Technische Universität Braunschweig

Institute of Operating Systems and Computer Networks

A Back-end System for an Autonomous Parking and Charging System for Electric Vehicles

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IEVC 2012

V-Charge Project

Goals

- A system combining autonomous valet parking with e-mobility
- Increasing customer acceptance of electric vehicles
- By compensating for longer charging cycles

Challenges

- Efficiently using scarce charging resources
- Multiple communication channels (V2I, Web, mobile)
- Autonomous driving and parking (not in this talk)

V-CHARGE

V-Charge Partners

BOSCH

ETH

Motivation

Scenario: EV driver at airport

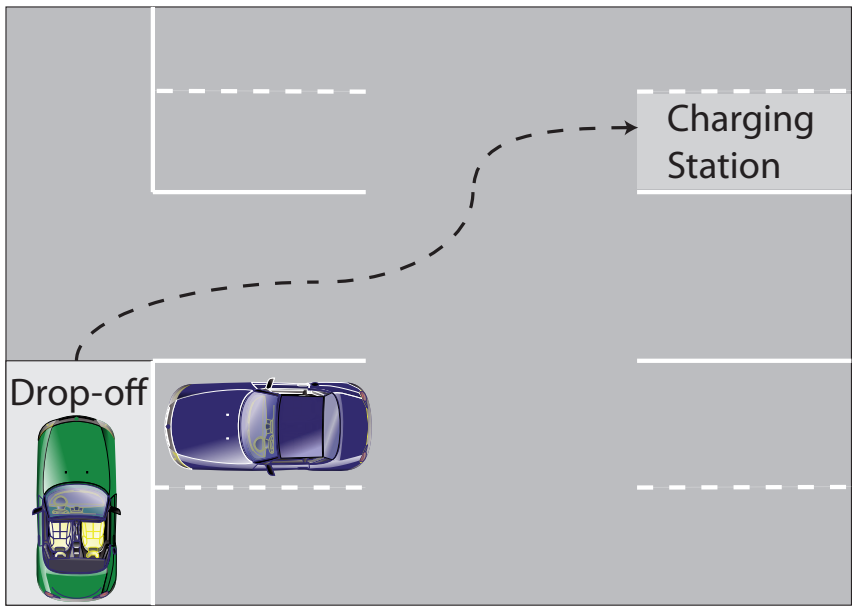
- Roam for a free spot
- Use shuttle services
- Transport luggage
- What about charging?

Disadvantages

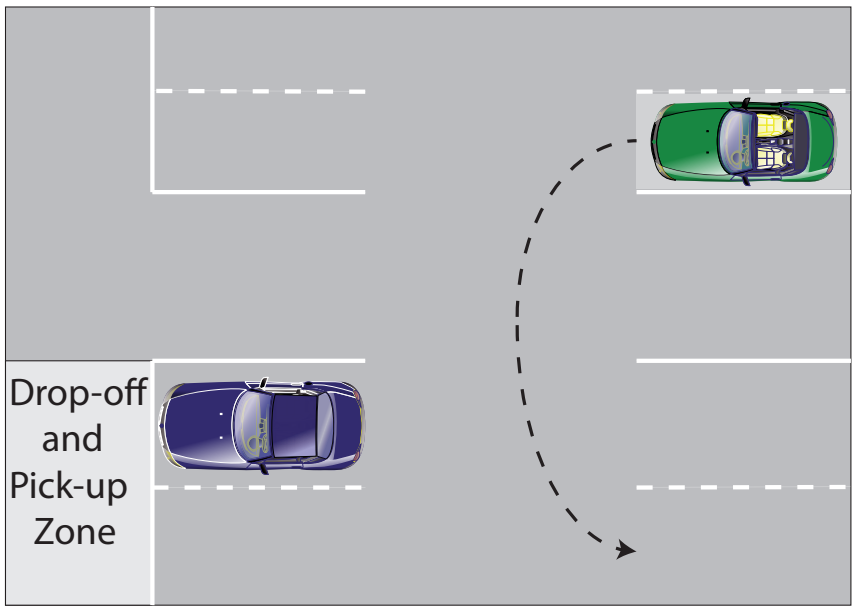
- Cumbersome
- Only few charging stations
- Makes it even harder to find parking

Solution: V-Charge

Autonomous Parking and Charging



(a) Drop-off



(b) Reparking

Required Back-end Functionality

- Communication with vehicles and mobile user devices
- Management of the overall system
- Scheduling concepts and assignment of free parking spots and charging stations to connected vehicles
- Distribution of mission information to connected vehicles

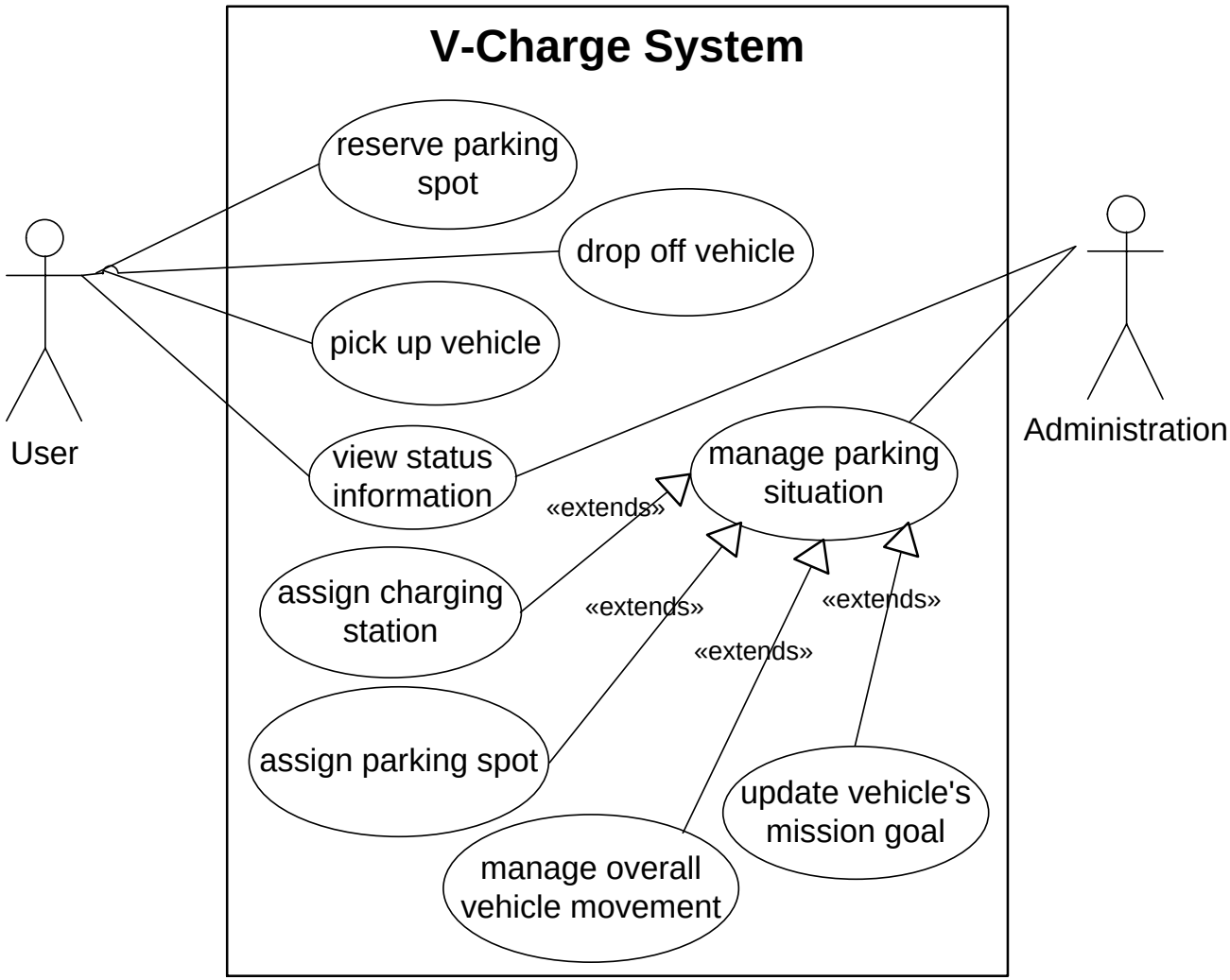
Supporting Back-end Functionality

- Storage and online distribution of a parking lot map to connected vehicles
- Sensor data aggregation (e.g., parking spot occupation) and fusion with central map
- System monitoring, with status information being available via a user interface
- Security and trust concepts

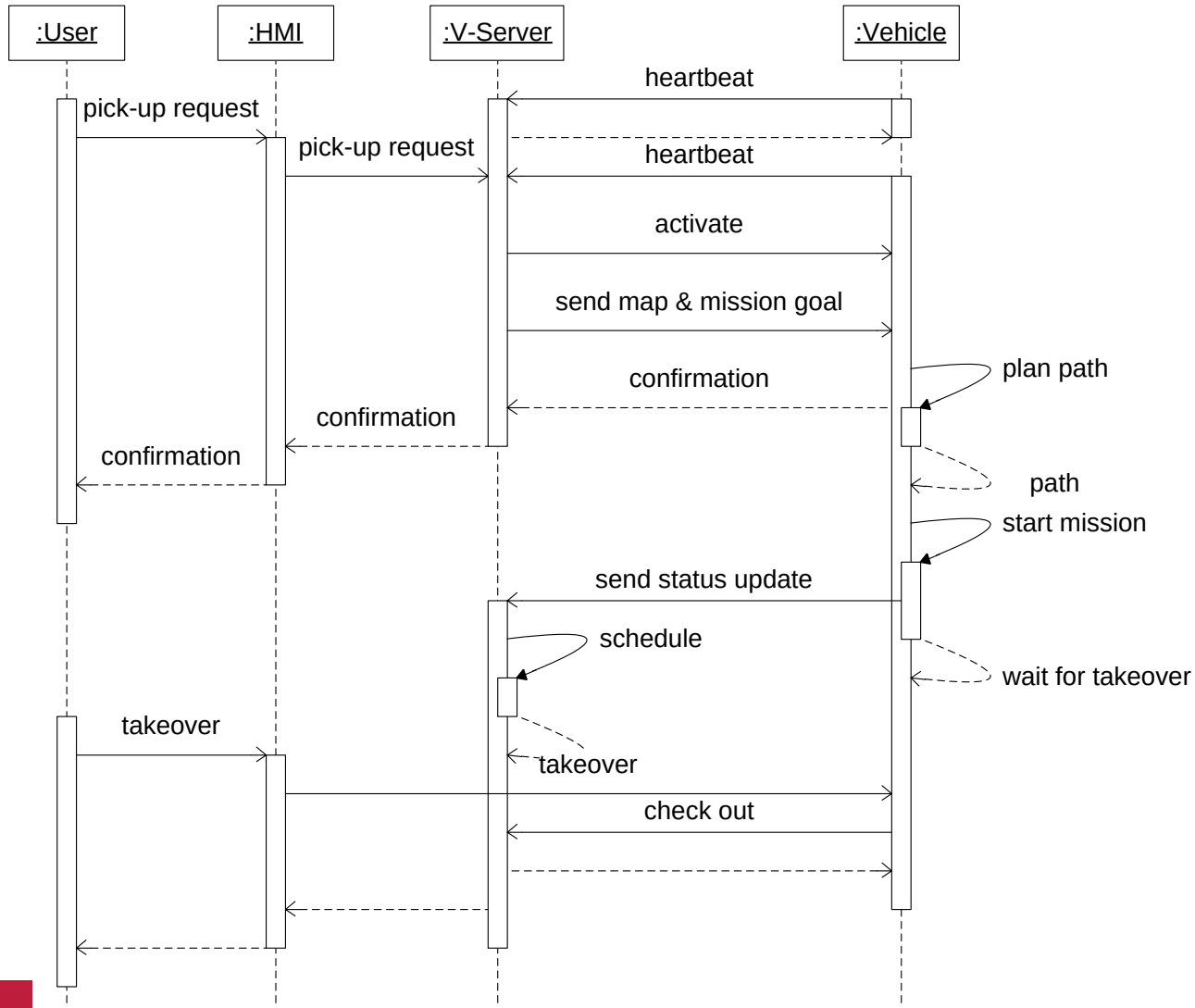
Outline

- Motivation
- **Software Architecture**
- Conclusion

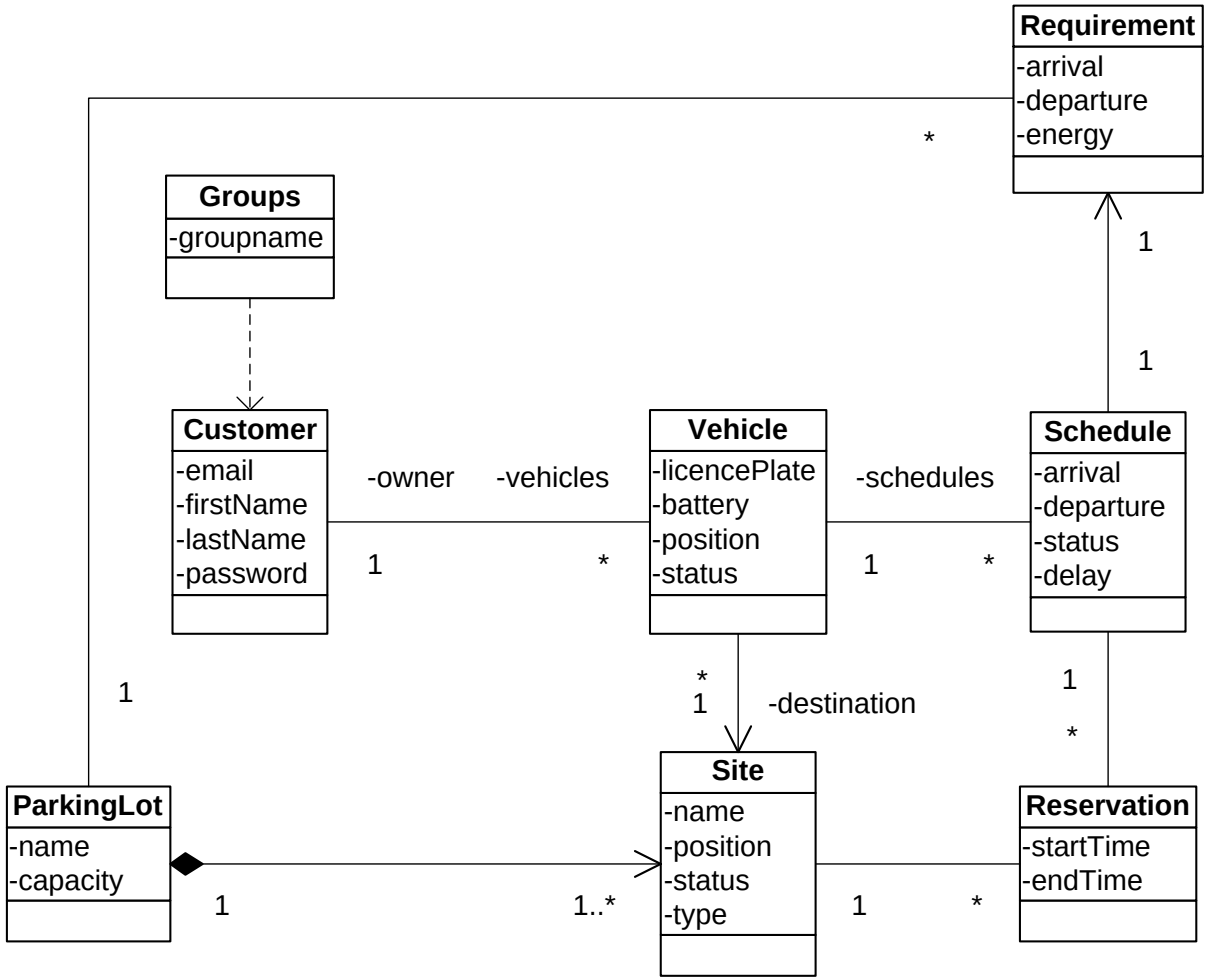
Use Cases


V-Charge System
reserve parking spot
drop off vehicle
pick up vehicle
view status information
assign charging station
assign parking spot
manage parking situation
manage overall vehicle movement
update vehicle's mission goal
«extends»
«extends»
«extends»
«extends»
User
Administration

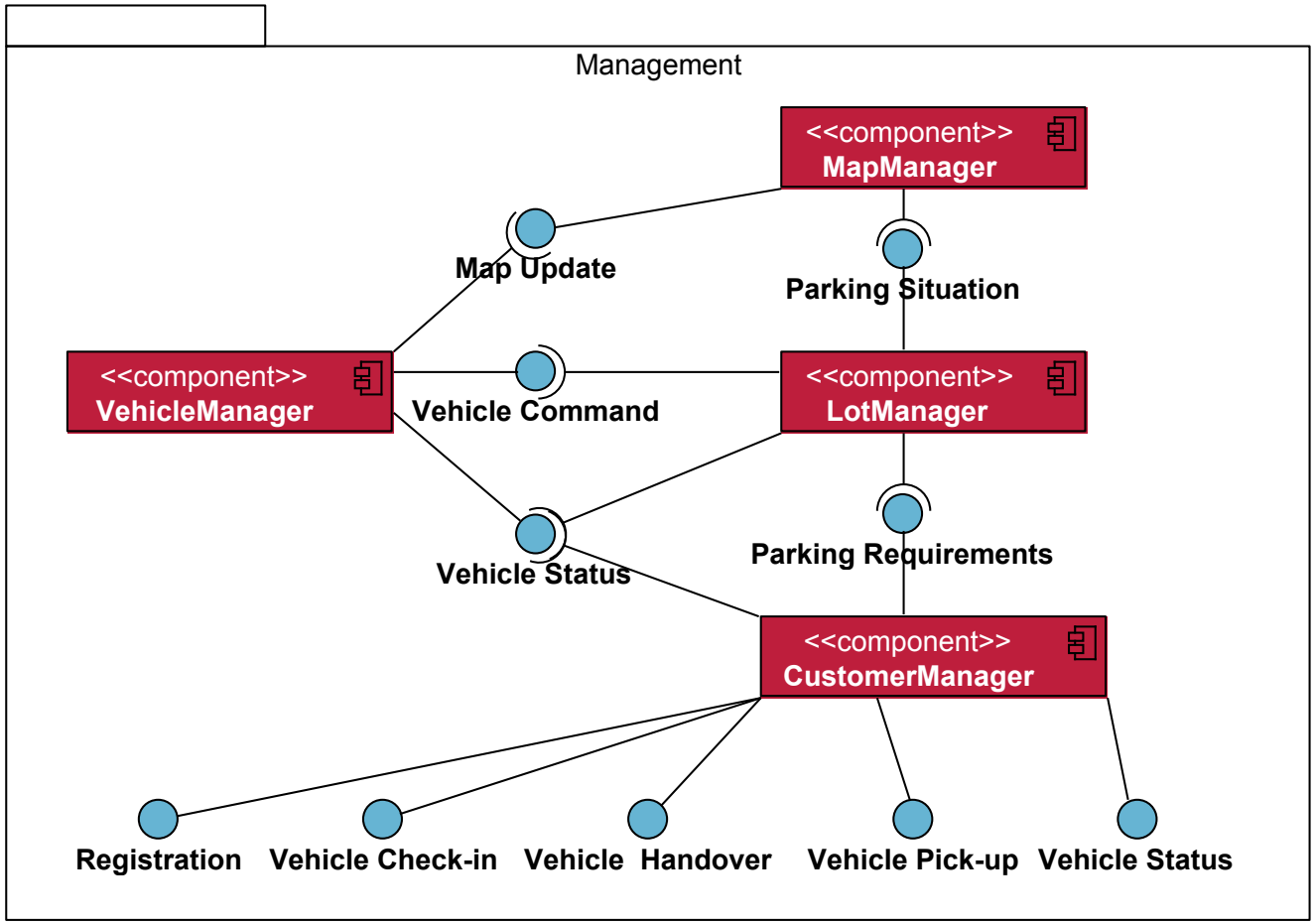
Use Case: Pick-up



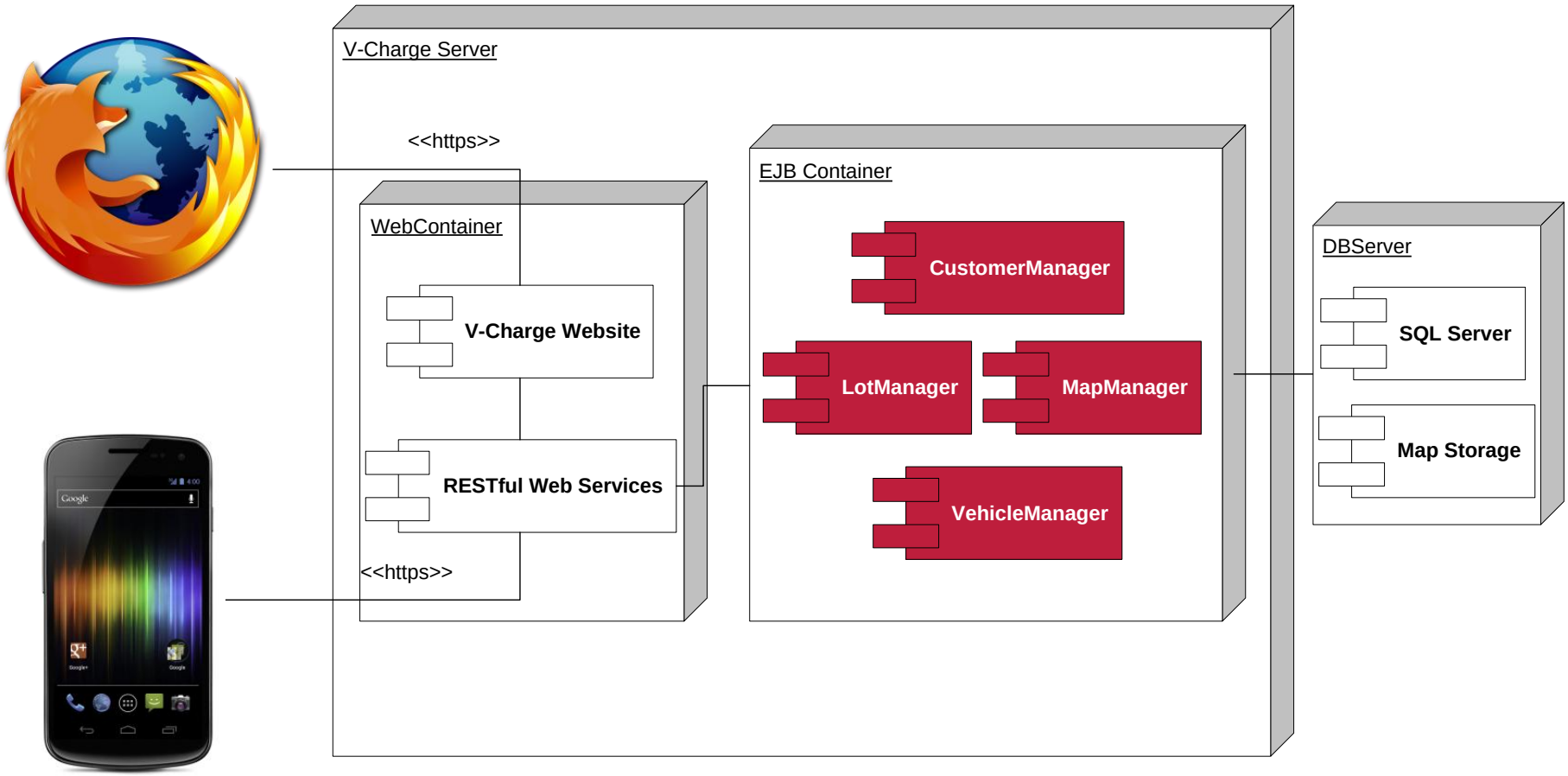
Domain Model



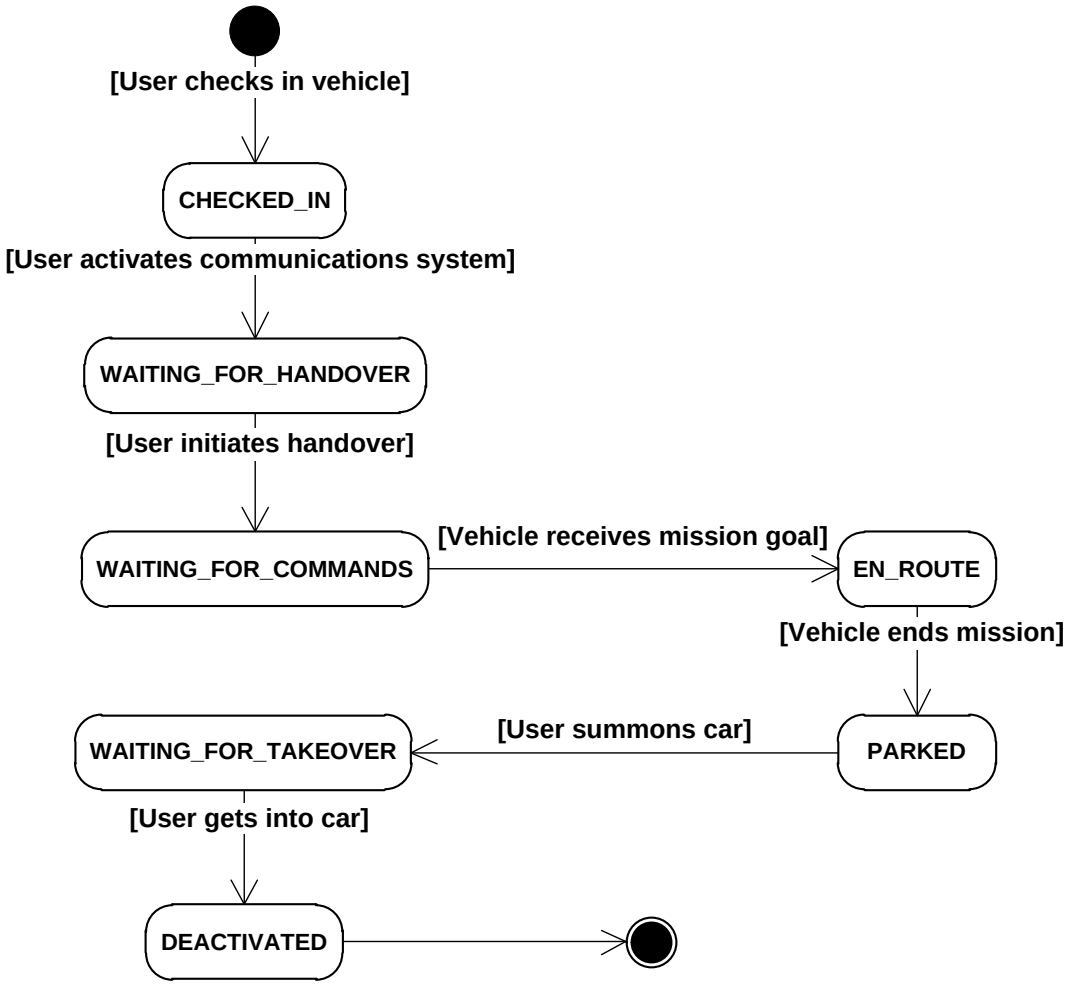
Component Specification



Software Technology and Deployment



Vehicle Interaction Concept



Outline

- Motivation
- Software Architecture
- **Conclusion**

On-going Work

- Concepts for efficient charging station management (scheduling)
- Evaluating suitability of different scheduling strategies
- Real test cases with actual vehicles (April 2012)

Summary

- Back-end architecture for
  - autonomous valet parking
  - automatic recharging capabilities
- Standards-based, e.g., Java EE, RESTful Web services, SSL
  - Portable
  - Scalable
  - Secure
- Supporting multiple communications channels (V2I, Web, mobile)

Summary

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Thank you!

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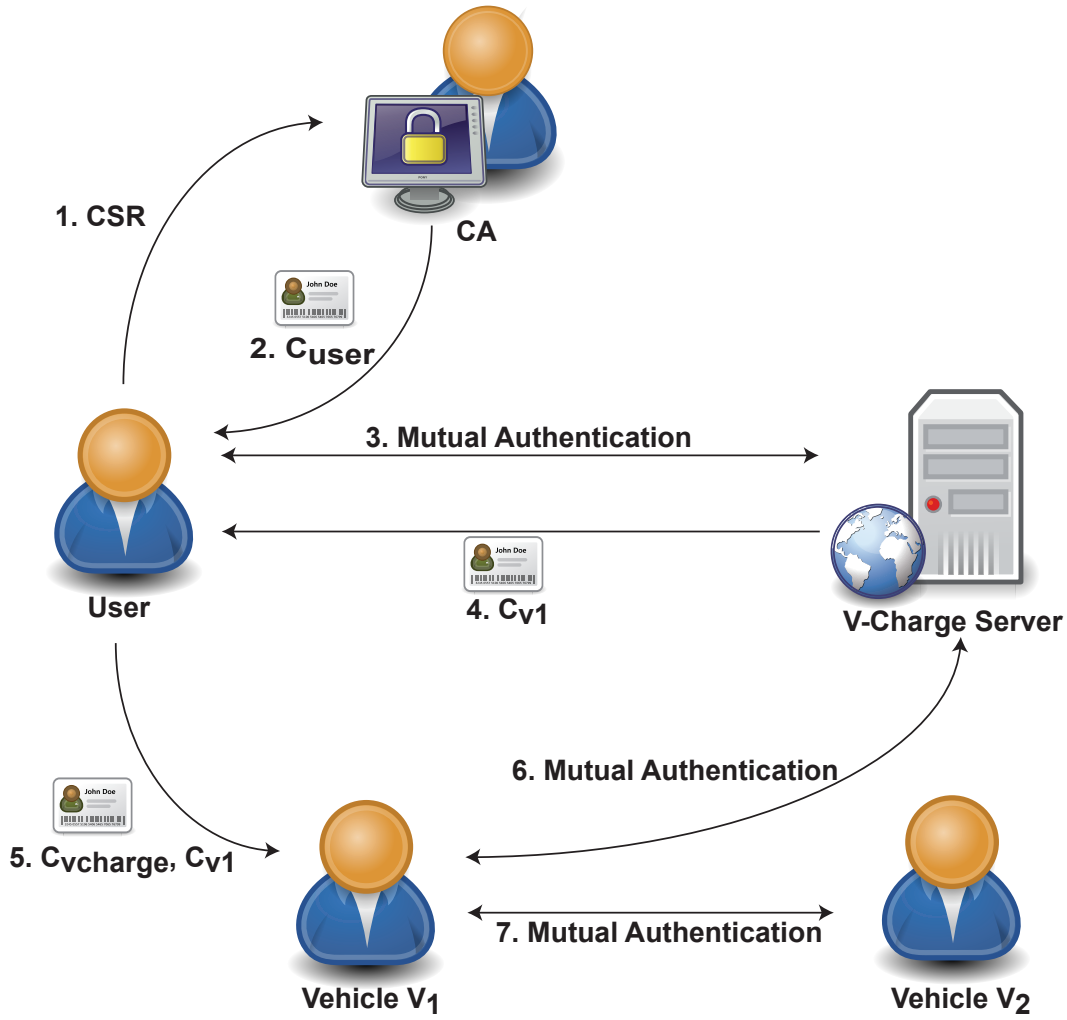
Section 4

Appendix

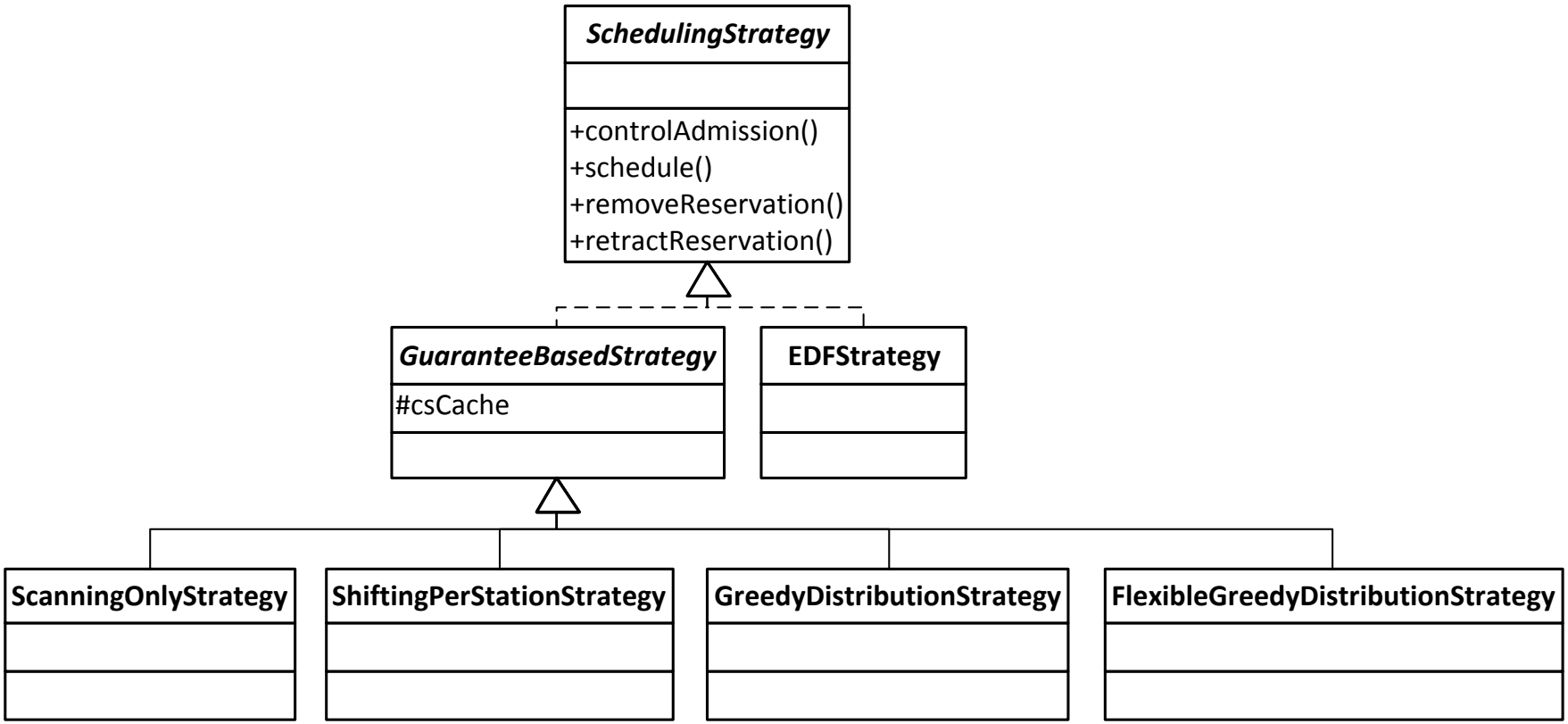
Communications

- Support of several data channels
  - Wi-Fi (802.11a) as standard
  - 3G, C2X to be considered
- Mobile users will use a smartphone to interact with the system
- Server will distribute maps and updates via Wi-Fi to the vehicles
- Administration via Web interface

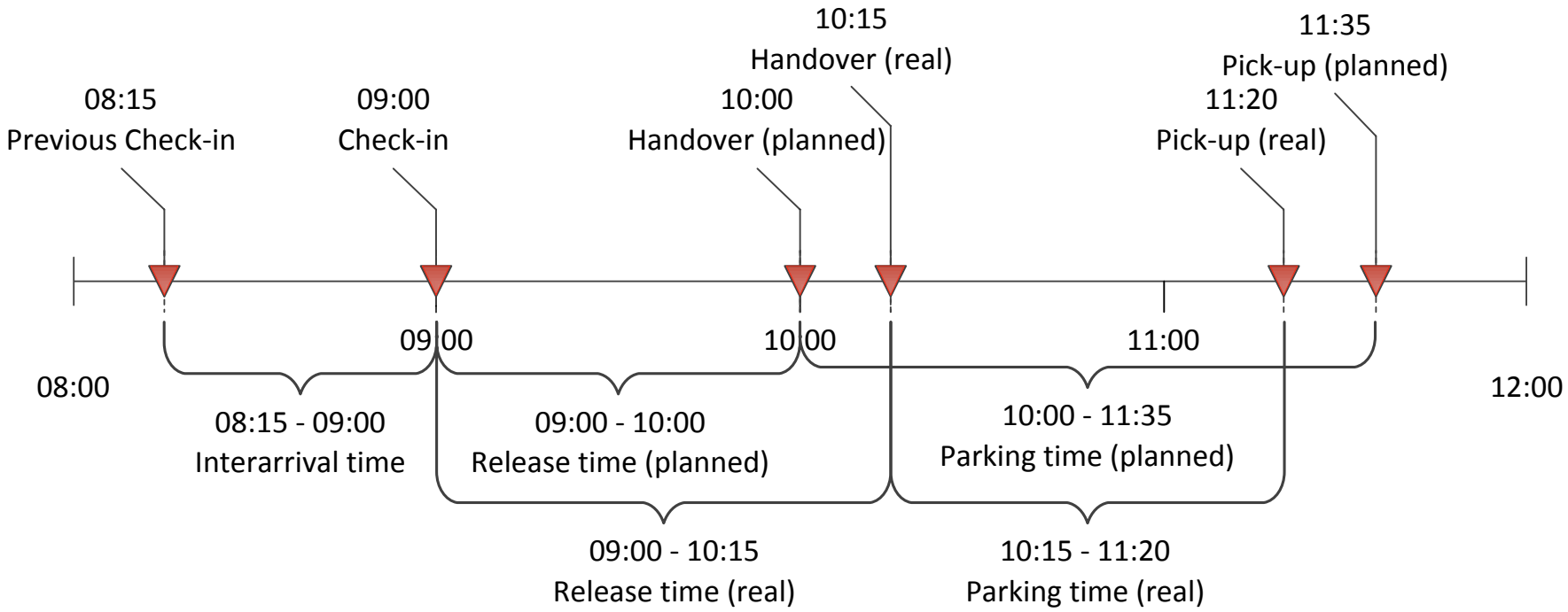
Security Concept



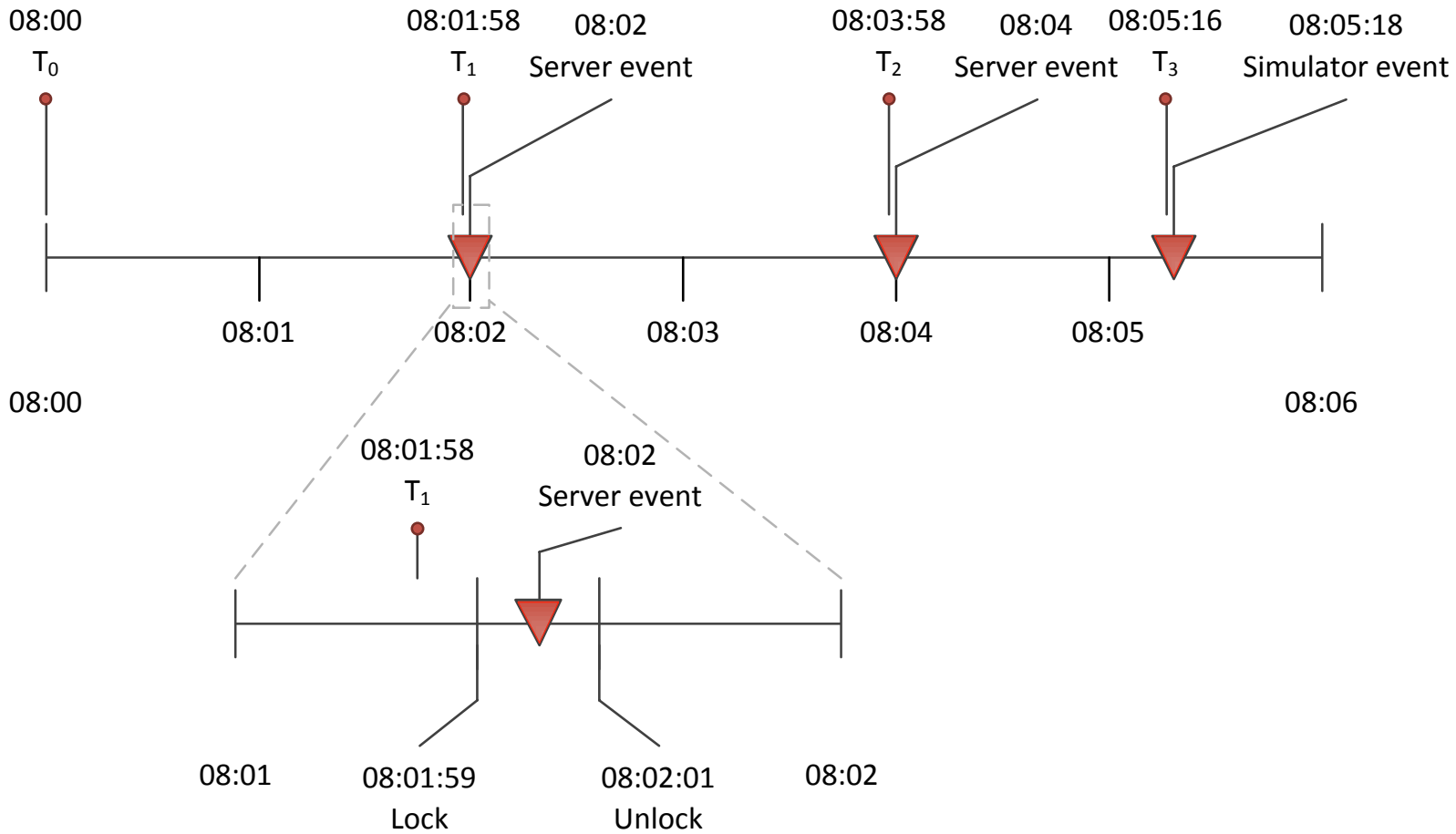
Charging Station Scheduling



Simulation Setup



Simulation Speed-up



Metrics

- Facility use, such as
  - Overall peak-period utilization (e.g. daily spaces occupied)
  - Charging station utilization
  - Number of charging station switches per vehicle
- Customer satisfaction, such as
  - Percent satisfied customer parking requirements
  - Energy demand vs. provided energy