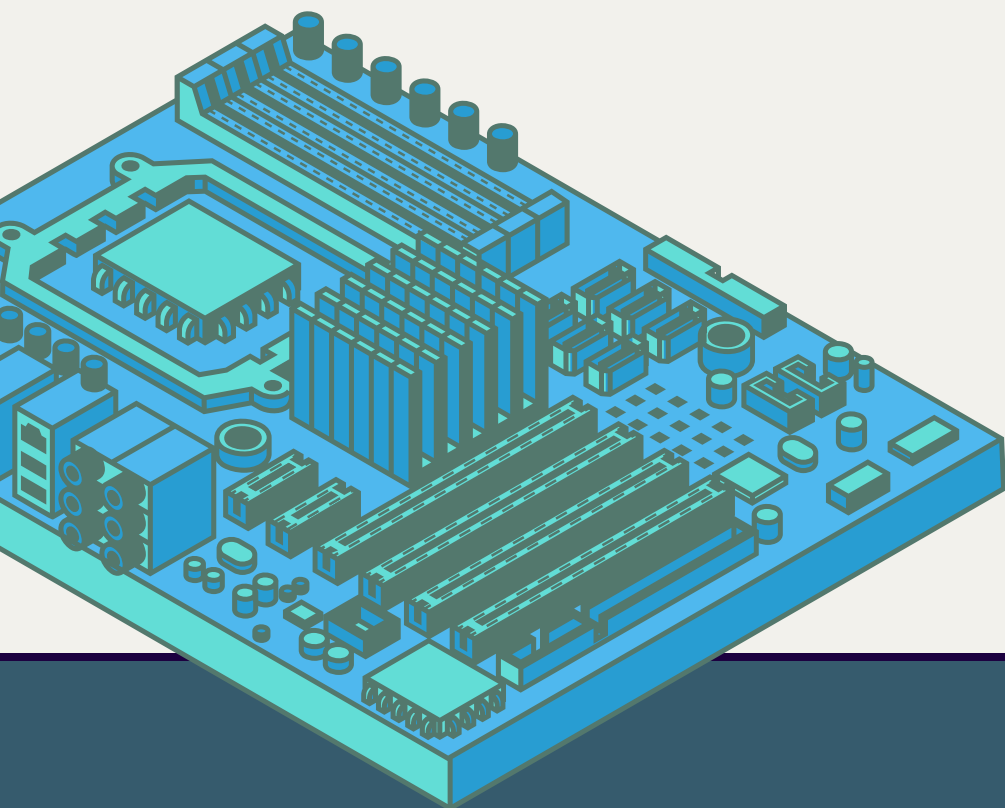
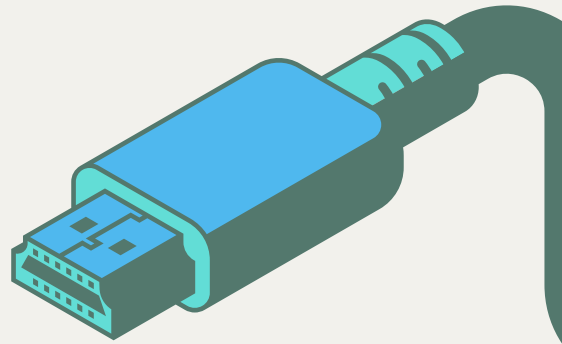
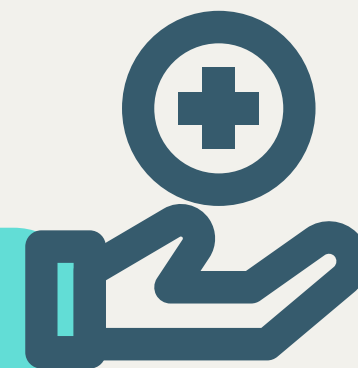


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# Edge-Based Hybrid System Implementation for Long-Range Safety and Healthcare IoT Applications



HEALTHCARE IOT



# Problems in Healthcare IoT

## THE CORE PROBLEM: SHORT-RANGE PROTOCOLS IN HEALTHCARE ENVIRONMENTS

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.



**HIGH LATENCY &  
DELAYS**

**NETWORK  
BANDWIDTH  
BOTTLENECKS**

**INTERMITTENT  
CONNECTIVITY  
RISKS**

**PRIVACY AND  
SECURITY  
CONCERNS**

**CLOUD CENTRIC**

# How the Proposed Edge System Transforms Healthcare IoT

This paper introduces a novel hybrid edge architecture, integrating self-powered hybrid routers and a versatile IoT gateway, specifically designed to overcome the limitations of cloud-centric IoT in healthcare.

It strategically distributes computational and storage capabilities closer to the data sources, ensuring robust and responsive healthcare monitoring.

SIGNIFICANTLY  
REDUCED  
LATENCY FOR  
REAL-TIME  
CARE

EXTENDED  
NETWORK  
COVERAGE IN  
LARGE  
FACILITIES

ENHANCED  
RELIABILITY &  
OFFLINE  
OPERATION

STRENGTHENED  
SECURITY &  
PRIVACY

VERSATILE  
APPLICATION  
SUPPORT

# Justification of the Hybrid Edge Strategy & Architecture

The paper's core strategy is to implement an edge-based hybrid network system that strategically distributes computational and storage capabilities closer to the data sources.

It specifically tackles the problem of limited short-range coverage by integrating long-range capabilities at the edge, reducing the need for numerous, costly gateways.

## Hybrid Router

Low power +  
robust  
LoRa based  
LPWAN  
Preliminary Processing

## IOT Gateway

Powerful hub within edge  
Centralized point  
advanced edge tasks

---

# Edge Implementations

04

## HYBRID ROUTER

RANGE EXTENSION

PRELIMINARY DATA PROCESSING

PROMPT RESPONSES/EMERGENCY  
DETECTION

## IOT GATEWAY

ADVANCED PROCESSING AND  
NETWORK MANAGEMENT

LOCAL GUI

SeCURITY

CLOUD CONNeCTION

# Components for the Implementation

## WEARABLE HEALTHCARE SENSOR NODE

Employs the AD8232 ECG front end to measure ECG signals or Synthetic ECG signals to mimic real ECG signals

## HYBRID ROUTER

UTILIZES a Nordic nRF52840 MCU with BLE 5 and a LoRa module.

## IOT GATEWAY

Based on Raspberry Pi with LoRa, BLE, and WiFi modules.



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# State of the Art Literature

## 1. Recent Advances in Wearable Sensing Technologies

by Alfredo J Perez, Sherali Zeadally

Focus: The safety measures discussed center around device communication reliability, data integrity during short-range transmission, and real-time local responsiveness

## 2. Recent Advances on IoT-Assisted Wearable Sensor Systems for Healthcare Monitoring

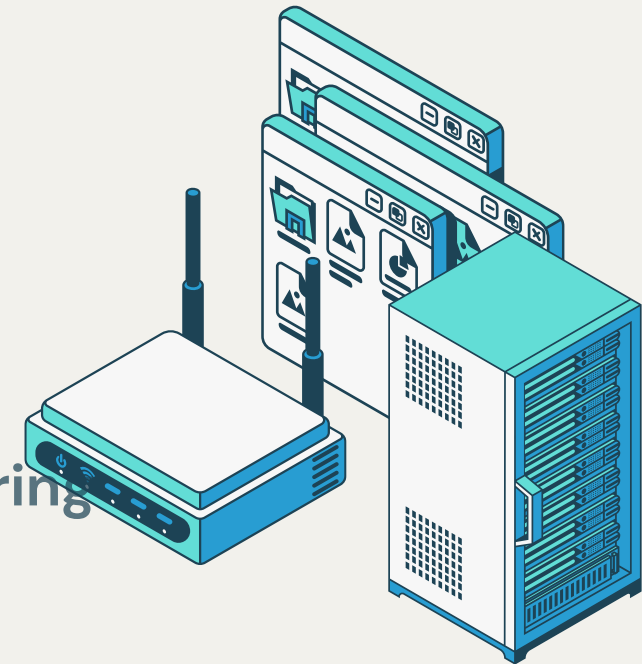
by Shwetank Dattatraya Mamdiwar, Akshith R, Kathiravan Srinivasan, Chuan-Yu Chang

Focus: The paper examines data transfer protocols and proximity-based patient monitoring, underscoring mechanisms for user and device authentication in closed environments.

## 3. The Rise of Wearable Devices during the COVID-19 Pandemic

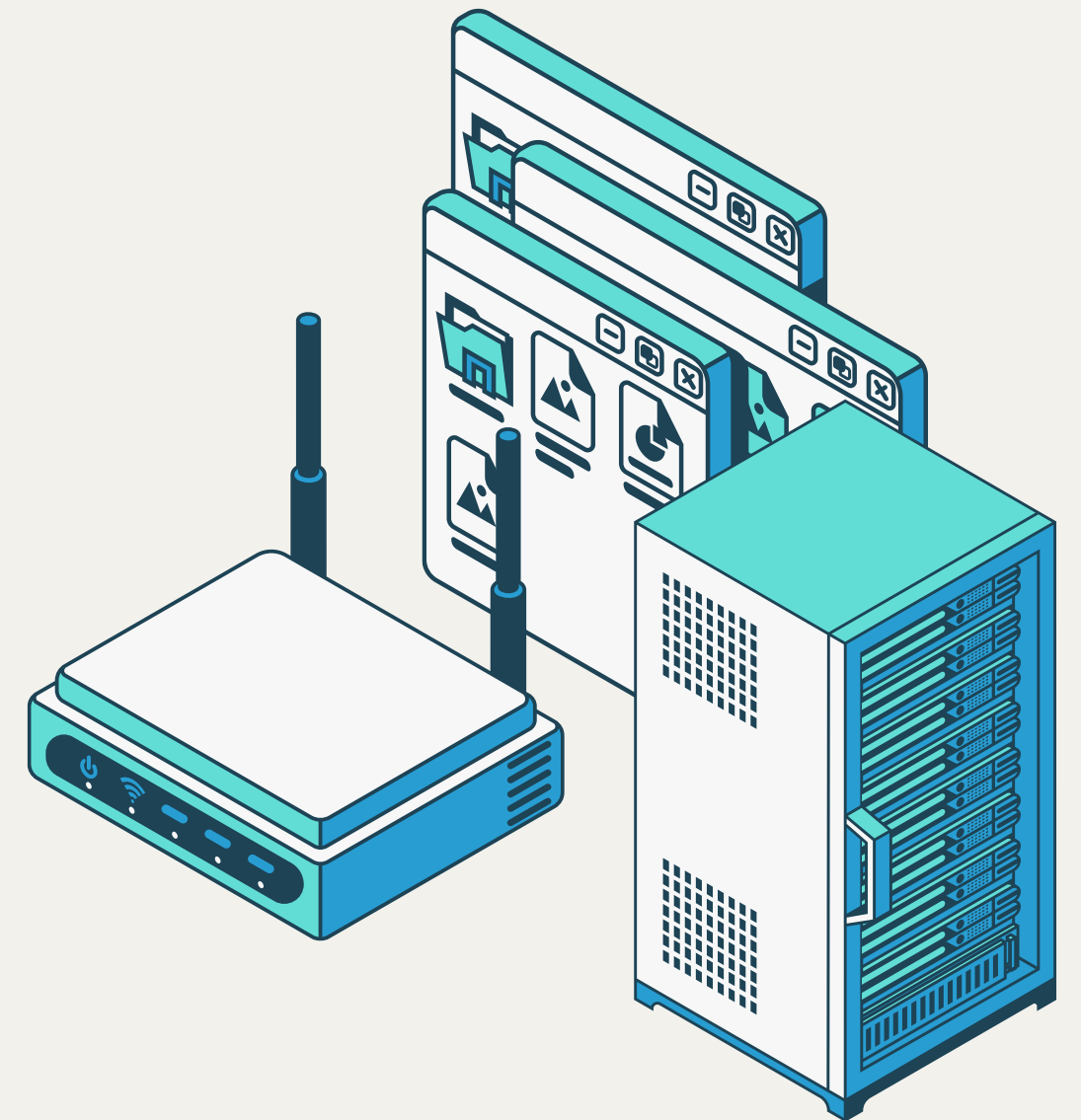
by Asma Channa, Nirvana Popescu, ustyna Skibinska, Radim Burget

Focus: Systematic review of wearable devices deployed for real-time, short-range health monitoring



# State of the Art Literature

- Explicit Long-Range Safety Support
- Unified Hybrid Network Architecture
- Edge Computing for Both Proximity and Remote Scenarios
- Energy Efficiency and Autonomous Operation
- Comprehensive Security Handling
- Real-World, Multi-Scenario Validation
- Network Scalability and Robustness





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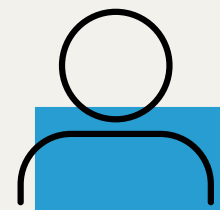
# Why Resource Allocation Matters ?

- Real-time health data (HR, SpO<sub>2</sub>) is variable and continuous
- Edge devices (e.g., Raspberry Pi) have limited power
- Delays can risk patient safety
- Smart allocation = low latency, high efficiency

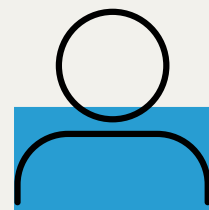
## KEY CHALLENGES ADDRESSED

- Task Scheduling: Prioritize urgent health tasks
  - Task Offloading: Shift load → wearable → edge → cloud
  - Load Balancing: Prevent overload on nodes
  - Communication Overhead: Smart use of BLE & LoRa
  - Security & Efficiency: Lightweight protection for data
-

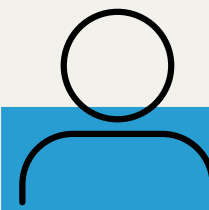
# Task split up



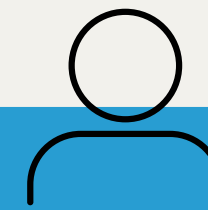
**Assembly and  
deployment of  
hardware**



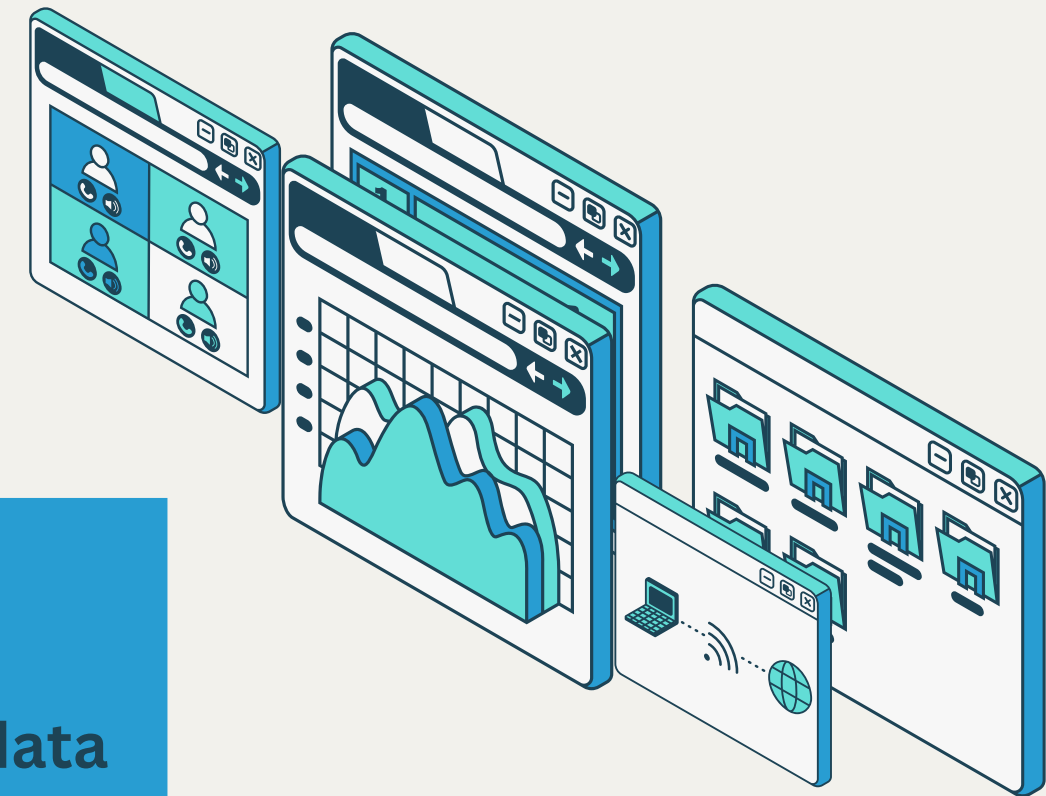
**Module  
understanding  
+Router  
programming**



**Gateway  
optimization +  
cloud  
synchronization**



**Edge tasks - data  
processing +  
filtering**



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# Thank You

B H U V A N E S H W A R I D

C B . S C . U 4 C S E 2 3 6 1 2

R A M A R O S H I N E E S V

C B . S C . U 4 C S E 2 3 6 4 5

S H R U T H I L A Y A A V

C B . S C . U 4 C S E 2 3 6 5 3

S H A R U M A T H I P S

C B . S C . U 4 C S E 2 3 6 6 5

