Test Bed
Setup at IIT-D

Sub Projects at IIT D

- Massive MIMO/mmWave
- Security
- IoT
- LiFi
- Energy Harvesting
- Multi Access Edge Computing
- An Integrated Test Bed

Sub-project: Massive MIMO

Massive MIMO Test Bed Setup

✓ Algorithms completed:

- Channel Estimation at Base Station receiver for FR1
- Single stream channel equaliser at Base Station receiver for FR1

Sub-project: Security

DYNAMIC KEY GENERATION

1. Can UEs in a 5G network harvest secret keys from physical-layer?

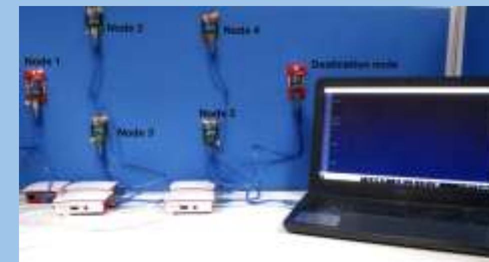
2. End-to-end privacy for UEs in D2D framework?

Test Bed Highlights

- Physical-layer key generation on 5G compliant UEs

NETWORK PROVENANCE

1. How to facilitate low-latency communication in 5G-compliant networks?
2. How to detect security threats on multi-hop networks?



Test Bed Highlights

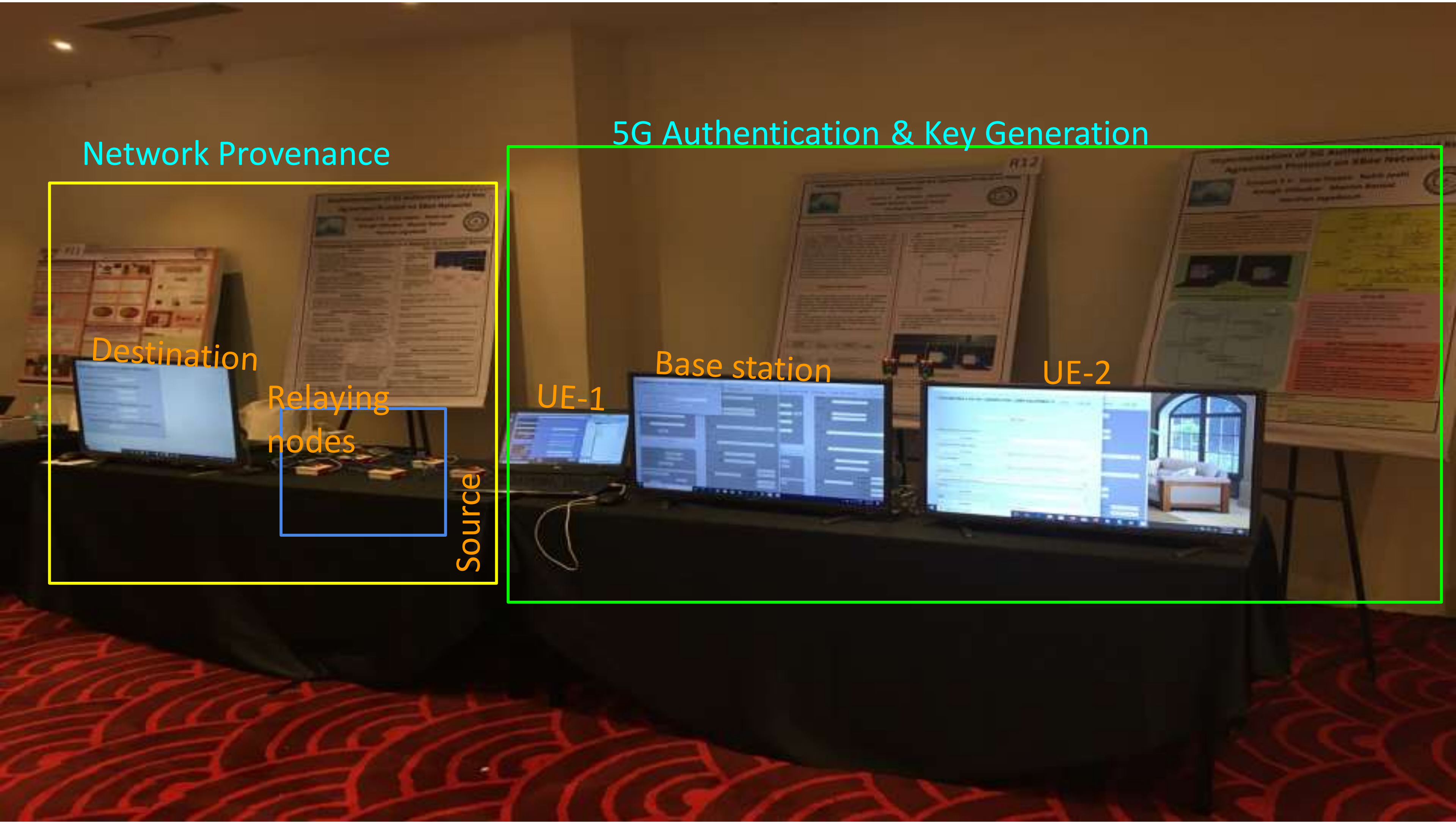
- A new framework of network provenance on a text bed of six XBee devices

Security of Connected Devices in 5G

1. How secure is 5G?
2. Salient features of 5G security architecture?
3. Developments with respect to 4G?

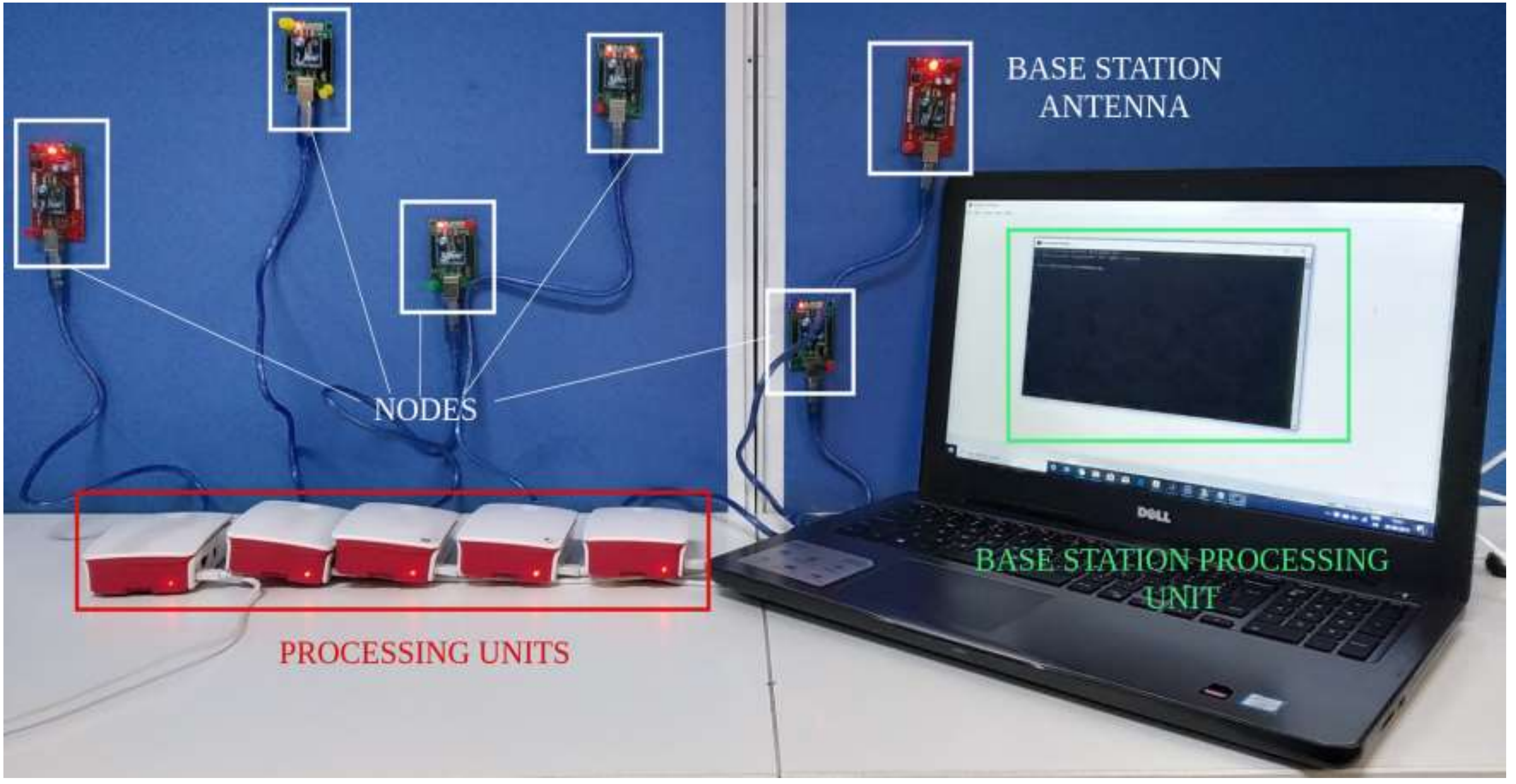
Test Bed Highlights

- 5G AKA protocol
- AS and NAS key hierarchy.
- Implementation on a network of XBee devices to emulate home network and UEs

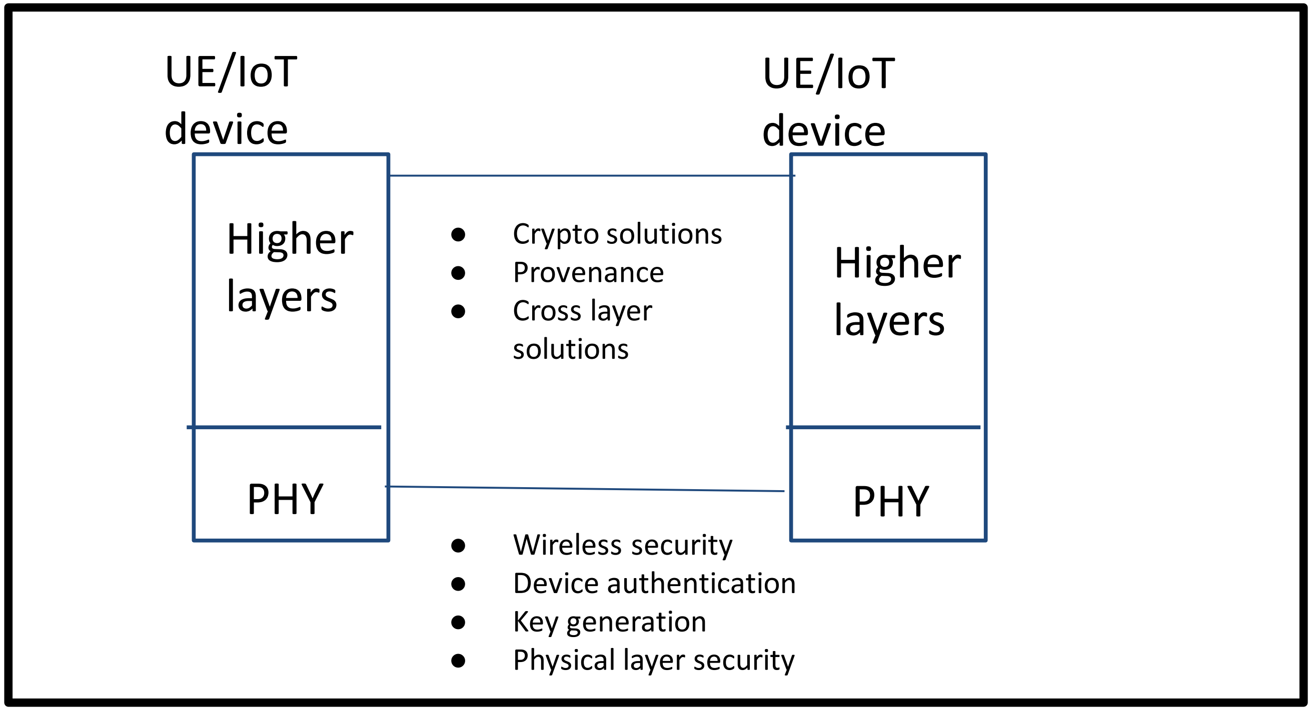


Network Provenance
5G Authentication & Key Generation
Destination
Relaying nodes
Source
UE-1
Base station
UE-2

Network Provenance Set-up



Security of Connected Devices

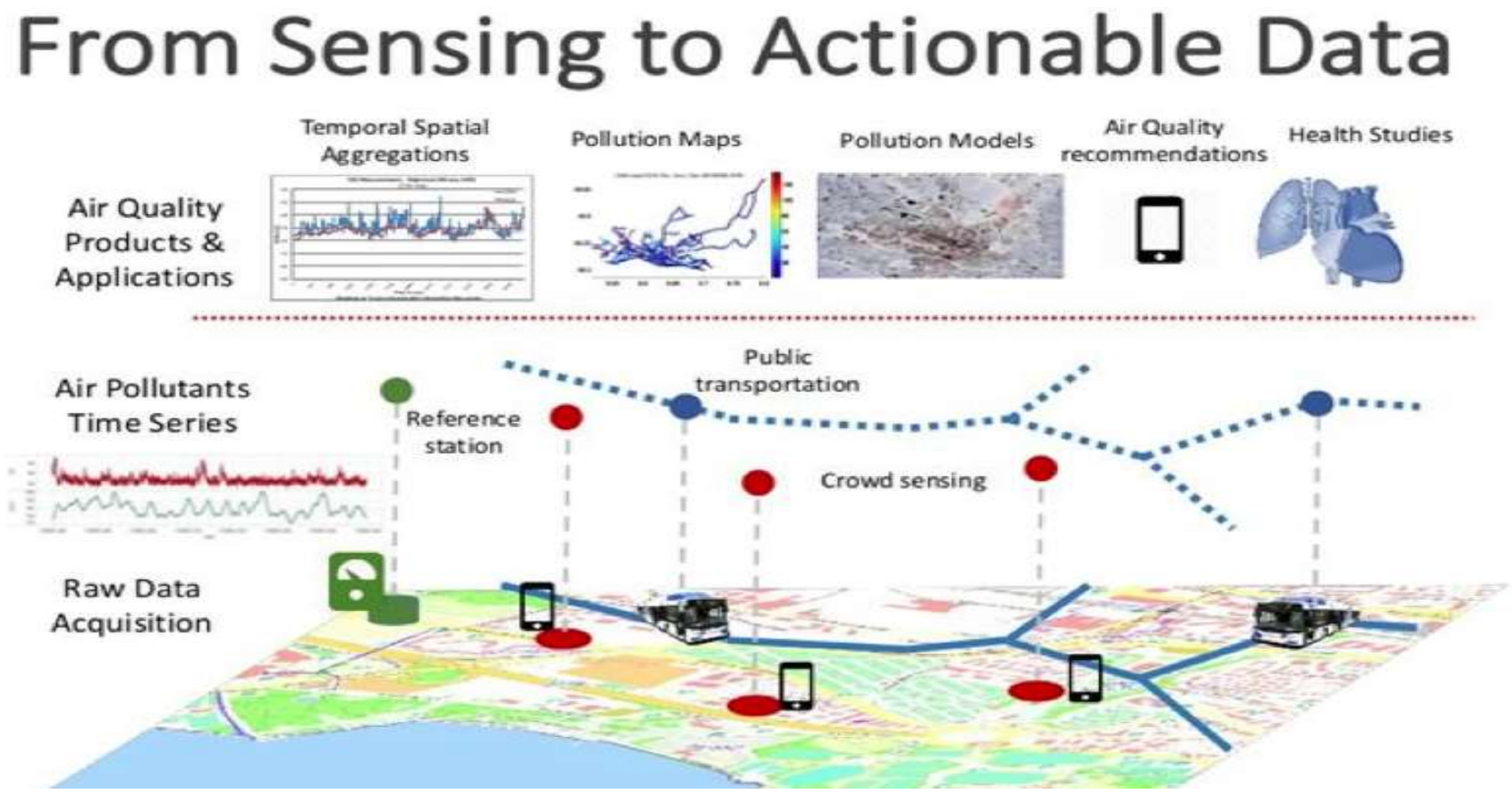


Test Bed Uses

- Software solutions on
  - Physical layer security by key generation from physical channel
  - Key management
  - Provenance
  - Algorithm implementation of Lightweight crypto RFID
  - Secure Boot
  - Distributed attestation and malware analysis
  - Physical Layer Security for FSO backhauling in 5G

Sub-project: IoT

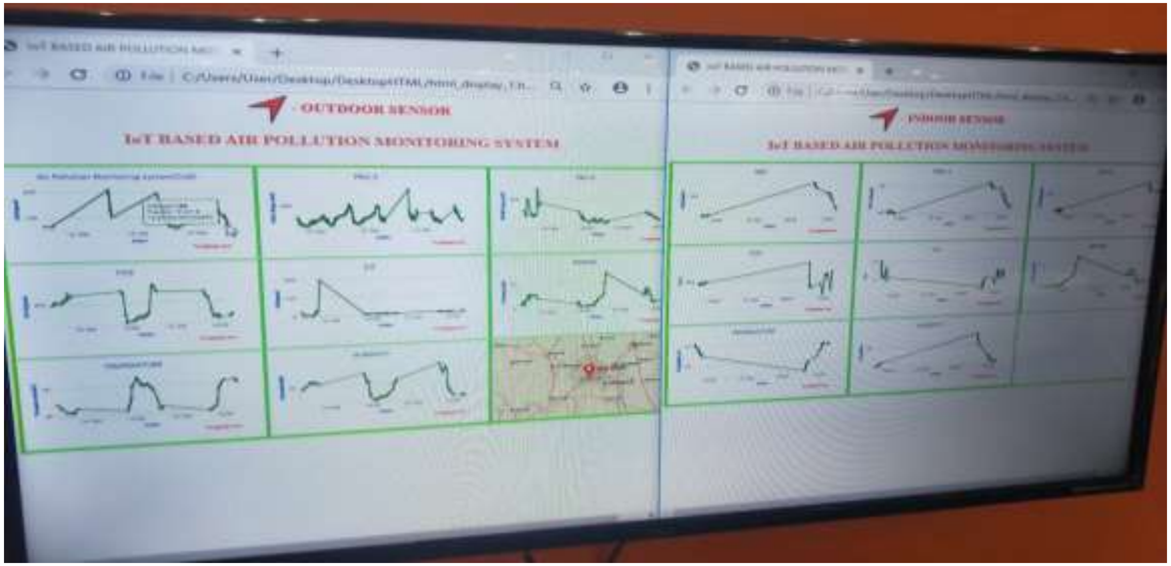
IoT Framework



- 5G standards based Interfaces and protocols available for IoT app & device developers on 5G network
- IoT apps like Air pollution monitoring, health care (will be explored with AIIMS) on network setup within IITD and will be made available to developers and manufacturers

Highlights of Test Bed @ IIT D

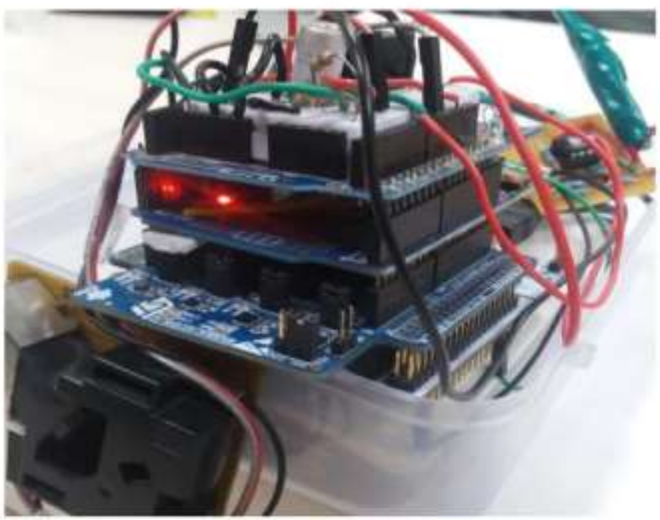
IoT

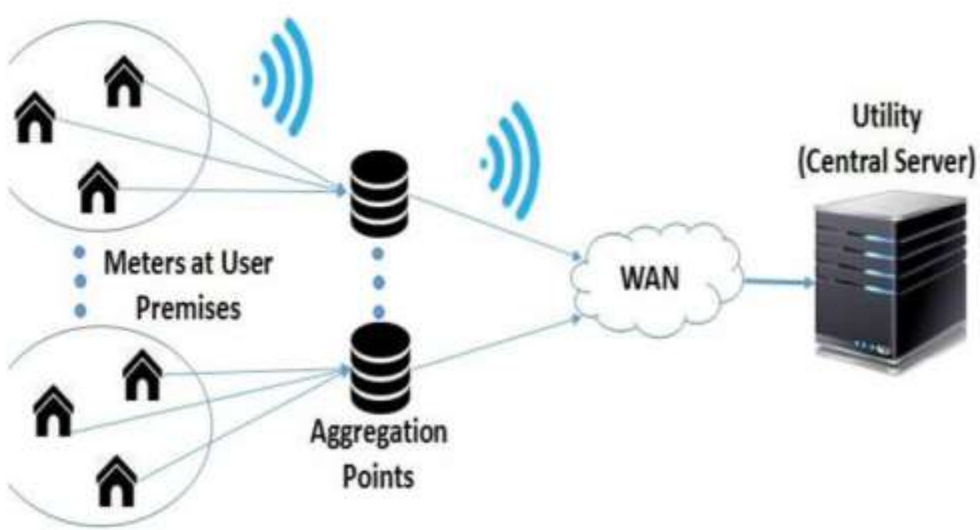


Sub-project: Energy Harvesting

Energy Harvesting

- WSN node development for telemetry:
  - Multi-sensing platform development and optimization
  - Customized data communication/aggregation
  - IoT data processing for low-power and low-bandwidth cloud communication
- Node-level information generation optimization
  - Context-aware data pruning
- Energy sustainability using UAV-assisted energy transfer





- Novel powering techniques
  - Terrestrial
  - Air-to-Ground (UAV-assisted)

Smart IoT Communication : Circuits and Systems

Dept. of Electrical Engg. IIT Delhi

Energy Harvesting Enabled Multi-Sensing in Smart IoT Applications: A Test Case of Air Pollution Monitoring

Payali Das, Sushmita Ghosh, Sandeep Kaur

ABSTRACT

We have designed a prototype for a 5G capable environmental air pollution monitoring system. The system measures concentrations of NO2, ozone, CO and SO2 using semiconductor sensors. Further, the system gathers other environmental parameters like temperature, humidity, PM1, PM2.5 and PM10. The prototype is equipped with a GPS sub-system for accurate geo-tagging. The board communicates through Wi-Fi and NB-IoT. The board is also equipped with energy harvesting power management, and is powered through solar energy and battery backup.

INTRODUCTION

Global air pollution is one of the major concerns of our era. Improved monitoring systems are needed, which will be having superior precision, high sensitivity, and require less laboratory analysis. Also it should be less power consuming and energy efficient one.

SYSTEM OVERVIEW

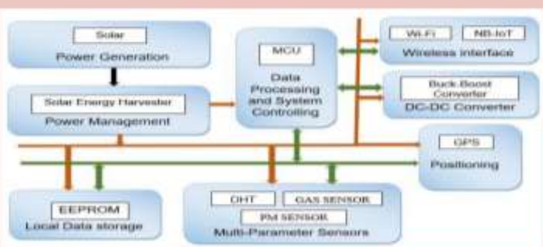


Fig1. 5G Enabled Designed Prototype.

Sensors Wi-fi NBIoT

Fig2. Temperature Graph in Cloud

Fig3. Humidity Graph in Cloud

Fig4. CO gas concentration in cloud

Fig5. SO2 gas concentration in cloud

Fig6. Gas sensor data at a particular instance

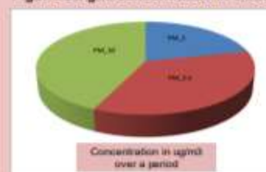


Fig7. PM sensor data at a particular instance

Context Specific Data Pruning in Smart IoT Applications : An Implementation Case Study on Smart Energy Meter.

Wadood Ahmad Khan, Mayukh Roy Chowdhury, Sharda Tripathi

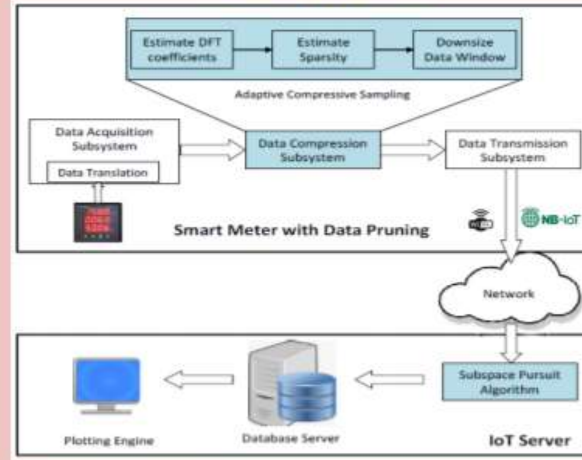
ABSTRACT

A working model of Smart Energy Meter with Data Pruning Subsystem is designed. As a proof of concept we are demonstrating data compression at the edge to save bandwidth required for data transmission to a remote cloud. At each smart meter, sparsity of data is exploited to devise an adaptive data reduction algorithm using compressive sampling technique such that the bandwidth requirement for smart meter data transmission is reduced with minimum loss of information. The Smart Energy Meter is Wi-Fi and NB-IoT enabled. This meter is capable of logging multiple energy consumption parameters.

INTRODUCTION

Advanced metering in smart grid has emerged as a powerful paradigm to enable bidirectional information flow between utility and consumers in the electricity distribution network. IoT devices such as Smart Meters follow a rapid data logging approach. Loads of fine grained electricity consumption data is generated. Due to limitation in handling big data, strategies for smart meter data reduction need to be employed. However, Data Driven Resource Optimization techniques have not been incorporated in Smart Meters. It is therefore proposed to incorporate a Data Pruning Subsystem in Smart Meters.

SYSTEM OVERVIEW



Smart Energy Meter

Plotting Engine

REFERENCES

1. S. Tripathi, S. De, "An efficient data characterization and reduction scheme for smart metering infrastructure", IEEE Trans. Ind. Informatics, vol. 14, issue 10, pp. 4300-4308, October 2018.
2. W. Dai and O. Milenkovic, "Subspace pursuit for compressive sensing signal reconstruction," IEEE Trans. Inf. Theory, vol. 55, no. 5, pp. 2230–2249, May 2009.

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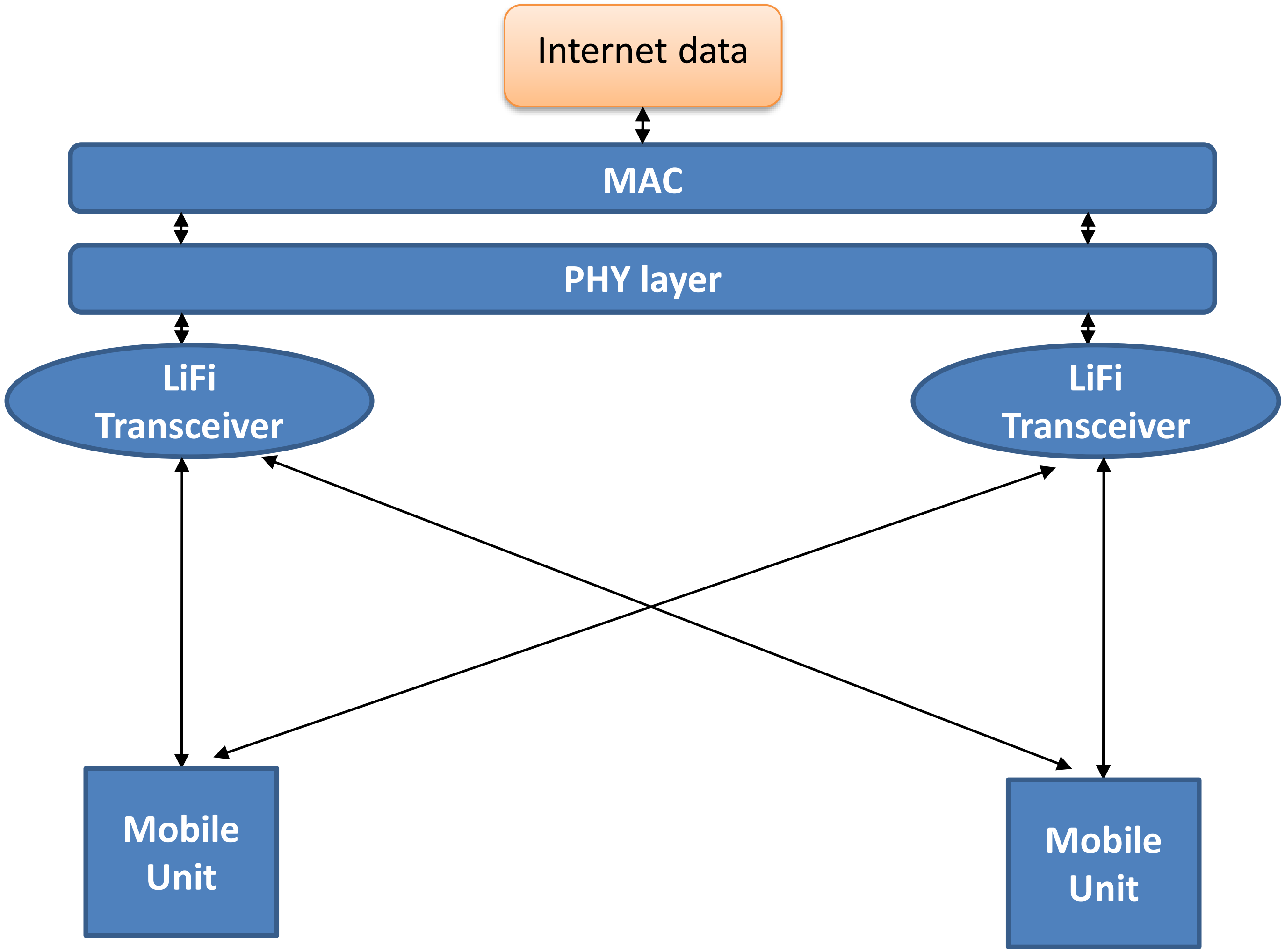
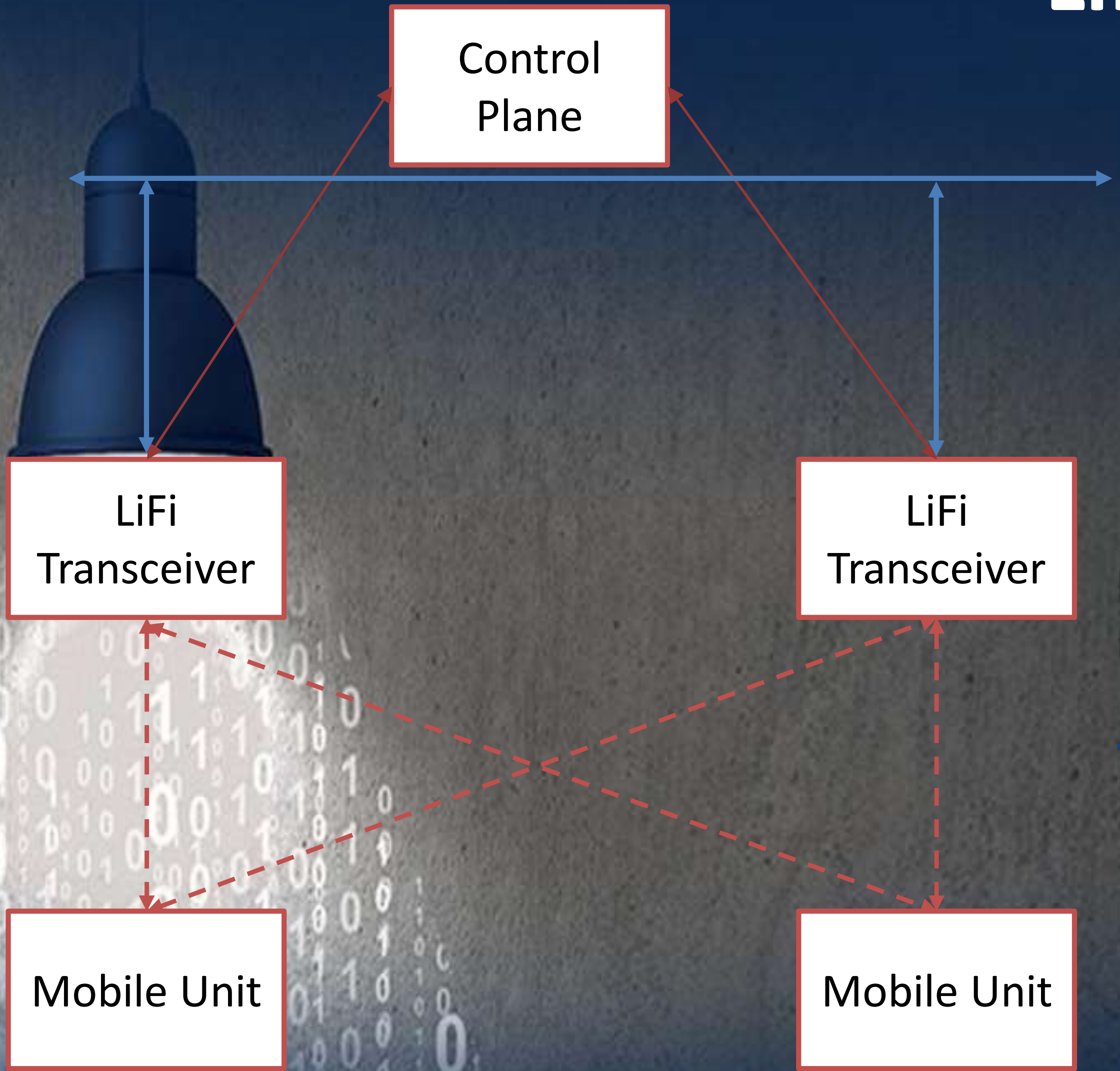
Sub-project:LiFi



Deliverables:

1. User can test different MAC algorithms.
2. Performance evaluation of different modulation schemes.
3. Limited multiplexing schemes depending upon the final hardware design.

LiFi Setup



500 Mb/s

Mobile Unit
Downlink speed 500 Mbps
Uplink 10 Mbps
Transmitter
Uplink 500 Mbps
Downlink 10 Mbps

PC: Airbnb.com

Highlights of Test Bed @ IIT D

LiFi demo at IMC

LiFi

Sub-project:MEC

Multi-Access Edge Computing

Multi-Access Edge Computing
Equipment identification and procurement
Requirements and Architecture Document, Resource hiring, use-case identification
Software Implementation for MEC and Integration
Use-case implementation (Pollution Monitoring and Video Surveillance with Analytics)
Additional API implementation and integration