

Welcome!

- Thank you for joining today's webinar:
OpenADR and the Internet of Things (IoT)

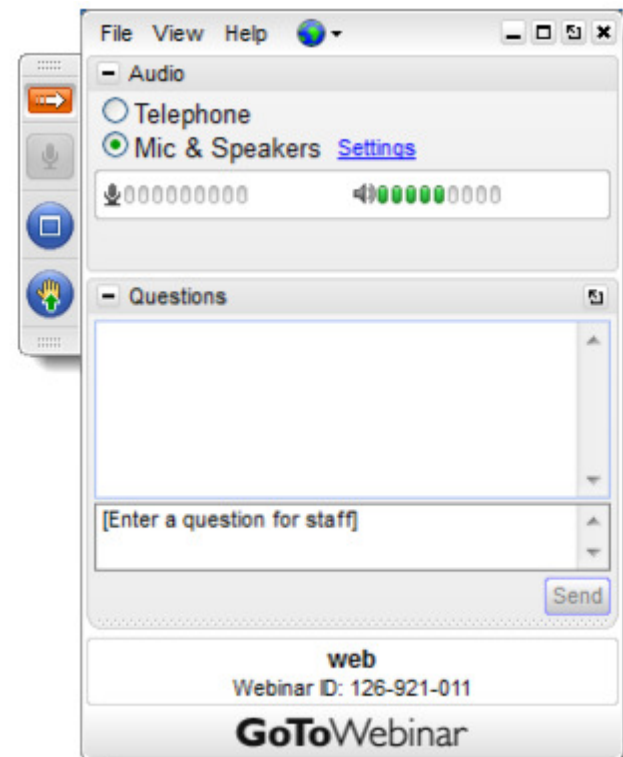
Today's Speakers:

- Jim Zuber is co-founder of QualityLogic and the company's Chief Test Architect. Many of the testing products architected by Mr. Zuber and released by QualityLogic over the past 20 years have become de facto testing standards in the smart grid, imaging, facsimile, and telephony industries.
- Michel Kohanim is the CEO of Universal Devices, Inc. He has Masters in Artificial Intelligence, a veteran at IBM, and well versed in systems engineering, sensors and actuators/IoT, and machine-to-machine communications and standards.

Webinar Logistics

GoToWebinar

- ▣ Grab Tab: From the Grab Tab, you can hide the Control Panel, or mute yourself (if you have been unmuted by the organizer).
 - ▣ You will be defaulted to mute by organizer.
 - ▣ Please use the Questions Pane for comments or questions.
- ▣ Audio Pane: Use the Audio pane to switch between Telephone and Mic & Speakers
- ▣ Questions Pane: Post your questions for panelists.
- ▣ Webinar slides and audio will be made available on the OpenADR website





OpenADR and the Internet of Things

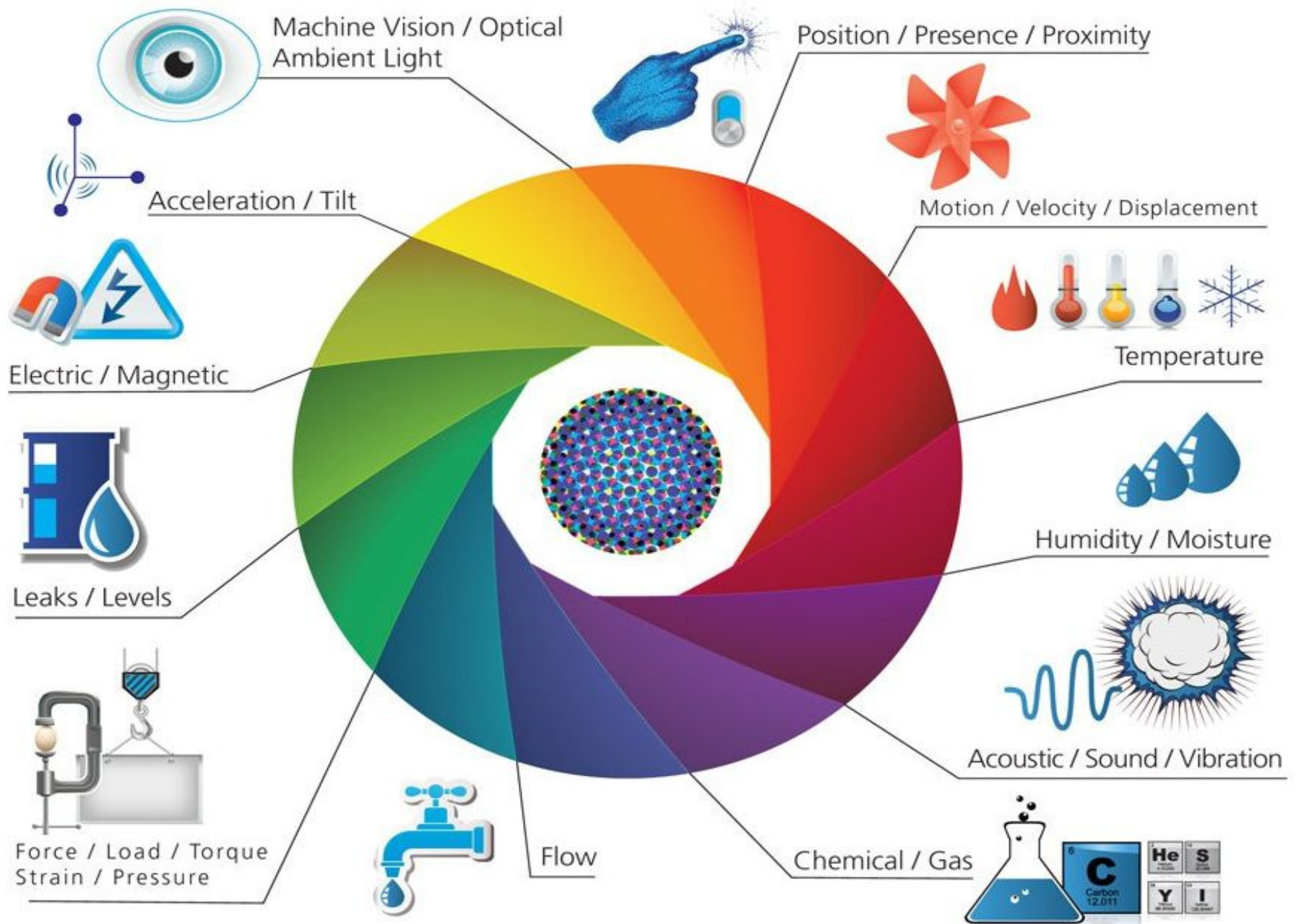
Jim Zuber, CTO, QualityLogic, Inc.

Topics

- IoT Big Picture - Jim
- OpenADR and IoT Intersect – Michel
- OpenADR Enabling Samsung's SmartThings Hub – Jim
- Questions

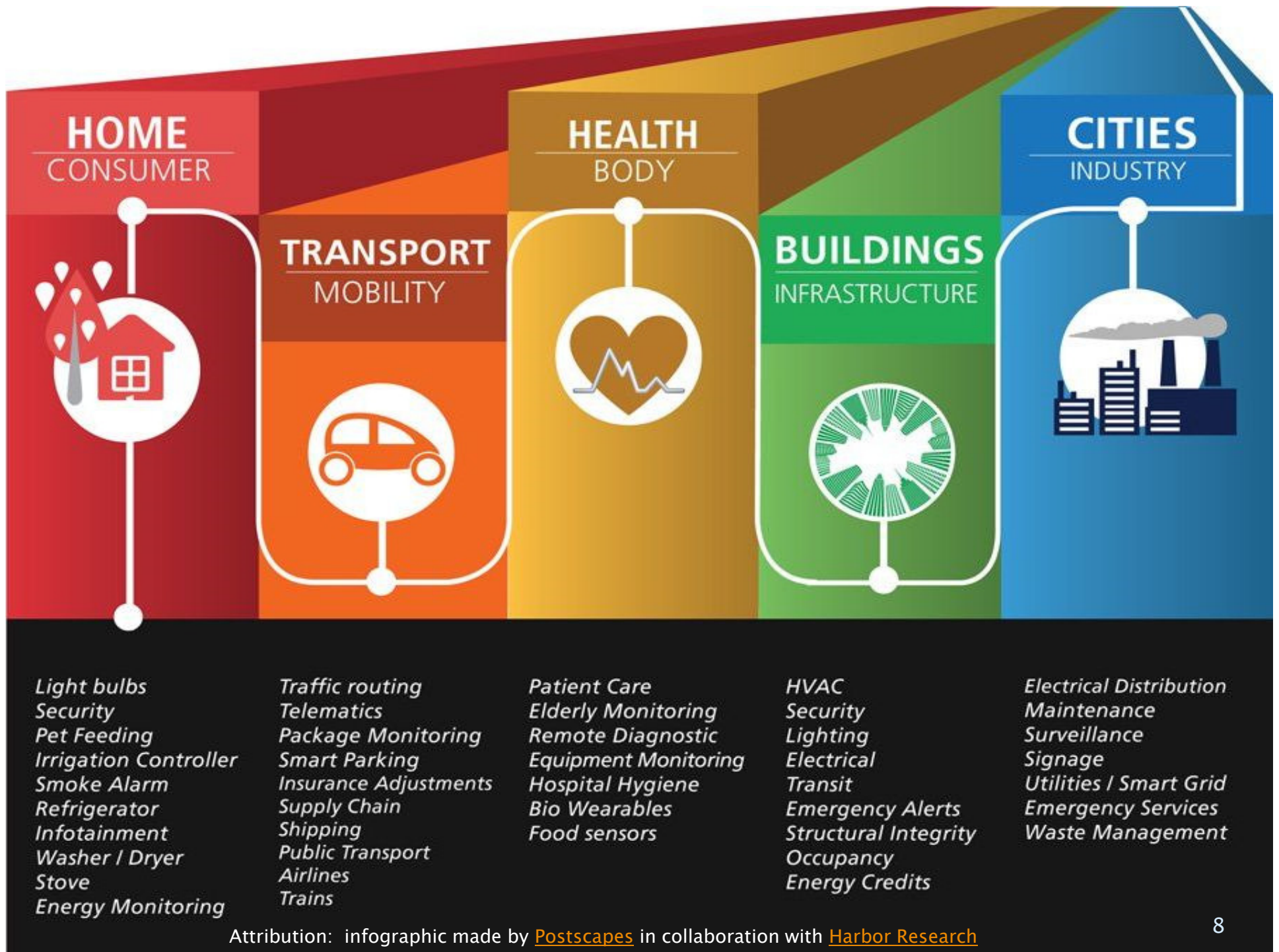
Internet of Things Defined

- **Sensors** and **actuators** embedded in physical objects linked through wired and wireless networks
- Sensors are aware of the environment and communicate changes in the state of the environment
 - Sensing movement in a room
 - More abstractly, sensing a change in the price of electricity
- Actuators translate changes in sensor state into mechanical motion
 - Locking of a door
 - More abstractly, the dimming of a light



Enabling Technologies

- The availability of
 - Small inexpensive sensors and microcontrollers
 - Pervasive wired and wireless connectivity (WiFi, ZigBee, Z-Wave, Bluetooth, etc.)
 - Hubs and gateways that bridge wireless protocols
 - Cloud computing
- ...has resulted in thousands of IoT products that can be...
 - Controlled
 - Monitored
 - Remotely configured
 - Interoperate with each other
 - Automated through simple rules engines

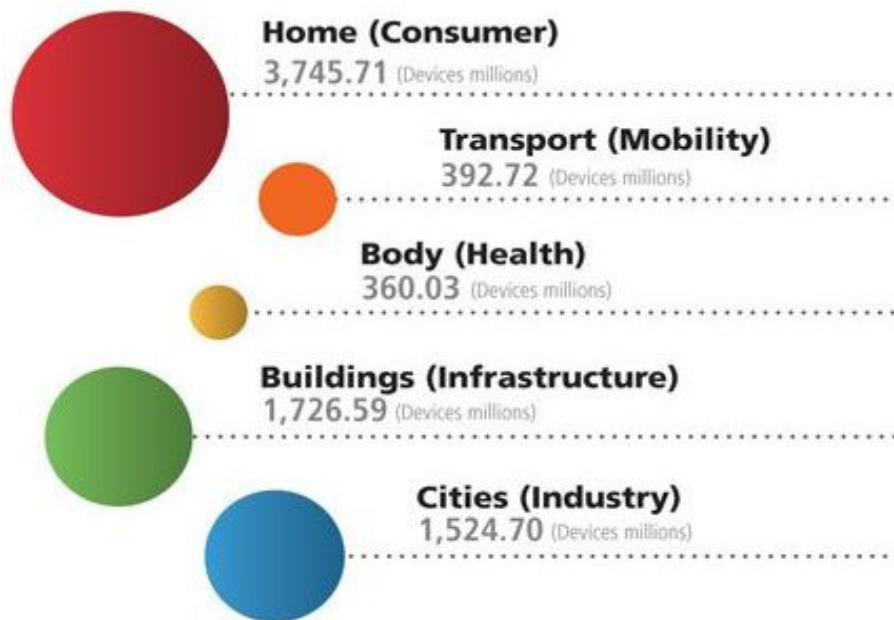


Attribution: infographic made by [Postscapes](#) in collaboration with [Harbor Research](#)

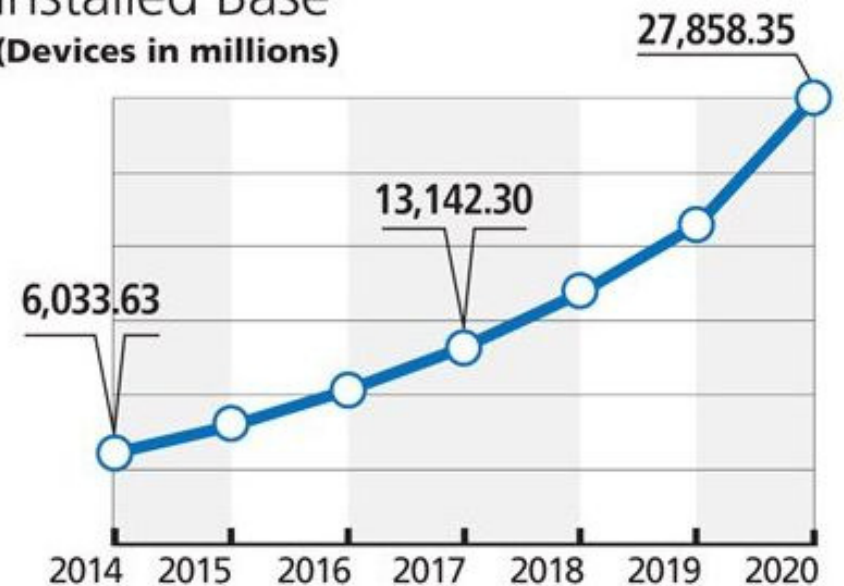
IoT Devices Installed Base Growth

8 billion devices for the year 2020

**Not including mobile phones*



Installed Base
(Devices in millions)



Demand Response and IoT

- Why is this exciting for the Demand Response (DR) space?
- Traditional DR model: utility/aggregator fund infrastructure to enable DR
- IoT DR opportunity:
 - Thousands of IoT products whose load profile can be remotely controlled
 - Consumers comfortable defining “rules” that control load behavior
 - Millions of devices that could participate in DR with no infrastructure investment
- Universal Devices is an early adopter in this intersect of DR and IoT, and Michel will now share his experience and perspective on this space.
- <Michel’s Presentation>



OpenADR and Internet of Things

An Overview

Presentation By:

Michel Kohanim

CEO

Universal Devices, Inc.



March , 2016

➤ IoT is Here

- Ubiquity of connected and off-the-shelf communicating devices

➤ DR Programs Target Large Loads

- No low cost and non-proprietary solution that extends DR and M&V to IoT

➤ Automating IoT Is Cool But Benefits Are Not Tangible

- Customers cannot reap the benefits of energy conservation programs and rebates
- How about those billions of IoT devices out there which can participate in DR programs but are left out?



➤ The Marriage!

- Why don't we marry IoT Automation with Energy Management?
- They are definitely compatible: Energy Management and Automation are pretty much two sides of the same coin
- But: the marriage would be short-lived without a common language!

➤ The Language: OpenADR

- Standards based and Device Agnostic (common)
- Communicates DR and Price events to the VENs
- Measurement and Verification reports sent to the VTNs

➤ The Rest is History!

- And they are still married ... but ...



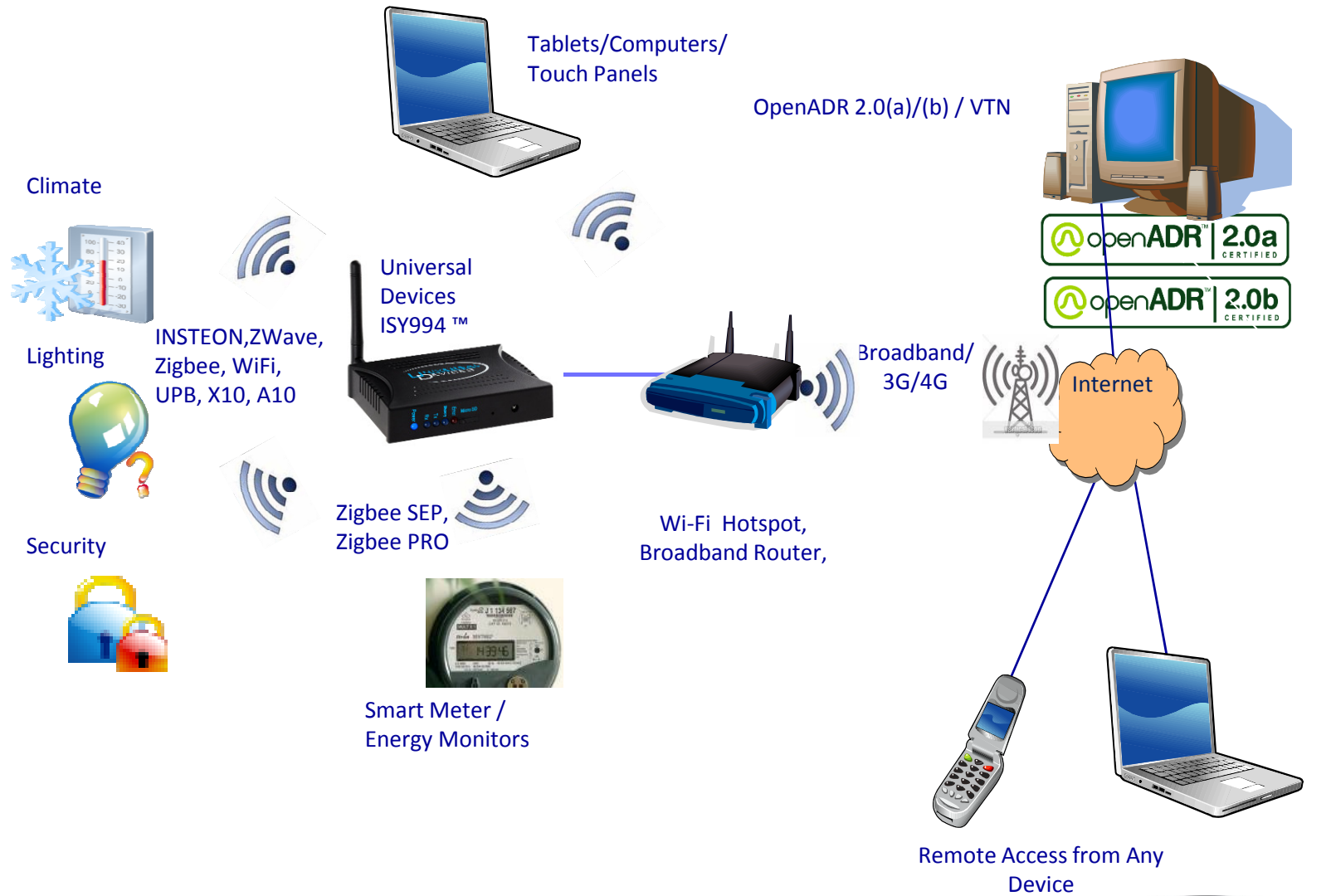
➤ Interoperability

- Currently ISY figures out device classes and capabilities based on some heuristics
- In the brave new world of IoT, device classes and capabilities must be automatically discoverable
- Many disjoint and competing IoT standards: IPSO, AllJoyn, OIC/UPnP, Lightweight M2M, Thread, etc.

➤ Cooperation

- OpenADR and IoT standards bodies must cooperate otherwise every minor change may cause major interoperability issues





SAMPLE - CONFIGURATION

ISY Dashboard
Online Mon 2016/03/21 02:41:11 PM

My Devices

Office Lamp

Office **Z-Wave Dimmer**

Off On Off

Table Lamp

Table **Z-Wave Load Controller**

Off On Off

ZW 004 Thermostat

74° 65° (H) 80° (C)

Down Up Mode

Z-Wave Thermostat

My Electricity

Status

EUID 0021ED0000062A5F Install Code 9ED74423C50F3582

Network Joined Securely | 84CA | 001D2301000085AB | 12

Time Synchronized

Summary

Inst. Demand **1.688 kW** Cost **\$ 0.244 / Hour**

Price Tier DDDDDDD \$ 0.144444 / kWh

Next Price Tier AAAAAAA \$ 0.111111 / kWh 2016/03/21 14:44:22 PM

Today 24.662 kWh \$ 2.880550

Yesterday 81.103 kWh \$ 4.928021

Month 785.673 kWh \$ 94.789215 Billing Cycle

All Time 13725.154 kWh Cycle Ends 2016/04/01 11:59:59 PM

Load Control

Status Start Time Criticality Duration

List All Opt In Opt Out

Messages

Status Start Time Priority Duration

Message

List All Confirm

My OpenADR

56730E43-AAE8-43A6-BA5E-CBEC1D9158F9 / 1

Status ✔ Completed Disposition Opted In

Current Value N/A Priority 1 Mod. # 0

Start Time 2016/03/18 8:10:00 AM End Time 2016/03/18 8:14:00 AM

Opt Out Details

OpenADR Settings

Profile 2.0 b

Server URL

User ID Password

OpenADR 2.0 Settings

VTN Interaction Mode Pull XML Signature

Evaluation Interval (sec) 5 Auto Registration

Push URL Base

VTN ID dev

VEN ID universal_ven1

Party ID

Resource ID

Group ID

Market Context

Registration ID b3eaccbd-f6b8-4bc4-b2c3-b50776a351e1

Normal Mode Settings Simple Mode Based Settings

Setpoint Offset ° 0 Duty Cycle % 100 Load Adj % 0

Moderate Mode Settings

Setpoint Offset ° 2 Duty Cycle % 50 Load Adj % 0

High Mode Settings

Setpoint Offset ° 4 Duty Cycle % 25 Load Adj % 0

My Weather

Snow 23.00° F

	Tue	Wed	Thu
	Hi 21.00°F	Hi 25.00°F	Hi 23.00°F
	Lo 18.00°F	Lo 16.00°F	Lo 5.00°F

Feels	16.00° F	Rain	0.00 inches
Hi	26.00° F	Wind	6 mph NNE
Lo	17.00° F	Gust	10 mph 0
Humidity	28.00 %	Dew Point	-5.00° F

SAMPLE – RULES

The screenshot shows the 'Administrative Console' interface. At the top, there is a menu bar with 'File', 'Z-Wave', 'Tools', and 'Help'. Below the menu bar is a toolbar with various icons. The main area displays the date and time 'Mon 03/21/2016 03:06:41 PM, [USA, CA, Los Angeles]' along with sunrise and sunset times: '06:55:36 AM [Sunrise]' and '07:06:08 PM [Sunset]'. The interface has tabs for 'Main', 'Programs', and 'Configuration'. Under 'Programs', there are sub-tabs for 'Summary', 'Details', and 'Variables'. A tree view on the left shows a hierarchy of programs: 'My Programs' (expanded) containing 'Irrigation', 'Normal Operations', 'Pending', 'Precool' (highlighted), 'Time Test', 'var', 'var stre', 'Denon', 'DRLC Optout', 'IR', and 'Stress'. The main pane displays the 'Program Content for 'Precool'' with the following logic:

```
Program Content for 'Precool'
If
  Module 'Climate' Temperature >= 95 °F
  And Module 'OpenADR' Mode is High
  And (
    Module 'OpenADR' Status is Pending Near
    Or Module 'OpenADR' Status is Pending Far
  )
  And On Mon, Tue, Wed, Thu, Fri
  From 12:00:00PM
  To Sunset - 1 hour and 15 minutes (same day)
Then
  Set 'ZW 004 Thermostat' 70° F (Heat Setpoint)
  Send Notification to 'michel@universal-devices.com' content 'pending'
  Wait 1 hour
  Run Program 'Normal Operations' (Then Path)
Else
  - No Actions - (To add one, press 'Action')
```



- **Smart Meter, Thermostats, and Load Controllers in Residential (2.0b)**
 - Off-the-shelf Z-Wave
 - Off-the-shelf INSTEON
 - Zigbee SEP 1.1
- **Thermostats in SMB (2.0b)**
 - Off-the-shelf Z-Wave and Zigbee
- **Thermostats in College Campus (2.0b)**
 - Off-the-shelf Zigbee
- **Load Controllers on RTUs (2.0a)**
 - Off-the-shelf Zigbee
- **DR + Measurement & Verification (2.0b)**
 - Off-the-shelf wired relays
 - EM3 Energy Monitor + Pulse counter



Thank you!

Contact Information

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Universal Devices, Inc.
michel@universal-devices.com
(818) 631 - 0333



➤ ISY994 Series

- A fully autonomous and low cost Automation and Energy Management system:
 - Utilizes off-the-shelf devices for command/control
 - Z-Wave, Zigbee, INSTEON, A10, X10 and Network
 - OpenADR 2.0a/2.0b Certified
 - Simple configuration for how devices respond to OpenADR Events
 - Opt Schedules automate when to Opt-in or Opt-out of OpenADR Events
 - Measurements are automatically sent to the VTN/DRAS utilizing OpenADR 2.0b Report Service
 - Not cloud based
 - Supports up to 1024 devices and therefore applicable to both residential as well as SMB



➤ ISY994zw ZS

- Ideal For SMB and Residential Venues
- Direct Communications with Smart Meters
 - SEP 1.1 Certified
 - PG&E, SCE, NVE, and Oncor Certified
 - Near real-time energy readings from the Smart Meter are automatically sent to the VTN using OpenADR 2.0b Report Service
- Z-Wave Support
 - Support for any off-the-shelf Z-Wave device, including – but not limited to – thermostats and heavy duty load controllers
 - Energy readings from Z-Wave devices that report energy information is automatically sent to the VTN
 - Our OEM Z-Wave thermostats show OpenADR Events on their displays



➤ ISY994R ZS

- Ideal for Venues with Existing Building Management Systems
- Direct Communications with Smart Meters
 - SEP 1.1 Certified
 - PG&E, SCE, NVE, and Oncor Certified
 - Near real-time energy readings from the Smart Meter are automatically sent to the VTN using OpenADR 2.0b Report Service
- Relays
 - Two relays to send signals to building management systems



➤ EM3 Series

- Ideal for Venues without Smart Meters
- A fully autonomous and low cost Energy Monitoring and Relay Control System
 - OpenADR 2.0a/2.0b Certified
 - Energy Monitor – 3 Phase / Billing grade
 - Up to 480 volts balanced
 - 5 Channels of energy monitoring
 - 2 Temperature sensors
 - 2 Pulse counters or 1 KZY Simple configuration
 - Up to 16GB of storage
 - 4 x Relays
 - Communicate with Building Management Systems or
 - Turn on/off devices directly
 - Opt Schedules automate when to Opt-in or Opt-out of OpenADR Events
 - Measurements, for all channels – and including Pulse Counts – are automatically sent to the VTN/DRAS utilizing OpenADR 2.0b Report Service
 - Not cloud based



➤ EM3 ZW

- Ideal for Venues without Smart Meters and Building Management Systems (SMB)
- Extends EM3 with Z-Wave Capabilities
 - Support for any off-the-shelf Z-Wave device, including – but not limited to – thermostats and heavy duty load controllers
 - Energy readings from Z-Wave devices that report energy information is automatically sent to the VTN
 - Our OEM Z-Wave thermostats show OpenADR Events on their displays



➤ EM3 ZB

- Ideal for Larger Venues without Smart Meters and Building Management Systems such as SMB and Rooftops
- Extends EM3 with Zigbee Capabilities
 - Support for our OEM Zigbee Thermostats and Heavy Duty Load Controllers
 - Our OEM Z-Wave thermostats show OpenADR Events on their displays



➤ Hardware

- Freescale CPU
- 2MB Flash/8MB RAM
- Up to 16GB SD Card storage
- 10/100 Ethernet
- Real Time Clock on board
- 2 Serial Ports
- 4 digital I/O

➤ Firmware

- HTTP
- HTTPS
 - Up to TLS 1.2
 - Client Authentication/Digital Certificates
- Open ADR, SEP, Flex Your Power
- Abstraction layer for support of other devices/protocols



➤ EM3™

- 3 Phase Energy Monitor
 - Automatic configuration
 - Up to 480 volts balanced
 - 5 Channels of energy monitoring
 - 2 Temperature sensors
 - 2 Pulse counters or 1 KZY
 - Zigbee communications to ISY

➤ EM3-RTU™

- 3 Phase Energy Monitor and RTU Diagnostics (SMDS)
 - Same features as EM3
 - Up to 16GB data storage
 - Real time clock on board
 - Network accessible



OpenADR Enabling SmartThings Hub

- Determine if the popular SmartThings home control system can be leveraged to support DR
 - Kickstart funded company acquired by Samsung for \$200M in 2014
 - SmartThings technology to be leveraged across Samsung electronic/appliance offerings
 - Data point – SmartThings mobile App downloads 300K +



SmartThings Architecture

- Devices – Actuators and sensors over ZigBee, Z-Wave
- Hub - Connects IoT devices through “Device Handlers” to the SmartThing’s cloud infrastructure
- SmartApps – Define rules, reside in the cloud (mostly)
- SmartThings Mobile App...
 - “Pair” IoT devices to Hub
 - Define SmartApp rules
 - UI to manually control and monitor devices
- Development Portal – Create, debug, and test SmartApps and Device Handlers

Technical Approach

- Approach...
 - Write a OpenADR A profile VEN as SmartThings “device handler”
 - Receipt of an OpenADR signal would appear as a sensor state change
 - Use “Rules Engine” SmartApp to define behaviors for normal, moderate, high, and special load shed upon receipt of state change
- Challenges...
 - Extremely constrained programming environment
 - Very limited execution environment (40 second limit)
 - Slightly unstable environment (Polling from Cloud)
 - Arduino fallback – ZigBee ping

SmartThings Project



SmartThings Project

Welcome back, [jimzuber@gmail.com](#)

[Locations](#) [Hubs](#) [Devices](#) [SmartApps](#) [Device Handlers](#) [Public](#)

[Live Logging](#) [Documentation](#)

VEN Device Handler

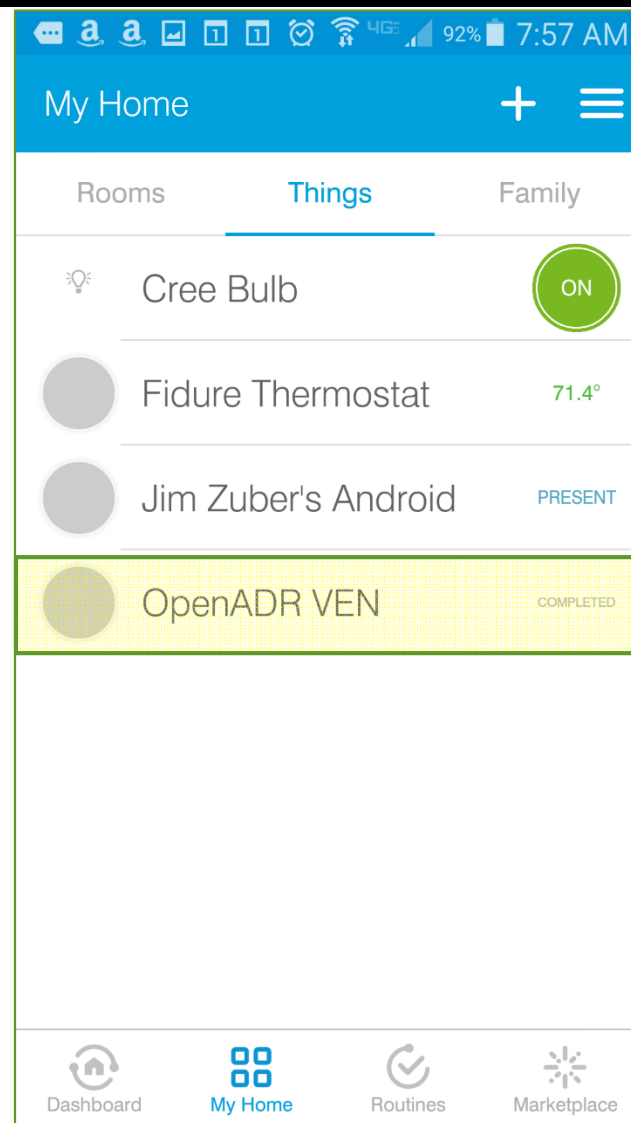
[Save](#) [Publish](#) [IDE Settings](#) [Device Type Settings](#) [Simulator](#) ◀

```
98 // VEN Configuration Settings
99 // Note will match any marketContext
100 // Note that S_vtnURI, S_venID, S_vtnID, S_pollInterval are set in phone GUI
101 //*****
102
103 @Field def S_normalIntervalValue = ["0", "0.0"] //must be 0,1,2,3
104 @Field def S_normalAttribute = "door"
105 @Field def S_normalAttributeValue = "closed"
106
107 @Field def S_moderateIntervalValue = ["1", "1.0"] //must be 0,1,2,3
108 @Field def S_moderateAttribute = "door"
109 @Field def S_moderateAttributeValue = "open"
110
111 @Field def S_highIntervalValue = ["2", "2.0"] //must be 0,1,2,3
112 @Field def S_highAttribute = "door"
113 @Field def S_highAttributeValue = "opening"
114
115 @Field def S_specialIntervalValue = ["3", "3.0"] //must be 0,1,2,3
116 @Field def S_specialAttribute = "door"
117 @Field def S_specialAttributeValue = "closing"
118
119
120 //*****
121 // oadrPoll() - Get Events
```

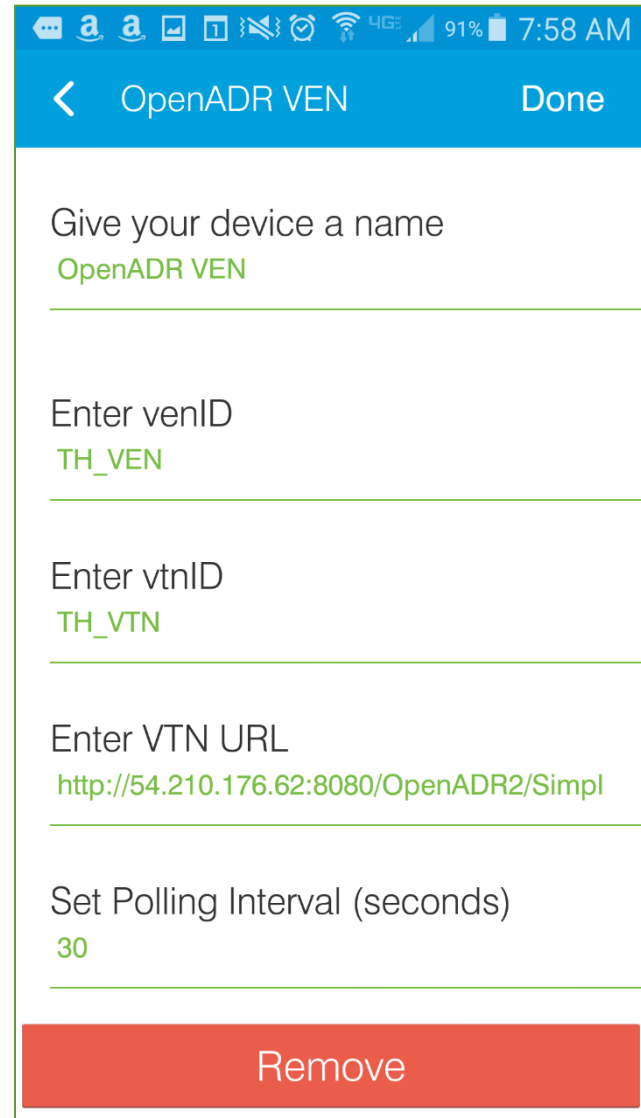
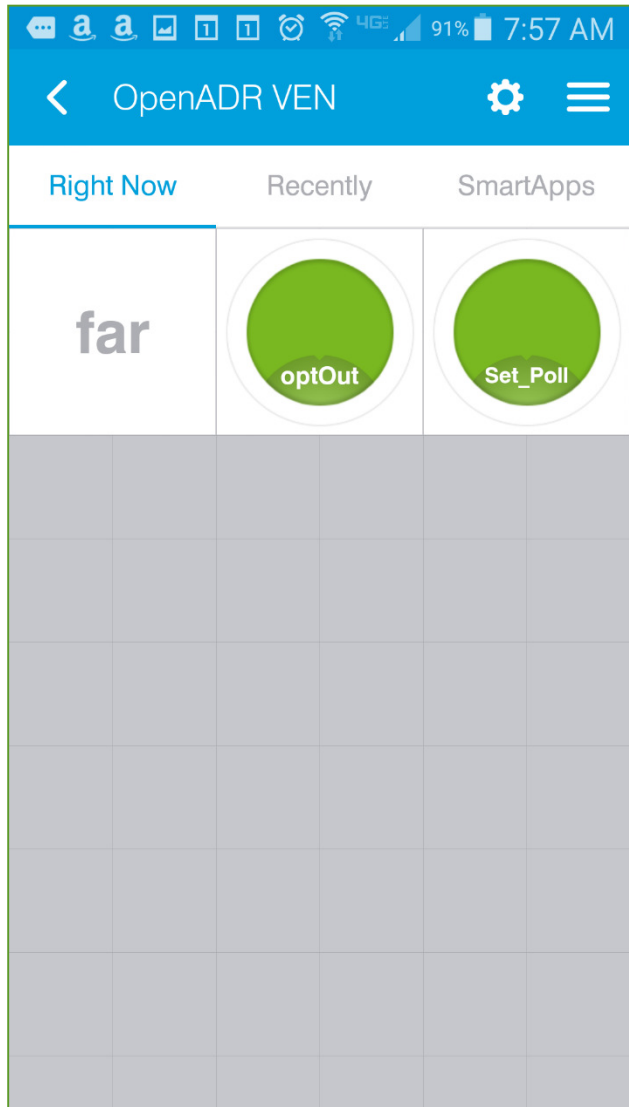

SmartThings Project

Jim Zuber's Android	Mobile Presence	OpenADR			f18ac6c51839f6faa28b1e2a0e
Jim Zuber's Android	Mobile Presence	Home			784e1a91862a84bc521034a7c
Lock	Z-Wave Lock	Home	Zuber House Hub		05
Nest Thermostat	Nest2 Thermo	Home			123432
OpenADR VEN	VEN Device Handler	OpenADR	OpenADR Hub	D052A8000A970007	BCA9
Pat Presence	Arrival Sensor	Home	Zuber House Hub	D052A80046540005	B103
Porch Light	Hue Bulb	Home	Zuber House Hub		849c5f10-f3aa-4988-a3b4-25d52017b628/2

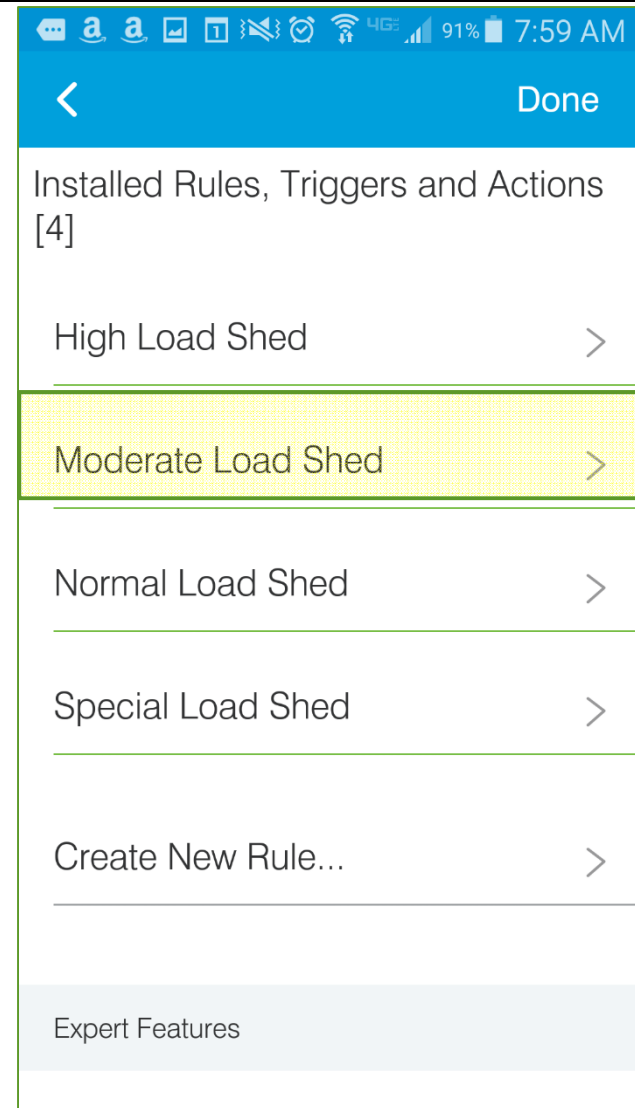
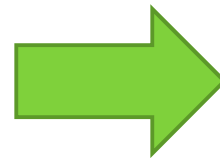
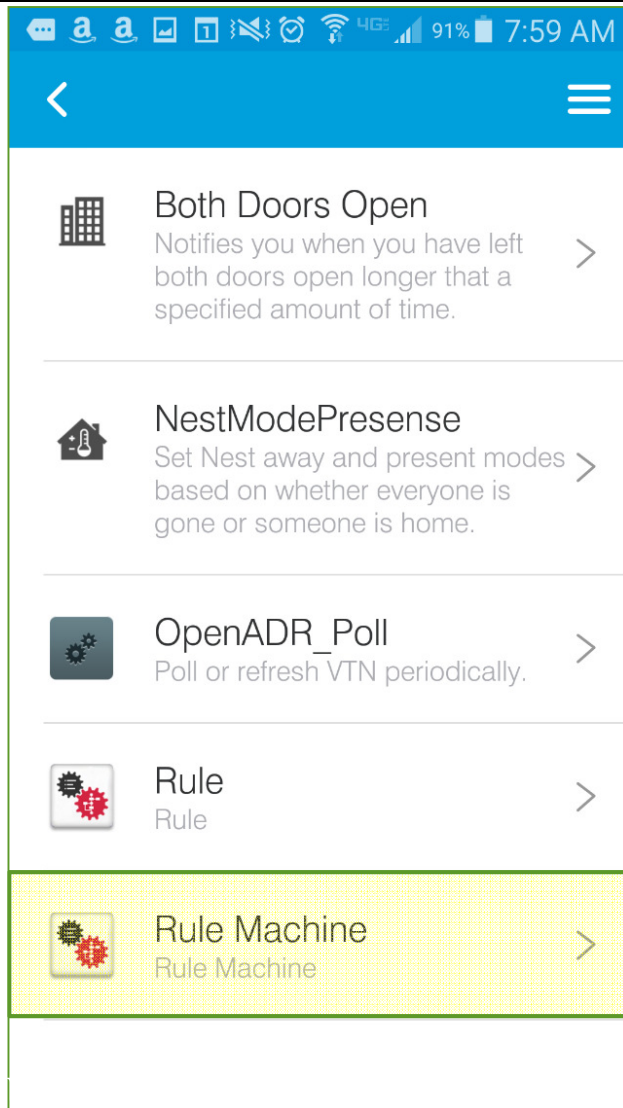
SmartThings Project



SmartThings Project



SmartThings Project



SmartThings Project

The screenshot shows a mobile application interface for configuring a SmartThings rule. At the top, there is a status bar with various icons and the time 7:59 AM. Below that is a blue header bar with a back arrow, the text 'Moderate Load Shed', and a 'Done' button. The main content area is divided into several sections:

- Name the Rule:** The rule is named 'Moderate Load Shed'.
- Select Conditions:** A yellow highlighted box contains the text 'Select Conditions' and 'OpenADR VEN open [FALSE]' with a right-pointing arrow.
- Define Rule:** This section shows the rule definition: 'OpenADR VEN open [FALSE]' with a right-pointing arrow.
- Select Actions for True:** A yellow highlighted box contains the text 'Select Actions for True' and a list of actions: 'Dim: Cree Bulb: 40', 'Fidure Thermostat: Mode: heat', and 'Heat to 68' with a right-pointing arrow.
- Select Actions for False:** This section is currently empty.

SmartThings Project

Menu

[Accounts](#)

[VENs](#)

[Events](#)

[Schedules](#)

[Admin](#)

[Dashboard](#)



Resources

[Getting Started Video](#)

[Cloud Admin/Forum](#)

[VTN User's Guide](#)

[Premium Support](#)

[OpenADR Training](#)

Event Details

Start Time

2016-03-21 15:56:08 UTC

Duration (minutes)

2

Market Context ID

http://MarketContext1 ▼

Priority

0

Response Required

always ▼

VTN Comment

Test Event

false

Event Signal and Interval

Signal Name

simple ▼

Signal Type

level ▼

Payload Value

2

[Create Event](#)

All

OpenADR VEN

Fidure Thermostat

Bedroom Remote

Zuber Burger Alarm

Logs

Clear

```

2651c99c-bd92-459a-8689-5f66ff840f3f 7:33:21 AM: debug OADR: Received oadrResponse
2651c99c-bd92-459a-8689-5f66ff840f3f 7:33:21 AM: debug OADR: Sending oadrCreatedEvent: optIn, 200 (payload), 200 (event)
2651c99c-bd92-459a-8689-5f66ff840f3f 7:33:21 AM: debug OADR: *** Unmodified far event in payload
2651c99c-bd92-459a-8689-5f66ff840f3f 7:33:20 AM: debug OADR: Received oadrDistributeEvent
2651c99c-bd92-459a-8689-5f66ff840f3f 7:33:20 AM: debug OADR: Sending oadrRequestEvent
2651c99c-bd92-459a-8689-5f66ff840f3f 7:33:20 AM: debug *****
2651c99c-bd92-459a-8689-5f66ff840f3f 7:32:52 AM: debug OADR: Received oadrResponse
2651c99c-bd92-459a-8689-5f66ff840f3f 7:32:52 AM: debug OADR: Sending oadrCreatedEvent: optIn, 200 (payload), 200 (event)
2651c99c-bd92-459a-8689-5f66ff840f3f 7:32:52 AM: debug OADR: ++ oadrResponseRequired: always
2651c99c-bd92-459a-8689-5f66ff840f3f 7:32:52 AM: debug OADR: ++ interval 1 value: 2.0
2651c99c-bd92-459a-8689-5f66ff840f3f 7:32:52 AM: debug OADR: ++ interval 1 duration PT2M
2651c99c-bd92-459a-8689-5f66ff840f3f 7:32:52 AM: debug OADR: ++ overall duration PT2M
2651c99c-bd92-459a-8689-5f66ff840f3f 7:32:52 AM: debug OADR: ++ dtstart 2016-03-21T14:33:38Z
2651c99c-bd92-459a-8689-5f66ff840f3f 7:32:52 AM: debug OADR: ++ eventStatus far
2651c99c-bd92-459a-8689-5f66ff840f3f 7:32:52 AM: debug OADR: ++ modificationNumber 0
2651c99c-bd92-459a-8689-5f66ff840f3f 7:32:52 AM: debug OADR: ++ eventID Event032116_073238_234_0
2651c99c-bd92-459a-8689-5f66ff840f3f 7:32:52 AM: debug OADR: ++ requestID OadrDisReq032116_073238_234
2651c99c-bd92-459a-8689-5f66ff840f3f 7:32:51 AM: debug OADR: *** New far event in payload
2651c99c-bd92-459a-8689-5f66ff840f3f 7:32:51 AM: debug OADR: Received oadrDistributeEvent
2651c99c-bd92-459a-8689-5f66ff840f3f 7:32:49 AM: debug OADR: Sending oadrRequestEvent
2651c99c-bd92-459a-8689-5f66ff840f3f 7:32:49 AM: debug *****

```

SmartThings Project

- SmartThing's VEN polls VTN
- VEN receives event
- Sensor event sent to cloud when event goes active
- Rules evaluated, actuator commands sent to Hub
- Hub commands devices to change behavior (lower temp, dim bulb)



Take Away from SmartThings Effort

- Technically, it was not difficult to DR enable SmartThings
- Unclear if secure OpenADR communication could be implemented in the SmartThings infrastructure
- Consumers need to be willing to tinker to get home automation to work
- Emerging technologies from OIC and Alljoyn will...
 - Simplify discovering IoT devices
 - Help standardize IoT device type profiles
 - More transparently bridge across incompatible wireless protocols
- Fruitful area for DR Program pilots

SmartThings VEN Download

- QualityLogic plans to make the SmartThings code available as open source
- VEN limitations...
 - Not certified, HTTP Pull only
 - One event limit in payload, max 3 intervals in event
 - No randomization support, accepts any marketContext
 - Targeting limited to venID
 - Very limited testing!!
- Contact me if you would like to receive a download link for the source code

Jim Zuber, CTO
QualityLogic, Inc.
jimzuber@QualityLogic.com

Contact

Contact Info...

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Q&A

- Recording and slides from this presentation will be available at www.openadr.org.
- The OpenADR Webinar Series will continue throughout 2016. More information on future webinar topics can be found on www.openadr.org.

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Thank You!

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