

Edge-Based Hybrid System Implementation for Long-Range Safety and Healthcare IoT Applications

Presentation content

Problems in Healthcare IOT

- The Core Problem: Short-Range Protocols in Healthcare Environments
- Other problems include high latency, network bandwidth bottlenecks, connectivity risks, privacy concerns and cloud centric
- To achieve broader coverage for these devices, conventional solutions require deploying multiple gateways, leading to significant inconvenience, increased costs, and added complexity in network infrastructure.

How the Proposed Edge System Transforms Healthcare IoT

- The proposed architecture integrates self powered router and gateway designed to overcome the limitations of cloud-centric IoT
- Ensures robust and responsive healthcare monitoring
- Significantly reduced latency, extended network coverage, enhanced reliability, strengthened security and versatile application support.

Justification of the Hybrid Edge Strategy & Architecture

- The two major components of the edge system are the Hybrid Router and IOT Gateway.
- The router is low in power consumption and performs basic edge processing. The tasks the router is intended to perform are basic threshold checks , signal processing and all necessary computations.
- The objective is to bring the processing as close to the data source as possible. This reduces latency and increases the ability to tackle critical situations satisfactorily.
- The IOT gateway is capable of more complex tasks like data filtration and analysis.
- The novelty in the research has been brought about by the router component which sends all the computed data via LoRa by setting up a LPWAN.

Components for the implementation

- Wearable node: synthetic ecg signals
- Hybrid router: utilizes nordic nrf52840 module
- IOT gateway: based on raspberry pi with LoRa, BLE modules
- Cloud layer: cloud platform

Key Challenge: Real-Time Health Monitoring

- Continuous, dynamic health data (ECG, heart rate, SpO₂)
- Limited power on edge devices (e.g., Raspberry Pi)
- Delay in processing risks patient safety

Solution: Layered Resource Allocation

- Wearable sensor → Collects ECG only (energy saving)
- Router (edge layer) → Signal filtering, heart rate calculation, alert trigger
- Gateway → Data storage, visualization, cloud forwarding if needed

Benefits: Low latency, bandwidth efficiency, reliable operation without internet

Questions posed and addressed after the presentation.

Q1) How will failure of nodes be addressed ?

Soln - Regular maintenance and monitoring of nodes will happen at both edge layers 1 and 2 via the router and gateway respectively. Fallback routers and nodes will be present to keep the system functional.

Q2) How is security ensured?

Soln - In each layer, data is encrypted using AES encryption which ensures raw data is not flow being shared within layers. In the cloud layer, security services are provided by the cloud platforms.