CSIT321
Autumn 2025

S.H.I.E.L.D

SECURE HEALTH INTELLIGENCE & EVALUATION LOGIC DATABASE

The HexaCore

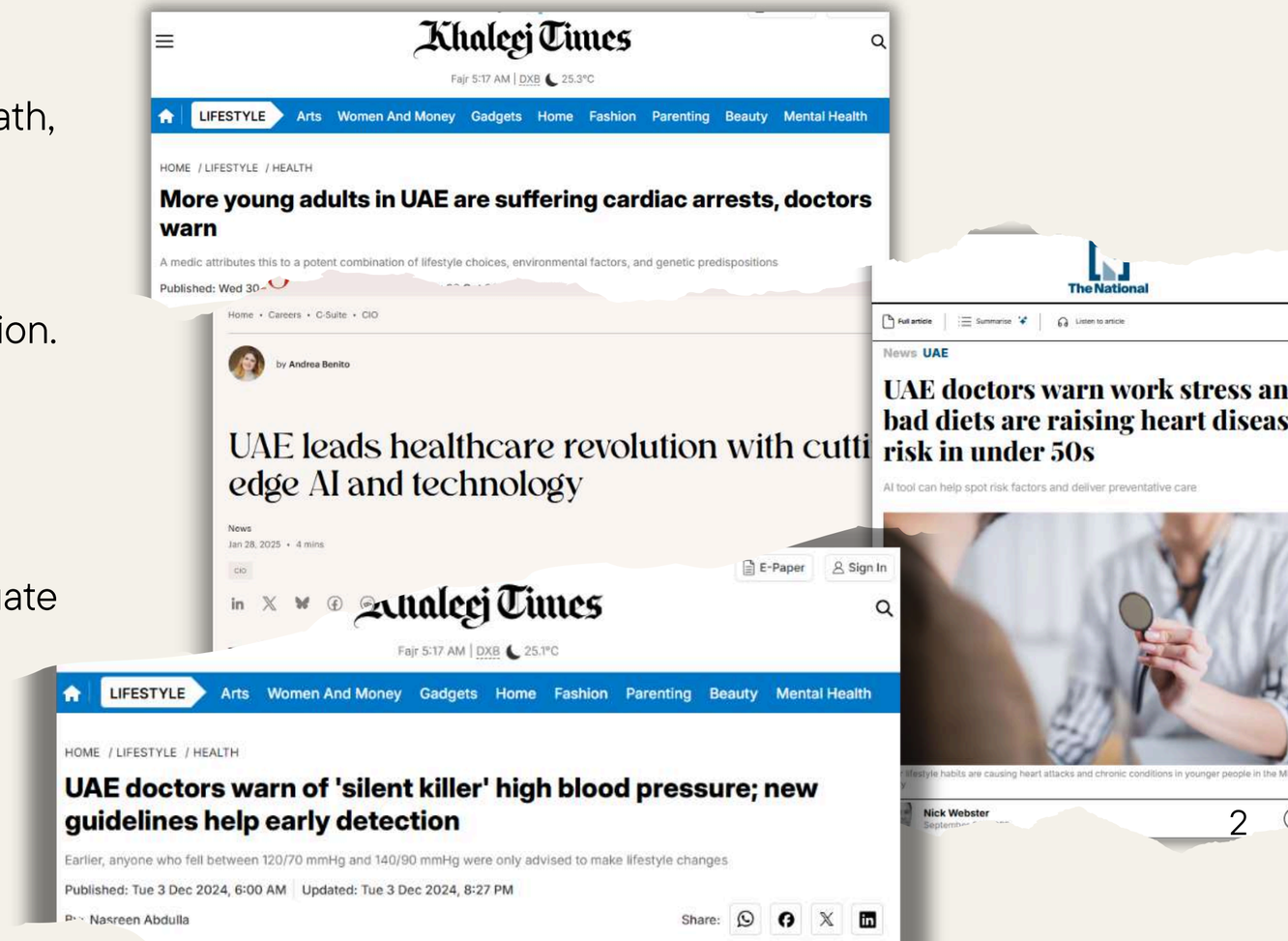
Group 10

THE PROBLEM

Let's begin with the critical issue we're solving:

- Cardiovascular disease is the world's leading cause of death, and it's now sharply rising among people under 50 in the UAE.
- Current health apps are failing us, they are reactive, only showing past data, and insecure with our private information.
- This creates a dangerous gap where people lack a trustworthy, early-warning system for one of the biggest health threats we face.

We have a massive health crisis, met with completely inadequate technology.



WHY IS IT INTERESTING?

This isn't just another health app. It's interesting because we're solving a critical problem at the perfect time.

- First, there's a massive and growing need, with heart disease now striking a younger population here in the UAE.
- Second, we are directly aligned with the UAE's AI Strategy 2031, using cutting-edge technology for national health goals.
- And third, we're using revolutionary Federated Learning, a privacy-first AI that has never been applied like this in consumer heart health.

We're not just tracking health; we're forecasting it, securely.

THE OBJECTIVE

Our objective is precise and ambitious.

S.H.I.E.L.D

SECURE HEALTH INTELLIGENCE & EVALUATION LOGIC DATABASE

An AI-powered mobile application that acts as a proactive health guardian.

Its core function is to provide predictive warnings for cardiovascular risks, not just reactive alerts.

And it achieves this with a fundamental promise: keeping all sensitive user data securely on their own device.

RESEARCH STUDY 

When we researched the landscape, the findings were clear.

- Studies confirm that AI can accurately predict cardiovascular events.
- However, these models are often 'black boxes'—they lack explainability, which hurts user trust.
- And the standard approach of uploading health data to the cloud creates significant privacy risks.

So, therfore is clear: the potential of AI is proven, but its current implementation is inadequate for building a trusted health partner.

THE MARKET GAP

On-Device Data
Current platforms rely on cloud-only processing, risking delays and privacy exposure

Digital Twin
Personalized heart modeling on-device doesn’t exist anywhere else

Predictive Analysis
Existing apps are reactive only in the moment, none predict cardiovascular events on past trends

High Accuracy Metrics
Competitors provide limited or generic stats, they lack precise, validated metrics.

Insights on Metrics
Raw data is reported, but actionable insights and explanations are missing

COMPETITOR ANALYSIS

App	Pros	Cons
Apple health	Measures HR, HRV, SpO_2, respiratory rate, and basic vitals	• Insights are generic with minimal clinical explain-ability • Lacks advanced or high-accuracy cardiovascular metrics
Samsung health	Measures HR, HRV, SpO_2, respiratory rate, and activity metrics	• Recommendations are surface-level and lack explain ability • Does not deliver higher-fidelity cardiovascular analytics
WHOOP	Tracks HR, HRV, SpO_2, respiratory rate, sleep, recovery, and strain	• Heavy dependence on cloud storage for analysis • No on-device or real-time predictive AI • Insights remain generalized rather than personalized • Requires a recurring subscription
iCardiac	Captures basic cardiac data through forms and camera-based readings	• No IoT, wearable, or smartwatch integration • Provides no meaningful insights or guidance • Measurement precision is low and inconsistent

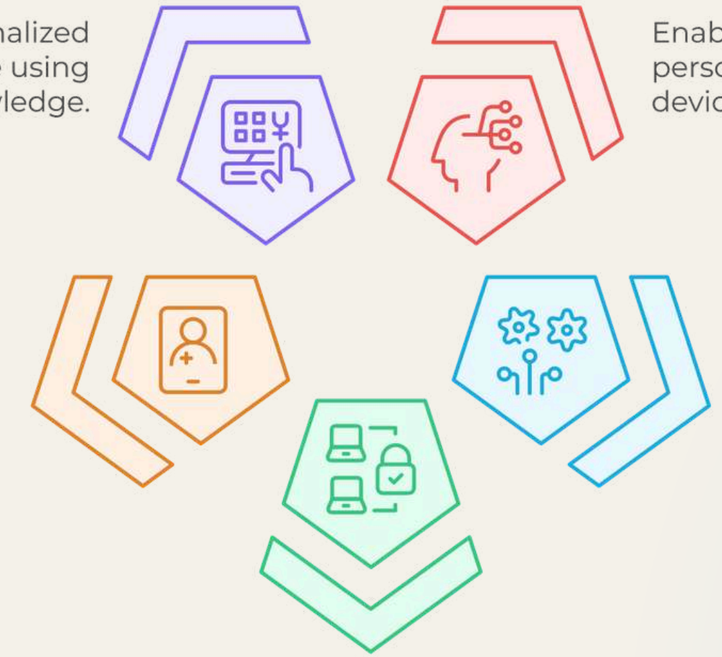
S.H.I.E.L.D - FEATURE ECOSYSTEM

RAG System

Provides personalized medical advice using clinical knowledge.

Edge AI

Enables predictions and personalized insights on-device.



Digital Twin

Creates personalized health models for proactive health management.

IoT Integration

Seamlessly connects wearable and medical sensors for real-time data.

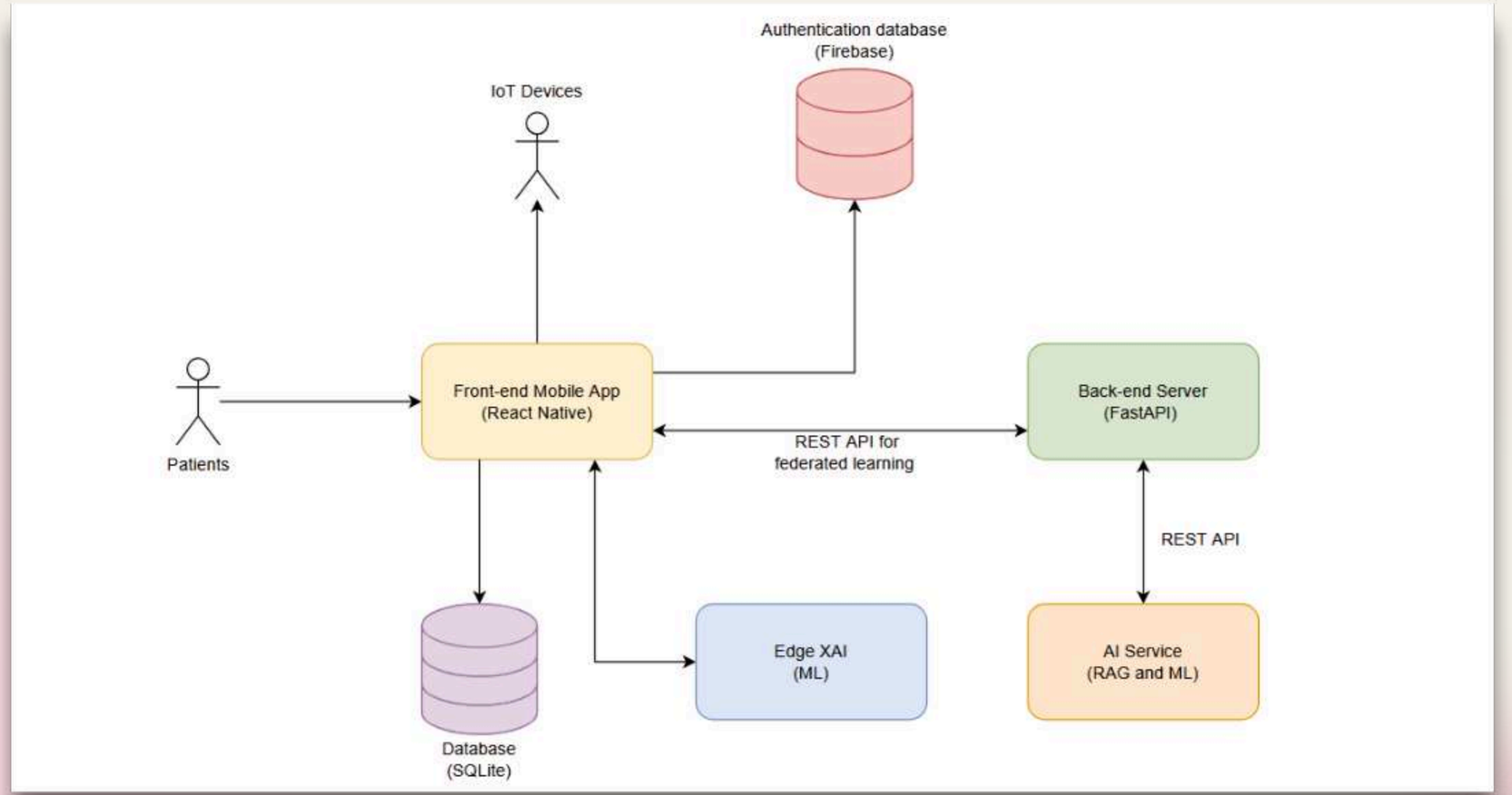
Federated Learning

Ensures privacy by training models locally and sharing only updates.

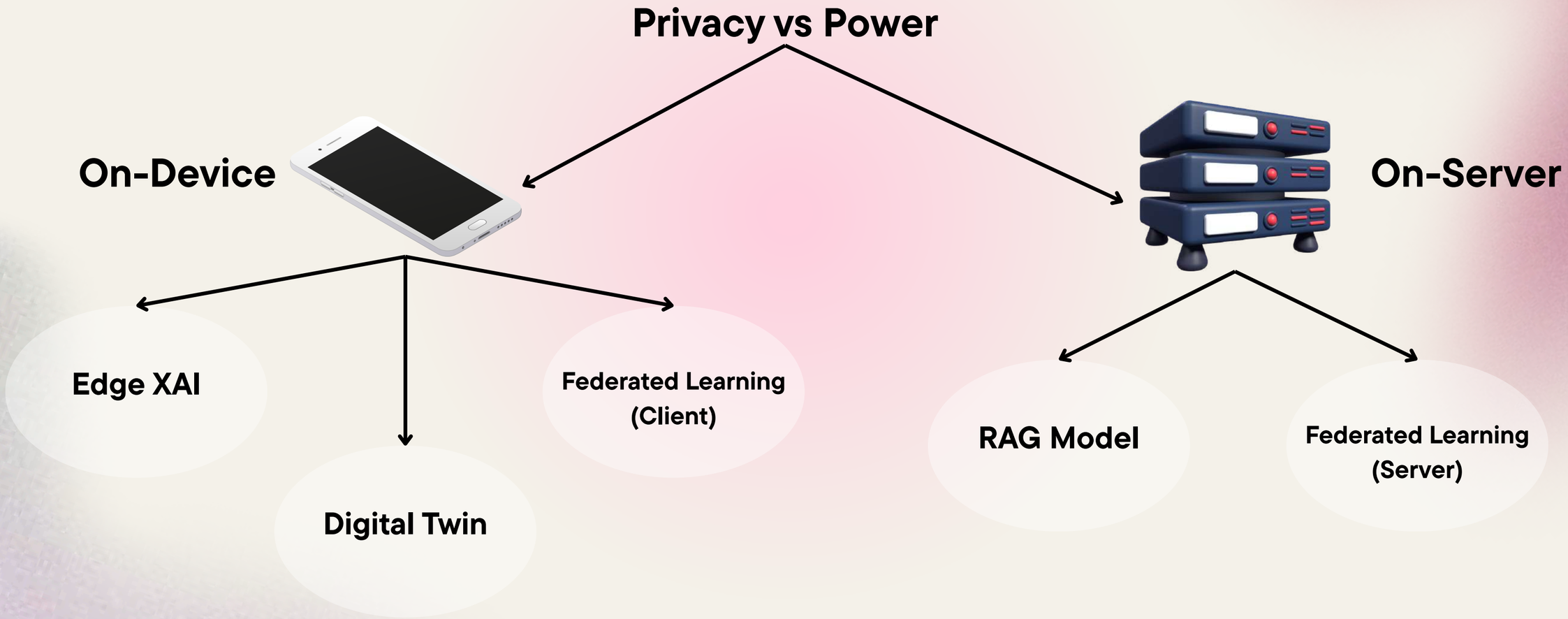
COMPETITOR TABLE

App	Apple Health / Samsung Health	iCardiac	WHOOP	S.H.I.E.L.D
IoT Integration	✔	X	✔	✔
Digital Twin	X	X	X	✔
Privacy / Federated Learning	X	X	X	✔
Predictive Analysis	X	X	X	✔
Medical Advice	Limited	X	Limited	✔

HIGH-LEVEL SYSTEM ARCHITECTURE

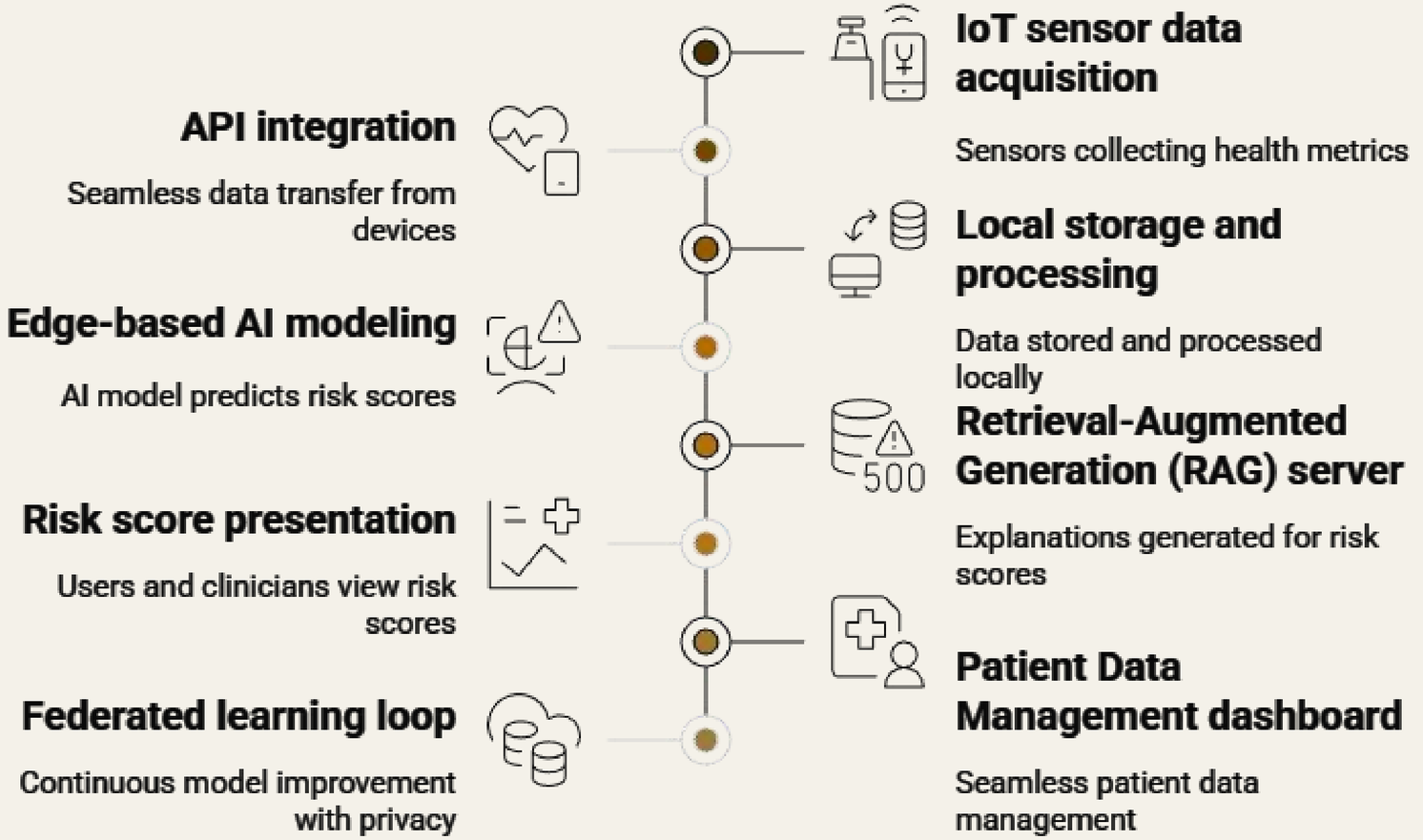


CORE COMPONENTS



END-TO-END PROCESS FLOW

The Data Journey →



OUR METHODOLOGY

Parallel Prototyping →

5 Release

Deploy the fully functional AI-powered application.

4 Integrate & Demo

Integrate the proven AI into the final app and demonstrate its capabilities.

3 Develop & Engineer

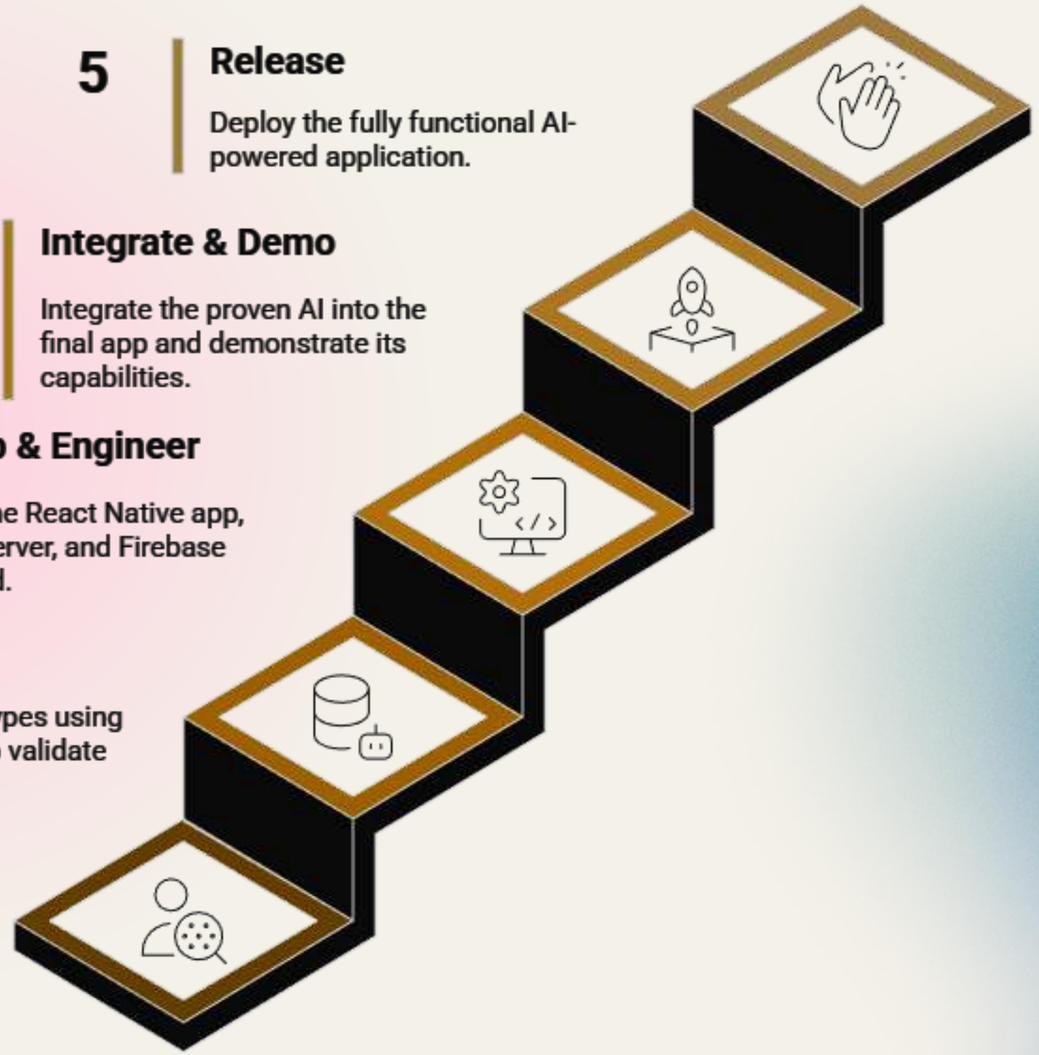
Develop the React Native app, FastAPI server, and Firebase dashboard.

2 Prototype & Test

Build and test AI prototypes using Raspberry Pi/Arduino to validate functionality.

1 Research & Validate

Conduct literature review and gather feedback to ensure the AI concept is sound.



THE TECHNOLOGIES

Our Core Innovations

IoT Sensor Network

Federated Learning

Edge XAI

RAG Engine

TECHNOLOGIES:
IOT SENSOR NETWORK

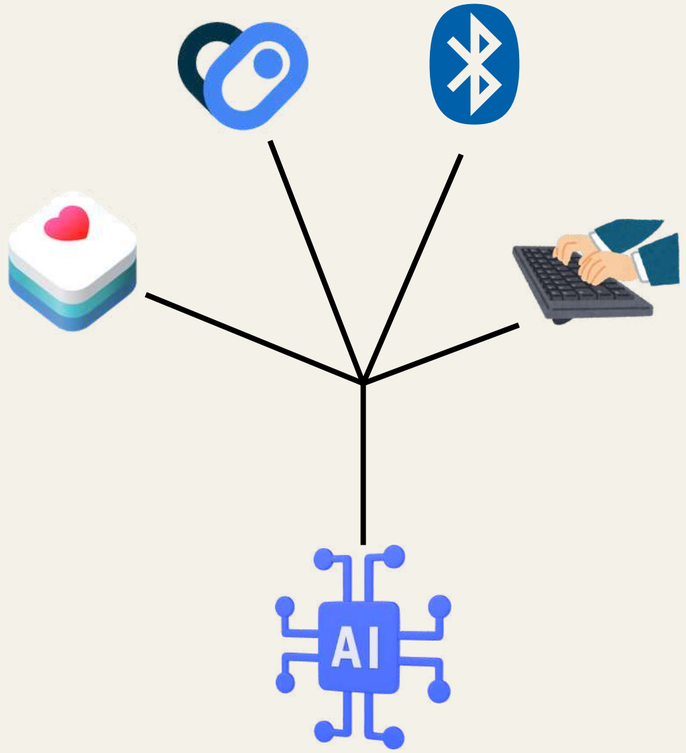
The Devices:

Consumer Grade: Apple Watch, Samsung Watch, Fitbit, Garmin

Medical Grade: Bluetooth BP Cuffs, ECG Patches, Continous GM Devices

The Data:

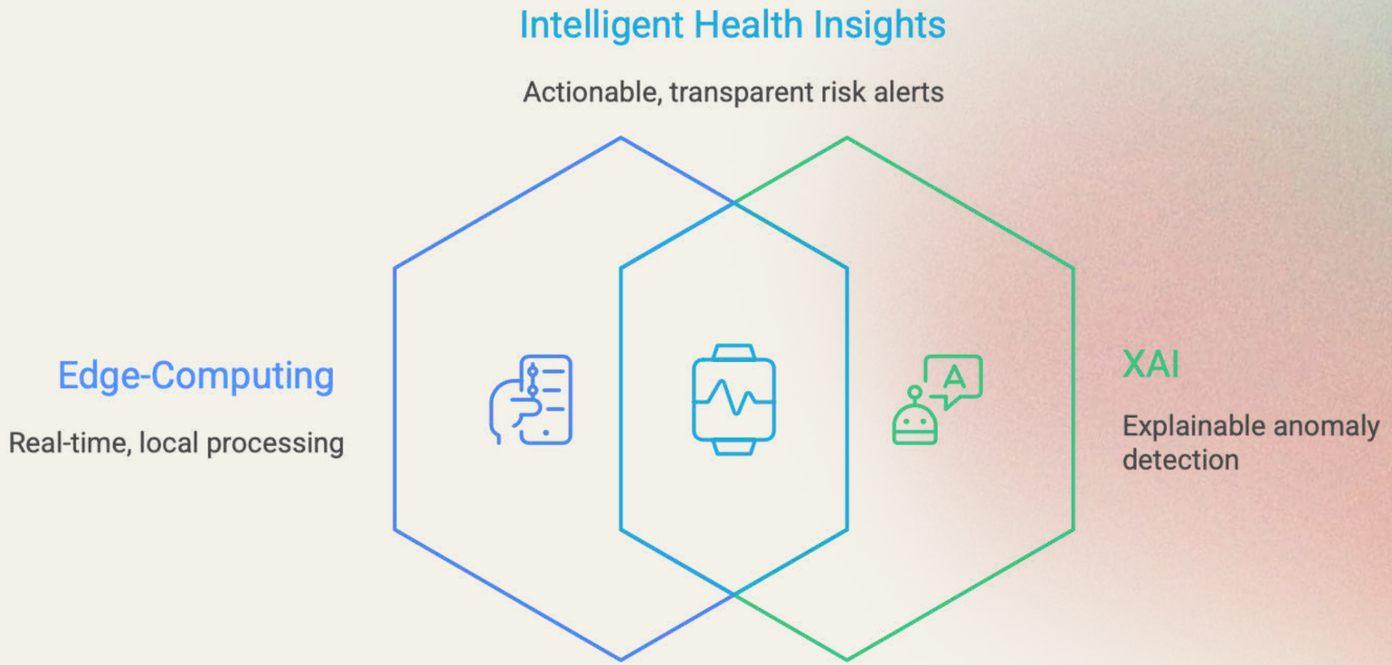
HR, HRV, BP, Sp02, ECG, Sleep Metrics



TECHNOLOGIES:
EDGE XAI

Values:

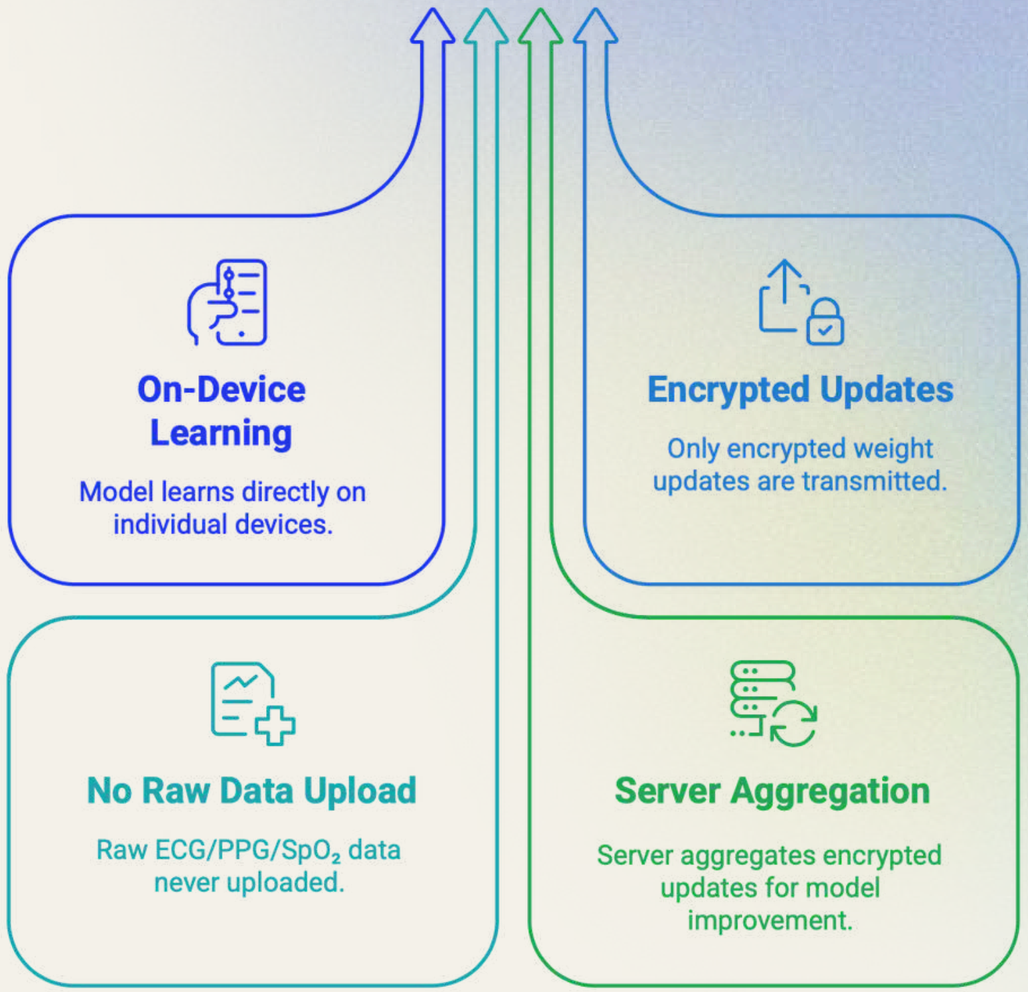
- Ultra-low latency
- Works offline
- Privacy preserved
- Zero cloud dependancy



TECHNOLOGIES:
FEDERATED LEARNING

Model training without the training data.

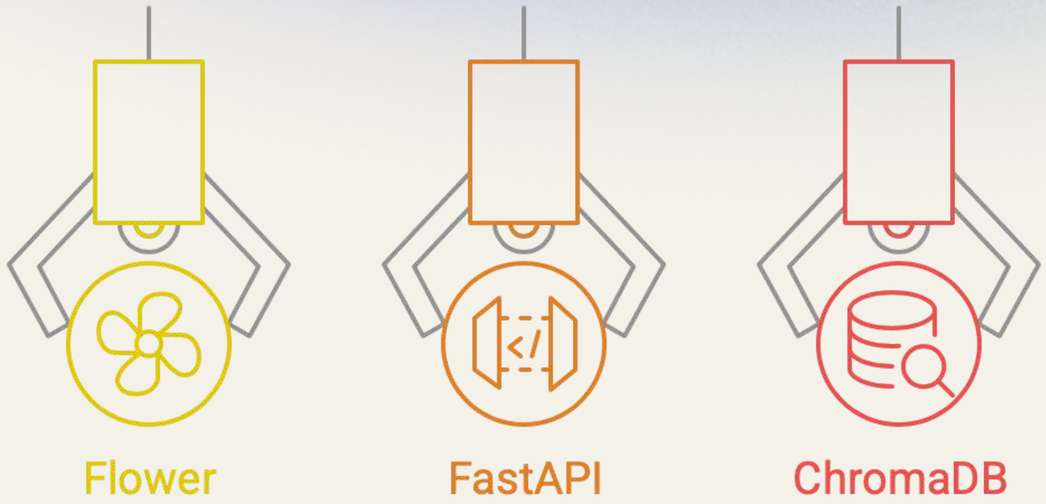
- Data stays on device
- PDPL-friendly design
- Privacy-by-design
- Better accuracy from diverse real-world data



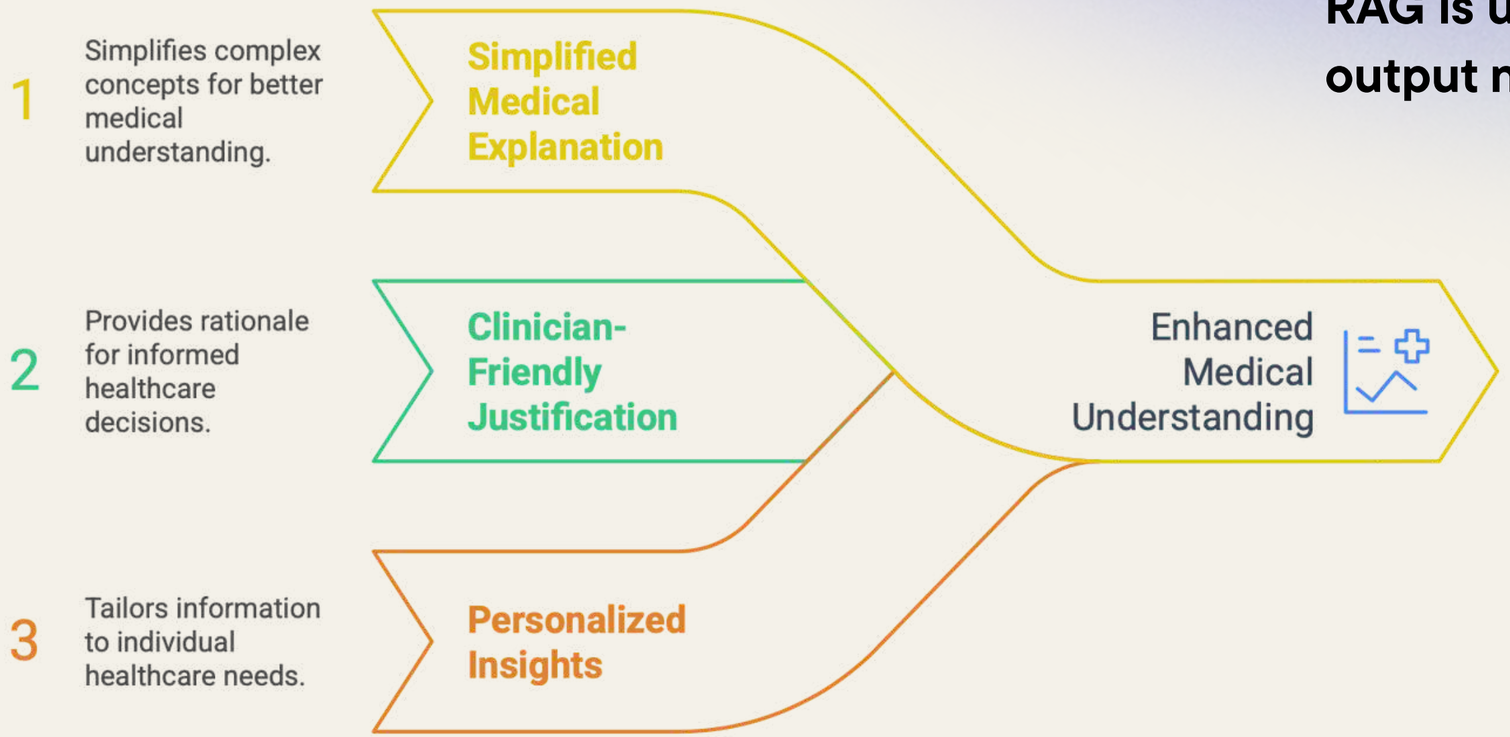
TECHNOLOGIES ON-SERVER

Server Responsibilities

- Zero raw heart data
- Aggregate FL model updates
- Perform secure aggregation
- Run inference API (FastAPI)
- Manage explanation engine (RAG)
- Access ChromaDB for medical context
- Return human-readable insights



TECHNOLOGIES:
RAG ENGINE



RAG is used as a translator to convert AI given output numbers into clear/human sentences.

- Help patients understand health risks
- Help clinicians validate AI behaviour
- No privacy risk

FOREGROUND AND BACKGROUND: INTEGRATION

Story Flow

1) Sensor captures data (ECG / HR / SpO_2)

2) On-device: model predicts risk instantly

3) Edge-XAI : explains which signals triggered the risk

4) Federated learning: updates the global model privately

5) RAG engine: turns the explanation into simple human sentence

6) Mobile app shows:

- Risk level (Low/Med/High)
- Clear explanation
- Action recommendation

TOOLS & TECH: SOFTWARE

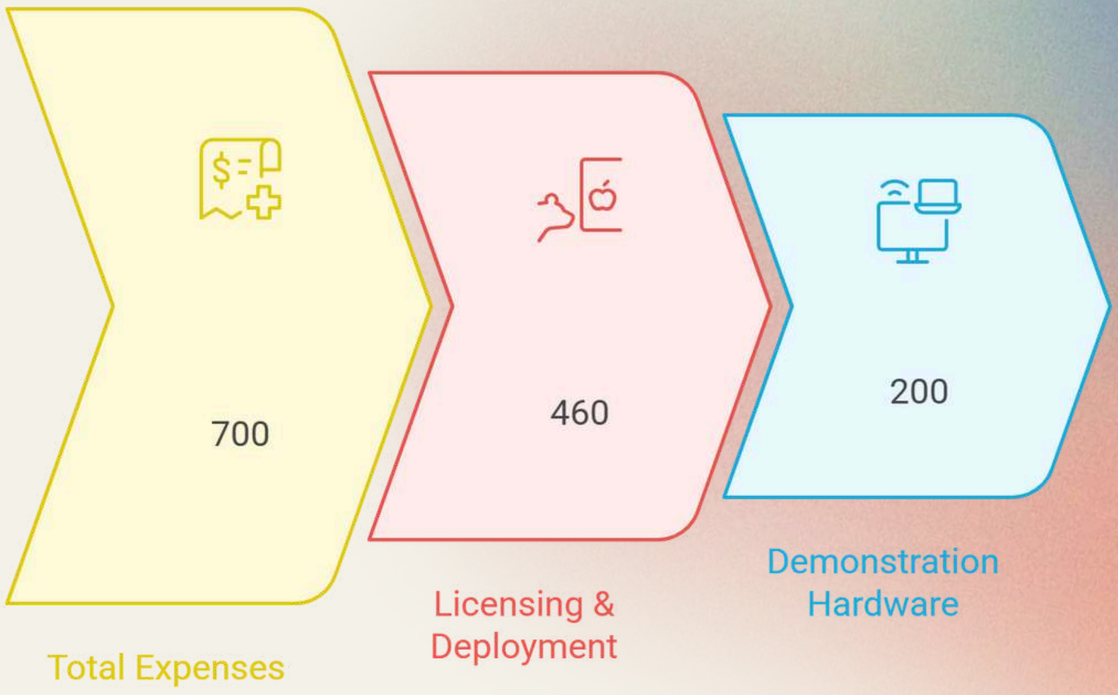
- **Mobile Development: React Native**- Allows us to build for both iOS and Android from a single codebase, saving development time.
- **Backend API**: FastAPI - A modern Python framework that will create our high-performance REST API with automatic documentation.
- **Database**: PostgreSQL for secure data management.
- **AI/ML Framework**: TensorFlow for model development and training, SQLite for biometrics data.
- **Federated Learning:** TensorFlow Federated - Enables phones to collaboratively learn from user data while keeping all personal information on-device.
- **RAG Framework**: LangChain - Connects our live sensor data with medical knowledge bases to provide evidence-based health advice.

TOOLS & TECH: HARDWARE

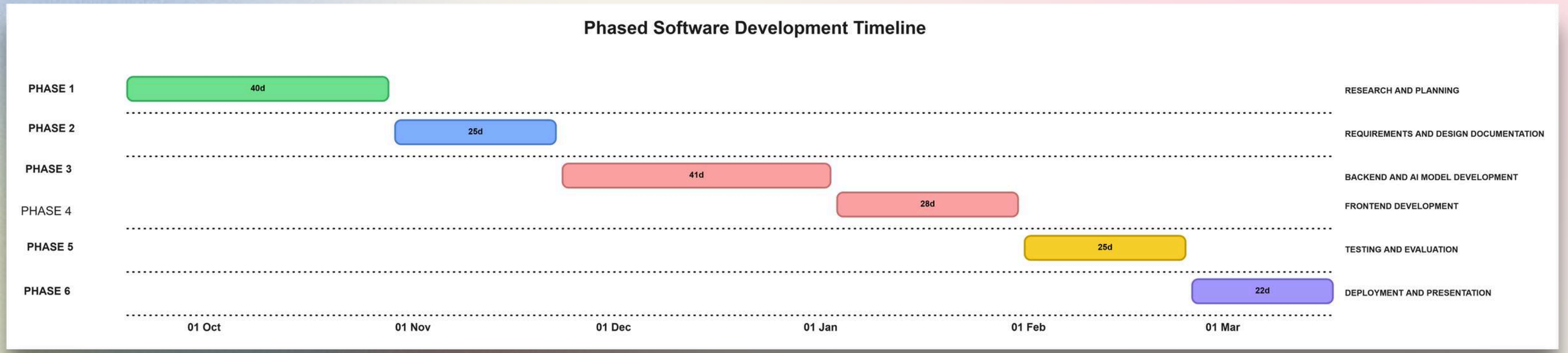
- **Raspberry Pi 4** – Serves as the central data hub, collecting and processing inputs from environmental sensors like temperature and air quality.
- **Pulse Sensor** – Measures heart rate and blood-flow patterns, providing essential cardiovascular metrics.
- **Arduino Uno** – Handles medical sensor signals and manages real-time processing of health-related readings.
- **AD8232 ECG Sensor** – Captures accurate ECG signals to monitor heart activity and detect irregularities.
- **Bluetooth BP Cuff:** Delivers validated blood pressure measurements, a critical vital sign for cardiovascular risk assessment.

FEASIBILITY

Our project takes a resource-efficient approach by using open-source tools and services instead of expensive commercial systems. This allows us to build a fully functional demonstration on a near-zero-cost infrastructure.



ROADMAP


Phased Software Development Timeline
PHASE 1
PHASE 2
PHASE 3
PHASE 4
PHASE 5
PHASE 6
40d
25d
41d
28d
25d
22d
RESEARCH AND PLANNING
REQUIREMENTS AND DESIGN DOCUMENTATION
BACKEND AND AI MODEL DEVELOPMENT
FRONTEND DEVELOPMENT
TESTING AND EVALUATION
DEPLOYMENT AND PRESENTATION
01 Oct
01 Nov
01 Dec
01 Jan
01 Feb
01 Mar

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Lecturer/Coordinator

ETHICAL CONSIDERATIONS

Given the sensitive nature of health data, ethical integrity forms the cornerstone of SHIELD's architecture. Our approach prioritizes user privacy, transparency, and responsible AI deployment.

No Real Patient Data

We exclusively use publicly available datasets and voluntary team member data for development and testing.

Federated Learning Privacy

All personal health data remains on-device. Only encrypted model updates are transmitted—never raw patient information.

Explainable AI Transparency

Users receive clear explanations for predictions, minimizing misinterpretation and building trust through algorithmic transparency.

Wellness-Level Insights Only

SHIELD provides health monitoring and risk indicators—not medical diagnosis. Users are always directed to healthcare professionals for clinical decisions.

FUTURE CLINICAL COLLABORATION

Important
Our current Proof of Concept does not involve real patient trials or clinical settings

Partnership & Oversight

- Partnership with hospital systems for supervised clinical validation
- Ethics board approval and institutional review
- Controlled testing environments with medical oversight

Validation & Integration

- Longitudinal studies to validate predictive accuracy
- Integration with existing electronic health record systems

CONCLUSION

SHIELD represents a convergence of cutting-edge technologies: IoT biosensors, on-device AI, federated learning, and explainable insights—unified into a comprehensive cardiovascular wellness monitoring system.

Innovative Digital Twin Approach

Real-time personalized health modeling

Real Sensor Integration

Hardware-software ecosystem synergy

Privacy-First Architecture

Federated learning ensures data sovereignty

Explainable & Transparent

Building user trust through clarity

SHIELD has the potential to evolve into a clinically valuable tool. This Proof of Concept establishes the foundation for transforming cardiovascular care through intelligent, privacy-preserving technology.

THANK YOU.

We welcome your questions and look forward to discussing how SHIELD can advance healthcare innovation.

References

- Khaleej Times. (2025). More young adults in UAE are suffering cardiac arrests, doctors warn. [online] Available at: https://www.khaleejtimes.com/lifestyle/health/young-adults-suffering-cardiac-arrests-doctors-alarming-trend [Accessed 17 Nov. 2025].
- Webster, N. (2025). UAE doctors warn work stress and bad diets are raising heart disease risk in under 50s. [online] The National. Available at: https://www.thenationalnews.com/news/uae/2025/09/29/uae-doctors-warn-work-stress-and-bad-diets-are-raising-heart-disease-risk-in-under-50s/.
- Benito, A. (2025). UAE leads healthcare revolution with cutting-edge AI and technology. [online] CIO. Available at: https://www.cio.com/article/3810146/uae-leads-healthcare-revolution-with-cutting-edge-ai-and-technology.html.
- Khaleej Times. (2024). UAE doctors warn of ‘silent killer’ high blood pressure; new guidelines help early detection. [online] Available at: https://www.khaleejtimes.com/lifestyle/health/new-guidelines-help-uae-doctors-identify-patients-at-high-risk-of-silent-killer-blood-pressure?_refresh=true [Accessed 17 Nov. 2025].