netcetera

# Hands on Java8 and RaspberryPi

## Hacking the RaspberryPi with Java8, JavaFX8 and add-on hardware modules

17 September 2014, jug.ch – Pance Cavkovski & Aleksandar Nikov

# About the speakers

**Pance Cavkovski**
pance.cavkovski@netcetera.com
Senior Software Engineer @ Netcetera Skopje

**Aleksandar Nikov**
aleksandar.nikov@netcetera.com
Head of Software Engineering @ Netcetera Skopje

# About the session

## What will we present

- Using Java8 and JavaFX8 on Raspberry Pi
- Extending the RasPi with components
- Interfacing with the components via Java code

You should have at the moment:

- RasPi Model B with pre-configured Raspbian on an SD Card
- A set of components (6 resistors, 10 jumper wires, 2 LEDs, 1 LDR)
- Breadboard (with a taster installed on it)
- Arduino UNO/Leonardo
- ITEAD Studio NFC module

Online source at https://github.com/hsilomedus/hands-on-raspi

# Java8 is out!

- Lang: Lambda, Method references, default methods, repeating annotations ...
- Collections: StreamAPI, HashMaps improvements
- Compact profiles, Security and tools improvements
- **JavaFX8: bundled with JDK8, UI components, new theme, WebView, 3D graphics, print, css styling...**
- Nashorn javascript engine
- New Date-Time, concurrency extensions, new Java DB...
- **Linux ARM v6/v7 Hard Float ABI JDK8**

# Java8 on ARM devices

## Get and use with RasPi and Raspbian

- Get from http://www.oracle.com/technetwork/java/javase/downloads
  - Specifically Linux ARM v6/v7 Hard Float ABI

- tar xfv jdk-8….tar.gz
- ./jdk1.8.0/bin/java and ./jdk1.8.0/bin/javac

- Need hardware access? Get pi4j: http://pi4j.com/
  - Based on WiringPi
  - Jar(s) ready for usage

# pi4j

## Java library for full access to the Raspberry Pi

- JNI to the WiringPi C library
- Features
  - Export & unexport GPIO pins
  - Configure and Control GPIO pins for both input and output
  - Interrupt-based listeners
  - RS232 communication
  - I2C and SPI support
  - Extensions …
- Both managed and direct access to WiringPi

# JavaFX8

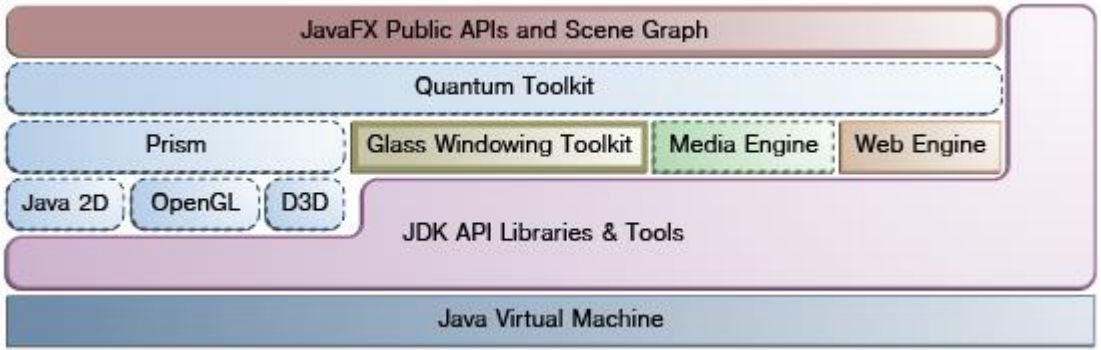
JavaFX is a set of graphics and media packages that enables developers to design, create, test, debug and deploy rich client applications that operate consistently across diverse platforms (tl;dr: Java framework for building RIA / Desktop apps)

- Java APIs, fully integrated in JavaSE
- Declarative in FXML or explicit in Java
- Swing interoperability
- CSS stylable UI components library, Modena theme
- 3D features, hardware acceleration, web view, high-performance media engine
- Canvas & printing API, rich text support

# A glimpse into the architecture

- Stage, Scene, Layouts
- Nodes, states, effects

- Hardware/software rendering




- JavaFX, Prism and Media separate threads
- Async elements update via Pulse

# UI

- Layouts
- Transformations
- Effects
- CSS Styling
- Event Handlers

# JavaFX8 - How To

## Layout and place Components

```
primaryStage.setTitle("JavaFX Welcome");

GridPane grid = new GridPane();
grid.setAlignment(Pos.CENTER);
grid.setHgap(10);
grid.setVgap(10);
grid.setPadding(new Insets(25, 25, 25, 25));

Scene scene = new Scene(grid, 300, 275);
primaryStage.setScene(scene);

Label userName = new Label("User Name:");
grid.add(userName, 0, 1);

TextField userTextField = new TextField();
grid.add(userTextField, 1, 1);
```

```
Button btn = new Button("Sign in");
HBox hbBtn = new HBox(10);
hbBtn.setAlignment(Pos.BOTTOM_RIGHT);
hbBtn.getChildren().add(btn);
grid.add(hbBtn, 1, 4);

btn.setOnAction(new EventHandler<ActionEvent>() {
    @Override
    public void handle(ActionEvent e) {
        actiontarget.setFill(Color.FIREBRICK);
        actiontarget.setText(
           "Sign in button pressed");
    }
});

primaryStage.show();
```

# JavaFX8 - How To

## Style with CSS

```
scene.setStyle(“-fx-background-image:
url(‘background.jpg’);”);

userName.setStyle(“-fx-font-size: 12px;” +
    “-fx-font-weight: bold;” +
    “-fx-text-fill: #333333; ” +
    “-fx-effect: dropshadow( gaussian ,
rgba(255,255,255,0.5) , 0,0,0,1 );”);
```

```
//OR:
scene.getStylesheets().add
(Login.class.getResource("Login.css").toExternalFo
rm());


.root {
     -fx-background-image: url("background.jpg");
}
.label {
    -fx-font-size: 12px;
    -fx-font-weight: bold;
    -fx-text-fill: #333333;
    -fx-effect: dropshadow( gaussian ,
rgba(255,255,255,0.5) , 0,0,0,1 );
}
```

# JavaFX8 - How To

## Declarative

```
Parent root = FXMLLoader.load(getClass().getResource("fxml_example.fxml"));
```

```
<?import javafx.geometry.*?>
<?import javafx.scene.control.*?>
<?import javafx.scene.layout.*?>
<?import javafx.scene.text.*?>
<GridPane fx:controller="fxmlexample.FXMLExampleController"
    xmlns:fx="http://javafx.com/fxml" alignment="center" hgap="10" vgap="10">

    <padding><Insets top="25" right="25" bottom="10" left="25"/></padding>

    <Label text="User Name:"
        GridPane.columnIndex="0" GridPane.rowIndex="1"/>
    <TextField
        GridPane.columnIndex="1" GridPane.rowIndex="1"/>
</GridPane>
```

# However…

The ARM devices are slower. Be careful

- RasPi has a 700MHz v7 ARM processor with 512MB ram.
- The Embedded Full Size Operating System are still catching on
- Runs in FrameBuffer and not in X

Not really plug & play:

- - sudo jdk1.8.0/bin/java –cp ./:pi4j-core.jar:jdk1.8.0/jre/lib/jfxrt.jar* –Djavafx.platform=eglfb* Main

*(not needed in the last Raspbian version)

# RasPi GPIO header


**Raspberry Pi Model A**

| | | | |
|---|---|---|---|
| 3.3V | 1 | 2 | 5V |
| I2C0 SDA | 3 | 4 | DNC |
| I2C0 SCL | 5 | 6 | Ground |
| GPIO 4 | 7 | 8 | UART TXD |
| DNC | 9 | 10 | UART RXD |
| GPIO 17 | 11 | 12 | GPIO 18 |
| GPIO 21 | 13 | 14 | DNC |
| GPIO 22 | 15 | 16 | GPIO 23 |
| DNC | 17 | 18 | GPIO 24 |
| SP10 MOSI | 19 | 20 | DNC |
| SP10 MPSO | 21 | 22 | GPIO 25 |
| SP10 SCLK | 23 | 24 | SP10 CEO N |
| DNC | 25 | 26 | SP10 CE1 N |

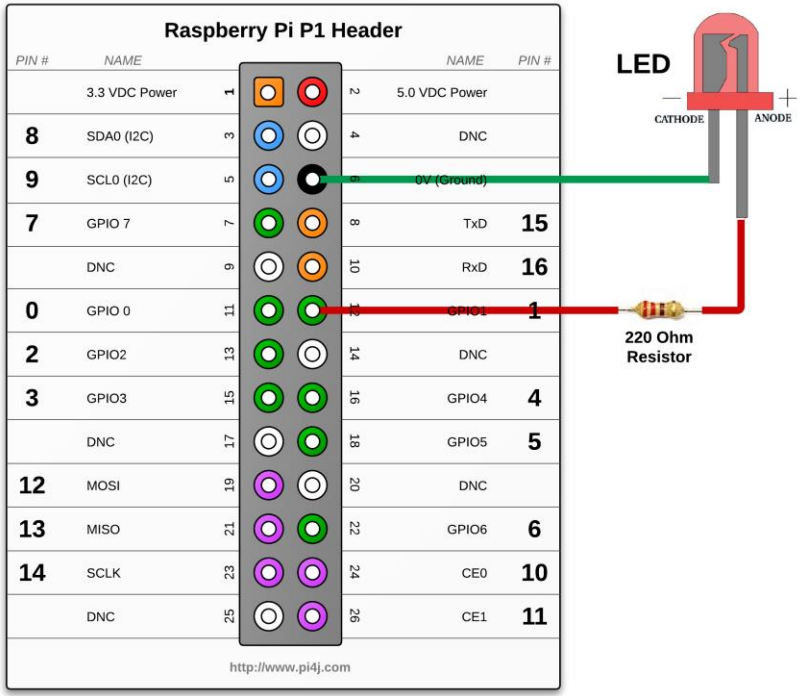
**Raspberry Pi Model B**

| | | | |
|---|---|---|---|
| 3.3V | 1 | 2 | 5V |
| I2C1 SDA | 3 | 4 | 5V |
| I2C0 SCL | 5 | 6 | Ground |
| GPIO 4 | 7 | 8 | UART TXD |
| Ground | 9 | 10 | UART RXD |
| GPIO 17 | 11 | 12 | GPIO 18 |
| GPIO 27 | 13 | 14 | Ground |
| GPIO 22 | 15 | 16 | GPIO 23 |
| 3.3V | 17 | 18 | GPIO 24 |
| SP10 MOSI | 19 | 20 | Ground |
| SP10 MPSO | 21 | 22 | GPIO 25 |
| SP10 SCLK | 23 | 24 | SP10 CEO N |
| Ground | 25 | 26 | SP10 CE1 N |

# RasPi GPIO header

| Phyical / Raspberry Pi Name | | | |
|---|---|---|---|
| 3.3v | 1 | 2 | 5v |
| SDA0 | 3 | 4 | DNC |
| SCL0 | 5 | 6 | 0v |
| GPIO 7 | 7 | | TX |
| DNC | 9 | 10 | RX |
| GPIO 0 | 11 | 12 | GPIO 1 |
| GPIO 2 | 13 | 14 | DNC |
| GPIO 3 | 15 | 16 | GPIO 4 |
| DNC | 17 | 1 | GPIO 5 |
| SPI MOSI | 19 | 20 | DNC |
| SPI MISO | 21 | 22 | GPIO 6 |
| SPI SCLK | 23 | 24 | SP10 CEO N |
| DNC | 26 | 26 | SP10 CE1 N |

| Broadcom names | | | |
|---|---|---|---|
| 3.3v | 1 | 2 | 5v |
| I2C0 SDA | 3 | 4 | DNC |
| I2C0 SCL | 5 | 6 | 0v |
| GPIO 4 | 7 | | UART TXD |
| DNC | 9 | 10 | UART RXD |
| GPIO 17 | 11 | 12 | GPIO 1 |
| GPIO 21 | 13 | 14 | DNC |
| GPIO 22 | 15 | 16 | GPIO 23 |
| DNC | 17 | 1 | GPIO 24 |
| SPI MOSI | 19 | 20 | DNC |
| SPI MISO | 21 | 22 | GPIO 25 |
| SPI SCLK | 23 | 24 | SP10 CEO N |
| DNC | 26 | 26 | SP10 CE1 N |



# RaspberryPi Model B+

## Raspberry Pi B+ J8 Header

| Pin# | NAME | | NAME | Pin# |
|---|---|---|---|---|
| 01 | 3.3v DC Power | | DC Power 5v | 02 |
| 03 | GPIO02 (SDA1 , I2C) | | DC Power 5v | 04 |
| 05 | GPIO03 (SCL1 , I2C) | | Ground | 06 |
| 07 | GPIO04 (GPIO_GCLK) | | (TXD0) GPIO14 | 08 |
| 09 | Ground | | (RXD0) GPIO15 | 10 |
| 11 | GPIO17 (GPIO_GEN0) | | (GPIO_GEN1) GPIO18 | 12 |
| 13 | GPIO27 (GPIO_GEN2) | | Ground | 14 |
| 15 | GPIO22 (GPIO_GEN3) | | (GPIO_GEN4) GPIO23 | 16 |
| 17 | 3.3v DC Power | | (GPIO_GEN5) GPIO24 | 18 |
| 19 | GPIO10 (SPI_MOSI) | | Ground | 20 |
| 21 | GPIO09 (SPI_MISO) | | (GPIO_GEN6) GPIO25 | 22 |
| 23 | GPIO11 (SPI_CLK) | | (SPI_CE0_N) GPIO08 | 24 |
| 25 | Ground | | (SPI_CE1_N) GPIO07 | 26 |
| 27 | ID_SD (I2C ID EEPROM) | | (I2C ID EEPROM) ID_SC | 28 |
| 29 | GPIO05 | | Ground | 30 |
| 31 | GPIO06 | | GPIO12 | 32 |
| 33 | GPIO13 | | Ground | 34 |
| 35 | GPIO19 | | GPIO16 | 36 |
| 37 | GPIO26 | | GPIO20 | 38 |
| 39 | Ground | | GPIO21 | 40 |

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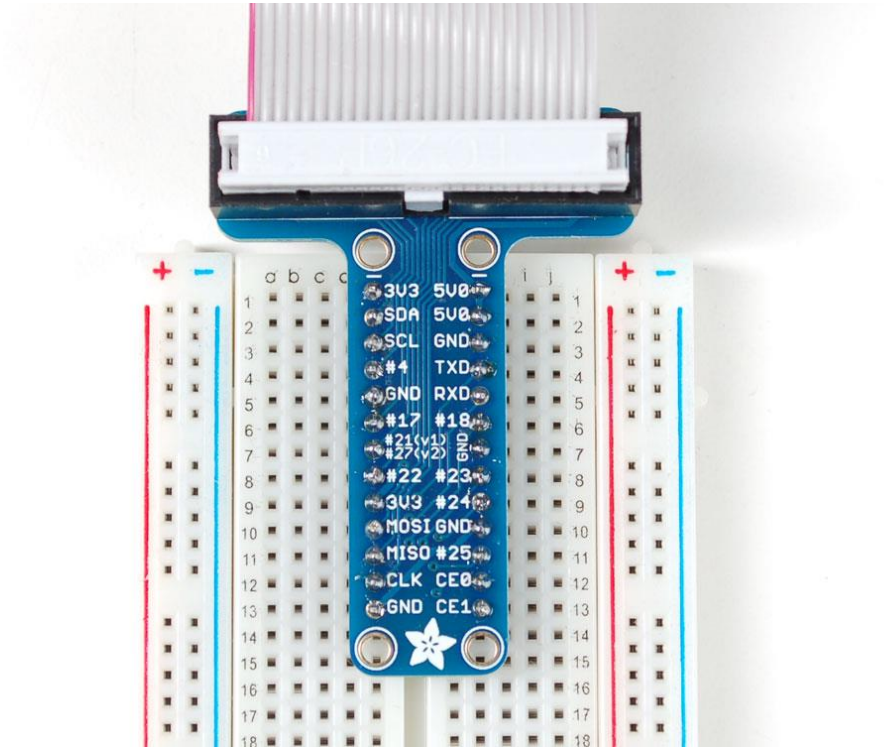
16/07/2014

http://www.element14.com

# RasPi GPIO header cobbler and protoboard



# Examples

- LED Blink
- Taster + LED Blinker
- Serial Comm + Arduino + Light Sensor + LED
- NFC Reader
- JavaFX LED and Taster

- Examples stored as git branches
- Source code available at https://github.com/hsilomedus/hands-on-raspi

# LED Blink

## Checkout

Open terminal

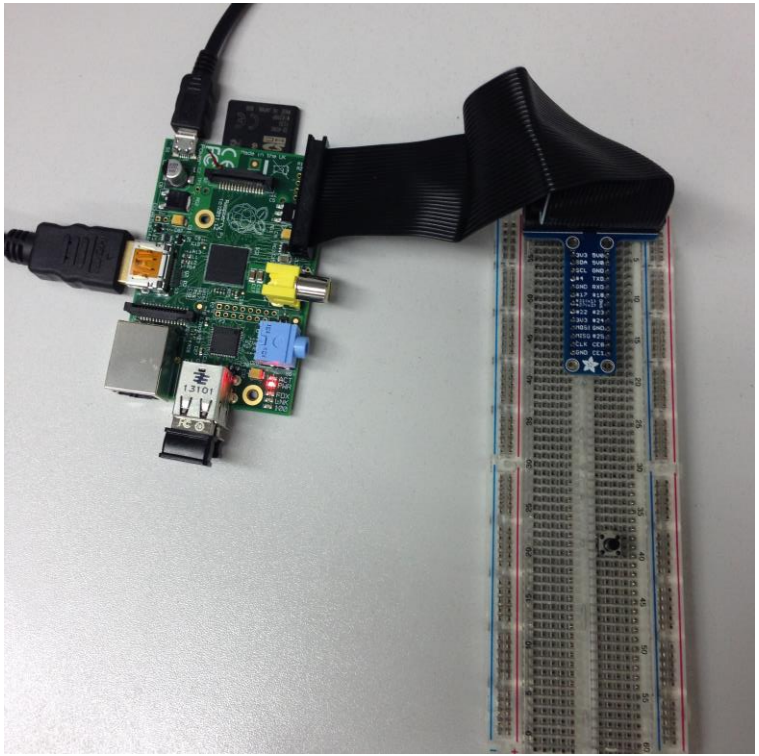
- cd hands-on-raspi/
- git checkout master

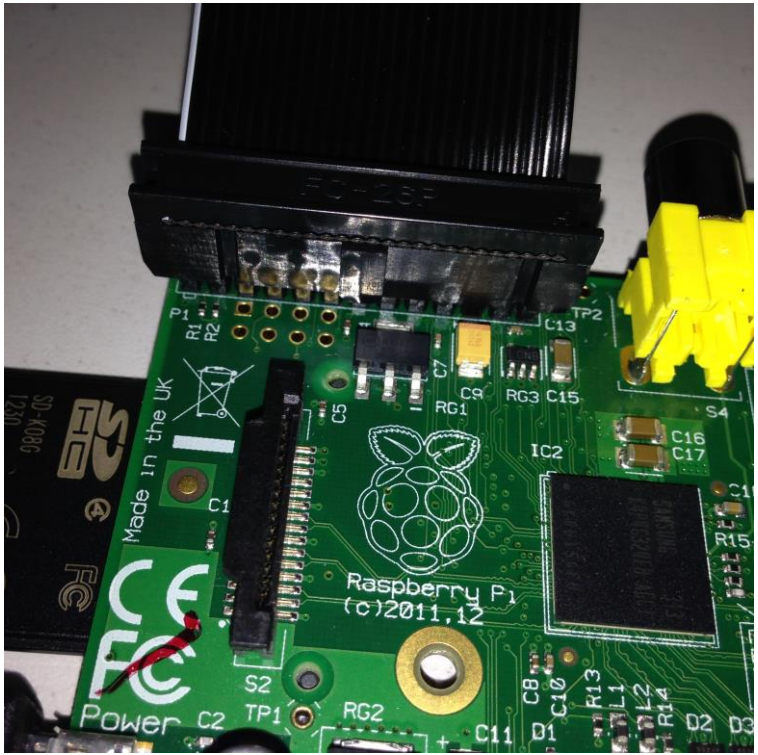
- Open the Main source file for inspection
  - [ leafpad | vi | nano ] src/Main.java

# LED Blink

```
import com.pi4j.io.gpio.GpioController;
import com.pi4j.io.gpio.GpioFactory;
import com.pi4j.io.gpio.GpioPinDigitalOutput;
import com.pi4j.io.gpio.PinState;
import com.pi4j.io.gpio.RaspiPin;

public class Main {

        public static void main(String[] args) throws InterruptedException {
                GpioController gpio = GpioFactory.getInstance();

                System.out.println("Pin going UP!");
                final GpioPinDigitalOutput pin = gpio.provisionDigitalOutputPin(
                                RaspiPin.GPIO_00, "LED", PinState.HIGH);

                Thread.sleep(5000);
                System.out.println("Ping going down.");
                pin.low();
                gpio.shutdown();

        }
}
```

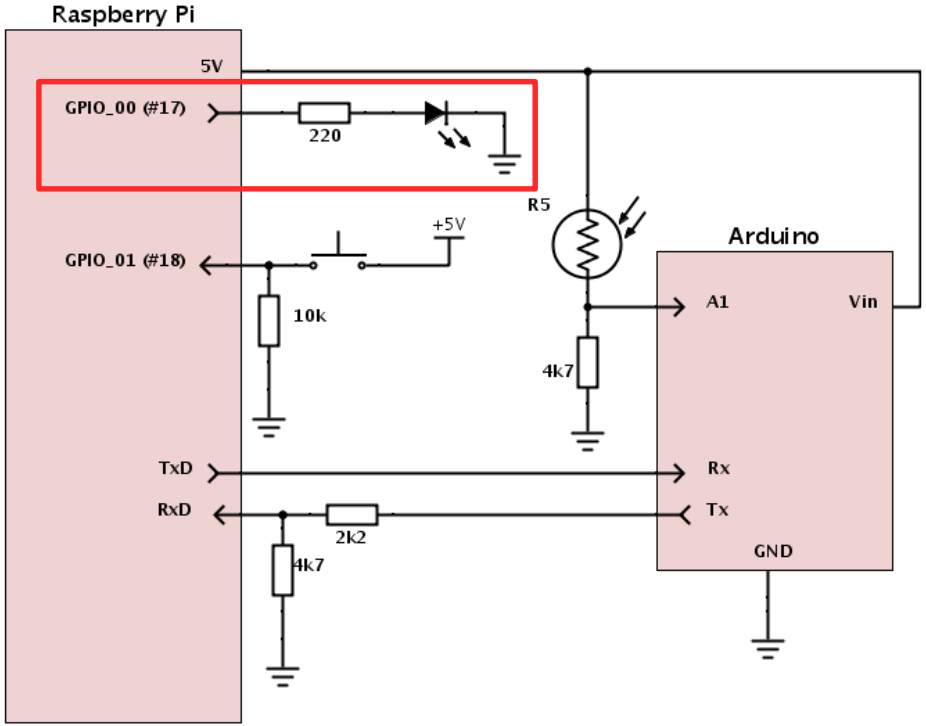
# Connect the breadboard



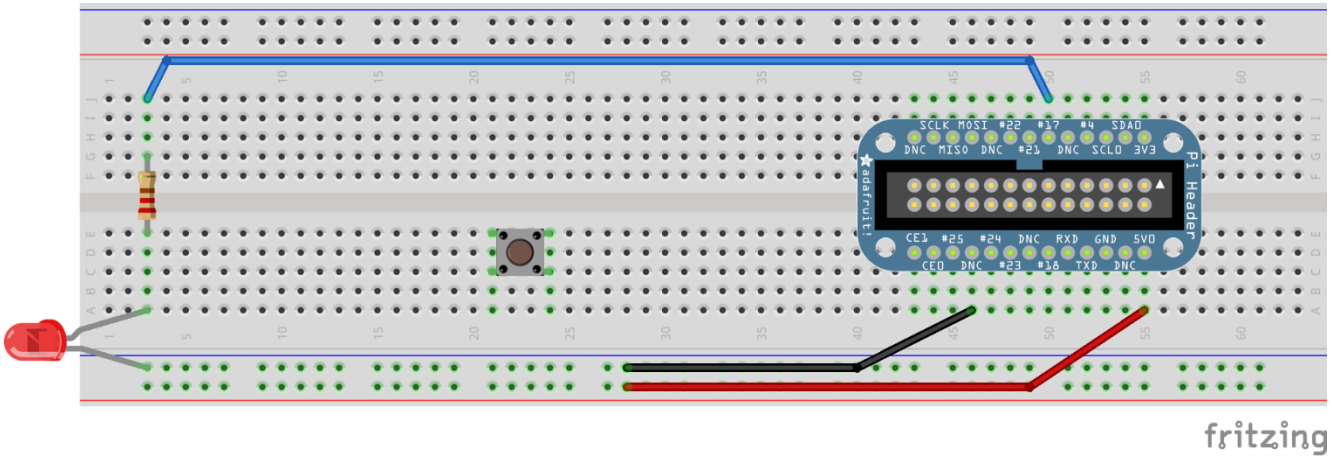


# LED Blink

## Schematics



# LED Blink


SCLK MOSI #22 #17 #4 SDA0
DNC MISO DNC #21 DNC SCL0 3V3
adafruit
Pi Header
CE1 #25 #24 DNC RXD GND 5V0
CE0 DNC #23 #18 TXD DNC
fritzing

# LED Blink

## Build and run

- ./build.sh
  - Create/clean target dir
  - Copy libs
  - Execute javac with added pi4j into classpath
- ./run.sh
  - Sudo execute java with added pi4j into classpath

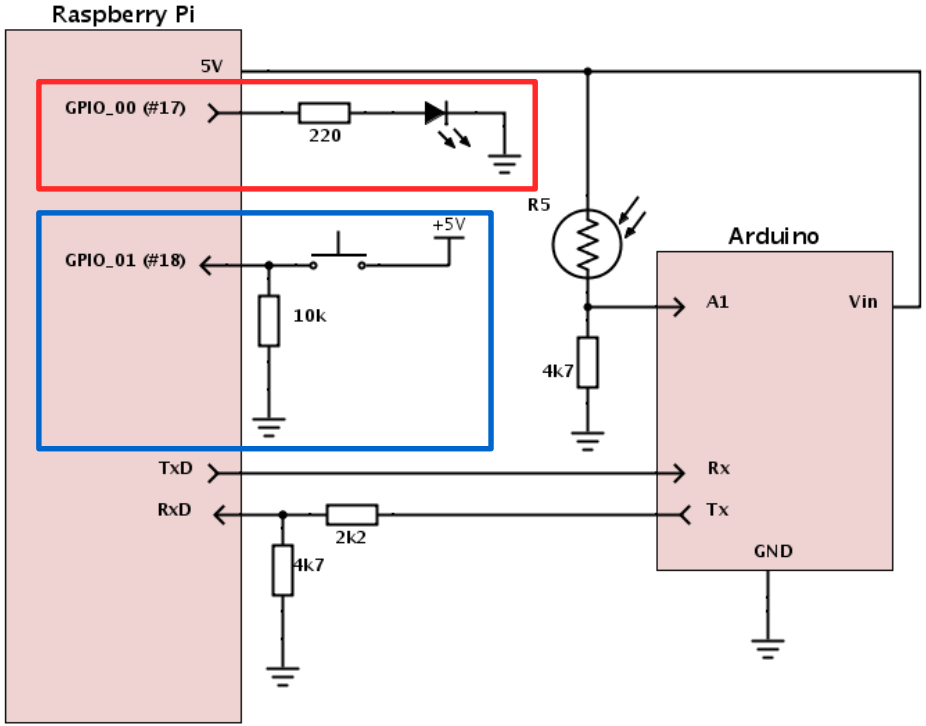
# Taster + LED Blinker (git checkout taster)

```
final GpioPinDigitalInput pinInput = gpio.provisionDigitalInputPin(
                RaspiPin.GPIO_01, PinPullResistance.PULL_DOWN);
pinInput.addListener(new GpioPinListenerDigital() {
        @Override
        public void handleGpioPinDigitalStateChangeEvent(
                        GpioPinDigitalStateChangeEvent event) {
                if (event.getState().equals(PinState.HIGH)) {
                        System.out.println("Taster clicked!");
                        change = !change;
                }
        }

});
```

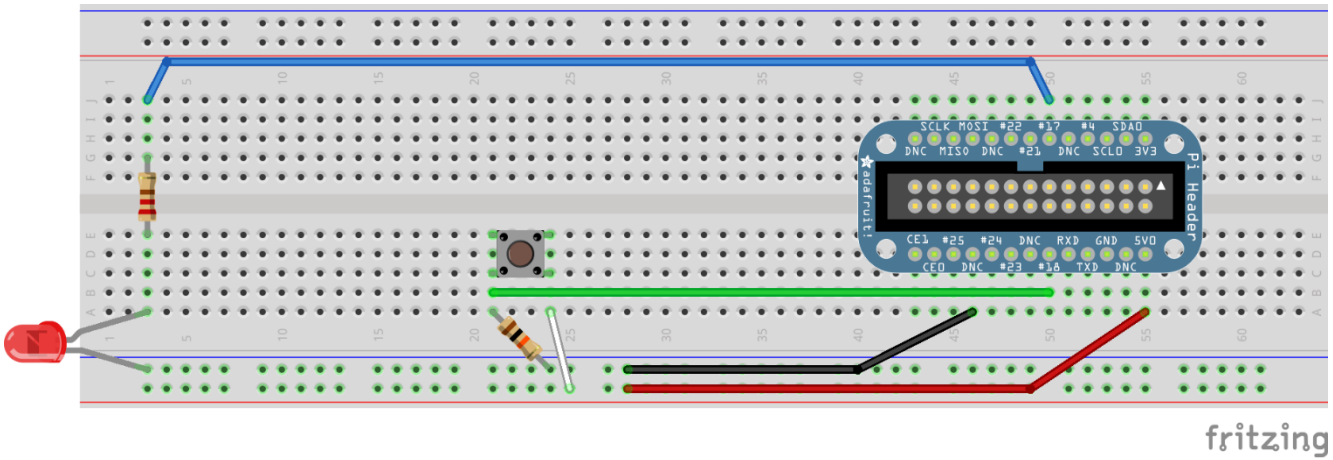
```
while (true) {
        Thread.sleep(200);

        if (change) {
                pin.toggle();
        }
}
```

# Taster + LED Blinker

## Schematics



# Taster + LED Blinker



# Taster + two blinkers

## Extend

- Use RaspiPin.GPIO_02
- Connect jumper cable + another 220 Ohms + Green LED in serial
- Code
  - Make the LEDs to blink alternatively
  - Make the green LED to light up while the taster is down.

# Serial Comm + Arduino + Light Sensor + LED

- Arduino
  - Open-source electronics prototyping platform
  - Programmable IC on board with header pins
- Serial Communication
  - Lightweight two-way communication between two devices
  - Needs two connections: Rx1 to Tx2 and Rx2 to Tx1
  - Needs compatible baud-rate (9600bps), data/stop/parity bits (8-N-1) and voltage
- Light Sensor
  - Variable resistor based on light
  - <1K on intense light, ~4k7 on daylight, > 70K on dark

# Serial Comm (git checkout serial) - Arduino code

```
int led = 13;

//if UNO:
HardwareSerial serial = Serial;

//if LEONARDO:
//HardwareSerial serial = Serial1;

void setup() {
  serial.begin(9600);
  pinMode(led, OUTPUT);

}
int readValue=0;
```

```
void loop() {

  readValue = analogRead(A1);
  serial.print(" ");
  serial.println(readValue,DEC);
  serial.flush();
  delay(1000);
}

void serialEvent() {
  while (serial.available()) {
    serial.read();
  }
  digitalWrite(led, HIGH);   // turn the LED on (HIGH is the voltage level)
  delay(50);                // wait for a second
  digitalWrite(led, LOW);    // turn the LED off by making the voltage LOW

}
```

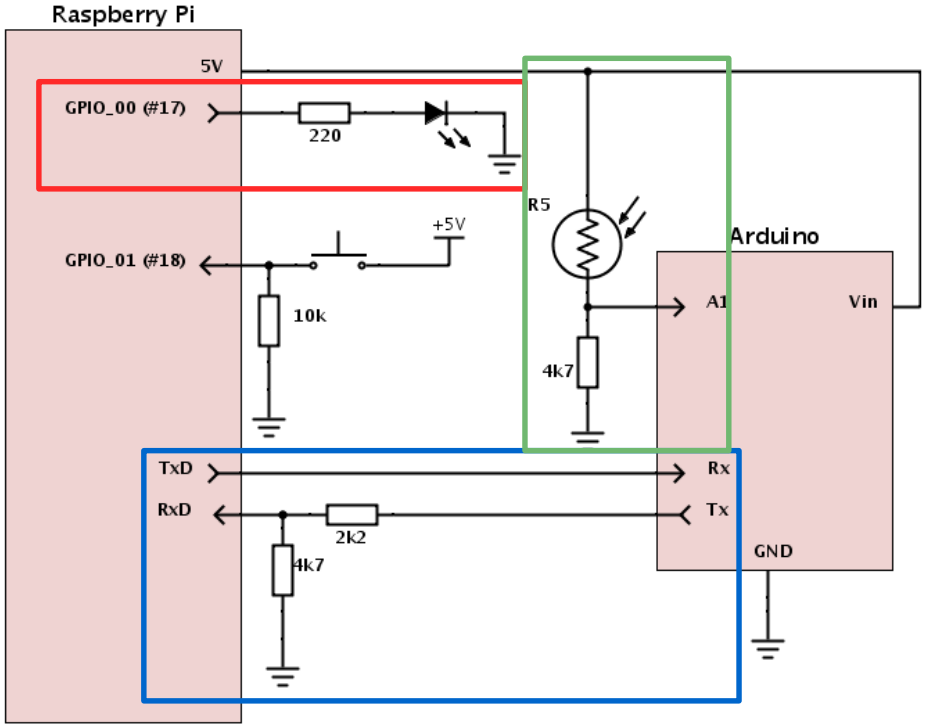
# Serial Comm (git checkout serial) – pi4j code

```
Serial serial = SerialFactory.createInstance();

serial.addListener(new SerialDataListener() {

        @Override
        public void dataReceived(SerialDataEvent event) {
                String readString = event.getData().trim();
                System.out.println("Data received: " + readString);
                try {
                        int value = Integer.parseInt(readString);
                        lastValue = value;
                } catch (Exception ignore) {

                }

                //alter the state
                boolean newState = lastValue < 200;
                if (newState != outState) {
                        outState = newState;
                        pinOutput.setState(outState);
                }

        }
});
```

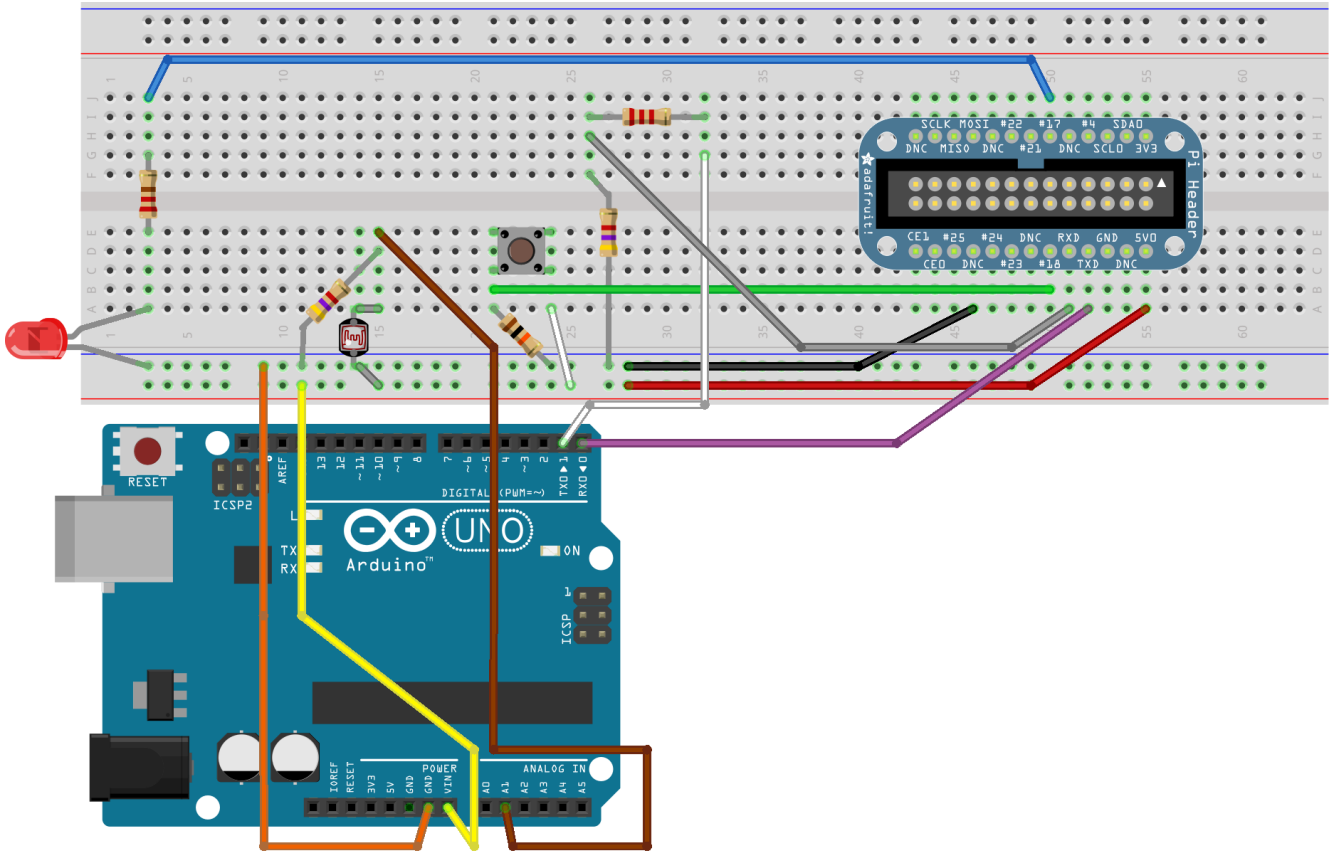
```
serial.open(Serial.DEFAULT_COM_PORT, 9600);


while (true) {
        System.out.println("Sent to serial.");
        serial.writeln("Text");
        serial.flush();
        Thread.sleep(2000);
}
```

# Serial Comm

## Schematics



# Serial Comm




fritzing

# Serial Comm

## Execute

- Build & run
- Inspect the standard output
- Illuminate the sensor with your phone
- Cover the sensor with your finger

- Alternative:
  - RasPi will recognize input < 1 V as a logical zero, > 2V as a logical one
  - “Calculated” voltage divider can do the trick

# NFC Reader

## ITEAD PN532 NFC Module

- http://imall.iteadstudio.com/im130625002.html
- 13.56 MHz Near Field Communication
- Onboard antenna
- Up to 3 CM effective distance
- Compatible with ISO14443 Type A and B
- Supports SPI, I2C and UART interface
- With exact RasPi GPIO layout
  - Connects with the same ribbon cable

- Provided Arduino and RasPi libraries (in C)

# NFC Reader

## git checkout nfc-serial

- **Inspect Main.java, PN532.java and PN532Spi.java**
- Follows strict protocol on byte level
  - Begin()
    - Init wiringPi and wiringPiSpi with channel and speed
  - Wakeup()
    - Fire up CS falling edge
  - Write Command()
    - Send  boxed command, data, computed checksum, wait for and check ACK
  - ReadResponse()
    - Read bytes and store in internal buffer

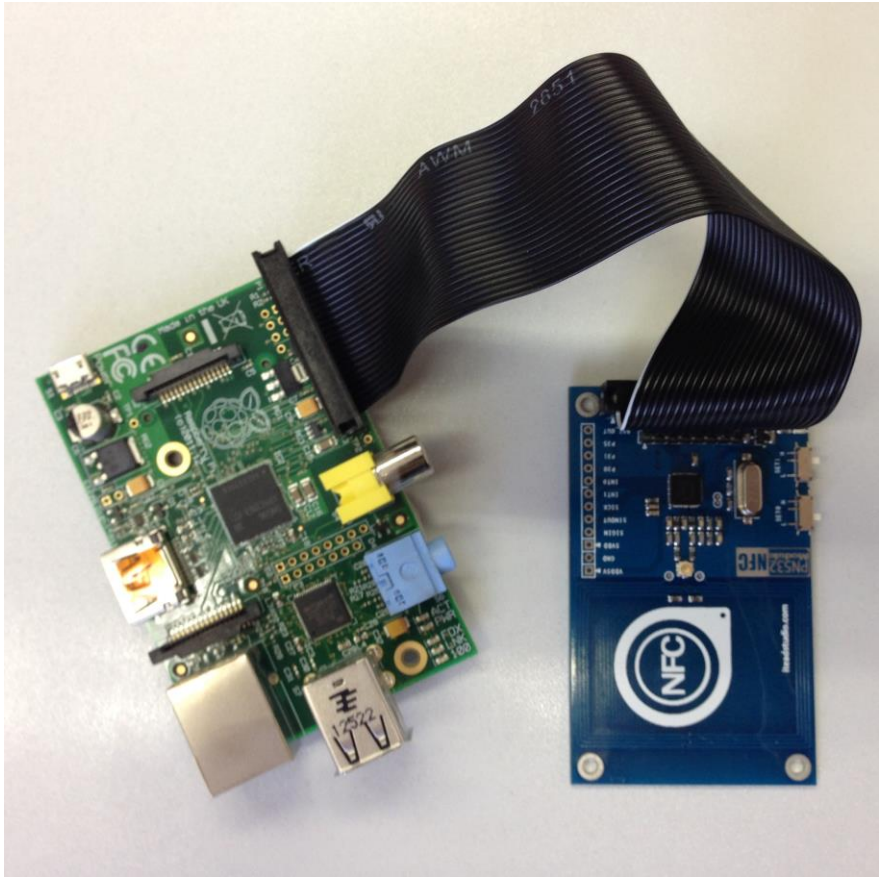
# NFC Reader

## git checkout nfc-serial

- Various commands
  - getFirmwareVersion() [0x02]
  - SAMConfig() [0x14, 0x01, 0x14, 0x01]
  - readPassiveTargetID [0x4A, 0x01, baudrate]
  - Auth/read/write Block (not implemented)
  - Used non-managed pi4j approach
    - Gpio.wiringPiSetup()
    - Gpio.wiringPiSPISetup(SPICHANNEL, SPISPEED)
    - Gpio.pinMode(pin, INPUT/OUTPUT) and Gpio.digitalWrite(pin, HIGH/LOW)
    - Spi.wiringPiSPIDataRW(SPICHANNEL, dataToSend, 1);

# NFC Reader

- Connect
- Build & Run
- Observe



# TasterFX (git checkout taster-fx)

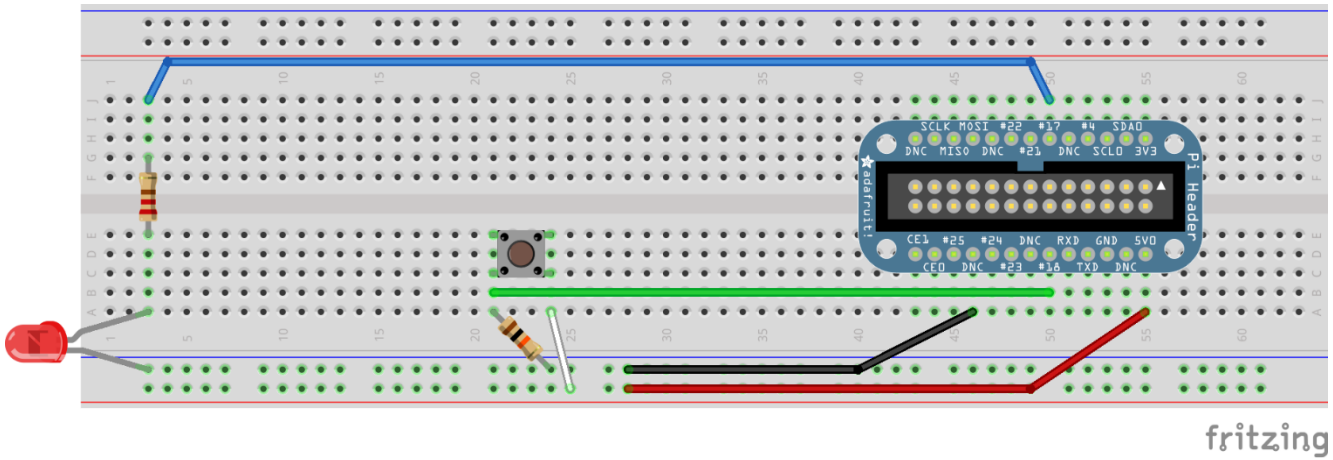
```
Button btn = new Button();
btn.setText("Toggle LED");
btn.setOnAction(new EventHandler<ActionEvent>() {

        @Override
        public void handle(ActionEvent event) {
                pin.toggle();
        }
});

lab = new Label();
lab.setText("Clicks: ");

Button btnExit = new Button();
btnExit.setText("Exit");
btnExit.setOnAction(new EventHandler<ActionEvent>() {

        @Override
        public void handle(ActionEvent event) {
                Platform.exit();
        }
});
```

```
VBox vBox = new VBox();
vBox.getChildren().addAll(btn, lab, btnExit);

StackPane root = new StackPane();
root.getChildren().add(vBox);

Scene scene = new Scene(root, 300, 250);

primaryStage.setTitle("Hello World!");
primaryStage.setScene(scene);
primaryStage.show();
```

# TasterFX

```
pinInput.addListener(new GpioPinListenerDigital() {
        @Override
        public void handleGpioPinDigitalStateChangeEvent(
                        GpioPinDigitalStateChangeEvent event) {
                if (event.getState().equals(PinState.HIGH)) {
                        System.out.println("Taster clicked!");
                        Platform.runLater(new Runnable() {
                                @Override
                                public void run() {
                                        lab.setText(lab.getText() + "*");
                                }
                        });
                }
        }

});
```

# TasterFX


SCLK MOSI #22 #17 #4 SDA0
DNC MISO DNC #21 DNC SCL0 3V3
CE1 #25 #24 DNC RXD GND 5V0
CE0 DNC #23 #18 TXD DNC
Pi Header
adafruit
fritzing

# TasterFX

## Execute

- Build & run
- Click on the button
- Click the taster
- Exit and see what happens

# Q & A

- https://twitter.com/hsilomedus
- http://hsilomedus.me/
- pance.cavkovski@netcetera.com