Project 1 Definition **Child Pick-Up and Location Tracking System with RFID:**

**Purpose**

* **What is this going to do for the user?**
  + Ensure the safe pick-up of children by pairing them with the correct parent using RFID authentication.
  + Provide real-time location tracking using BLE to locate the child in a designated area.
* **Why are we making this?**
  + To enhance security and efficiency in child pick-up processes at schools, daycare centers, and other facilities.
  + To reduce errors and delays associated with manual pick-up systems.
* **What are the top usage scenarios / user stories?**
  + A parent picks up their child and authenticates their identity via an RFID tag.
  + A staff member locates a child quickly within the premises using BLE tracking.
  + Unauthorized attempts trigger alerts, ensuring security.

**Client**

* **Contact Information**
  + Name: [To be determined]
  + Email: [To be determined]
  + Phone: [To be determined]
* **Roles**
  + Project Sponsor: Oversees goals and outcomes.
  + Developer Team: Responsible for hardware and software implementation.
  + End User: Parents, staff, and children.
* **Budget**
  + Estimated: $500–$1000, accounting for prototyping, components, and PCB manufacturing.

**Communication**

* **Repository**
  + GitHub Repository: [URL Placeholder for version control and code storage].
* **Logbook**
  + Physical and digital logbook for documenting meeting notes, changes, and testing results.

**Objectives**

* **High Level**
  + Build a compact and portable system for secure child pick-up and location tracking.
* **Descriptions**
  + RFID authentication ensures correct parent-child matches.
  + BLE tracking provides location updates.
  + LEDs, buzzer, and OLED display provide visual and auditory feedback.
* **Drawings**
  + Block diagrams of hardware and signal flows.
* **Brochure**
  + Create a marketing one-pager explaining features and benefits.
* **Models**
  + Prototype using Arduino Nano, RC522 RFID module, HM-10 BLE module, and SSD1306 OLED.

**Scenario**

* **User Interaction Stories**
  + **Unboxing**: Open the kit containing the RFID tag, receiver module, and instructions.
  + **Configuring**: Pair child and parent RFID tags and test BLE connectivity.
  + **Using**: Scan RFID tags, confirm matches, and monitor the child’s proximity.
  + **Troubleshooting**: Resolve issues like RFID misreads or BLE connectivity failures.
  + **Passive/Active Interaction**: Active scanning and passive location monitoring.
  + **Servicing**: Replace batteries or recalibrate RFID/BLE systems.

**User Interface**

* **Displays**
  + 1.3" OLED shows status messages (e.g., "Match Successful," "Access Denied").
* **Buttons**
  + Reset button for reinitializing the system.
* **Switches**
  + Power toggle for energy-saving mode.
* **Indicators**
  + LEDs: Green for success, red for failure.
  + Buzzer: Audio alerts for errors or warnings.

**User Acceptance**

* **Given-When-Then Criteria**
  + Given the parent and child RFID tags, when scanned, then the system confirms the match.
  + Given the BLE tracking module, when queried, then the system provides location proximity.
* **Quantifiable Goals**
  + RFID match accuracy: >95%.
  + BLE tracking range: 10–30 meters with a <3-meter error margin.

**Parameters**

* **Technical**
  + Dimensions: PCB size < 10x10 cm.
  + Weight: <150g.
  + EMC/EMI: Meets FCC Part 15 standards.
  + Protection: Basic shielding for outdoor environments.
* **Functions**
  + Core: RFID authentication, BLE tracking, alert system.
* **Integration**
  + Interfaces: SPI (RFID), I2C (OLED), Serial (BLE).
  + Protocols: UART for BLE communication.
* **Operational**
  + Restrictions: Indoors or in predefined outdoor zones.
  + Duty Cycle: 8 hours on a single charge.
* **Regulatory**
  + Compliance with child safety and wireless communication laws.

**Life Cycle**

* **Manufacturing**
  + PCB manufactured by JLCPCB or PCBWay.
* **Programming**
  + Preloaded Arduino code for ease of deployment.
* **Tracking**
  + Device tagged with a unique ID for inventory purposes.
* **Service**
  + Replaceable batteries and firmware updates.
* **Associated Services**
  + BLE-based mobile app for tracking.

**Environment**

* **Temperatures**
  + Operating range: 0–50°C.
* **Hazards**
  + Must withstand minor drops and spills.
* **Ingress**
  + Dust and splash-resistant design.
* **Power**
  + Rechargeable lithium-ion battery or USB-C power supply.

**Starting Point**

* **Existing IP**
  + Arduino Nano, RFID, and BLE modules as proven off-the-shelf components.
* **Existing Prototypes**
  + Bench-tested modules for RFID authentication and BLE tracking.

**Key Concerns**

* **Most Important**
  + RFID matching reliability.
  + BLE signal stability in crowded environments.
* **Set-in-Stone Parameters**
  + Compact design, simple user interface, and low-cost production.

**Future**

* **Plans**
  + Add ultra-wideband (UWB) for precise indoor tracking.
  + Develop cloud integration for real-time data storage.
* **Ideas**
  + Include additional sensors (e.g., temperature, heartbeat) for safety monitoring.

**Glossary**

* **RFID**: Radio-frequency identification.
* **BLE**: Bluetooth Low Energy.
* **RSSI**: Received Signal Strength Indicator.

**Open Questions**

* Should we include mobile app development within this budget and timeline?
* What specific BLE range and accuracy does the client expect?
* Are there any branding or aesthetic requirements for the device?

Project 2 Definition **RFID-Enabled Litter Box Access System for House Cats**:

**Purpose**

* **What is this going to do for the user?**
  + Restrict access to a litter box for a house cat while preventing entry by a pet dog, ensuring cleanliness and privacy for the cat.
* **Why are we making this?**
  + To solve the common problem of dogs getting into litter boxes, which can cause messes and potential health issues.
  + To provide pet owners with a smart, reliable, and low-maintenance solution.
* **What are the top usage scenarios / user stories?**
  + A house cat approaches the litter box, and the system recognizes its unique RFID tag, unlocking access.
  + A pet dog attempts to access the litter box, but the system denies entry, keeping the litter box secure.
  + An owner can replace or update the RFID tag easily if needed.

**Client**

* **Contact Information**
  + Name: [To be determined]
  + Email: [To be determined]
  + Phone: [To be determined]
* **Roles**
  + Project Sponsor: Pet product company or individual pet owner.
  + Development Team: Engineers responsible for PCB design and system integration.
  + End User: Pet owners with both cats and dogs.
* **Budget**
  + Estimated: $250–$500 for prototyping and initial deployment.

**Communication**

* **Repository**
  + GitHub Repository: [URL Placeholder for version control and firmware storage].
* **Logbook**
  + A physical or digital log for documenting hardware, software changes, and test results.

**Objectives**

* **High Level**
  + Create a smart access-controlled litter box using RFID for cat identification and an automated locking mechanism.
* **Descriptions**
  + An RFID-enabled door unlocks only when a cat with a valid tag approaches.
  + Audible and visual feedback informs the user and pets of system status (e.g., unlocked or access denied).
  + Compact and durable design suitable for home environments.
* **Drawings**
  + Include system block diagrams and PCB schematics showing connections between RFID module, locking mechanism, and microcontroller.
* **Brochure**
  + Marketing material explaining features like "Dog-Proof," "RFID-Based," and "Pet-Friendly Design."
* **Models**
  + Functional prototype with a working locking door and RFID tag interaction.

**Scenario**

* **User Interaction Stories**
  + **Unboxing**: Open the kit containing the smart litter box door, RFID collar tag for the cat, and instructions.
  + **Configuring**: Assign the RFID tag to the system (optional pre-paired configuration).
  + **Using**: Cat approaches, the system unlocks the door for access. It automatically locks after use.
  + **Troubleshooting**: Owner can manually reset the system or replace the tag if needed.
  + **Passive/Active Interaction**: Active unlocking for valid tags, passive denial for invalid tags.
  + **Servicing**: Replace batteries or recalibrate the RFID reader as needed.

**User Interface**

* **Displays**
  + Optional OLED or LED indicators showing system status (e.g., "Unlocked," "Access Denied," "Low Battery").
* **Buttons**
  + Reset button to recalibrate or pair a new RFID tag.
* **Switches**
  + Power toggle for the system.
* **Indicators**
  + Green LED: Access granted.
  + Red LED: Access denied.
  + Buzzer: Audible feedback for denied entry or error conditions.

**User Acceptance**

* **Given-When-Then Criteria**
  + **Given** the RFID collar tag is assigned to a cat, **when** the cat approaches, **then** the door unlocks.
  + **Given** an unregistered RFID tag or no tag, **when** an animal approaches, **then** the system denies access and keeps the door locked.
* **Quantifiable Goals**
  + RFID recognition accuracy: >98%.
  + Door unlocking response time: <1 second.
  + Battery life: At least 1 month of typical use.

**Parameters**

* **Technical**
  + Dimensions: Door module fits standard litter box openings (~8” x 10”).
  + Weight: Lightweight module (<500g).
  + EMC/EMI: Ensures no interference with other home devices.
  + Protection: Durable materials to withstand wear and tear from pets.
* **Functions**
  + Core: RFID authentication, door locking/unlocking, feedback system.
* **Integration**
  + Interfaces: SPI (RFID), GPIO (locking mechanism), I2C (OLED or LED control).
  + Protocols: N/A.
* **Operational**
  + Restrictions: Indoor use only.
  + Duty Cycle: Continuous operation with intermittent locking/unlocking.
* **Regulatory**
  + Compliance with pet safety standards and FCC wireless communication rules.

**Life Cycle**

* **Manufacturing**
  + Custom PCB design fabricated by PCB manufacturers like JLCPCB or PCBWay.
* **Programming**
  + Pre-programmed microcontroller with firmware to handle RFID and locking mechanisms.
* **Tracking**
  + Devices shipped with a unique serial number for inventory and warranty tracking.
* **Service**
  + Replaceable parts, including lock motors and RFID reader modules.
* **Associated Services**
  + Customer support for troubleshooting and additional RFID tags.

**Environment**

* **Temperatures**
  + Operating range: 10–40°C (suitable for indoor environments).
* **Hazards**
  + Resistant to scratches, accidental bumps, and minor spills.
* **Ingress**
  + Dust and splash-resistant.
* **Power**
  + Battery-powered (rechargeable lithium-ion) or plug-in power adapter.

**Starting Point**

* **Existing IP**
  + Standard RFID modules (e.g., RC522) and servo motors for locking mechanisms.
* **Existing Prototypes**
  + Concept tested with basic Arduino setup for RFID authentication.

**Key Concerns**

* **Most Important**
  + Reliable RFID tag recognition for cats of all sizes.
  + Secure locking mechanism that prevents dogs from bypassing it.
* **Set-in-Stone Parameters**
  + Must fit standard litter box sizes.
  + Simple setup for users without technical expertise.

**Future**

* **Plans**
  + Develop an app-based interface for configuration and monitoring.
  + Add BLE functionality for tracking pet activity near the litter box.
* **Ideas**
  + Integrate additional sensors to monitor litter box usage and send alerts (e.g., full or unused litter).
  + Allow multi-cat configurations for households with multiple pets.

**Glossary**

* **RFID**: Radio-frequency identification for tag-based authentication.
* **EMC**: Electromagnetic compatibility to avoid interference with other electronics.
* **EMI**: Electromagnetic interference.

**Open Questions**

* How will pet owners prefer to attach RFID tags (collars, embedded in a harness, or other methods)?
* Should the system include manual override controls for emergencies?
* What aesthetic design features would appeal most to pet owners?