# Solution for Exercise 04: E-Scooter Ride-Share System

**TU Clausthal** | Institut für Software and Systems Engineering
**Course:** Requirements Engineering | **Exercise:** 04 (Agent-Oriented Modeling)
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## 1. Agents and Roles

| Agent | Role | Description |
|---|---|---|
| Commuter (Human) | Commuter Role | Handles user-side processes: registration, scooter reservation, riding, and payment authorization |
| E-Scooter (Hardware) | Fleet Manager Role | Controls physical vehicle state (lock/unlock), reports real-time status and GPS location |
| Backend System (Software) | Payment Processor Role | Manages account verification, fee computation, and secure financial transactions |

## 2. Design Rationale

> **Three-Agent Decomposition:** Separating human (Commuter), hardware (E-Scooter), and software (Backend) agents follows the *separation of concerns* principle, enabling independent development and deployment of each system component.

> **Time-Based Pricing Choice:** Selected over distance-based due to: (1) user comprehension simplicity, (2) hardware reliability (GPS accuracy issues), and (3) fairness (prevents gaming via circular routes).

## 3. Goals

| ID | Goal | Description |
|---|---|---|
| **Functional Goals** | | |
| FG-01 | Registration | Allow new commuters to register with identity and payment validation |
| FG-02 | Reservation | Enable locating and reserving idle scooters |
| FG-03 | Commute | Allow unlocking and riding the reserved scooter |
| FG-04 | End Ride | Detect ride termination and lock scooter automatically |
| FG-05 | Payment | Calculate and debit fees without manual intervention |
| **Quality Goals** | | |
| QG-01 | Data Accuracy | Real-time scooter status synchronization |

| ID | Goal | Description |
|---|---|---|
| QG-02 | Billing Precision | Accurate fee calculation based on exact duration |
| QG-03 | Security | Encrypted storage of payment credentials |

## 4. Ride Cost Computation

$$\textbf{TotalFee} = \textbf{UnlockFee} + (\textbf{Duration}_{\textbf{minutes}} \times \textbf{Rate}_{\textbf{per min}})$$

| Variable | Description | Example Value |
|---|---|---|
| UnlockFee | Fixed starting fee | €1.00 |
| Duration | Time from unlock to end ride (rounded up) | 15 minutes |
| Rate | Per-minute usage charge | €0.20 |

**Example:** A 15-minute ride costs €1.00 + (15 × €0.20) = **€4.00**

## 5. Behavioral Interface Model (BIM)

The BIM illustrates the complete interaction workflow, **including error recovery paths**:

**Happy Path:**

1. Registration → Account creation
2. Reservation → Scooter selection
3. Unlock → Motor activation
4. Commute → Travel period
5. End Ride → Vehicle lock
6. Payment → Fee deduction

**Error Handling:**

| Error State | Trigger | Recovery |
|---|---|---|
| ReservationTimeout | User doesn't unlock within 10 min | Scooter released, no charge |
| PaymentFailed | Insufficient funds / card declined | Retry (max 3×) → Suspension |

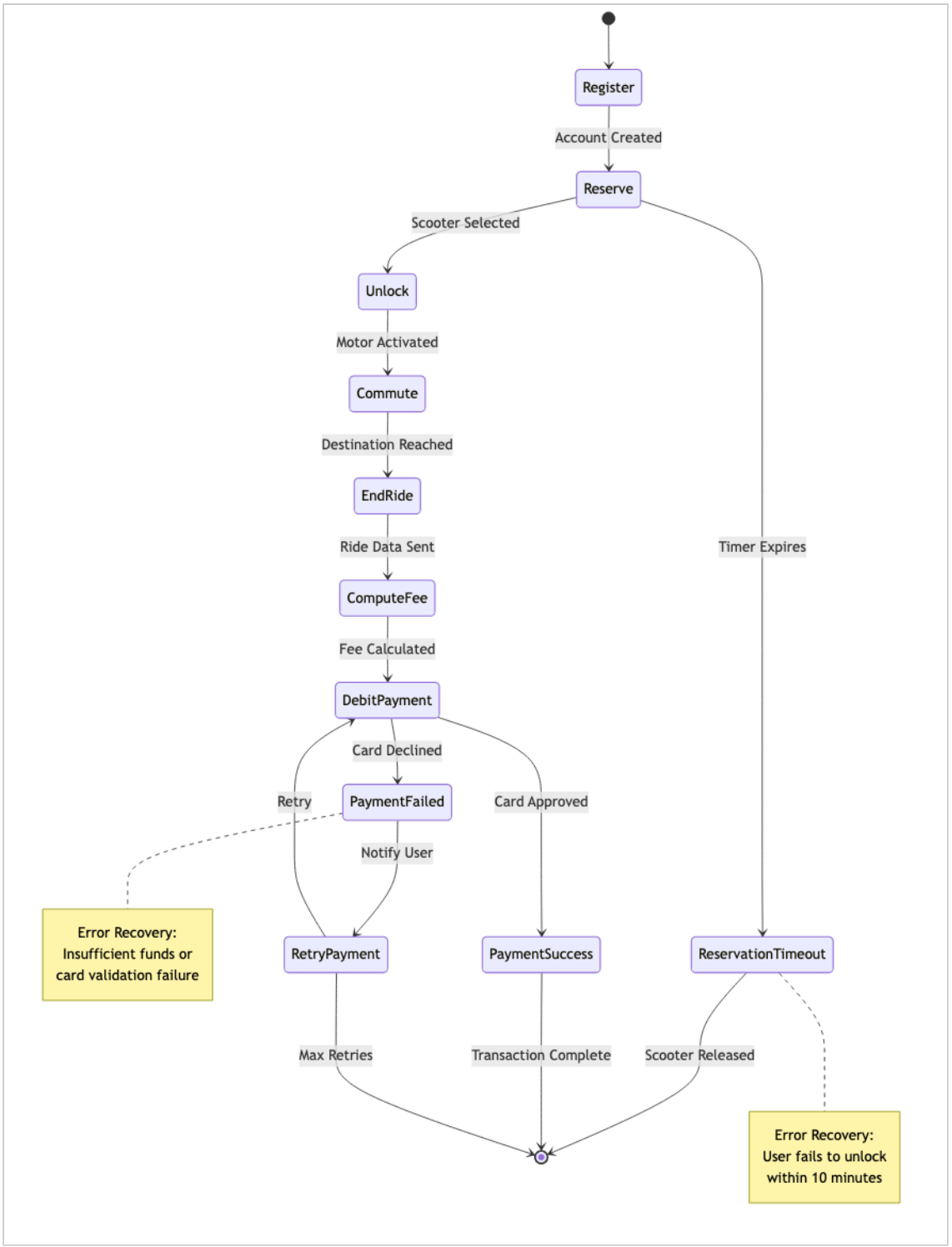


*Figure 1: Behavioral Interface Model with Error Recovery*

## 6. Goal Hierarchy Diagram (Enhanced 4-Level Model)

The goal hierarchy has been **rebalanced** to distribute complexity evenly:

- **Level 1 (Blue):** Main Goal – Manage E-Scooter Ride Sharing
- **Level 2 (Green):** Four Sub-Goals:
  - SG-1: Manage User Registration
  - SG-2: Manage Scooter Reservations
  - SG-3: Manage Active Rides
  - SG-4: Manage Payment Processing
- **Level 3 (Yellow/Light Green):** Leaf Goals (5 Functional + 3 Quality)

> **Hierarchy Balance:** Splitting "Ride Operations" into Reservations (SG-2) and Active Rides (SG-3) creates clearer separation of concerns and prevents one sub-goal from dominating the model.

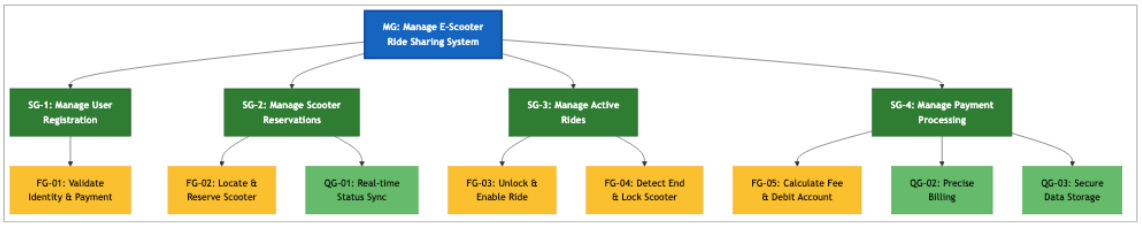


*Figure 2: AOM Goal Model – Balanced 4-Level Hierarchy*