Exercise 04: E-Scooter Ride-Share System

Course: Requirements Engineering | **University:** TU Clausthal
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1. Agents and Roles

The system comprises three autonomous agents with distinct roles:

Agent	Role	Type	Responsibilities
Commuter	User	Human Actor	Registration, scooter reservation, ride operation, payment authorization
E-Scooter	Vehicle Controller	IoT Device	Lock/unlock control, GPS tracking, battery monitoring, telemetry reporting
Backend Server	Service Orchestrator	Software System	Account management, availability coordination, fare computation, payment processing

2. Goals

2.1 Functional Goals

ID	Goal	Owner Role	Description
FG-1	User Registration	Service Orchestrator	Enable account creation with identity and payment validation
FG-2	Scooter Reservation	Service Orchestrator	Allow users to locate and reserve available scooters
FG-3	Ride Execution	Vehicle Controller	Unlock scooter and enable motor control during commute
FG-4	Ride Termination	Vehicle Controller	Lock scooter and transmit final ride telemetry
FG-5	Payment Processing	Service Orchestrator	Calculate fare and debit registered payment method

2.2 Quality Goals

ID	Goal	Owner Role	Description
QG-1	Data Synchronization	All Roles	Real-time consistency between scooter state and backend
QG-2	Billing Accuracy	Service Orchestrator	Fare matches actual duration/distance (±1s tolerance)
QG-3	Transaction Security	Service Orchestrator	PCI-DSS compliant payment encryption

3. Ride Cost Computation

The system uses a **hybrid time-and-distance model** as required:

```
Total Fee = Base Fee + (Duration × Time Rate) + (Distance × Distance Rate)
```

Parameter	Value	Rationale
Base Fee	€1.00	Fixed unlock cost covering operational overhead
Time Rate	€0.10/min	Primary component; time is precisely measurable
Distance Rate	€0.05/km	Secondary component; reflects battery usage

Example: 15 min, 3.2 km → €1.00 + (15 × €0.10) + (3.2 × €0.05) = **€2.66**

4. Goal Hierarchy

The Goal Model (see attached PDF) follows a **3-level AOM hierarchy**:

Level	Goals	Mapping
Level 1	MG: Manage E-Scooter Ride-Share Operations	Root goal
Level 2	SG-1: User Lifecycle, SG-2: Fleet Operations, SG-3: Financial Services	Sub-goals
Level 3	FG-1 to FG-5, QG-1 to QG-3	Leaf goals

Level 1	MG: Manage E-Scooter Ride-Share Operations	Root goal

5. Behavioral Interface Model (BIM)

The BIM models the complete ride lifecycle with state transitions mapped to responsible agents:

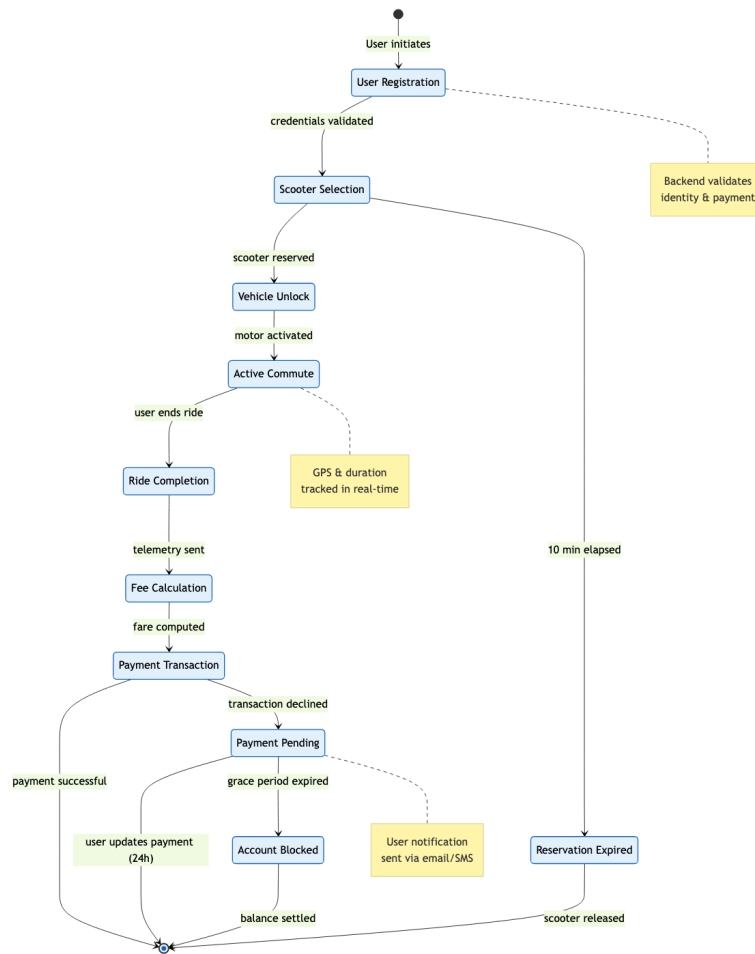*Figure 1: BIM showing state transitions for E-Scooter ride-share system*

5.1 State-Agent Mapping

State	Responsible Agent	Goal Covered	Description
Register	Backend Server	FG-1	Validate user credentials and payment method
Reserve	Backend Server	FG-2	Mark selected scooter as reserved
Unlock	E-Scooter	FG-3	Activate motor and controls
Commute	User + E-Scooter	FG-3, QG-1	Active ride with real-time telemetry
EndRide	E-Scooter	FG-4	Lock vehicle and send final data
ComputeFee	Backend Server	FG-5, QG-2	Calculate fare from telemetry
DebitPayment	Backend Server	FG-5, QG-3	Process secure payment transaction

5.2 Exception States

Exception	Trigger	Recovery
Reservation Timeout	No unlock within 10 min	Release scooter, no charge
Payment Pending	Transaction declined	24h grace period for payment update
Temporary Block	Grace period expired	New rides blocked until settled

6. BIM-Goal Traceability

Every functional and quality goal is covered by the BIM:

Goal	BIM States	Verification
FG-1 Registration	Register	✓ Complete
FG-2 Reservation	Reserve, Timeout	✓ With exception
FG-3 Ride Execution	Unlock → Commute	✓ Complete
FG-4 Termination	EndRide	✓ Complete
FG-5 Payment	ComputeFee → DebitPayment	✓ With exceptions
QG-1 Sync	All transitions	✓ Implicit
QG-2 Accuracy	Commute, ComputeFee	✓ Complete
QG-3 Security	DebitPayment	✓ Complete