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CEF440: INTERNET PROGRAMMING AND MOBILE PROGRAMMING

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Requirements Analysis and Specification Report: Mobile Ap for Collection of Users Experience Data from Mobile Network Subscribers.

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Introduction:

This report documents the requirements analysis and specification process for the proposed Mobile Quality of Experience (QoE) Data Collection Application targeting subscribers in Cameroon. It follows the analysis of requirements gathered through surveys, interviews, and Quality of Service (QoS) measurements (as detailed in Requirement Gathering document of task 2). This report covers the review and analysis of these requirements, identification of gaps, prioritization, classification, and the resulting Software Requirement Specification (SRS).

1. Review and Analysis of Gathered Requirements

This section assesses the gathered requirements based on completeness, clarity, technical feasibility, and dependency relationships. This assessment incorporates critical gaps identified after the initial review.

1.1 Completeness:

- **Initial Assessment:** The requirements covered core functionality (objective/subjective data collection), identified key user roles, and outlined data types/purpose.
- **Updated Assessment: Critically Incomplete.** Foundational requirements concerning the specific legal and regulatory environment in Cameroon were overlooked.

Identified Gaps:

- **ART Compliance:** Absence of requirements addressing specific regulations from Cameroon's *Autorité de Régulation des Télécommunications* (ART) regarding QoE data collection, data handling, or MNO interactions.
- **Local Data Privacy Law Compliance:** Lack of requirements derived from specific Cameroonian data protection laws (e.g., Law No. 2024/017) governing consent, user rights, data retention, etc.
- **Detailed Security Requirements:** Insufficient detail on security measures beyond a high-level NFR, especially for sensitive geolocation and device data.
- *Other gaps noted previously:* Specific NFR metrics, error handling, detailed privacy mechanisms.

1.2 Clarity:
- **Assessment:** While high-level goals are clear (collect QoE data), significant ambiguities remain. Terms like "real-time data," "user-friendly UI," and "securely store" lack precise, measurable definitions. The *absence* of legal, regulatory, and detailed security requirements introduces major ambiguity regarding mandatory operational constraints. Specifications for data collection frequency, specific feedback formats (though preferences noted), and cross-platform behaviour need refinement.

1.3 Technical Feasibility:
- **Assessment:** Core functions (location, basic network info, UI feedback, data storage/upload) are generally feasible using standard cross-platform mobile technologies. However, significant feasibility concerns and risks exist:

- **Cross-Platform Limitations (iOS):** Accessing detailed network metrics (esp. signal dBm) and multi-SIM info is highly restricted on iOS compared to Android. Achieving feature parity for FR4 and FR13 is challenging.
- **Background Execution:** Implementing reliable, battery-efficient background tasks across both Android and iOS is complex due to OS restrictions.
- **Legal & Regulatory Non-Compliance Risk: (Newly emphasized)** Proceeding without addressing ART and local data privacy laws poses significant risks of legal penalties, operational blocks, and reputational damage. This impacts overall project feasibility if compliance proves overly burdensome or requires major design changes.
- **Security Implementation:** Ensuring robust security (encryption, anonymization) requires dedicated effort and expertise.
- **Backend & MNO Dependencies:** Feasibility relies on the timely availability and integration with backend APIs and reward systems.

1.4 Dependency Relationships:
- **Internal:** Feedback collection depends on permissions and UI; data upload depends on local storage and network access; performance depends on background task efficiency and OS limits.
- **External:** Heavy reliance on the Backend System (API availability, security, scalability), MNO/Reward System integration, OS Permissions APIs, underlying network connectivity, and **critically, compliance with ART regulations and Cameroonian Data Privacy Laws.**

2. Identification of Inconsistencies, Ambiguities, and Missing Information

Building upon the analysis of survey/interview feedback:

2.1 Identified Inconsistencies

- User desires conflict (e.g., "simple app" vs. "many features", "strong security" vs. "quick login").
- Notification preferences vary (engagement vs. annoyance).
- Expectations on support features differ (chat vs. FAQ only).

2.2 Identified Ambiguities

- Vague terms ("smooth operation," "low memory," "simple interface," "good for all ages") lack measurable criteria.
- Notifications lack specificity (type, frequency).

2.3 Missing Information (including Critical Omissions: ART, Local Laws, Security)

- ➢ **Critical Omissions:**
- ART Regulatory Requirements & Compliance Strategy.
- Cameroonian Data Protection Law Requirements & Compliance Strategy.
- Detailed Security Specifications (Encryption, Anonymization, Testing).
- *Other Missing Information Noted Previously:* Specific language support, detailed device/OS version support, monetization strategy, accessibility features, detailed offline mode behaviour.

2.4 Recommendations for Overcoming Gaps

i. **Conduct Legal & Regulatory Research:** Engage legal counsel expert in Cameroonian ICT law to define mandatory requirements based on ART rules and Data Protection laws.
ii. **Define Detailed Security Requirements:** Perform risk assessment and define specific, measurable security NFRs (encryption, anonymization, access control, testing).
iii. **Update Privacy Policy & Consent Flow:** Ensure compliance with local laws identified in step 1.
iv. **Stakeholder Clarification:** Discuss findings and requirements (especially legal/security/privacy) with MNOs and potentially seek guidance from ART.
v. **Revise Requirements Documentation:** Integrate these mandatory legal, regulatory, and security requirements into the SRS (Section 5).

3. Prioritization of Requirements

Requirements gathered were prioritized using the MoSCoW (Must Have, Should Have, Could Have, Won't Have) method based on their importance to the core project aim (real-time QoE data collection), feasibility (especially considering cross-platform constraints), and user feedback (motivation, usability). This prioritization informs the scope of Version 1.0 detailed in the SRS (Section 5).

- **3.1 Functional Requirements (MoSCoW Prioritization)**
- **Must Have (V1.0):**
  - FR-001: Background Data Collection (basic metrics)
  - FR-002: User Feedback Submission (simple formats)
  - FR-003: Feedback Prompting (basic)
  - FR-004: Local Data Storage (offline)
  - FR-005: Secure Data Upload
  - FR-006: Reward Mechanism Interface
  - FR-007: User Onboarding & Permissions
  - FR-008: Privacy Controls *(Acknowledging cross-platform limitations for certain data metrics)*
- **Should Have (Post V1.0):**
  - FR-009: Smart Feedback Prompting
  - FR-010: Multi-SIM Identification (Android)
  - FR-011: Basic Engagement Tracking
  - FR-012: User-Initiated Network Test
- **Could Have (Post V1.0):**
  - FR-007 (in original list, now renumbered likely): Survey and interview integration (basic in-app)
- **3.2 Non-Functional Requirements (MoSCoW Prioritization)**
- **Must Have (V1.0):**
  - NFR-001: Performance Efficiency (Battery)
  - NFR-002: Usability (Simple)

- NFR-003: Security
- NFR-004: Privacy
- NFR-005: Reliability (Offline)
- NFR-006: Responsiveness
- NFR-007: Data Accuracy (acknowledging limitations)
- NFR-008: Interoperability (OS Support - Android/iOS core)
- NFR-009: Fault Tolerance
- **Should Have (Post V1.0):**
    - NFR-010 (Prev NFR2): Scalability (Backend)
    - NFR-011 (Prev NFR10): Maintainability
    - NFR-012 (Part of Prev NFR8): Interoperability (Network Operators).

4. Classification of Requirements

Requirements identified and prioritized fall into two main categories:

- **4.1 Functional Requirements:** Define *what* the system must do. These specify the features, tasks, and interactions the software must support to meet user and stakeholder needs. Examples include Background Data Collection (FR-001), User Feedback Submission (FR-002), Secure Data Upload (FR-005). *(Refer to Section 3.1 for the prioritized list)*.

- **4.2 Non-Functional Requirements:** Define *how* the system should perform or the qualities it must possess. These specify constraints on performance, usability, security, reliability, etc. Examples include Performance Efficiency (NFR-001), Usability (NFR-002), Security (NFR-003), Reliability (NFR-005). *(Refer to Section 3.2 for the prioritized list)*.

5. Software Requirement Specification (SRS) V1.1

This section presents the detailed Software Requirement Specification for the Mobile QoE Data Collection App, Version 1.1. Including the full SRS here provides complete context for the requirements derived from the preceding analysis.

- **5.1 SRS Introduction**

5.1.1 Purpose:

This document specifies the requirements for a mobile application designed to collect Quality of Experience (QoE) data from mobile network subscribers in Cameroon. The purpose is to capture both subjective user feedback and objective network performance metrics in real-time or near real-time to help Mobile Network Operators (MNOs) understand user experience accurately, optimize networks, improve customer satisfaction, and make informed decisions. This SRS is intended for stakeholders including the App Development Team, Mobile Network Operators, and potentially Regulators.

5.1.2 Scope (Included and Excluded Features V1.0)

The initial version (V1.0) of this cross-platform mobile application will focus on providing a core set of features enabling the collection, storage, and transmission of user QoE data on both Android and iOS platforms.

➢ **Included Features (V1.0):**

- User onboarding including necessary permission requests (Location, Network State, Notifications) and user consent.

- Background operation to periodically collect basic objective metrics (Network Type, Location, Timestamp, best-effort Signal Information).

- Mechanism for users to provide subjective feedback (primarily star/emoji ratings, optional text) when prompted or voluntarily.

- Secure local storage of collected data with basic offline caching capability.

- Secure transmission of cached data to a designated backend server.

- Integration points for a reward mechanism (e.g., triggering based on feedback submission), likely focused on mobile data/airtime.

- Basic user controls for privacy settings (e.g., opting out of location tracking).

➢ **Excluded Features (V1.0 - potential future enhancements):**
- Advanced background network performance tests (e.g., automated speed, latency, jitter tests due to cross-platform limitations and battery concerns). User-initiated foreground tests may be considered.
- Deep integration of external survey/interview data directly within the app interface.
- Advanced AI-driven adaptive feedback prompting.
- Detailed in-app analytics dashboards for users.
- Full multi-SIM diagnostic reporting on iOS.
- Advanced "Shame Maps" or public reporting features.

5.1.3 Definitions, Acronyms, and Abbreviations

- **App:** The Mobile QoE Data Collection Application described in this document.
- **API:** Application Programming Interface.
- **ART:** *Autorité de Régulation des Télécommunications* (Cameroon's Telecommunications Regulatory Authority).
- **dBm:** Decibels relative to one milliwatt, a standard unit for signal strength.
- **FR:** Functional Requirement.
- **GPS:** Global Positioning System.
- **HTTP:** Hypertext Transfer Protocol.
- **HTTPS:** Hypertext Transfer Protocol Secure.
- **iOS:** Apple's mobile operating system.

- **JSON:** JavaScript Object Notation.
- **KPI:** Key Performance Indicator.
- **MNO:** Mobile Network Operator.
- **MoSCoW:** Prioritization method (Must Have, Should Have, Could Have, Won't Have).
- **MVP:** Minimum Viable Product.
- **NFR:** Non-Functional Requirement.
- **OS:** Operating System.
- **QoE:** Quality of Experience. Incorporates subjective user perception alongside objective metrics.
- **QoS:** Quality of Service. Traditional network-centric performance metrics.
- **SRS:** Software Requirements Specification.
- **TBD:** To Be Determined.
- **UI:** User Interface.
- **UX:** User Experience.

5.1.4 References

- . Project Proposal Document (Task 2)
- Stakeholder Survey Data & Analysis (Task 2)
- Stakeholder Interview Data & Analysis (Task 2)
- QoS Measurement Data (Task 2)
- User Reluctance Assessment (Task 2)
- Google Forms Survey Data
- Cameroonian Law No. 2024/017 of 23 December 2024 relating to personal data protection.
- Relevant ART Regulations/Directives

5.1.5 Overview

This document details the functional and non-functional requirements for the Mobile QoE Data Collection App. Section 2 provides an overall description of the product, its users, operating environment, and constraints. Section 3 specifies the detailed functional, non-functional, and interface requirements, along with illustrative use cases. Section 4 lists potential appendices.

5.2 SRS Overall Description

5.2.1 Product Perspective

The application is a user-centric tool designed to bridge the gap between traditional network-centric monitoring and actual subscriber experience in Cameroon. It will operate on end-user devices (smartphones) and transmit collected data to a backend system managed likely in coordination with MNOs. It is a new product, not replacing an existing one, aimed at addressing the lack of integrated subjective and objective QoE data.

5.2.2 Product Functions (Summary) The core functions of the V1.0 application include:

- Running passively in the background to gather contextual data (location, network type, signal info).
- Prompting users (based on configurable logic or user action) to provide subjective experience ratings.
- Allowing users to submit feedback easily (star ratings).
- Storing collected data locally, handling offline scenarios.
- Uploading stored data securely to a backend server.
- Interfacing with a reward mechanism.
- Providing basic user control over privacy settings.

5.2.3 User Classes and Characteristics

- **Mobile Network Subscribers (End-Users):** Primary users providing data. Predominantly young (18-34), students, likely tech-savvy. Located across urban, suburban, and rural areas. Motivated by improved network service and tangible rewards (data/airtime). Prefer simple, low-effort interaction. May use single or multiple SIMs (predominantly MTN). Varying levels of trust towards MNOs.
- **Mobile Network Operators (MNOs):** Primary consumers of the collected data via the backend system. Interested in accurate QoE data for network optimization, churn reduction, and targeted upgrades.
- **App Administrators (via Backend):** Manage backend system, monitor data flow, potentially configure prompting rules or rewards. (Assumed stakeholder).

5.2.4 Operating Environment

- **Platform:** Cross-platform, targeting mobile devices running: Android (Specific minimum OS version TBD, e.g., Android 6.0+), iOS (Specific minimum OS version TBD, e.g., iOS 13.0+).
- **Hardware:** Standard smartphones with GPS/Location services and cellular network connectivity. Must be mindful of varying device capabilities.
- **Network:** Operates over mobile data (2G, 3G, 4G, 5G) and potentially Wi-Fi for data uploads. Must function reliably in areas with fluctuating or poor connectivity.

5.2.5 Design and Implementation Constraints

- **Cross-Platform Development:** Must use a framework or approach suitable for both Android and iOS deployment. This constrains technology choices.
- **Client-Server Architecture:** The system necessitates a client-server model, where the mobile app (client) collects data and uploads it to a central backend server.
- **Platform API Limitations (iOS):** Cannot reliably access detailed cellular signal strength (dBm) or differentiate multi-SIM activity natively on iOS. Network metric collection must account for these limitations.
- **Background Processing Restrictions:** Both Android and iOS impose strict limits on background execution. Background task design must prioritize efficiency and adhere to these platform-specific constraints.

- **Battery Consumption:** Background operation must be highly optimized to minimize battery drain.
- **Data Privacy Regulations:** Must comply with relevant Cameroonian data privacy laws (e.g., Law No. 2024/017) and ART regulations.
- **Backend Dependency:** App functionality relies on a defined, available, and secure backend API.
- **MNO Integration:** Reward fulfillment likely requires integration with external MNO or third-party APIs.

5.2.6 Assumptions and Dependencies

- **User Consent:** Users must grant necessary permissions for the app to function correctly.
- **Backend Availability:** A functional, secure backend system and API will be available.
- **Reward Mechanism:** A defined process and technical interface for reward fulfillment will be available.
- **Network Access:** User devices will have intermittent access to mobile data or Wi-Fi.
- **API Stability:** External APIs (MNO/Reward, OS APIs) are assumed reasonably stable.
- **Legal Compliance Clarity:** Assumes that research will clarify specific ART and data privacy law requirements before development completion.

5.3 SRS Specific Requirements

Requirements below reflect the MoSCoW prioritization and have been validated and refined based on stakeholder feedback (Section 6).

5.3.1 Functional Requirements (FR)

MUST HAVE (V1.0 Validated Scope)

- **FR-001: Background QoE Monitoring:** The app MUST operate in the background periodically to collect and timestamp objective data points, optimized for battery efficiency.

    - **FR-001.1:** Collect current Location (Latitude, Longitude using GPS/WiFi triangulation) if permission granted.

    - **FR-001.2:** Collect current Network Type (e.g., WiFi, 3G, 4G, 5G, None).

    - **FR-001.3:** Collect best-effort Signal Information available cross-platform.

    - **FR-001.4:** Collect Speed/Latency/Jitter metrics using integrated SDK logic (e.g., based on SpeedTest Master/Meteor principles, *not necessarily the apps themselves*), sampled periodically (e.g., target 5-minute sampling, adjusted for battery impact).

    - **FR-001.5:** Timestamp all collected data points.

    - **FR-001.6 (Constraint):** Background operation intervals refined (e.g., Android Work Manager target 15-min intervals, iOS target limited background bursts). Max 3% estimated daily battery impact goal.

- **FR-002: User Feedback Submission:** The app MUST provide a simple interface for users to submit subjective QoE feedback, optimized for speed (<3 taps target workflow).

    o **FR-002.1:** Support 5-star rating input (Default interface).

    o **FR-002.2:** Support emoji-based rating input (Alternative).

    o **FR-002.3:** Provide an optional short text comment field (e.g., max 50 characters).

    o **FR-002.4:** Associate submitted feedback with timestamp and current context (Location, Network data).

- **FR-003: Smart Feedback Collection:** The app MUST prompt the user for feedback based on detected events rather than fixed schedules.

    o **FR-003.1:** Trigger prompts based on events like detected call drops or significantly slow speeds.

    o **FR-003.2:** Implement adaptive prompting logic (e.g., reduce frequency after multiple ignored prompts).

    o **FR-003.3:** Allow emergency bypass for critical issue reporting.

- **FR-004: Offline Mode & Data Storage:** The app MUST securely store collected data locally (e.g., SQLite) when offline, with defined retention.

    o **FR-004.1:** Retain data locally for a defined period (e.g., 7 days) if upload fails.

    o **FR-004.2:** Implement data compression for stored reports (e.g., target <50KB/report).

    o **FR-004.3:** Auto-sync stored data upon network reconnection.

- **FR-005: Secure Data Upload & MNO Integration:** The app MUST securely transmit data to the backend via defined pipelines and support MNO data access needs.

    o **FR-005.1:** Use secure transmission (TLS 1.3 minimum).

    o **FR-005.2:** Implement dual data pipeline to backend: Real-time (e.g., WebSocket) for critical issues, and Batch uploads (e.g., hourly CSV batches via API) for regular metrics).

    o **FR-005.3:** Backend MUST provide data access for MNOs (e.g., via API for raw data access or heatmap visualization API).

- **FR-006: Reward System:** The app MUST provide an interface to trigger a potential reward mechanism upon successful feedback submission or other defined events. **Implementation is contingent upon securing agreement and technical integration capabilities with participating MNOs or a third-party provider.**

- **FR-007: User Onboarding & Permissions:**

- **FR-008: Privacy Controls & Data Protection:** The app MUST provide granular privacy controls and adhere to data protection principles.

  - **FR-008.1:** Provide granular opt-ins during onboarding or via a privacy dashboard for: Location tracking (Cell tower vs GPS), Call log access (if used for drop detection).

  - **FR-008.2:** Provide GDPR-compliant (or equivalent local law compliant) mechanisms for user data deletion requests.

  - **FR-008.3:** Support Biometric authentication for sensitive actions (if applicable, e.g., viewing personal data history).

- **FR-013: Multi-SIM Support (Platform Specific):**

  - **FR-013.1 (Android):** MUST automatically identify and segregate data per SIM using Telephony Manager where possible.

  - **FR-013.2 (iOS):** Provide a manual network selection UI for users to indicate the active SIM/network due to OS restrictions.

SHOULD HAVE (Post V1.0 - Validated Status)

- **FR-009 (was FR-11): User Engagement Analytics:** Track user reluctance/engagement patterns to potentially refine prompting.

- **FR-010 (was FR-12): Basic QoE Analytics Display:** Provide MNOs with basic real-time analytics via the backend (e.g., dashboard).

REJECTED / DEFERRED (Validated Status)

- **iOS Multi-SIM Automation:** Deferred due to platform restrictions. Manual workaround implemented in FR-013.2.

- **Advanced AI Analytics:** Deferred to Phase 2 due to budget constraints.

- **Multilingual Support:** Deferred post-launch based on initial user demographics/demand.

5.3.2 Non-Functional Requirements (NFR)

MUST HAVE (V1.0 Validated Scope)

- **NFR-001: Performance Efficiency:** Minimize battery consumption.

  - **Metric:** Target < 3% daily battery impact.

  - **Implementation:** Utilize low-power modes, motion-activated collection (where applicable), platform-specific background task managers (WorkManager/BGTaskScheduler).

- **NFR-002: Usability:** Simple, intuitive UI, minimal effort for feedback.

    - **Metric:** Target <= 3 taps for feedback submission workflow.

    - **Implementation:** Star ratings as default.

- **NFR-003: Security:**

    - **Metric:** Data in transit encrypted via TLS 1.3 minimum.

    - **Metric:** Sensitive data at rest encrypted (platform specific implementation).

    - **Metric:** Adherence to secure coding practices (e.g., OWASP Mobile).

    - **Metric:** Biometric authentication for sensitive actions (FR-008.3).

- **NFR-004: Privacy:** Adherence to Privacy Policy and local laws (placeholder for specific law details); granular opt-ins (FR-008.1); data deletion rights (FR-008.2).

- **NFR-005: Reliability:** Function with intermittent connectivity; robust offline caching.

    - **Metric:** App should survive short network drops (e.g., 15 seconds) without losing state/data.

    - **Metric:** Failed transmissions reliably cached locally.

- **NFR-006: Responsiveness:** Fast UI interactions.

    - **Metric:** Feedback prompt loading < 1 second.

- **NFR-007: Data Accuracy:** Accurate recording of user input and objective metrics possible within platform limits.

    - **Implementation:** Use GPS/WiFi triangulation for improved location accuracy.

- **NFR-008: Interoperability (OS Support):** Support for target Android/iOS versions with functional parity where platform allows. Document differences clearly.

- **NFR-009: Fault Tolerance:** Graceful error handling (network, permissions, API errors). Resilient sync mechanisms.

SHOULD HAVE (Post V1.0 - Validated Status)

- **NFR-010 (was NFR-2): Scalability:** Backend system designed for growth.

- **NFR-011 (was NFR-10): Maintainability:** Modular architecture (e.g., microservices mentioned by devs, applies more to backend but influences app API interaction). Well-documented code.

5.3.3 Interface Requirements

5.3.3.1 User Interfaces (UI): Simple, intuitive design. Clear feedback mechanisms (star/emoji rating, optional text). Clear permission requests/privacy info. Access to settings. Consider accessibility.

5.3.3.2 Software Interfaces (Backend API, Reward API, OS APIs):

- *Backend API:* Receives JSON data uploads (Timestamp, Location, Network Type, Signal Info, Ratings, Comments). Secured (e.g., token auth). Returns success/failure status.
- *Reward System API:* Receives trigger (e.g., feedback ID). Response TBD.
- *OS APIs:* Utilizes platform APIs for Location, Network State, Background Tasks, Notifications, Permissions, Storage.

5.3.3.3 Hardware Interfaces: Standard smartphone GPS, Cellular, Wi-Fi radios.

5.3.3.4 Communications Interfaces: HTTPS (TLS 1.2+). Mobile network protocols (3G/4G/5G), Wi-Fi.

5.3.4 Use Cases (Illustrative Examples: UC-001, UC-002, UC-003)

5.3.4.1 UC-001: Submit Prompted Feedback

- **Actor:** Mobile Network Subscriber (User)
- **Trigger:** User receives feedback notification.
- **Preconditions:** App installed, onboarded, permissions granted.
- **Basic Flow:**

  1. App triggers notification.

  2. User taps notification.

  3. App shows feedback screen.

  4. User provides rating +/- comment.

  5. User submits.

  6. App captures data (FR-002).

  7. App stores locally (FR-004).

  8. App confirms to user.

9. App triggers reward interface (FR-006).

10. App attempts upload (FR-005).

- **Alternate Flows:** User ignores notification; User cancels feedback; No network for upload; Reward trigger fails.

5.3.4.2 UC-002: Onboard New User

- **Actor:** New User
- **Trigger:** First app launch.
- **Preconditions:** App installed.
- **Basic Flow:**

1. Display Welcome/Intro.

2. Request Location permission.

3. Request Network/Phone State (if needed).

4. Request Notifications permission.

5. Request Background permission.

6. Display Privacy Policy/Get Consent (compliant with local law).

7. User consents.

8. Display Setup Complete.

9. Background monitoring starts (FR-001).

Alternate Flows: User denies permissions (app explains impact); User denies consent (app cannot proceed); User quits onboarding.

5.3.4.3 UC-003: Background Data Collection and Upload

- **Actor:** System (App Background Service)
- **Trigger:** Background schedule/event.
- **Preconditions:** Onboarded, permissions granted, service active.
- **Basic Flow:** 1. Task wakes up. 2. Collects Location/Network data (FR-001). 3. Timestamps data. 4. Stores locally (FR-004). 5. Checks for pending uploads. 6. Checks network/preferences. 7. If OK, attempts upload via API (FR-005). 8. On success, removes local data. 9. Task completes/reschedules.
- **Alternate Flows:** Permission denied; No network for upload; Upload fails (retry later); Task killed by OS.

5.4 SRS Appendices (Reference to Supporting Info)

- Link to Full Survey Data:
  https://www.google.com/search?q=https://docs.google.com/spreadsheets/d/1uF-wQ-2sD8G2E3sIO89jnBI2Y4Y_2_xS9LmpAFrUSNQ/edit%3Fusp%3Dsharing
- Link to relevant ART regulations documentation:
  www.art.cm
- Link to relevant Cameroonian Data Protection Law documentation:
  Law No. 2024/017 of 23 December 2024 relating to personal data protection in Cameroon

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6. Validate Requirements with Stakeholders

6.1 Introduction To ensure the application meets the needs and expectations of stakeholders, a comprehensive requirements validation process was conducted. This section provides an overview of the validation techniques applied and the outcomes.

6.2 Stakeholders Involved Validation activities involved representatives from all key stakeholder groups:

- Mobile Network Subscribers (End-Users)

- Mobile Network Operators (MNOs)

- App Development Team

6.3 Validation Methods Two primary methods were used for validation:

- **Surveys:** A survey was distributed to 30 participants (25 end-users, 3 developers, 2 MNO representatives) to gather quantitative feedback on the initially proposed requirements.

- **Interviews:** Targeted interviews were conducted with individuals from each stakeholder group to delve deeper into usability, motivations, technical aspects, and operational needs.

6.4 Survey Validation Insights The survey mapped specific findings to the initial requirements list:

- **Functional Requirements:** MNOs confirmed the criticality of real-time data; background operation acceptance was tied to battery efficiency; users preferred event-triggered prompts; slow internet confirmed speed monitoring as priority; MNOs require API access; users demand deletion rights; star/emoji ratings were preferred; data/airtime are top motivators; star ratings ranked #1 format; location sharing conditional on anonymization; prompt frequency is a concern; MNOs want real-time analytics; multi-SIM analysis supported; mandatory opt-outs desired.

- **FR8 Reward-based engagement:** Survey confirmed data/airtime is the top user motivator (90.9%); **Validation:** Requirement for a reward mechanism is confirmed as critical for user adoption, however, **implementation method and MNO participation is pending confirmation.**

- **Non-Functional Requirements:** Battery drain is top user concern; offline sync critical for devs/scalability; simplicity (via star ratings) valued; opt-outs demanded; offline reliability key; non-disruptive prompts needed; precise location data needed by MNOs; cross-platform support needed; fault tolerance (offline) critical; modular architecture requested.

6.5 Interview Validation Insights Interviews provided qualitative context:

- **End-Users:** Confirmed reluctance to report due to perceived inefficacy, frustration with call drops/slow internet, strong preference for instant data/airtime rewards and <10 second feedback effort, and concerns over battery drain and location privacy.

- **MNOs:** Highlighted limitations of tower metrics (missing indoor issues), need for real-time user data, preference for visual formats (heatmaps) and CSV exports, and the need for transparency back to users about feedback impact.

- **Developers:** Confirmed battery optimization strategies (WorkManager, iOS limits), iOS multi-SIM limitations, and feasibility of offline mode with SQLite.

- **Conflicts & Resolutions:** Users desire for immediate reporting vs. MNO preference for batches was resolved with a priority/batch alert system compromise.

6.6 Validated Adjustments & Final Specification

Based on survey and interview feedback, several adjustments were made, leading to the final requirements specification detailed in the SRS (Section 5), summarized below:

- **Reward Requirement:** User need for instant rewards (data/airtime) strongly validated.

   Status: Requirement (FR-006) included as MUST HAVE due to user importance, but implementation is **Pending MNO Agreement**.

- Feedback prompts changed to event-triggered.

- Background collection optimized for battery.

- Offline mode details defined.

- Platform-specific multi-SIM handling defined.

- MNO data integration refined.

- Privacy controls made granular.

- Security details added.

- Performance/Responsiveness metrics defined.

- Adaptive prompting rules added.

6.7 Rejected/Deferred Requirements The validation process also confirmed certain requirements were not feasible or suitable for V1.0:

- iOS Multi-SIM Automation (Platform Restriction).

- Advanced AI Analytics (Budget Constraint - Phase 2).

- Multilingual Support (Limited Initial Demand - Post-Launch).

6.8 Conclusion of Validation

The validation process confirmed that the requirements specified in Section 5 (SRS) generally align with stakeholder needs after incorporating crucial feedback and adjustments. However, **a critical dependency remains: securing agreement and a viable integration path with MNOs for the user-preferred reward mechanism (FR-006) is essential for maximizing user adoption and requires urgent resolution.** The process successfully refined other functional implementations, clarified non-functional expectations, and confirmed priorities. Further validation, including legal/regulatory review and MNO commitment, is required.

Conclusion: This report outlines the analysis, prioritization, specification, and initial validation of requirements for the Mobile QoE Data Collection App. While a core set of functional and non-functional requirements for a cross-platform MVP has been defined and specified in the included SRS, the analysis has revealed critical gaps concerning compliance with Cameroonian ART regulations, local data privacy laws, and detailed security measures that require immediate attention. Furthermore, validation confirmed that while users strongly desire instant rewards, **securing MNO agreement for this mechanism is currently pending and represents a significant project risk.** Addressing these legal/regulatory gaps and resolving the MNO reward agreement, followed by rigorous final stakeholder validation of the complete SRS, are essential prerequisites for successful project execution.

Appendix

Link to survey conducted :

https://docs.google.com/spreadsheets/d/18gI69KQlzZZLwz5afp_vTC3Y3WcWosgCuyjNadBUIaQ/edit?usp=sharing