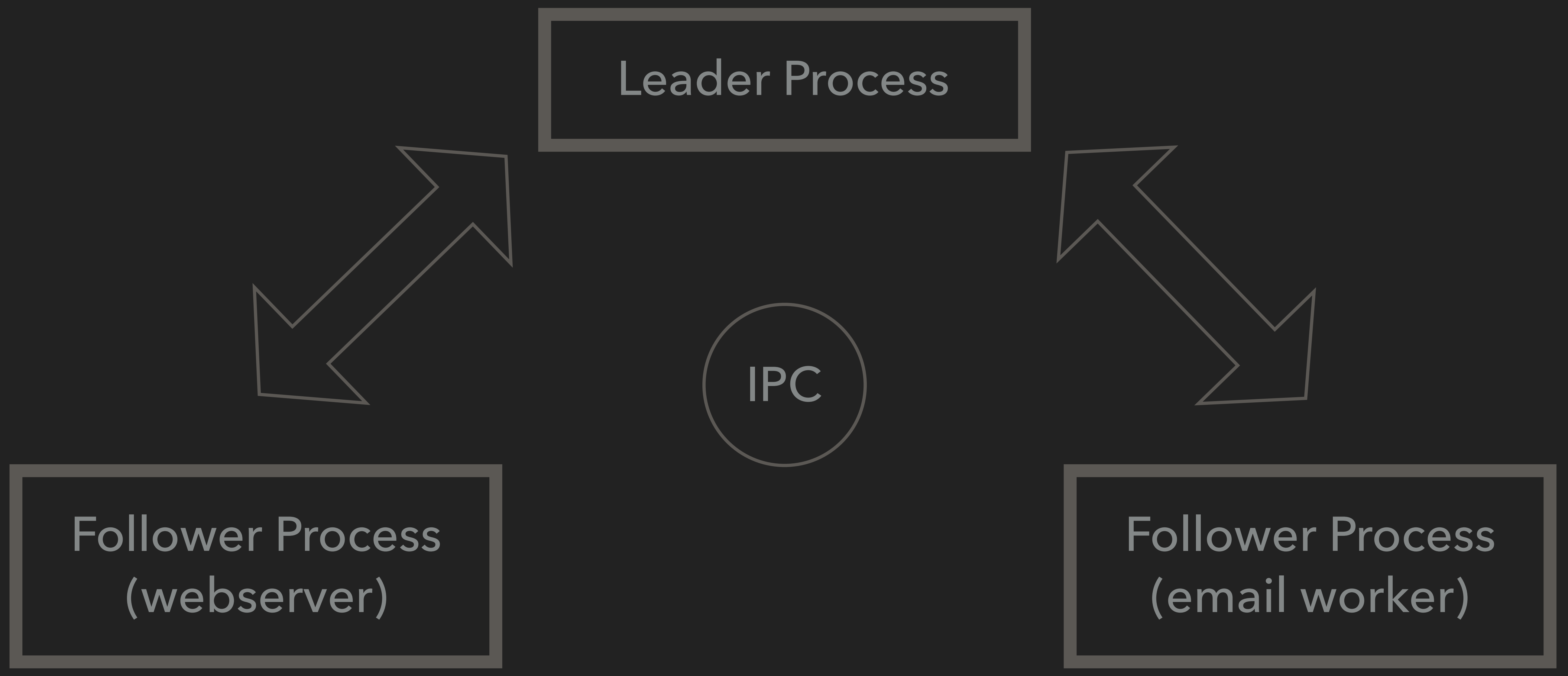
STRATEGY SUMMARY

- **Why it is better in node:**
  - It’s rare you can actually do this in a language… without threading or folks!
  - Crazy-wicked-fast.
- **Why it is still a bad idea:**
  - 0 callbacks, 0 data captured
  - I guess you could log errors?
  - But what would you do with that data?
  - The client has no idea what happened

3) LOCAL MESSAGES

or: "The part of the talk where we grossly over-engineer some stuff"

IMPROVEMENT IDEAS



CLUSTERING IN NODE.JS
A SIMPLE TIMED MANAGER SCRIPT…

```
var cluster = require('cluster');


if(cluster.isMaster){
  doMasterStuff();
}else{
  if(process.env.ROLE === 'server'){ doServerStuff(); }
  if(process.env.ROLE === 'worker'){ doWorkerStuff(); }
}
```

```
var doMasterStuff = function(){
  log('master', 'started master');

  var masterLoop = function(){
    checkOnWebServer();
    checkOnEmailWorker();
  };

  var checkOnWebServer = function(){
  …
  };

  var checkOnEmailWorker = function(){
  …
  };

  setInterval(masterLoop, 1000);
};
```

CLUSTERING IN NODE.JS

```
var doServerStuff = function(){
  var server = function(req, res){
    var urlParts = req.url.split('/');
    var email    = {
      to:      decodeURI(urlParts[1]),
      subject: decodeURI(urlParts[2]),
      text:    decodeURI(urlParts[3]),
    };

    var response = {email: email};
    res.writeHead(200, {'Content-Type': 'application/json'});
    res.end(JSON.stringify(response, null, 2));

    process.send(email);
  };

  http.createServer(server).listen(httpPort, '127.0.0.1');
};
```

Interprocess Communication (IPC) with complex data-types

CLUSTERING IN NODE.JS

```
var checkOnWebServer = function(){
    if(children.server === undefined){
      log('master', 'starting web server');
      children.server = cluster.fork({ROLE: 'server'});
      children.server.name = 'web server';
      children.server.on('online',    function(){ log(children.server, 'ready on port ' + httpPort); });
      children.server.on('exit',      function(){
        log(children.server, 'died :(');
        delete children.server;
      });
      children.server.on('message',   function(message){
        log(children.server, 'got an email to send from the webserver: ' + JSON.stringify(message));
        children.worker.send(message);
      });
    }
  };
```

…IT'S ALL JUST MESSAGE PASSING

CLUSTERING IN NODE.JS

```
var checkOnEmailWorker = function(){
    if(children.worker === undefined){
      log('master', 'starting email worker');
      children.worker = cluster.fork({ROLE: 'worker'});
      children.worker.name = 'email worker';
      children.worker.on('online',    function(){ log(children.worker, 'ready!'); });
      children.worker.on('exit',      function(){
        log(children.worker, 'died :(');
        delete children.worker;
      });
      children.worker.on('message',   function(message){
        log(children.worker, JSON.stringify(message));
      });
    }
  };
```

...IT'S ALL JUST MESSAGE PASSING

LOCAL MESSAGES

```
var doWorkerStuff = function(){
  process.on('message', function(message){
    emails.push(message);
  });

  var sendEmail = function(to, subject, text, callback){
    …
  };

  var workerLoop = function(){
    if(emails.length === 0){
      setTimeout(workerLoop, 1000);
    }else{
      var e = emails.shift();
      process.send({msg: 'trying to send an email...'});
      sendEmail(e.to, e.subject, e.text, function(error){
        if(error){
          emails.push(e); // try again
          process.send({msg: 'failed sending email, trying again :('});
        }else{
          process.send({msg: 'email sent!'});
        }
        setTimeout(workerLoop, 1000);
      });
    }
  };

  workerLoop();
};
```

Message Queue

Throttling

Retry

Interprocess Communication (IPC) with complex data-types

DEMO TIME

STRATEGY SUMMARY

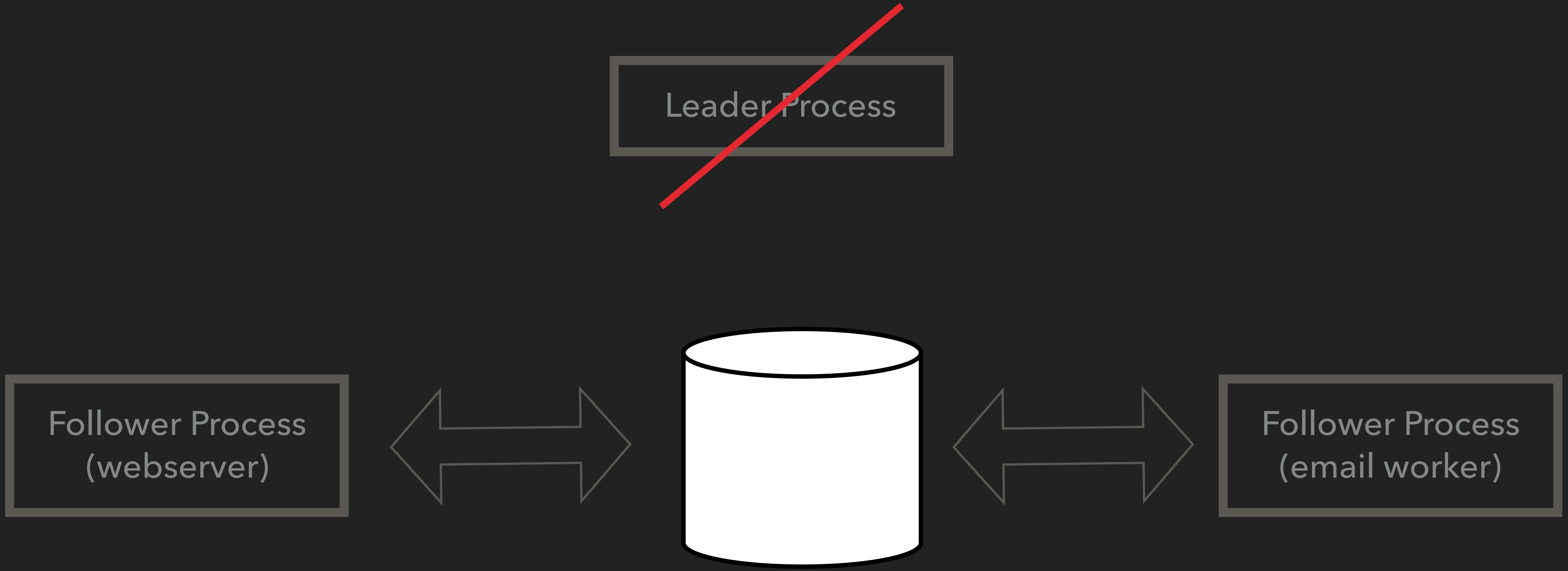
- Notes:
  - the children never log themselves
    - the master does it for them
  - Each process has it’s own “main” loop:
    - web server
    - worker
    - master
  - we can kill the child processes / allow them to crash…

STRATEGY SUMMARY

- **Why it is better in node:**
  - In ~100 lines of JS…
    - Messages aren’t lost when server dies
    - Web-server process not bothered by email sending
    - Error handling, Throttling, Queuing and retries!
    - Offline support?
- **Why it is still a bad idea:**
  - Bound to one server

4) REMOTE MESSAGES

IMPROVEMENT IDEAS



node
JS®

IPC => REDIS PUB/SUB

```
var doServerStuff = function(){
  var server = function(req, res){
    var urlParts = req.url.split('/');
    var email    = {
      to:       decodeURI(urlParts[1]),
      subject:  decodeURI(urlParts[2]),
      text:     decodeURI(urlParts[3]),
    };

    var response = {email: email};
    res.writeHead(200, {'Content-Type': 'application/json'});
    res.end(JSON.stringify(response, null, 2));

    process.send(email);
  };

  http.createServer(server).listen(httpPort, '127.0.0.1');
};
```

```
var doServerStuff = function(){
  var publisher = Redis();

  var server = function(req, res){
    var urlParts = req.url.split('/');
    var email    = {
      to:       decodeURI(urlParts[1]),
      subject:  decodeURI(urlParts[2]),
      text:     decodeURI(urlParts[3]),
    };

    publisher.publish(channel, JSON.stringify(email), function(){
      var response = {email: email};
      res.writeHead(200, {'Content-Type': 'application/json'});
      res.end(JSON.stringify(response, null, 2));
    });
  };

  http.createServer(server).listen(httpPort, httpHost);
  console.log('Server running at ' + httpHost + ':' + httpPort);
  console.log('send an email and message to /TO_ADDRESS/SUBJECT/YOUR_MESSAGE');
};
```

REMOTE MESSAGES

```
var doWorkerStuff = function(){
  process.on('message', function(message){
    emails.push(message);
  });

  var sendEmail = function(to, subject, text, callback){
    …
  };

  var workerLoop = function(){
    if(emails.length === 0){
      setTimeout(workerLoop, 1000);
    }else{
      var e = emails.shift();
      process.send({msg: 'trying to send an email...'});
      sendEmail(e.to, e.subject, e.text, function(error){
        if(error){
          emails.push(e); // try again
          process.send({msg: 'failed sending email, trying again :('});
        }else{
          process.send({msg: 'email sent!'});
        }
        setTimeout(workerLoop, 1000);
      });
    }
  };

  workerLoop();
};
```

```
var subscriber = Redis();

  subscriber.subscribe(channel);
  subscriber.on('message', function(channel, message){
    console.log('Message from Redis!');
    emails.push(JSON.parse(message));
  });
```

Still with Throttling and Retry!

DEMO TIME

STRATEGY SUMMARY

- **Why it is better in node:**
  - Redis Drivers are awesome
    - Message Buffering (for connection errors)
    - Thread-pools
    - Good language features (promises and callbacks)
  - Now we can use more than one server!
- **Why it is still a bad idea:**
  - Errors are logged, not passed back to the client
  - Email payload is lost on error or worker failure

5) REMOTE QUEUE

IMPROVEMENT IDEAS

- Observability
  - How long is the queue?
  - How long does an item wait in the queue?
  - Operational Monitoring
- Redundancy
  - Backups
  - Clustering
  - Backups

node
JS

DATA STRUCTURES NEEDED FOR AN MVP QUEUE

- Array
  - push, pop, length

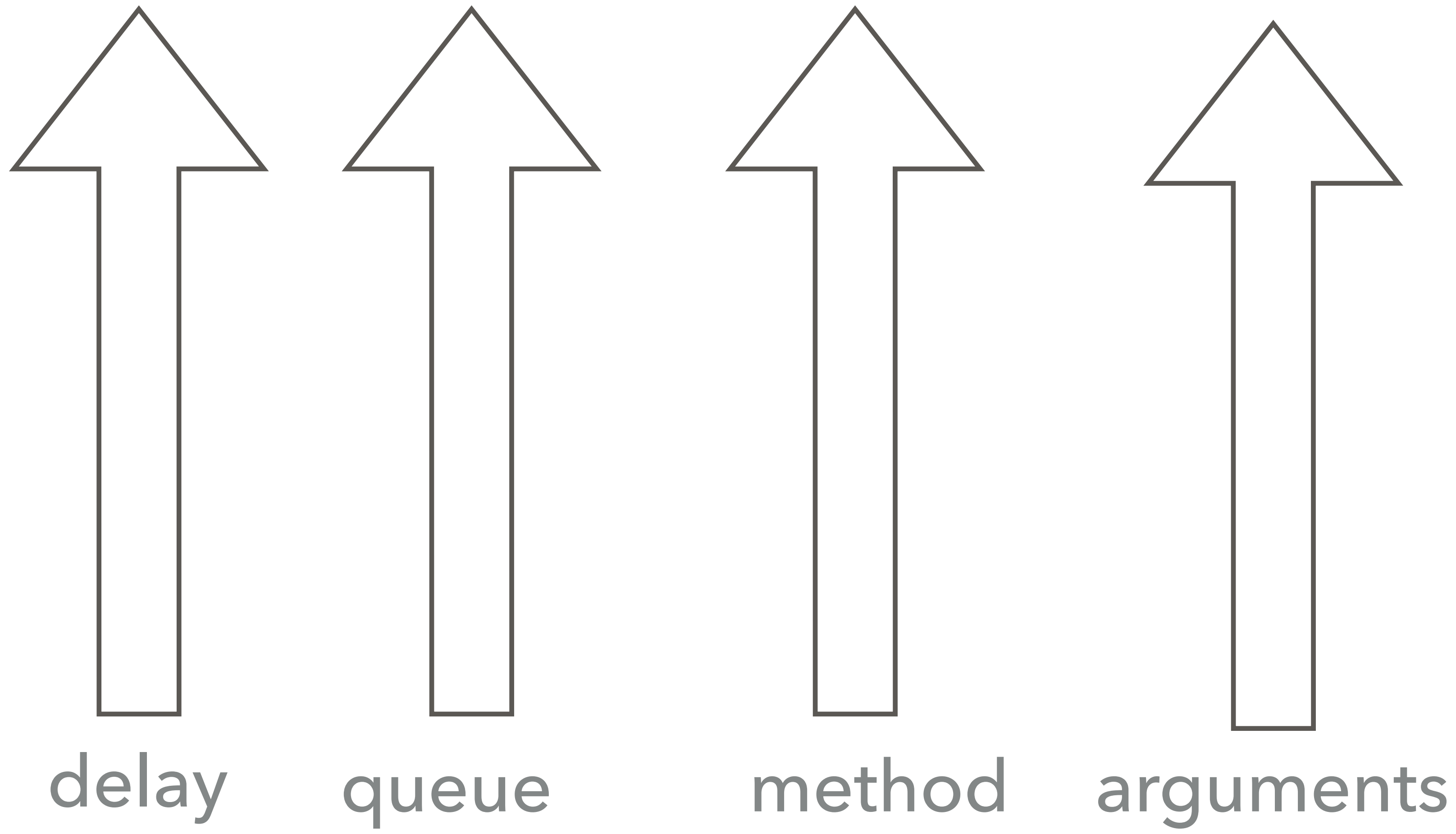
DATA STRUCTURES NEEDED FOR A GOOD QUEUE

- Array
  - push, pop, length
- Hash (key types: string, integer, hash)
  - Set, Get, Exists
- Sorted Set
  - Exists, Add, Remove

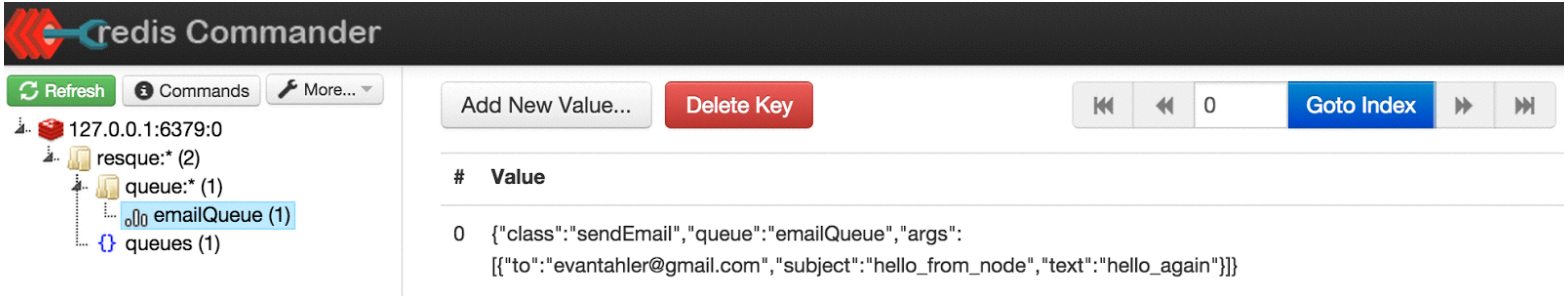
REDIS HAS THEM ALL!

RESQUE: DATA STRUCTURE FOR QUEUES IN REDIS

```
var queue = new NR.queue({connection: connectionDetails}, jobs);

queue.on('error', function(error){ console.log(error); });

queue.connect(function(){
  queue.enqueue('math', "add", [1,2]);
  queue.enqueueIn(3000, 'math', "subtract", [2,1]);
});
```

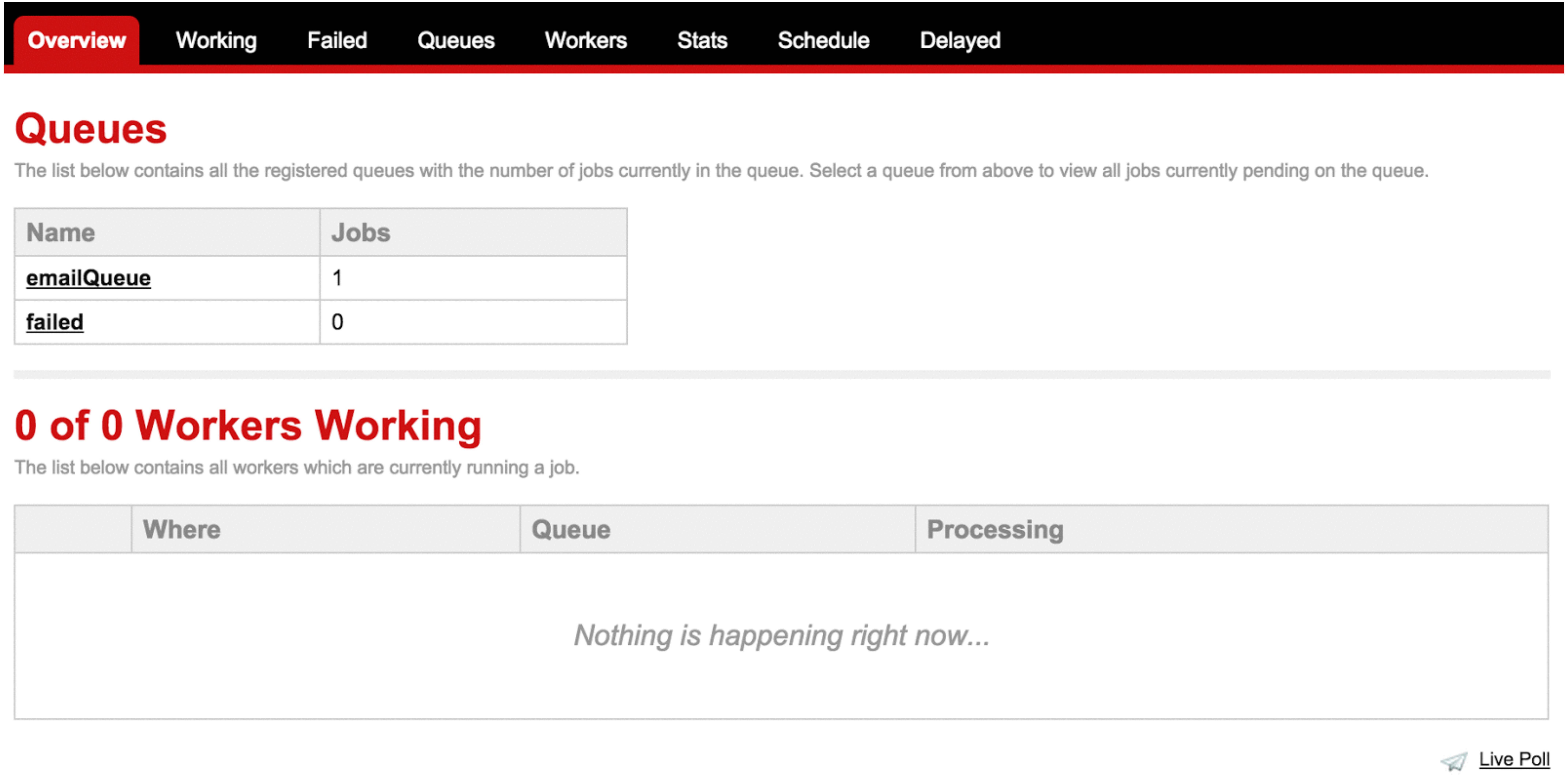


RESQUE: DATA STRUCTURE FOR QUEUES IN REDIS



#	Value
0	{"class":"sendEmail","queue":"emailQueue","args":[{"to":"evantahler@gmail.com","subject":"hello_from_node","text":"hello_again"}]}

RESQUE: DATA STRUCTURE FOR QUEUES IN REDIS



Queues

The list below contains all the registered queues with the number of jobs currently in the queue. Select a queue from above to view all jobs currently pending on the queue.

Name	Jobs
emailQueue	1
failed	0

0 of 0 Workers Working

The list below contains all workers which are currently running a job.

	Where	Queue	Processing

Nothing is happening right now...

USING NODE-RESQUE

```
var transporter = nodemailer.createTransport({
  service: 'gmail',
  auth: {
    user: require('./.emailUsername'),
    pass: require('./.emailPassword')
  }
});

var jobs = {
  sendEmail: function(data, callback){
    var email = {
      from:    require('./.emailUsername'),
      to:      data.to,
      subject: data.subject,
      text:    data.text,
    };

    transporter.sendMail(email, function(error, info){
      callback(error, {email: email, info: info});
    });
  }
};
```

SENDING EMAILS IS A “JOB” NOW

USING NODE-RESQUE

```
var server = function(req, res){
  var urlParts = req.url.split('/');
  var email    = {
    to:      decodeURI(urlParts[1]),
    subject: decodeURI(urlParts[2]),
    text:    decodeURI(urlParts[3]),
  };

  queue.enqueue('emailQueue', "sendEmail", email, function(error){
    if(error){ console.log(error) }
    var response = {email: email};
    res.writeHead(200, {'Content-Type': 'application/json'});
    res.end(JSON.stringify(response, null, 2));
  });
};


var queue = new NR.queue({connection: connectionDetails}, jobs);
queue.connect(function(){
  http.createServer(server).listen(httpPort, httpHost);
  console.log('Server running at ' + httpHost + ':' + httpPort);
  console.log('send an email and message to /TO_ADDRESS/SUBJECT/YOUR_MESSAGE');
});
```

USING NODE-RESQUE

```
var worker = new NR.worker({connection: connectionDetails, queues: ['emailQueue']}, jobs);
worker.connect(function(){
  worker.workerCleanup();
  worker.start();
});
```

```
worker.on('start',           function(){ console.log("worker started"); });
worker.on('end',             function(){ console.log("worker ended"); });
worker.on('cleaning_worker', function(worker, pid){ console.log("cleaning old worker " + worker); });
worker.on('poll',            function(queue){ console.log("worker polling " + queue); });
worker.on('job',             function(queue, job){ console.log("working job " + queue + " " + JSON.stringify(job)); });
worker.on('reEnqueue',       function(queue, job, plugin){ console.log("reEnqueue job (" + plugin + ") " + queue + " " + JSON.stringify(job)); });
worker.on('success',         function(queue, job, result){ console.log("job success " + queue + " " + JSON.stringify(job) + " >> " + result); });
worker.on('failure',         function(queue, job, failure){ console.log("job failure " + queue + " " + JSON.stringify(job) + " >> " + failure); });
worker.on('error',           function(queue, job, error){ console.log("error " + queue + " " + JSON.stringify(job) + " >> " + error); });
worker.on('pause',           function(){ console.log("worker paused"); });
```

DEMO TIME

BUT WHAT IS SO SPECIAL ABOUT NODE.JS HERE?

IMPROVEMENT IDEAS

- The node.js event loops is great for processing all non-blocking events, not just web servers.
- Most Background jobs are non-blocking events
  - Update the DB, Talk to this external service, etc
- So node can handle many of these at once per process!
- Redis is fast enough to handle many “requests” from the same process in this manner
  - We can use the same connection or thread-pool

USING NODE-RESQUE AND MAXIMIZING THE EVENT LOOP

```
var multiWorker = new NR.multiWorker({
  connection: connectionDetails,
  queues: ['slowQueue'],
  minTaskProcessors: 1,
  maxTaskProcessors: 20,
}, jobs);
```

non-blocking

blocking

```
var jobs = {
  "slowSleepJob": {
    plugins: [],
    pluginOptions: {},
    perform: function(callback){
      var start = new Date().getTime();
      setTimeout(function(){
        callback(null, (new Date().getTime() - start) );
      }, 1000);
    },
  },

  "slowCPUJob": {
    plugins: [],
    pluginOptions: {},
    perform: function(callback){
      var start = new Date().getTime();
      blockingSleep(1000);
      callback(null, (new Date().getTime() - start) );
    },
  },
};
```

HOW CAN YOU TELL IF THE EVENT LOOP IS BLOCKED?

```
// inspired by https://github.com/tj/node-blocked

module.exports = function(limit, interval, fn) {
  var start = process.hrtime();

  setInterval(function(){
    var delta = process.hrtime(start);
    var nanosec = delta[0] * 1e9 + delta[1];
    var ms = nanosec / 1e6;
    var n = ms - interval;
    if (n > limit){
      fn(true, Math.round(n));
    }else{
      fn(false, Math.round(n));
    }
    start = process.hrtime();
  }, interval).unref();
};
```

… SEE HOW LONG IT TAKES FOR THE NEXT “LOOP”

DEMO TIME

REDIS

- Redis has unique properties that make it **perfect** for this type of workload
  - FAST
  - Single-threaded so you can have real array operations (pop specifically)
  - Data-structure creation on the fly (new queues)
  - Dependent on only RAM and network

STRATEGY SUMMARY

- **Why it is better in node:**
    - In addition to persistent storage and multiple server/process support, you get get CPU scaling and Throttling very simply!
    - Integrates well with the resque/sidekiq ecosystem
- **This is now a good idea!**

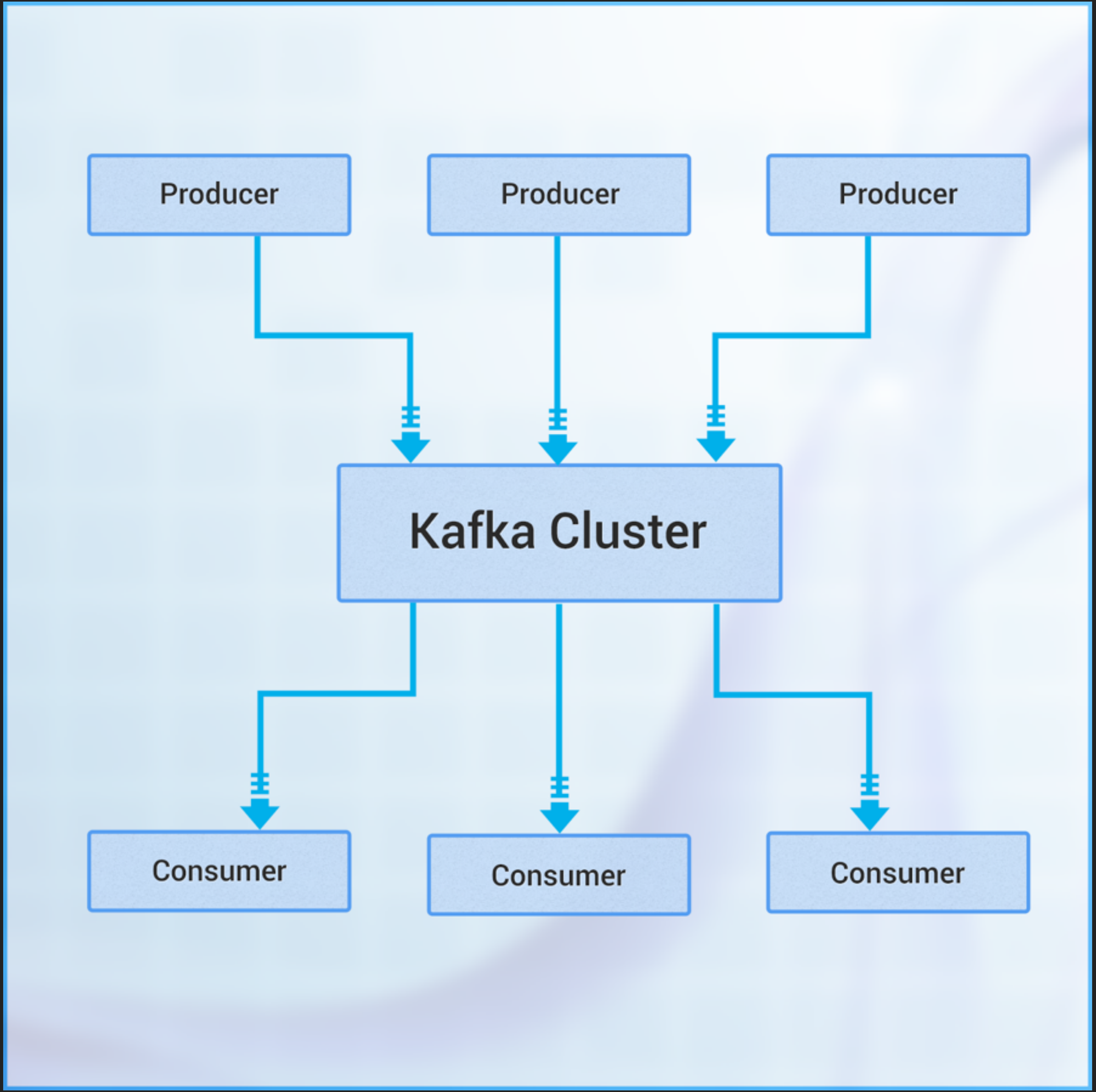
6) IMMUTABLE EVENT BUS

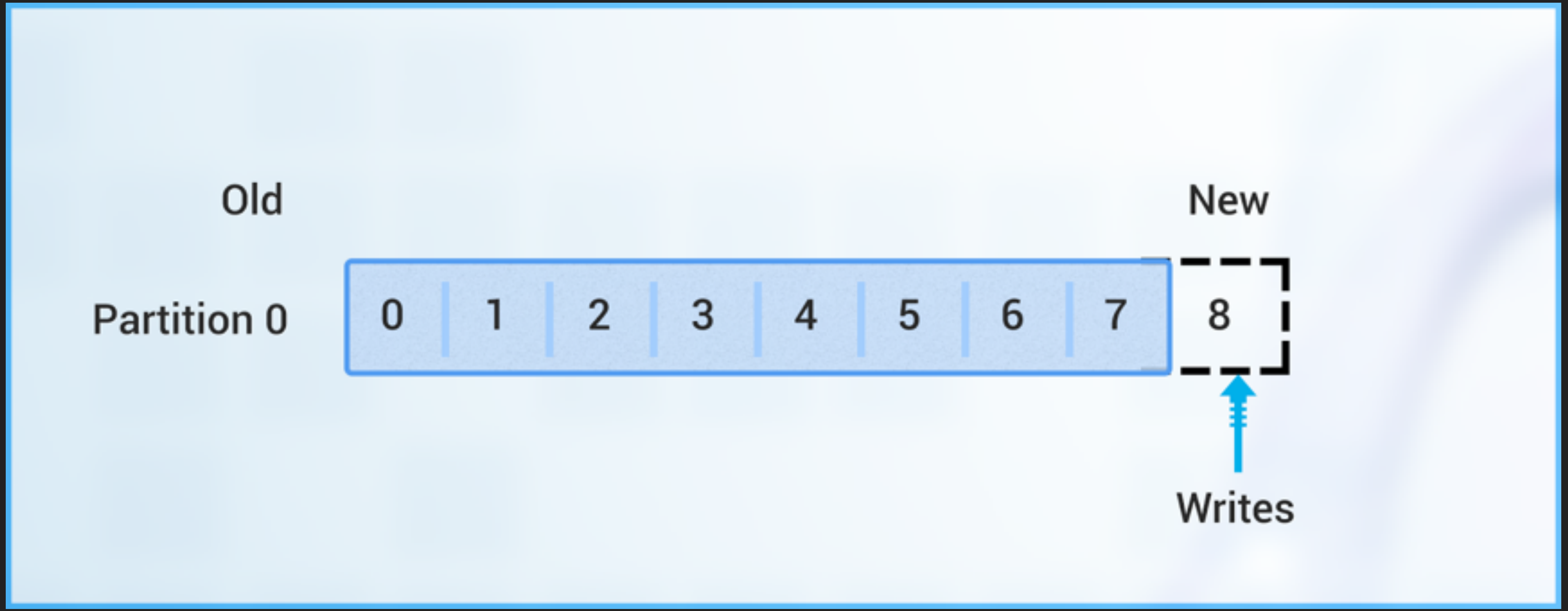
“The Future”… “Maybe”

IMPROVEMENT IDEAS

- What was wrong with the resque pattern?
  - Jobs are consumed and deleted… no historical introspection
  - In redis, storing more and more events to a single key gains nothing from redis-cluster
  - If you wanted to do more than one thing on user#create, you would need to fire many jobs
  - What if we just fired a "user_created" event and let the workers choose what to do?

IMMUTABLE EVENT BUS





- Events are written to a list and never removed
- Consumers know where their last read was and can continue

IMPROVEMENT IDEAS

- What to we need that redis cannot do natively
  - A “blocking” get and incr
  - Tools to seek for “the next key” for listing partitions

… GOOD THING WE HAVE LUA!

WHAT WOULD LUA LOOK LIKE FOR THIS?

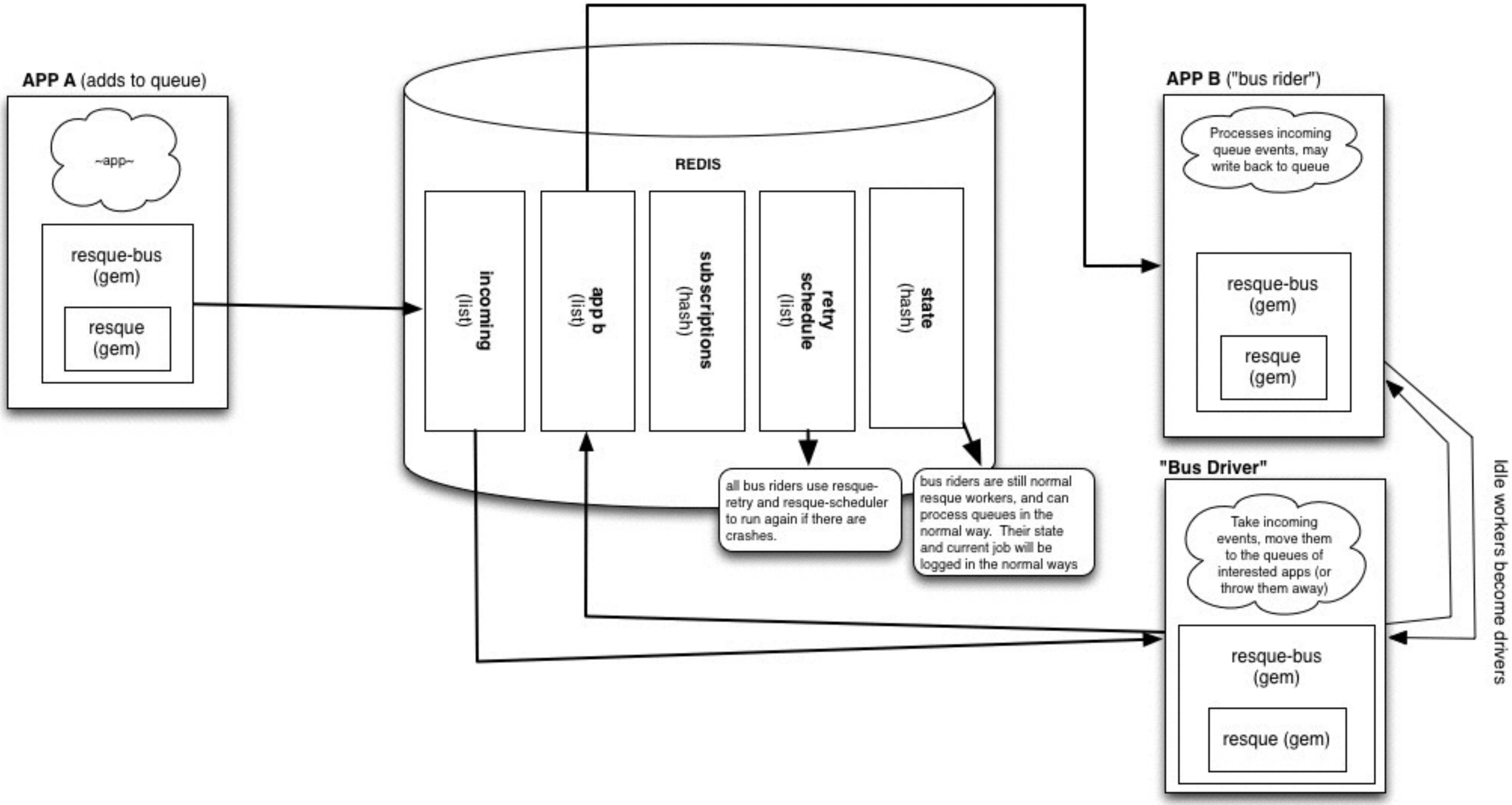
```
var luaLines = [];
// get the counter for this named consumer
luaLines.push('local counter = 0');
luaLines.push('if redis.call("HEXISTS", "' + this.prefix + 'counters", KEYS[1]) == 1 then');
luaLines.push('  local counter = redis.call("HGET", "' + this.prefix + 'counters", KEYS[1])');
luaLines.push('end');
// if the partition exists, get the data from that key
// otherwise + the partition and end
luaLines.push('local partition = "' + this.prefix + 'partitions:" .. KEYS[2]');
luaLines.push('if reids.call("EXISTS", partition) == 0 then');
luaLines.push('  retun nil');
luaLines.push('else ');
luaLines.push('  local event = reids.call("LRANGE", partition, counter, counter)');
luaLines.push('  reids.call("HSET", "' + this.prefix + ':counters", (counter + 1))');
luaLines.push('  return event');
luaLines.push('end');


this.redis.defineCommand('getAndIncr', {
  numberOfKeys: 2, lua: luaLines.join('\r\n')
});
```

STRATEGY SUMMARY

- **Why it is better in node:**
    - Just like with Resque, we can poll/stream many events at once (non-blocking)
- **Why us this a bad idea?**
    - We would need a *lot* of LUA. We are actively slowing down Redis to preform more operations in a single block. With Cluster, we might have enough RAM for this, but this is more expensive than using another technology which stores data on disk.

CAN WE WE MEET IN THE MIDDLE OF “IMMUTABLE EVENT BUS” + “RESQUE”?

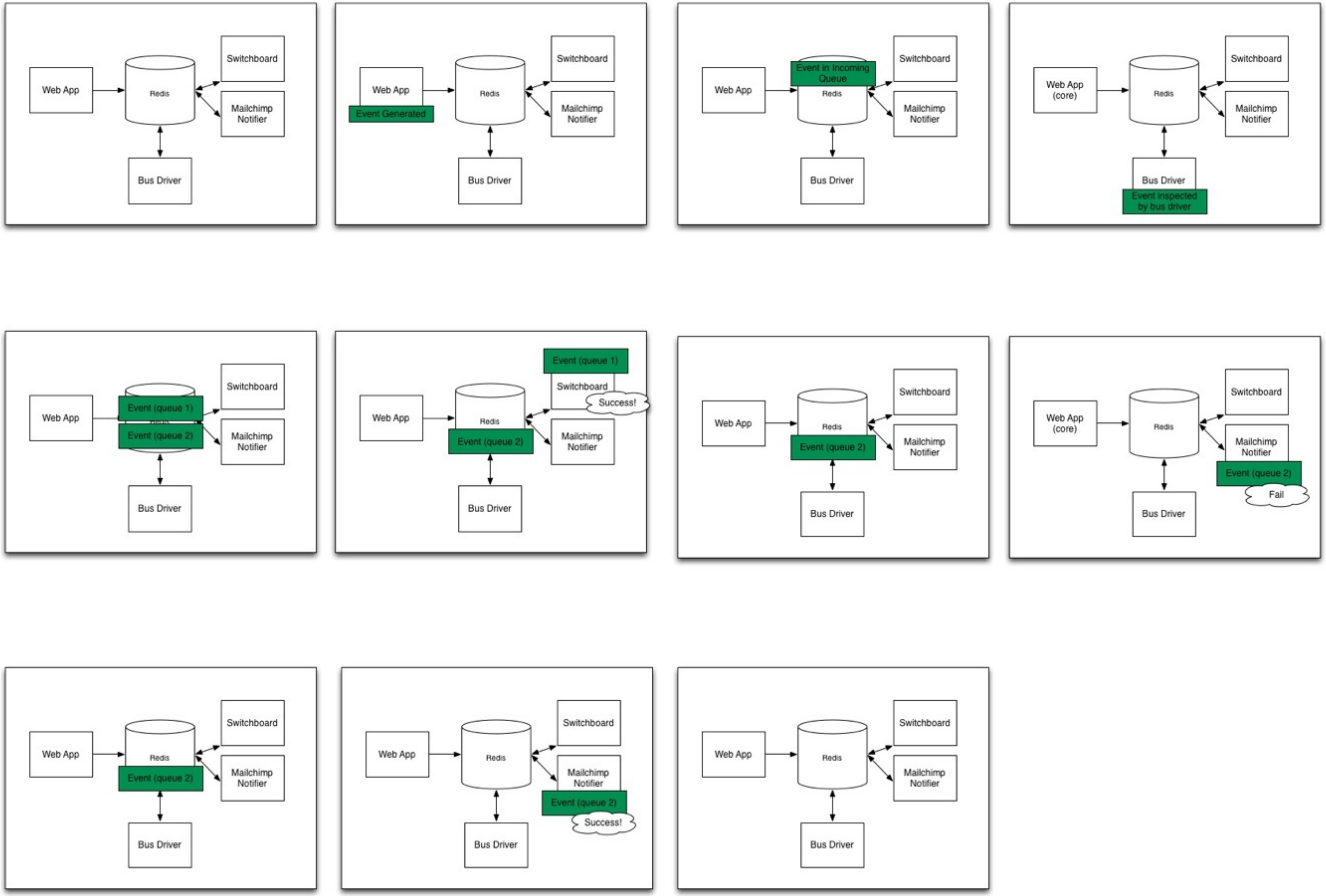
QUEUEBUS



all bus riders use resque-retry and resque-scheduler to run again if there are crashes.

bus riders are still normal resque workers, and can process queues in the normal way. Their state and current job will be logged in the normal ways

QUEUEBUS



Web App
Redis
Switchboard
Mailchimp Notifier
Bus Driver
Web App
Event Generated
Redis
Switchboard
Mailchimp Notifier
Bus Driver
Web App
Event in Incoming Queue
Redis
Switchboard
Mailchimp Notifier
Bus Driver
Web App (core)
Redis
Switchboard
Mailchimp Notifier
Bus Driver
Event inspected by bus driver
Web App
Event (queue 1)
Redis
Event (queue 2)
Switchboard
Mailchimp Notifier
Bus Driver
Web App
Redis
Event (queue 2)
Event (queue 1)
Switchboard
Success!
Mailchimp Notifier
Bus Driver
Web App
Redis
Event (queue 2)
Switchboard
Mailchimp Notifier
Bus Driver
Web App (core)
Redis
Switchboard
Mailchimp Notifier
Event (queue 2)
Fail
Bus Driver
Web App
Redis
Event (queue 2)
Switchboard
Mailchimp Notifier
Bus Driver
Web App
Redis
Switchboard
Mailchimp Notifier
Event (queue 2)
Success!
Bus Driver
Web App
Redis
Switchboard
Mailchimp Notifier
Bus Driver

STRATEGY SUMMARY

- **Why it is better in node:**
  - Just like with Resque, we can poll/stream many events at once (non-blocking)
- **What did we gain on Resque?**
  - Syndication of events to multiple consumers
- **What didn’t we get from Kafka?**
  - repayable event log

BACKGROUND TASKS IN NODE.JS

NODE-RESQUE:

https://github.com/taskrabbit/node-resque

QUEUE-BUS:

https://github.com/queue-bus

SUPPORTING PROJECT:

https://github.com/evantahler/background_jobs_node

THESE SLIDES:

http://bit.ly/1pDm9Vf

@EVANTAHLER