Team Aura Farmers

IDEATHON 2026

Decentralized Smartphone Collision Avoidance Network

Proposed Solution:

- Builds a **decentralized safety network** using **regular smartphones**.
- Turns phones into high-precision nodes in a **Vehicular Ad-Hoc Network** (VANET).
- Uses already present Android device sensors for real-time surrounding traffic awareness.
- Works **independently of mobile networks** for core safety features.

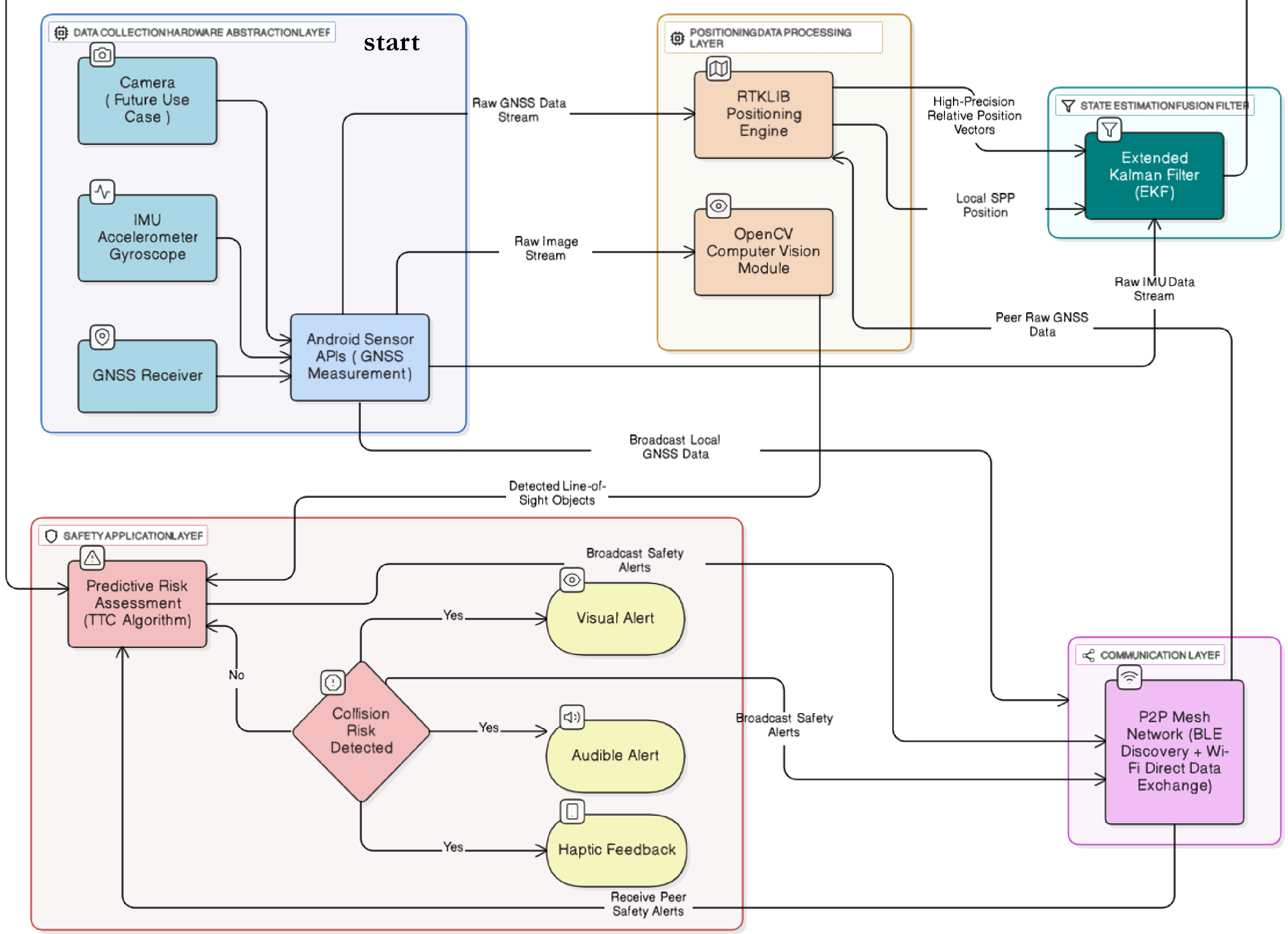
How It Addresses the Problem:

- **Cuts Costs:** Replaces expensive sensors (like LIDAR/radar) with smartphone GNSS and IMU data.
- **High Accuracy:** Achieves **centimeter-level precision** using cooperative RTK positioning.
- **Instant Alerts:** Uses **Wi-Fi Direct** and **Bluetooth LE** for real-time, serverless communication between vehicles.
- **Indoor Navigation Ready:** Can work in **GNSS-denied areas** using phones as base stations and Wi-Fi RTT for positioning.

How It Is Unique:

- **Accessible to All:** Makes advanced safety features available to all vehicles through software.
- **Beyond Line-of-Sight:** Detects hidden hazards (e.g., cars braking ahead or around corners).
- **Resilient & Scalable: No central server needed**, no network dependency, and improves as more users join.

System Architecture :



Prototype link: https://ikugo.zenika.in/

Explanation - Demonstration link:

https://youtube.com/Aura_Farmers_25177

Resources and Extra Explanation Videos - for a deeper idea :

https://drive.google.com/Aura_Farmers

Team Aura Farmers

TECHNICAL APPROACH

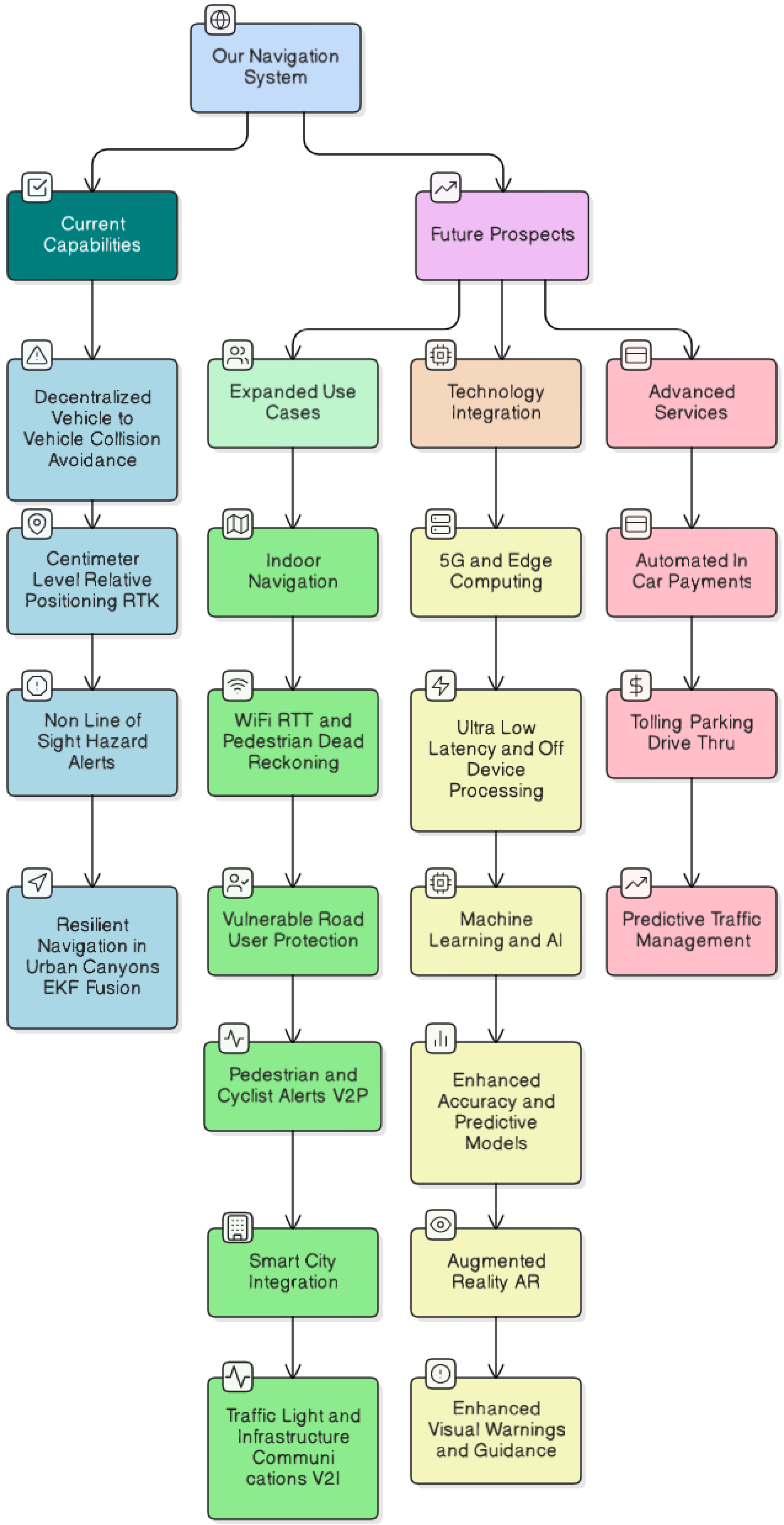
Platform & Core Languages

Platform:

- **Android (Native)**: The application will be built specifically for the **Android OS** (version 7.0 and newer) to gain direct access to **raw GNSS measurement APIs.**

Primary Languages:

- **Kotlin / Java:** Used for the main application logic, **user interface (UI)**, and for interfacing with the standard Android SDK APIs, including **sensor** and **communication managers.**
- **C / C++ (via Android NDK):** Essential for performance-critical modules. The computationally intensive **RTKLIB positioning engine** will be integrated and optimized using the **Native Development Kit (NDK)** to **ensure low-latency**, real-time processing directly on the device.



Key Frameworks & Libraries

Positioning & Sensor Fusion:

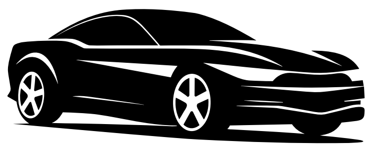
- **Framework**: Integration of the **RTKLIB C-library** (using an Android port like RtkGps) as the core for **centimeter-level** RTK calculations.
- **APIs:** Native **Android Location** and **Sensor APIs** (GnssMeasurement, SensorManager) will be used to access the **raw satellite** and **IMU data streams**.

Communication:

- **Framework:** A hybrid peer-to-peer framework combining two open-source libraries:
  - **Meshrabiya (Java):** For creating the robust, high-bandwidth Wi-Fi Direct mesh network.
  - **nRF Mesh Library (Kotlin/Java):** For managing the initial low-power, rapid device discovery via Bluetooth LE.

Computer Vision:

- **Framework: OpenCV for Android SDK** (Java/C++) will be integrated to build the camera-based **line-of-sight collision detection** and **warning system**.



Team Aura Farmers

FEASIBILITY AND VIABILITY

Feasibility: A Technically Sound Foundation

This project is achievable now because three key technologies have come together:

- **Advanced Sensor Access:** Modern Android phones now provide the **raw GNSS data** needed for **high-precision** location calculations.
- **Mature Open-Source Tools:** We can build on existing, **professional-grade software**, which significantly reduces development cost and risk.
- **Standard Smartphone Hardware:** Phones are already equipped with the Wi-Fi and Bluetooth technology required to create a direct, **serverless communication network**.

Viability: A Disruptive & Sustainable Model

Scalability :

- As a **software-only solution**, it eliminates expensive hardware and uses a **serverless** design for near-zero operational costs, making it **highly scalable**.

Market:

- Addresses a **global market of billions** by offering a free, life-saving solution to a **universal problem**.

Technical:

- Technically viable by using standard smartphone technology: **raw GNSS data**, direct **Wi-Fi/Bluetooth**, and mature **open-source software.**

Challenges	Mitigation Strategy
• **Consumer-Grade Hardware Limitations (Noisy antennas, unstable clocks)**	The core cooperative RTK algorithm is specifically designed to **cancel out these common hardware errors** through **double-differencing.** Our software intelligently compensates for lower-quality hardware.
• **Signal Degradation in Urban Canyons (Signal blockage and multipath)**	The **Extended Kalman Filter (EKF)** provides resilience by fusing multiple data sources. It uses high-certainty data from well-positioned peers to correct the local estimate and **leverages the phone's IMU** for dead reckoning during **brief signal outages**, ensuring graceful degradation instead of **catastrophic failure.**
• **Power Consumption (Continuous processing and communication)**	A **hybrid communication** protocol is used. **Low-power Bluetooth LE handles** the **constant task** of peer discovery, while the more power-intensive **Wi-Fi Direct is activated only** when necessary **for high-bandwidth data exchange**.
• **Device Heterogeneity (Varying sensor quality across Android devices)**	The EKF is **adaptive.** It dynamically weights incoming data based on its reported uncertainty, **automatically giving** more influence to **measurements from higher-quality sensors** within the network.

Team Aura Farmers

IMPACT AND BENEFITS

Potential Impact on Target Audience (Drivers, Pedestrians & All Road Users)

1. Universal & Affordable Safety

- Converts any smartphone into a **life-saving safety device** for all vehicles.
- **Replaces costly sensors**, making advanced safety accessible to everyone.

2. Beyond-Line-of-Sight Collision Prevention

- Warns drivers of hidden **hazards** like sudden braking or blind intersections.
- Provides crucial extra seconds to react, preventing major accidents.

3. Reliable and Network-Free Operation

- Works **without internet or mobile networks** using direct peer-to-peer connections.
- Remains **functional in rural areas**, tunnels, or during network outages.

4. Enhanced Driving Experience

- Offers **early alerts** that reduce driver stress and enable smoother reactions.
- Promotes **smoother traffic flow**, **improving fuel efficiency** and **reducing emissions**.

5. Collective Network Effect and Privacy

- Each new user increases safety for everyone else on the road.
- Uses secure, **decentralized data sharing** with **no central tracking** or storage.

Benefits of the Solution :

Social:

- **Saves Lives:** Directly **reduces accidents** and injuries caused by human error.
- **Democratizes Safety:** Makes advanced safety technology accessible to everyone, not just owners of luxury cars.
- **Protects Everyone:** The system is **designed to include pedestrians and cyclists,** making roads safer for all.

Economical:

- **Zero Hardware Cost:** Works on the smartphone you already own—**no need to buy expensive** equipment.
- **No Operational Costs:** A decentralized network means **no expensive servers** or maintenance fees.
- **Market Disruption:** Offers a **scalable**, software-only alternative to the costly traditional ADAS industry.

Enviromental:

- **Reduces Emissions & Congestion:** Promotes smoother traffic flow, leading to **less fuel consumption** and pollution.
- **Lowers Accident Impact:** Fewer collisions mean less **environmental waste** from vehicle repairs and cleanup.

Team Aura Farmers

RESEARCH AND REFERENCES

- Performance of Smartphone Raw GNSS Measurements for High-Accuracy Positioning: https://www.mdpi.com/1424-8220/22/10/3825
- myGNSS: An open-source real-time PPP/RTK positioning engine for Android devices: https://www.sciencedirect.com/science/article/pii/S2352711025002941
- Forward Collision Warning System with an Android Smartphone: https://pmc.ncbi.nlm.nih.gov/articles/PMC6111719/
- RTKLIB: An Open Source Program Package for GNSS Positioning: https://www.rtklib.com
- Google's Official GPS Measurement Tools Repository: https://github.com/google/gps-measurement-tools
- Android Official Documentation: Raw GNSS Measurements: https://developer.android.com/develop/
- Pedestrian dead reckoning for MARG navigation using a smartphone: https://www.researchgate.net/publication/
- How Baidu Apollo Builds HD (High-Definition) Maps for Autonomous Vehicles: https://towardsdatascience.com/how-baidu-apollo-builds
- Audi Technology Portal: Car-to-X Communication: https://www.audi-technology-portal.de/
- Android Official Documentation: Wi-Fi RTT https://developer.android.com/develop/connectivity/wifi/wifi-rtt

Comparison:

Feature / Capability	Standard Smartphone GPS (e.g., Google Maps)	High-End OEM ADAS (LiDAR/Radar)	Our Proposed System
Accuracy	2-10 meters	N/A (Relative sensing)	~2 cm (Relative)
Cost	✅ (Zero)	❌ (High)	✅ (Zero)
Signal & Track Awareness	❌	❌	✅
Connectivity Requirement	❌ (Cellular Network)	✅ (None)	✅ (None)
Scalability / Market Penetration	✅ (High)	❌ (Low)	✅ (Potentially Universal)
Ecosystem	❌ (Proprietary)	❌ (Proprietary, Closed)	✅ (Open-Source Core)

According to the U.S. National Highway Traffic Safety Administration (NHTSA), this type of Vehicle-to-Vehicle (V2V) communication technology has the potential to prevent or mitigate up to 80% of crashes involving unimpaired drivers.