



CareBridge-The 3D Digital Twin Framework for Proactive Elderly Care Using Real Time Sensor Data and GenAI Analytics

Presented by:



Theme: HealthCare

[CareBridge: Deployment, Scaling, Documentation](#)

The Problem

173 Million Indian seniors by 2026 ([UNFPA 2023](#))

75% suffer from chronic diseases: Existing apps show raw numbers without predictive analytics

70% face a digital literacy gap: No explainability for elderly users

No correlation between vital spikes and environmental stressors: No integration of AQI, heat, humidity into cardiac risk modeling

Current monitoring systems are reactive and threshold-based

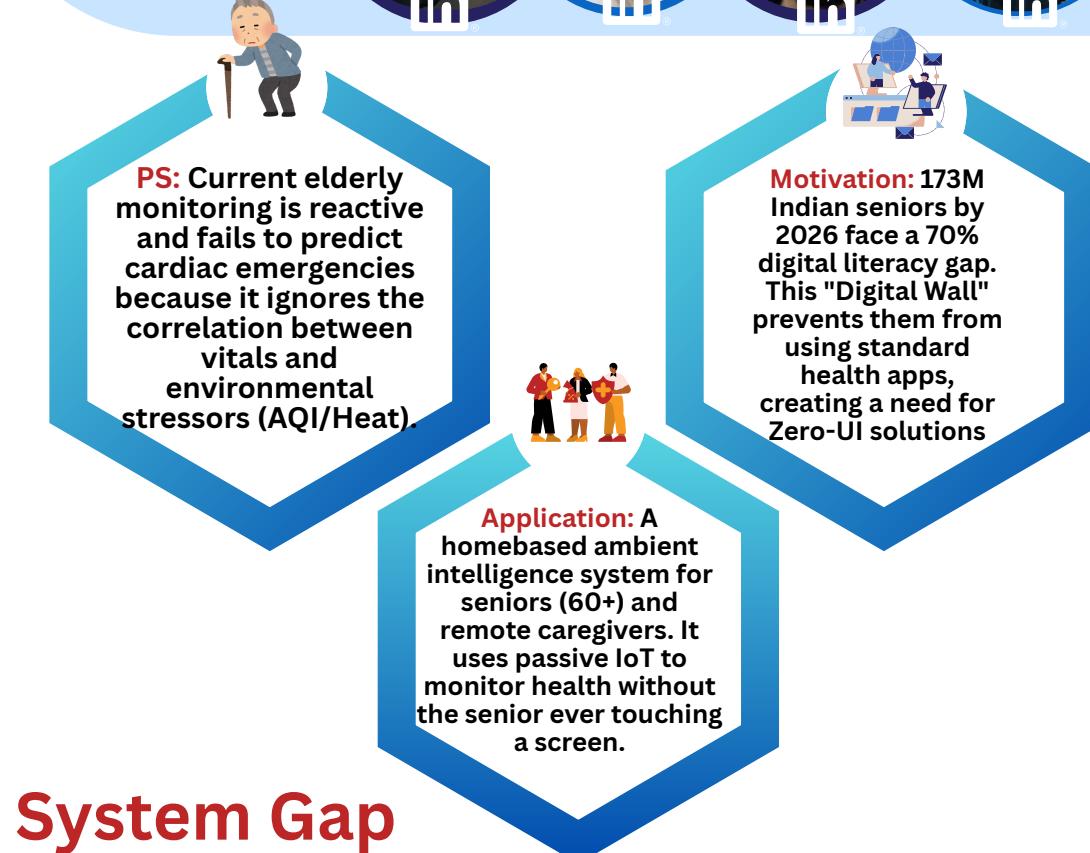
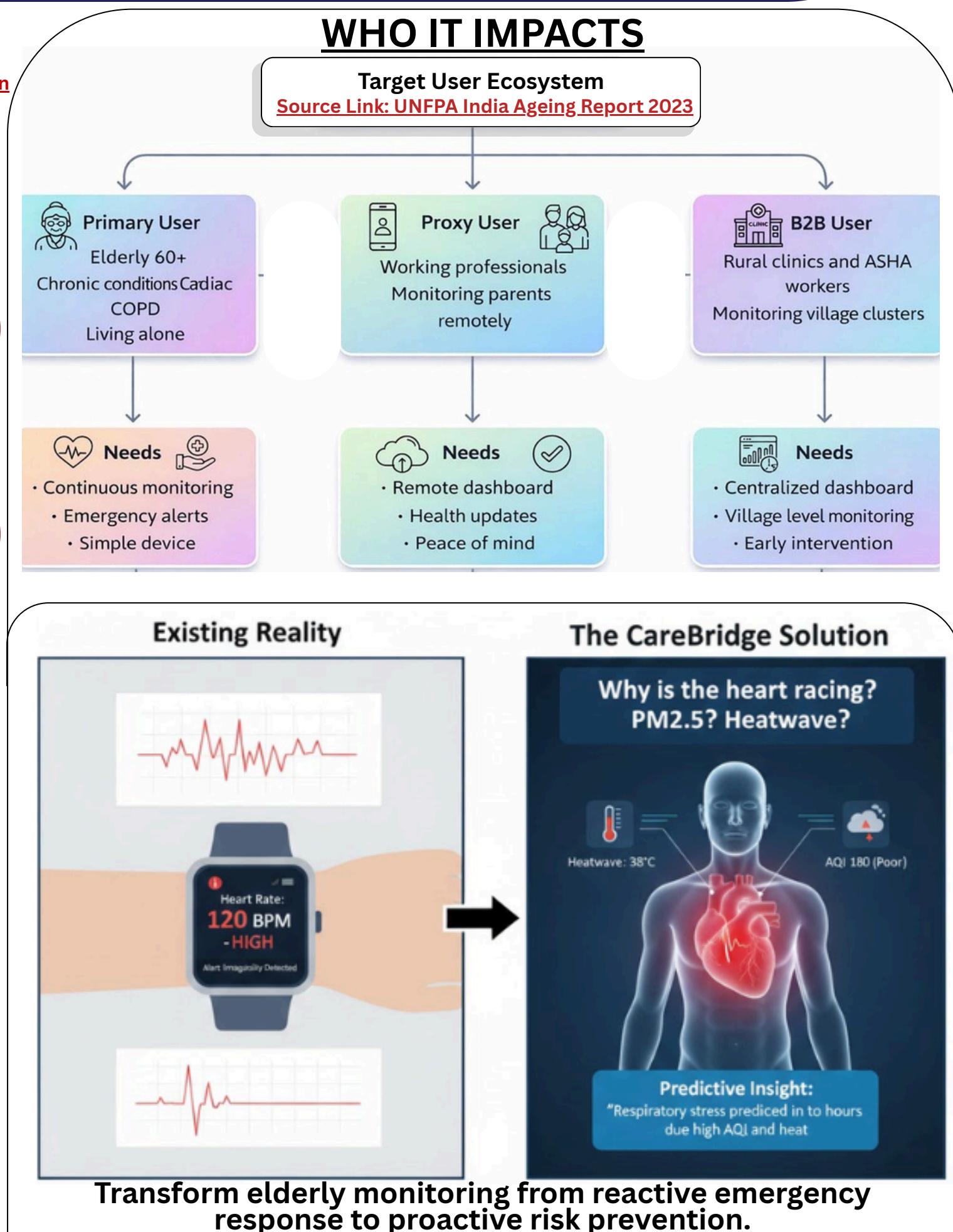
The Solution – CareBridge

GenAI-powered Med-RAG clinical reasoning system

Moving beyond 2D charts to a real-time 3D human world:
Built with Three.js to provide "At-a-glance" status (Red/Amber/Green organ stress) instead of confusing 2D charts.

Zero-UI passive monitoring (no screen interaction required)

Environmental–Vital Correlation Engine



System Gap

PROBLEM: High readmission for heart failure.
SOLUTION: Remote heart rate monitoring reduces hospitalization significantly

PROBLEM: Frequent ER visits for asthma/COPD.
SOLUTION: Integrating air quality/humidity data reduces emergency visits

PROBLEM: Unidentified atrial fibrillation strokes.
SOLUTION: Optical sensors in wearables show high sensitivity for early detection.

Core Novelty

First framework correlating AQI/heat triggers with cardiac stress

Predictive alerts 2–3 hours before possible events

Voice-first, local-language risk explanation

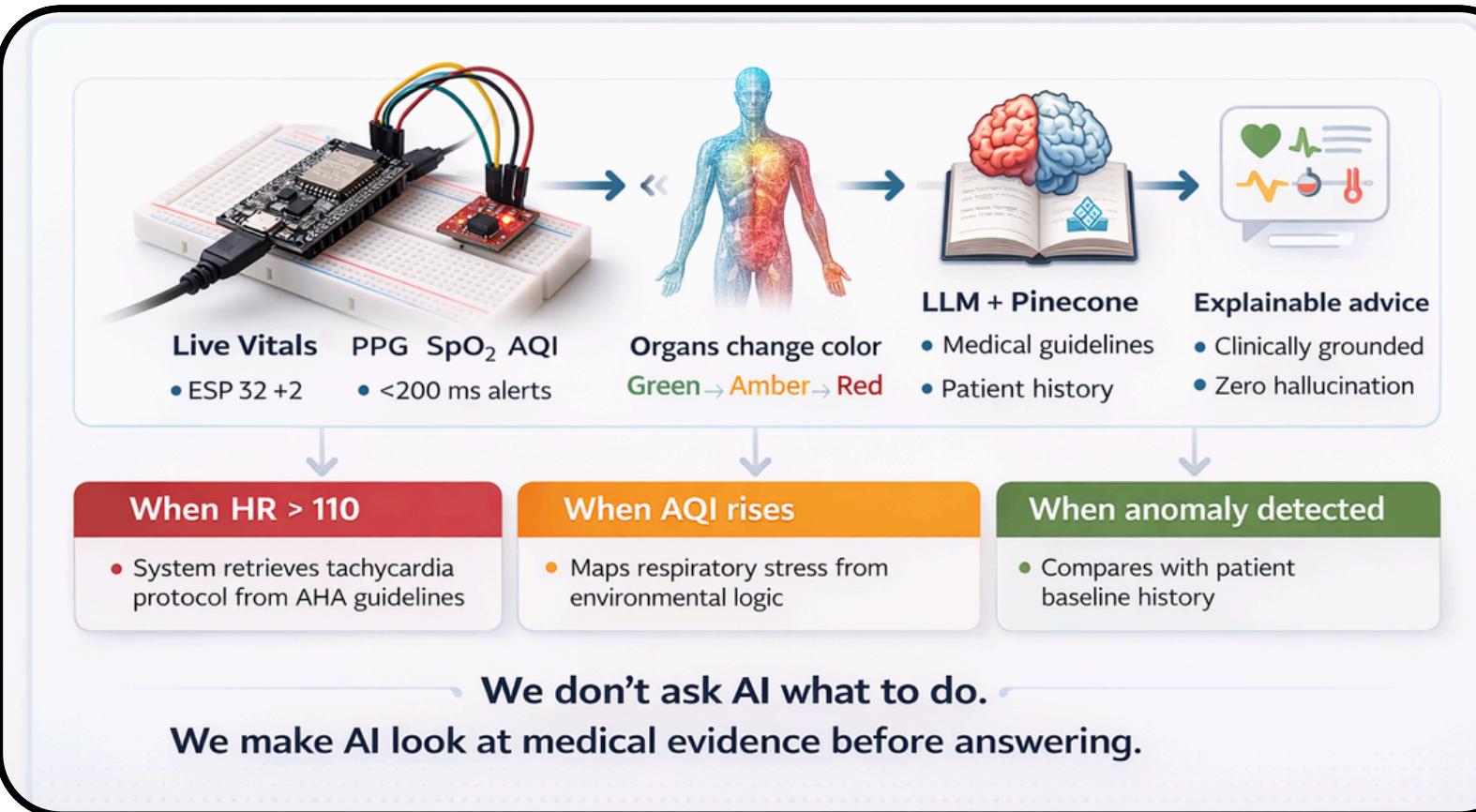
Architecture, Data Sources & Technology Stack



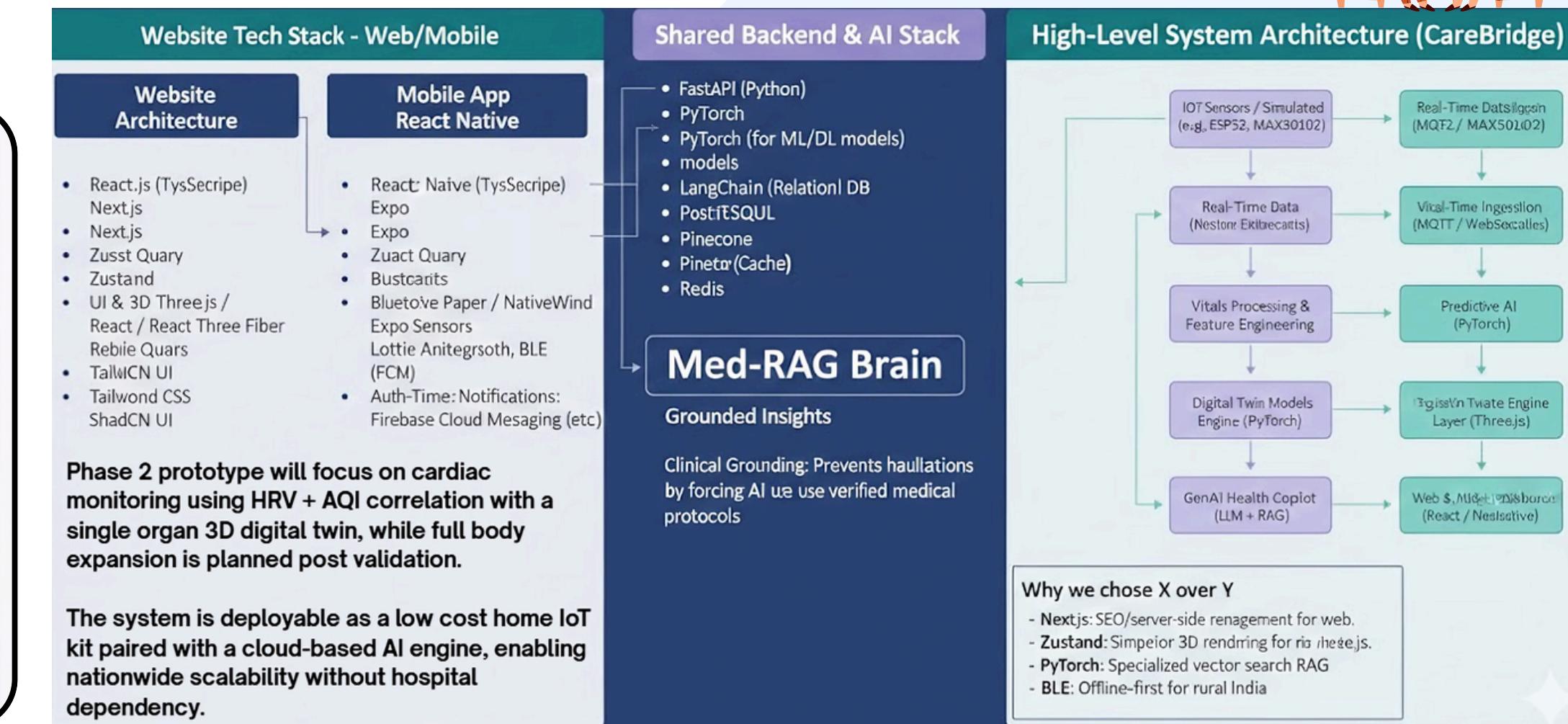
System Architecture

ESP32 Sensors → Edge Processing → Med-RAG Engine

→ 3D Twin Dashboard



FULL STACK ARCHITECTURE



IoT Layer

- Passive heart rate, respiratory and wearable optical sensors
- Bluetooth Store-and-Forward (24-hour caching)
- LoRa-based ASHA Mesh Network for rural scaling

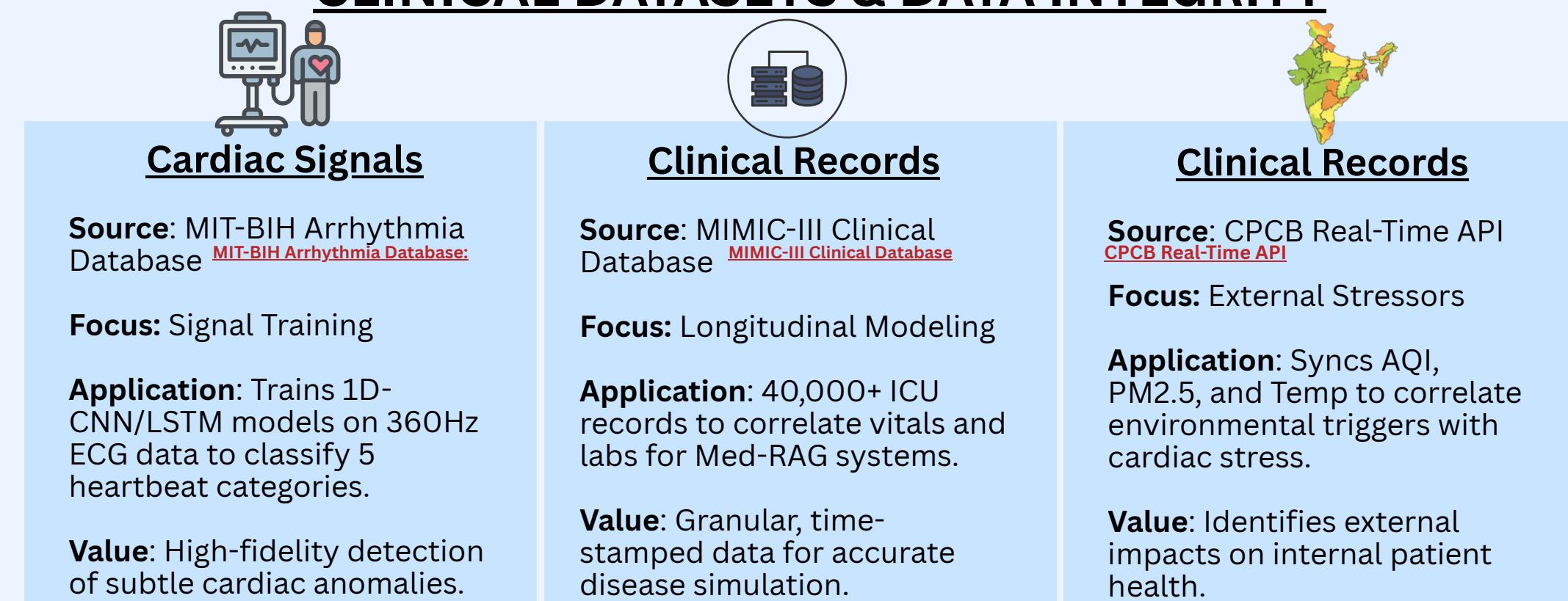
AI & Intelligence Layer

- Gemini 1.5 Pro + Llama-3 for reasoning
- Pinecone Vector Database for grounded clinical protocols
- Quantized Edge Llama-3 for offline rural inference

Validation Framework

- Precision, Recall, F1-score (Anomaly Detection)
- Time-to-Alert vs threshold-based systems
- Human-in-the-loop explainability validation

CLINICAL DATASETS & DATA INTEGRITY





Summary



Solving Rural / No-Internet Access

Edge AI Inference: Uses quantized Llama-3 models locally to analyze data without cloud reliance.
 Bluetooth Store-and-Forward: ESP32 sensors cache 24h of data and sync via BLE to a caregiver's phone.
 ASHA Mesh Network: Uses low-power radio/LoRa to sync multiple homes to one central rural health post.

Evidence & Data Sources

- Clinical Signals: [MIT-BIH Arrhythmia Database](#) – Open-access, gold-standard EKG data for training cardiac anomaly detection.
- Medical Context: [MIMIC-III Database](#) – Restricted-access ICU records used for longitudinal modeling and RAG clinical grounding.
- Env. Triggers: [CPCB Real-Time API](#) – Public Govt. API providing live AQI/PM2.5 data to correlate external stressors with vitals.
- Market & Demand: [UNFPA Ageing Report](#) & [NITI Aayog Senior Care](#) – Reports validating the 173M elderly surge and the 70% digital literacy gap.

Understanding EKG Basics

This video provides an overview of the India Ageing Report 2023, which is a key document for understanding the demographic shifts and healthcare needs of the elderly population in India that our project addresses.

Experiments & Validations

1. Cardiac Stress Detection

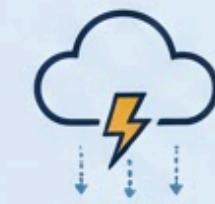


95%

Sensitivity on MIT-BIH Dataset

Validated using a five-fold cross-validation strategy on expert-annotated ECG data to ensure high accuracy in identifying early cardiac anomalies.

2. Real-Time IoT-to-Web Latency

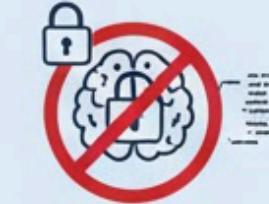


<200ms

From Sensor to Alert

Critical for timely interventions like fall detection and acute event alerts. Tested under typical Indian rural network conditions using BLE Proxy-Sync.

3. AI Hallucination Reduction



30%

Less Hallucinations with Med-RAG

Our RAG layer grounds responses in clinical facts (MIT-BIH, MIMIC-III), preventing mifomomeration and ensuring reliable caregiver advice.

Revenue Model

B2B2C Subscription: Flat ₹10/month per patient for scalable community-led deployments.

HaaS (Hardware-as-a-Service): Low-cost "Invisible Guardian" sensor kits sold to clinics/families.

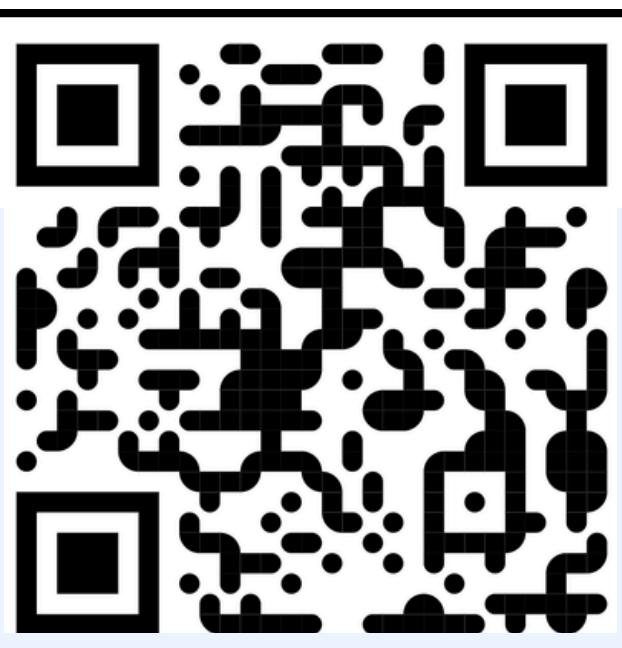
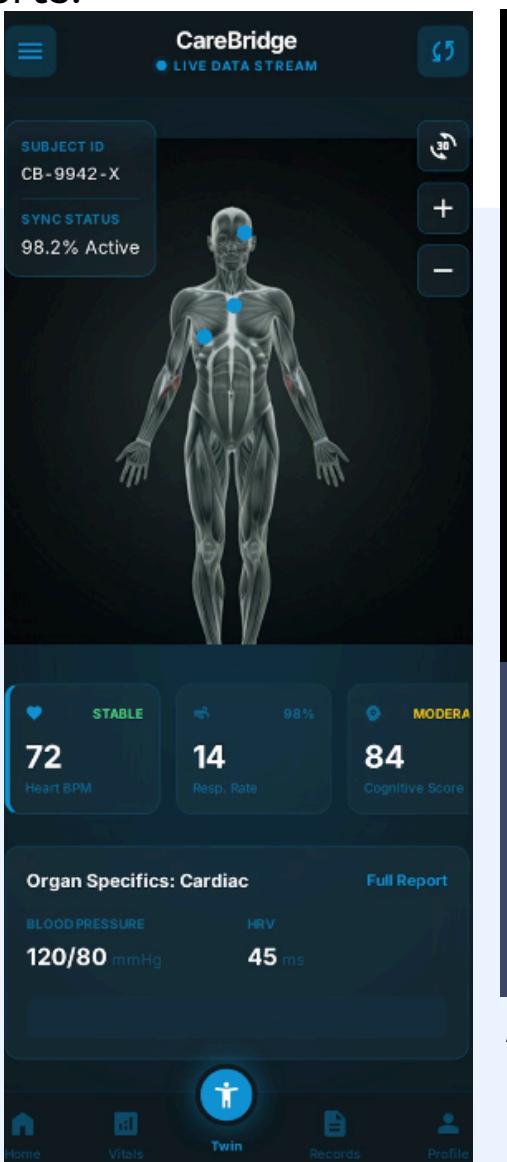
G2B Scaling: Partnering with Ayushman Bharat (ABDM) for government-funded rural monitoring. [Source Link: IoT in Healthcare Market Size - MarketsandMarkets](#)

The "Why Use It" (Zero Tech-Savviness)

Zero-UI Interaction: No buttons to press; monitoring is 100% passive and automatic.

Visual Diagnosis: Replaces complex charts with a 3D Heart that turns Red when stressed.

Voice-First Feedback: GenAI explains risks through simple local-language audio alerts.



**CareBridge :
Research Platform**

URL:
<https://carebridge-research.vercel.app/>



**CareBridge :
Prototype**

URL:
<https://care-bridge-iota.vercel.app/>

All research findings, clinical analyses, environmental models and system architecture documentation are available on the research portal