E-MAll
(e-Mobility for all)

Prof. Rossi

Sara Limooee, 10886949

Parham Ebadi, 10870289

E-Mall

- Cause
  - Global warming
  - Less use of fuels
  - And etc.
- Users & Systems
  - EV-drivers -> User
    - Electric mobility service provider (eMSP) -> System
  - Charging point operators (CPOs) -> User
    - Charging point management systems (CPMS) -> System
- External System
  - Distribution System Operators (DSOs) -> External System

RASD
(Requirement Analysis and Specification Document)

Goals

Goals	Descriptions
G1	eMSP allows EV-drivers to search for charging stations nearby, their cost, and any special offer.
G2	eMSP allows EV-drivers to book a charge in a specific charging station 15 minutes before connection.
G3	eMSP allows EV-drivers to sort the available charging point stations based on the selected filter.
G4	eMSP allows EV-drivers to rate the charging station they received the service from.
G5	eMSP allows EV-drivers to add credit to the wallet inside their account for paying later.
G6	eMSP allows EV drivers to pay for the obtained service either using internal wallet or by credit card.
G7	CPMS allows CPOs to know about the amount of energy used by each vehicle.
G8	CPMS allows CPOs to know the “external” status OF charging stations, e.g. location of available charging sockets, type, cost
G9	CPMS allows CPOs to monitor the charging process to infer when the battery is full
G10	CPMS allows CPOs to know the “internal” status of a charging station
G11	CPMS allows CPOs to know the current price of energy acquired from the DSOs

World/shared phenomena

Shared Phenomea	Descriptions	Control
SP1	User searches for nearby charging stations	World
SP2	eMPS shows the nearby stations by default	System
SP3	User sort the available stations	World
SP4	eMPS shows the occupied and free sockets of that station (type, cost, etc.)	System
SP5	eMPS shows the amount of time for the first occupied socket to be freed	System
SP6	The user books one of the free sockets	World
SP7	eMPS provides a receipt (QR code) for booking confirmation	System
SP8	eMPS shows the remaining time of charging to the user	System
SP9	Users can monitor the charging process of his/her car	World
SP10	eMPS notifies the user when the charging process is finished	System
SP11	User pay for the bill	World

World phenomena
* facts that occur in world

Shared Phenomena
* events/facts that occur between system & world
* controlled by system/world

World Phenomena	Descriptions
WP1	The user finds out that his/her car needs charging
WP2	User plug in the car
WP3	The user shows the QR code of booking confirmation to the station

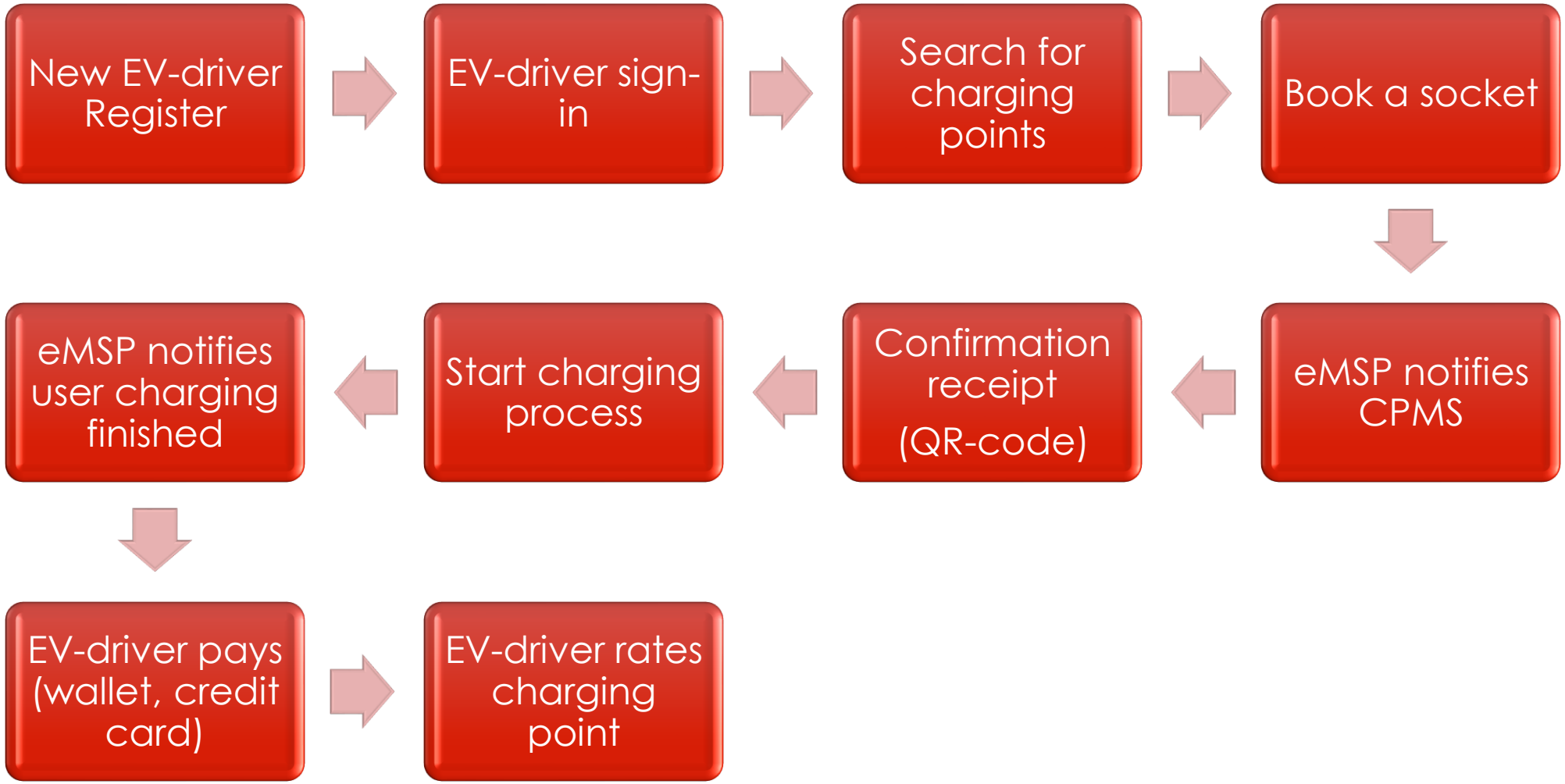
Assumptions

- The charging stations always have batteries and/or are supported by DSO
- The locations and information of each station that is inserted into eMSP by CPOs, are observed and correct.
- The Current price of energy provided by DSO is correct and updated instantly
- The comments and rates which are given by every EV-driver for each station are meaningful

Requirements (eMSP vs. CPMS)

- eMSP
  - The eMSP must allow an unregistered user to register
  - The eMSP must allow users to top-up their virtual wallet to complete payments
  - The eMSP must show the nearest charging stations
  - The eMSP must send a notification to the user that the charging process is finished
  - The eMSP must allow users to pay for the service
  - The eMSP must allow users to rate charging stations
- CPMS
  - The CPMS must allow CPOs to login
  - The CPMS allows CPOs to View charging stations' location
  - The CPMS Allow CPO to monitor external status
  - The CPMS allows CPO to monitor the internal status
  - The CPMS allows CPO to monitor the status of the batteries
  - The CPMS allows CPO to view the current price of the energy through DSOs

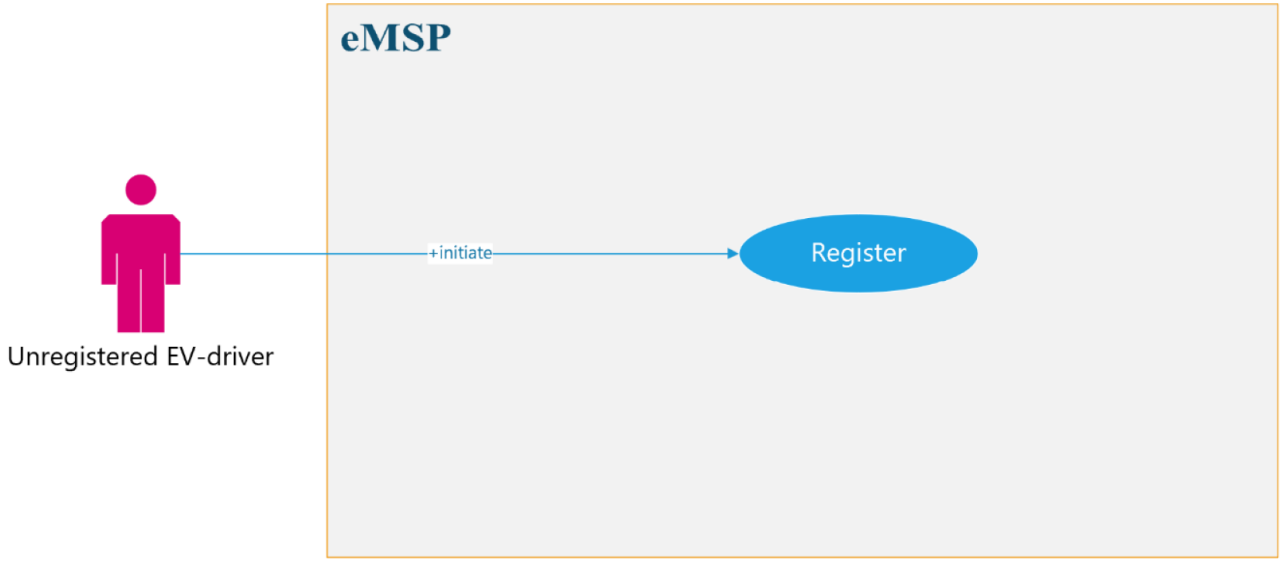
Complete use case

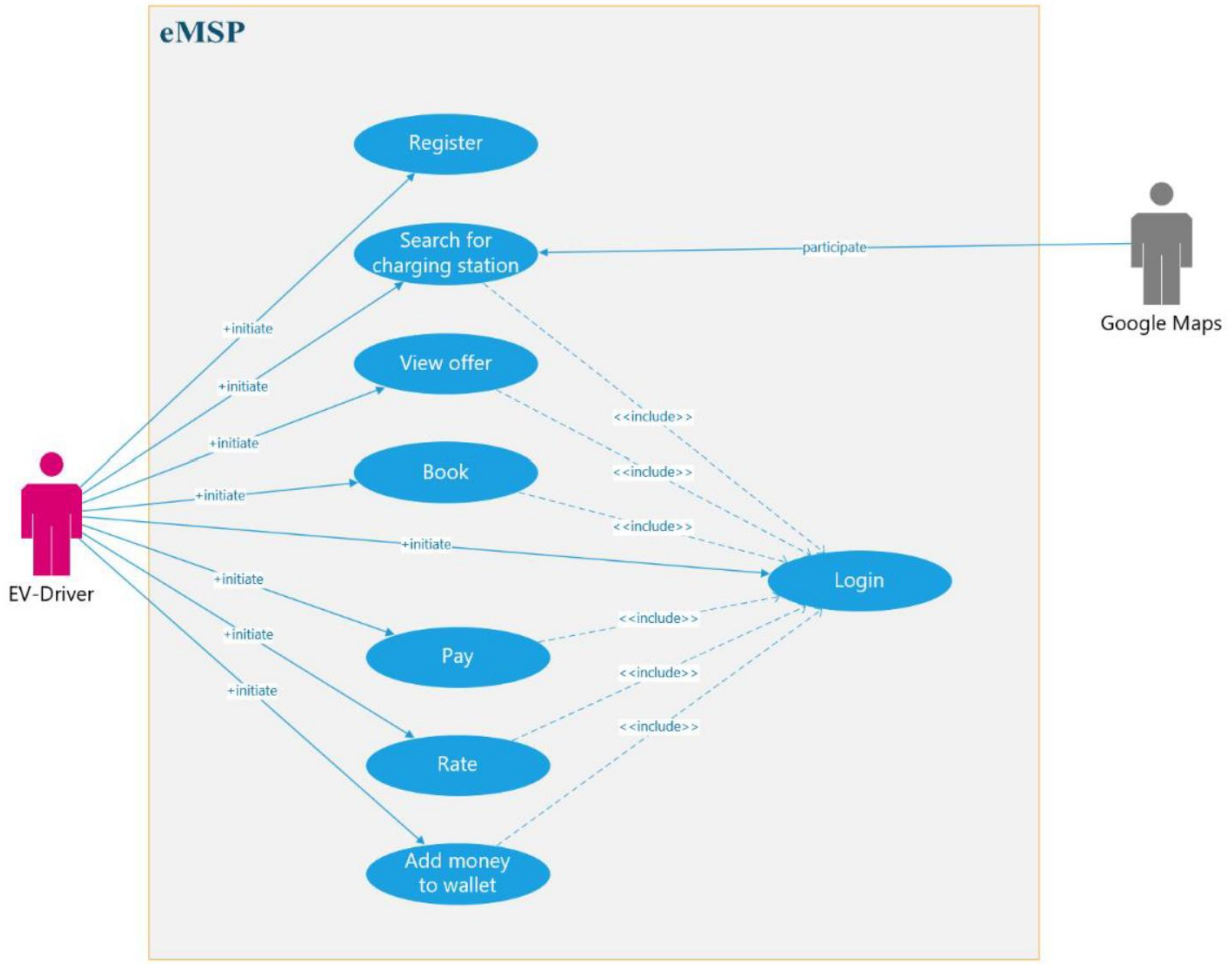


Complete use case

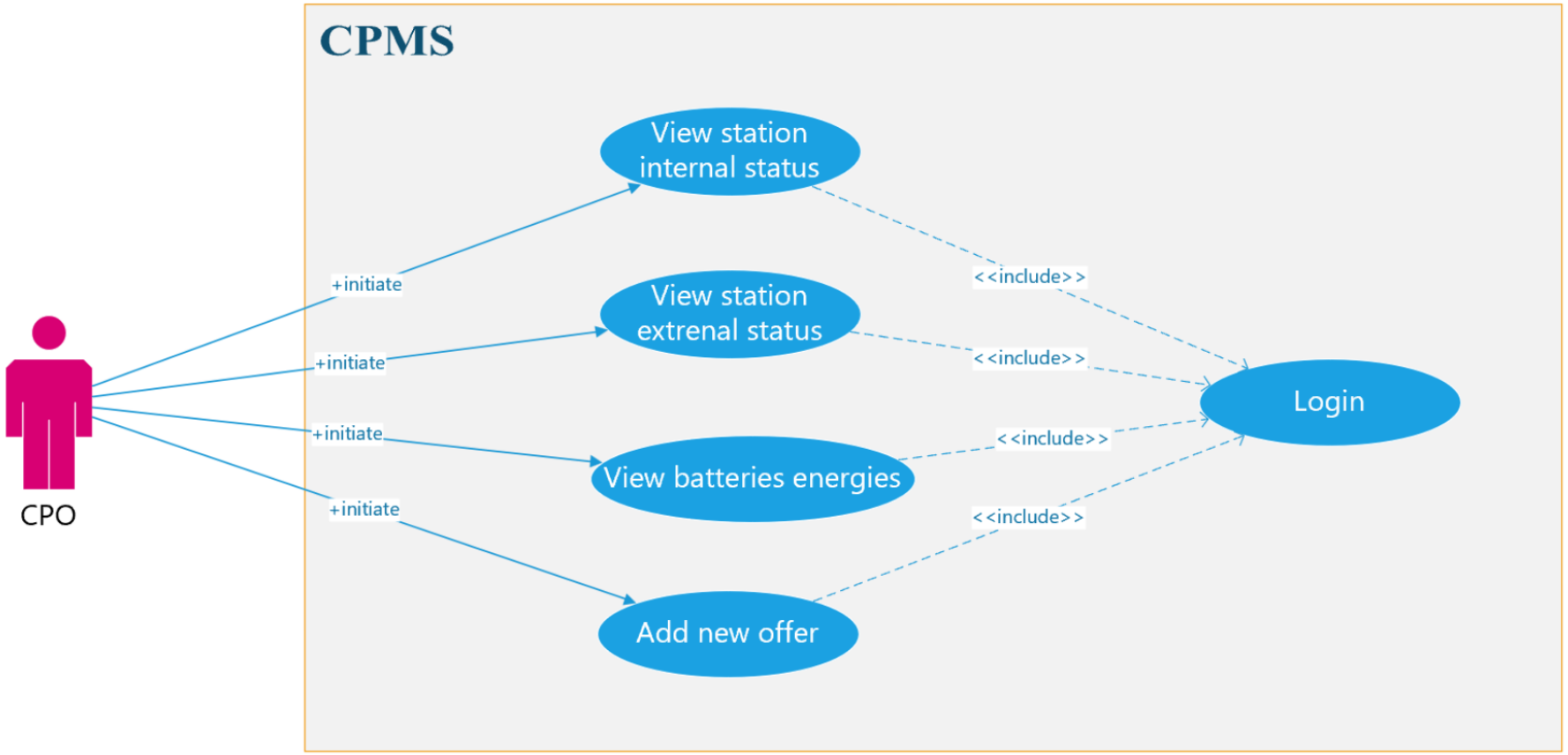
- A new EV-driver signs up in the eMSP system.
- EV-driver logins to the system.
- EV-driver searches for charging point stations (nearby, lowest price, highest rate, socket type, and etc.) in eMSP system.
- EV-driver books a socket 20 minutes before connection in a charging point.
- eMSP notifies CPMS about the new booking and gives confirmation receipt to EV-driver.
- Charging process is started by connecting the vehicle to the socket.
- eMSP notifies EV-driver when charging process is finished.
- EV-driver pays for the service either from internal wallet credit or using credit card.
- EV-driver rates the charging station.

Use case Diagrams (EV-driver)

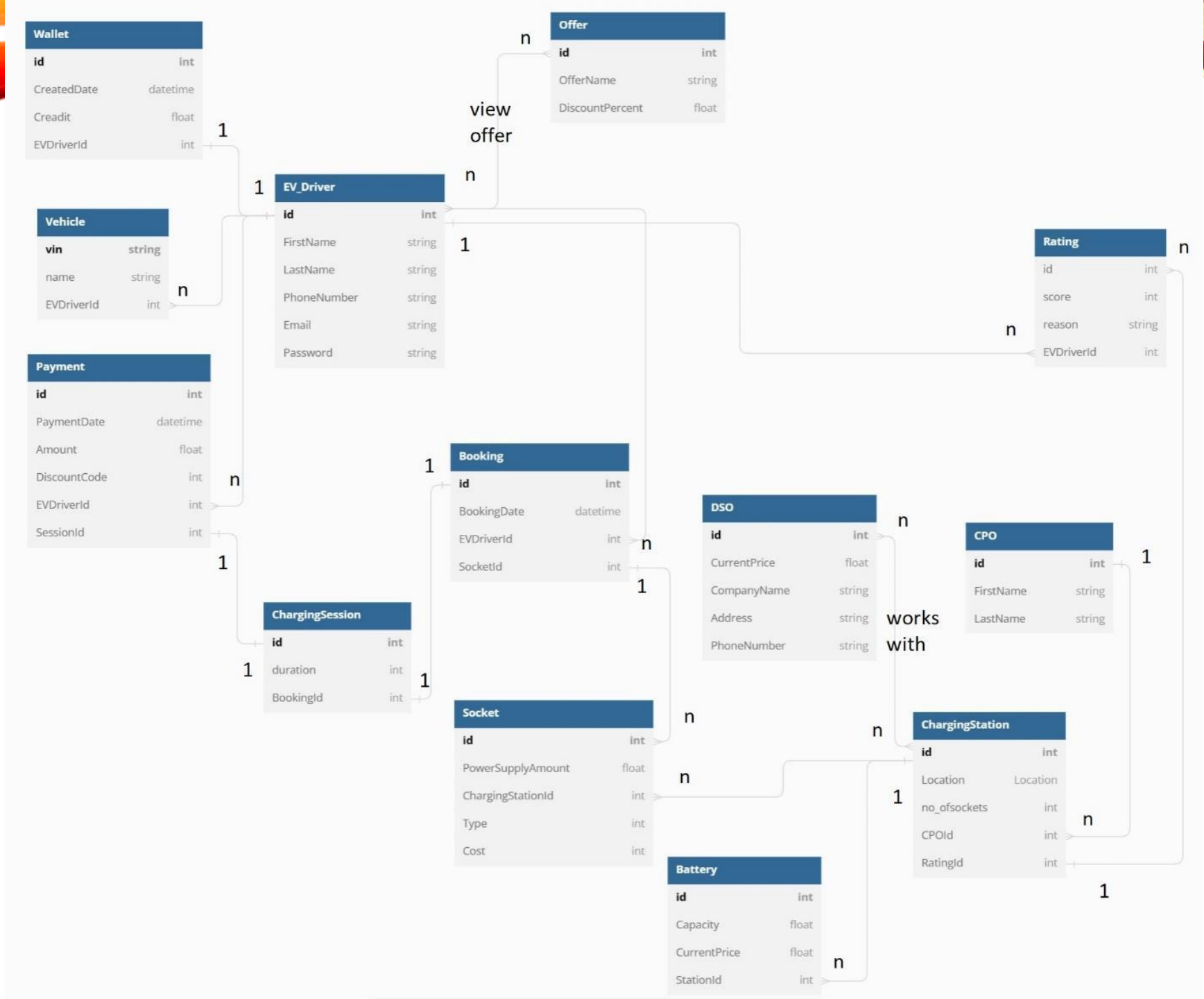




Use case Diagrams (CPO)



Class Diagram



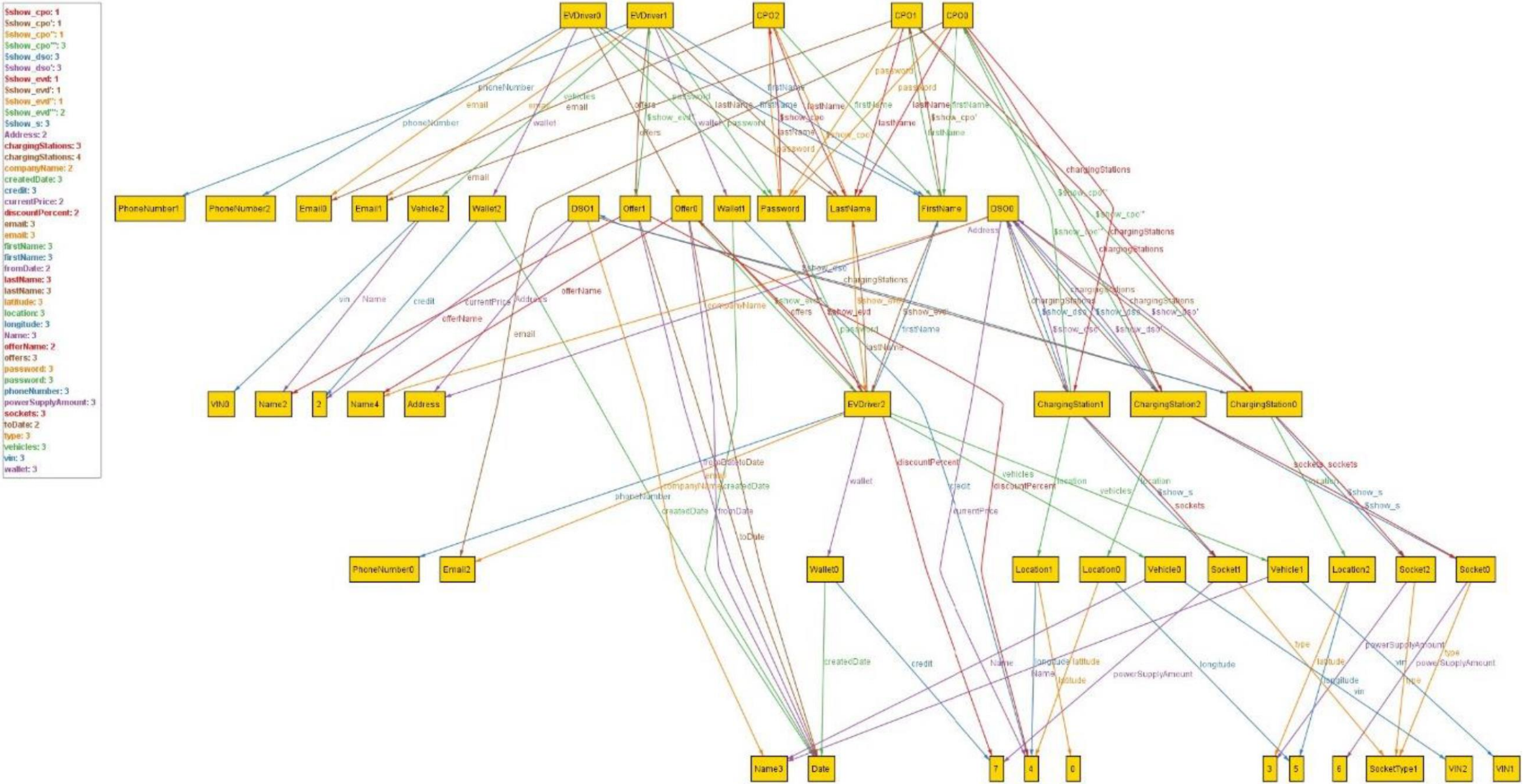
ALLOY

Some important signatures

- EV-driver
  - Wallet
  - vehicle
- CPO
- Charging station
  - Socket
  - battery
- DSO
  - battery
- Charging session
- Booking
- Payment

Some important facts

- Each user has one wallet.
- Each DSO wors with multiple charging stations.
- Each charging station is linked to at least a CPO.
- Each socket is linked to at least a charging station.
- Each charging session is linked to a booking.
- Each charging session must be linked to only one payment.
- Each payment must be linked to only one offer.

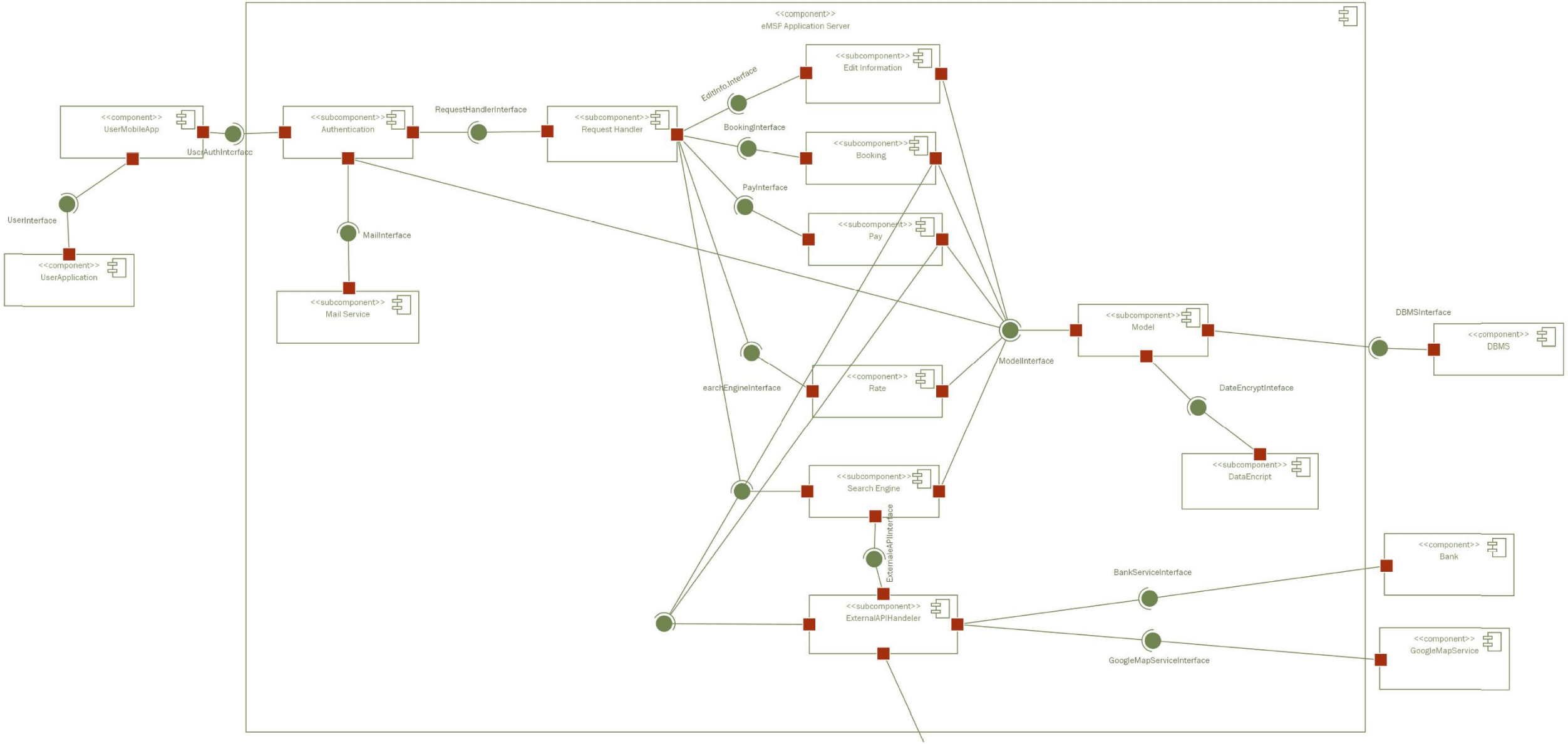

$show_cpo: 1
$show_cpo': 1
$show_cpo'': 1
$show_cpo''': 3
$show_dso: 3
$show_dso': 3
$show_evd: 1
$show_evd': 1
$show_evd'': 1
$show_evd''': 2
$show_s: 3
Address: 2
chargingStations: 3
chargingStations: 4
companyName: 2
createdDate: 3
credit: 3
currentPrice: 2
discountPercent: 2
email: 3
email: 3
firstName: 3
firstName: 3
fromDate: 2
lastName: 3
lastName: 3
latitude: 3
location: 3
longitude: 3
Name: 3
offerName: 2
offers: 3
password: 3
password: 3
phoneNumber: 3
powerSupplyAmount: 3
sockets: 3
toDate: 2
type: 3
vehicles: 3
vin: 3
wallet: 3
EVDriver0
EVDriver1
CPO2
CPO1
CPO0
PhoneNumber1
PhoneNumber2
Email0
Email1
Vehicle2
Wallet2
DSO1
Offer1
Offer0
Wallet1
Password
LastName
FirstName
DSO0
VIN0
Name2
2
Name4
Address
EVDriver2
ChargingStation1
ChargingStation2
ChargingStation0
PhoneNumber0
Email2
Wallet0
Location1
Location0
Vehicle0
Socket1
Vehicle1
Location2
Socket2
Socket0
Name3
Date
7
4
0
3
5
6
SocketType1
VIN2
VIN1

DD
(Design Document)

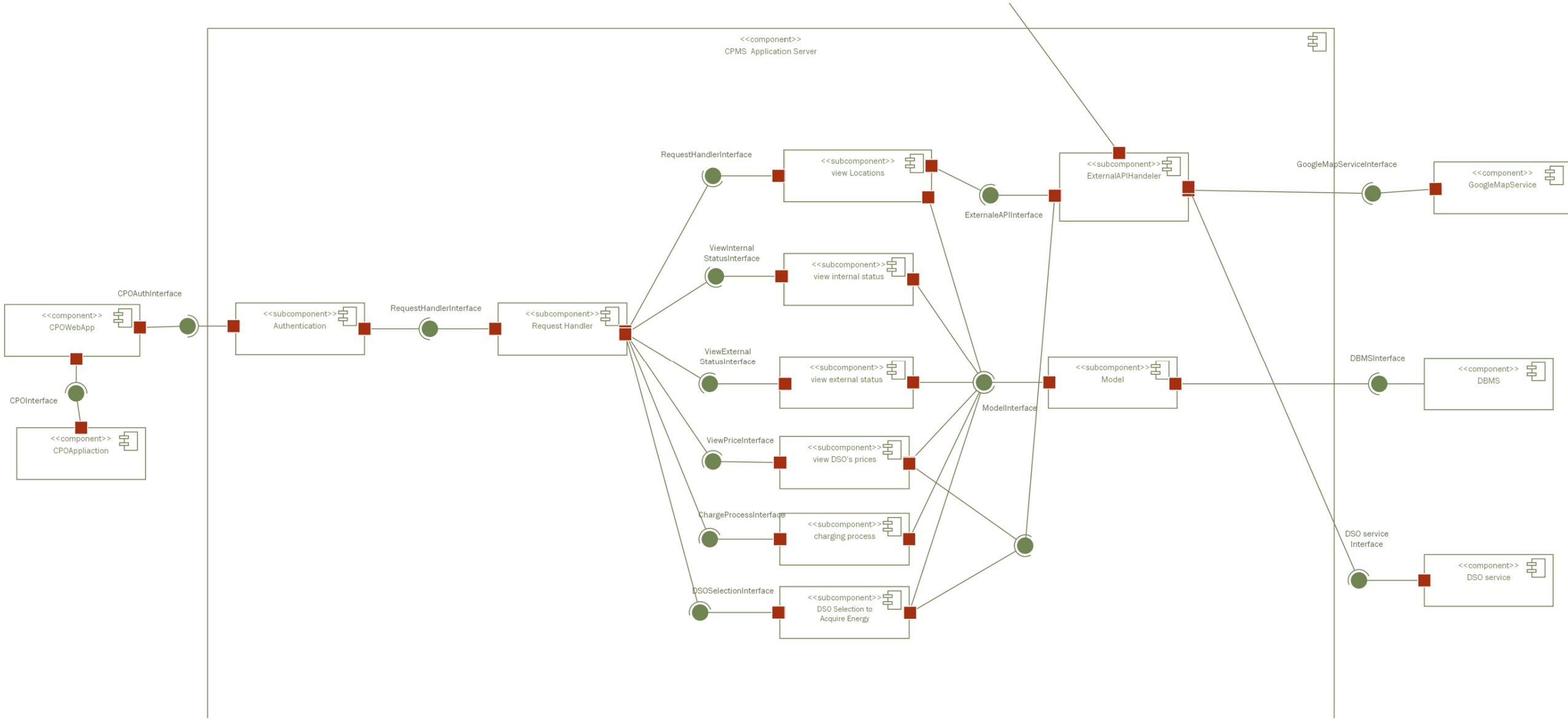
Components

- 2 Systems
  - CPMS -> which CPO works with
  - eMSP -> which EV-driver works with
- These two systems are linked via an external API connection interface
- External components
  - Mobile Applications (USER & CPO)
  - Google Map Services
  - Bank System
  - Data Base Management System (DBMS)

Component Diagram (eMSP)



Component Diagram (CPMS)

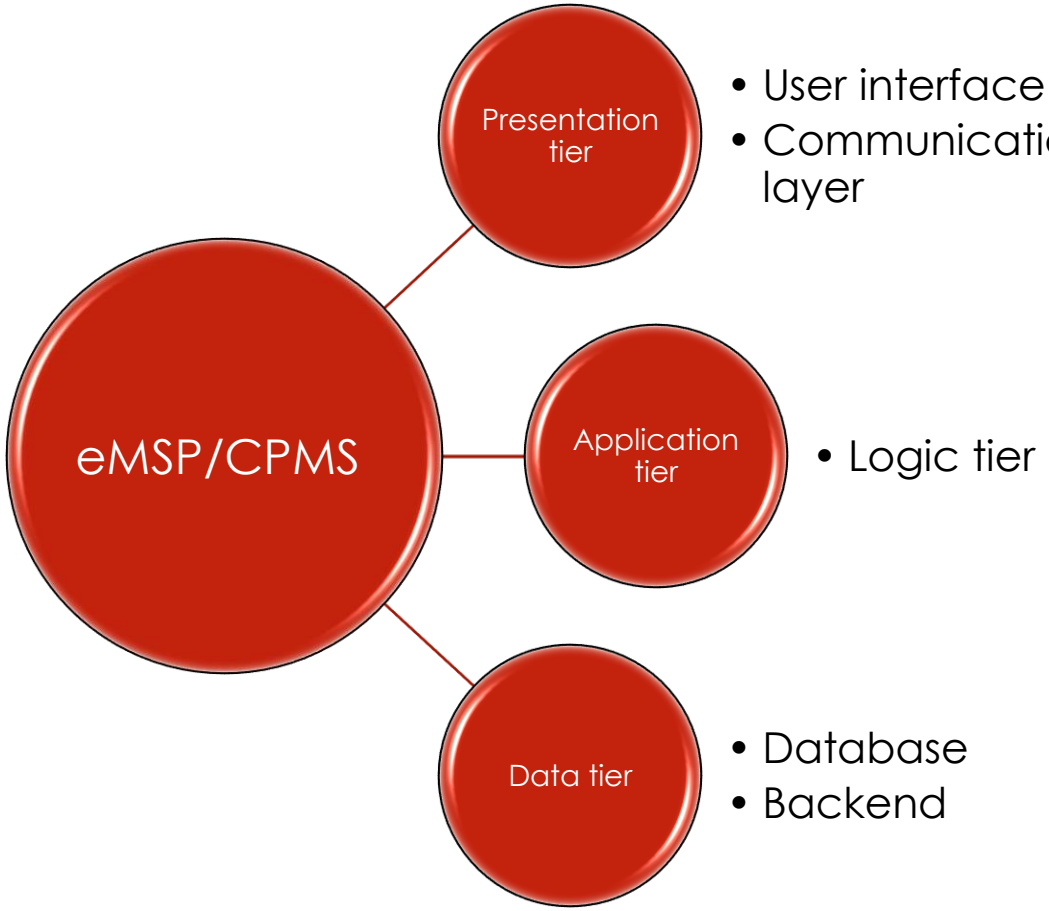


External Interfaces & Interactions

- eMSP interacts with:
  - Google Map Services
    -> for navigation & searching process
  - Bank System
    -> to complete payments
  - Data Base Management System(DBMS)
  - CPMS
    -> to notify CPMS about any new booking

- CPMS interacts with:
  - Google Map Services
    -> for navigation & searching process
  - Data Base Management System(DBMS)
  - eMSP
    -> to notify other eMSPs if any time slot or socket has been booked

Architectural Design

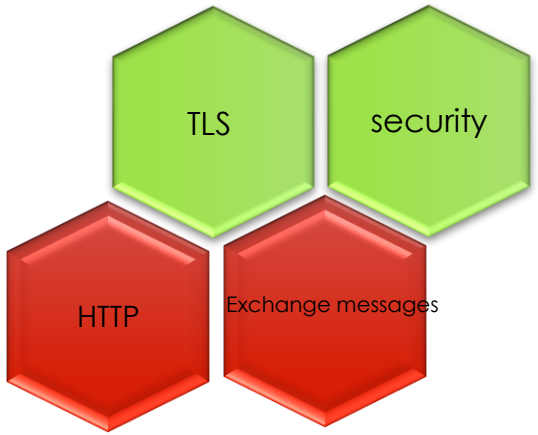


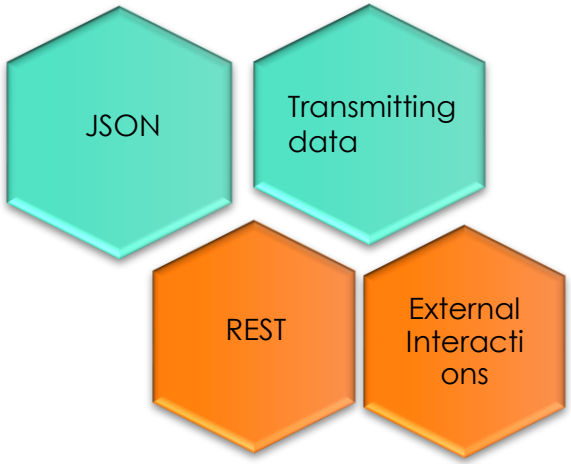
- User interface
- Communication layer

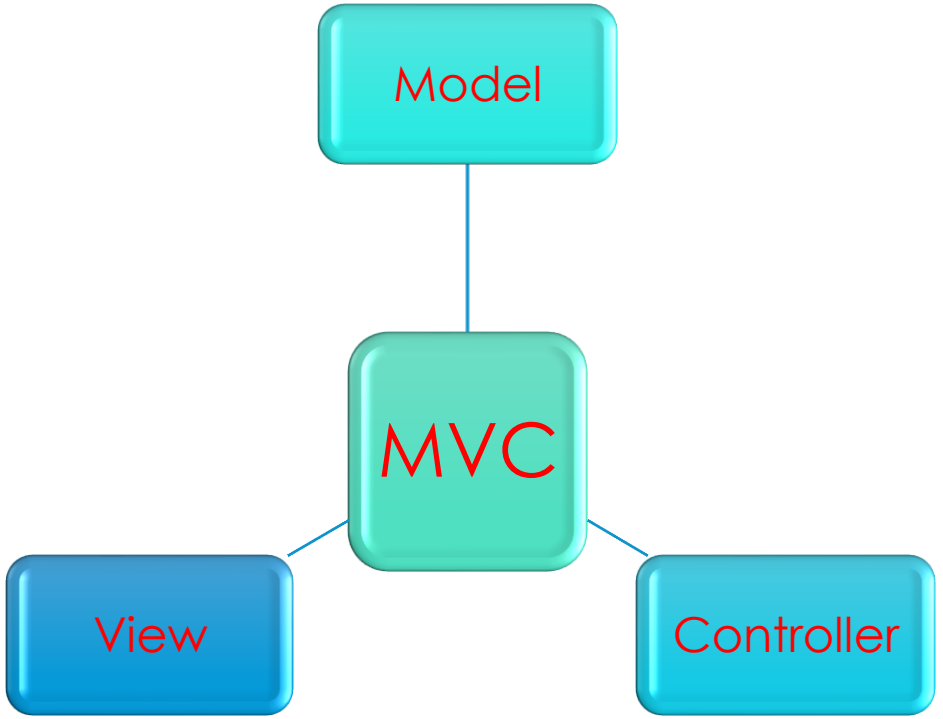
- Logic tier

- Database
- Backend

Architectural styles and patterns







Implementation and Testing

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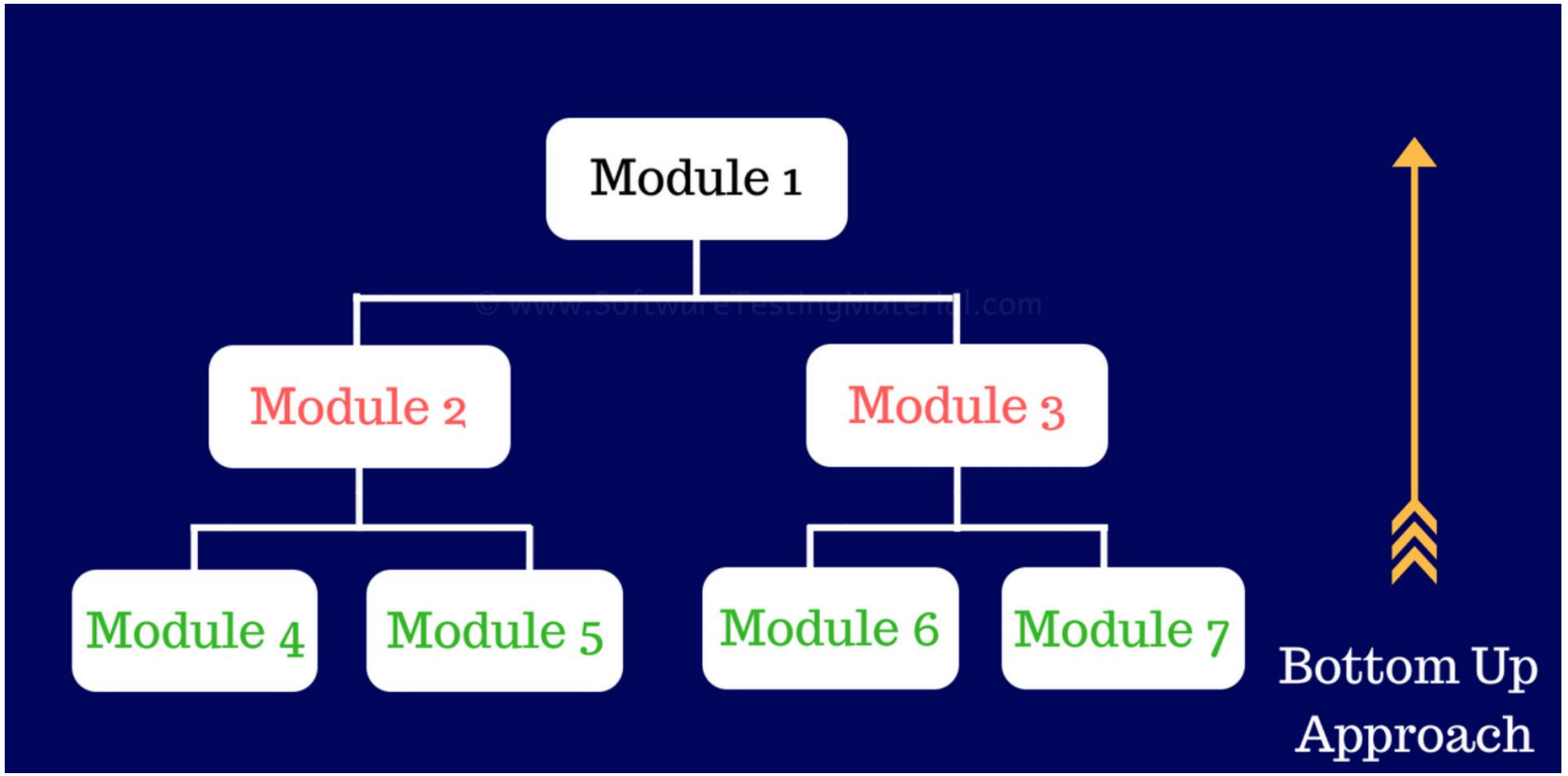
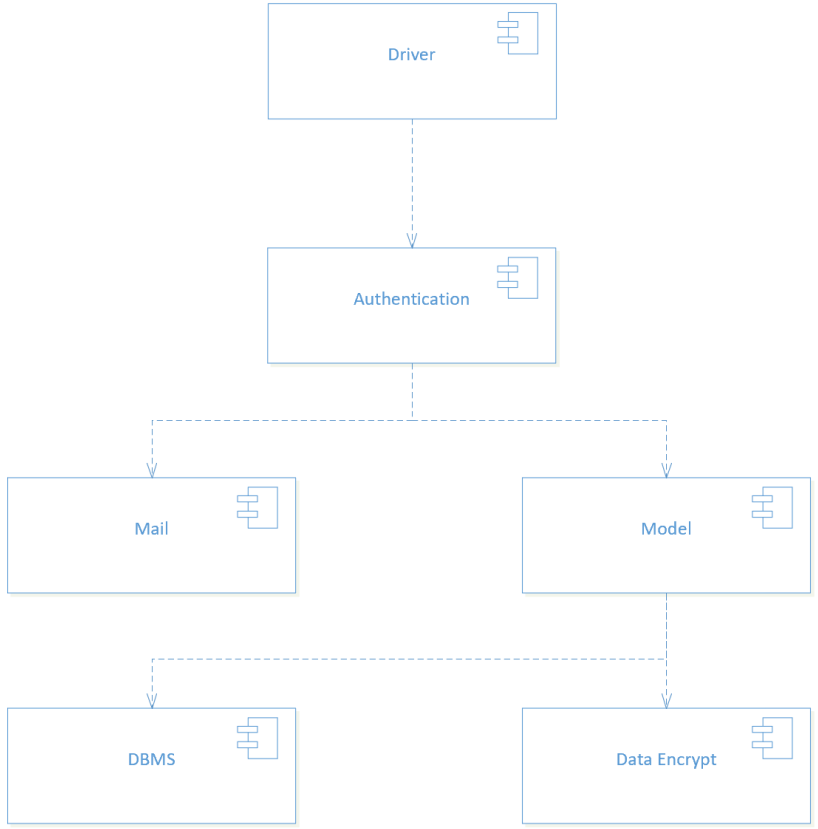
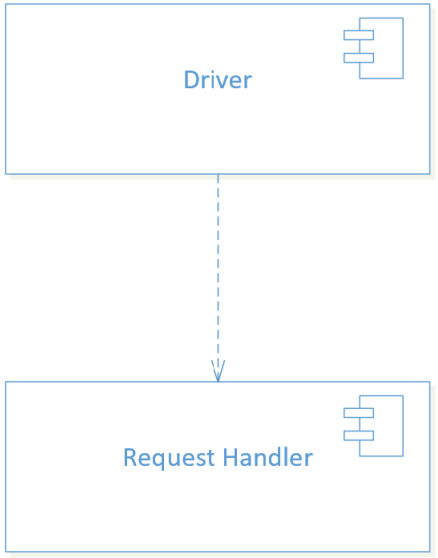


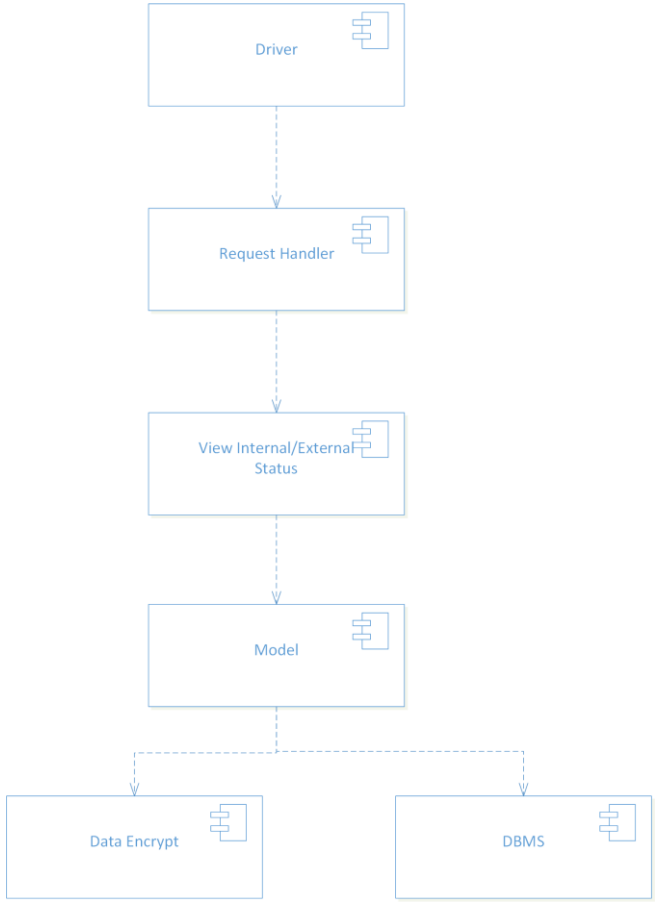
eMSP Authentication



Request Handler



CPMS View Internal/External status



Thank you for your attention