Building IoT systems with openHAB

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Overview

+ Timeline
+ Frameworks and Protocols
+ openHAB architecture
+ openHAB features
+ openHAB configuration
+ openHAB examples
+ Demo
IoT Timeline

+ ARPANET online in 1969 with “things” talking Network Control Program (NCP)
+ Internet born in 1983: ARPANET “things” start talking TCP/IP
+ Trojan Room Coffee Pot goes on Internet in 1993
  + http://en.wikipedia.org/wiki/Trojan_Room_coffee_pot
+ Kevin Ashton (Auto-ID) coins “IoT” in 1999
+ Media goes into a frenzy about IoT that just won’t quit.
+ openHAB started in 2010
+ Thomas Ruecker’s Tweeting Toilet goes online, ushering in the Internet of Toilets (IoT) era in 2014
Frameworks

+ AllJoyn - framework for distributed applications
  + [https://allseenalliance.org/developers/learn/architecture](https://allseenalliance.org/developers/learn/architecture)

+ IOTivity - framework for Machine to Machine (M2M) communication
  + [https://www.iotivity.org/](https://www.iotivity.org/)

+ Kura - OSGi-based framework for M2M applications
  + [https://eclipse.org/kura/](https://eclipse.org/kura/)

+ Mihini - Lua-based M2M framework
  + [https://eclipse.org/mihini/](https://eclipse.org/mihini/)

+ openHAB - Home Automation and IoT gateway framework
  + [http://openhab.org](http://openhab.org)

+ …
Protocols

- CoAP (Constrained Application Protocol)
  - request/response, low overhead, translates to HTTP
- MQTT
  - pub/sub, low overhead
- RESTful HTTP
  - request/response, one way from devices to service
- XMPP (Extensible Messaging and Presence Protocol)
  - pub/sub, built in authentication
- ...
OASIS standard: MQTT v3.1.1
+ Publish/Subscribe and hub/spoke model
  + MQTT brokers provides the communication hub
+ Mosquitto 1.3.4 broker supports MQTT v3.1.1
+ Fixed header required, variable header and payload optional

Fixed header just 2 bytes
openHAB basics

- FOSS automation software
- [http://www.openhab.org](http://www.openhab.org)
  - Eclipse Public License 1.0
- Written mostly in Java
  - *Java, UGH!*
- Central automation hub
- Hardware/protocol agnostic
  - Many bindings [http://www.openhab.org/features-tech.html](http://www.openhab.org/features-tech.html)
- Component-based architecture
  - Each component is an OSGi bundle
openHAB architecture

- Event bus
  - Asynchronous communication bus
- Repository
  - Persistent storage
- Items
  - Objects that can be read or written
  - Have a type and state
- Bindings
  - Translate event bus events to/from external system
- Actions
  - Programmatic methods available for use by scripts/rules
openHAB Event Bus

- KNX Binding
  - KNX
- xPL Binding
  - xPL
- VSCP Binding
  - VSCP
- RS-232 Binding
  - RS-232

openHAB Repository

- Automation Logic
- User Interface

openHAB Logging

openHAB Console

Stateful Services

Status Updates

Commands
openHAB features

+ Plugin framework
+ Rules engine
+ Logging mechanism
+ UI abstraction
  + Sitemap - Tree structure of UI widgets
  + Item UI Providers - Dynamic UI configuration
+ UI implementations
  + Web
  + Android
  + iOS
+ Designer tool - graphic configuration of runtime
openHAB add-ons

- **Actions**
  - HTTP - access URL on event
  - Mail - ancient notification technology
  - Pushover/Prowl - notifications
  - Twitter - Tweet that your toilet flushed

- **Bindings**
  - Bluetooth - device proximity events
  - GPIO - Linux sysfs-based GPIO events
  - KNX - home automation events
  - MQTT - raw protocol support
  - OneWire - various sensor events
  - Serial - RS-232 will never die
  - ZWave - home automation events
Running openHAB

- Runs “well” on any x86 or ARM board with 512MB+ RAM
  - A resource hog like any other Java/Jetty/OSGi application
- OpenJDK or Oracle JREs are supported
  - Some bindings may not work on OpenJDK on ARM
- Packaged on some distros
  - Debian Cloudbees repository has the core and all bindings packaged
    - openhab-runtime
    - openhab-addon-*
  - $ cat /etc/apt/sources.list.d/openhab.list
deb http://repository-openhab.forge.cloudbees.com/release/1.6.1/apt-repo/
openHAB configuration

$(openhab)/configurations/

openhab.cfg
items/*.items
persistence/*.persist
rules/*.rules
scripts/*.script
sitemaps/*.sitemap
transform/*.map
# The SMTP server hostname, e.g. "smtp.gmail.com"
mail:hostname=smtp.gmail.com

# the SMTP port to use (optional, defaults to 25 (resp. 587 for TLS))
mail:port=587

# the username and password if the SMTP server requires authentication
mail:username=torvalds
mail:password=linux1991

# The email address to use for sending mails
mail:from=Not Really Linus <torvalds@gmail.com>

# set to "true", if TLS should be used for the connection
# (optional, defaults to false)
mail:tls=true
Contact FrontDoor "Front Door [MAP(en.map):%s]" {mqtt="<[openhab:/house/frontdoor:state:default]"}

Contact GarageDoor "Garage Door [MAP(en.map):%s]" {zwave="3: command=sensor_binary"}
openHAB rules

+ Java-like
  + Imports
  + Variable declarations
  + Rules

var VarType var1

rule “rule name”
when
  <trigger1> or <trigger2>
then
  <execute_actions>
end
openHAB triggers

+ Item/Event-based

Item <item> received command [<command>]
Item <item> changed [from <state>] [to <state>]

+ Time-based

Time is midnight

+ System-based

System started
openHAB actions

+ Actions used in rules engine to accomplish a task
+ Core actions

  sendCommand()
  postUpdate()
  logInfo()

+ Binding actions

  sendMail()
  pushNotification()
  sendTweet()
  sendXbmcNotification()
If the state of the door item changes, send a notification indicating the state of the door.

rule "Notify Front Door"
when
    Item FrontDoor changed
then
    pushover("Front door is " + FrontDoor.state.toString)
end

rule "Notify Garage Door"
when
    Item GarageDoor changed
then
    pushover("Garage door is " + GarageDoor.state.toString)
end
A contact item has the state of CLOSED, OPEN, or - (undefined). These are too shouty to print out as is, so transform to lower case before sending to the action.
default.sitemap

```xml
sitemap default label="Home"
{
    Frame label="House" {
        Text item=FrontDoor
    }
    Frame label="Garage" {
        Text item=GarageDoor
    }
}
```

The sitemap defines Items to be displayed in the UI, grouping, and layout.
Scripts are another tool useful for reuse of code blocks between rules
  + Java syntax like Xtend language is used
+ Persistence allows multiple methods for state to be save
  + Each Item may specify a persistence strategy
  + Addons
    + db4o
    + mysql
    + mongodb
    + Logback
ESP8266-based door sensor

- $2-3 WiFi SoC module with Tensilica core and GNU toolchain
  - [http://www.esp8266.com](http://www.esp8266.com)
- NodeMcu - FOSS firmware with lua interpreter for ESP8266
  - [http://www.nodemcu.com](http://www.nodemcu.com)
  - Full I/O library including MQTT v3.1.1 client compatible with openHAB
- Reed switch interfaced to GPIO on ESP8266
- Just 28 lines of lua
  - Configure WiFi
  - Handle GPIO/switch interrupts
  - Publish MQTT “open”/”closed” messages
Door sensor code fragment

-- Door switch contact interrupt callback
function switchcb(level)
  if level == 1 then
    state = "CLOSED"
  else
    state = "OPEN"
  end

-- Publish a message on each change in state
  tmr.alarm(2, 1000, 0, function() m:publish(topic, state, 0, 0, function(conn) print("sent") end) end)
end

-- Create an MQTT client instance and connect to the broker
m = mqtt.Client(clientid, keepalive, username, password)
m:connect(broker, port, 0, function(conn) print("connected") end)

-- Configure GPIO2 as an interrupt with a pullup
gpio.mode(gpio2, gpio.INT, gpio.PULLUP)
-- Set GPIO2 to call our handler on both edges
gpio.trig(gpio2, "both", switchcb)
**ZWave Tilt Sensor**

- **Zwave is a proprietary mesh network**
  - Controllers and common sensors have open protocols
  - Fully supported in openHAB
- **ZWave products are easy to purchase in U.S. at any home improvement store**
  - Cheap off the shelf sensors
- **AEON Labs Z-Stick USB controller**
  - [http://aeotec.com/z-wave-usb-stick](http://aeotec.com/z-wave-usb-stick)
  - Push button inclusion of ZWave device to mesh network
  - Works out of the box with openHAB
- **EcoLink garage door tilt sensor**
  - Battery powered tilt sensor suitable for overhead doors
  - Works out of the box with openHAB
openHAB future

+ More bindings, of course
+ openHAB2 is coming
  + optimize for embedded (hub with 256MB RAM)
  + Minimal runtime
  + Switch to Concierge OSGi?
  + New binding API incorporate concept of “Things”
  + “Things” will be discoverable (IP addresses, etc.)
  + New UI based on material design
Q&A

References

+ https://github.com/konsulko/iot-openhab
+ http://www.openhab.org
+ https://github.com/openhab/openhab/wiki/MQTT-Binding
+ https://github.com/openhab/openhab/wiki/Z-Wave-Binding
+ http://nodemcu.com/
+ http://esp8266.com
+ http://www.openzwave.com/