PIVIOT

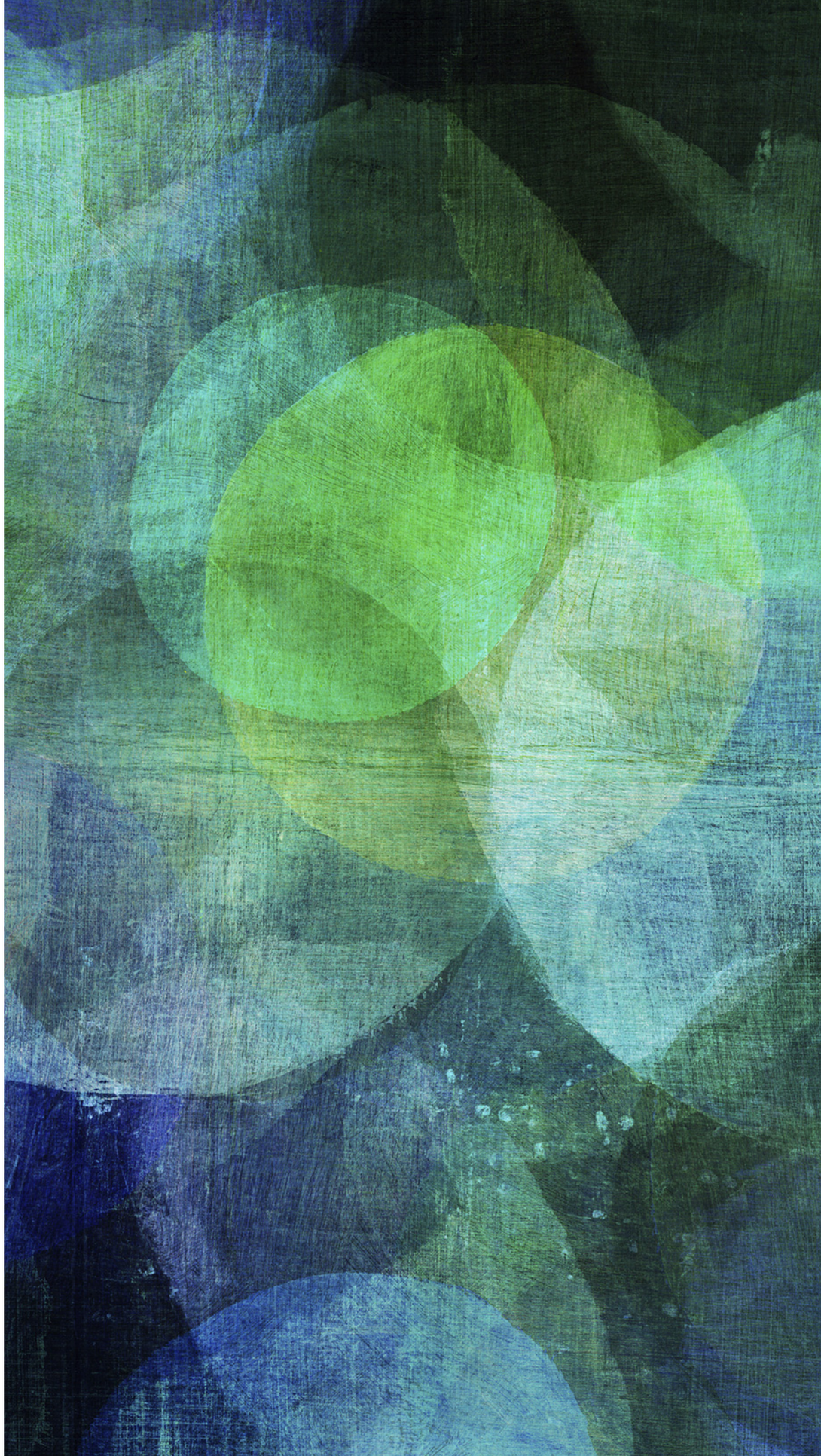
An platform for gaining remote control over applications. … ?

MEETING OUTCOME GOALS:

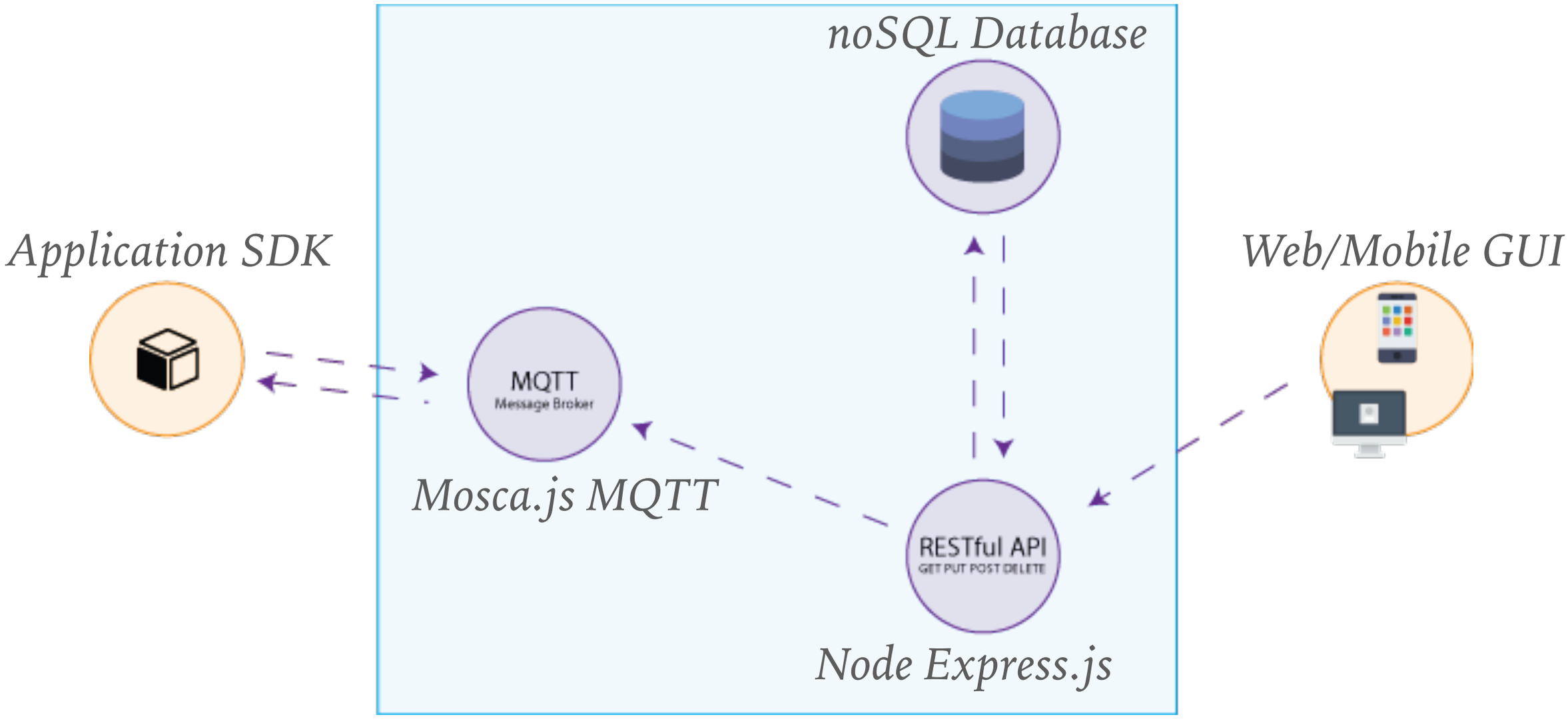
- ~25 min - Presentation of proposed capstone project.
  - Outcome: **Approval** or Disapproval of proposal
    - ~ 5 min - If not approved present 3 alternative ideas and approve.
      - Mobile App for a Conifer (Trees) database.
      - Build an application for a local art museum.
        - Description: Be able to answer question through an app while guests are walking through the museum.
      - Rebuild local museums website?

SYSTEM ARCHITECTURE

An Overview



SYSTEM ARCHITECTURE



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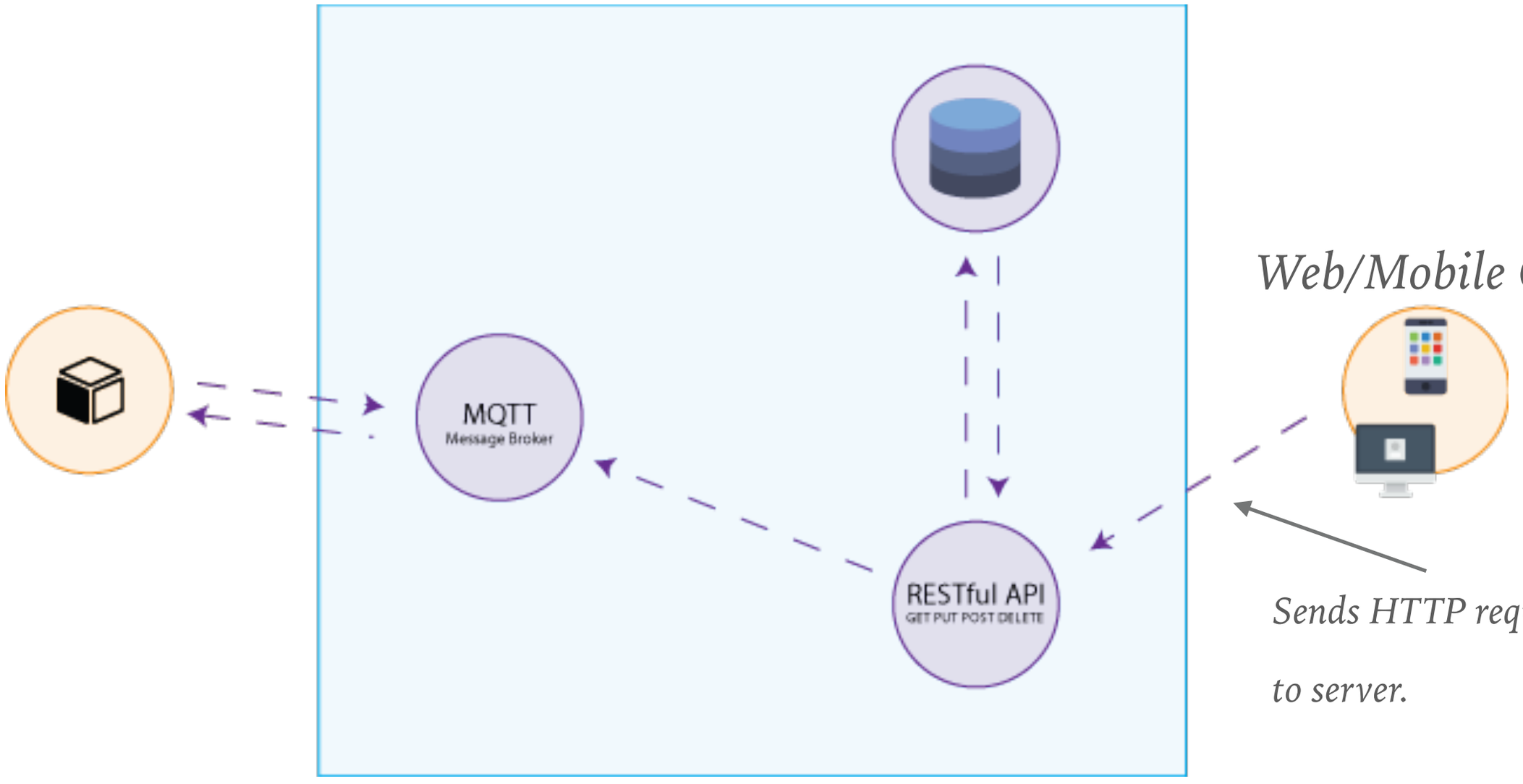
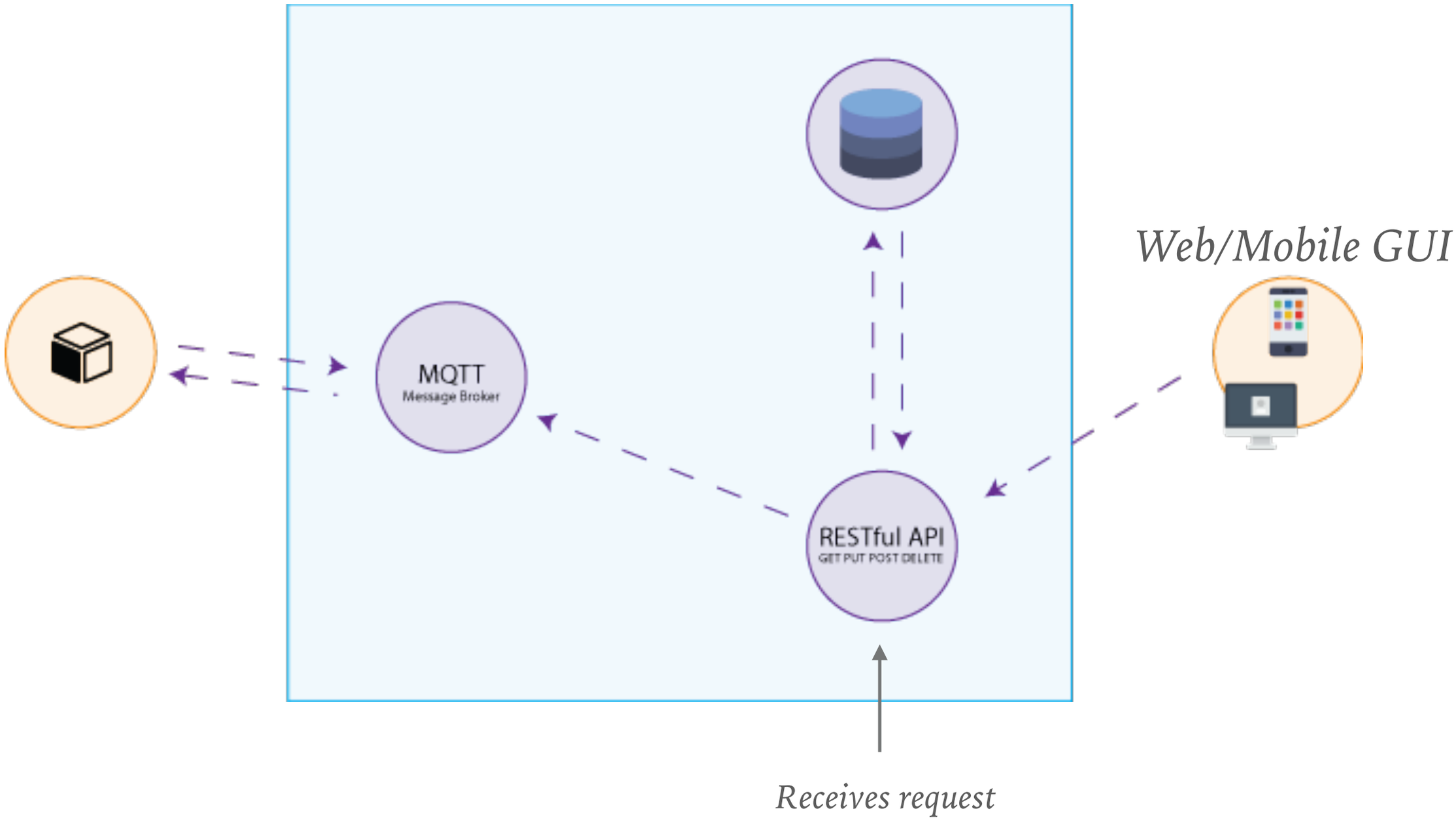


SYSTEM ARCHITECTURE



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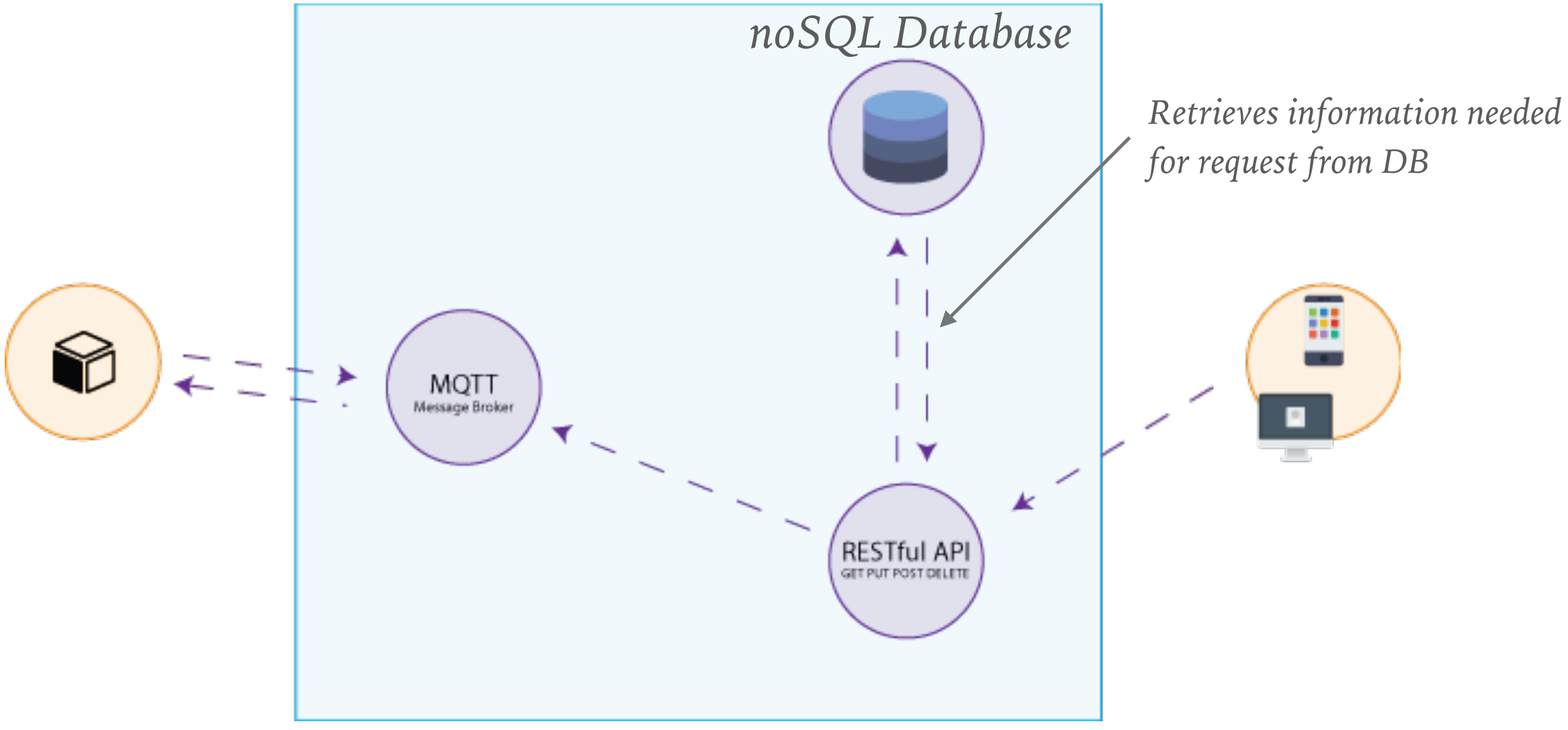

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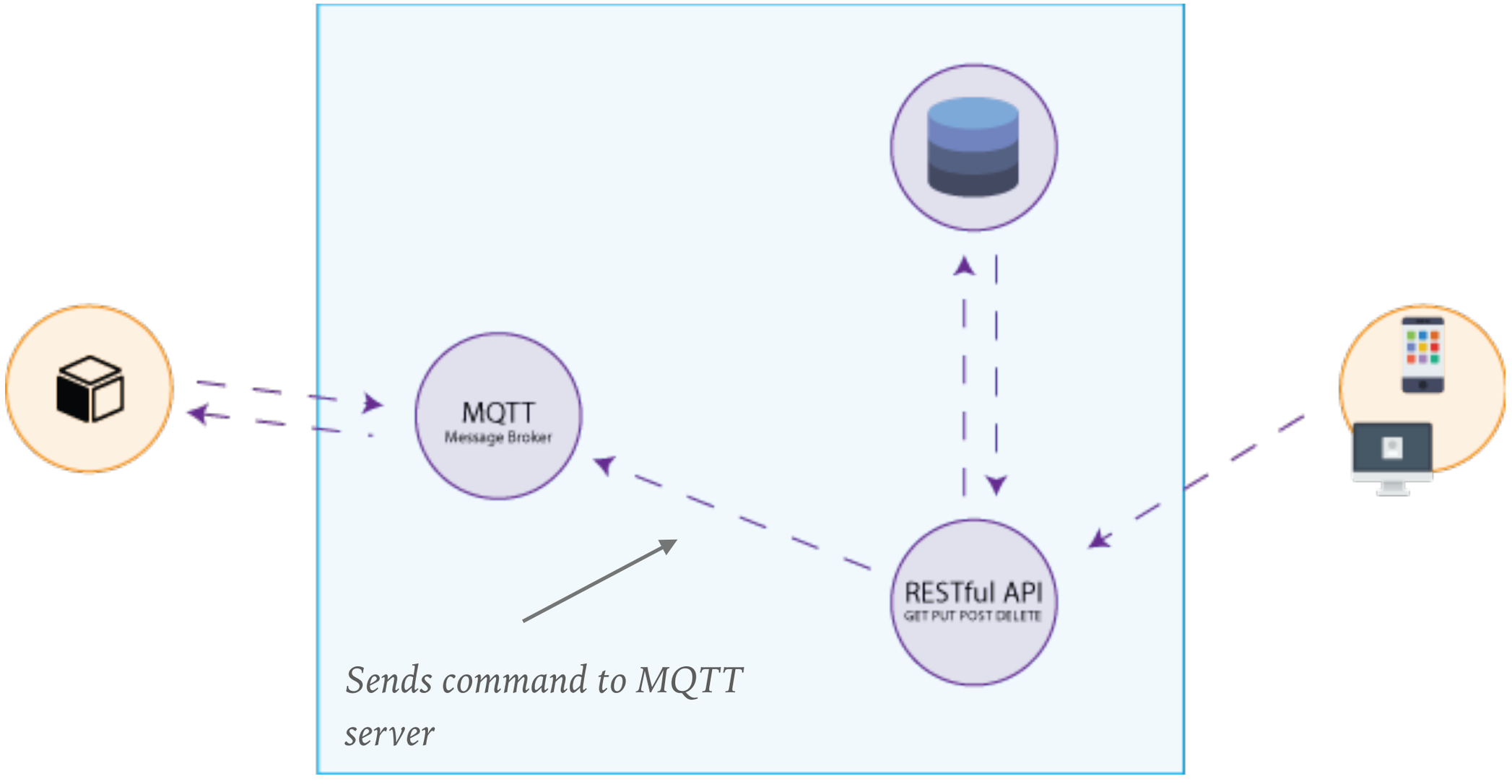
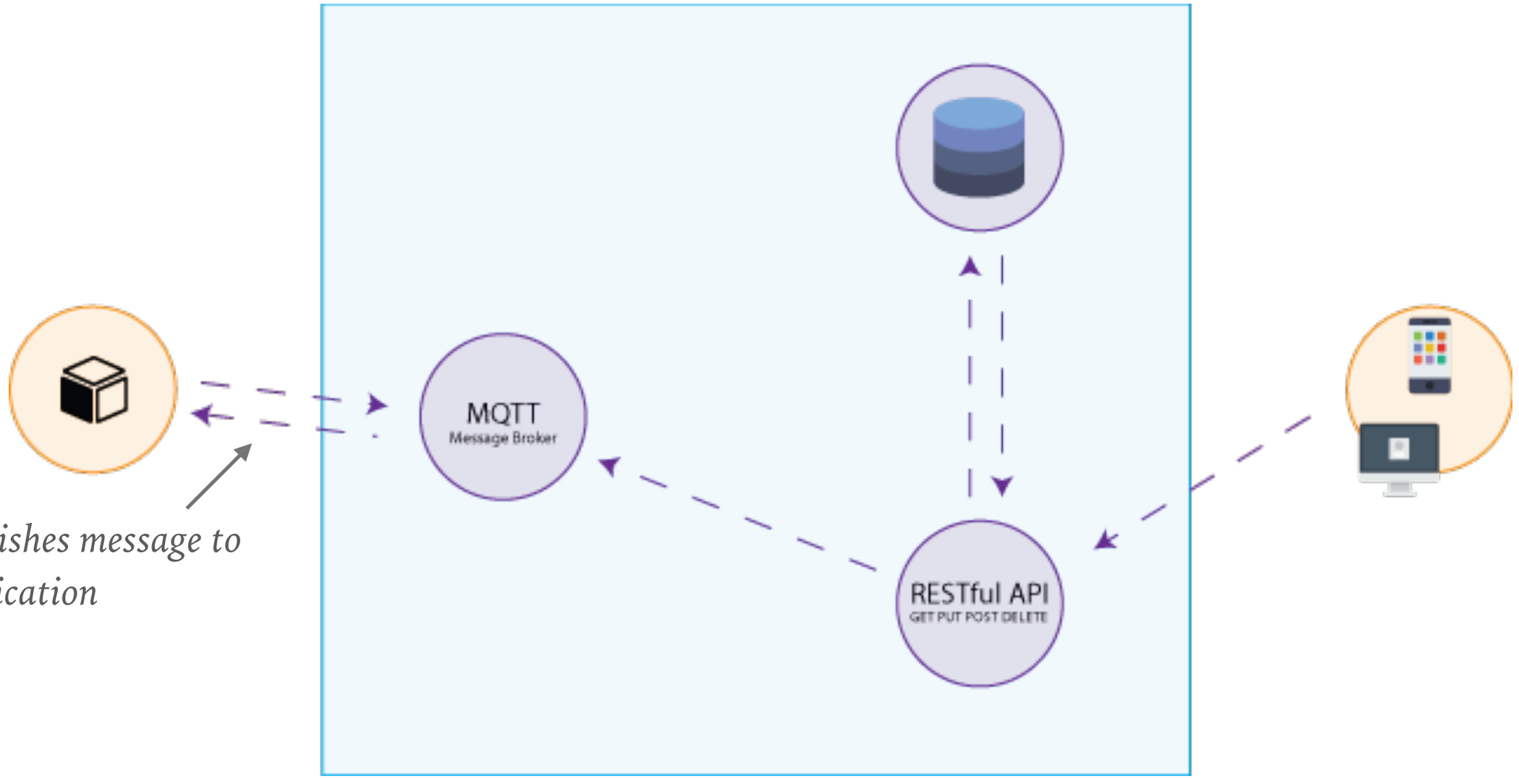
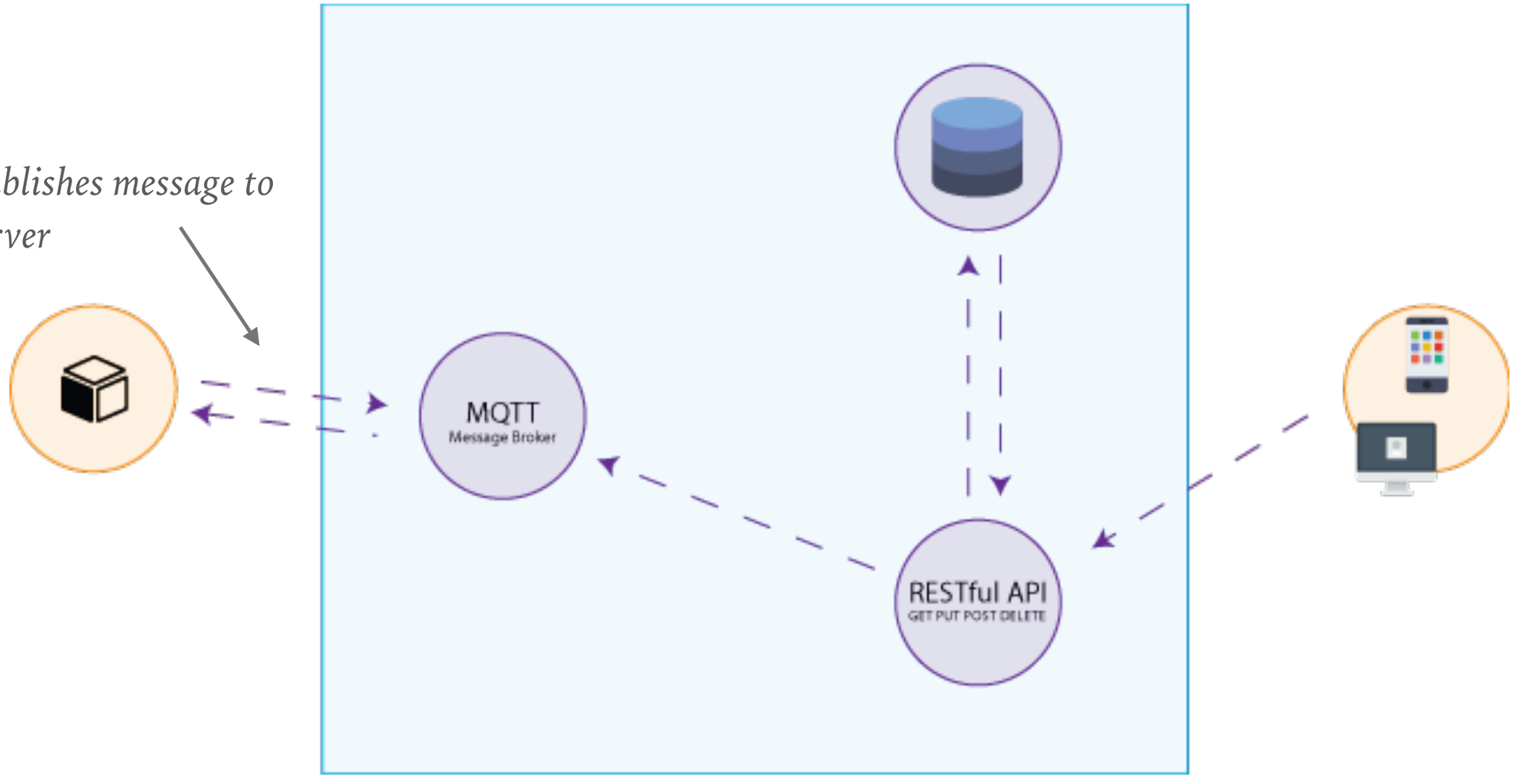


SYSTEM ARCHITECTURE



Publishes message to application

SYSTEM ARCHITECTURE



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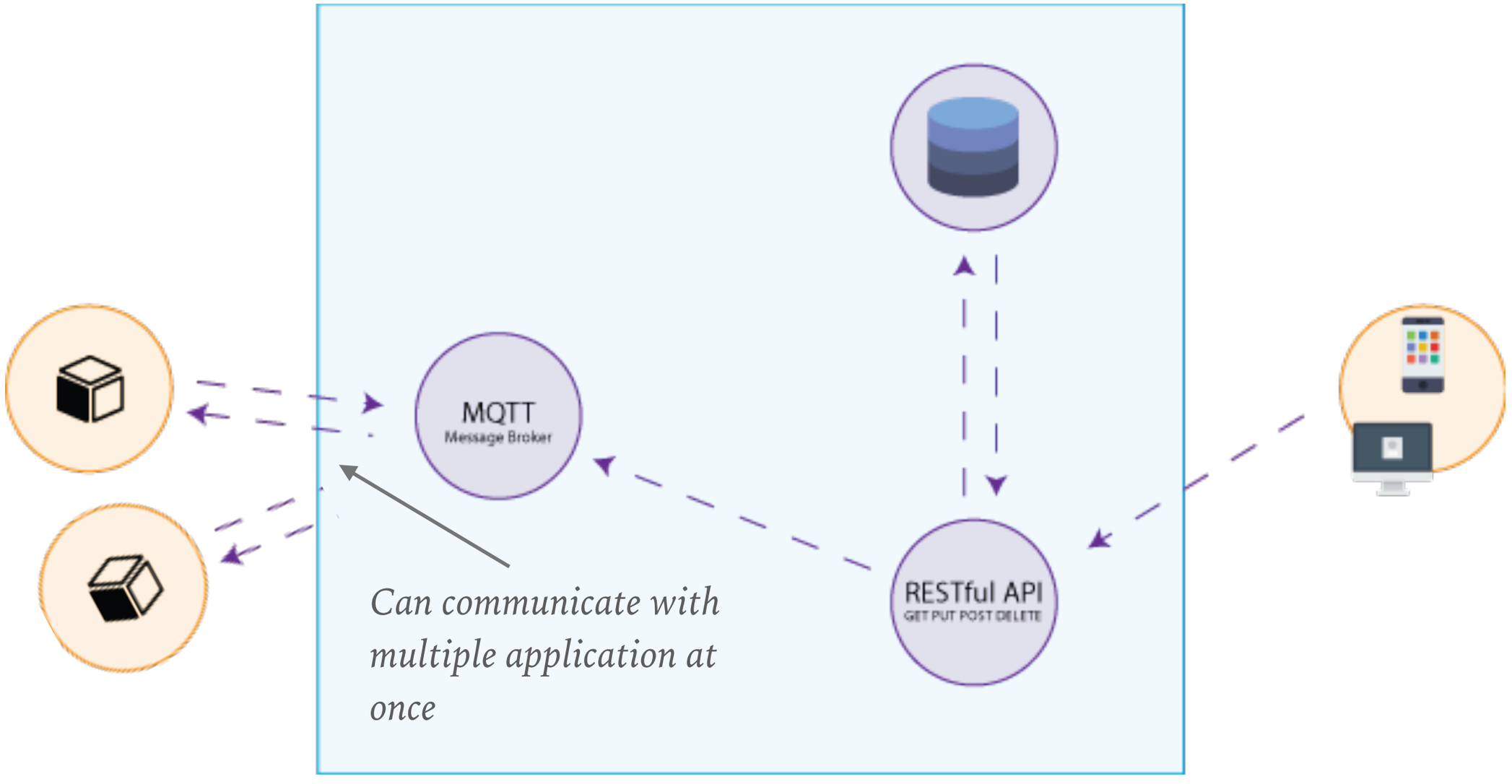
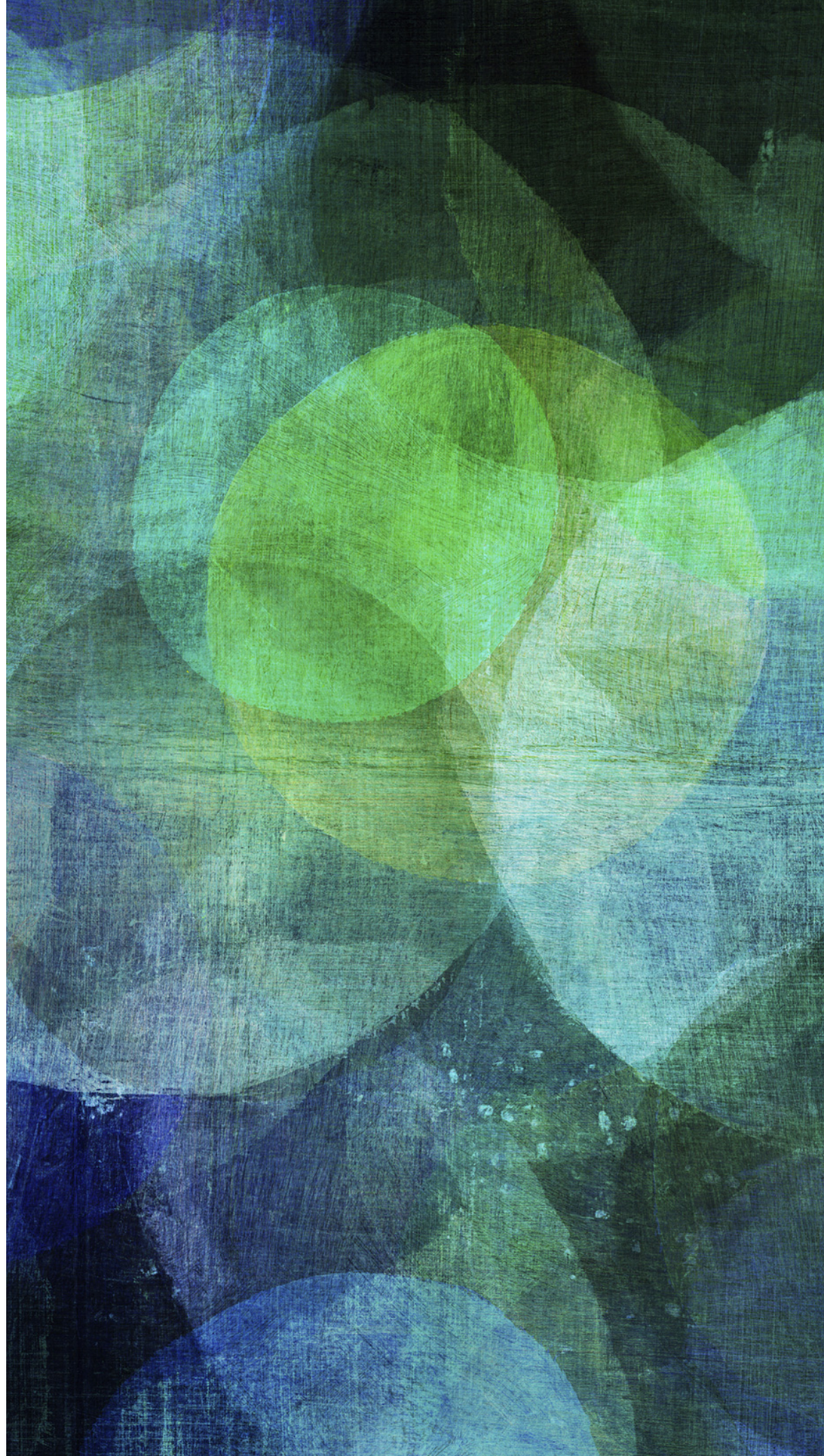


FROM THE SERVER SIDE

A look at the server side implementation



NODEMON AP-SERVER.JS —— STARTING THE SERVER

```
// GLOBAL VARIABLES
require('./globals.js')
```

Global Variables

NODEMON AP-SERVER.JS —— STARTING THE SERVER

Global Variables

```
settings = require('./config/settings.js')
```

NODEMON AP-SERVER.JS —— STARTING THE SERVER

Settings.js

```
module.exports = {
      RESTful:{
            port: 3000
      },
      crypto:{
            secret: "%0Bb-$sCJ+u2rq6r'3|sg#)j1?[dj/,82*%xXkH~QheJ2NvN%,W.\"Bal29DvLJP"
      },
      mongo: {
     uri: 'mongodb://capstone-admin:zuRM3NXycfQN4FZRbBaAQEAXSw7RLn8F5HfRL8tDBXThDTk6vwH8@ds063946.mlab.com:63946/capstone',
            hostname: 'zaphyrr.com',
            db: 'main',
            port: 27017
      }
}
```

This file is just used to store settings of the application so that we may share it across the application.

NODEMON AP-SERVER.JS —— STARTING THE SERVER

Global Variables

```
settings = require(‘./config/settings.js')


//VARIOUS LIBRARIES
jwt = require('jwt-simple');
Promise = require('promise');
crypto = require('crypto');
bcrypt = require('bcrypt');
bodyParser  = require('body-parser');
morgan = require('morgan');
randtoken = require('rand-token');
cookieParser = require('cookie-parser');
NodeRSA = require('node-rsa');
passport = require('passport');
cors = require('cors');
HashMap = require('hashmap');
async = require("async");
```

NODEMON AP-SERVER.JS —— STARTING THE SERVER

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//Some Data Structures
ArrayList = require('./classes/ArrayList.js');
Queue = require(‘./classes/Queue.js'); //for queues
Graph = require(‘node-dijkstra') //for graphing
fs = require(“fs") //file reader



// RESTFUL SERVICES
rest = require('express')();
RESTfulServices = require('http').Server(rest);
rest.set('superSecret', settings.crypto.secret);
```

NODEMON AP-SERVER.JS —— STARTING THE SERVER

Global Variables

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//VARIOUS LIBRARIES
jwt = require('jwt-simple');
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// RESTFUL SERVICES
rest = require('express')();
RESTfulServices = require('http').Server(rest);
rest.set('superSecret', settings.crypto.secret);
```

```
//bodyparser (authentication ignore for now)
rest.use(bodyParser.urlencoded({extended:true}));
rest.use(bodyParser.json());
rest.use(cookieParser());
rest.use(morgan('dev'));
rest.use(cors());
rest.use(passport.initialize());

//passport stuff
passport.serializeUser(function(user,done){
      done(null, user._id);
})

passport.deserializeUser(function(id, done){
      User.findById(id, function(err, user){
            done(err,user)
      })
})



// Database Connection
Mongoose = require('./classes/Mongoose.js')
mongoose = new Mongoose(settings)

//Automata Processor
Automaton = require('./classes/Automaton.js');

// MODELS
User = require('./classes/User.js')
ThingSchema = require('./classes/Thing.js').schema
Thing = require('./classes/Thing.js').class
```

NODEMON AP-SERVER.JS —— STARTING THE SERVER

```
// GLOBAL VARIABLES
require('./globals.js')

// START THE MQTT SERVER
Mosca = require('./classes/Mosca.js');
mosca = new Mosca(settings)
```

A FEW NOTES ON NODE.JS MODULES

- JavaScript by default can't "include" other scripts.
- Using Node's require method allows for this.
- The code can `require` modules
  - Allow for 'requiring' dependencies

Credit: https://darrenderidder.github.io/talks/ModulePatterns/#/2

SIMPLE MODULE EXAMPLES

```
//EXAMPLE 1
// magic.js
console.log(“magic!”)

//app.js
require(“magic.js”)
```

SIMPLE MODULE EXAMPLES

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```
//EXAMPLE 2 Declaring Global
//magic_global.js
magic = function(){
   console.log(“magic!”)
}

//app.js
require(“magic.js”)
magic()
```

SIMPLE MODULE EXAMPLES

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require(“magic.js”)
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```

```
//EXAMPLE 3 Exporting Module stuff
//magic_global.js
module.exports = function(){
   console.log(“magic!”)
}

//app.js
var magic = require(“magic.js”)
magic()
```

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//EXAMPLE 1
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```

Cool…

SIMPLE MODULE EXAMPLES

Cool… But Even Cooler … and how I am using it in my application

Javascript Function

```
function Foo(){
  //do some cool constructor stuff
}

Foo.prototype = {
  attribute1: ‘bar’,
  function: function(){
    console.log(“Hello”)
  }
}

module.exports = Foo
```

```
//app.js
var Foo = require(‘Foo.js’)

var foo = new Foo();
console.log(foo.attribute1)
```

SIMPLE MODULE EXAMPLES

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Javascript Prototype

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Node.js Exporting

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//app.js
var Foo = require(‘Foo.js’)

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```

Oh Look it’s basically a class

SIMPLE MODULE EXAMPLES

Cool… But Even Cooler … and how I am using it in my application

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Javascript Function

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Javascript Prototype

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module.exports = Foo
```

Node.js Exporting

```
//app.js
var Foo = require(‘Foo.js’)

var foo = new Foo();
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```

Oh Look it’s basically a class

And now it’s an object.

Object-Oriented Programming using Node.js

NODEMON AP-SERVER.JS —— STARTING THE SERVER

```
// GLOBAL VARIABLES
require('./globals.js')

// START THE MQTT SERVER
Mosca = require('./classes/Mosca.js');
mosca = new Mosca(settings)
```

NODEMON AP-SERVER.JS —— STARTING THE SERVER

Mosca Class (Mosca.js)

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


//CLASS TO START THE MQTT SERVER
function Mosca(){

      this.ascoltatore = {
        //using ascoltatore
        type: 'mongo',
        url: settings.mongo.uri,
        pubsubCollection: 'MQTT',
        mongo: {}
      },

      this.settings = {
            port: 1883,
            backend: this.ascoltatore,
            http: {
          port: 1884,
          bundle: true,
          static: './'
        }
      },

      //Create the server
      this.server = new mosca.Server(this.settings)
      //get some listener functions
      this.server.on('clientConnected', this.clientConnected);
      this.server.on('clientDisconnecting', this.clientDisconnecting);
      this.server.on('clientDisconnected', this.clientDisconnected);
      this.server.on('published', this.published);
      this.server.on('delivered', this.delivered);
      this.server.on('subscribed', this.subscribed);
      this.server.on('unsubscribed', this.unsubscribed);
      // fired when a message is received
      //when the server is ready let us know please
      this.server.on('ready', this.setup);
}
```

```
Mosca.prototype = {
      setup: function(){
            console.log('MQTT up');
      },

      clientConnected: function(client){
            console.log('connected', client.id)
      },

      clientDisconnecting: function(client){
            console.log('disconnecting', client.id)
      },

      clientDisconnected: function(client){
            console.log('disconnected', client.id)
      },

      published: function(packet, client){
            console.log('published', packet)
            console.log('from', client)
      },

      delivered: function(packet, client){
            console.log('delivered', packet)
            console.log('to', client)
      },

      subscribed: function(topic, client){
            console.log(client, 'subscribed')
            console.log('to', topic)
      },

      unsubscribed: function(topic, client){
            console.log(client, 'unsubscribed')
            console.log('from', topic)
      }

}
```

module.exports = Mosca

NODEMON AP-SERVER.JS —— STARTING THE SERVER

```
// GLOBAL VARIABLES
require('./globals.js')

// START THE MQTT SERVER
Mosca = require('./classes/Mosca.js');
mosca = new Mosca(settings)



 /**
  *
  *
  * RESTful ROUTES
  *
  *
  */

rest.get('/api/v1', function(req, res){
      res.send("RESTful Services")

})

//PLACE WHERE AUTHENTICATION WOULD BE IMPLEMENTED
// rest.get('/api/v1/authorize', function(req, res){
// })
// rest.get('/api/v1/device/authorize', function(req,res){
// })

//USERS
rest.get('/api/v1/users', function(req, res) {
  User.find({}, function(err, users) {
    res.json(users);
  });
});
```

Continued…

NODEMON AP-SERVER.JS —— STARTING THE SERVER

```
//DEVICE ROUTES
rest.route('/api/v1/devices')
     .get(function(req, res){
     })
     .post(function(req, res){
     })
//SINGLE DEVICE ROUTES
rest.route('/api/v1/device/:id')//match all routes
     .get(function(req, res){        // GET THE REQUESTED DEVICE
          ap = new Automaton(req.params.id); //ignore this name please
          ap.M.findOne({_id: req.params.id}, function(err, model){
               if(err) handleError(err);
               res.send(model)
          })
     })
     .put(function(req, res){        // UPDATE WHOLE DEVICE MODEL
     })
     .patch(function(req,res){       // UPDATE ONLY CHANGED ATTRIBUTES (just implement the same)
     })
     .delete(function(req, res){     // DELETE THE SPECIFIED DEVICE
     })

// Trigger an action
rest.route('/api/v1/device/:id/action/:action')
     .get(function(req, res){
          mosca.server.publish({
               topic: req.params.id + '/transition/' + req.params.action,
               payload: 'Message'
          }, function(){
               res.send("Pushed")
          })
     })
//Turn the restful service on
RESTfulServices.listen(settings.RESTful.port, function(){
     console.log('RESTful port 3000')
})
```

2 things

NODEMON AP-SERVER.JS —— STARTING THE SERVER

```
rest.route('/api/v1/device/:id')//match all routes
     .get(function(req, res){        // GET THE REQUESTED DEVICE
          ap = new Automaton(req.params.id); //ignore this name please
          ap.M.findOne({_id: req.params.id}, function(err, model){
               if(err) handleError(err);
               res.send(model)
          })
     })
```

1. *When a client visits api/v1/device/:id (:id is the device id)*
2. *If the request type is a GET request passion the request and response information to a function*
3. *Create a new "Automaton" graph.*

AUTOMATON.JS CLASS

```
function Automaton(M){
      //Temp Values
      this.machine = null
      this.nodes = null
      this.node_graph = null
      this.paths = null

      //Add the model..
      if(typeof(M) == "string"){
            //EXISTING MODEL
            this._id = M
            var promise = this.fetch(this._id)
      }
      else{
            //NEW MODEL
            this.machine = M
            this.nodes = []
            this.node_graph = {}
            for(var k in this.machine.states){
                  if(this.node_graph[k] == undefined){
                        this.node_graph[k] = {}
                  }
                  for(var l in this.machine.states[k].transitions){
                        this.node_graph[k][l] = 1
                  }

                  this.nodes.push(k)
            }
            this.route = new Graph(this.node_graph)
            this.computePaths()
            this.model = new this.M({
                  machine: this.machine,
                  nodes: this.nodes,
                  node_graph: this.node_graph,
                  paths: this.paths
      })
      this.save()
      }
}
```

AUTOMATON.JS CLASS – PROTOTYPE

```
Automaton.prototype = {
      M: mongoose.mg.model('Automaton', mongoose.mg.Schema({
            machine: mongoose.mg.Schema.Types.Mixed,
            nodes: [mongoose.mg.Schema.Types.Mixed],
            node_graph: mongoose.mg.Schema.Types.Mixed,
            paths: mongoose.mg.Schema.Types.Mixed
      }, {
        toObject: {
        virtuals: true
        },
        toJSON: {
        virtuals: true
        }
      })),
```

DB Schema for Mongoose

AUTOMATON.JS CLASS - PROTOTYPE

```
computePaths: function(){
            var paths = {}
            var count = 0
            for(var i = 0; i < this.nodes.length; i++){
                  for(var j = 0; j < this.nodes.length; j++){
                        // get the path from i to j
                        var path = this.route.path(this.nodes[i], this.nodes[j]);
                        // the path will be null if it is trying to get a path to itself. i.e. 1->1
                        if(path != null){
                              path_label = this.nodes[i] + '-' + this.nodes[j]
                              // create a null Q variable
                              var Q = null
                              // console.log("i = " + i + "j = " + j + "k = " + k)
                              for(var k = 0; k < path.length - 1; k++){
                                    // create the label
                                    label = path[k] + '-' + path[k+1]
                                    fname = this.machine.states[path[k]].transitions[path[k+1]].fname
                                    dependency = this.machine.states[path[k]].transitions[path[k+1]].dependency
                                    // THIS IF STATEMENT SHOULD BE HANDLED IN THE QUEUE CLASS.
                                    if(Q == null){
                                          if(dependency != undefined){
                                                Q = new Queue('dep', dependency)
                                                Q.enqueue(label, fname)
                                          }
                                          else{
                                                Q = new Queue(label, fname)
                                          }
                                    }
                                    else{
                                          if(dependency != undefined){
                                                Q.enqueue('dep', dependency)
                                          }
                                          Q.enqueue(label, fname)
                                    }
                              }
                              paths[path_label] = Q.toArray()
                              this.paths = paths
                        }
                  }
```

AUTOMATON.JS CLASS – PROTOTYPE

```
getPaths: function(){
      return this.paths;
},

getPath: function(from, to){
      var label = from + '-' + to
      return this.paths[label]
},

fetch: function(id){
      var MOD = null
      this.M.findOne({_id: id}, function(err, model){
            if(err) handleError(err);
            MOD = model
                  console.log(MOD)
            })
            console.log(MOD)
      },

      save: function(){

      }
}

module.exports = Automaton ;
```

Just Return Paths

Return just a single path

Fetch from the DB

Mongoose Function

NODEMON AP-SERVER.JS —— STARTING THE SERVER

```
rest.route('/api/v1/device/:id')//match all routes
     .get(function(req, res){        // GET THE REQUESTED DEVICE
          ap = new Automaton(req.params.id); //ignore this name please
          ap.M.findOne({_id: req.params.id}, function(err, model){
               if(err) handleError(err);
               res.send(model)
          })
     })
```

1. *When a client visits api/v1/device/:id (:id is the device id)*
2. *If the request type is a GET request passion the request and response information to a function*
3. *Create a new "Automaton" graph.*
4. *The next function is so send the DB entry back to the client*

NODEMON AP-SERVER.JS —— STARTING THE SERVER

```
rest.route('/api/v1/device/:id/action/:action')
     .get(function(req, res){
          mosca.server.publish({
               topic: req.params.id + '/transition/' + req.params.action,
               payload: 'Message'
          }, function(){
               res.send("Pushed")
          })
     })
```

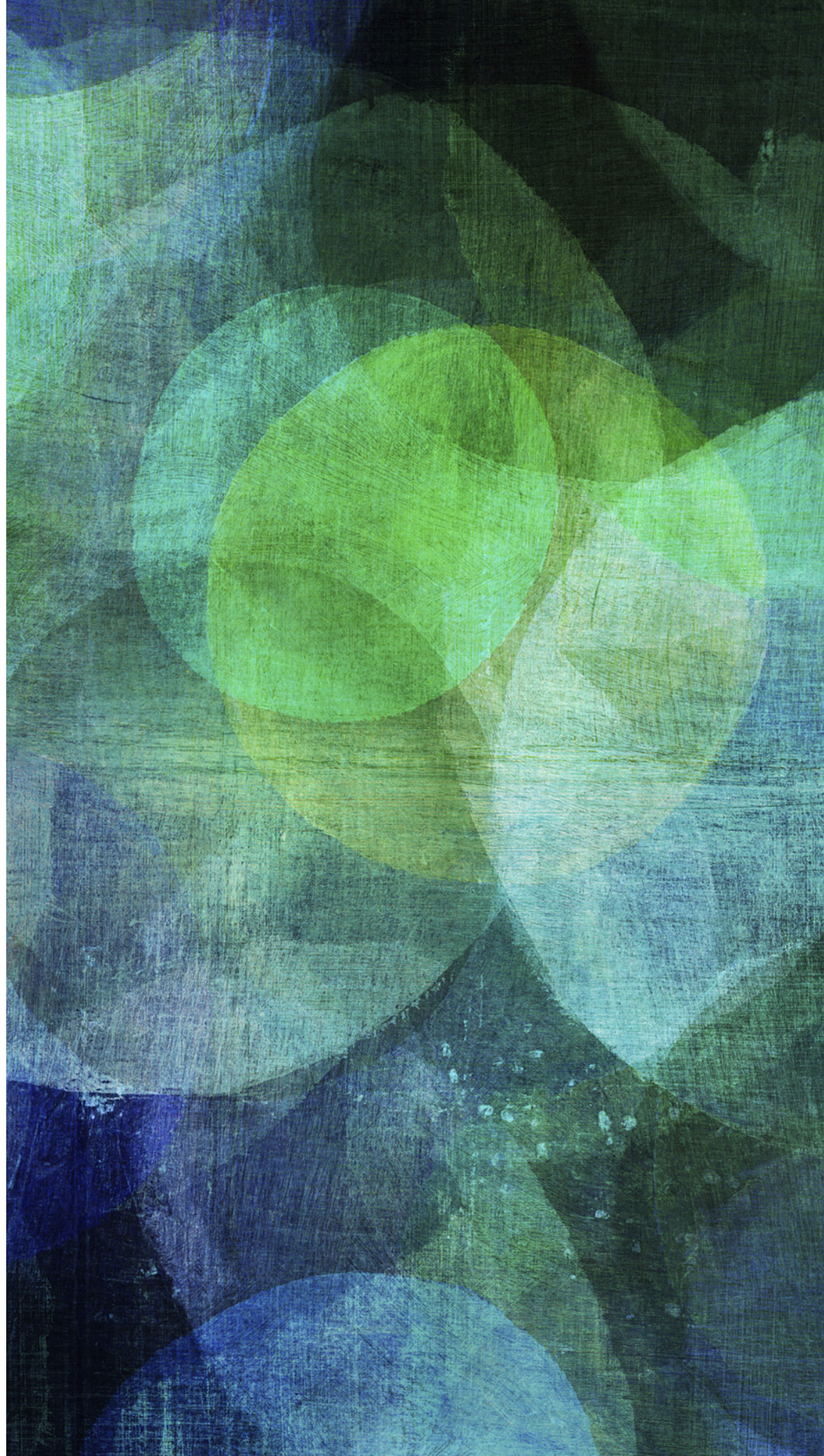
1. *When a client visits api/v1/device/:id/action/:action*
    1. *:id is the device/application id*
    2. *:action is the name of the function to call (explained in a bit)*
2. *If the request type is a GET request passion the request and response information to a function*
3. *Publish a message to the MQTT server with the topic to post to*
4. *Send acknowledgement of sent message to client*

NODEMON AP-SERVER.JS —— STARTING THE SERVER

Good place to switch gears

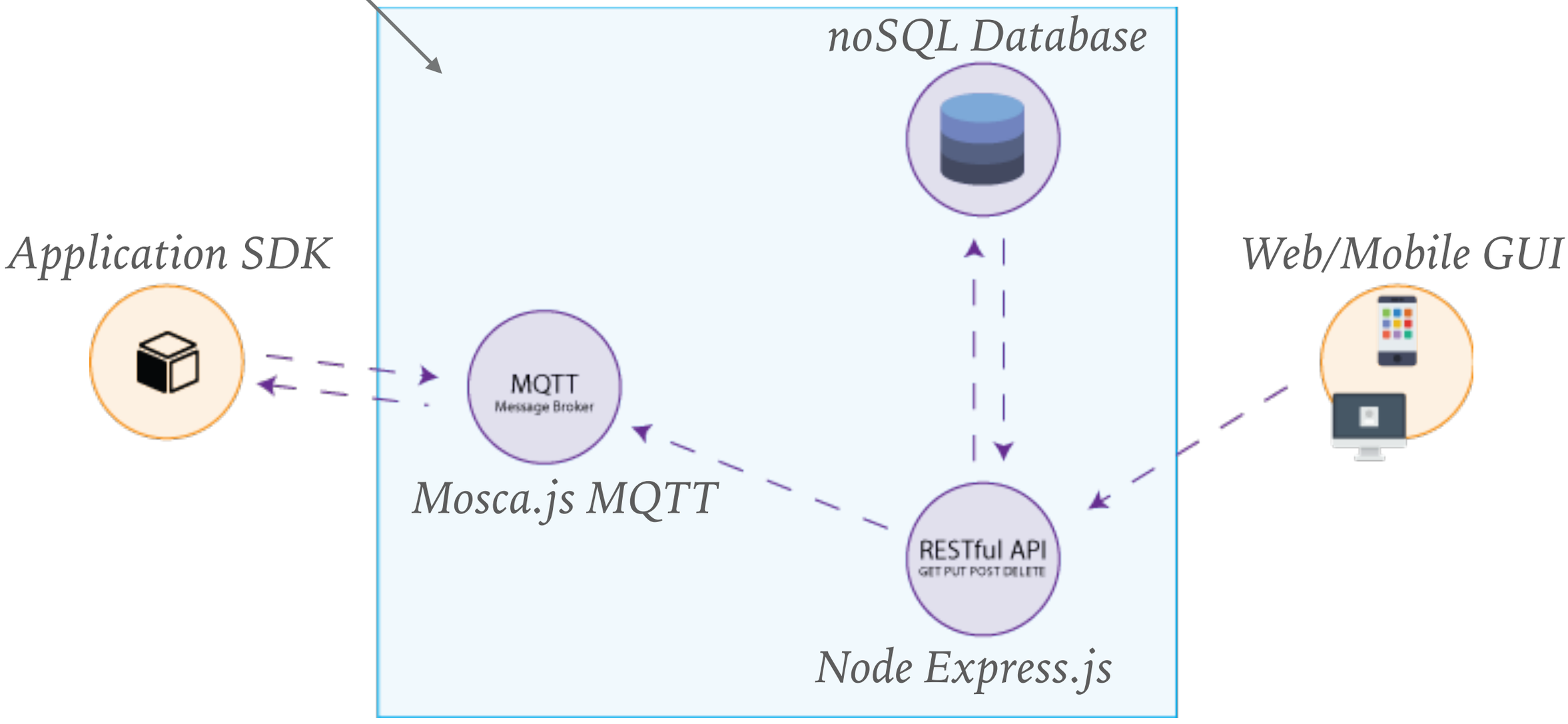
FROM THE USER SIDE

A look at the user implementation

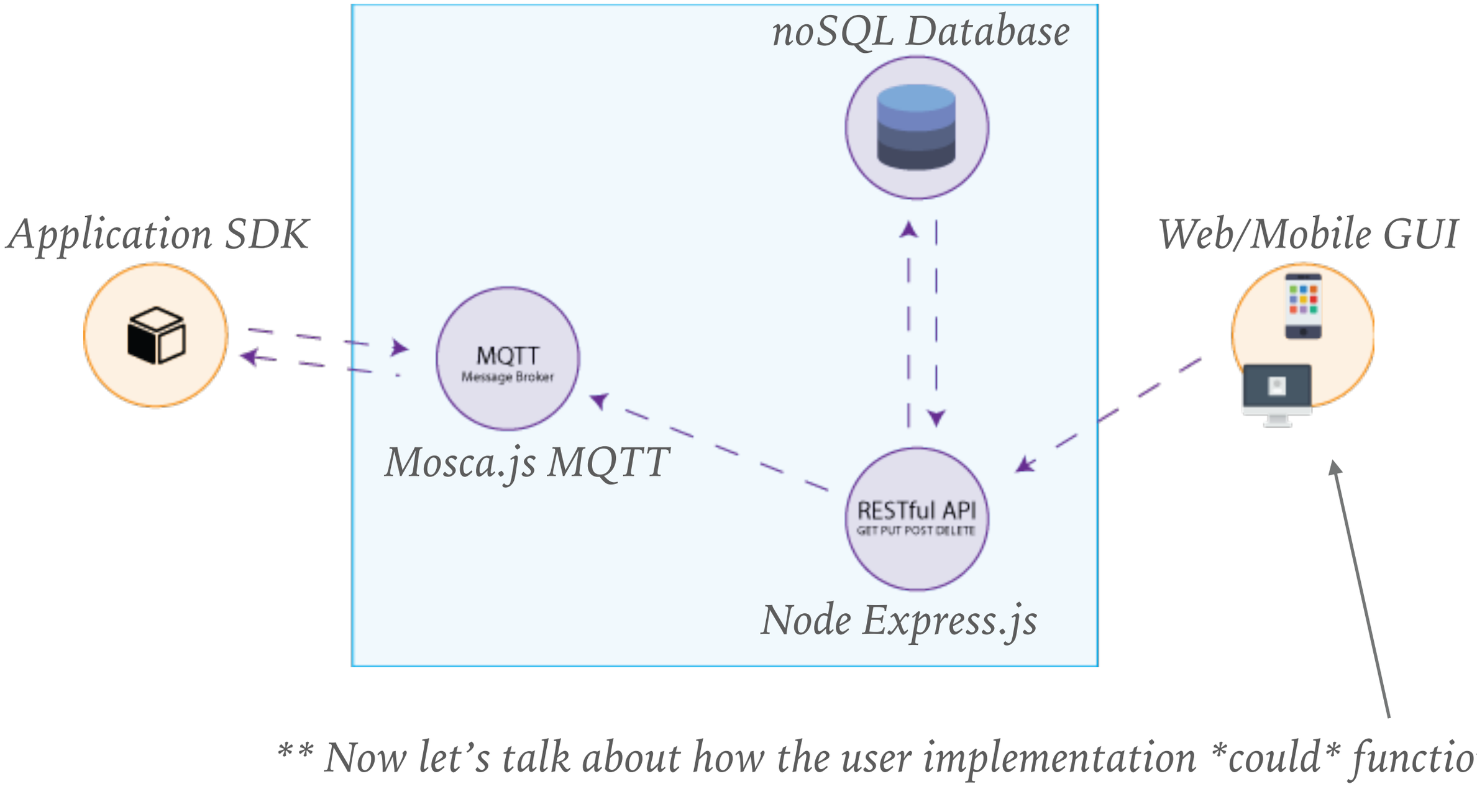


RECAP

We discussed the inner working of the server



RECAP



** Now let's talk about how the user implementation *could* function

SIMULATION OF PLATFORM

- MQTTLens - Allows us to see the messages getting passed
- Postman - Allows us to send http requests to the RESTful interface
- Chrome - allows us to run an in browser visual demonstration

SIMULATION OF PLATFORM – COMPONENTS

- Client SDK - For using with various platforms (index.js)
  - Browsers
  - Node.js
- Browser - For demonstration
  - demo.js - implementation of the Client SDK

CLIENT SDK (INDEX.JS)

```
mqtt = require('mqtt')
```

MQTT Library

```
/**
 * [Client description]
 * @param {[type]} ID [description]
 */
function Client(ID, JSON){
      //check with the server if this is a valid id
      //also needs some kind of authentication
      if(ID){
            this.id = ID
      }
      else{
            console.log("You have initialized the client without the ID")
      }
}
```

CLIENT SDK (INDEX.JS)

```
Client.prototype = {
      //this is the location of the MQTT server right now
      mqtt_options: {
        clientId: 'mqttjs_' + Math.random().toString(16).substr(2, 8),
        protocolId: 'MQTT',
      },
      mqtt_uri: 'ws://localhost:1884',
      /**
       * Initializes the MQTT connection up with the presence and id topic subscribed to
       * @return none
       */
      init: function(){
            if(this.id){
                  this.client = mqtt.connect(this.mqtt_uri, this.mqtt_options)
                  var C = this.client
                  console.log(this.client)

                  //we have to assign the Client the function because of the
                  //scoped nature of Node that way we will have access to the function in the callbacks

                  C.functions = this.functions

                  C.on('connect', function () {
                    C.subscribe('presence')
                    C.publish('presence', 'Hello mqtt')
                  })

                  C.on('message', this.onMessage)
                  //NOT SURE IF THIS WILL BE A SECURITY NIGHTMARE
                  this.subscribe(this.id + "/#") //subscribe to all id channels
            }
            else{
                  console.log('Please add an ID')
            }
},
```

MQTT WebSocket URL on port 1884

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```

Important!

CLIENT SDK (INDEX.JS)

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      /**
       * subscribes the client to a channel
       * @param  {string} topic the topic to be subscribed to
       */
      subscribe: function(topic){
            this.client.subscribe(topic)
      },
      /**
       * Publishes a message to the MQTT server for propogation
       * @param  {string} topic   the topic to be published to
       * @param  {string} message the message to be published
       */
      publish: function(topic, message){
            this.client.publish(topic,message)
      },
      /**
       * the callback function for MQTT on message
       * @param  {string} topic   the topic of the message
       * @param  {string} message the message byte string
       */
      onMessage: function(topic, message){
            var url_arr = topic.split('/')

            if(url_arr[1] === 'transition'){
                  // console.log(url_arr[2])
                  this.functions[url_arr[2]](message.toString())
                  return
            }
            // we will probably add more functionality here
            // this will be a large function
      }
}

//for browsers?
c = Client
//for node
module.exports = Client
```

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Important!

DEMONSTRATION FILE (DEMO.JS)

```
var machine = {

}

var client = new c('aasdkfjhaskjdhf', machine) //fake id

//these functions work because it is scoped
client.functions = {
      sayHi: function(){
            console.log('HELLO WORLD!');
      },
      sayNo: function(){
            console.log('I DONT WANT TO TALK!');
      },
      sayMessage: function(message){
            console.log('message')
      },
      makeBox: function(message){
            $(‘body').append('
                <div style="background-color:pink; display:block; width:50px; height:50px;”>
                '+message+'</div>')
      }
}

client.init()    //start the server
```

Instantiate the client

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Instantiate the client

Define the functions

Connect

PROPOSED CAPSTONE DEMONSTRATION

- Embedding framework logic in various applications
  - Remote control simple music player application
    - Cross platform compatibility
  - Controlling IoT device
    - Demonstrate dependency feature