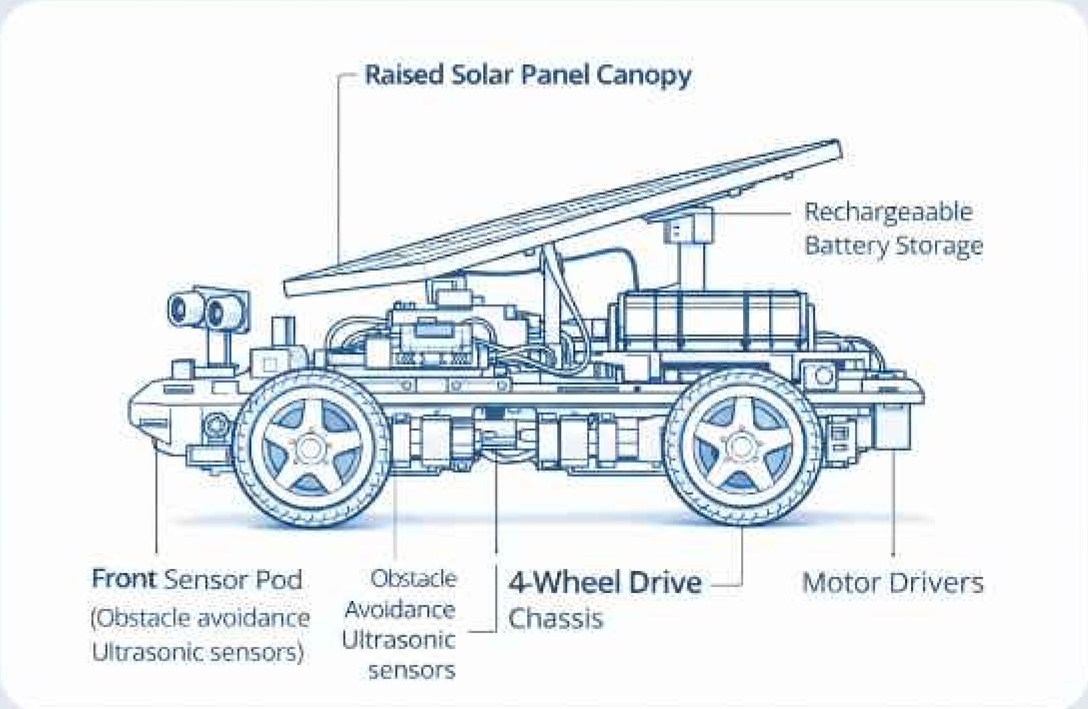
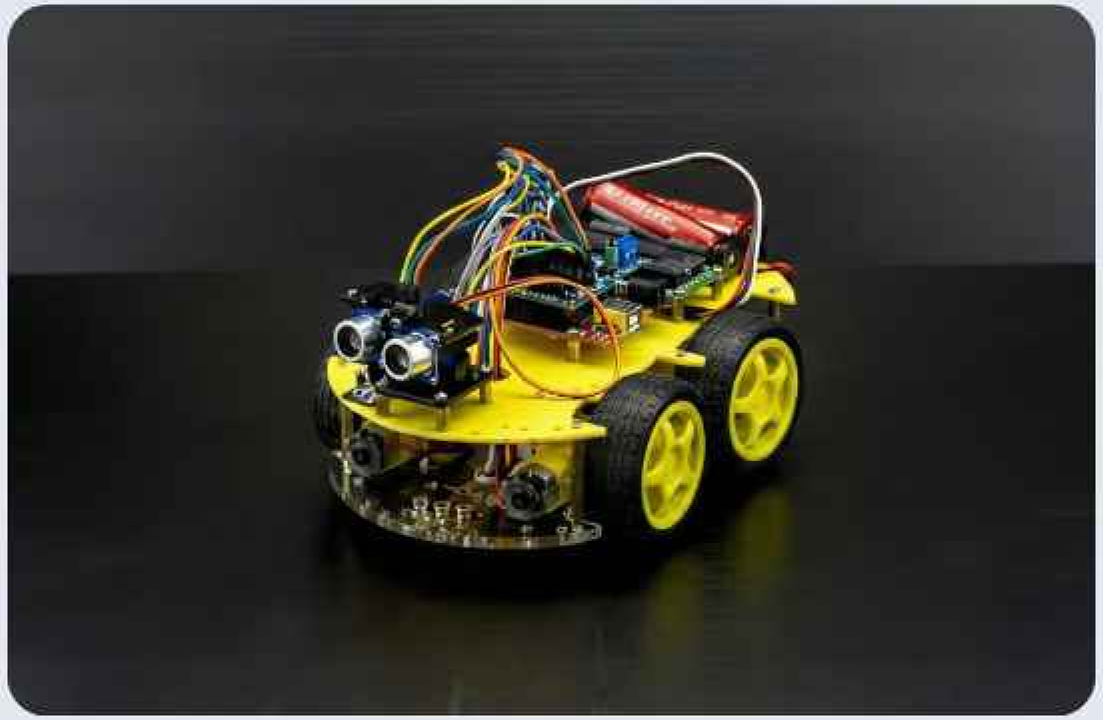
Renewable Energy Powered Vehicle



PRESENTATION BY:
S HRUDAY SIMHA(1CR25AD094)

PROJECT BY:
S HRUDAY SIMHA(1CR25AD094)
ROUNIT RAJ(1CR25AD093)
ROHITH R(1CR25AD092)



How do you teach a machine to navigate a world it cannot see?

You give it a "sixth sense." By replicating biological echolocation using ultrasonic sensors, we have engineered a system that translates reflected sound waves into real-time distance data. This allows the robot to perceive its environment, execute collision-avoidance logic in milliseconds, and navigate the unknown without a single line of human intervention.

Our Goal:

Teach a machine to 'see' sound and decide for itself.

Objective: Autonomy

Core Hardware Specifications

Aurduino Uno

Ultra Sonic Sensor

IR Sensor

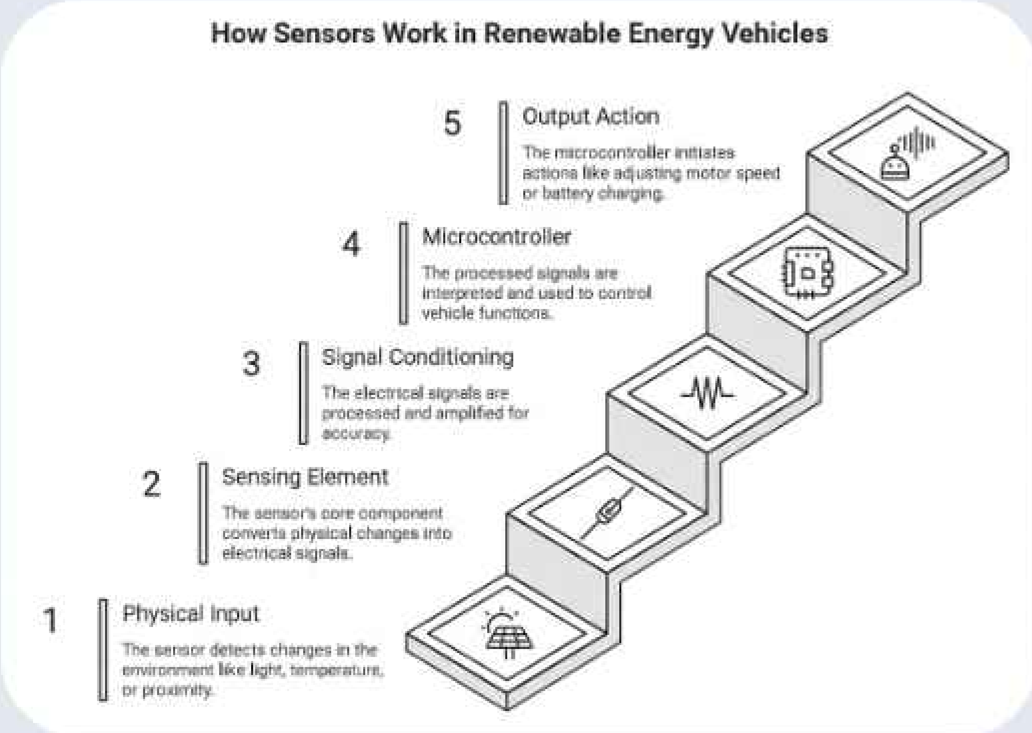
Motor Control Module

Solar Panel

The Working Principle

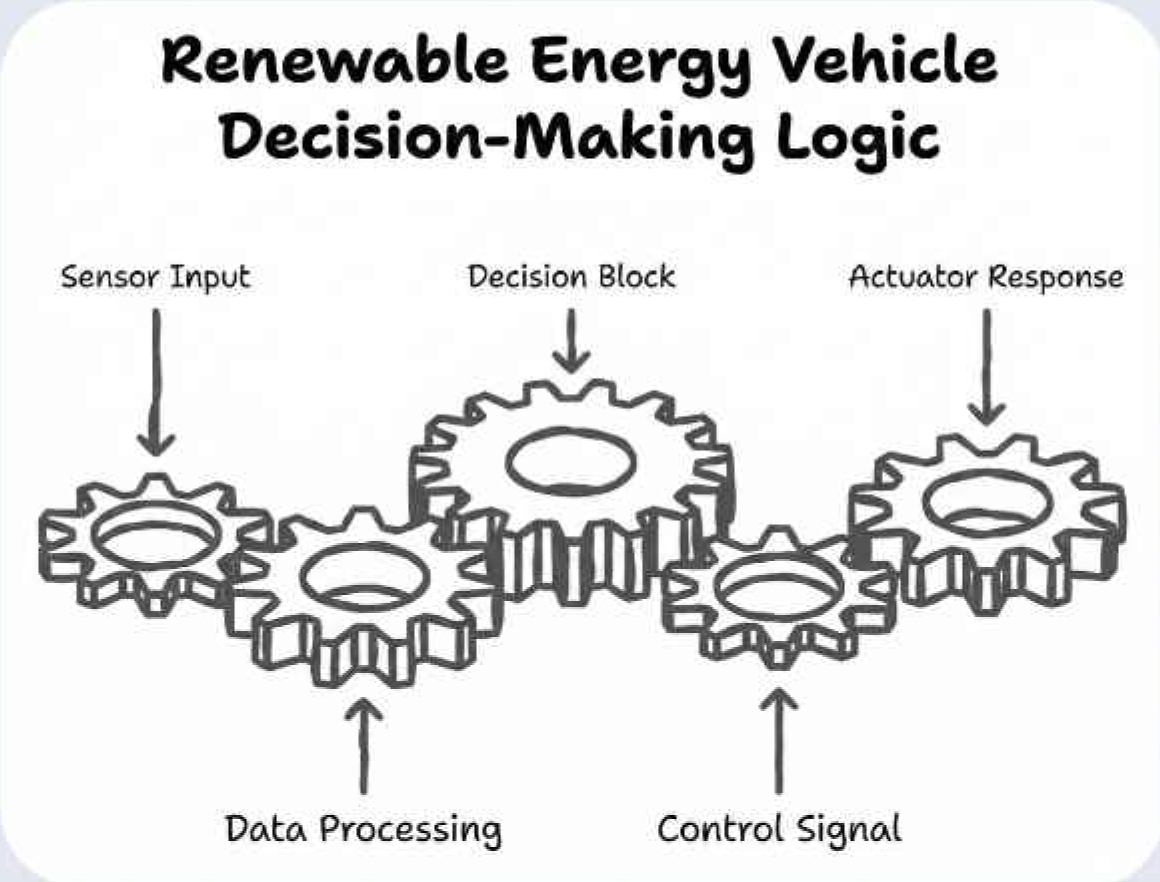
Signal Transmission

The system acts like a bat, using the HC-SR04 sensor to emit a high-frequency (40kHz) ultrasonic sound pulse. This wave travels outward, scanning the immediate environment for physical obstructions.



Echo Reception & Calculation

When the wave hits an object, it reflects back to the sensor. The microcontroller measures the Time of Flight—how long the trip took—and calculates the exact distance using the formula: Distance = (Speed x Time) / 2.



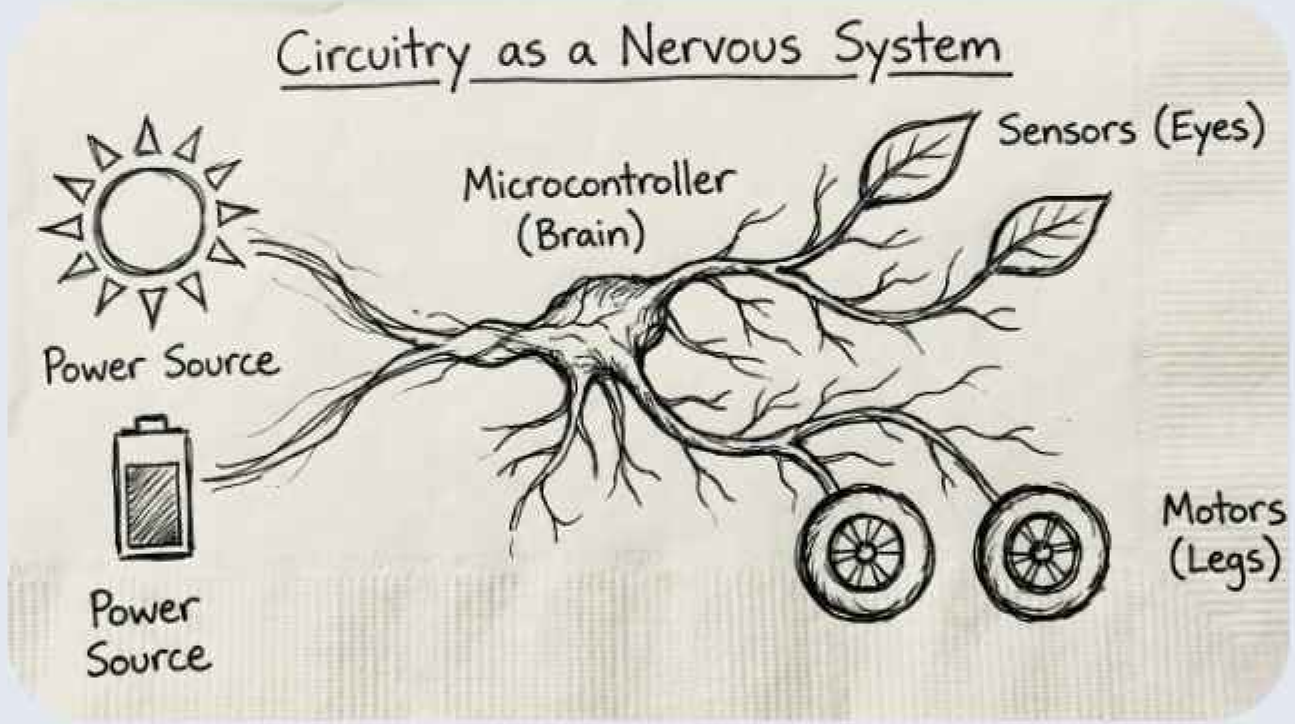
Algorithmic Decision Making

The Arduino continuously compares this distance against a safety threshold (e.g., 15 cm). If an object is detected within this range, the code instantly interrupts forward motion and triggers a turning maneuver to avoid collision.

The Circuitry

The Nervous System: Logic & Control

The Arduino Uno serves as the command center, but it cannot power the motors directly due to their high current draw. To solve this, we integrated an L298N Motor Driver, which acts as a "muscle amplifier." The Arduino sends low-voltage logic signals (telling the robot when to turn), and the driver uses energy from the main battery to spin the motors, effectively translating digital decisions into physical motion.



Power Management Strategy

Stable power is critical for autonomy. We implemented a split-power design where the heavy load from the motors is isolated from the sensitive microcontroller. The L298N driver handles the high-current delivery to the wheels, while the Arduino receives a regulated voltage. Crucially, a common ground connection unites the entire system, ensuring clear communication between the logic and power circuits without electrical noise.

Real-World Impact

Field Research & Validation

- Event: Visit to KTPO Tech Summit.
- Key Insight: Engaging with industry experts confirmed that renewable energy integration (solar/wind) combined with autonomous navigation is a top priority for next-gen agricultural and surveillance robots.
- Outcome: This visit validated our decision to prioritize energy-efficient algorithms and sensor-based obstacle avoidance.

Industrial & Commercial Applications

- Autonomous Logistics: similar logic is used in Amazon Kiva robots to move goods in warehouses without human guidance.
- Self-Driving Vehicles: Companies like Tesla and Waymo use advanced versions of this sensor-fusion technology for passenger safety.
- Space Exploration: NASA Mars Rovers utilize autonomous navigation to traverse unknown terrain where remote control latency is too high.

The Journey: Challenges and Learnings

Challenges We Conquered

- Dual-Source Integration: Successfully merged two distinct power inputs (Solar & Wind) into a single, stable battery system without back-flow or overcharging.
- Energy Safety: Implemented thermal management protocols to ensure battery reliability under highly variable charging conditions.
- Weight vs. Range: Optimized the chassis materials to reduce drag and weight, maximizing the vehicle's energy efficiency.

Key Learnings

- Interdisciplinary Skillset: Bridged the gap between Mechanical design, Electrical power systems, and Control logic (Data Science).
- The Power of Prototyping: Learned that rapid testing and iteration (failing fast) is crucial for design optimization.
- Collaborative Problem Solving: Navigating complex technical hurdles required coordinated teamwork and shared expertise.

Future Enhancement AI & IoT

SLAM (Simultaneous Localization and Mapping)

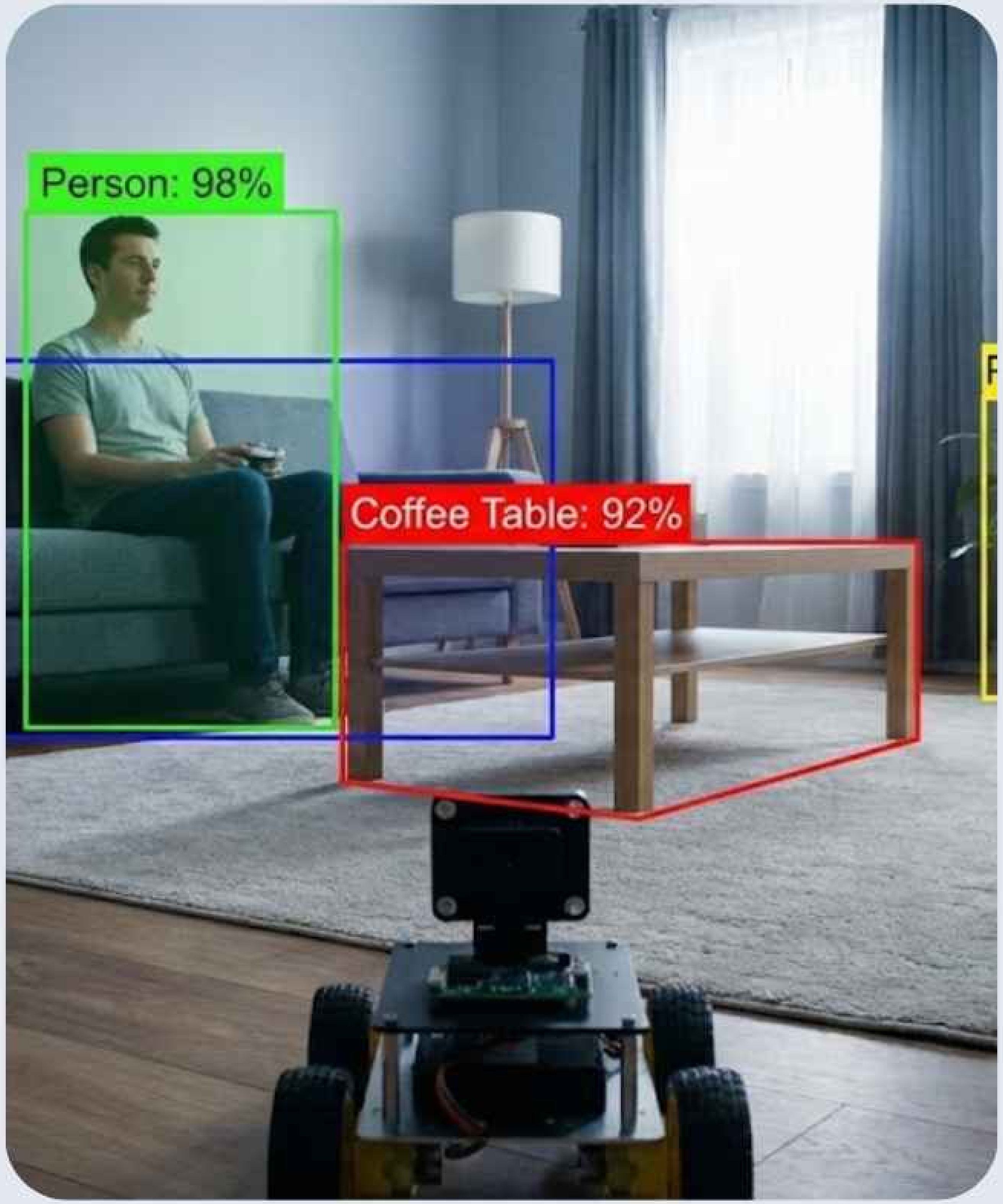
- The Goal: To move from "reactive wandering" to "intelligent pathfinding."
- The Tech: Using sensor data to build a real-time digital map of the environment, allowing the robot to plan the most efficient route from Point A to Point B.

Computer Vision Integration

- Current State: Blind navigation using distance sensors.
- Future Upgrade: Integrating an ESP32-CAM or Raspberry Pi to process visual data.
- AI Application: Implementing Object Detection algorithms (YOLO/OpenCV) to classify obstacles (e.g., distinguishing between a human, a pet, or a wall) rather than just avoiding them.

IoT & Remote Telemetry

- Connectivity: Adding Wi-Fi capabilities to stream battery health, solar efficiency, and navigational data to a mobile dashboard.
- Voice Control: Integrating Natural Language Processing (NLP) to execute complex commands like "Go to the kitchen and charge."



"We believe that the intersection of Renewable Energy and Autonomous Logic is the key to sustainable innovation. This prototype is just our first step toward that future."

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Thank you