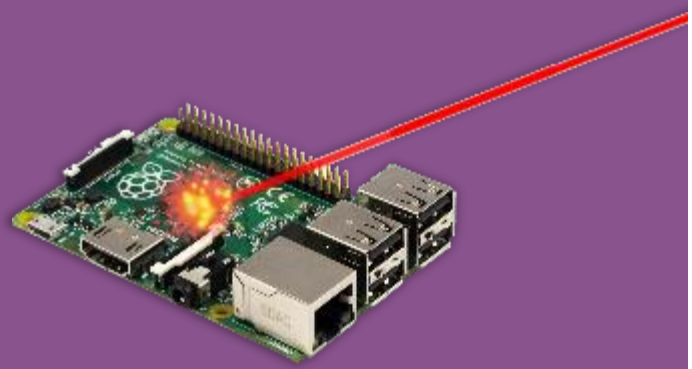


Shoot A Pi!
with Eclipse Kura

EUROTECH
Imagine. Build. Succeed.

David Woodard @ Eurotech
Luca Dazi @ Eurotech

Agenda

- Presentation of Kura architecture for Java and OSGi based multi service gateway platforms. (Dave, 20 mins)
- Presentation of the Shoot-A-Pi arcade game simulator, game logic explanation, MQTT topics and metrics (Luca, 15 mins)
- Hardware setup on the Raspberry Pi B+ (15 mins)
- Assisted creation of the Shoot-A-Pi bundle (90 mins)
- Tests (15 mins)
- Dashboard showcase and final game (15 mins)
- Q&A

Before starting…

- Power on the Raspberry Pi with the micro USB cable
- Connect the Raspbery Pi to an ethernet port on your PC
- Connect your PC to the WiFi network named 'ShootAPi'
  Password: ***KuraTutorial***
- Set the IP Address of your ethernet to 192.168.2.1
- Start VirtualBox and import the tutorial image (*shootapi.ova*)
- Start the newly imported EclipseCon VM
- Start the Terminal Emulator
- Access the Raspberry Pi with ssh at address 192.168.2.10
  ssh pi@192.168.2.10
  Password: ***raspberry***

Share your WiFi with the Pi

Linux / Mac users

- Open the Kura Web Console on a browser (*192.168.2.10*)
- Navigate to the Network panel and set eth0 on DHCP
- Share your WiFi with the Ethernet interface
- Do an ifconfig on the terminal and take note of the IP address assigned to eth0 (defaults to *10.42.0.1* on Ubuntu)
- Scan for the IP of the Pi using nmap

  nmap 10.42.0.0-255

Windows users

- Share your WiFi with the Ethernet interface
- Set the IP address of the Ethernet interface to *192.168.2.1*
- The Raspberry Pi will be available at address *192.168.2.10*

Share your WiFi with the Pi

Windows

- Right-click on the Network icon in the taskbar
- Open Network and Sharing Center
- Click on Change adapter settings
- Right-click on WiFi, open the Properties
- Activate the Sharing tab
- Check the Allow other network users to connect checkbox
- Select Ethernet from the combo box below
- Apply and close

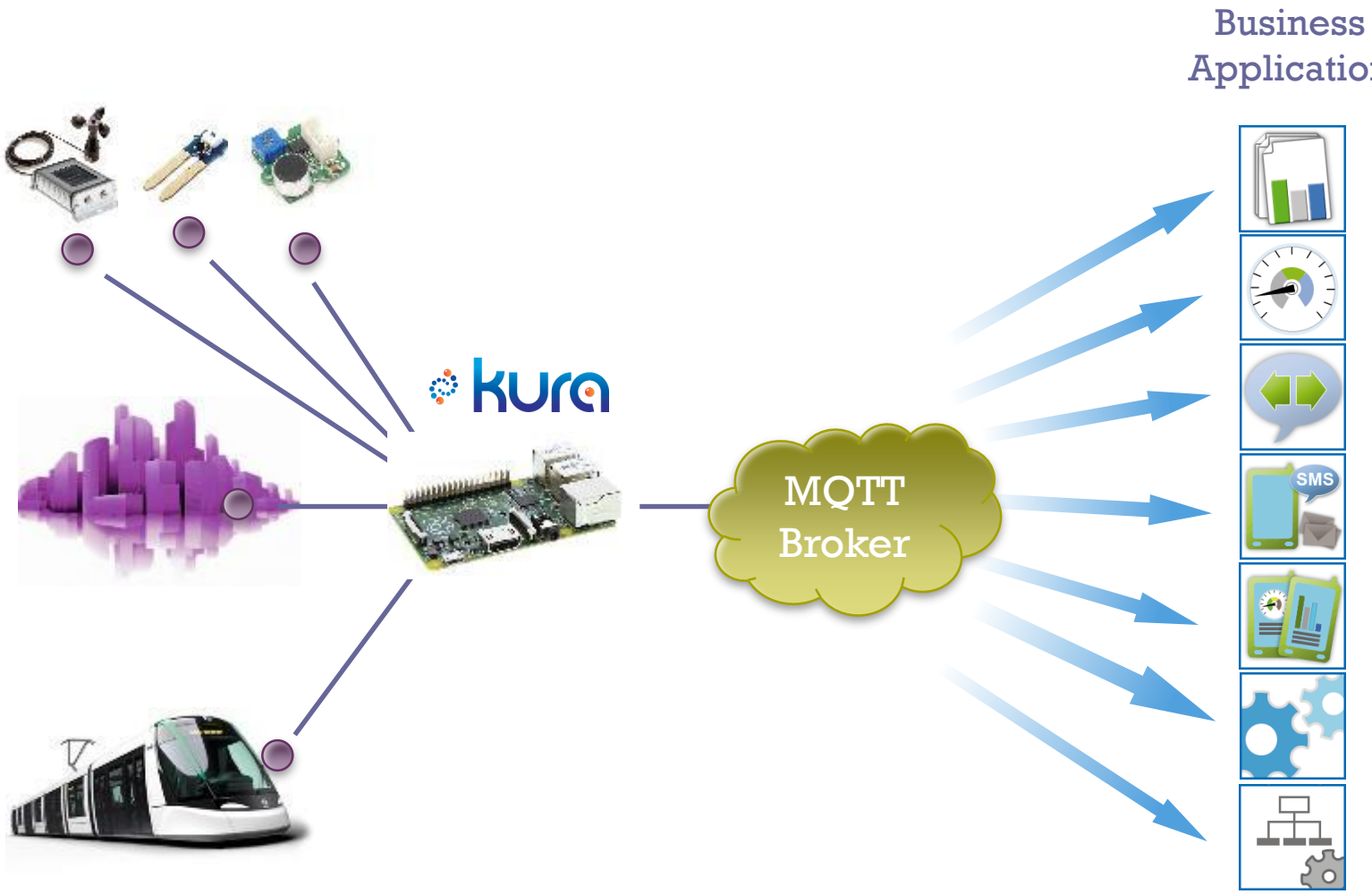
Share your WiFi with the Pi

Ubuntu

- Click on the network icon, then Edit Connections…
- Double click on the Wireless Connection
- Open the IPv4 Settigns tab
- Select Shared with other computers on the Method combo box
- Apply and exit. Once the Pi is connected and set to DHCP click on the Wired Network so to renew the DHCP lease

IoT Gateways

Revolution: Towards Real-time Actionable Data



KURA is the open source Java and OSGi-based Application Framework for M2M Service Gateways in the Eclipse IOT Working Group.

Purpose

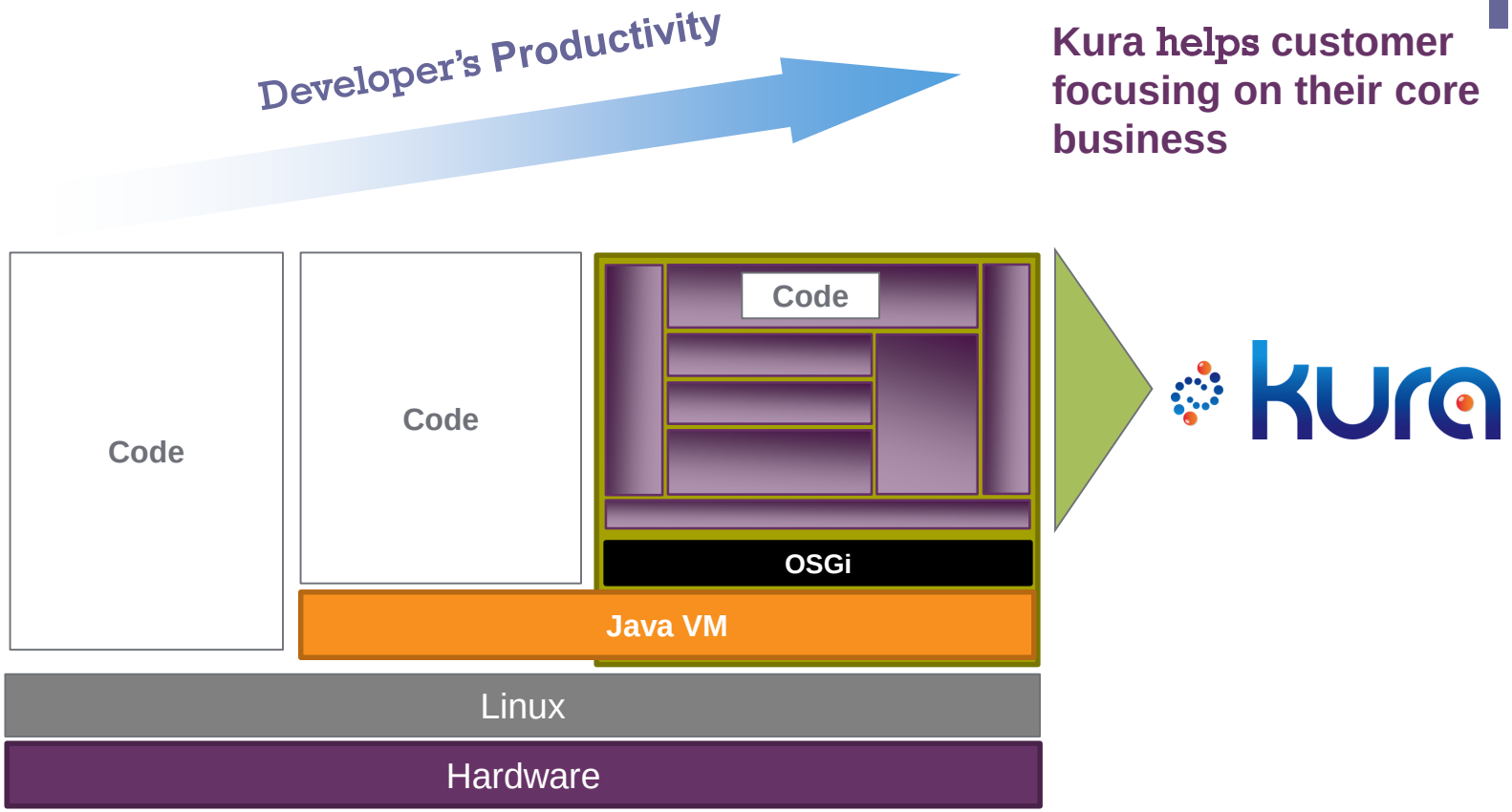
Simplify the design, deployment and remote management of embedded applications.

It provides

- Cohesive and integrated app environment
- Modular software components
- HW abstraction layer
- Field protocol libraries
- Cloud connectivity
- Remote app and device management
- Local app and device management
- Built-in Security
- Development tools

Encapsulating complexity

Increase productivity and decrease cultural barriers

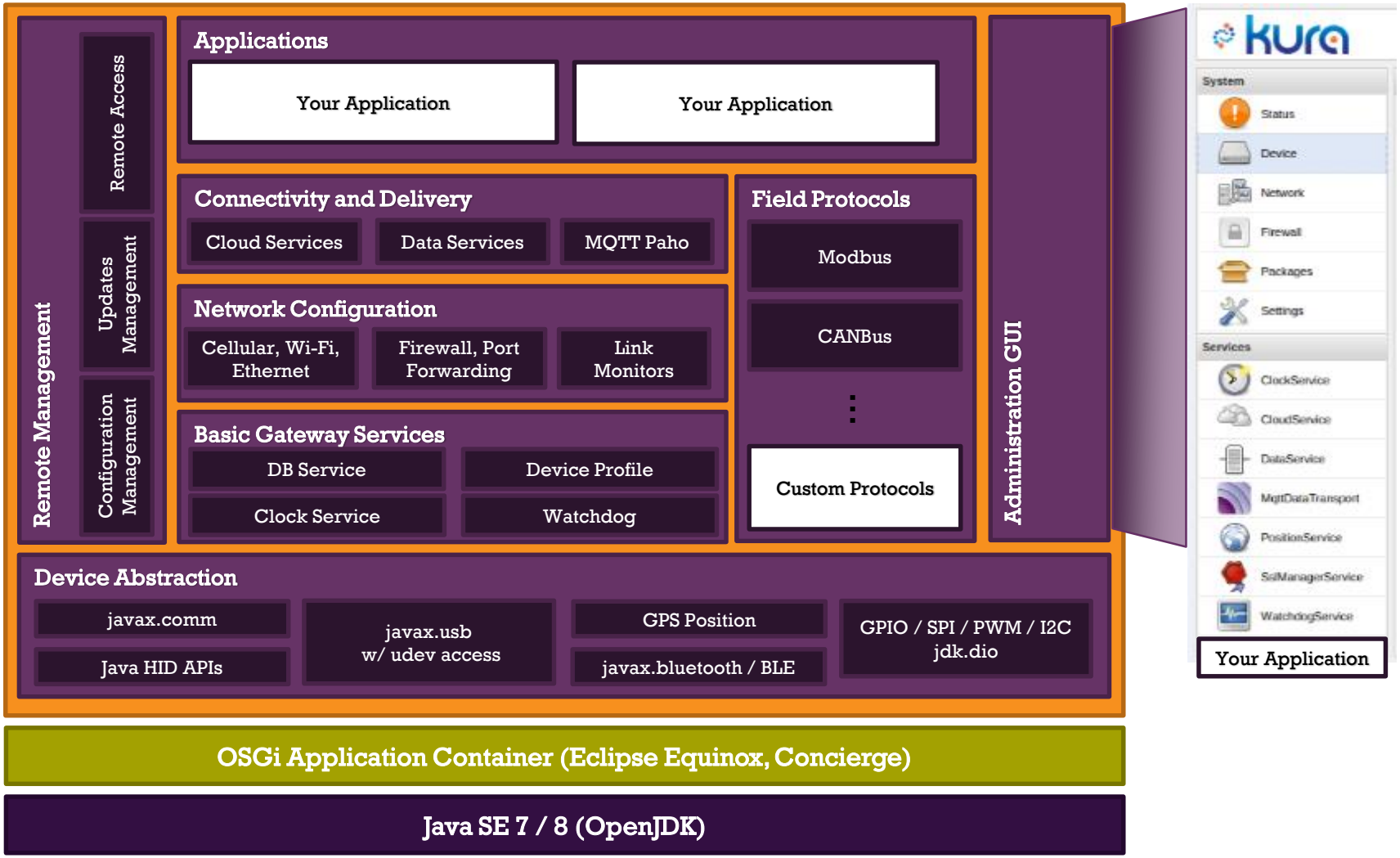


Kura Developers' Experience

Designed from ground-up for developers

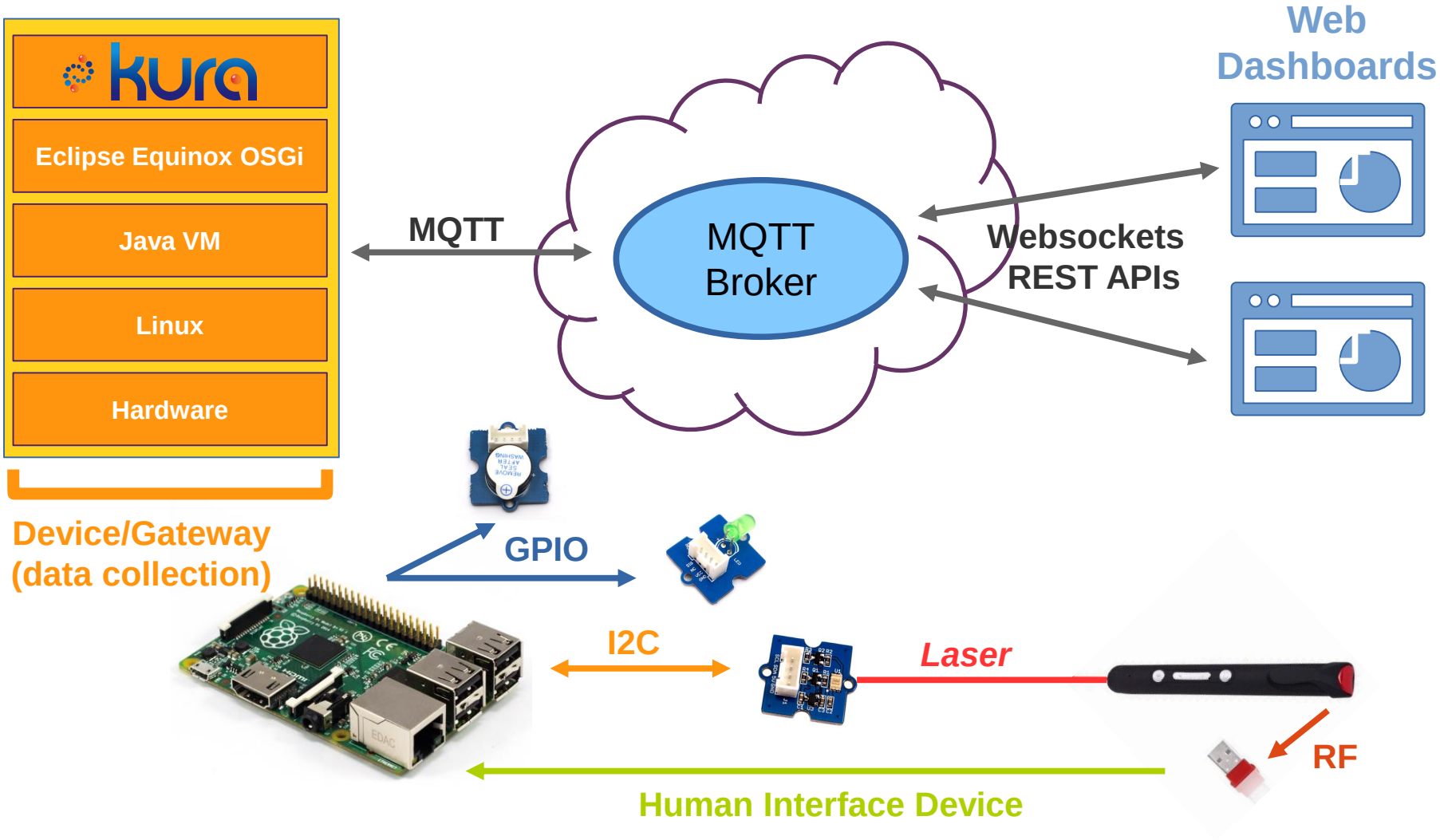
Emulate on PC	Deploy on Target	Cloud Managed
		
Start developing your M2M application in the comfort of your PC. •Full Eclipse Integration •Target Platform Definition •Emulated Services •Run/Debug from Eclipse •Support Mac/Linux Hosts	When you are ready, deploy your application on the gateway. •One-click Deployment •Eclipse Plugin •Remote Debugging	Provision your application to field devices from the Cloud. Manage your application configuration and lifecycle from a Cloud infrastructure. No more field visits! •Web-based Console •REST API Integration •Smart Alerts

Eclipse Open IoT Stack for Java



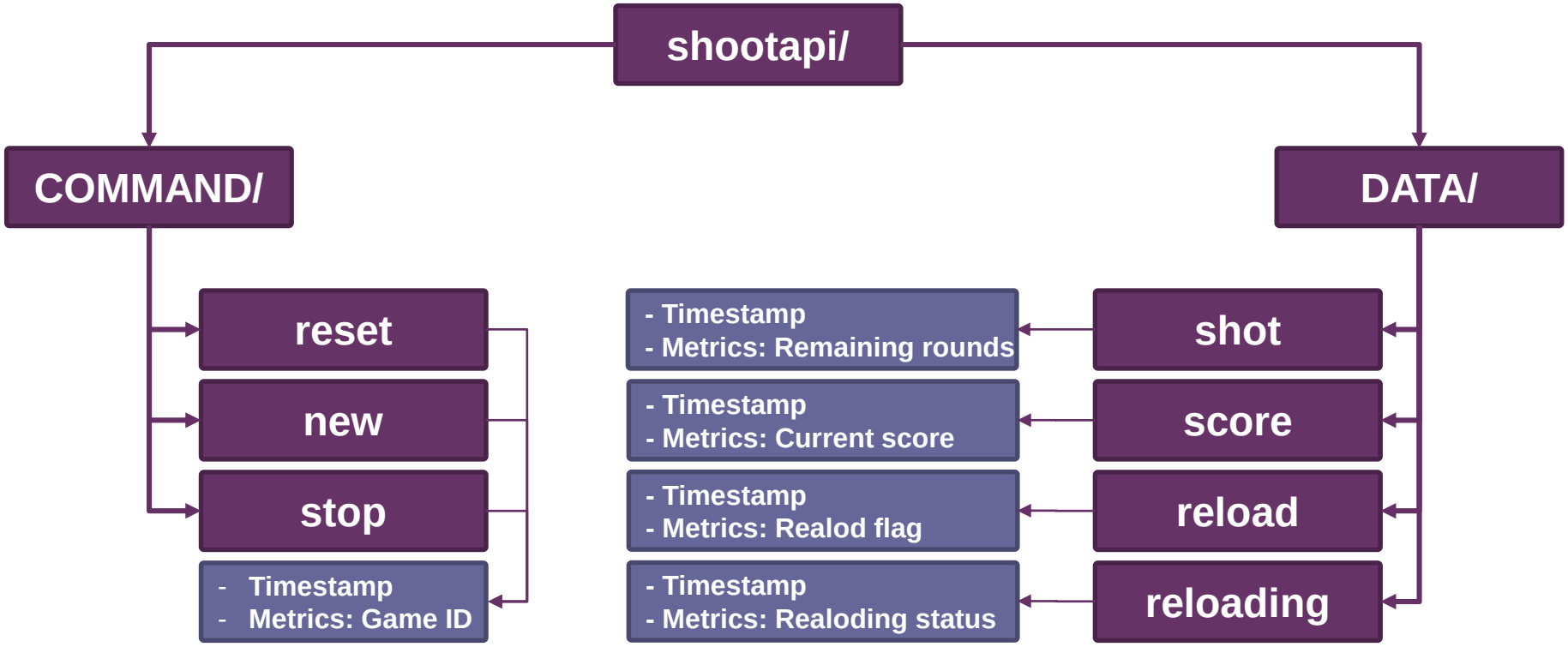
Shoot-A-Pi Arcade Shooter Simulator

Architecture



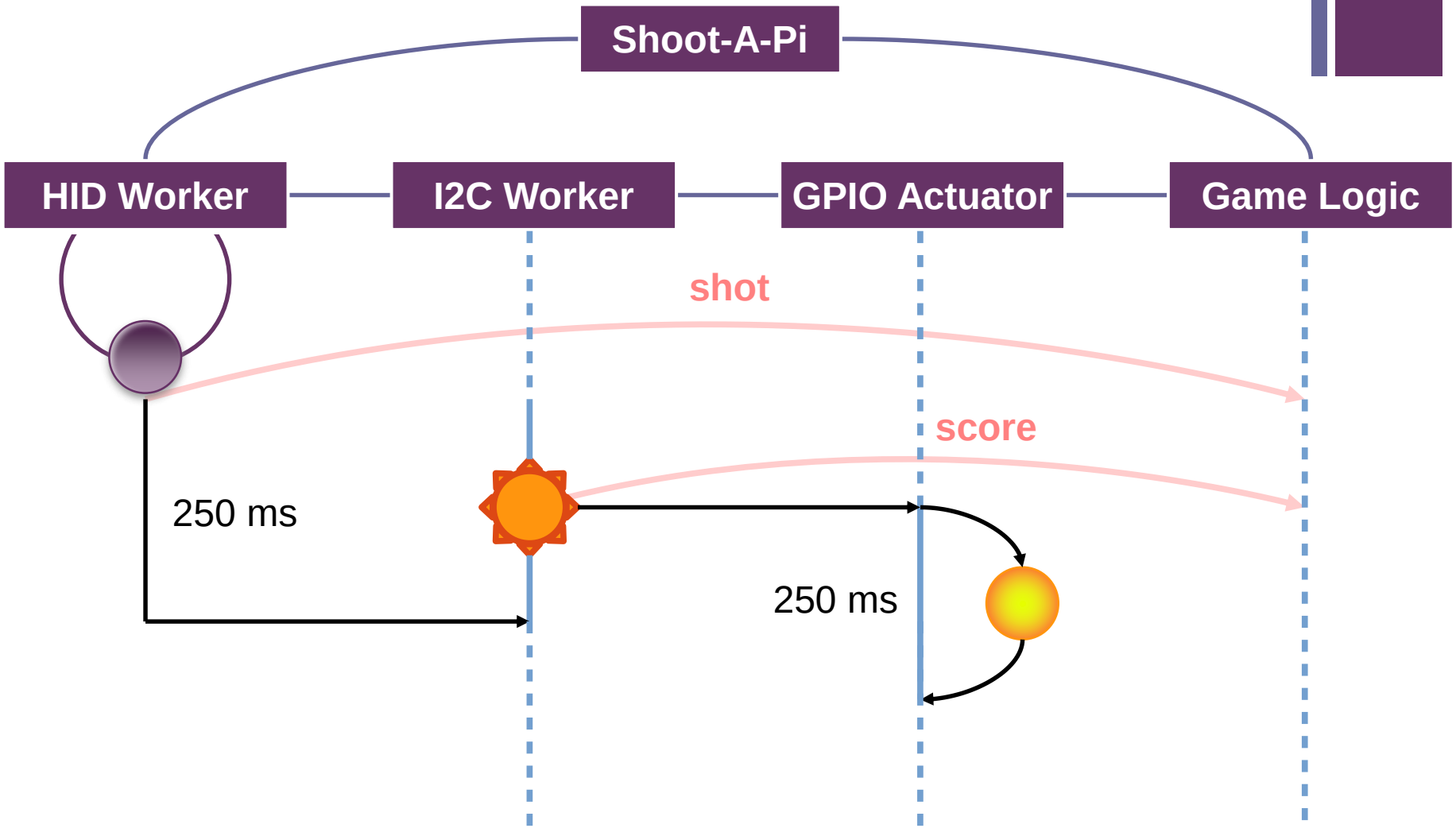
Shoot-A-Pi Arcade Shooter Simulator

MQTT Topics and Metrics



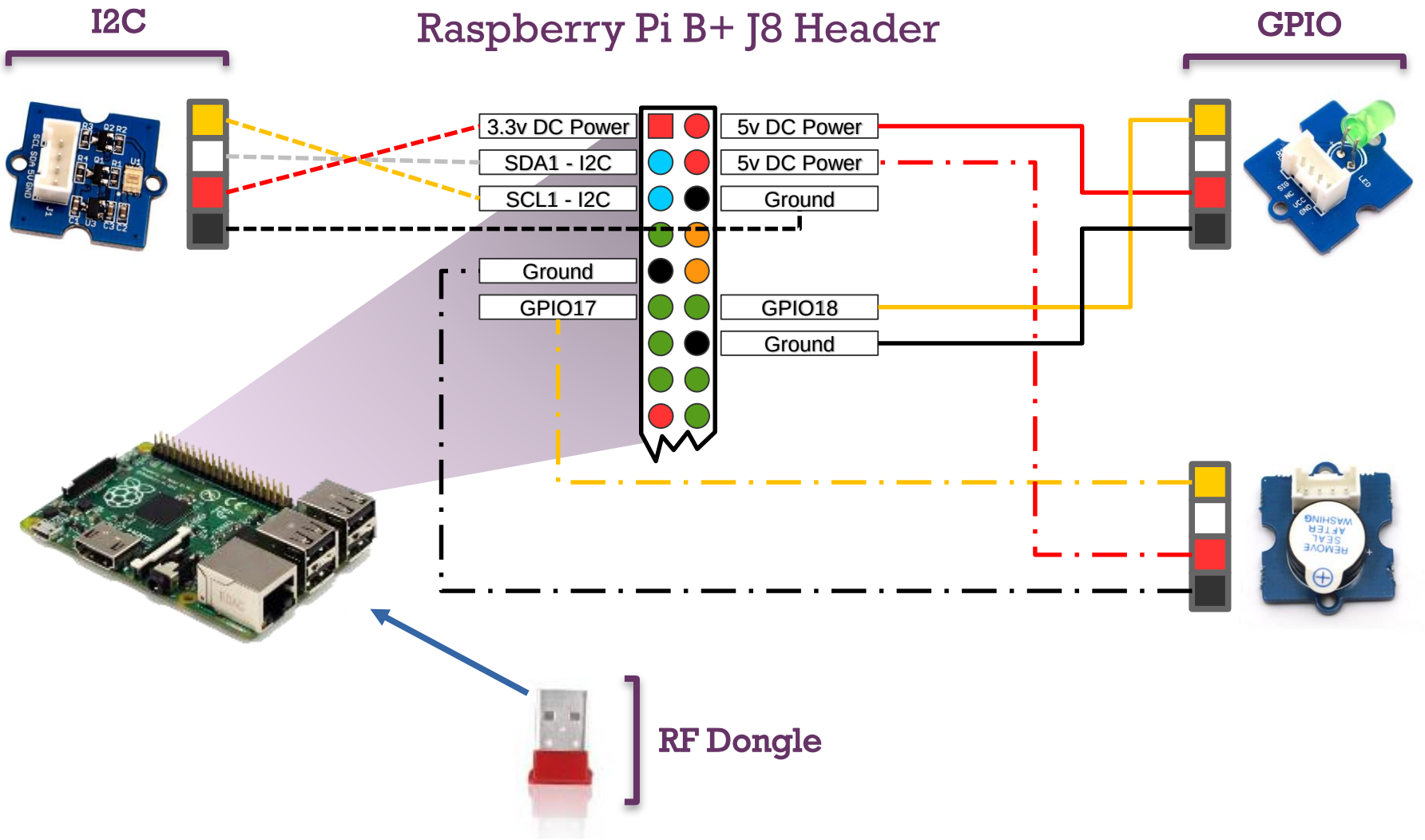
Shoot-A-Pi Arcade Shooter Simulator

Game Logic

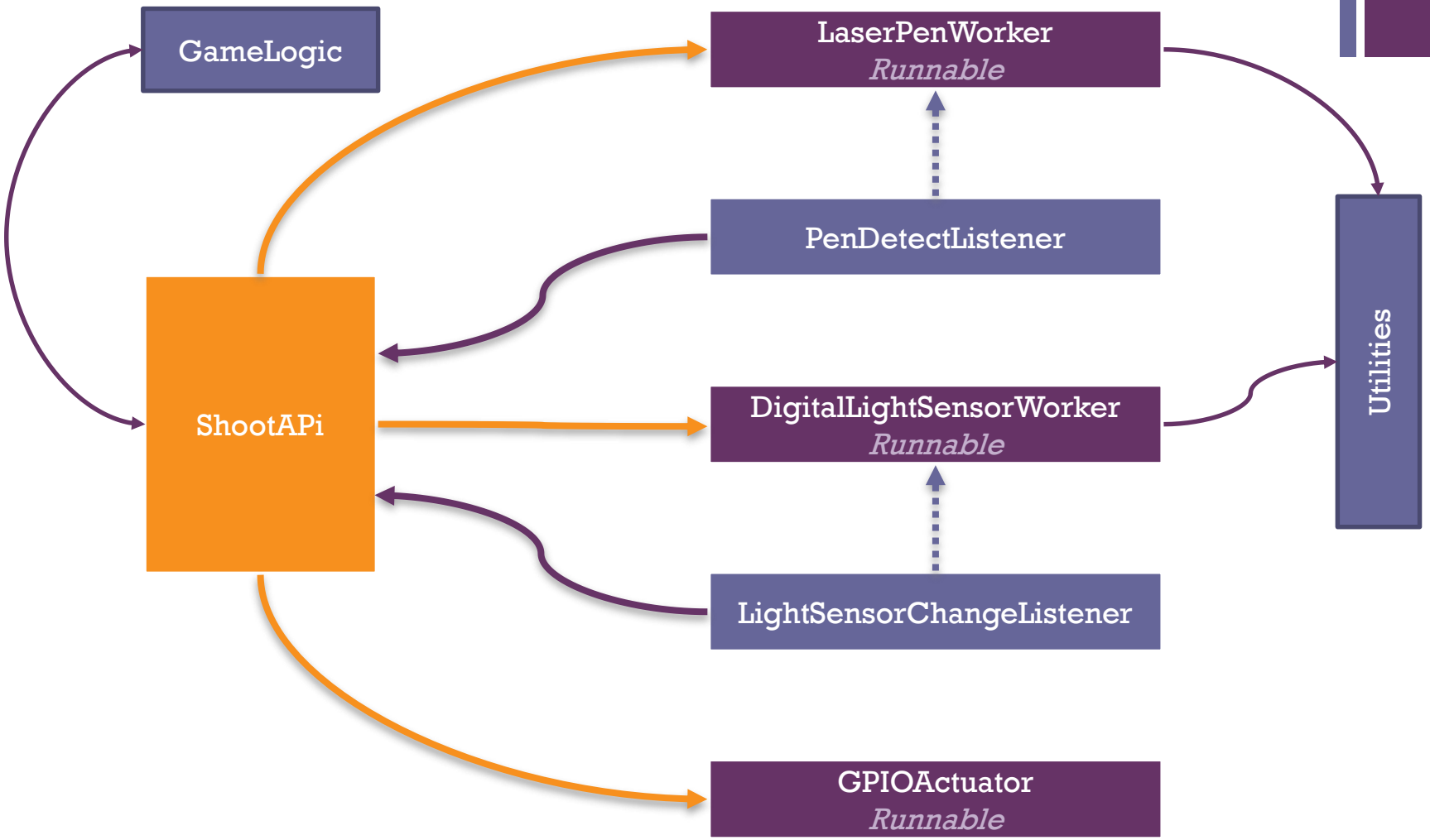


Shoot-A-Pi Arcade Shooter Simulator

Hardware Setup



Class Diagram



Setting up the Laser Tag

The LP-170 Laser Tag has two working modes.

Mode A			
Pen Function		Shoot A Pi Function	Payload
A	Mode Switch	-	NONE
B	Page Down	None	0x00004e
C	Page Up	None	0x00004b

Mode B			
Pen Function		Shoot A Pi Function	Payload
A	Mode Switch	-	NONE
B	Start Slideshow	Reload	0x02003e
B	Stop Slideshow	Reload	0x000029
C	Hide Slideshow	Shoot	0x000005

A. Mode Switching
B. Reload
C. Fire
D. Only laser
E. RF USB Dongle

Setting up the Laser Tag

Helpers

We will use a helper class to trace the commands received from the pen

```
public static enum PenCommand{
        CMD_LASER_NO_REPEAT("000005", "Shooting Laser!"),
        CMD_LASER_REPEAT("00004b", "Scrolling down..."),
        CMD_RELOAD_REPEAT("00004e", "Scrolling up..."),
        CMD_RELOAD_NO_REPEAT_A("02003e", "Reload 1"),
        CMD_RELOAD_NO_REPEAT_B("000029", "Reload 2"),
        CMD_UNKNOWN_COMMAND("000000", "Unknown command");
.
.
.
}
```

Stub file: *PenCommandsEnum.stub.java*

Setting up the Laser Tag

Worker

Reading from the pen will be handled by a Runnable class, which will constantly poll the pen for input using HID APIs provided by Kura.
A listener is passed in the constructor, so that when the worker detects a command, it can wake up the caller.

```
public class LaserPenWorker implements
Runnable {

private static final int PEN_VENDOR_ID =
4643;
private static final int PEN_PRODUCT_ID =
16230;

private static HIDDevice thePen = null;

private static PenDetectListener callback;

public LaserPenWorker(PenDetectListener
callback){
  LaserPenWorker.callback = callback;
}
.
.
.
```

```
public void run() {
  byte[] data = new byte[3];
  try {
    if (null == thePen) {
      thePen= HIDManager.getInstance().openById(
        PEN_VENDOR_ID,
        PEN_PRODUCT_ID, null);
    }
    while (true) {
      thePen.read(data);
      // Convert data to string and put in result
      if (!result.toString().isEmpty()
          && !result.toString().equals("000000")) {
        fireChangeEvent(result.toString());
      }
    }
  } catch (HIDDeviceNotFoundException ex) {
  } catch (IOException ex) {
  } finally { }
}
```

Stub file: *LaserPenWorker.stub.java*

Deploying the Bundle

mToolkit

- Export the bundle using *Export -> Plug-in development -> Deployable plug-in and fragments*
- *Open the mToolkit Frameworks view using Window -> Show View -> Others...*
- Activate the Frameworks tab and create a new Framework using the IP Address of the Pi
- Start the newly created framework
- Right-click on Bundles
- Click on «Install new...» and select the plug-in you exported before
- Connect to the Pi and see the Bundle in action!

Debugging and Logging

- After accessing the Pi through ssh you will be able to inspect the log files and control Kura using these commands:

`tail –f /var/log/kura.log`	will show the realtime kura log
`tail –f /var/log/kura-console.log`	will show the System.err log
`telnet 127.0.0.1 5002`	will open the OSGi telnet terminal
`sudo /etc/init.d/kura restart`	Will restart Kura. *Bundles installed with mToolkit will be removed.*

Setting up the Digital Light Sensor

Enable I2C on the Raspberry Pi

The Rapsberry Pi ships with the I2C disabled.
In order to communicate with the Grove Digital Light Sensor we have to enable the Linux modules that will enable I2C communication on the Pi.
Enter the following commands in the Pi command line:

```
sudo nano /etc/modules
```

And add these two lines to the file:

```
i2c-bcm2708
i2c-dev
```

Then save the file and reboot the Pi

Setting up the Digital Light Sensor

Worker overview

- Detecting luminosity changes will be demanded to a separate Runnable
- The I2C Digital Light Sensor is acquired and managed using OpenJDK Device I/O APIs, provided by Kura
- The worker will be constantly polling the Light Sensor reading the luminosity and will trigger listeners when it needs to.
- The change in luminosity between polls is evaluated using several thresholds, programmable through the Kura Web UI.
- The LUX value is calculated using an helper method, provided in the stub.

Stub file: *LuxCalculation.stub.java*

Setting up the Digital Light Sensor
Managing I2C

I2C Devices are accessed using jdk.dio.I2CDevice and jdk.dio.I2CDeviceConfig classes.
Reads and writes on the sensor can be atomic or transacted.

```
private static void initDevice() {
  try {
    I2CDeviceConfig config = new I2CDeviceConfig(
      1,
      LIGHT_SENSOR_ADDRESS,
      7,
      400000
    );
    s_light_sensor = (I2CDevice) DeviceManager.open(I2CDevice.class, config);
    // INIT
    s_light_sensor.begin();
    s_light_sensor.write(0x80); s_light_sensor.write(0x03);
    s_light_sensor.write(0x81); s_light_sensor.write(0x11);
    s_light_sensor.write(0x86); s_light_sensor.write(0x00);
    s_light_sensor.end();
  } catch (UnavailableDeviceException e) {
  } catch (DeviceNotFoundException e) {
  } catch (ClosedDeviceException e) {
  } catch (IOException ex) {
  }
}
```

Refer to OpenJDK Device I/O APIs for further info

Setting up the Digital Light Sensor Worker

Another Runnable is used to implement the Digital Light Sensor logic

```
public class DigitalLightSensorWorker implements Runnable {
  public void run() {
    if (null == s_light_sensor || !s_light_sensor.isOpen()) { initDevice(); }
    try {
      while (true) {
        s_light_sensor.write(0x8C); Thread.sleep(5);
        L0 = s_light_sensor.read(); Thread.sleep(5);
        s_light_sensor.write(0x8D); Thread.sleep(5);
        H0 = s_light_sensor.read(); Thread.sleep(5);
        s_light_sensor.write(0x8E); Thread.sleep(5);
        L1 = s_light_sensor.read(); Thread.sleep(5);
        s_light_sensor.write(0x8F); Thread.sleep(5);
        H1 = s_light_sensor.read();

        int ch0 = (((H0 & 0xff) * 0x100) + L0) & 0xffff;
        int ch1 = (((H1 & 0xff) * 0x100) + L1) & 0xffff;
        int lux = Utilities.calculateLux(ch0, ch1);

        if (lux > PROP_THRESHOLD_LUX_MAX) {
          fireChange(lux);
        }
        Thread.sleep(READ_RESOLUTION);
      }
    } catch (IOException ex) {
    } catch (InterruptedException ex) {
    } finally {
      closeDevice();
    }
  }
```

Stub file: *LightSensorWorker.stub.java*

Setting up the Digital Light Sensor

Wake-up / Sleep logic

A simple wake-up / sleep logic is implemented in the worker in order to have it fire lux change events only when needed.

```
public class DigitalLightSensorWorker implements Runnable {

private static LightSensorChangeListener callback;
private static boolean s_listen = false;

public DigitalLightSensorWorker(LightSensorChangeListener callback) {
  DigitalLightSensorWorker.callback = callback;
}

public static void startListeningForLaser() {s_listen = true;}
public static void stopListeningForLaser() {s_listen = false;}
public static boolean isAcquiring() {return s_listen;}

private void fireChange(int lux) {
  if (s_listen) {
    callback.lightSensorChangeDetected(lux);
    stopListeningForLaser();
  }
}
```

The *startListeningForLaser()* method is called when the Laser Tag Worker detects a Shot command

Stub file: *LightSensorWorker.stub.java*

GPIO Actuator

The GPIO Actuator is yet another runnalbe. This time it is a simple class delegated to work on the GPIOs using jdk.dio.GPIOPin.
In this class Device I/O features are loaded using the default configuration.

```
public class GPIOActuator implements Runnable {
private static final int ledPinGPIO = 17;
private static GPIOPin led;

public GPIOActuator() {
  try {
    Device<?> d = DeviceManager.open(ledPinGPIO);
    led = (GPIOPin) d;
    led.setValue(false);
  } catch (IOException e) {}
}
public static void closeGPIOs(){
  try{
    led.close();
  }catch(IOException ex){}
}

public void run() {
  try {
    led.setValue(true); Thread.sleep(1000); led.setValue(false);
  } catch (IOException e) {
  } catch (InterruptedException e) {}
}
```

Stub file: *GPIOActuator.stub.java*

Game Logic

Overview

- When the game starts, player must be set to 0 scored points and must have a programmable amount of rounds (default 12)
- When the player fires a round (C button) the game starts listening for lux change on the DLS for a programmable time window (default 200ms)
  - Available rounds are decreased by 1. If the lux change is detected in the time frame, 1 point is scored, led and buzzer get activated
  - Lux variance threshold is programmable. Defaults to 300lux
- Once the clip is empty the player should reload the gun (B button). Reload will take a programmable amount of time (default 5s) during which no point can be scored.
- Game should subscribe to a Commands topic, listening for «NewGame» and «StopGame» commands.
  - When receiving a «NewGame» it should reset score and available rounds
  - When receiving a «StopGame» it should stop scoring points until a «NewGame» is received

Game Logic

Implementation

```
public class GameLogic {

private static int s_score;
private static int s_clip;
private static boolean s_reloading = false;
private static boolean s_game_stopped = false;

public static void startGame() {
  s_game_stopped = false;
  s_score = 0;
  s_clip = PROP_CLIP_SIZE;
}
public static void stopGame(){
  s_game_stopped = true;
}
public static void shoot() {
  if(s_game_stopped){ return; }
  if(isReloading()){ return; }
  if (s_clip == 0) {
    ShootAPi.doPublish("NeedsReload", true);
  } else {
    s_clip--;
    ShootAPi.doPublish("Shot!", s_clip);
  }
}
public static boolean isReloading() {
return s_reloading;
}
```

Stub file: *GameLogic.stub.java*

```
public static void scorePoint() {
  if(s_game_stopped){ return;}
  if (s_clip > 0) {
    s_score++;
    ShootAPi.doPublish("Score", s_score);
  }
}
public static void reload() {
  if(s_game_stopped){ return;}
  s_clip = PROP_CLIP_SIZE;
  Thread reloadThread = new Thread(
    new Runnable() {
      public void run() {
        try {
          ShootAPi.doPublish(
            "Reloading", true);
          s_reloading = true;
          Thread.sleep(PROP_RELOAD_DELAY);
          ShootAPi.doPublish(
            "Reloading", false);
        } catch (InterruptedException ex) {
        } finally {
          s_reloading = false;
        }
      }
    });
  if (!s_reloading) {
    reloadThread.start();
  }
}
```

Shoot A Pi

Main class overview

The ShootAPi class is responsible for managing the whole application

- Implements ConfigurableComponent
  - It exposes a component in the Kura Web UI, letting the user change configuration parameters from any browser
- Acquires the CloudService
  - Publishes data to the MQTT Broker using the MQTTDataTransport
- Implements CloudClientListener
  - Listens for requests on the Commands MQTT topic
- Manages the Executors
  - It starts, stops and cancels the runnables and wires everything together

Shoot A Pi

ConfigurableComponent and OSGi Component configuration

The ConfigurableComponent interface provides no methods. It will instead make the class appear as a Web UI component. The class will also exported as a OSGi Declarative Service

```
public class ShootAPi implements ConfigurableComponent, CloudClientListener {
private static final String APP_ID = "Shoot_A_Pi_Demo"; // Cloud App identifier
// Publishing Property Names
private static final String PUBLISH_TOPIC_PROP_NAME = "publish.appTopic";
private static final String PUBLISH_QOS_PROP_NAME = "publish.qos";
private static final String PUBLISH_RETAIN_PROP_NAME = "publish.retain";
// Configurable Properties Names
private static final String PROP_CLIP_SIZE = "clip.size";
private static final String PROP_DETECTION_WINDOW = "dls.detect.window";
private static final String PROP_DETECTION_THRESHOLD = "dls.detect.threshold";
private static final String PROP_DETECTION_THRESHOLD = "dls.detect.threshold";
private static Map<String, Object> m_properties;

. . .

public void updated(Map<String, Object> properties){
  // store the properties received
  m_properties = properties;
  for (String s : properties.keySet()) {
    s_logger.info("Update - " + s + ": " + properties.get(s));
  }
  // try to kick off a new job
  doUpdate();
}
```

Stub file: *Main.stub.java*

Shoot A Pi

CloudService and CloudClientListener

The CloudService will be used to publish data to the Broker, while the CloudClientListener will listen for MQTT messages on the «Commands» topic

```
public class ShootAPi implements
ConfigurableComponent, CloudClientListener {
  private CloudService m_cloudService;
  private static CloudClient m_cloudClient;

public void setCloudService(CloudService
cloudService) {
  m_cloudService = cloudService;
}

public void unsetCloudService(CloudService
cloudService) {
  m_cloudService = null;
}
protected void activate(ComponentContext
componentContext, Map<String, Object> properties) {
. . .
  try {
    m_cloudClient =
m_cloudService.newCloudClient(APP_ID);
    m_cloudClient.addCloudClientListener(this);
    doUpdate();
  } catch (Exception e) {
  }
}
```

```
public void onConnectionEstablished() {
  try {
    m_cloudClient.subscribe("Commands/#", 0);
  } catch (KuraException ex) {}
}

public void onMessageArrived(String deviceId,
  String appTopic,
  KuraPayload msg, int qos, boolean retain) {
  Object command = msg.getMetric("Command");
  if (command != null) {
    switch (command.toString()) {
      case "NewGame":
        GameLogic.startGame();
      break;
      case "StopGame":
        GameLogic.stopGame();
      break;
    }
  }
}
```

Stub file: *Main.stub.java*

Shoot A Pi

Executors

Executors are used to start the Runnables.

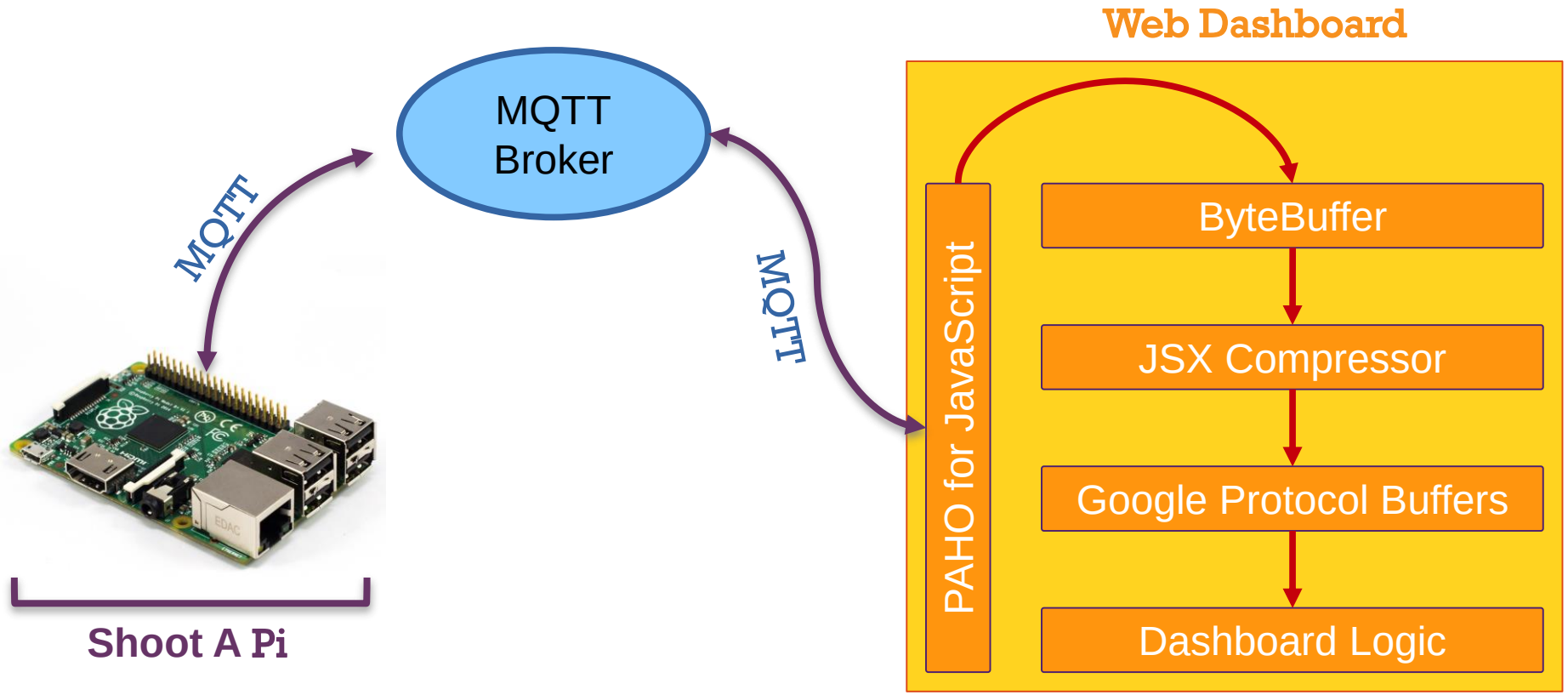
```
public class ShootAPi implements ConfigurableComponent,
CloudClientListener {
// Executors
private static ScheduledExecutorService s_pen_poller;
private static ScheduledExecutorService s_light_sensor;
private static ExecutorService s_activator;
// Handles
private static ScheduledFuture<?> s_pen_handle;
private static ScheduledFuture<?> s_sensor_handle;
private static Future<?> s_activator_handle;
. . .
public ShootAPi() {
  s_pen_poller =
    Executors.newSingleThreadScheduledExecutor();
  s_light_sensor =
    Executors.newSingleThreadScheduledExecutor();
  s_activator =
    Executors.newSingleThreadExecutor();
}
protected void deactivate(ComponentContext
componentContext) {
  s_activator.shutdown();
  s_light_sensor.shutdown();
  s_pen_poller.shutdown();
  . . .
}
```

```
private void doUpdate() {
 // cancel a current worker handle
 if (s_pen_handle != null) {
   s_pen_handle.cancel(true);
 }
 if (s_activator_handle != null) {
   s_activator_handle.cancel(true);
 }
 if (s_sensor_handle != null) {
   s_sensor_handle.cancel(true);
 }
 penWorkerRunnable =
   new LaserPenWorker(penButtonPressed);
 s_pen_handle =
   s_pen_poller.scheduleWithFixedDelay(
     penWorkerRunnable,
     1, 2, TimeUnit.SECONDS);

 sensorWorkerRunnable =
   new DigitalLightSensorWorker(laserDetected);
 s_sensor_handle =
   s_light_sensor.scheduleWithFixedDelay(
     sensorWorkerRunnable,
     1, 2, TimeUnit.SECONDS);

 GameLogic.startGame();
}
```

Stub file: *Main.stub.java*

Shoot-A-Pi Arcade Shooter Simulator

Web Dashboard Architecture



Complete dashboard in the *Dashboard* folder

You are important!

Kura helps you … Kura needs you

I was lucky to be involved and get to contribute to something that was important, which is empowering people with software. (By Bill Gates)

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