Prototyping IOT Solutions

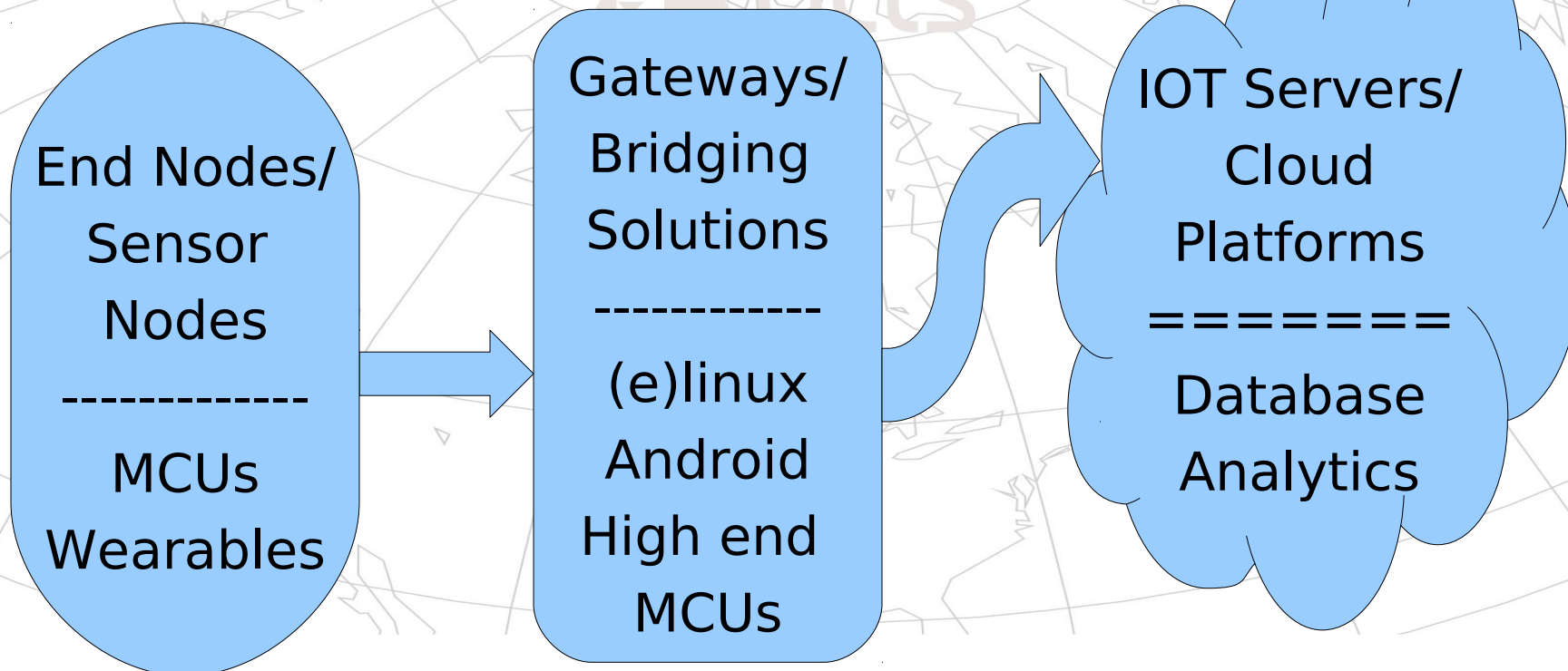*By*

Rohit Khanna and Rajesh Sola

CDAC ACTS,Pune

Outline

- Introduction to IOT, Architecture, Applications

- Introduction to NodeRED

- IOT Protocols – MQTT, CoAP, HTTP, Websockets

- Sensor Management – Embedded Linux, Firmata

- Cloud platforms,Data visualization

- Bridging Wired,Wireless networks

- Nodes for Social Media Access, SMS Alerts

IOT Architecture

- A Typical IOT Architecture
- Things in IOT – End Nodes,Gateways, Servers
- IOT Applications

End Nodes/
Sensor
Nodes

MCUs
Wearables

Gateways/
Bridging
Solutions

(e)linux
Android
High end
MCUs

IOT Servers/
Cloud
Platforms
========
Database
Analytics

Getting Started

- Introduction

- Supported targets, Installation

- Available nodes, configuration

- Creation of simple flows,sub flows

- Importing and exporting flows

- Installing additional nodes

Introduction to NodeRED

- Node based visual tool for wiring system components and network services

- Nodes built on Node.js

- Initiated by IBM, community product now

- Flow editor compatible with simple browsers

- Suitable for quick prototyping, learning/teaching with zero or minimal programming efforts

Supported Targets

- Any node.js supported platform, preferably Linux
- Embedded linux targets
  - Raspberry Pi
  - BeagleBoneBlack
  - Intel Edison
- Thingbox comes with pre installed NodeRED and custom nodes for Raspberry Pi (thethingbox.io)
- Microcontrollers with firmata,

  eg:- Arduino,Particle.io Photon (formerly spark.io)

Installation

- Install nodejs from package manager or set path for nodejs binaries

- npm install node-red -g

- Launch "node-red" from command line, Alternatively node.js process manager can be used

  npm install pm2 -g

  pm2 start <path-of-nodered>

- Can get a cloud instance from fred.sensetecnic.com

- Can get a 30 day trial instance from ibm bluemix

Available Nodes, Categories

- Input/Output Nodes
  - tcp,udp,http,serial,inject,debug,notify etc.

- Functions
  - delay,switch,change,trigger,json,xml etc.

- Social Media Access
  - twitter, mail, irc, twilio,xmpp,hangouts etc.

- Storage /Database connectivity
  - file access,mongo db,mysql, postgresql,influxdb etc.

- Configuration Nodes
  - serial port, mqtt, twitter etc.

Some more nodes

- Advanced
  - watch, rss feed, exec
- Nodes available through addons
  - Raspberry Pi,Beagle Bone specific
  - Sensor/Peripheral board specific nodes
  - Cloud Service related, eg:- IBM Bluemix,Sensetecnic Wotkit
- More addons are listed at http://flows.nodered.org/
- Most of them are available as npm packages or hosted at respective repositories

Some nodes of our interest

- Default
  - serial, tcp, udp
  - http, mqtt, websocket
- Few Addons
  - node-red-contrib-gpio,based on johnny-five I/O plugins
  - node-red-node-arduino
  - node-red-contrib-coap
  - node-red-contrib-noble

Flow Management

- Creation of simple flows

- Exporting, Importing flows

- Sub flows

- Flow library

- settings

Sensor Management

- NodeRED on targets like Raspberry Pi, rpi-gpio nodes

- Using firmata for targets like Arduino

- Peripheral management based on GPIO, ADC, I2C, SPI, UART etc.

- Nodes availble for Digital I/O
  - node-red-contrib-gpio (generic one using johnny-five IO plugins)
  - node-red-node-beaglebone
  - node-red-node-intel-gpio

IOT Protocols

- MQTT
- CoAP
- Websockets
- RESTful APIs

MQTT

- Initiated by IBM, OASIS standard now(v3.1.1)

- Light weight protocol based on publish-subscribe mechanism

- Implemented on top of TCP with minimum 2 byte header and support for packet size upto 256 MB

- Clients communicate via MQTT broker indirectly

- Mapping through hierarchical topic names

- QoS levels, LWT message, Keep alive timer

MQTT

- Brokers – mosquitto, HiveMQ
- Clients – mosquitto,eclipse paho,nodejs packages
- Android support – paho java library,sample app
- A simple demo

Publish/Subscribe
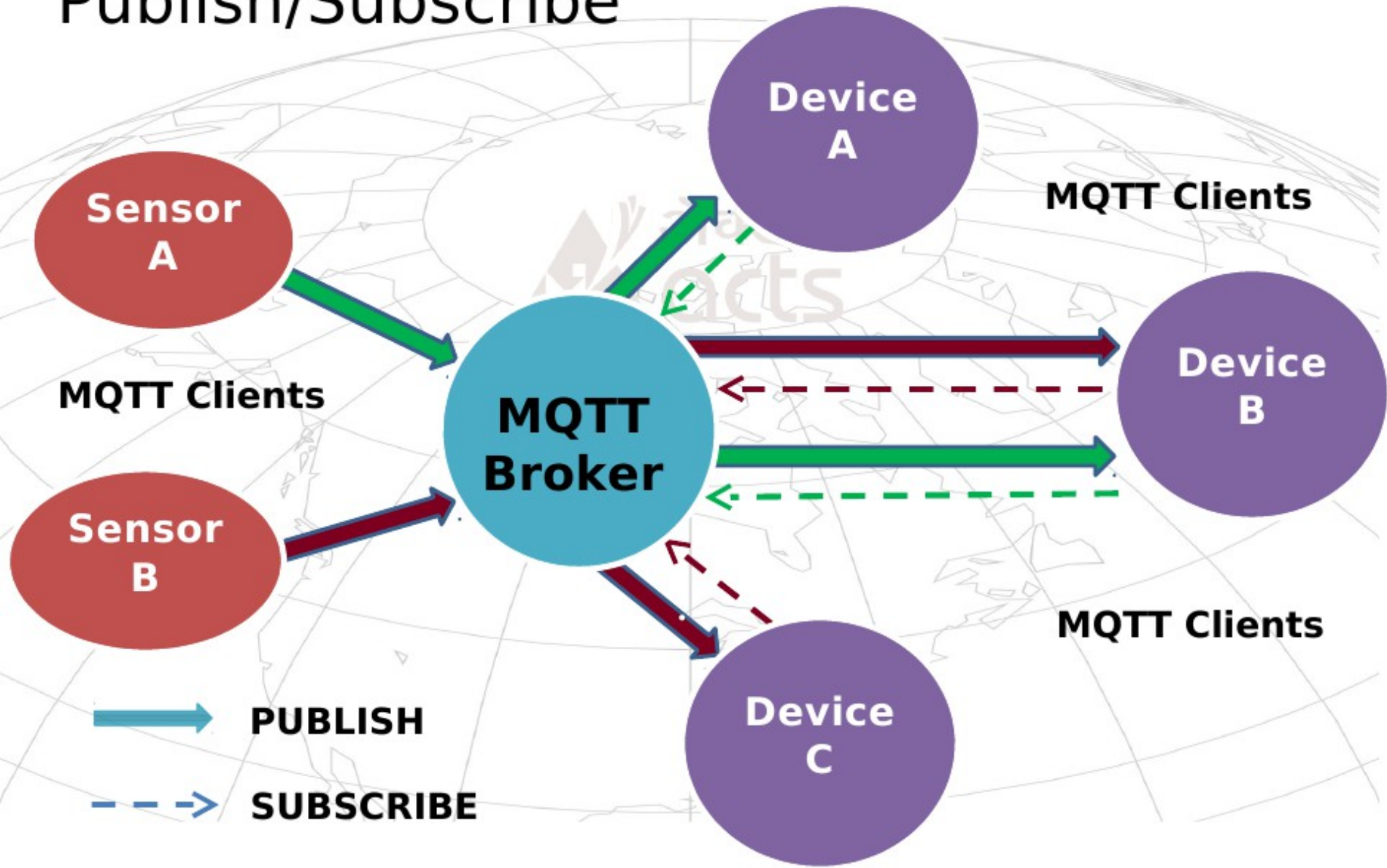
REST API

- Representational State Transfer, suitable for the needs of Sensor networks, IOT solutions

- Typical support from HTTP(but not limited to HTTP)

- RESTful methods – GET,POST, PUT, DELETE

- curl command, Firefox "poster" plugin for HTTP REST operations,

- Supported libraries – libcurl, Retrofit REST library

- A simple demo

CoAP

- Constrained Oriented Application Protocol based on RFC 7252

- Simple protocol based on UDP(default port:5683)

- Optional support over SMS

- HTTP like REST operations, additional support like observe method, blockwise transfer

- Server - Eclipse Californium, libcoap

- Client - Firefox copper plugin, libcoap, nodejs packages

- A simple demo

Websockets

- Full duplex communication using single TCP connection based on RFC 6455

- Browser support and HTML5 integration

- libwebsockets, nodejs packages

- Support from new versions of tomcat

- MQTT over websockets for browser based clients

- A simple echo server, NodeRED example

Bridging Protocols

- Interoperability among MQTT,CoAP, HTTP using nodejs package "ponte"

  npm install ponte -g

  npm install bunyan -g

  ponte -v | bunyan

- MQTT Topic name: hello   #port no.1883

- HTTP URL   : http://baseurl:3000/resources/hello

- CoAP URL   : coap://baseurl:5683/r/hello

- Example flow

IOT Cloud Platforms

- IBM Bluemix   - MQTT

- Thingspeak   - HTTP

- Carriots   - HTTP, MQTT

- Opensensors.io - MQTT

- Sensetecnic   - WOTKit

- thethings.io   - MQTT, CoAP, Websockets

- AWS IOT   - MQTT

Data Visualization

- Visualization support from cloud services
  - Bluemix
  - Sensetecnic wotkit
  - Thingspeak
- Node-red-contrib-graphs
- Plot.ly based on d3.js

Wired,Wireless Protocols

- WiFi/Ethernet – TCP/UDP

- NodeMCU,Particle.io Photon as Wifi sensor nodes

- Bluetooth Low Energy

  – Bluez stack, nodejs noble,bleno packages

- Serial Bus Communication : Serial In, Serial Out

- USB (node-red-contrib-usb)

- CANBus (node-red-contrib-canbus)

Contributing to NodeRED

- js file, html file for each node
- Packaging with a directory structure using json file for a set of nodes
- Naming conventions
  - node-red-node-???
  - node-red-contrib-???
- Contributing flows and nodes
  - Publishing to npm
  - Visibility in flows.nodered.org

Thank You

???