

# Invisible Monitoring

Enrique Saurez  
Ramyard Hadidi

# Motivation



# Why is challenging?



# Description I

- ▶ Two main sections:
  1. Central control system
    - ✓ Easy to extend
    - ✓ Rules based
    - ✓ Modifiable
    - ✓ Not restricted to this project

# Description II

- | Invisible monitoring
  - ✓ Low cost
  - ✓ Non intrusive
  - ✓ Real time access to information (position)

# Central Unit

## BeagleBone Black

- ▶ BBB:
  - ▶ ARM Cortex-A8 Processor
  - ▶ USB, Ethernet, microSD, HDMI ports
  - ▶ Debian, Android, Angostrom

Performance is only a constraint  
Not the resources BBB has

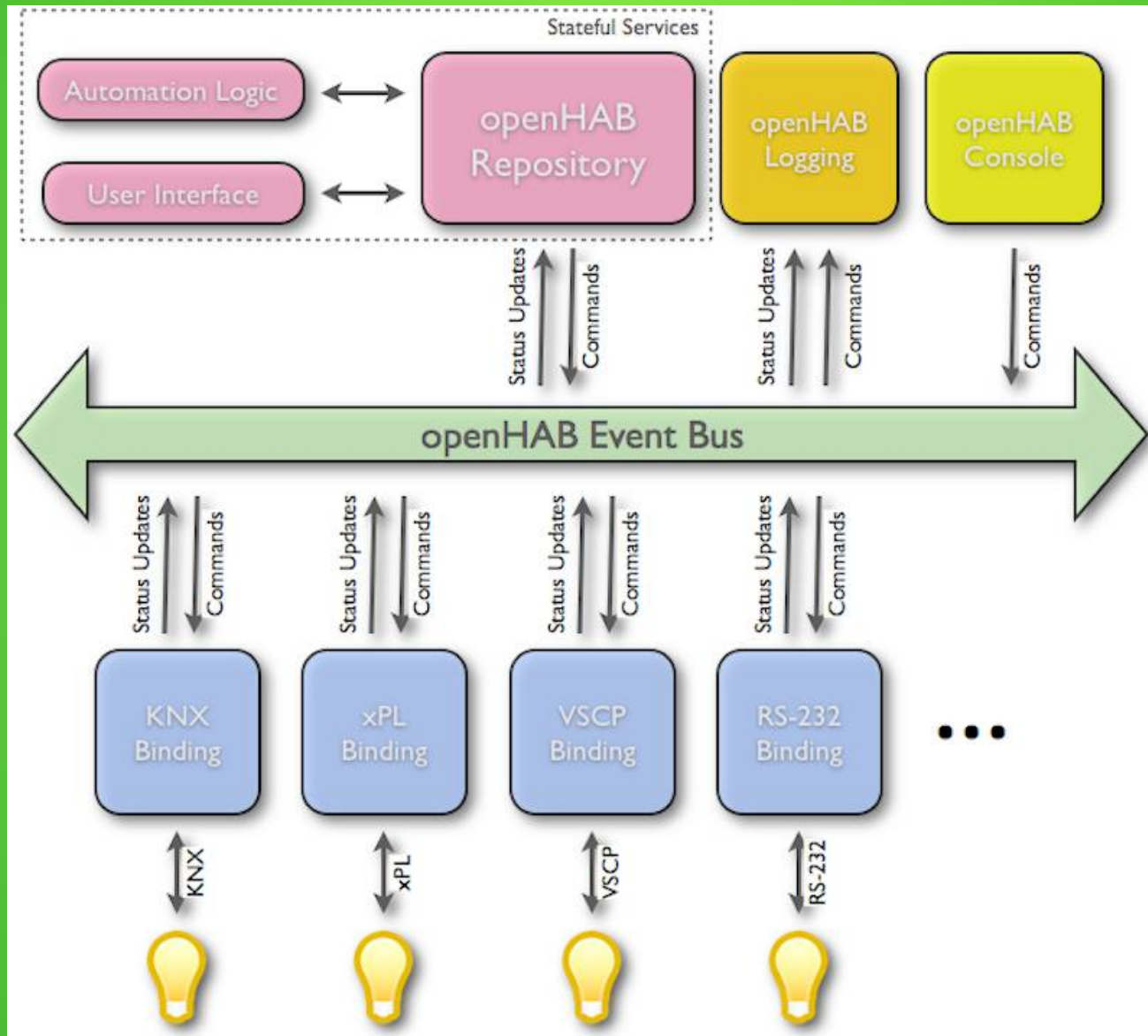






- ▶ Based on Java
- ▶ Open-Source
- ▶ Integration Platform for Smart Homes
- ▶ Support over 80 Technologies
- ▶ Two Parts
  - ▶ Runtime
  - ▶ Designer
- ▶ Plug-ins:
  - ▶ HABDoird
  - ▶ HABmin

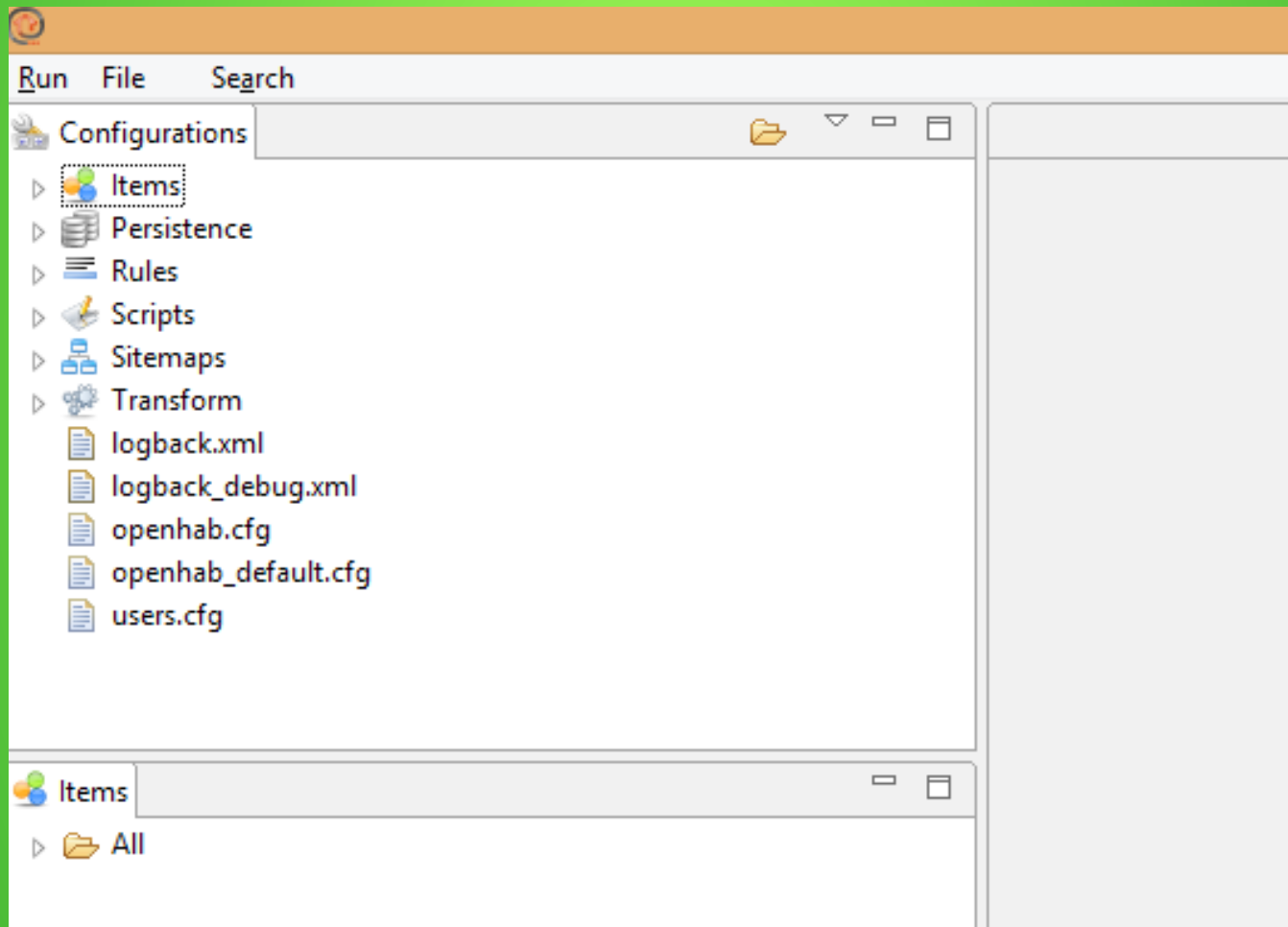
# OpenHAB Runtime Architecture







Designer





## Designer

openHAB Designer

Run File Search

Configurations

- Items
- Persistence
- Rules
- Scripts
- Sitemaps
- Transform
- logback.xml
- logback\_debug.xml
- openhab\_default.cfg
- users.cfg

demo.rules db4o.persist exec.persist README rrd4j.persist demo.items

```
Rollershutter Shutter_GF_Toilet "Toilet" (GF_Toilet, Shutters)
Rollershutter Shutter_GF_Kitchen "Kitchen" (GF_Kitchen, Shutters)
Rollershutter Shutter_GF_Living "Livingroom" (GF_Living, Shutters)

Rollershutter Shutter_FF_Bed "Bedroom" (FF_Bed, Shutters)
Rollershutter Shutter_FF_Bath "Bath" (FF_Bath, Shutters)
Rollershutter Shutter_FF_Office_Window "Office Window" (FF_Office, Shutters)
Rollershutter Shutter_FF_Office_Door "Office Door" (FF_Office, Shutters)

/* Indoor Temperatures */
Number Temperature_GF_Corridor "Temperature [%1.1f °C]" <temperature> (Temperature, GF_Corridor)
Number Temperature_GF_Toilet "Temperature [%1.1f °C]" <temperature> (Temperature, GF_Toilet)
Number Temperature_GF_Living "Temperature [%1.1f °C]" <temperature> (Temperature, GF_Living)
Number Temperature_GF_Kitchen "Temperature [%1.1f °C]" <temperature> (Temperature, GF_Kitchen)
Number Temperature_FF_Bath "Temperature [%1.1f °C]" <temperature> (Temperature, FF_Bath)
Number Temperature_FF_Office "Temperature [%1.1f °C]" <temperature> (Temperature, FF_Office)
Number Temperature_FF_Child "Temperature [%1.1f °C]" <temperature> (Temperature, FF_Child)
Number Temperature_FF_Bed "Temperature [%1.1f °C]" <temperature> (Temperature, FF_Bed)

/* Windows */
Contact Window_GF_Frontdoor "Frontdoor [MAP(en.map):%s]" (GF_Corridor, Windows)
Contact Window_GF_Kitchen "Kitchen [MAP(en.map):%s]" (GF_Kitchen, Windows)
Contact Window_GF_Living "Terrace door [MAP(en.map):%s]" (GF_Living, Windows)
Contact Window_GF_Toilet "Toilet [MAP(en.map):%s]" (GF_Toilet, Windows)

Contact Window_FF_Bath "Bath [MAP(en.map):%s]" (FF_Bath, Windows)
Contact Window_FF_Bed "Bedroom [MAP(en.map):%s]" (FF_Bed, Windows)
Contact Window_FF_Office_Window "Office Window [MAP(en.map):%s]" (FF_Office, Windows)
Contact Window_FF_Office_Door "Balcony Door [MAP(en.map):%s]" (FF_Office, Windows)

Contact Garage_Door "Garage Door [MAP(en.map):%s]" (Outdoor, Windows)

Group Weather_Chart (Weather)
Number Weather_Temperature "Outside Temperature [%1.1f °C]" <temperature> (Weather_Chart)
Number Weather_Temp_Max "Todays Maximum [%1.1f °C]" <temperature> (Weather_Chart)
Number Weather_Temp_Min "Todays Minimum [%1.1f °C]" <temperature> (Weather_Chart)
Number Weather_Chart_Period "Chart Period"
DateTime Weather_LastUpdate "Last Update [%1$ta %1$tr]" <clock>
```



Main Menu - Mozilla Firefox

openHAB Administrati... x Main Menu x Main Menu +

localhost:8080/openhab.app?sitemap=demo#\_Home

small png icons

Gmail Evernote Trello Twitter BuzzPort T-Square Facebook YouTube Instagram Soundcloud BofA Netflix Last.fm LinkedIn imdb

### Main Menu

- Lights
- Rooms

#### Activity

- Activity detection
- Debug

#### Charts

- Prueba

#### Information

- Avg. Room Temperature 69.8 °C
- Outside Temperature 12.0 °C
- Date Sunday, 23.11.2014

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localhost:8080/openhab.app?sitemap=demo#\_0102



Main Menu - Mozilla Firefox

Browser tabs: openHAB Administrati... x Main Menu x Main Menu +

Address bar: localhost:8080/openhab.app?sitemap=demo#\_0000

Search bar: small png icons

Navigation icons: Back, Forward, Home, etc.

Social media links: Gmail, Evernote, Trello, Twitter, BuzzPort, T-Square, Facebook, YouTube, Instagram, Soundcloud, BofA, Netflix, Last.fm, LinkedIn, imdb

Main Menu

## Lights

	Light Bedroom 1	<input type="checkbox"/>	<input type="radio"/>
	Light Bedroom 2	<input type="checkbox"/>	<input type="radio"/>
	Light Hallway	<input checked="" type="checkbox"/>	<input type="radio"/>
	Light Bathroom	<input type="checkbox"/>	<input type="radio"/>

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Lights



openHAB - Google Chrome

Dec 4 17:50

localhost:8080/greent/

Back

Main Menu > Rooms > Hallway

Bedroom 1

Bedroom 2

Hallway

Bathroom

Kitchen

Led Door Sensor Bedroom 1:	Motion
Led Door Sensor Bedroom 2:	No Motion
Light Hallway	<input type="checkbox"/>
Hallway temperature:	77.6 F
Hallway Relative humidity:	32 %
Hallway Luminance:	62 Lux
Hallway Sensor Battery:	100 %
Hallway Motion Sensor	No Motion
Pressure Sensor Hallway:	No Motion





## Our Debug on Web interface

openHAB - Google Chrome

openHAB x

localhost:8080/greent/

Back Main Menu > Debug

Arduino

ZWave

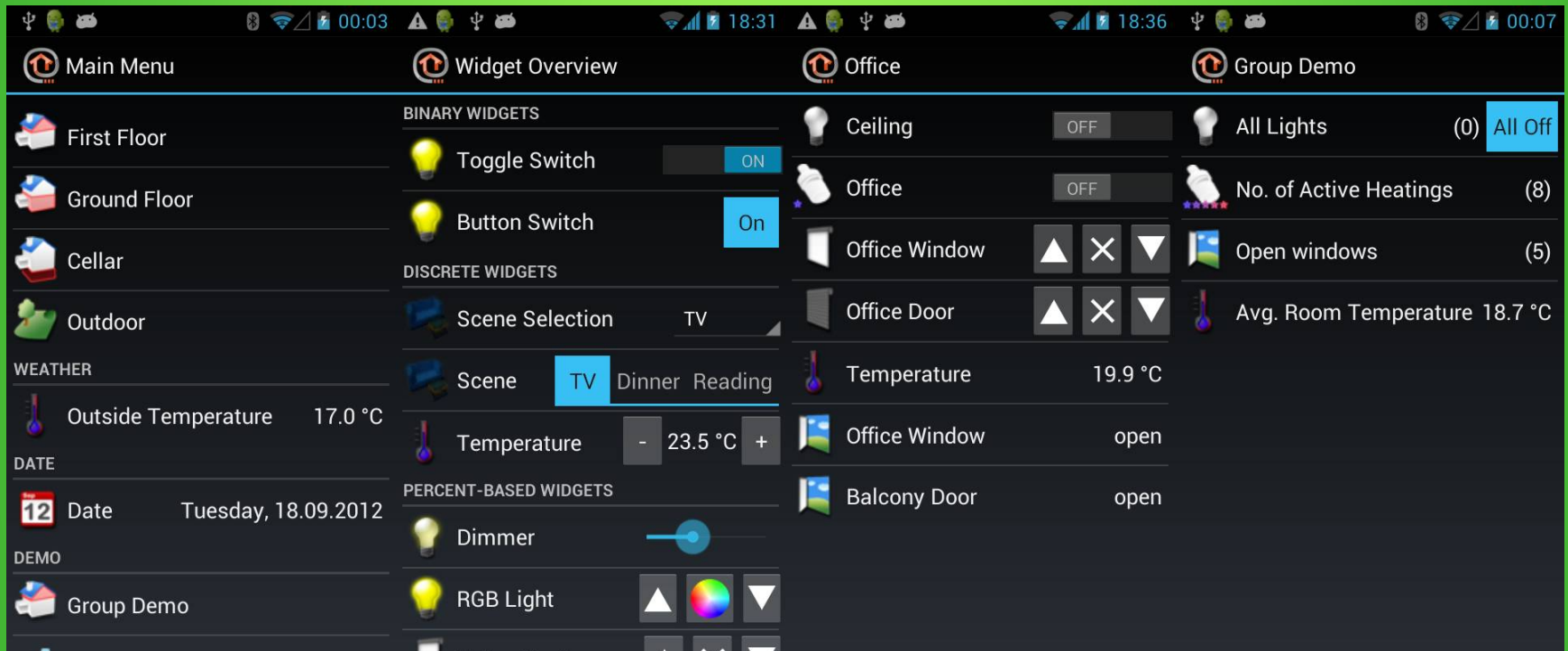
Arduino Coordinator Reads [4~OFF  
8~OFF  
6~OFF  
3~ON  
]

Arduino Coordinator Reads [4~OFF  
8~OFF  
6~OFF  
3~ON  
]



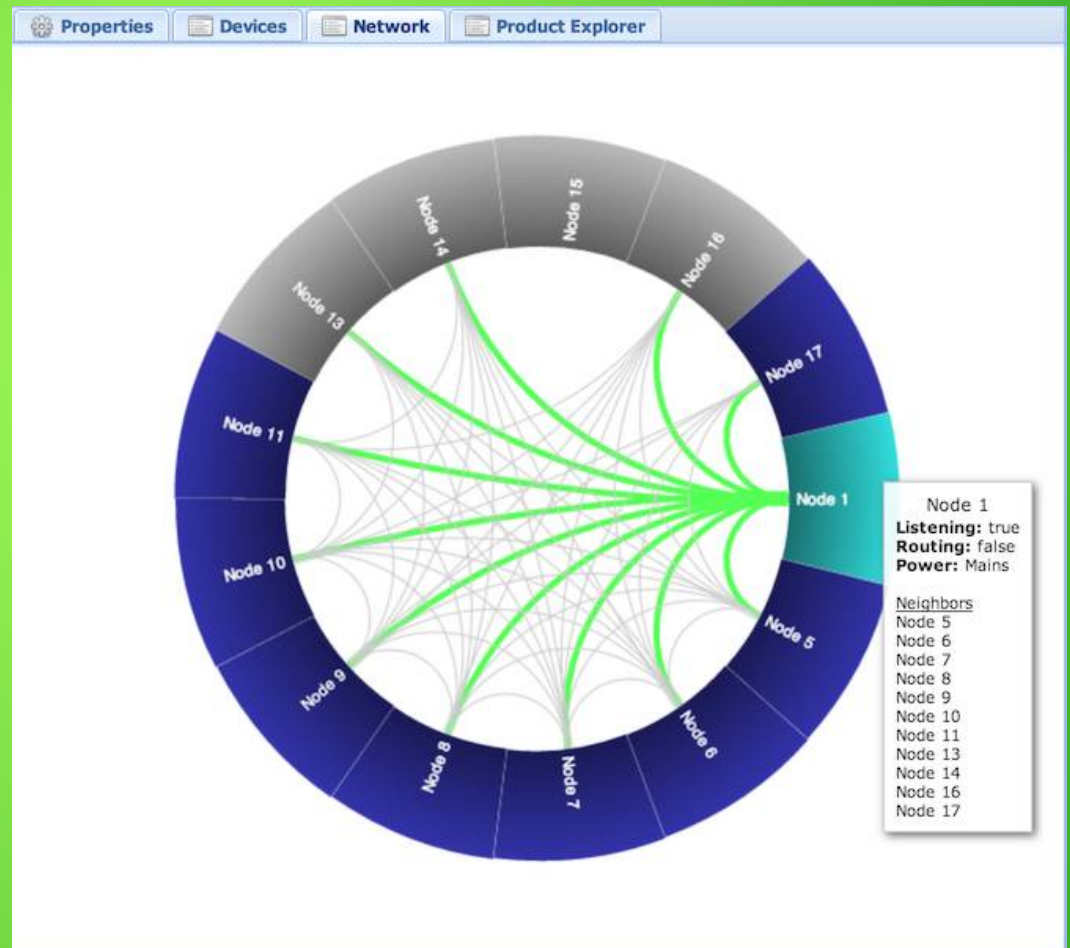
# HABDroid

Mobile App for interface (both iOS and Android)



# HABmin

- ▶ Web administration console for openHAB
- ▶ Easy to configure devices
- ▶ Example
  - ┌ Z-wave Network:



# Z-wave

- ▶ Z-wave Stick
- ▶ 4in1 Multi-Sensor
  - ▶ Motion ,Temperature ,Humidity
  - ▶ Luminance
- ▶ Lamp Module as an Actuator
  - ▶ Also a mesh booster



# Z-wave

Lamp Module and 4in1 Motion sensor



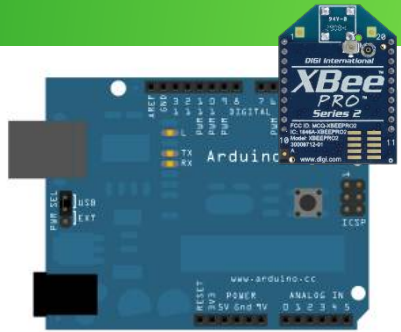
# Zigbee + Arduinos + Sensors



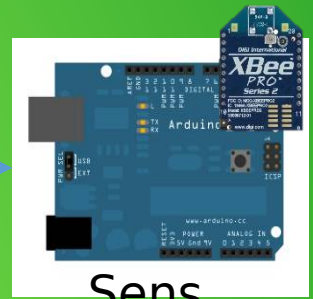


# API Mode

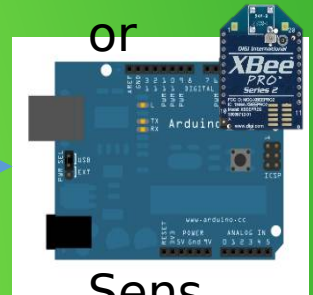
One to many  
connection



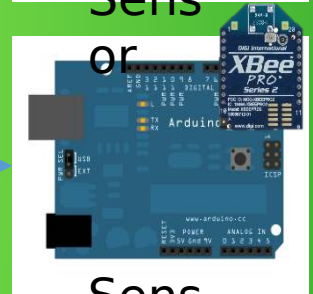
Coordinator



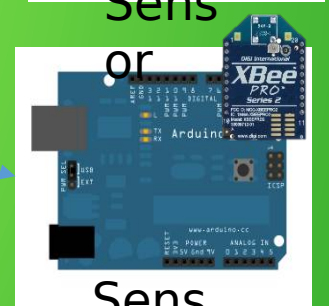
Sens  
or



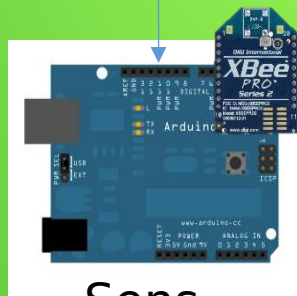
Sens  
or



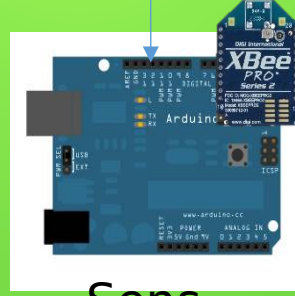
Sens  
or



Sens  
or



Sens  
or

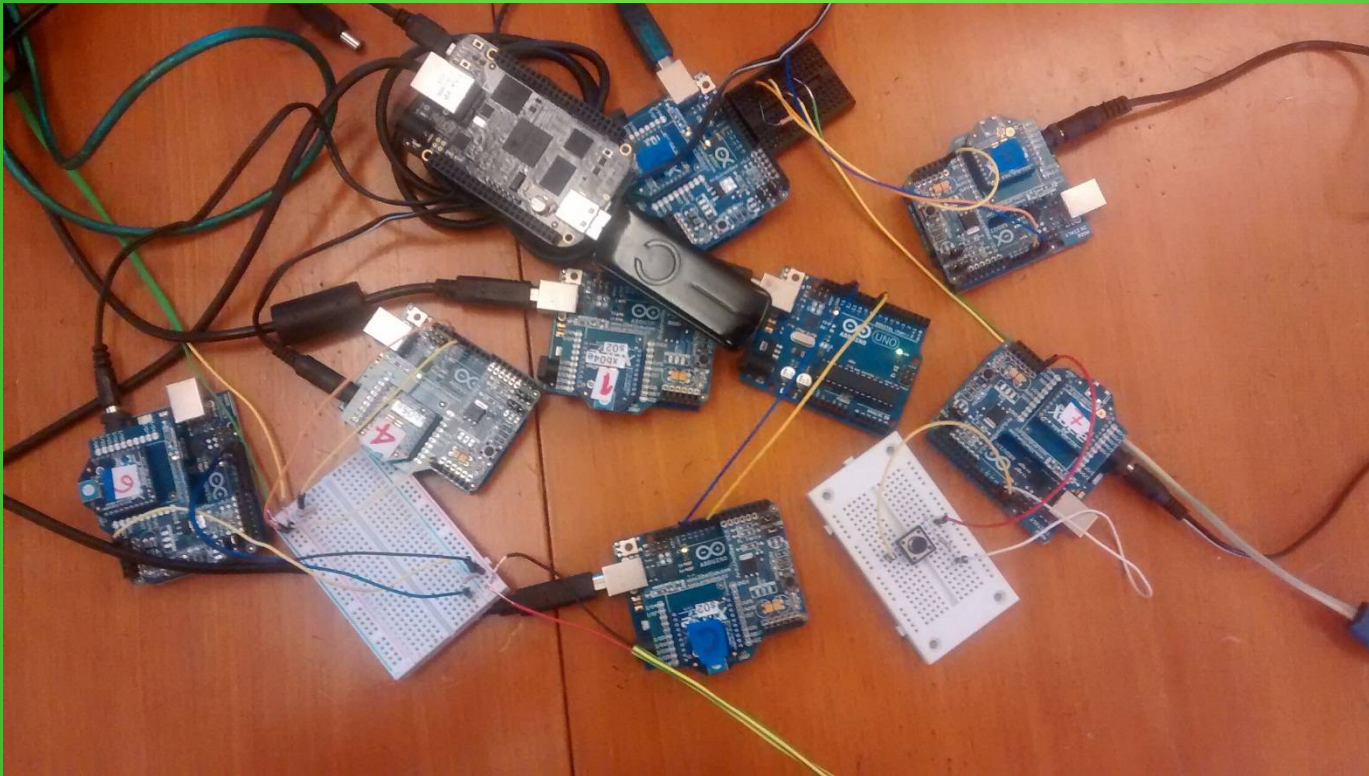


Sens  
or





The coordinator and some  
slaves



The coordinator and many  
slaves

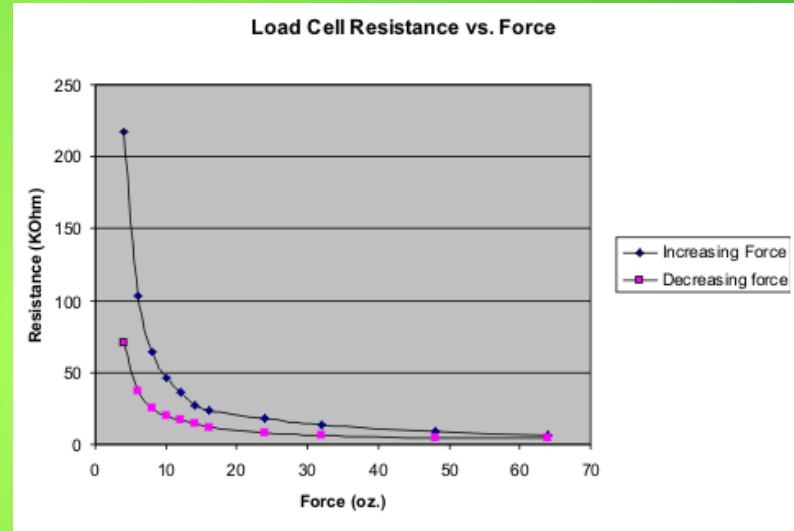
# message structure

- 2 Byte Packages
- **Why?**
- 10-bits resolution from the ADC in the Arduino
- Other bits are used for node identification
- | 6 bits node identification | | 10 bits data information |



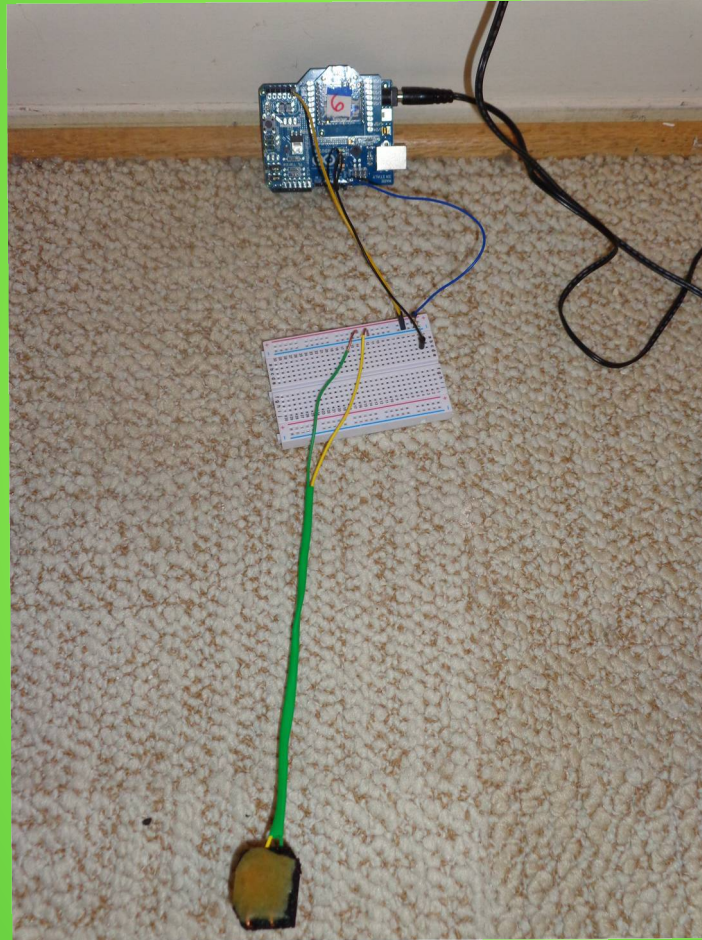
What kind of sensors?

# Force sensors (Pressure)



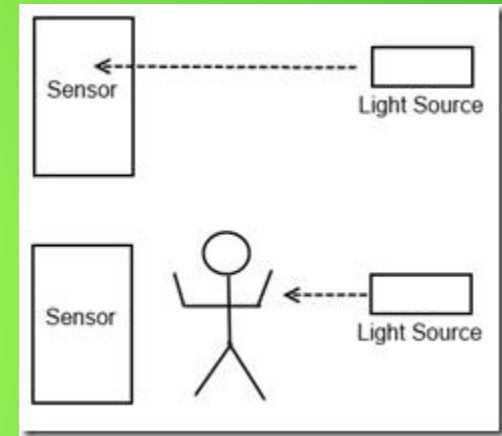


# Our Motion Sensor

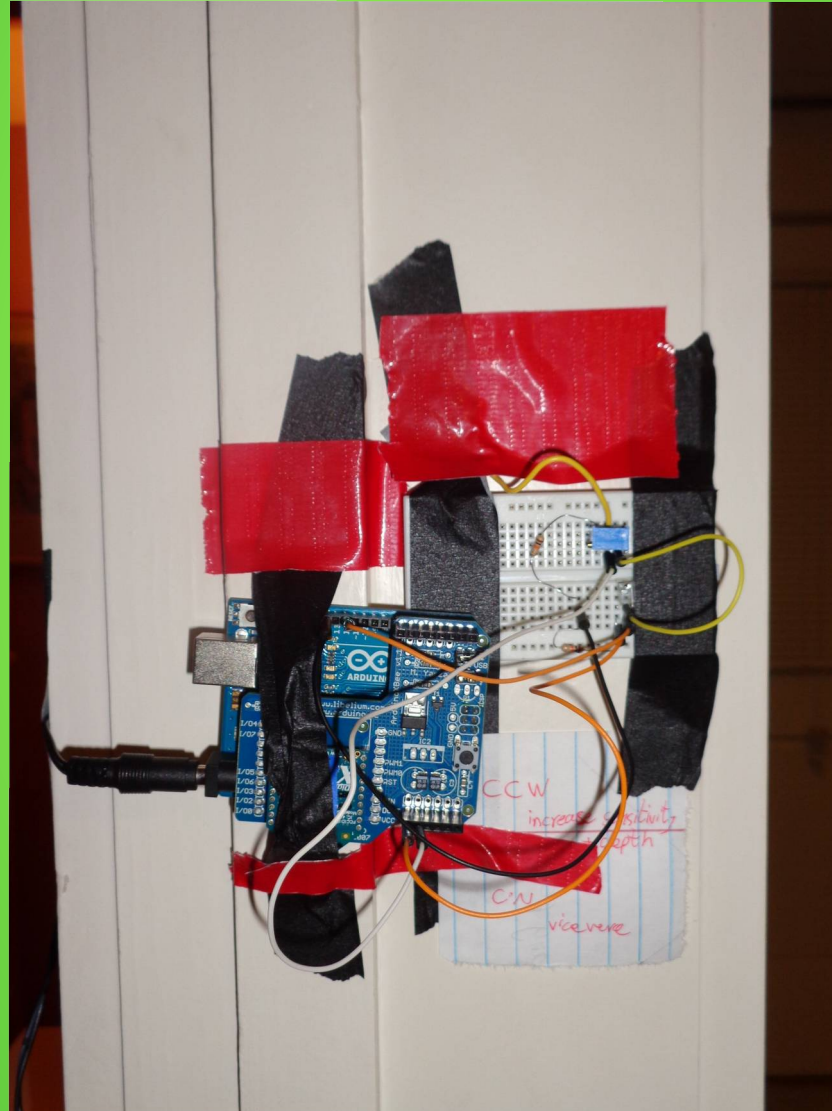


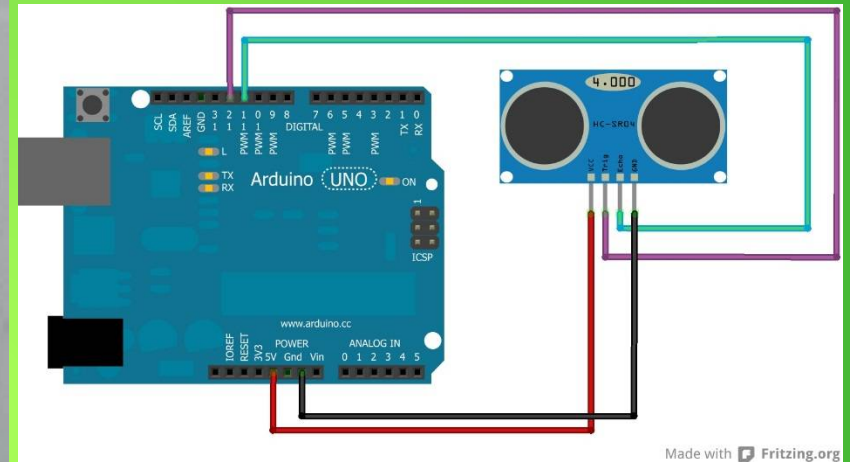


# A infrared barrier



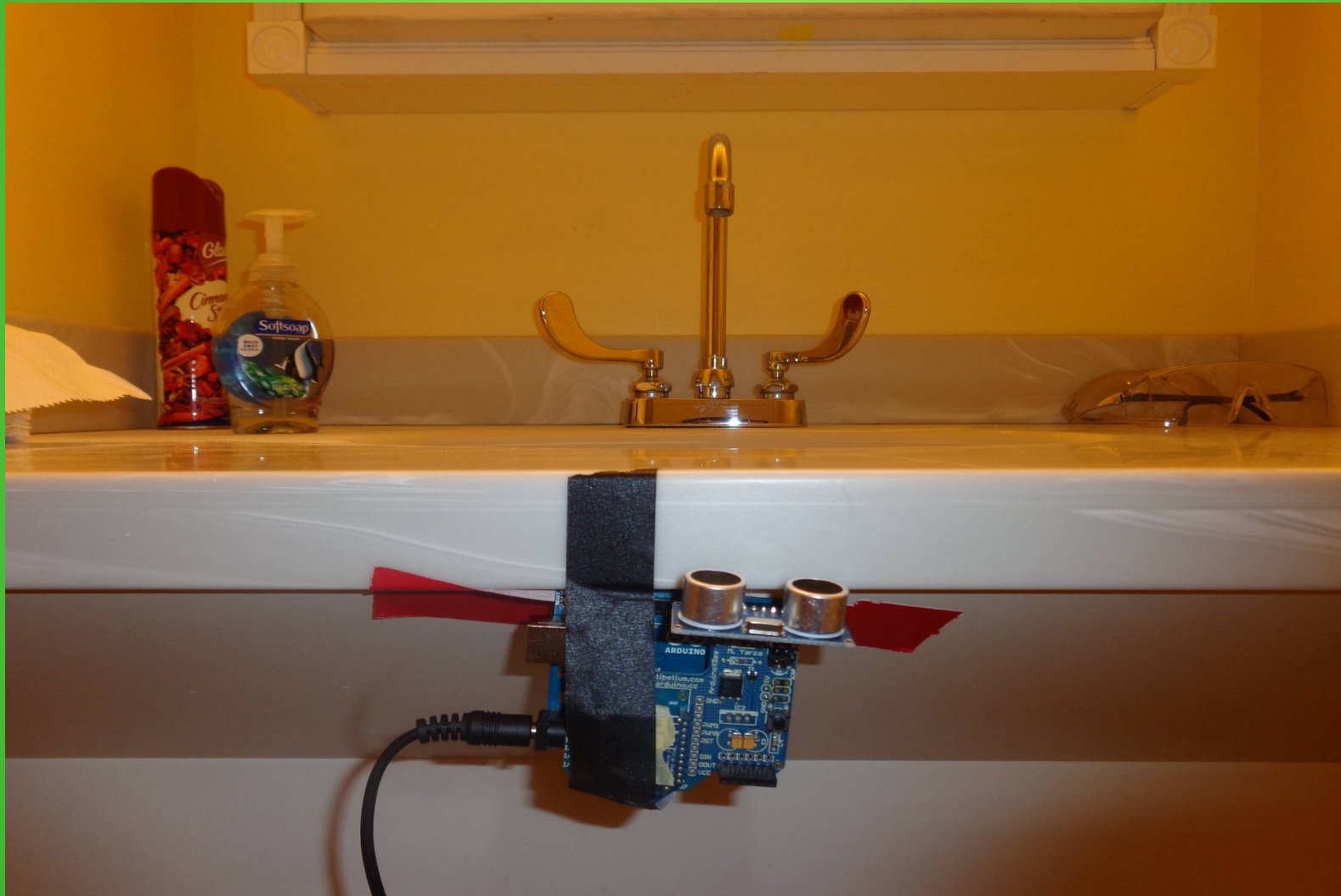
# Our Infrared Barrier





Ultrasonic sensor

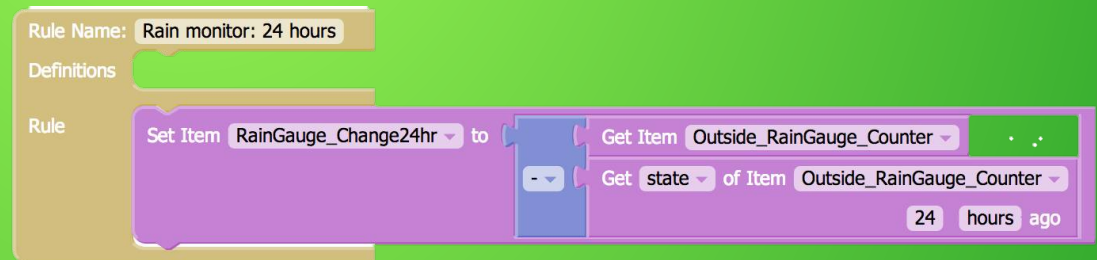
# Ultrasonic sensor



# Event-Driven Programming

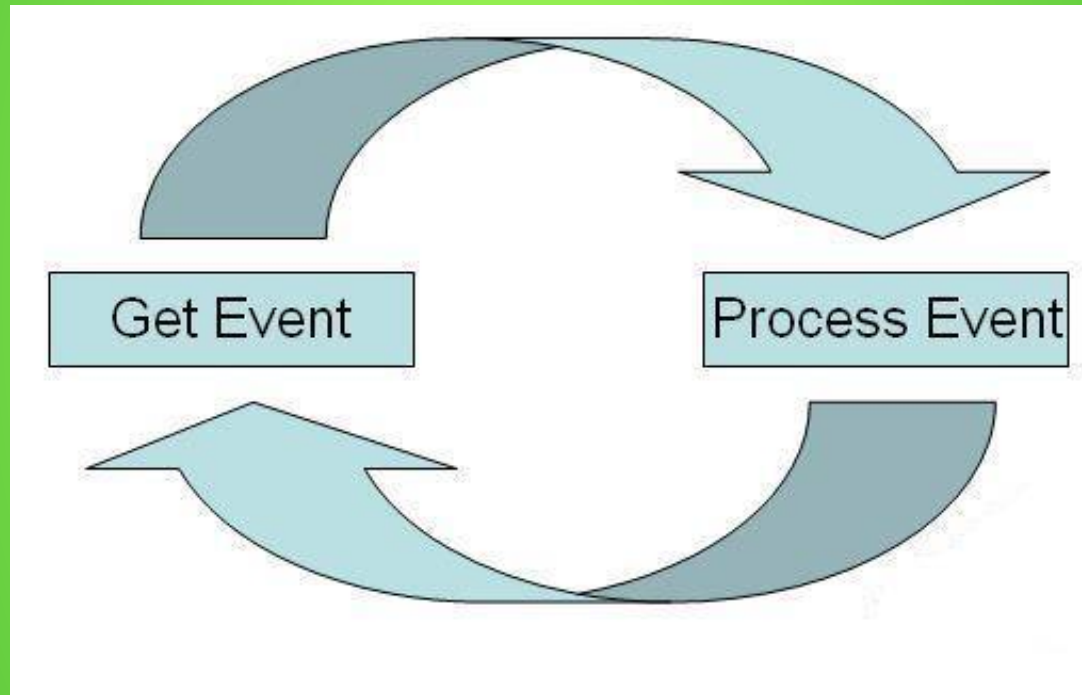
## Rules based programming

- Item(-Event)-based triggers: They react on events, i.e. commands and status updates for items
- Time-based triggers: They react at special times, e.g. at midnight, every hour, etc.
- System-based triggers: They react on certain system statuses.





# How to know if there is activity?





# How to know if there is activity?

- What information the infrared barrier give us?
  - That the person is near that door
  - For us is not important to know exactly in which room
    - We activate both rooms.
- It's better for coherence and multiple persons

# How to know if there is activity?

- ▮ Each action has a latency for which the activity is still valid as a indicator of activity.





# Activity interface

openHAB - Google Chrome

localhost:8080/greent/

Back Main Menu > Activity Detection

Lights

Rooms

Activity Detection

Debug

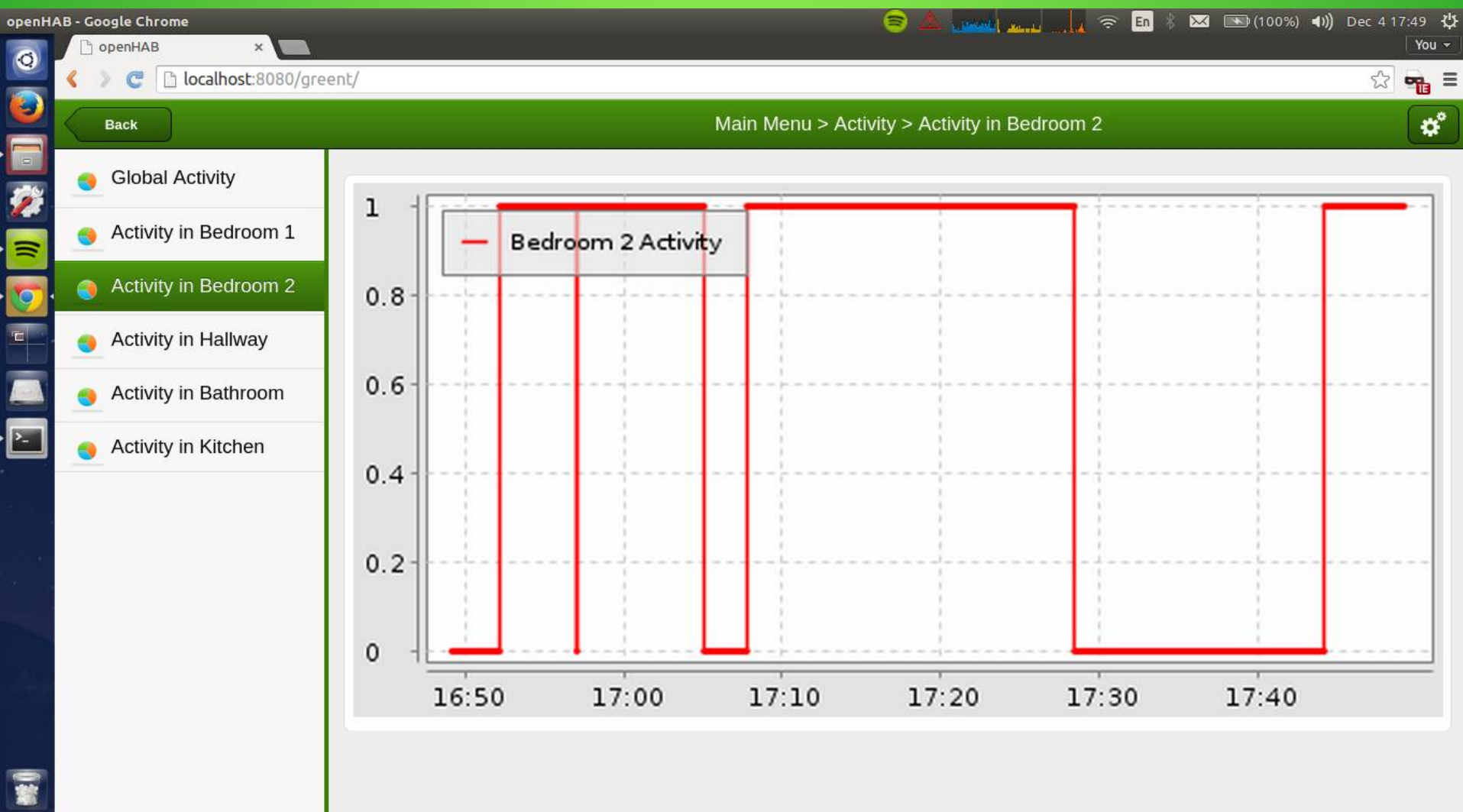
Activity

Avg. Room Temperature 77.3 °F

Outside Temperature 19.0 °C

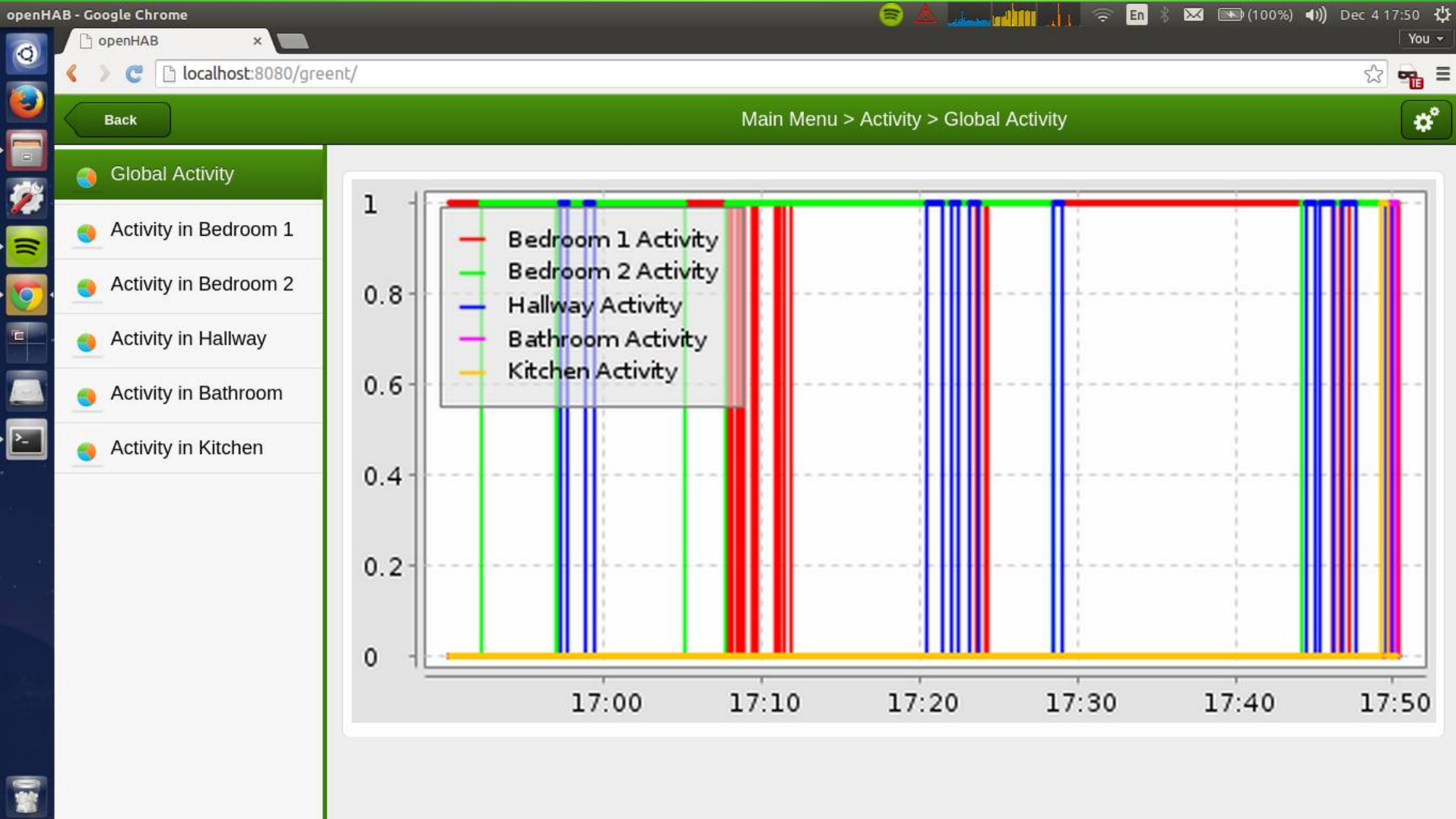
Bedroom 1 Activity	Detected
Bedroom 2 Activity	Not Detected
Hallway Activity	Not Detected
Bathroom Activity	Not Detected
Kitchen Activity	Not Detected

# Database and Graphs





# Database and Graphs



# Summary

- ▶ Low cost monitoring system
- ▶ Testbed for future projects in AwareHome
- ▶ Less intrusive position detection system.