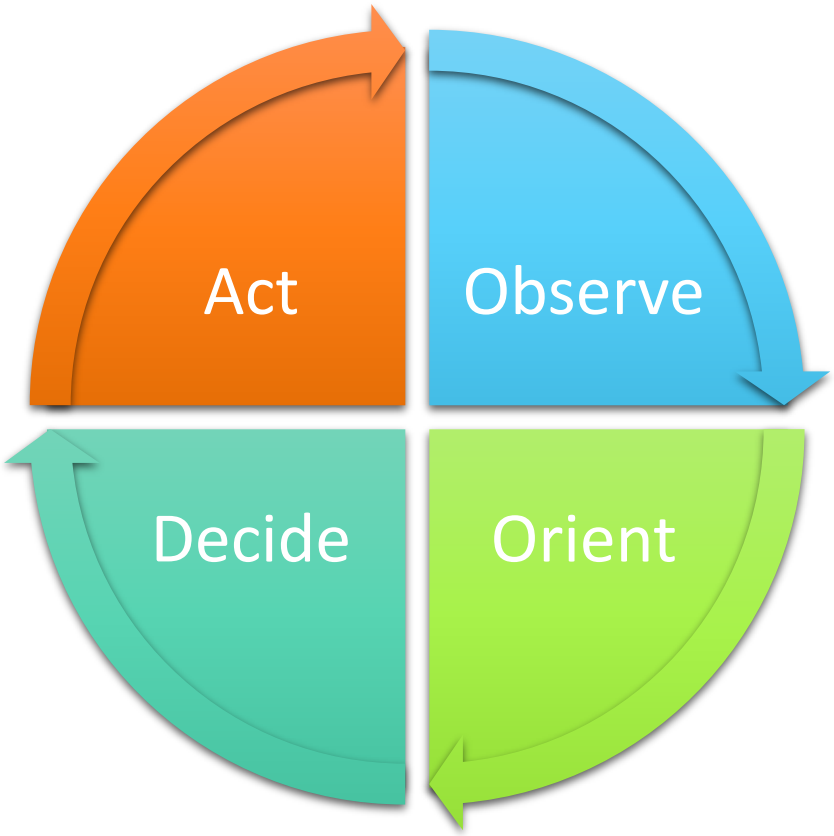
Opening Session

Day 1: 945AM

Yogesh Simmhan & Swami Manohar

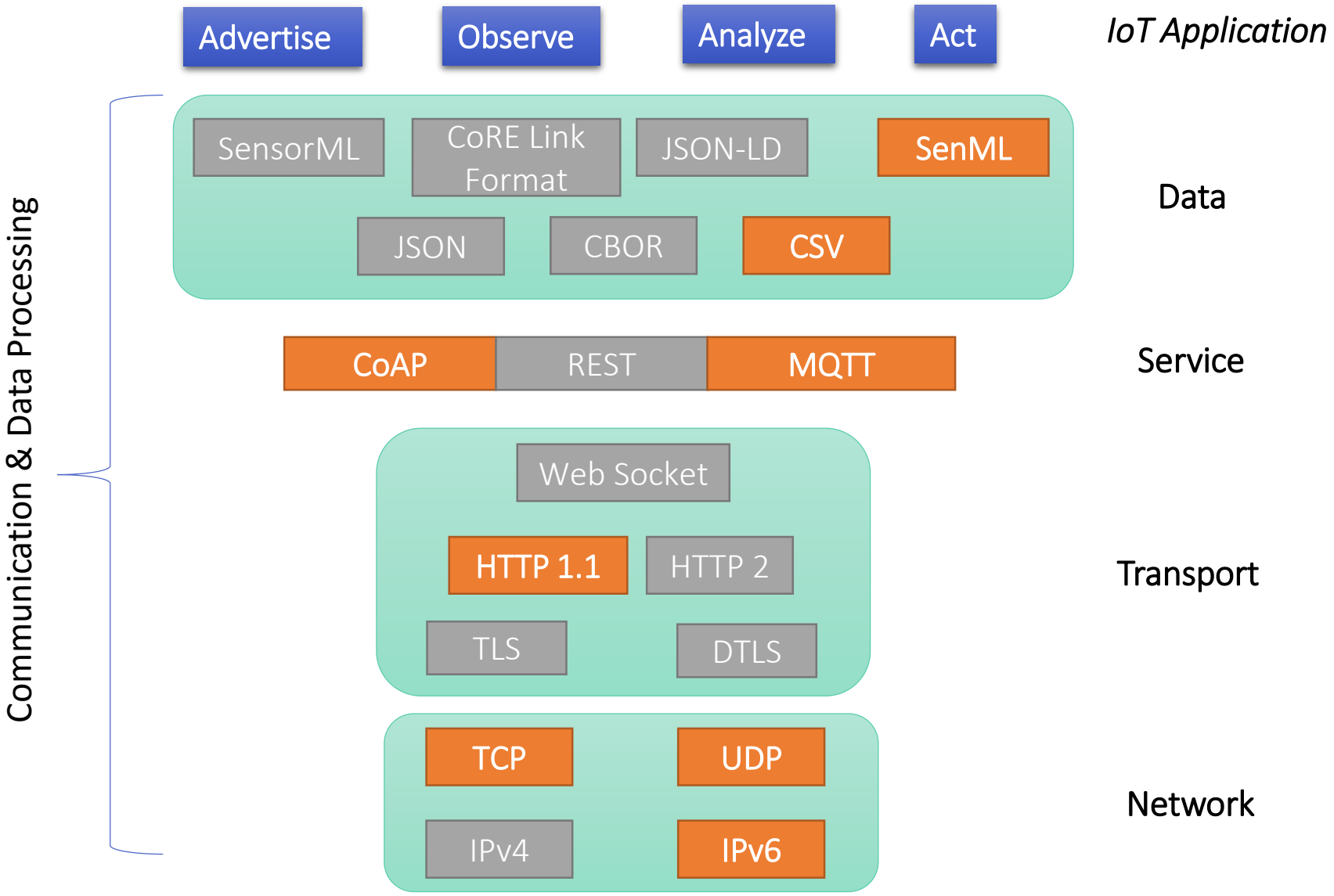
IoT Architectural View

IoT Functional View



- OODA loop at the heart of meaningful IoT applications

IoT Fabric

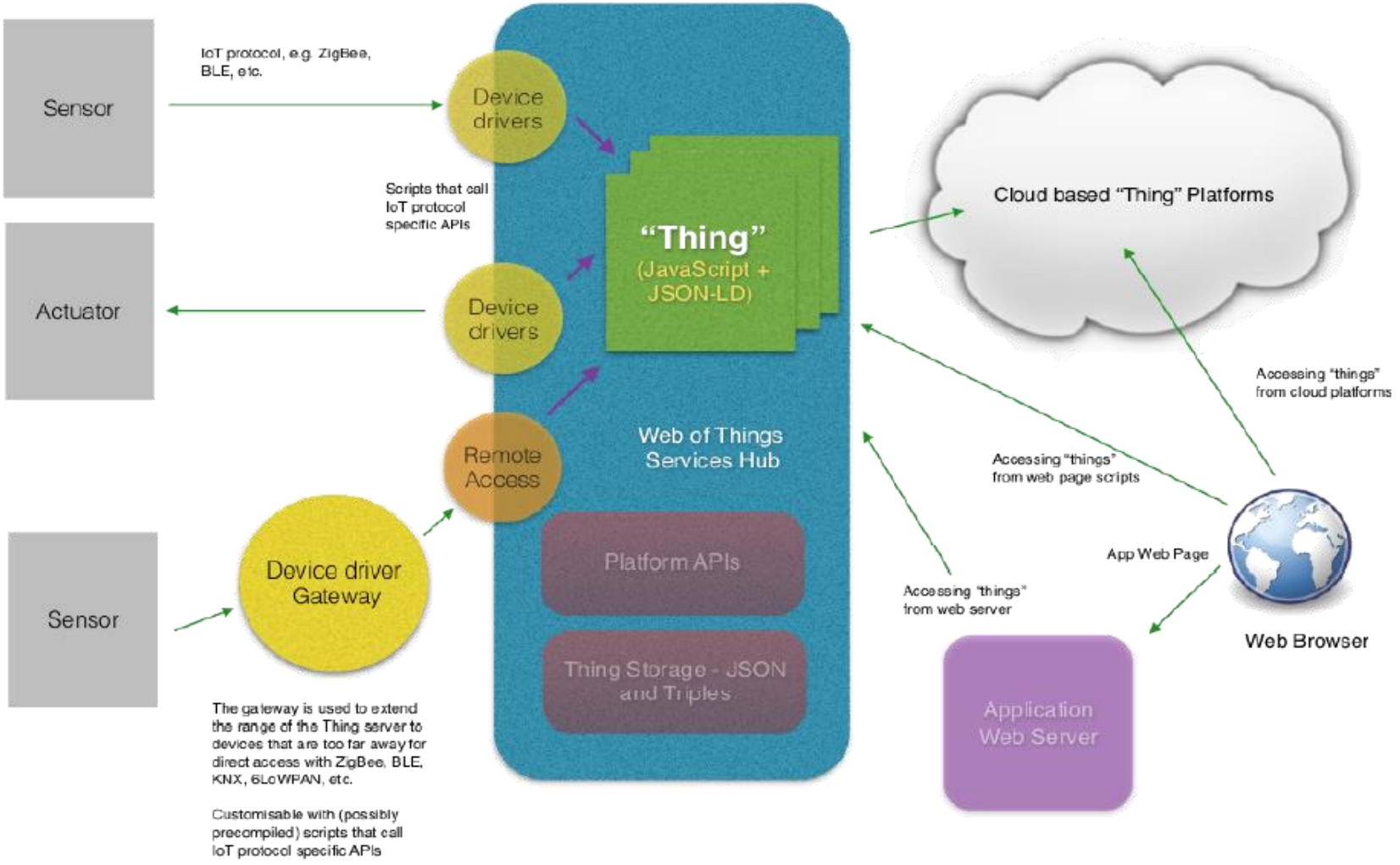

Advertise
Observe
Analyze
Act
IoT Application
Communication & Data Processing
SensorML
CoRE Link Format
JSON-LD
SenML
JSON
CBOR
CSV
Data
CoAP
REST
MQTT
Service
Web Socket
HTTP 1.1
HTTP 2
TLS
DTLS
Transport
TCP
UDP
IPv4
IPv6
Network

IoT Fabric

- IoT Fabric helps integrate these functions together, and maps them to the architecture
- Helps leverage infrastructure for multiple domains
  - Reusable platform as a service
  - Horizontal layers rather than vertical silos
- Spans physical and logical domains
  - Edge devices & Cloud
  - Public & private networks
  - Heterogeneous applications & analytics

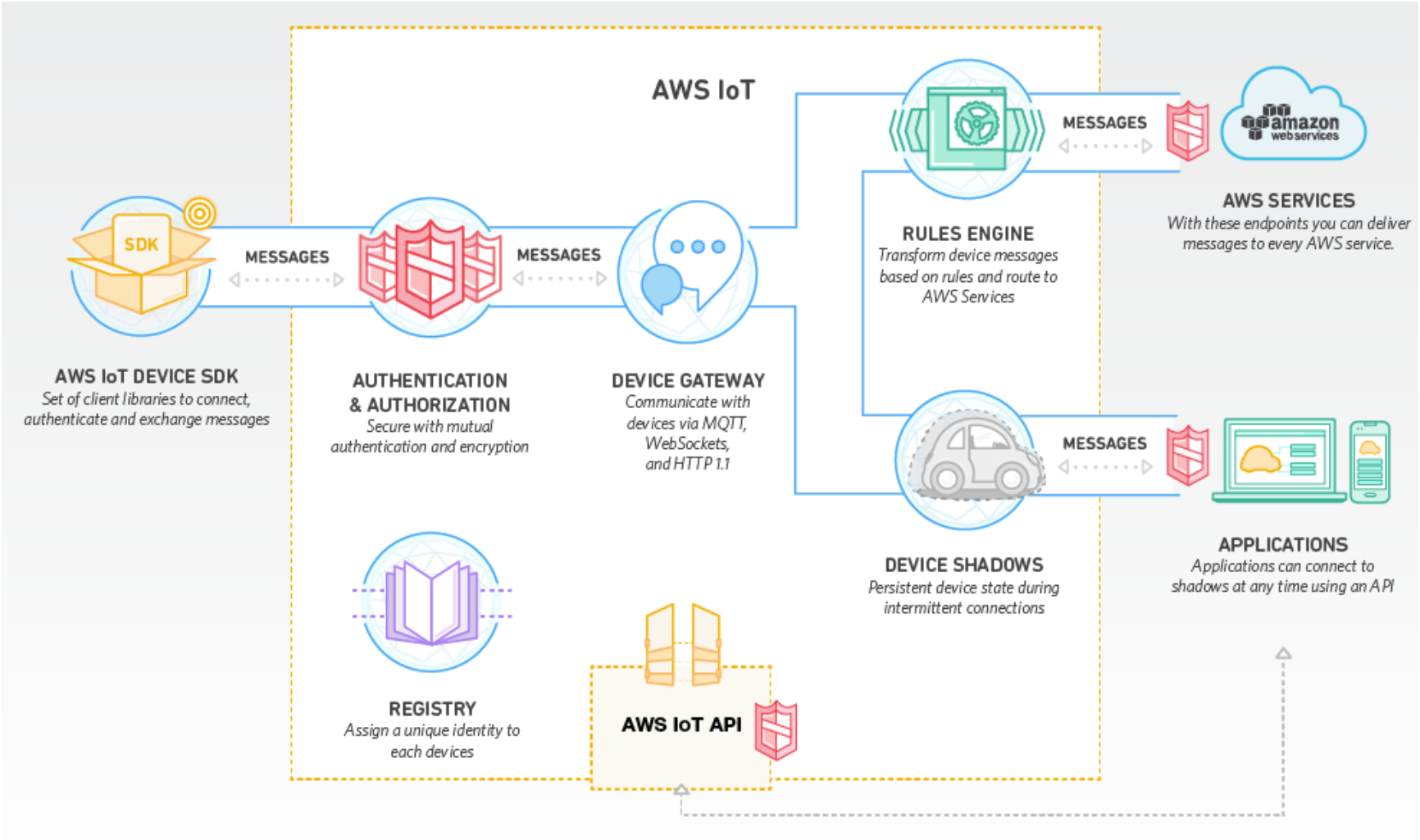
https://www.microsoft.com/en-in/server-cloud/internet-of-things/azure-iot-suite.aspx

W3C Web of Things Framework



Web of Things Framework, Dave Raggett, W3C, 2015

AWS IoT Platform



https://aws.amazon.com/iot/how-it-works/

IoT in Action

IISc Smart Campus Water Management Project

smartx.cds.iisc.ac.in

Objectives

1. *Can we use IoT & Big Data technologies to make campus infrastructure "smarter"?*
   - Efficient, reliable, safe, sustainable delivery & management of resources
   - Initial Case Study: **Water management**
2. *And in the process, understand technology for smart townships and improve on it?*
   - For the Indian context

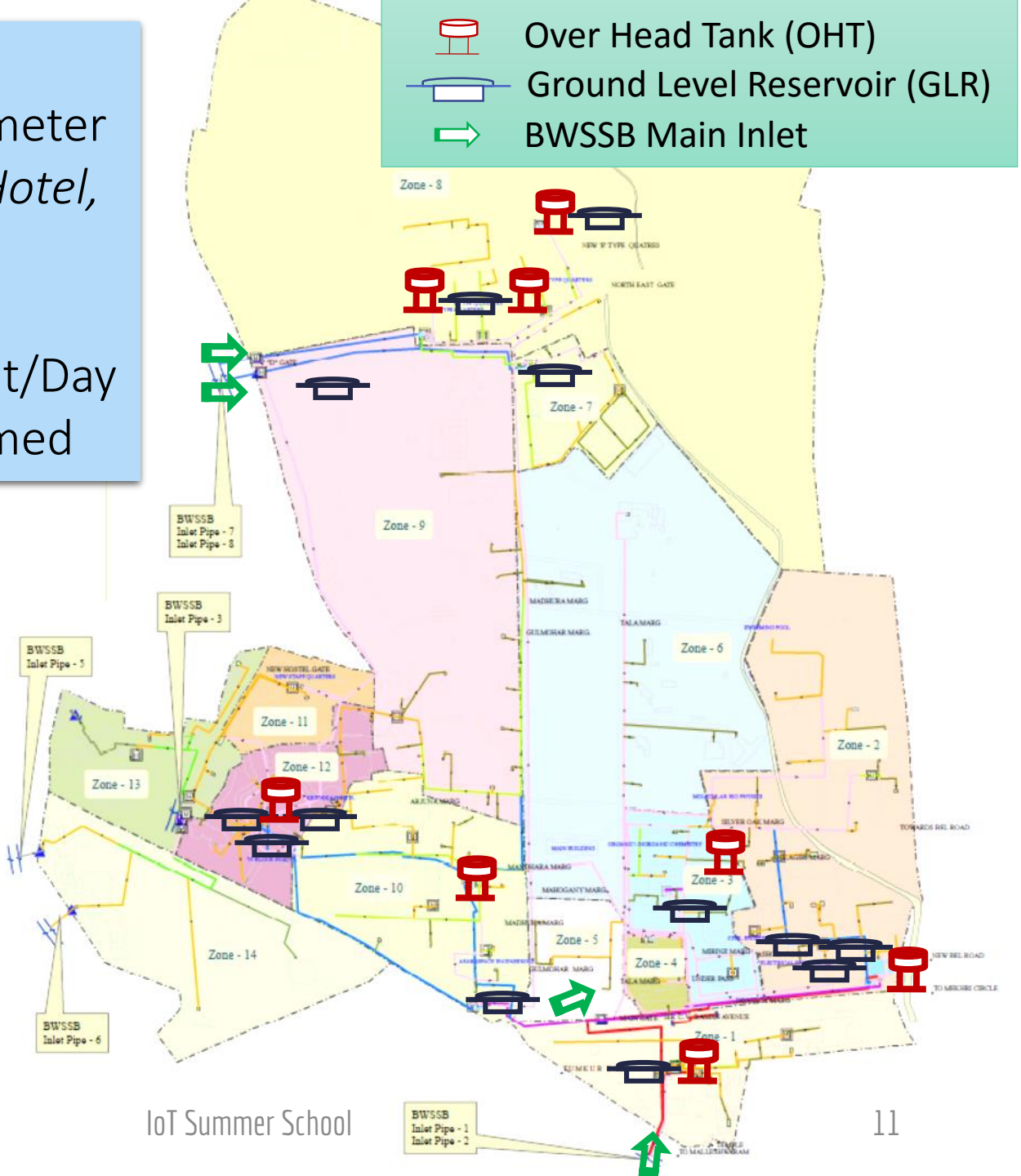
Smart Water Management

- Plan pumping operations for reliability
  - Avoid underflow/overflow of water
  - 12 hrs to fill a large OHT, scarcity in summer weeks
- Provide safer water
  - Leakages, contamination from decades old network
- Reduce water usage for sustainability
  - IISc average: **400 Lit/day**, Global standard: **135 Lit/day**
  - Lack of visibility on usage footprint, sources
  - Opportunities for water harvesting, recycling
- Lower the cost
  - Reduce cost for water use & electricity for pumping

IISc Campus

- 440 Acres, 8 Km Perimeter
- 50 buildings: *Office, Hotel, Residence, Stores*
- 10,000 people
- Water Use: 40 Lakh Lit/Day
- 10MW Power Consumed

OHT	8
GLR	13
Inlet	4+3



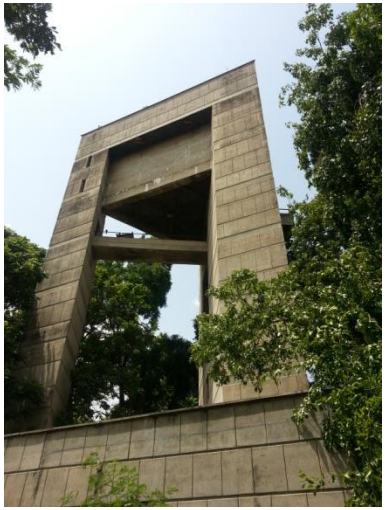
Over Head Tanks (OHT)

TPH (near Mechanical)

JNT Auditorium

Chemical Stores

Opposite to CENSE



Opposite to NESARA

Behind old C-Mess

Opposite to Cense (new)

E Type Quarters

Ground Level Reservoirs (GLR)


TPS 1


TPS 2


TPS 3


JNT Auditorium


Opposite to CENSE


Boys Hostel


Near C Mess


Near R Block


E Type Quaters

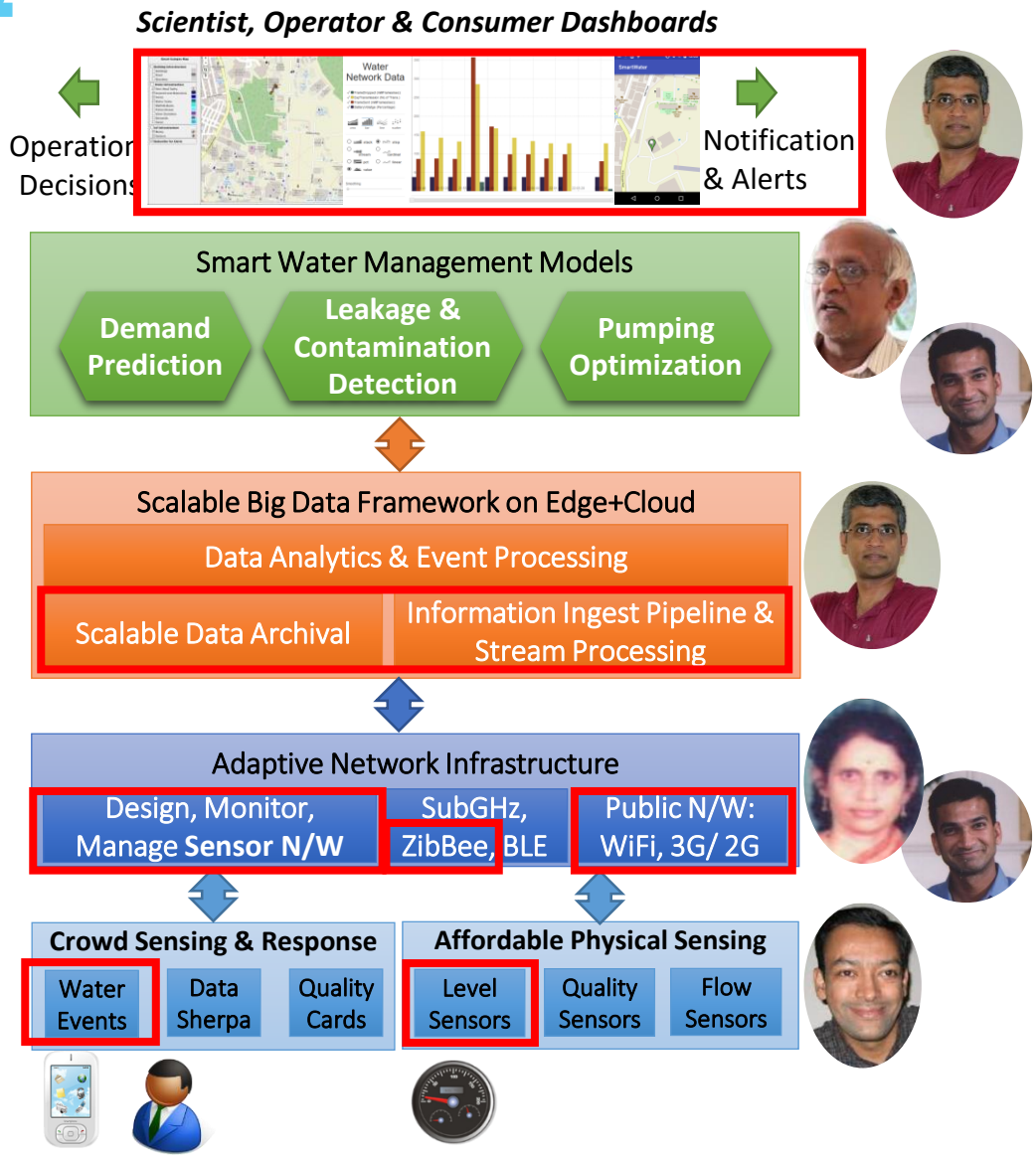

Main Pumping Station


Old Aerospace Building

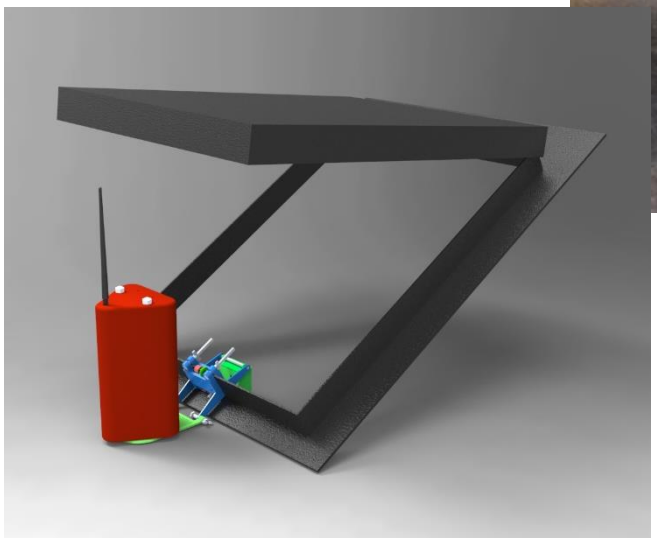

Near Janata Bazaar

IoT Technology Stack

An open, integrated & extensible platform for Smart Campus Resource Management



Custom Level + Quality Sensor



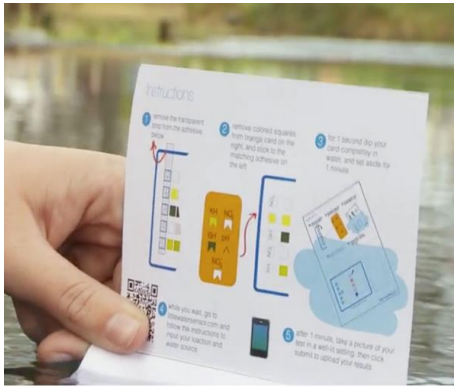
Installation of Flowmeters

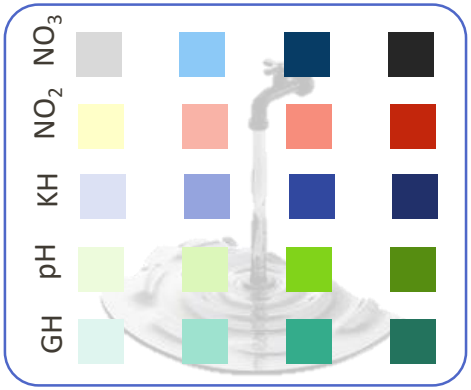
- Operate on different principles
  - Differential pressure, Positive displacement, Velocity, Mass flow
- *Electromagnetic flowmeters* operate on Faraday's law of electromagnetic induction
  - Voltage induced when a conductor moves through a magnetic field.
- EM flowmeters have many advantages
  - Accuracy, repeatability, longevity, flow range, no abstraction to flow, no moving parts and minimal maintenance.
  - But are costly
- Image capture of existing BWSSB meters
  - Cheaper (4x), but intermittent, maintenance overheads

Electro magnetic flow meter

Image capturing device for existing turbine type flow meters

Crowd-sourced Quality Sensing

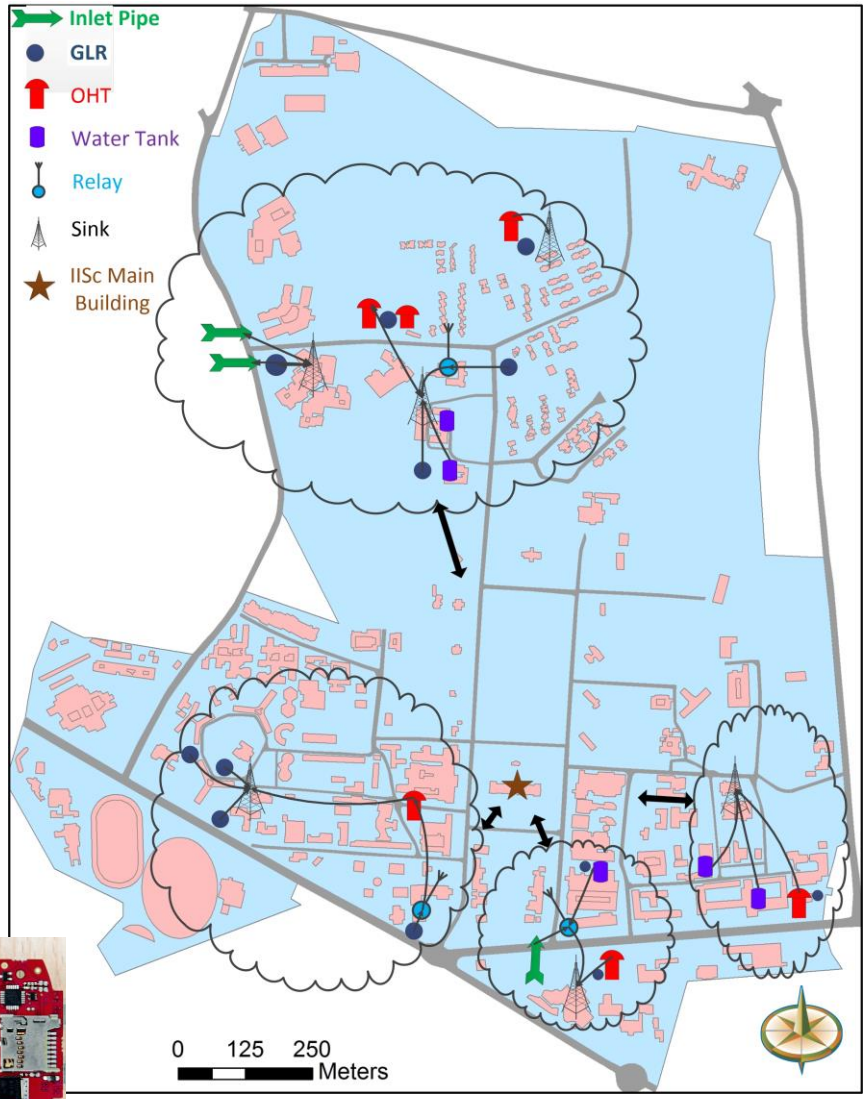


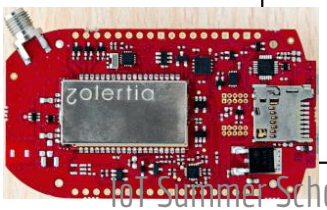


- **Cost-effective** quality sensing thru' Crowd Sourcing
  - Paper-based design allows diverse users to test water
  - Report via photo of card & Smart Phone App
  - A simple colorimetric, diagnostic developed by MIT to test *pH, calcium (Ca2+), magnesium (Mg2+), carbonates (CO32-), bicarbonates (HCO-3), and nitrites (NO-2 and NO-3)*
- Other ideas: App-based OCR Sensing for water meter

SmartCampus Network Deployment

- Efficient, reliable & manageable IoT network infrastructure
  - Connect water sensors to border router over wireless relay network
- ZigBee+SubGHz using RE-Mote
  - 2.4GHz IEEE 802.15.4 and CC1200 868/915MHz
  - 512KB of program flash and 32KB of RAM
  - Supported on Contiki/6LoWPAN

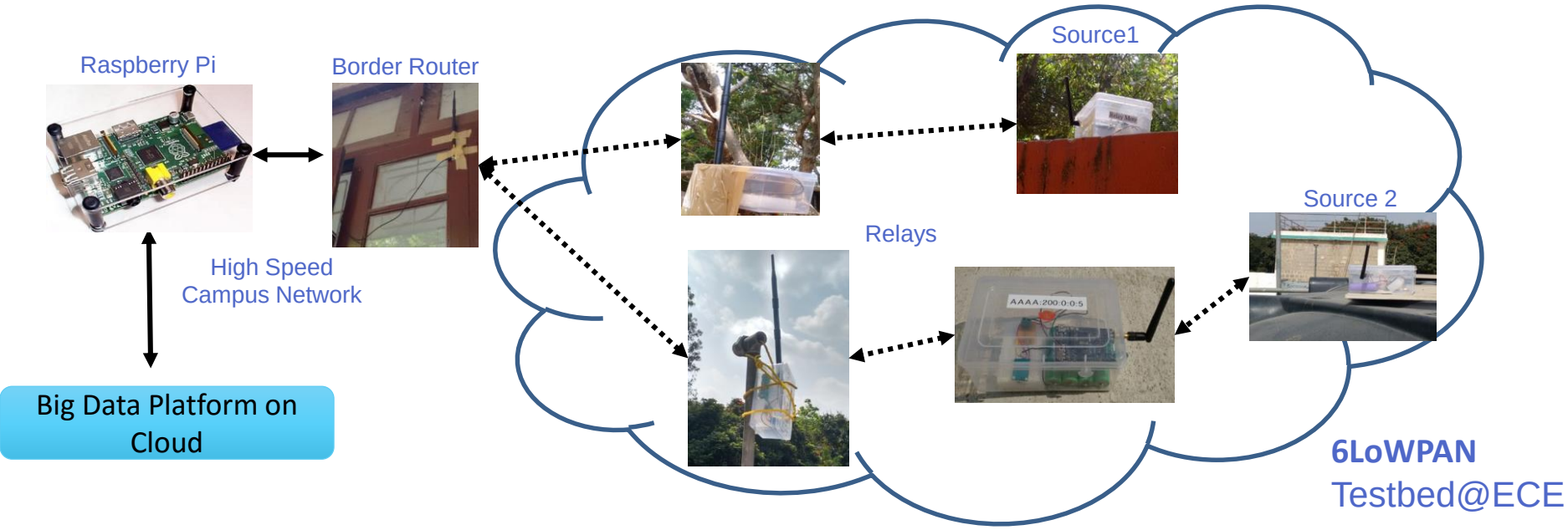




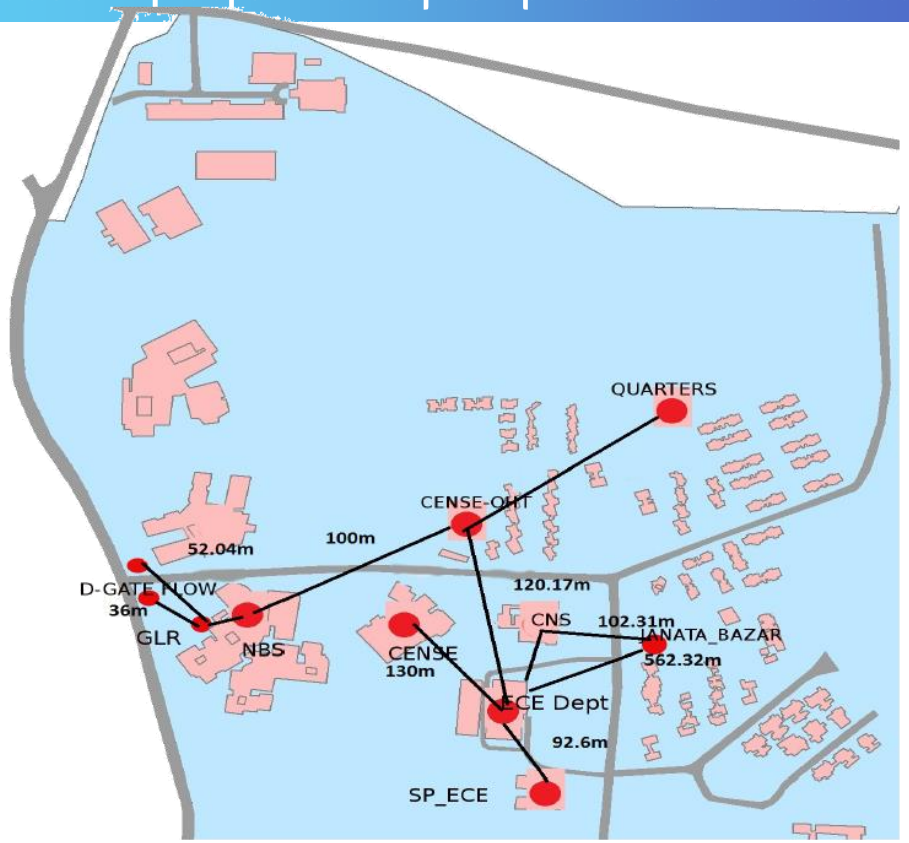
Zolertia's RE-Mote platform

SmartCampus Network Deployment

- ECE Pilot
  - Two water tanks, 5-node 6LoWPAN multi-hop network
  - Publish sensor and network health data to Cloud



Network Design Experiments



Range measurements			
Source/Sensor node	Destination node	RSSI(dBm)	PER (%)
GLR - D Gate	New Biological Sciences(NBS)	-69.5	0
300mm main D Gate-1	NBS	-67	0
300mm main D Gate-2	NBS	-69	0
CeNSe - OHT - new	ECE Roof Top	-75	3
CeNSe - OHT - new	NBS	-82	7
GLR - Janata Bazaar	CNS	-71	0
CNS	ECE Roof Top	-73	0
SP-building	ECE Roof Top	-67	0
ECE Roof Top	GLR-Janata Bazaar	-100	13

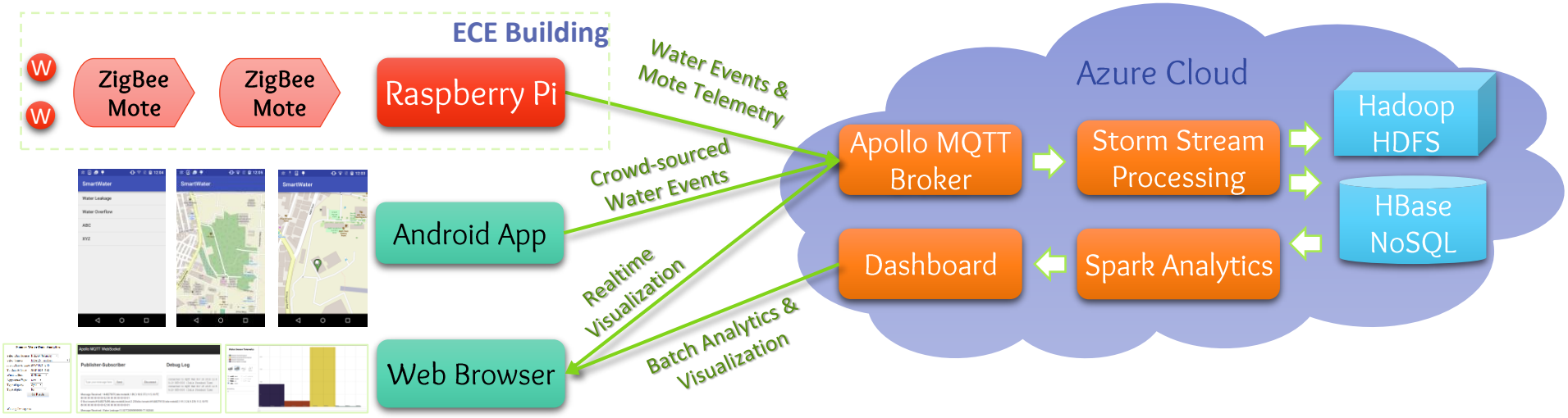
Crowd-sourced Communication using BLE

- Custom network deployment, management is costly
  - Deep inside buildings, in far off locations, etc.
- *Can we use users as "data sherpas"?*
  - Use Bluetooth Low Energy (BLE) to pass data from sensor to smart phone,
  - Use phone's data connection (WiFi, 2/3G) *when available* to transmit the data to Cloud.
- Understand the *environment conditions* under which data communication can be *effectively* crowdsourced using BLE, for specific application domains.
  - Cost for alternate solution is high for location
  - QoS of BLE solution acceptable for domain

Big Data Analytics on Clouds

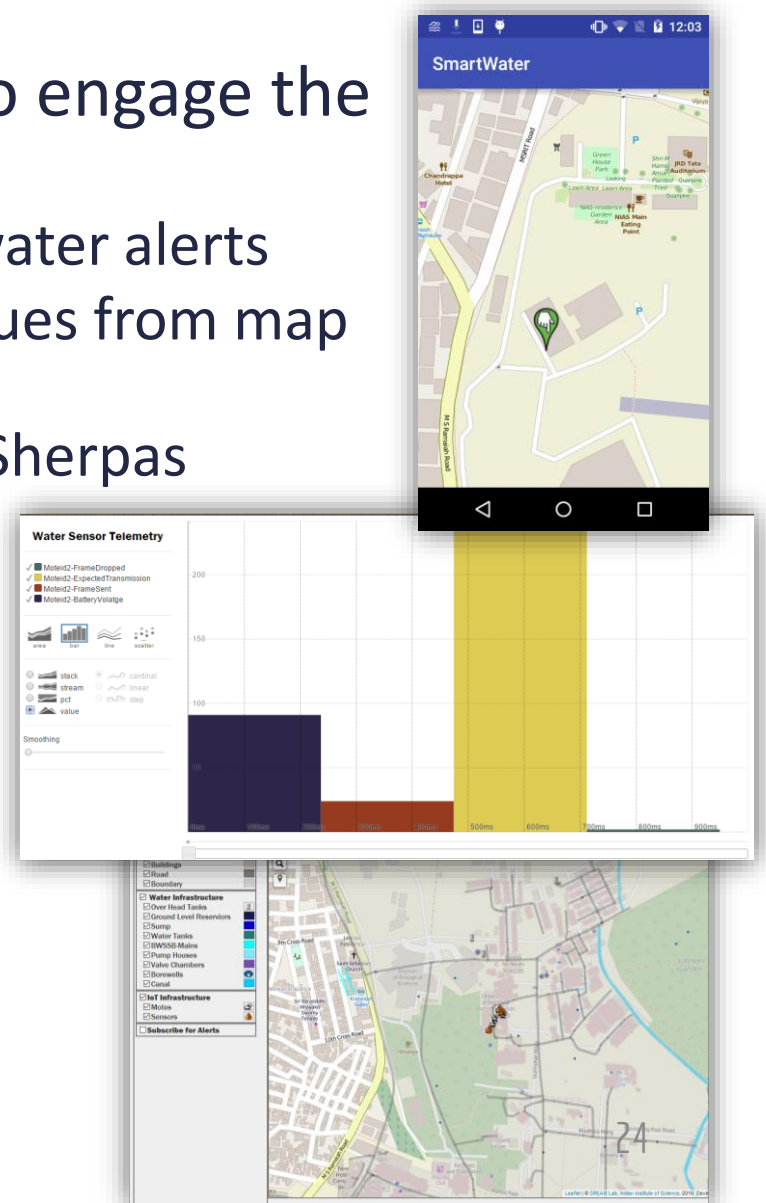
- ***Velocity*** of Big Data critical for IoT apps
  - Scalable ingest from K's of streams
  - Low-latency analytics for rapid response
- ***Volume*** support for offline analytics
  - Mining for interesting events
  - Building offline models, optimizers
- **Clouds** offer scalable & elastic platform
  - But not exclusively…latency, privacy, bandwidth!
  - *Edge devices as first-class analytics platforms*

Backend Design



Crowdsourcing & Visualization

- SmartPhone app as a means to engage the community
  - Offer realtime information on water alerts
  - Allows users to report water issues from map interface
  - Later: Water quality cards, BLE Sherpas
- Water Portal
  - Map interface on water network, IoT infrastructure
  - Visualize realtime water usage patterns, NW health
  - Analytics over historic data, comparisons, trends



Now, its *your* turn...

Tutorials

- Learn the standards, tools, technologies in an IoT fabric
  - Sensors
  - Communication
  - Data processing & Analytics
  - Cloud & Edge devices
- Start from first principles in designing your own IoT environment
- Learn about existing integrated platforms
- Two tracks over Day 1 & 2 afternoons
  1. Sensors & Communication
  2. Software & Analytics

IoT Hackaton

- Monday PM – Saturday AM
- Apply the learning to a practical IoT application
  - Come up with ideas using IoT technology for societal benefit. Bootstrapping ideas provided.
  - Use sensors & communication devices provided to design your hardware solution
  - Use edge devices & Cloud along with Big Data platforms for analytics and visualization
- Work as a team across disciplines
- Mentors to guide you, mailing list for technology support
- Publish your solution on GitHub for broader impact
- *Present your work & compete for top honors!*

Sensing & Communication Track [Room 202]

Day 1, Mon 20 June from 3-630PM

- Joint session of both tracks: Introduction to the Tutorials *(Yogesh, CDS)* [15mins]
- Practical Sensing *(Ashish, RBCCPS)* [60mins]
  - Types of sensors, properties, interfacing techniques, protocols
- Acquiring sensor data *(Akshay and Anand, ECE)* [40 mins]
  - Getting data from Sensor to Pi, and Sensor to Contiki to Pi
  - Hands on: Read data from sensor thru Laptop/Pi and Contiki
- Android and BLE *(Vasant, RBCCPS)* [20mins]
- JouleJotter Power Metering *(Abhirami & Yashaswini, ESE)* [15mins]
- jPLug Power Metering and Nebula Sensor kits *(Tanuja, Data Glen)* [30mins]
- Joint session for tracks: Team formation, project idea discussion *(Yogesh, CDS)* [30mins]

Sensing & Communication Track [Room 202]

Day 2, Tue 21 June from 330-630PM

- Joint session of both tracks: Using Pi & Azure VM by teams *(Anshu & Vyshak, CDS)* [30mins]
- Wireless Networking and Communication standards *(Akshay and Anand, ECE)* [150mins]
  - Power, standards, motes/WSN, 6lowpan, mesh NW
  - IPv6, routing, RPL, CoAP, MQTT
  - Hands on: Transmitting data through sensor network to border router (Pi)

Software & Analytics Track [Room 102]

Day 1, Mon 20 June from 3-630PM

- Joint session of both tracks: Introduction to the Tutorials *(Yogesh, CDS)* [15mins]
- Connecting to Azure VM & accessing GitHub *(Anshu, CDS)* [30mins]
- IoT Software Fabric & Event-based Architecture *(Vyshak, CDS)* [75mins]
  - COAP, Publish-Subcribe, MQTT & SenML
  - Hands on: Run MQTT Pub-Sub samples from personal laptop or Azure VM
- Complex Event Processing *(Rajrup, CDS)* [60mins]
  - Hands on: Run Siddhi CEP engine samples from personal laptop or Azure VM
- Joint session for tracks: Team formation, project idea discussion *(Yogesh, CDS)* [30mins]

Software & Analytics Track [Room 102]

Day 2, Tue 21 June from 330-630PM

- Joint session of both tracks: Using Pi & Azure VM by teams *(Anshu & Vyshak, CDS)* [30mins]
- Stream processing using Apache Storm *(Anshu, CDS)* [60 mins]
  - Hands on: Run Apache Storm IoT topology from Azure VM
- Pub-Sub on Android using IISc Notification Platform *(Abhilash, CDS)* [30mins]
  - Hands on: Run chat app from personal Android phone
- Analytics & Visualization Tools *(Rajrup, CDS)* [30mins]
  - R Analytics, Weka, Rickshaw
- Data Glen IoT Platform *(Tanuja, Data Glen)* [30mins]

Tasks for Participants

By this morning

- Subscribe to Mailing list
  - https://groups.google.com/forum/#!forum/iot_summer_school_2016
- Get connected to guest WiFi at IISc
- Have your Laptop with following software installed
  - Git or GitHub client & SSH Client
  - SW&A track
    - Java IDE such as Eclipse, IntelliJ, Java JDK 7 or later, Apache Maven
    - Python, R Studio, Android Studio (optional)
  - S&C Track
    - Ubuntu OS prefered
- GitHub
  - Request commit access to summer school GitHub site
  - **https://github.com/dream-lab/iot-school**
  - Clone the GitHub common folder to your laptop
  - https://github.com/dream-lab/iot-school/tree/master/common

Tasks for Participants

By start of Day 2

- Pick a team (2 from Sensing/Comm, 2 from SW/Analytics) and a team name.
- Create a folder with your team name on GitHub under https://github.com/dream-lab/iot-school/tree/master/teams. Create a file "members.txt" in your team folder with the name, affiliation and email address of your team members.
- Pick up Raspberry Pi and Azure VM account information for your team

By end of Day 2

- Pick a project topic to work on. Pick up sensors required for your project. Identify mentor for your project.

Thank you!

github.com/dream-lab/iot-school