NAMAL UNIVERSITY MIANWALI
Department of Computer Science

System Design Specification

Milestone 3
CattleCare Pro

Subject: Software Engineering

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Chapter 1

Introduction

1.1 Document Purpose

This System Design Specification document presents the complete design of the Cattle-Care Pro livestock management system based on the approved Software Requirements Specification (SRS). This document translates all requirements into detailed behavioral and structural models using standard UML diagrams.

1.2 Project Overview

CattleCare Pro is an intelligent livestock management system designed for cattle farm owners to manage their farms from a single digital hub. The emphasis of the system is on enhancing security and productivity among the cattle through a modern technological approach.

1.3 Document Organization

This document includes the following chapters:

- Chapter 2: Design Assumptions and Constraints
- Chapter 3: Key Design Decisions
- Chapter 4: Use Case Diagram
- Chapter 5: Data Flow Diagrams
- Chapter 6: Sequence Diagrams
- Chapter 7: Activity Diagrams
- Chapter 8: Class Diagram
- Chapter 9: Component Diagram
- Chapter 10: Requirements-Design Traceability
- Chapter 11: Links

Chapter 2

Design Assumptions and Constraints

2.1 Design Assumptions

During the design of the Cattle Care Pro system, certain assumptions were made to define the expected operating environment and user behavior.

1. The system will be used primarily by farm owner/admin responsible for cattle monitoring and management.
2. Each cattle unit is uniquely identifiable within the system using a unique cattle ID.
3. GPS-enabled devices are attached to cattle for location tracking.
4. Internet connectivity is assumed to be available for real-time data transmission.
5. The system is deployed in a single-farm environment and does not support multi-farm operations.
6. Data entered into the system is assumed to be accurate and verified by authorized personnel.

2.2 Design Constraints

2.2.1 Hardware Constraints

- The accuracy of cattle tracking is constrained by GPS signal strength and device availability.
- GPS collar devices must operate within temperature range of -20°C to +50°C.
- Device weight is constrained to maximum 500 grams.
- Battery life of GPS collars limits continuous high-frequency data transmission.

2.2.2 Network Constraints

- System performance depends on network stability and bandwidth.

- Limited cellular coverage in remote grazing areas may cause data transmission delays.

2.2.3 Security Constraints

- Data security mechanisms are restricted to authentication-based access control and role management.
- All communications must use HTTPS protocol.
- Password storage must use bcrypt hashing algorithm.
- Session timeout is constrained to 15 minutes of inactivity.

2.2.4 Platform Constraints

- The mobile application is constrained to Android platform (API level 29+).
- System operates within predefined hardware limitations such as processing power and storage capacity.
- The application is constrained to predefined screen resolutions and interface layouts.
- External hardware dependencies such as GPS trackers must be compatible with the system.

Chapter 3

Key Design Decisions

Key design decisions were made during the development of the CattleCare Pro system to ensure modularity, scalability, and ease of maintenance.

3.1 DFD Process Decomposition

The system functionality was decomposed into smaller and manageable processes to improve system clarity and maintainability. Instead of representing the entire system as a single process, it was divided into logical sub-processes such as authentication, cattle management, location tracking, shelter monitoring, and report generation.

This decomposition allows each process to operate independently while maintaining clear data flow between processes. It simplifies debugging, enhances system understanding, and supports future system extensions.

3.2 Selection of Class Relationships

Different types of class relationships were selected based on ownership, dependency, and object lifecycle.

Composition was used between the Cattle and Location classes because location data cannot exist independently without a corresponding cattle entity. This represents a strong lifecycle dependency.

Aggregation was applied between the Shelter and Cattle classes since cattle may exist independently of shelters. This relationship reflects a weak ownership model.

Association relationships were used where objects interact but do not share ownership, such as between Admin and Cattle.

3.3 Distribution of Functionality Across Multiple Diagrams

Complex system functionality was distributed across multiple sequence diagrams and activity diagrams instead of creating single comprehensive diagrams. This improves read-

ability, maintainability, and traceability.

Chapter 4

Use Case Diagram

The Use Case Diagram provides a high-level view of system functionality by identifying actors and their interactions with the system.

4.1 Actors

1. **Farm Owner/Administrator** - Primary user with full access
2. **GPS Collar Device** - External hardware providing data
3. **Cloud Server** - External system for data storage
4. **Camera** - External device for shelter security

4.2 Use Case Diagram

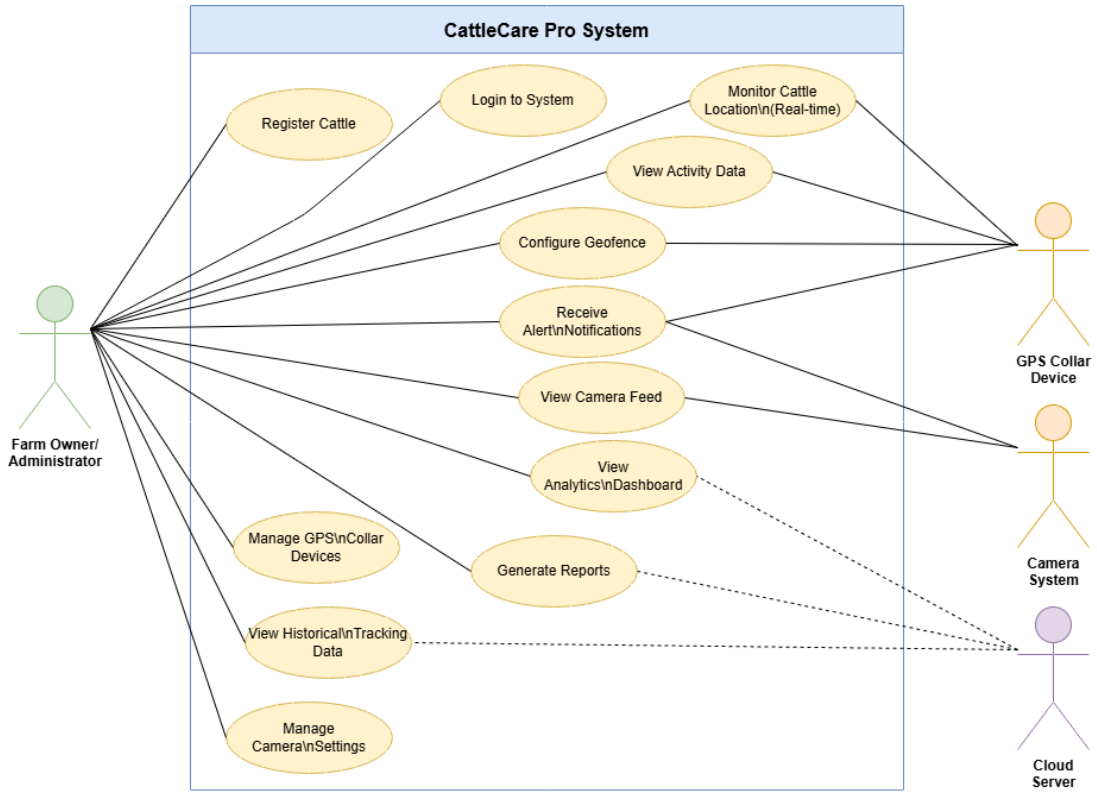

Figure 4.1: Use Case Diagram of CattleCare Pro System

Chapter 5

Data Flow Diagrams

Data Flow Diagrams represent the flow of data through the CattleCare Pro system at different levels of abstraction.

5.1 Level 0 DFD - Context Diagram

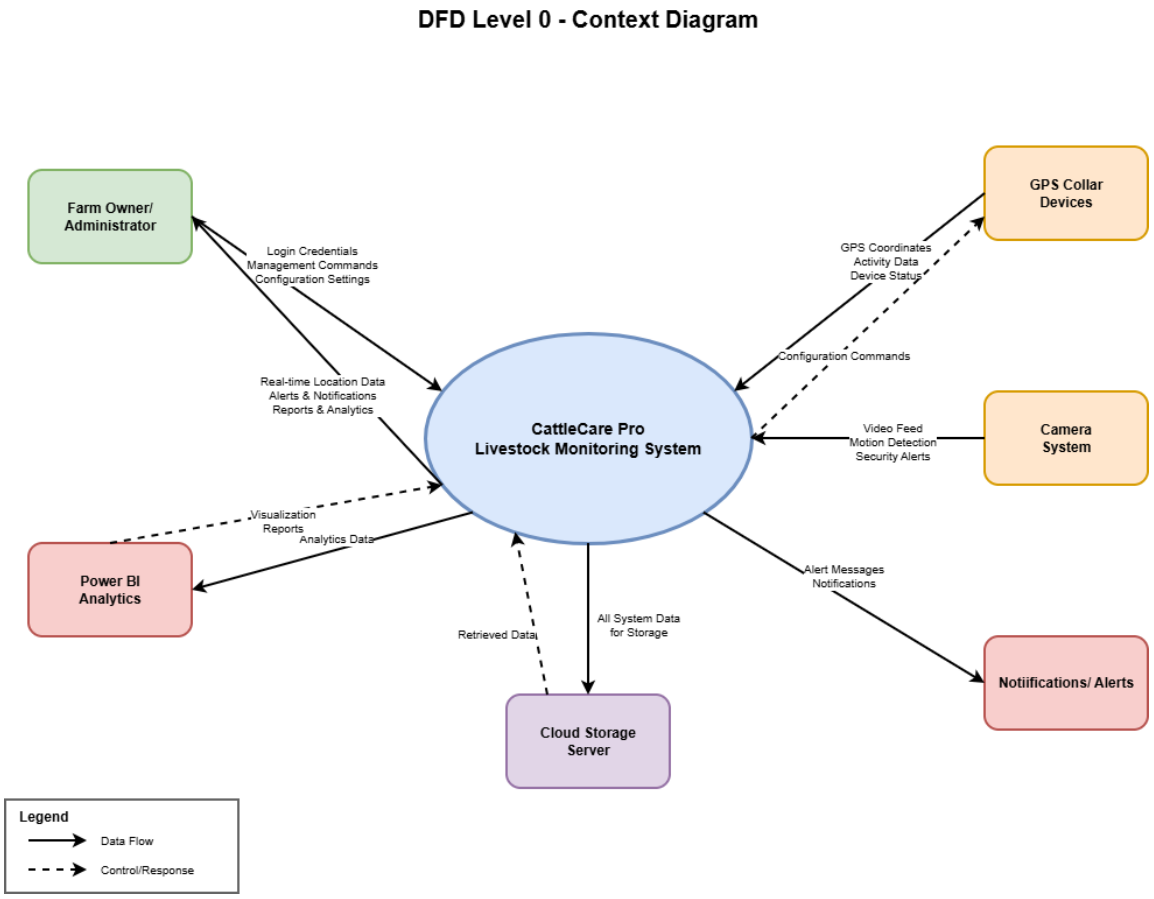

Figure 5.1: Level 0 DFD - Context Diagram

5.2 Level 1 DFD

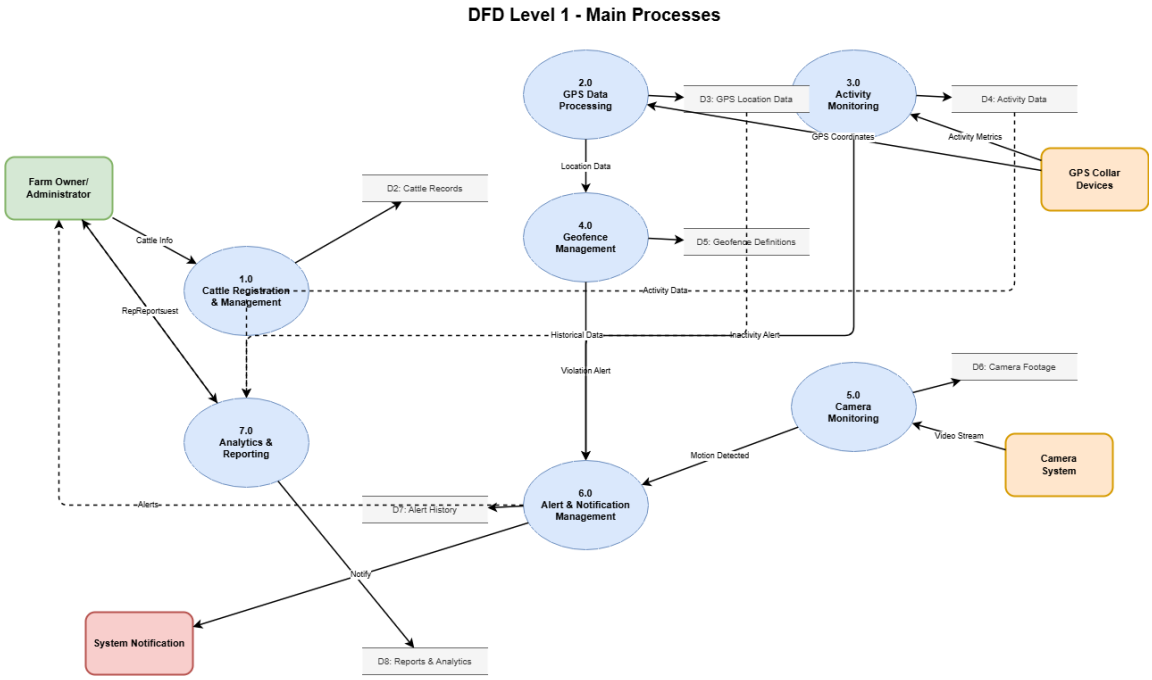

Figure 5.2: Level 1 DFD - Major System Processes

5.3 Level 2 DFD

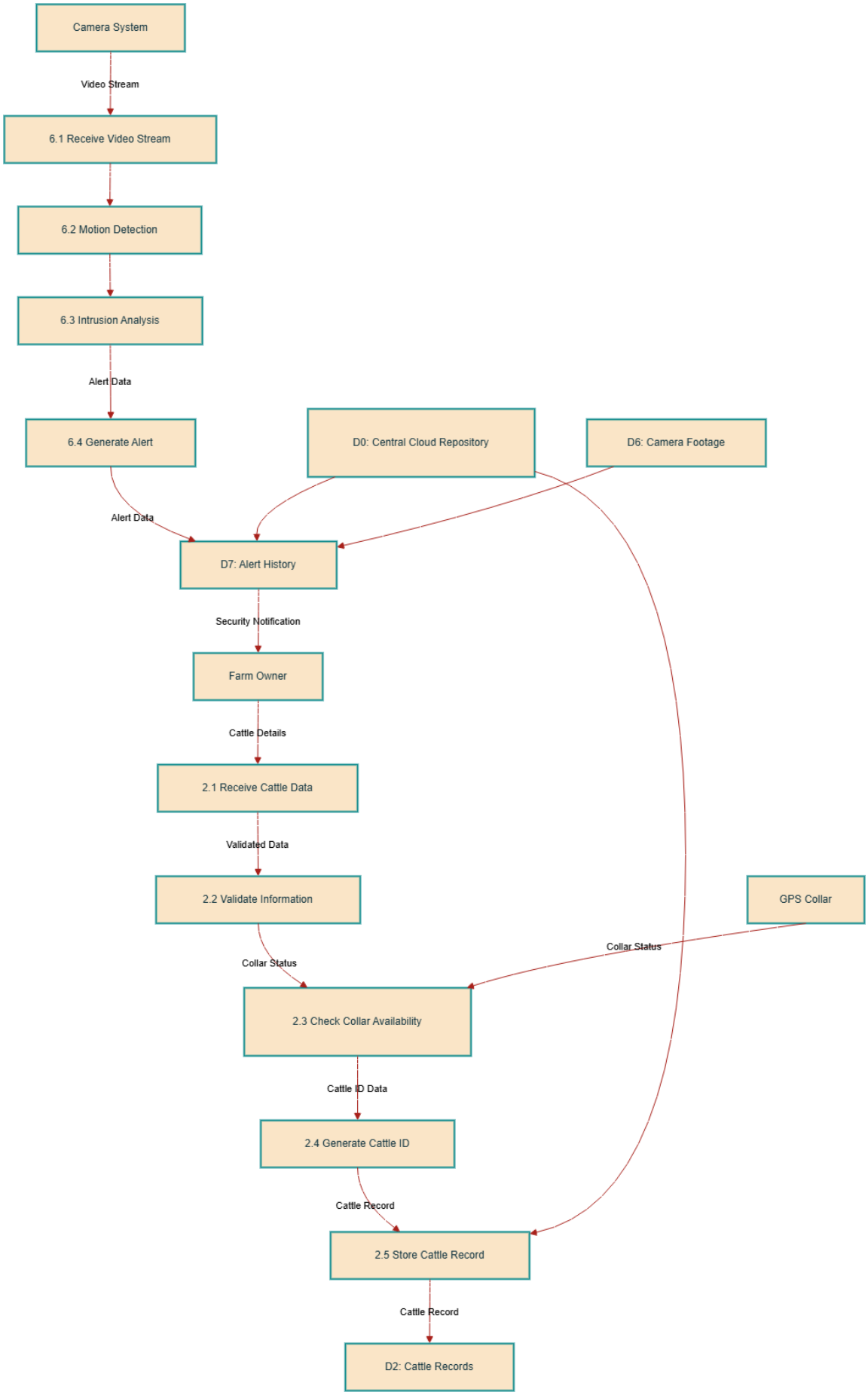

Figure 5.3: Level 2 DFD - Cattle Management Decomposition

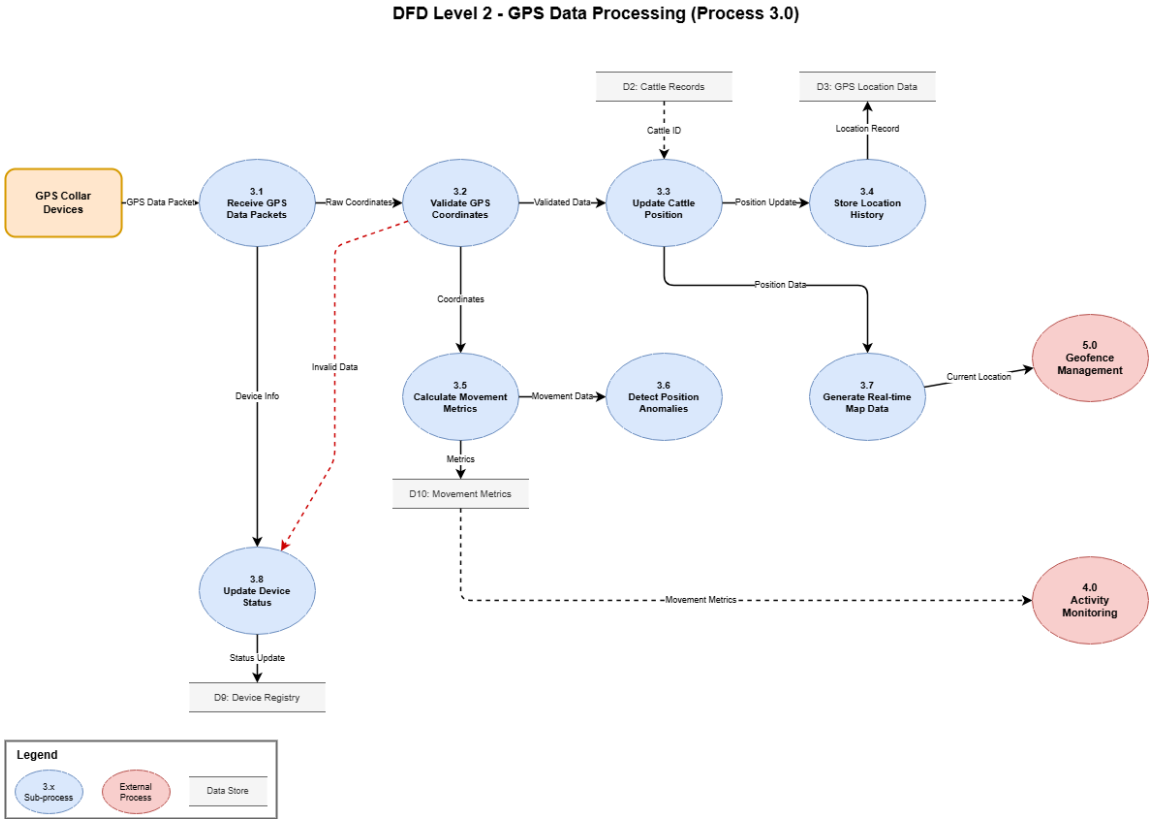

Figure 5.4: Level 2 DFD - Location Tracking

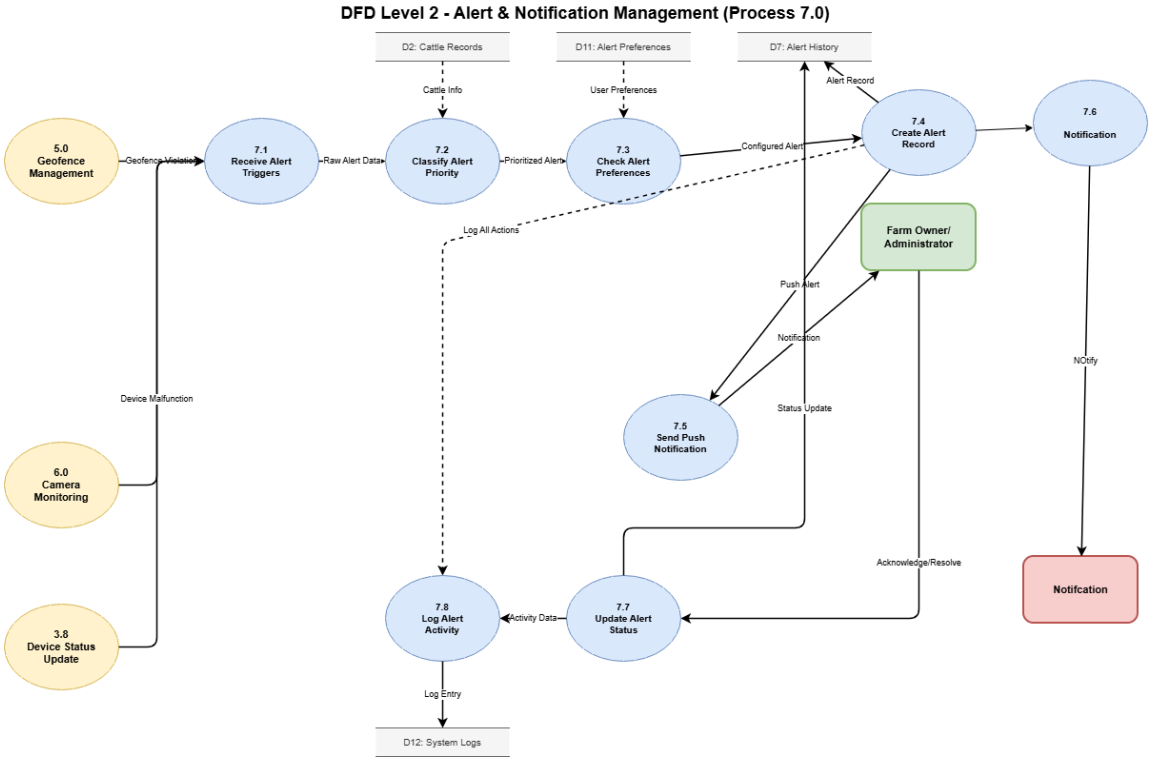

Figure 5.5: Level 2 DFD - Notification

Chapter 6

Sequence Diagrams

Sequence diagrams model the interaction between objects over time for key system functionalities.

6.1 User Authentication Sequence

Figure 6.1: Sequence Diagram - User Authentication

6.2 Cattle Registration Sequence

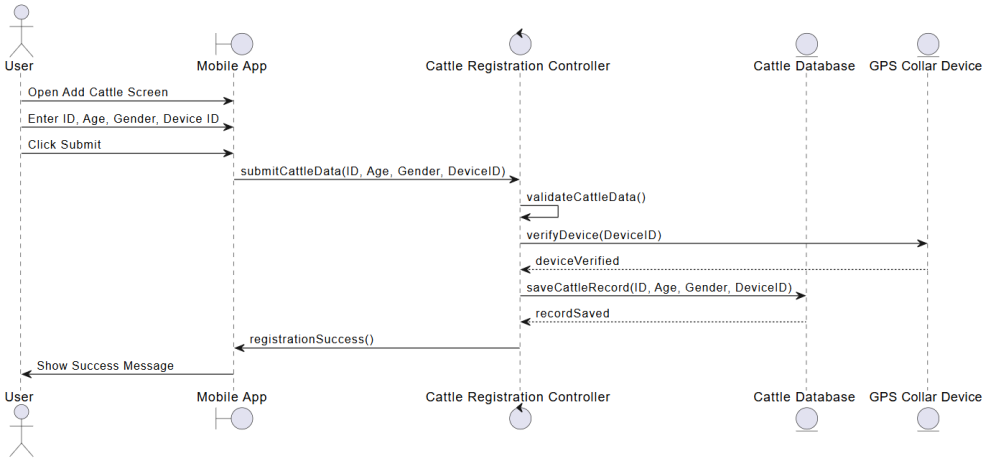

Figure 6.2: Sequence Diagram - Cattle Registration

6.3 Location Tracking Sequence

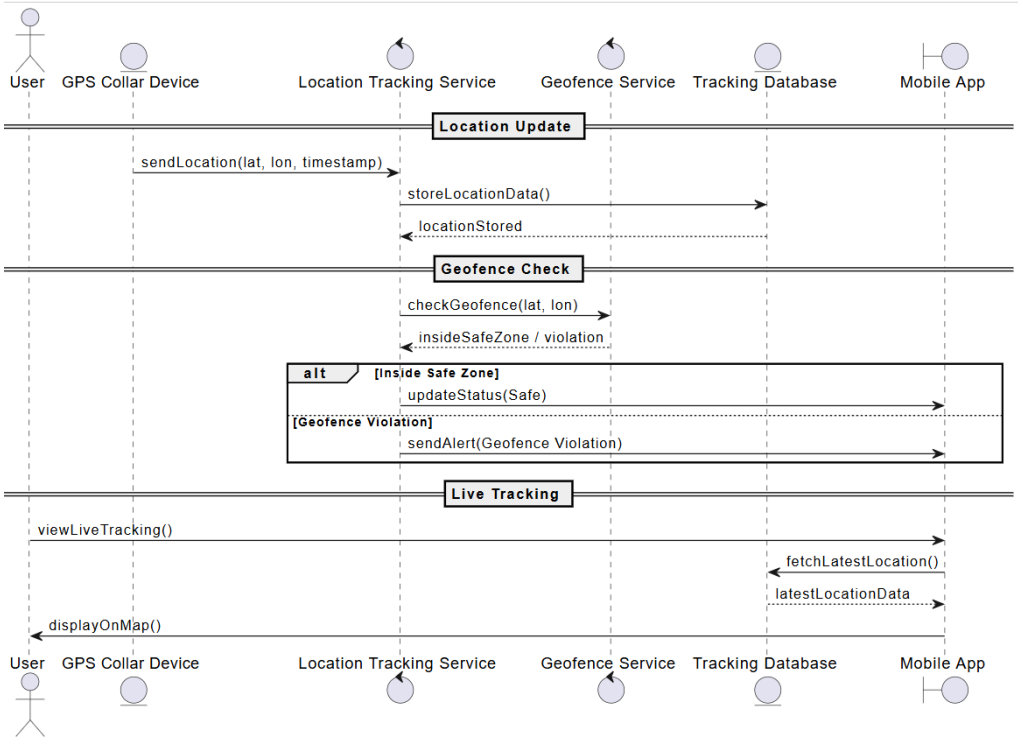

Figure 6.3: Sequence Diagram - Location Tracking

6.4 Alert Generation Sequence

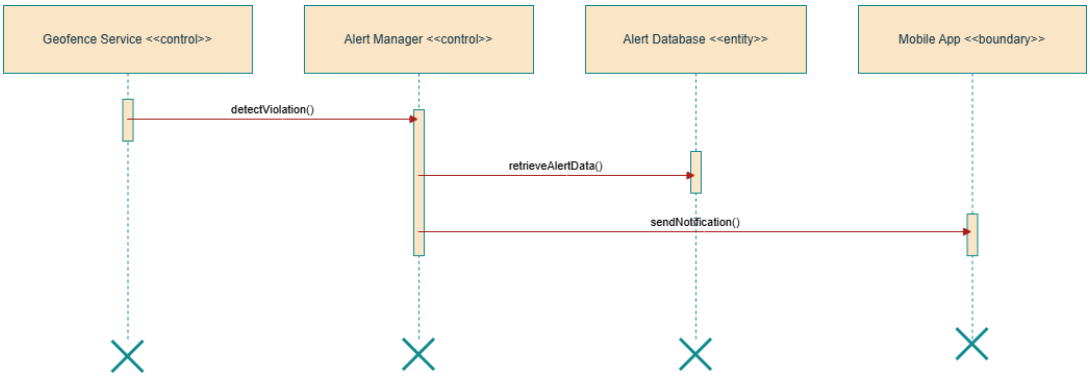

Figure 6.4: Sequence Diagram - Alert Generation

6.5 Report Generation Sequence

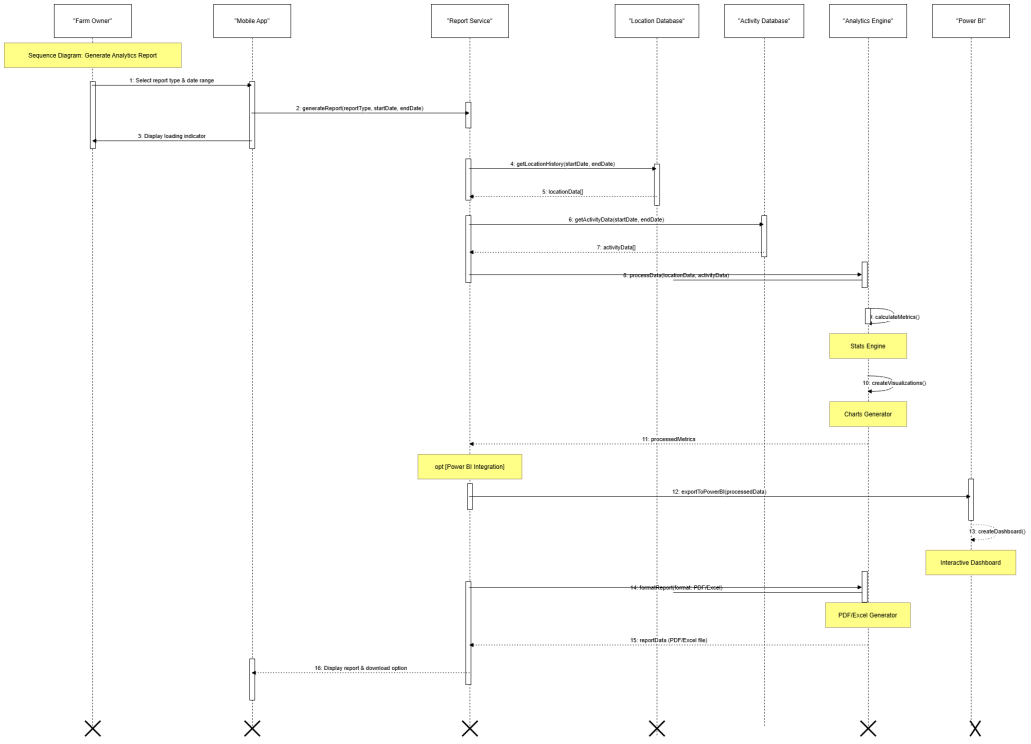

Figure 6.5: Sequence Diagram - Report Generation

Chapter 7

Activity Diagrams

Activity diagrams model the workflow of business processes, showing sequence of activities and decision points.

7.1 Cattle Registration Workflow

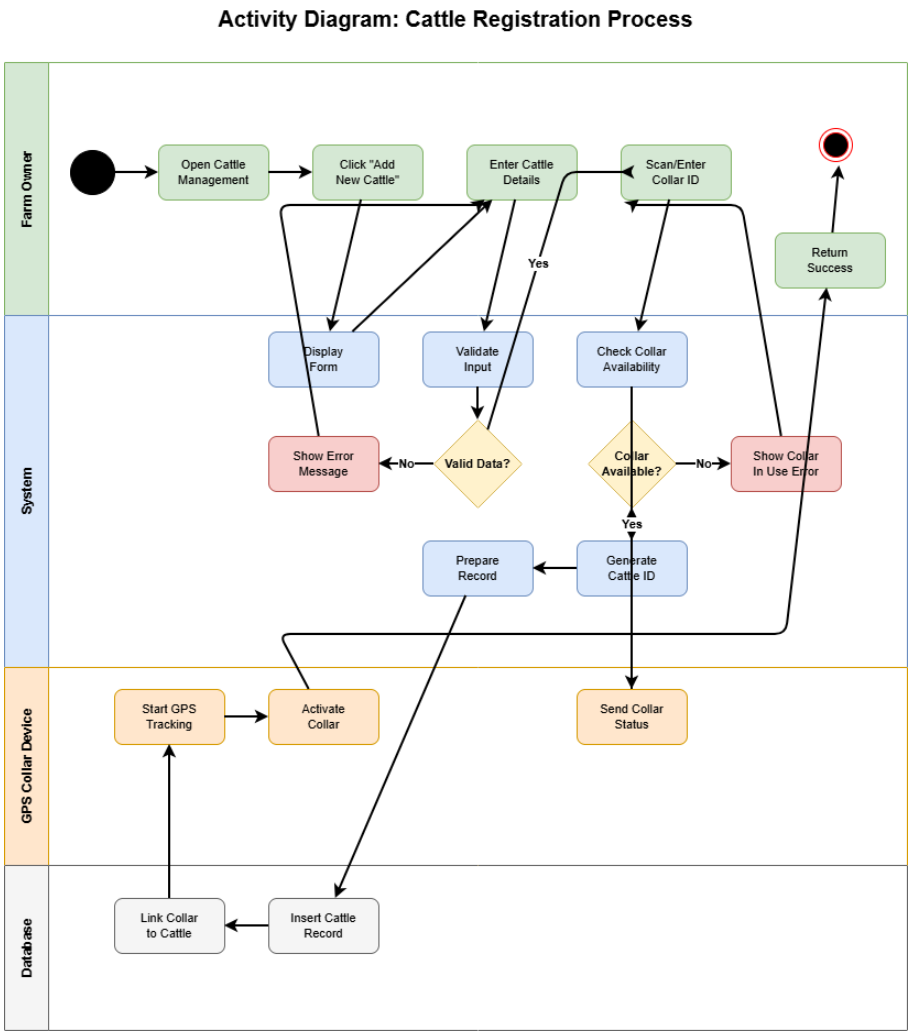

Figure 7.1: Activity Diagram - Cattle Registration Workflow

7.2 Alert Processing Workflow

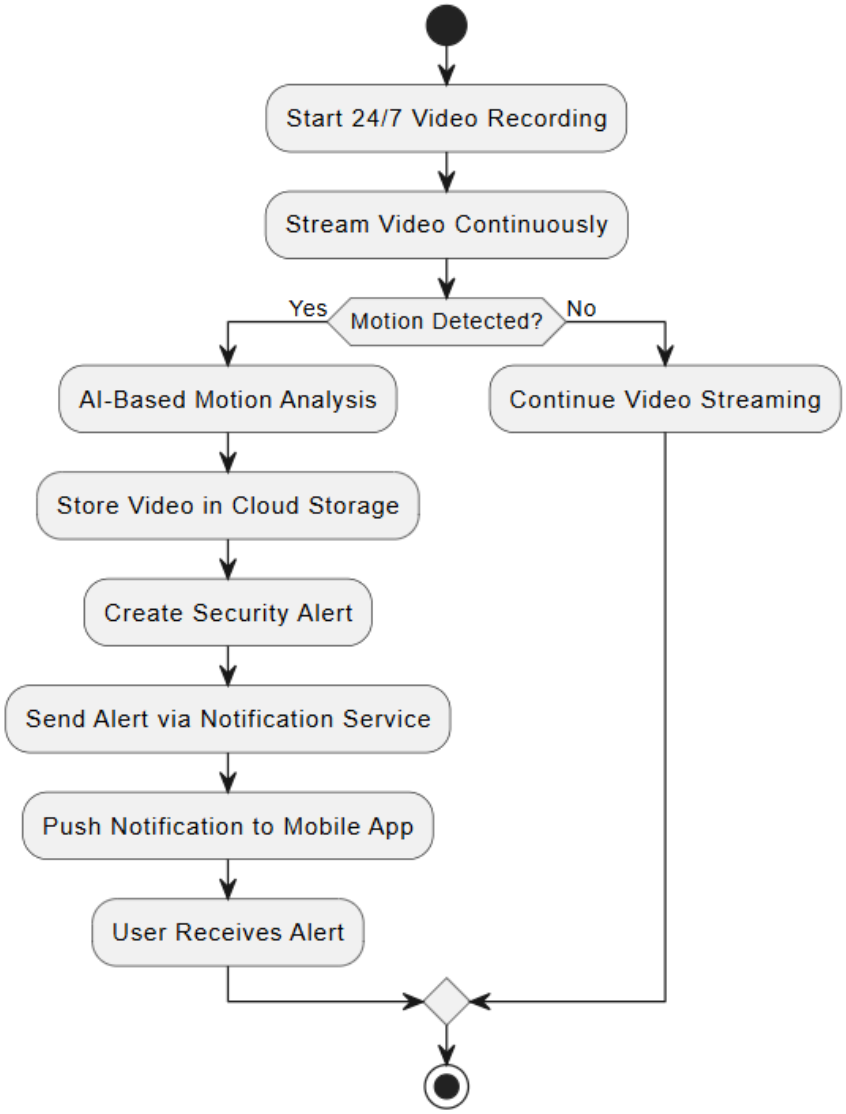

Figure 7.2: Activity Diagram - Alert Processing Workflow

7.3 Geofence Violation Detection

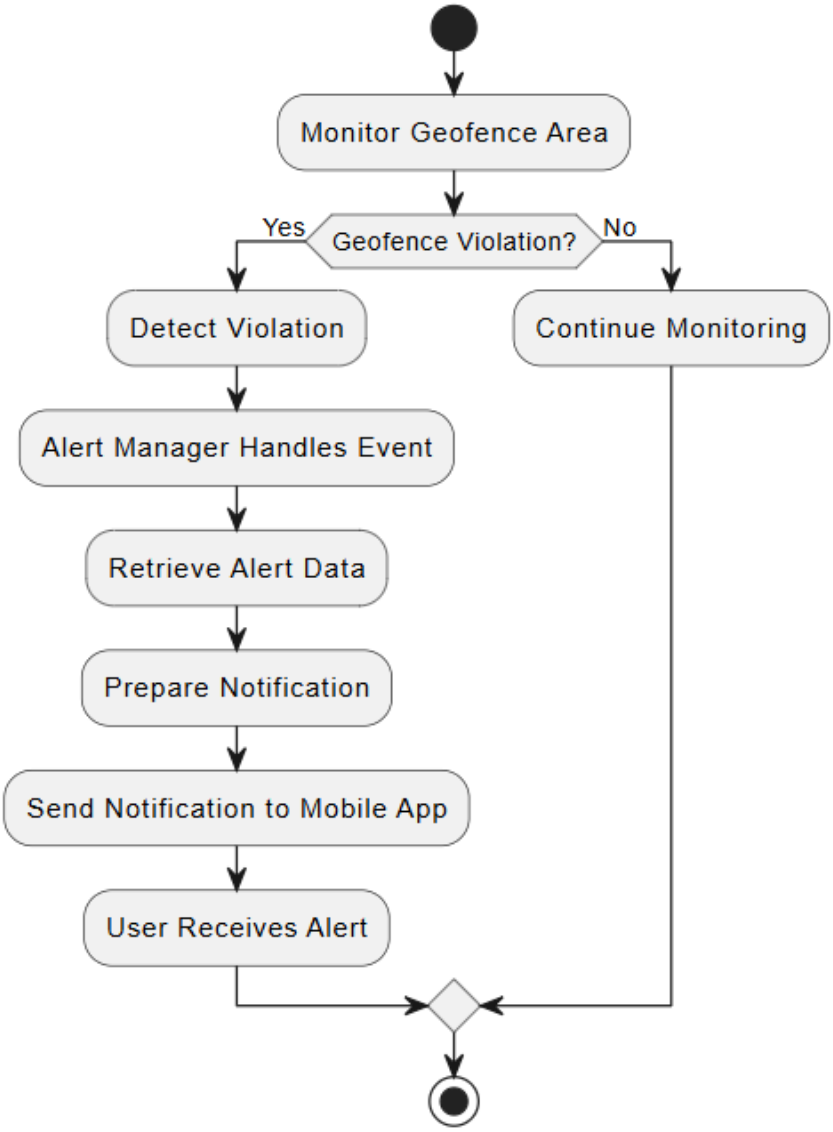

Figure 7.3: Activity Diagram - Geofence Violation Detection

Chapter 8

Class Diagram

The class diagram represents the static structure of the Cattle Care Pro system. It identifies the core classes, their attributes, operations, and the relationships among them.

8.1 Class Diagram

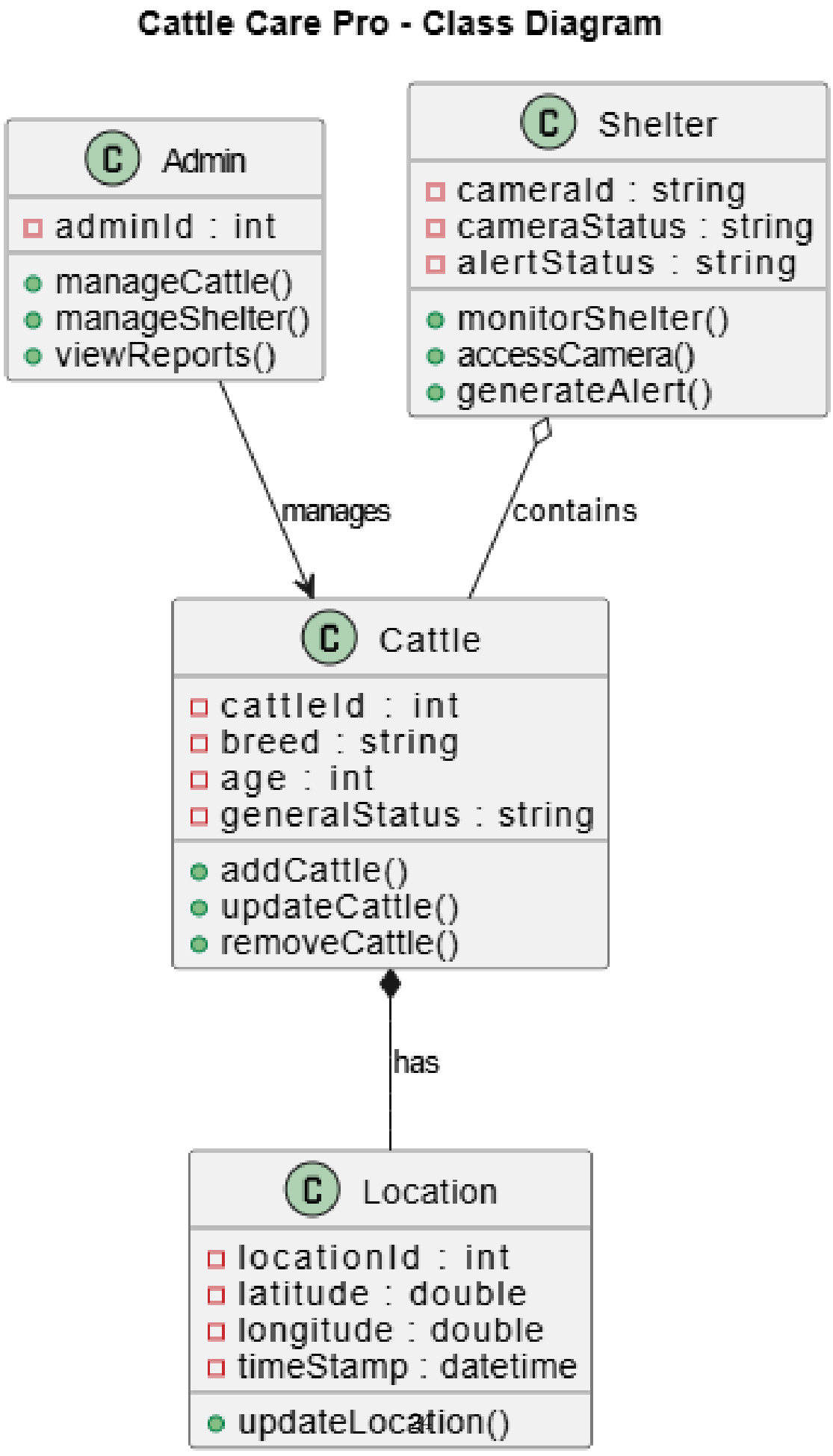

Figure 8.1: Class Diagram of CattleCare Pro System

Chapter 9

Component Diagram

The component diagram illustrates the high-level architectural structure of the Cattle Care Pro system. Each component represents a logical module responsible for a specific functionality.

9.1 Component Diagram

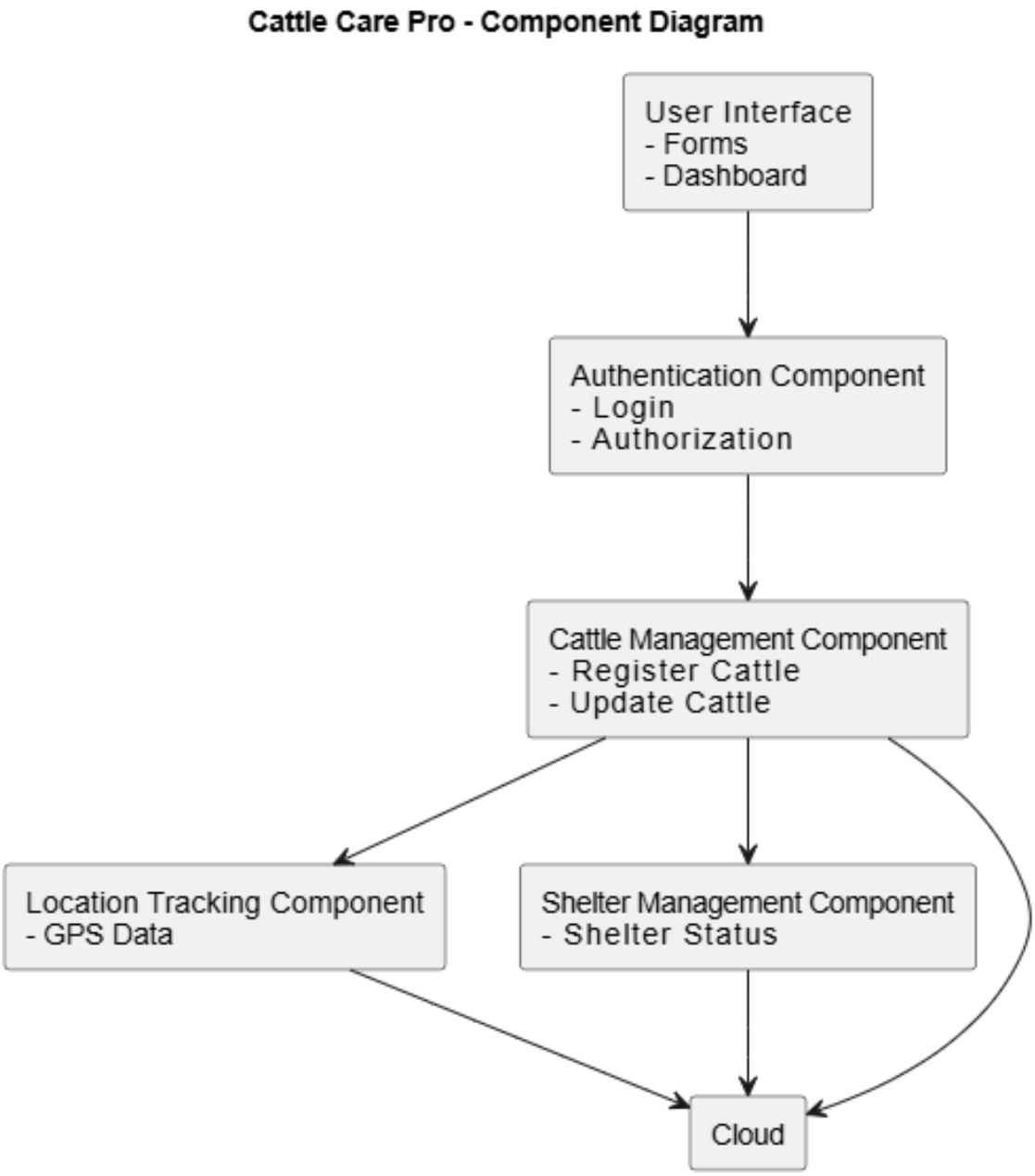

Figure 9.1: Component Diagram of CattleCare Pro System

Chapter 10

Requirements–Design Traceability Table

The Requirements–Design Traceability Table ensures that every functional requirement identified in the Software Requirements Specification (SRS) is properly addressed in the system design.

10.1 Traceability Matrix

Table 10.1: Requirements–Design Traceability Matrix

Req ID	Description	Use Case	DFD	Sequence	Classes
FR-01	Administrator authentication and authorization	UC-01	1.0	SD-1	User, Admin
FR-07	Register new cattle information	UC-02	2.1, 2.2	SD-2	Cattle
FR-08	Update cattle profile and health status	UC-02	2.4	-	Cattle
FR-12	Track real-time cattle location using GPS	UC-03	3.0	SD-3	Cattle, Location
FR-25	Monitor shelter capacity and conditions	UC-06	-	-	Shelter
FR-30	View cattle movement and reports	UC-07	6.0	SD-5	Admin, Cattle
FR-40	Store and retrieve system data securely	-	All	-	Cloud

Chapter 11

Links

11.1 GitHub Repository

Link: https://github.com/aligoharcodepulse/CattleCare-Pro

11.2 Figma Prototype

Link: https://www.figma.com/proto/8dRWAaDIKINkYw2nsUOst7/CattleCare-Pro?node-id=77-54&p=f&t=BxerLRbvYSEUO1UM-0&scaling=scale-down&content-scaling=fixed&page-id=0%3A1&starting-point-node-id=77%3A54

11.3 LinkedIn Post

Link: https://www.linkedin.com/posts/muhammad-ali-gohar-b47662277_softwareengineering-utm_source=social_share_send&utm_medium=member_desktop_web&rcm=ACoAAEOM8ecBymnVV$Nwzp