IIT KHARAGPUR

NPTEL ONLINE
CERTIFICATION COURSES

Case Study: Agriculture

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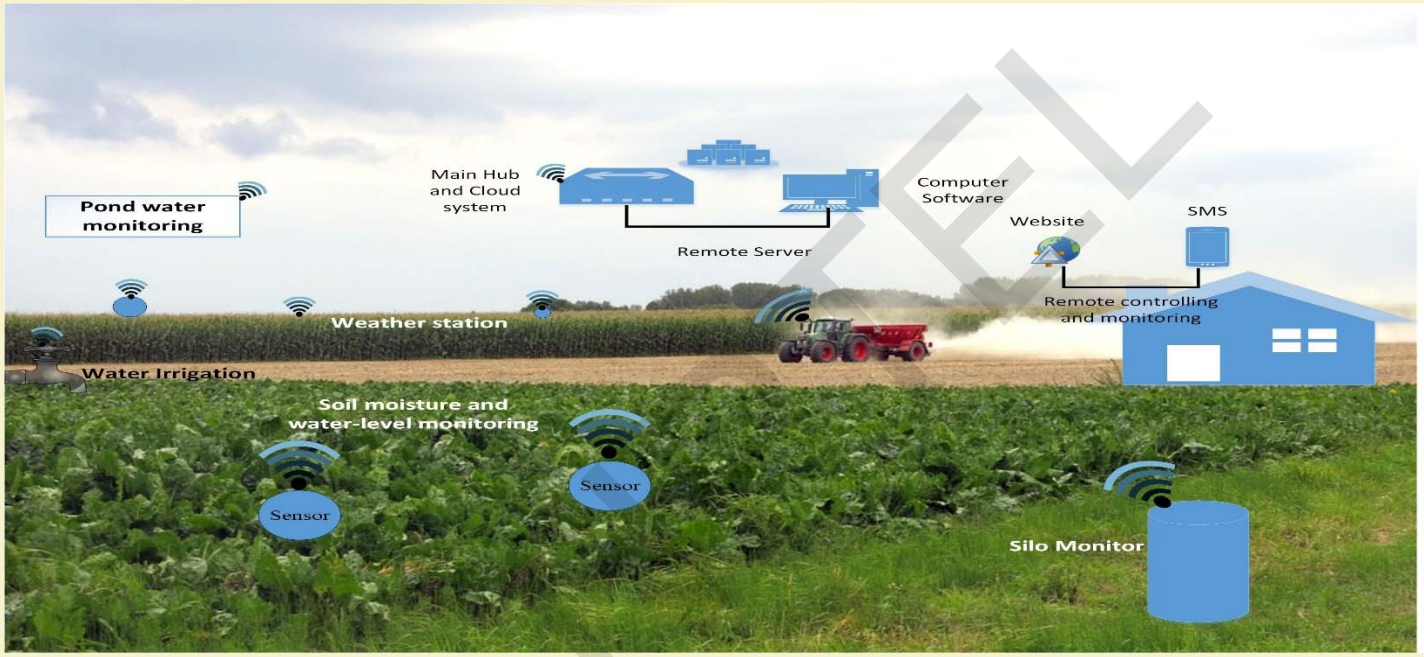
Future of IoT application in agriculture



- ✓ Soil moisture and water level monitoring
- ✓ Automated irrigation system
- ✓ Automation in Recycling of Organic Waste and Vermicomposting
- ✓ Automated sowing and weeding system

Image template source: https://pixabay.com/p-747175/?no_redirect

Case study on
Smart Water Management Using IoT

AgriSens: Smart Water Management using IoT

- ✓ Objectives
  - More yields with less water
  - Save limited water resource in a country
  - Automatic irrigation
  - Dynamic irrigation treatments in the different phases of a crop's life cycle
  - Remote monitoring and controlling

Source: Project name: Development of a Sensor based Networking System for Improved Water Management for Irrigated Crops, funded by MHRD, Govt. of India

AgriSens: Smart Water Management using IoT (Contd.)

- ✓ Proposed architecture
  - Sensing and actuating layer
  - Processing, storage, and service layer
  - Application layer

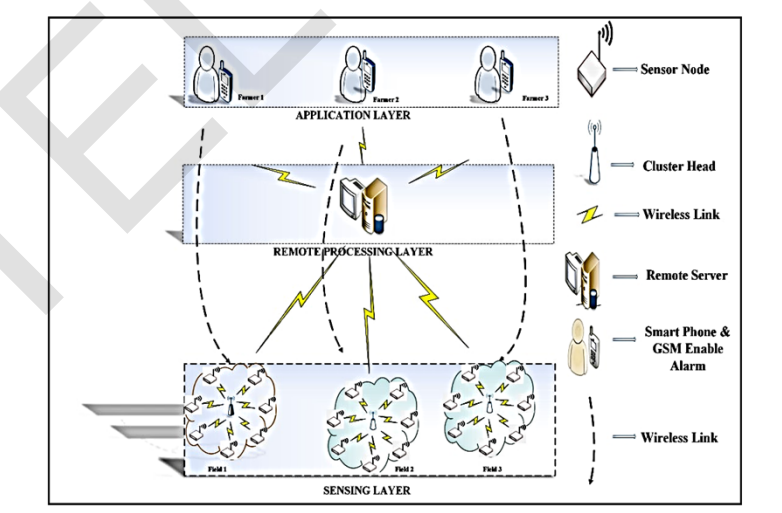


Fig 1: The proposed architecture of AgriSens

Source: Project name: Development of a Sensor based Networking System for Improved Water Management for Irrigated Crops, funded by MHRD, Govt. of India

AgriSens: Smart Water Management using IoT (Contd.)

- ✓ Design
  - Integrated design for sensors
  - Integrated design for sensor node
  - Integrated design for remote server

Source: Project name: Development of a Sensor based Networking System for Improved Water Management for Irrigated Crops, funded by MHRD, Govt. of India

AgriSens: Smart Water Management using IoT (Contd.)

✓ Integrated design for sensors

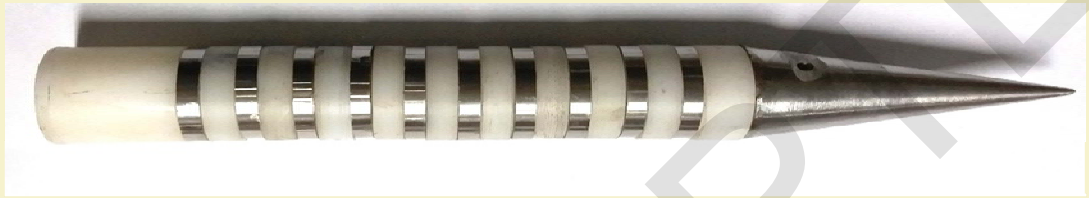


Fig 4: Designed water-level sensor

Fig 5: EC-05 soil moisture sensor

Source: Project name: Development of a Sensor based Networking System for Improved Water Management for Irrigated Crops, funded by MHRD, Govt. of India

AgriSens: Smart Water Management using IoT (Contd.)

✓ Integrated design for sensor node

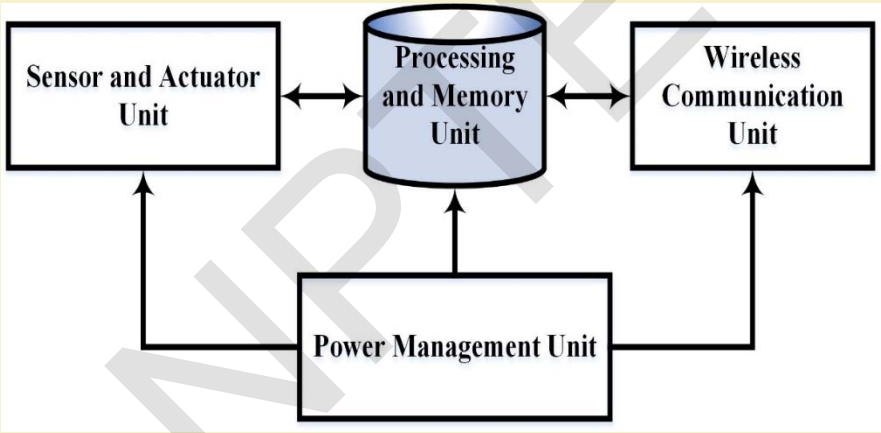


Fig 2: The block diagram of a sensor node

AgriSens: Smart Water Management using IoT (Contd.)

✓ Integrated design for sensor node

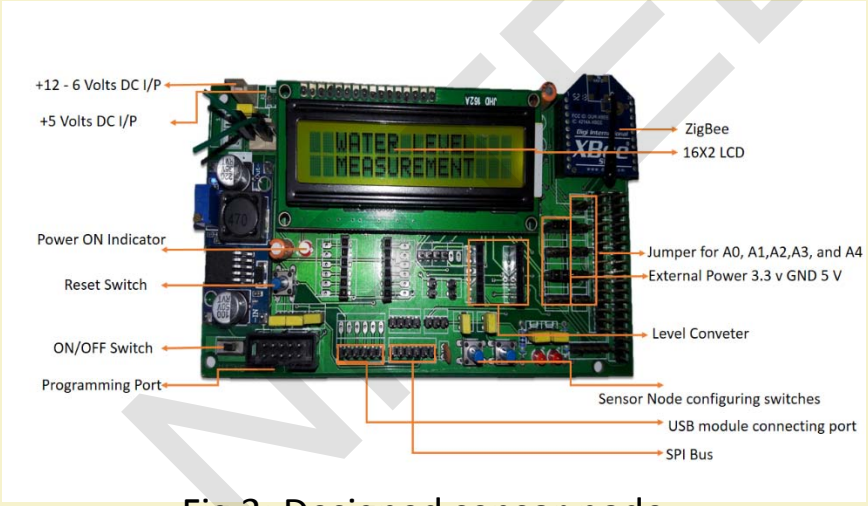


Fig 3: Designed sensor node

Source: Project name: Development of a Sensor based Networking System for Improved Water Management for Irrigated Crops, funded by MHRD, Govt. of India

AgriSens: Smart Water Management using IoT (Contd.)

- ✓ Integrated design for remote server
  - Repository data server: Communicates with the deployed IoT gateway in the field by using GPRS technology
  - Web server: To access field data remotely
  - Multi users server: Sends field information to farmer's cell using SMS technology and also executes farmer's query and controlling messages

Source: Project name: Development of a Sensor based Networking System for Improved Water Management for Irrigated Crops, funded by MHRD, Govt. of India

AgriSens: Smart Water Management using IoT (Contd.)

- ✓ Implementation
  - Field demo
  - Website demo
  - Project details from website

AgriSens: Smart Water Management using IoT (Contd.)

✓ Results

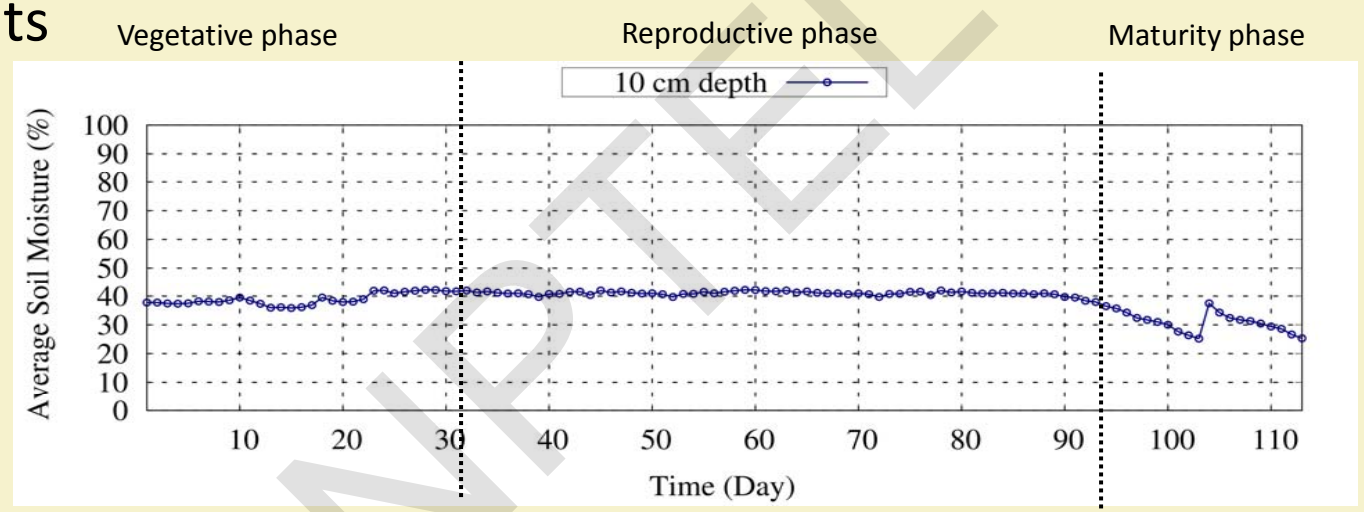


Fig. 6: Average soil moisture

Source: Project name: Development of a Sensor based Networking System for Improved Water Management for Irrigated Crops, funded by MHRD, Govt. of India

AgriSens: Smart Water Management using IoT (Contd.)

✓ Results

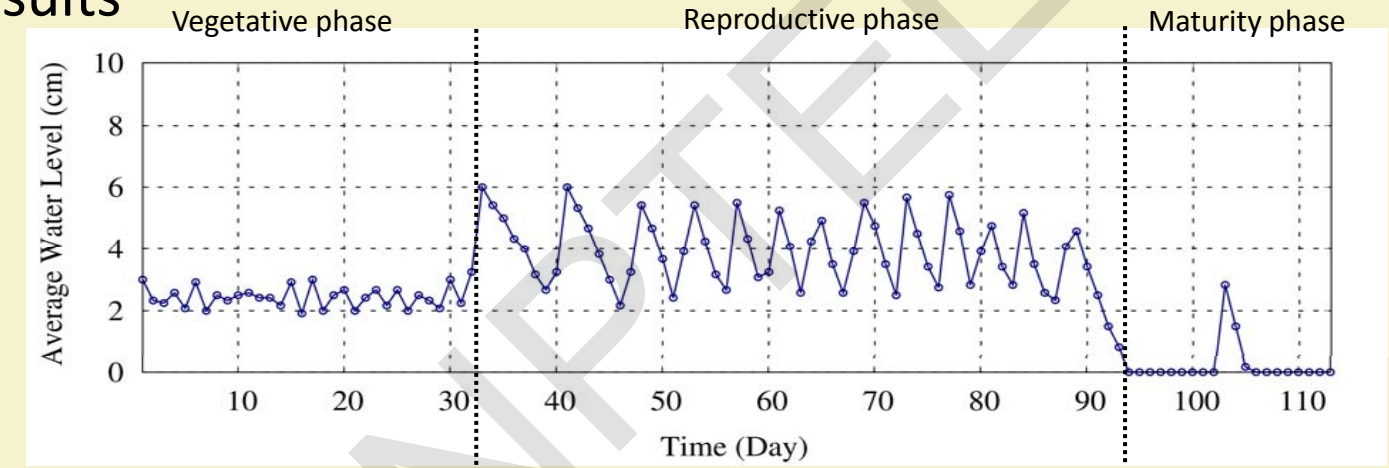


Fig. 7: Average water level

Source: Project name: Development of a Sensor based Networking System for Improved Water Management for Irrigated Crops, funded by MHRD, Govt. of India

AgriSens: Smart Water Management using IoT (Contd.)

✓ Results

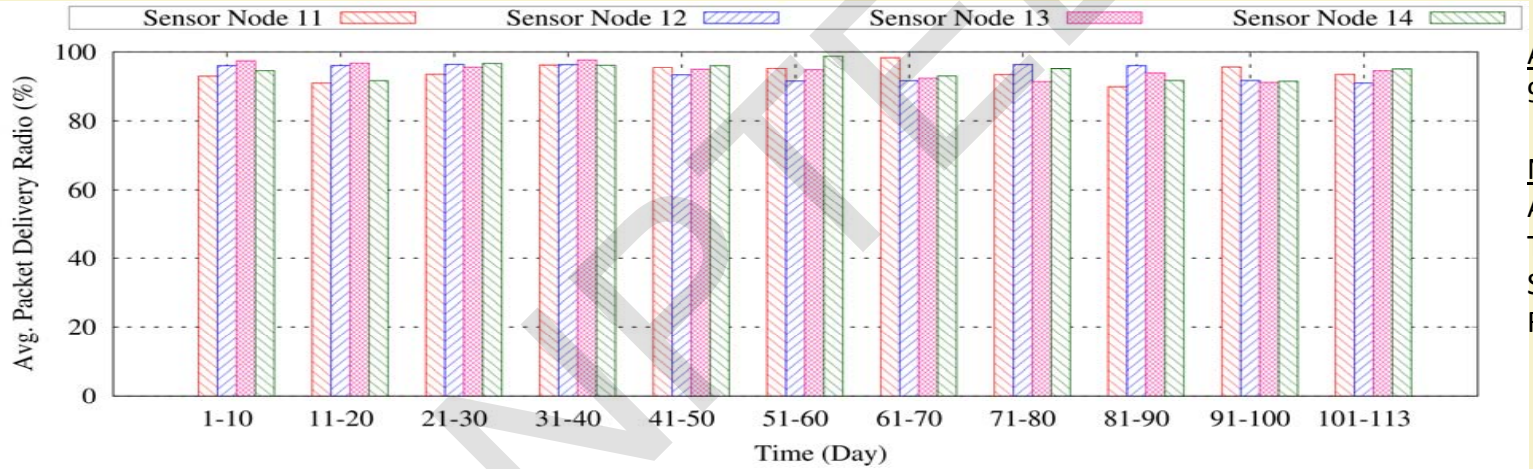


Fig. 8: Average packet delivery ratio

Avg. PDR:
98.75 – 89.75%

Noises:
Air flow,
Temperature,
Solar radiation,
Rain

Source: Project name: Development of a Sensor based Networking System for Improved Water Management for Irrigated Crops, funded by MHRD, Govt. of India

Thank You!!

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Case study: Healthcare

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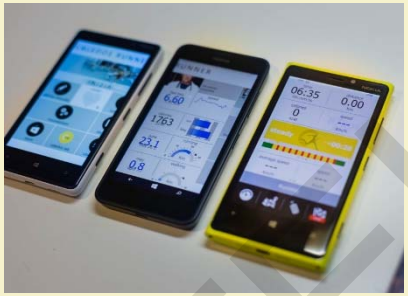
Emergence of IoT Healthcare

- ✓ Advances in sensor and connectivity
  - Collect patient data over time
  - Enable preventive care
  - Understanding of effects of therapy on a patient
- ✓ Ability of devices to collect data on their own
  - Automatically obtain data when and where needed by doctors
  - Automation reduces risk of error
  - Lower error implies increased efficiency and reduced cost

Components of IoT Healthcare

- ✓ Components of IoT is organized in 4 layers
  - Sensing layer: Consists of all sensor, RFIDs and wireless sensor networks (WSN). E.g: Google glass, Fitbit tracker
  - Aggregated layer: Consists of different types of aggregators based on the sensors of sensing layer. E.g: Smartphones, Tablets
  - Processing layer: It consists of servers for processing information coming from aggregated layer.
  - Cloud platform: All processed data are uploaded in cloud platform, which can be accessed by large no. of users

Sensing & Measurement



Data Aggregation

Cloud storage & Analytics

IoT in Healthcare : Directions

IoT Healthcare : Remote Healthcare

- Many people without ready access to effective healthcare
- Wireless IoT driven solutions bring healthcare to patients rather than bring patients to healthcare
- Securely capture a variety of medical data through IoT based sensors, analyze data with smart algorithms
- Wirelessly share data with health professionals for appropriate health recommendations

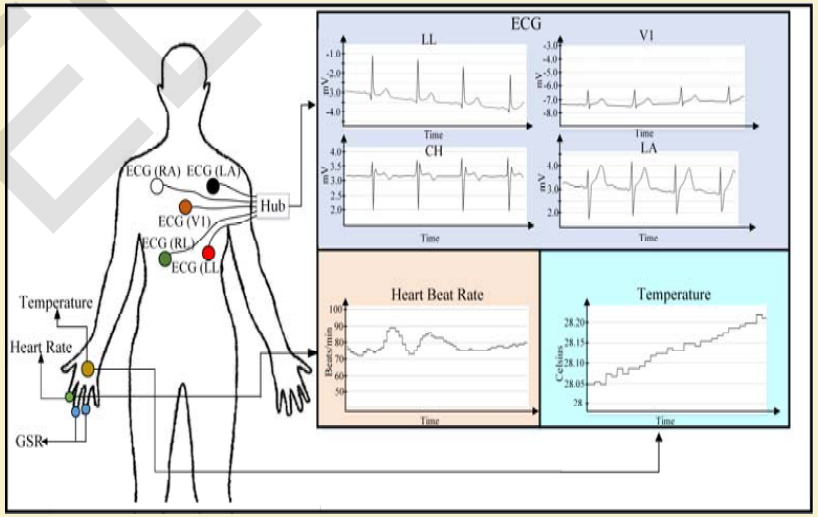
Withings BP Monitor*

Shimmer Temperature Monitor^

*http://www.withings.com/ ^http://www.shimmersensing.com/

IoT Healthcare : Real-time Monitoring

- IoT-driven non-invasive monitoring
- Sensors to collect comprehensive physiological information
- Gateways and cloud-based analytics and storage of data
- Wirelessly send data to caregivers
- Lowers cost of healthcare



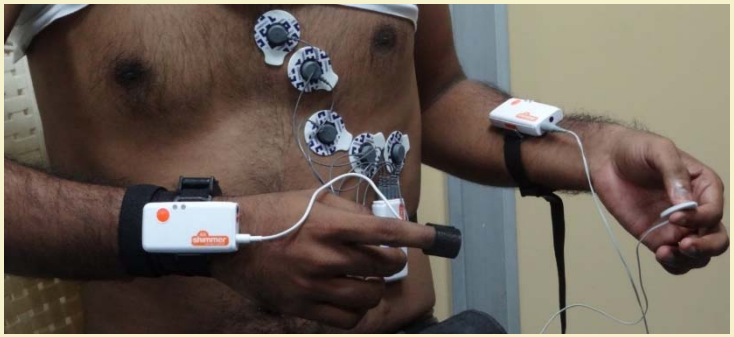
IoT Healthcare : Preventive care

- Fall detection for seniors
- Emergency situation detection and alert to family members
- Machine learning for health trend tracking and early anomaly detection

AmbuSens: Use-case of Healthcare system using IoT

Problem Definition & its Scope

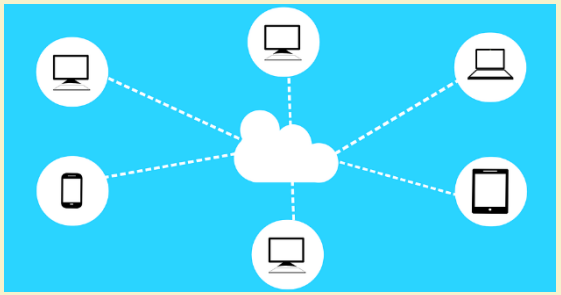
- ✓ **Telemedicine and Remote Healthcare:**
  - Problem - Physical presence necessary
  - Solution - Wireless sensors
- ✓ **Emergency Response Time**:
  - Problem – Not equipped to deal with complications.
  - Solution
    - Instant remote monitoring
    - Feedback by the skilled medical professionals



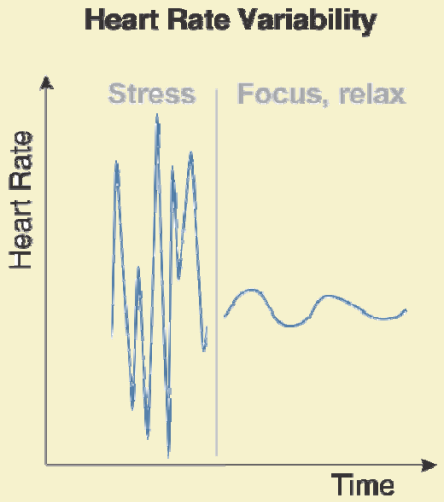
Problem Definition & its Scope (cont.)

- ✓ **Real Time Patient Status Monitoring:**
  - Problem – Lack of collaboration.
  - Solution - Real-time monitoring.
- ✓ **Digitized Medical History:**
  - Problem
    - Inconsistent
    - Physical records vulnerable to wear and tear and loss.
  - Solution - Consistent cloud-based digital record-keeping system

HashID	SensorValue_GSR_kOhms	SensorValue_HeartRate	Cur_Date	Cur_Time
9662SHR23y	97.78	73	Mon 14/11/2016	12:39:06:914 IST
e0c1SHR23y	97.97	73	Mon 14/11/2016	12:39:06:975 IST
7354SHR23y	98.19	75	Mon 14/11/2016	12:39:07:072 IST
7228SHR23y	97.83	75	Mon 14/11/2016	12:39:07:169 IST
ee32SHR23y	98.31	75	Mon 14/11/2016	12:39:07:243 IST
39c2SHR23y	98.48	73	Mon 14/11/2016	12:39:07:300 IST
350cSHR23y	98.99	73	Mon 14/11/2016	12:39:07:328 IST
f002SHR23y	100.36	75	Mon 14/11/2016	12:39:07:400 IST
d228SHR23y	101.01	75	Mon 14/11/2016	12:39:07:491 IST
bed0SHR23y	101.59	77	Mon 14/11/2016	12:39:07:537 IST
a58bSHR23y	100.7	77	Mon 14/11/2016	12:39:07:590 IST
4869SHR23y	100.65	77	Mon 14/11/2016	12:39:07:650 IST

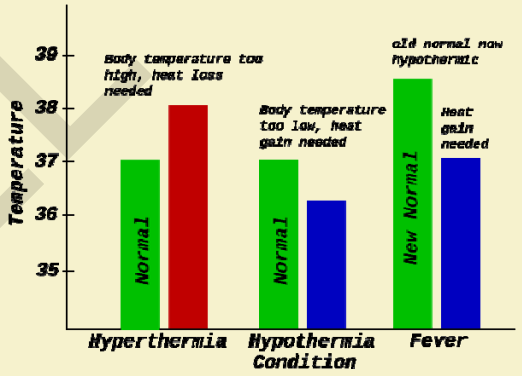


AmbuSens: Physiological Parameters

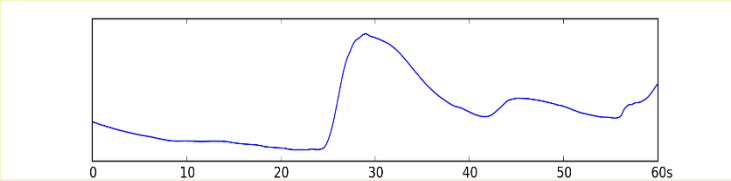


Heart Rate

Electrocardiogram (ECG)



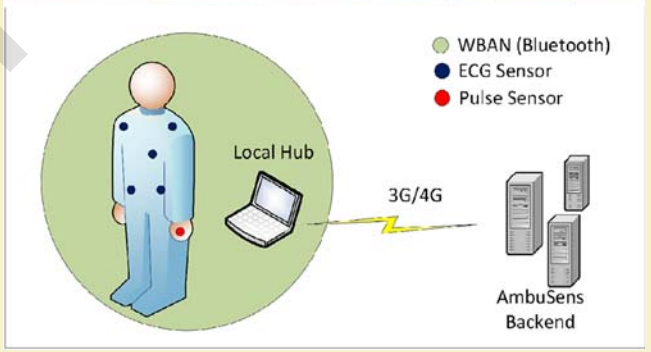
Temperature



Galvanic Skin Response (GSR)

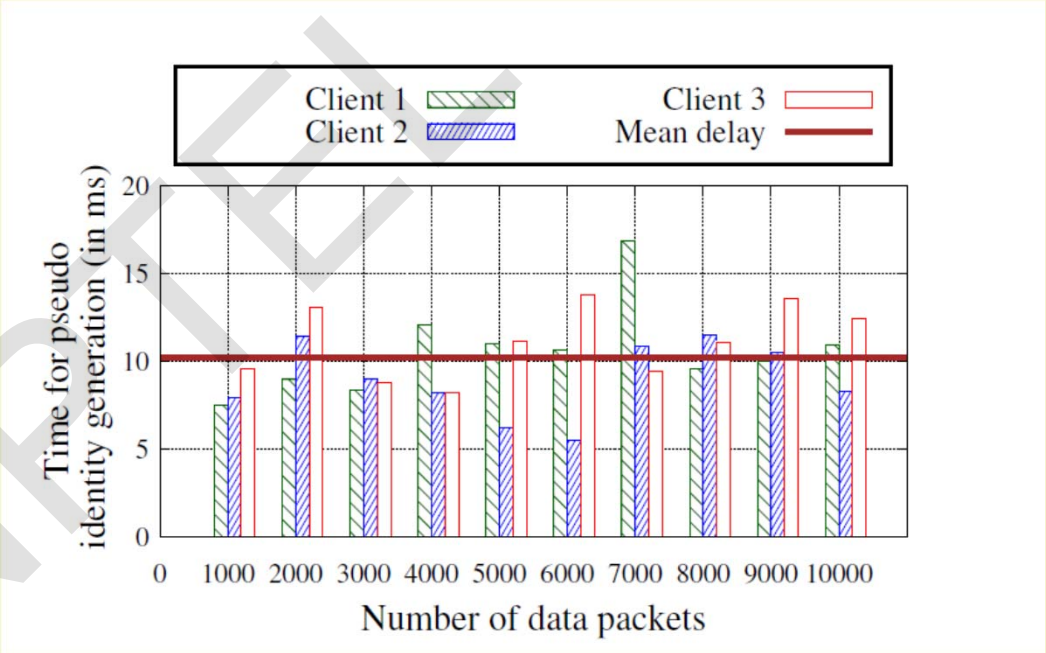
AmbuSens: Development of WBAN

- ✓ Single hop ***wireless body area network*** (WBAN)
- ✓ Communication protocol used is ***Bluetooth*** i.e. IEEE 802.15.1
- ✓ ***Power management*** and data-rate tuning
- ✓ ***Calibration*** of data
- ✓ ***Filtering*** and noise removal



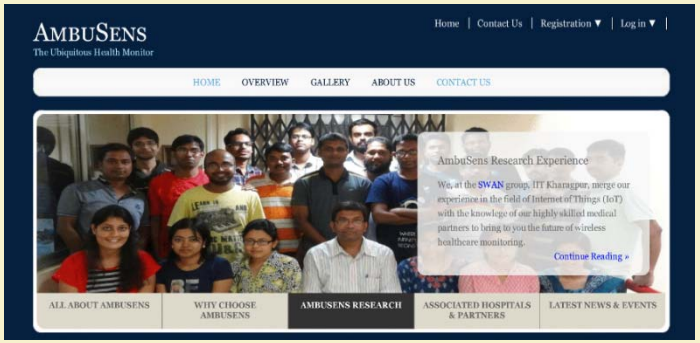
AmbuSens: Development of Cloud Framework

- ✓ ***Health-cloud*** framework
- ✓ The developed system is strictly ***privacy-aware***
- ✓ ***Patient-identity masking*** involves hashing and reverse hashing of patient ID
- ✓ ***Scalable*** architecture

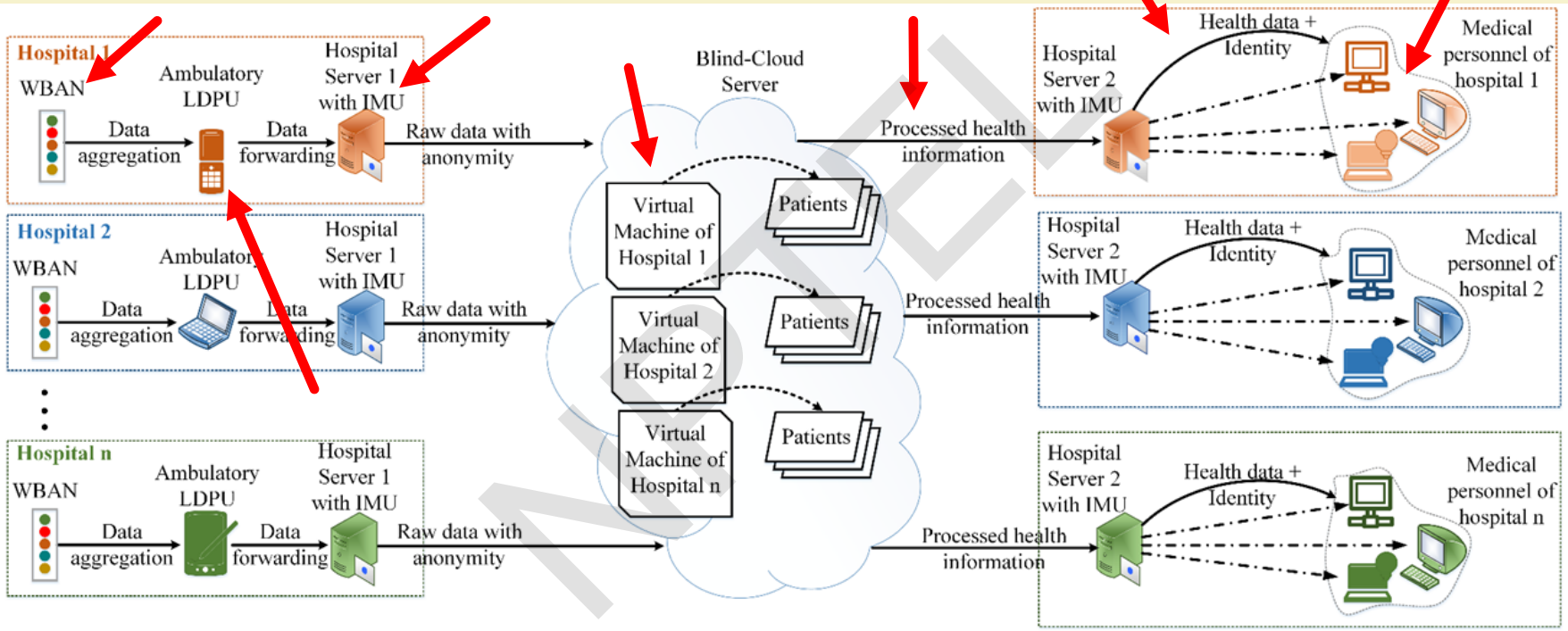


AmbuSens: Web Interface

- ✓ **URL**: ambusens.iitkgp.ac.in
- ✓ ***Paramedic*** and ***Doctor*** portals for ease of use.
- ✓ Provision for recording ***medical history*** and sending ***feedback.***
- ✓ Allows sensor ***initialization*** and ***data streaming.***
- ✓ Includes data ***visualization*** tools for better understanding.

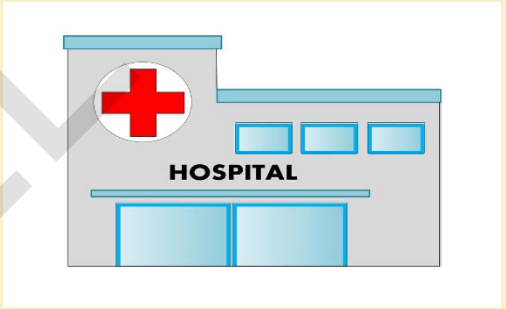


AmbuSens: System Architecture



AmbuSens: Implementation

- ✓ AmbuSens Implementation demo
  - Field demo animation
    - Part 1
      - AmbuSens in the ***Hospital***
      - Brief description of the ***sensors***
    - Part 2
      - ***Ambulatory*** Healthcare



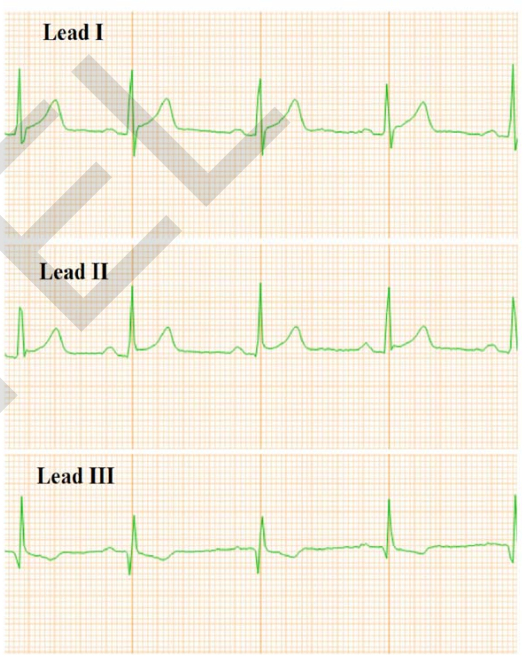
AmbuSens: System Trials

Figure 1: Hospital system trials

Figure 2: Ambulatory system trials

AmbuSens: Results (Comparison of ECG tracing)

ECG tracing from manual system



Real-time ECG tracing from AmbuSens

Thank You

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Activity Monitoring - Part 1

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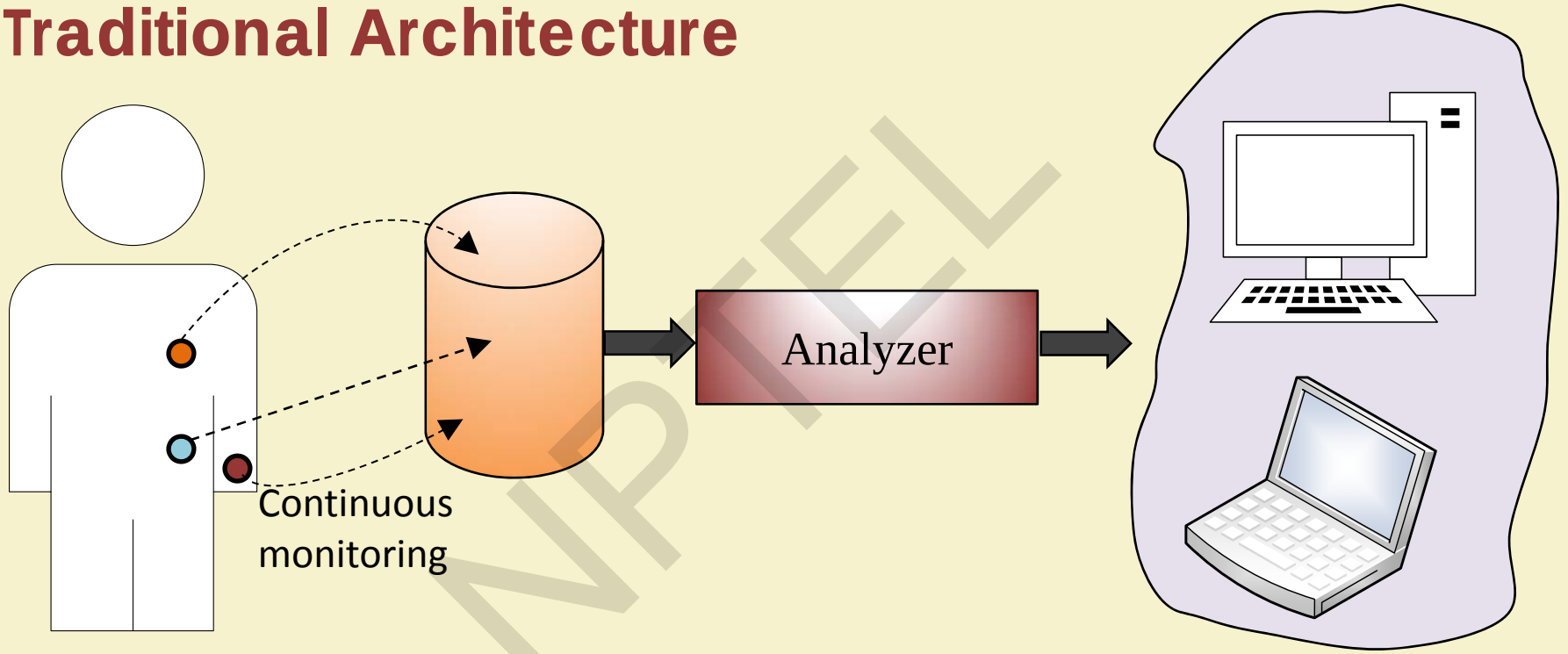
Introduction

- ✓ Wearable sensors have become very popular for different purposes such as:
  - Medical
  - Child-care
  - Elderly-care
  - Entertainment
  - Security
- ✓ These sensors help in monitoring the physical activities of humans

Introduction (Contd.)

- ✓ Particularly in IoT scenarios, activity monitoring plays an important role for providing better quality of life and safe guarding humans.
- ✓ Provides information accurately in a reliable manner
- ✓ Provides continuous monitoring support.

Traditional Architecture



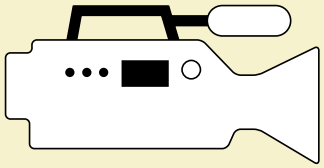
Advantages

- ✓ Continuous monitoring of activity results in daily observation of human behavior and repetitive patterns in their activities.
- ✓ Easy integration and fast equipping
- ✓ Long term monitoring
- ✓ Utilization of sensors of handheld devices
  - Accelerometer
  - Gyroscope
  - GPS
  - Others

Important Human Activities

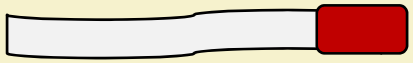
Actions	• Running • Jumping
Gesture	• Folding legs • Moving hand

Types of Sensors



Camera

Smart Phone



Activity Tracker Band

Data Analysis Tools

- ✓ Statistical
  - Sensor data
- ✓ Machine Learning Based
  - Sensor data
- ✓ Deep Learning Based
  - Sensor data
  - Images
  - Videos

Approaches

- ✓ In-place
  - On the device
  - Power intensive
  - No network connection required
- ✓ Network Based
  - Larger and processing intensive methods can be applied
  - Group based analytics possible
  - Low power consumption
  - Average to good network connection

Thank You!!