

# Grand Challenge Design OS

Getting started

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# Grand Challenge Operating System

- Supports the “Grand Challenge” IoT game used in schools, allowing students to extend and play with IoT, yet avoid the enormity of network programming and managing 10s to 100s of Rpi units
- Support a logical set of “resources” and physical circuits “basis” that can be reused to create the concept of a full IoT environment supporting a gaming or modeling environment
- No database needed, driven from a configuration file and command-line
- Nodejs web os running on Rpi units
- Data can be provided via direct query or via emitters
- Supports a framework to run on N Rpi units to ease the distributed programming
- Extensible by dev team to add any sort of IoT extensions
- Extensions loaded in real-time as needed and offer a rich state of standard framework APIs
- Command line and Restful api support provided to control all instances via many methods
- Github location: <https://github.com/pdykes/gcos>
- Todo: MPV2
  - Command line tool
  - Enable basis circuits
  - Emit results to target URLs, websocket endpoints

# Diagram

Grand Challenge  
Command Line and Web

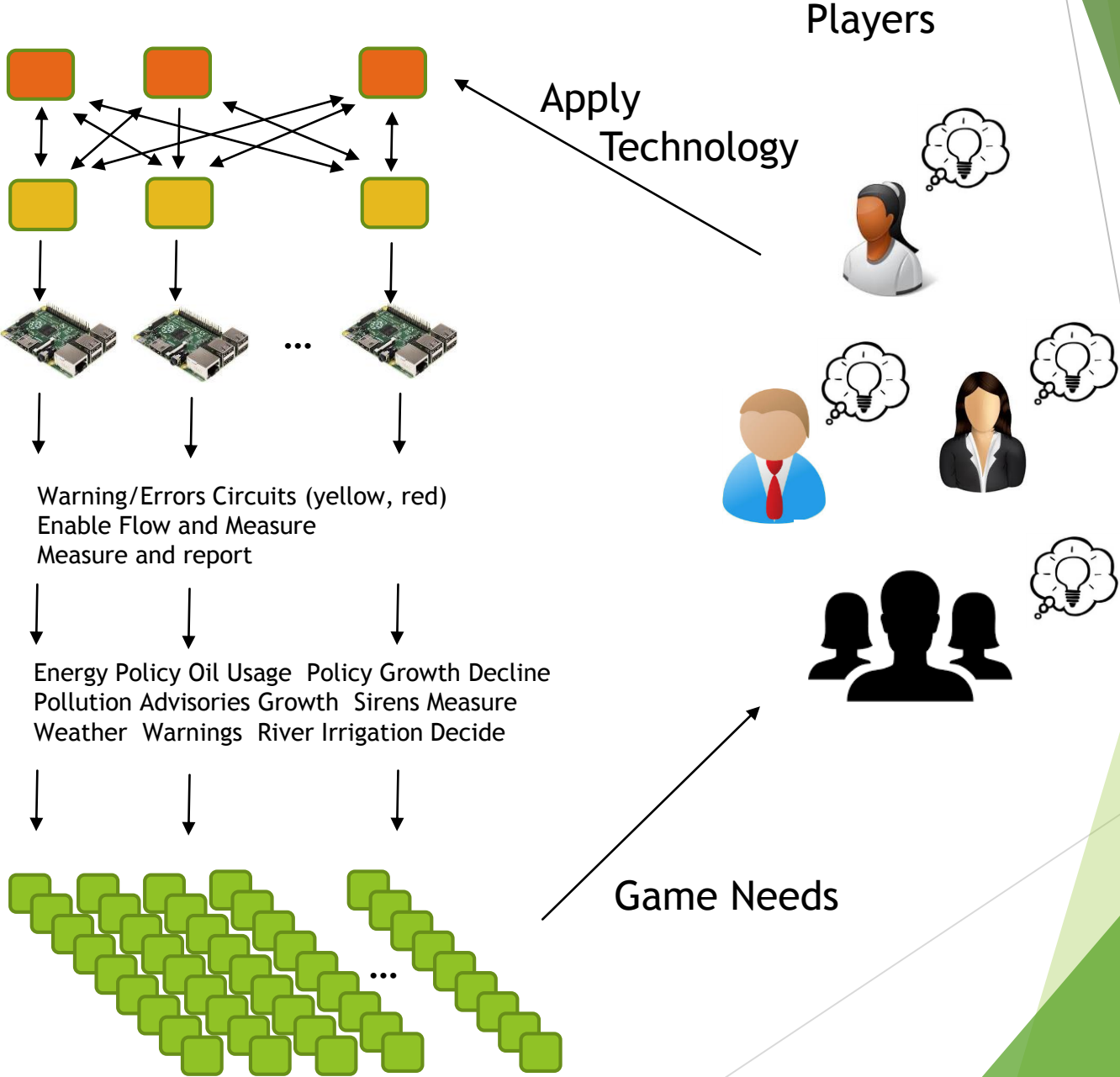
Grand Challenge  
Operating System

IoT Tier

Logical Game  
IoT Circuits

Logical Game  
Resources/Concepts

Game Cells



# Example

Grand Challenge  
Command Line and Web

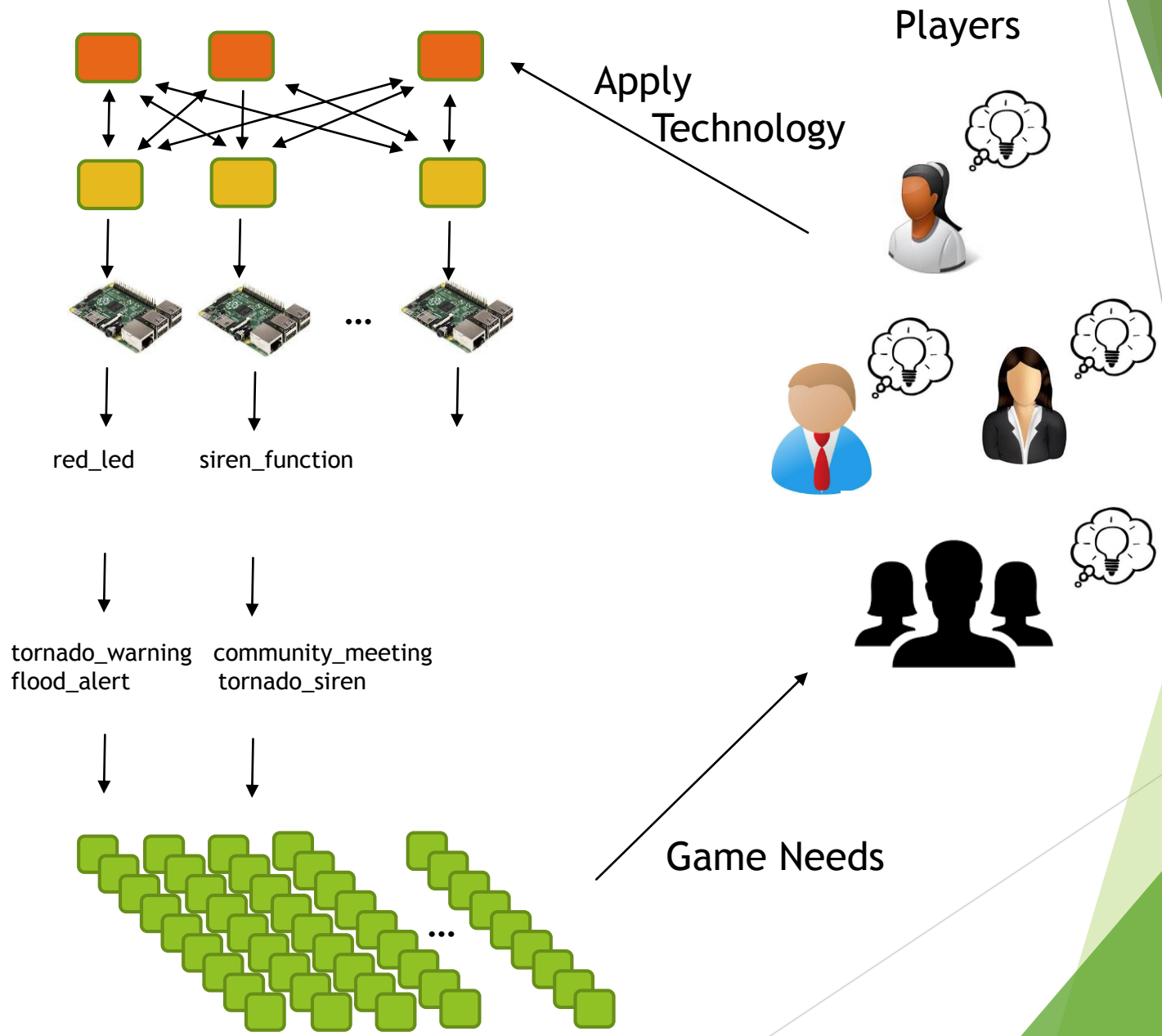
Grand Challenge  
Operating System

IoT Tier

Specific Circuit “Basis”  
(specific circuit)

Logical Game “Resource”  
(1 circuit -> n logical  
resources)

Game Cells



# What does the local Rpi/GCOS team do specifically?

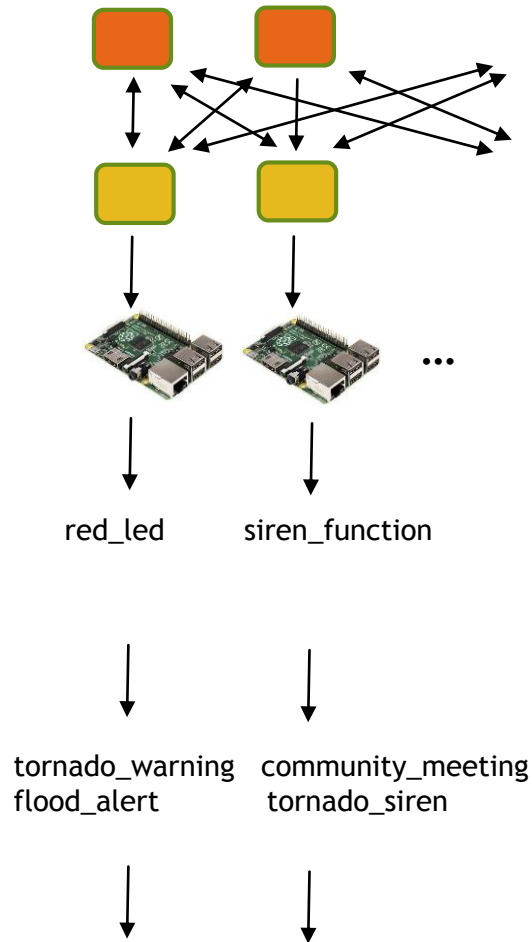
Grand Challenge  
Command Line and Web

Grand Challenge  
Operating System (GCOS)

IoT Tier

Specific Circuit “Basis”  
(specific circuit)

Logical Game “Resource”  
(1 circuit -> n logical  
resources)



## a) Work with Player/Game Designer

- Create logical resource required
- Create circuit designs to support logical resources
- Hopefully one physical circuit support many logical “resource(s)”

## b) Design the circuit on the Rpi (base circuit - “basis”)

- GPIO 24 -> Led -> Resistor -> Ground
- Test circuit
- Add to reference set of circuits available & ensure no conflicts

## c) Extend GCOS to support PI/Circuit with code

- Design software to initialize, control and unload to implement the “basis” of each resource
- Test, deploy and train players to use the solution
- Integrate basis/resource to report data to Game web application

# What does the local Rpi/GCOS team do specifically? (cont)

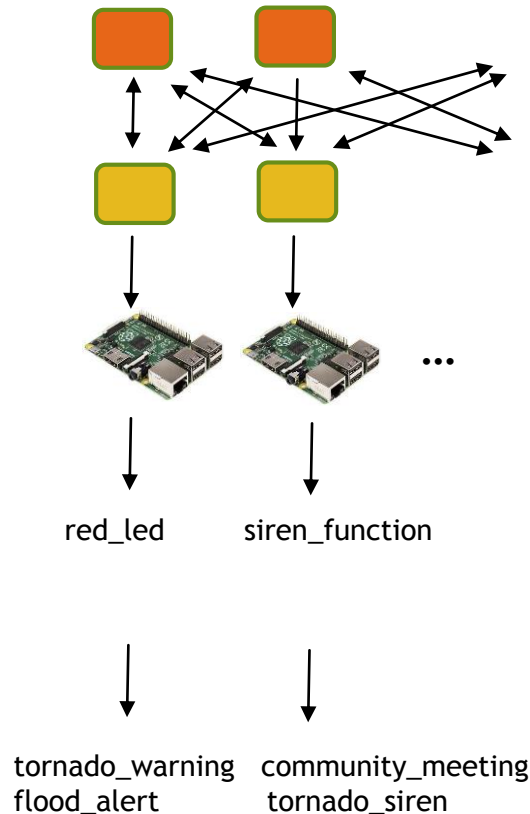
Grand Challenge  
Command Line and Web

Grand Challenge  
Operating System (GCOS)

IoT Tier

Specific Circuit “Basis”  
(specific circuit)

Logical Game “Resource”  
(1 circuit -> n logical  
resources)



## a) Create resource in global configuration

- Update gcoss\configuration.json
- For each node/player, add logical resource
- Reference the basis and instance of basis used (can have more than once instance)
- Manage the central file and ensure all Rpi units acquire new standard file

## b) Design the circuit on the Rpi (base circuit - “basis”)

- GPIO 24 -> Led -> Resistor -> Ground
- Test circuit
- Add to reference set of circuits available & ensure no conflicts

## c) Extend GCOS to support PI/Circuit with code

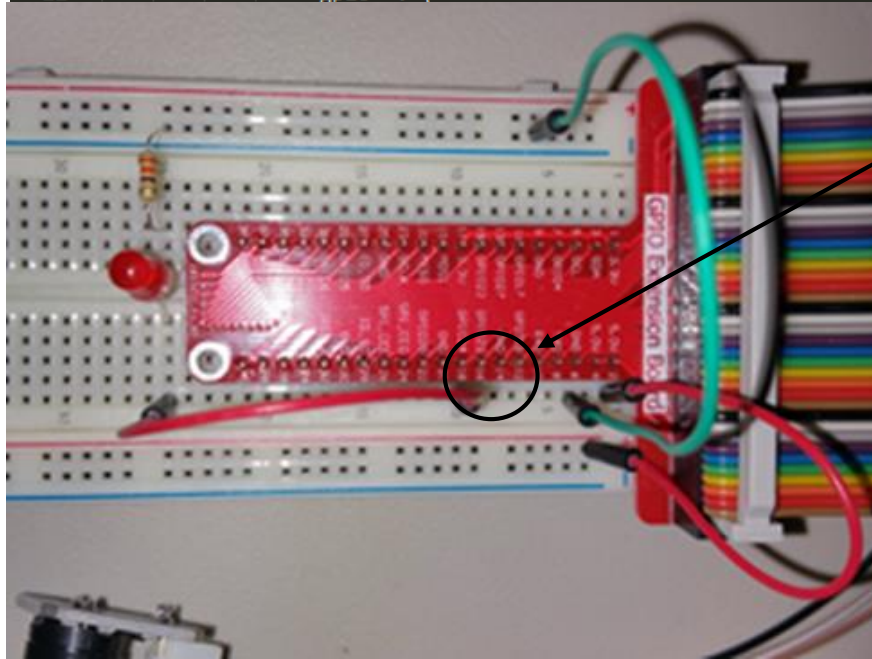
- Create an extension program that talks to the “basis” circuit
- Test the functions via GCOS to interact with the code that drives the circuit
- Code extension for each basis will be located in gcoss\ext
- Code dynamically pulled into GCOS at gcoss startup on Rpi

# GCOS resource -> basis configuration example

```
configuration.json
1 {
2   "player_1_pi": {
3     "resources": {
4       "internal_IT" : {
5         "ip"           : "192.168.1.111",
6         "port"         : "8085",
7         "gcoss_root_uri" : "/api/v01"
8       },
9       "red_warning_light": {
10        "basis" : "led_light",
11        "instance" : "1",
12        "gpio" : {
13          "led_pin" : {
14            "led_gpio_pin" : "24",
15            "led_mode" : "out"
16          }
17        }
18      },
19      "manual_yellow_warn_light": {
20        "basis" : "led_push_button_yellow",
21        "instance" : "1",
22        "gpio" : {
```

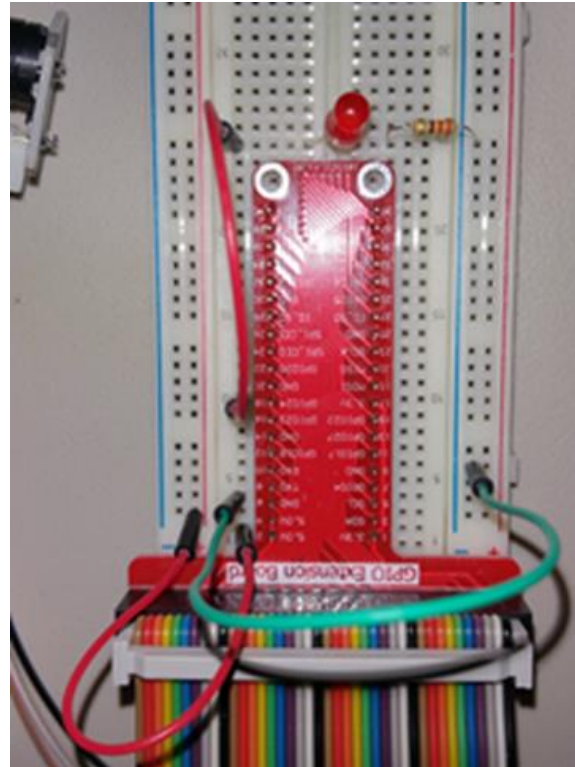
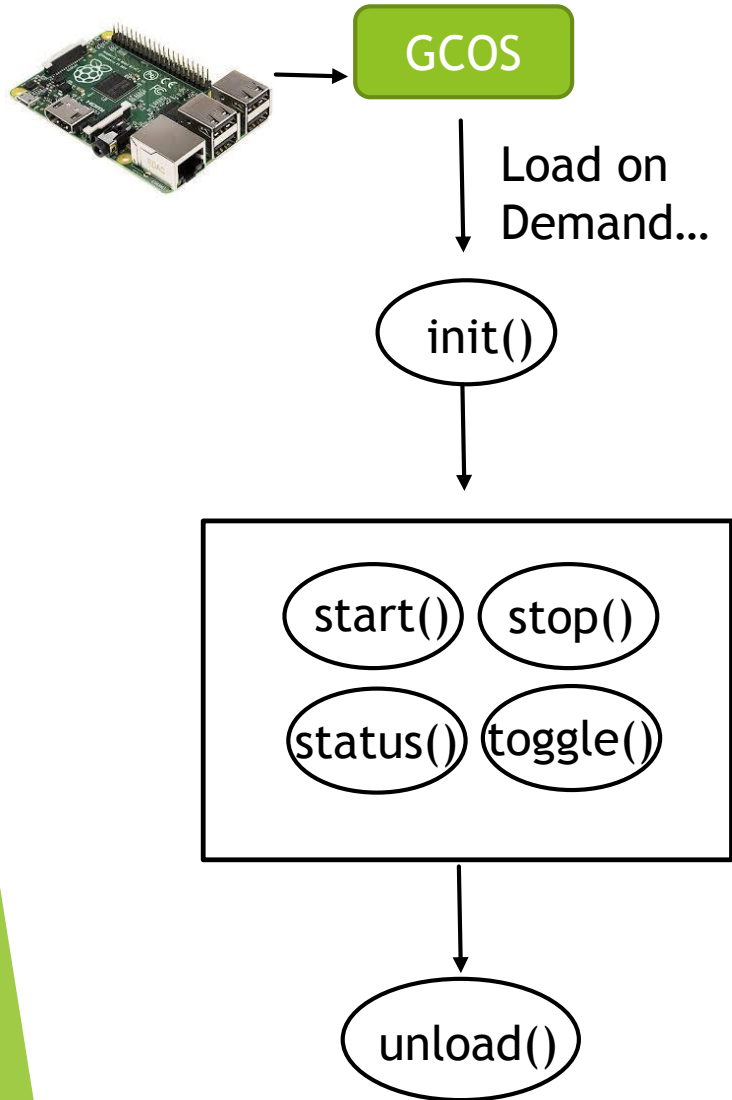
Add a resource to global configuration

- Update gcoss\configuration.json (to left)
- Each Rpi is related to player currently "player\_1\_pi"
- Each Rpi offers a set of resources and underlying basis circuits for all resources
- "red\_warning\_light" is an example resource
- There could be many uses of a red warning light, each having their own name and identity to the gamers and tied to grand challenge
- The "basis" describes the code and Rpi circuit supporting the logical resource
- There can be more than once instance of this circuit (instance = 1) in this case, the resource will be tied to a basis instance
- Eventually the basis could be shared or exclusively held by players
- gpio\_port (24, circled on left) and mode (output) are used to configure and use circuit during runtime and required by Rpi
- The other attribute are for future
- The current version only supports one gpio per circuit, a limitation that will be corrected soon
- Manage the central file and ensure all Rpi units acquire new standard file





# Extending GCOS & creating a basis-> life cycle for “led\_light” example



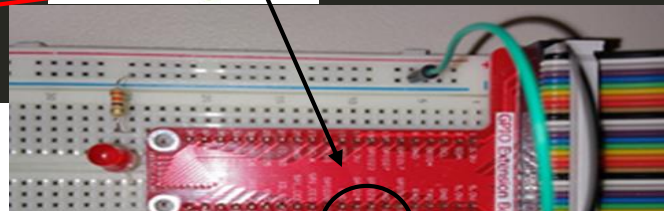
## Life Cycle of a GCOS Rpi Basis Circuit

- 1) Phase 1
  - Load basis module and initialize
  - => init() method - initialize the GPIO pin, set mode
- 2) start - start the circuit, or
- 2) stop - stop the circuit, or
- 2) status - query basis for status data, or
- 2) toggle - cycle state swap between on/off, or
- 2)/3) unload - removes reference & cleanup
- Status Considerations
  - init() call should be done first and will pass in GPIO pin and output direction data direction (“in”, “out”)
  - After init, all other methods can be called in the life cycle diagram (even unload(), but why?)
  - Typically, status() maybe called the most often, start(), stop() and toggle() to control state in normal operation
- Programmer will create a “led\_light.js” file from standard template, implement each method
- GCOS can support as many circuits as you can create



# Extending GCOS basis-> code “init” example to for “led\_light”

```
led_light.js
46 //
47 // init function - used to establish the gpio such that can start, stop and toggle the device
48 //
49 //      The core GPIO command is provided, and return data. The data can be augmented
50 //      as needed.
51 //
52 function init(gpio_object) { // TODO PERRY Need to handle > 1 GPIO pin, e.g could enable several
53
54     // Dump gpio object for example
55
56     debug("led_light sample gpio object" + JSON.stringify(gpio_object));
57
58     // Assign the information needed for on/off api from the gpio object
59
60     // user defines the data structure and variable names in json configuration file (see gcons.ini)
61     gpio_pin = gpio_object.led_pin.led_gpio_pin;
62     gpio_mode = gpio_object.led_pin.led_mode;
63
64     debug("Module [" + module_name + "] init [Mode: " + gpio_mode + " Pin: " + gpio_pin + "]");
65
66     try {
67         // Gpio = require("onoff").Gpio, led = new Gpio(Gpio_pin, Gpio_mode), iv;
68         Gpio = require('onoff').Gpio, // Constructor function for Gpio objects.
69         led = new Gpio(gpio_pin, gpio_mode); // Export GPIO #14 as an output.
70     } catch (err) {
71         console.log("Error: " + err);
72         return (err);
73     }
74
75     debug("init complete");
76
77     var data_response = {
78         "module" : module_name,
79         "method" : "init",
80         "status" : "OK",
81         "return_code" : "200"
82     };
83
84     return(data_response);
85 }
```



## Extension File for each “basis”

- Team members create a nodejs module which is added to the \ext directory and copied to the Rpi for use by gcoss
- The following methods need to be implemented by the user
  - init - initialize the GPIO
  - start - start the circuit
  - stop - stop the circuit
  - toggle - cycle state swap between on/off
  - unload - removes reference, cleanup
- There is an example to help, the init function is shown on the left
  - init() call passing in GPIO information
  - Debug statements should be added for testing and can be dynamically turned on if problems occur during operation
  - Logic that needs to be ran, in the init case the npm onoff package is used and communicates with the Rpi gpio circuit
  - Data should be created reflecting what happened and is added to what the GCOS applications that use the data when function returns
- Programmer will create a “led\_light.js” like file as a template and adjust methods for each new basis circuit
- Register the new resource using this basis in

# Debugging Tools - Postman (cli coming soon)

- ▶ Install Postman
  - ▶ Open Chrome
  - ▶ Chrome Apps
  - ▶ Search and install Postman
- ▶ Run PostMan
  - ▶ Chrome Apps
  - ▶ Select Postman
  - ▶ See the next screen (use after starting gcoss via the Readme.MD)

Initialize a resource (sample included, make a led circuit attached to gpio 24)

The screenshot displays a REST client interface with the following details:

- URL:** `http://192.168.1.111:8080/api/v01/ctrl`
- Method:** `POST`
- Authorization:** No Environment
- Body Type:** `x-www-form-urlencoded`
- Body Data:**

key	value
command	init
resource	red_warning_light
instance	1
- Status:** 200 OK, Time: 224 ms
- Response Body (Pretty):**

```
{
  "/ctrl undefined state information: {
    "command": "init",
    "resource": "red_warning_light",
    "host": "192.168.1.111:8080",
    "unit": "player_2_pi",
    "port": "8080",
    "url": "http://192.168.1.111:8080/api/v01/ctrl",
    "response": {
      "module": "led_light",
      "method": "init",
      "status": "OK",
      "return_code": "200"
    }
  }
}
```

Start a resource: (light should turn on)

The screenshot displays a REST client interface with the following details:

- URL Bar:** `http://192.168.1.111:8`
- Environment:** No Environment
- Method:** POST
- URL:** `http://192.168.1.111:8080/api/v01/ctrl`
- Params:** A red arrow points to the Params tab.
- Body Tab:** Selected, showing form-data encoding. The body is a JSON object with the following fields:
  - `command`: start (highlighted with a red box)
  - `resource`: red\_warning\_light
  - `instance`: 1
  - `key`: value
- Response Tab:** Shows the response body in JSON format:

```
{
  "command": "init",
  "resource": "red_warning_light",
  "host": "192.168.1.111:8080",
  "unit": "player_2_pi",
  "port": "8080",
  "url": "http://192.168.1.111:8080/api/v01/ctrl",
  "response": {
    "module": "led_light",
    "method": "init",
    "status": "OK",
    "return_code": "200"
  }
}
```
- Status:** 200 OK
- Time:** 224 ms

Stop a resource: (light should turn off)

The screenshot shows a REST client interface with a POST request to `http://192.168.1.111:8080/api/v01/ctrl`. The request body is set to `x-www-form-urlencoded` and contains the following data:

key	value
command	stop
resource	red_warning_light
instance	1

A red arrow points to the `Send` button. The response status is `200 OK` with a time of `224 ms`. The response body is shown in the `Body` tab, displaying the following JSON:

```
{
  "/ctrl undefined state information: {
    "command": "init",
    "resource": "red_warning_light",
    "host": "192.168.1.111:8080",
    "unit": "player_2_pi",
    "port": "8080",
    "url": "http://192.168.1.111:8080/api/v01/ctrl",
    "response": {
      "module": "led_light",
      "method": "init",
      "status": "OK",
      "return_code": "200"
    }
  }
```

- More Commands
  - manage - command line tool to target IoT device resources
  - gcos - command to start the server on a given instance
- Operations the rest api and command line support
  - init, start, stop provided as directive
  - toggle, unload are used as well
    - Toggle switches the value from on -> off, off -> on
    - Unload disables the circuit and user must run init again
  - Init and Unload are done once, then use for many times and when wrapping up unload for example