



State of the art of electric Mobility as a Service (eMaaS) An overview of ecosystems and system architectures

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CONTENTS

- **Introduction**
- **Presentation structure** (as in paper)
 - Mobility as a Service (MaaS)
 - Definition
 - Ecosystem
 - Architecture
 - electric Mobility as a Service (eMaaS)
 - Definition
 - Ecosystem
 - Architecture
- **Takeaways**

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- } From literature review

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- From literature review
- Authors proposition

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From literature
review

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Authors
proposition

**Focus of this
presentation**


- **Takeaways**

INTRODUCTION – About us

University of Twente – Department of Design, Production and Management
Systems Engineering and Multidisciplinary Design (SEMD) Group || Electric Mobility Team

| | | | |
|---|----------------------------|-------------------------|---|
|  | Associate Professor | Dr. Ir. Maarten Bonnema | Chair of SEMD and Project Supervisor |
|  | PostDoc Researcher | Dr. Ir. Steven Haveman | Lead Researcher - Systems Engineering and Systems Modeling Research |
|  | Junior Researcher | J. Roberto Reyes García | Research on Data Driven Architectures and Knowledge Sources for Electric Mobility Systems |

Urban Software Institute GmbH

| | | | |
|---|--------------------------------------|---------------|--|
|  | Technologist – IoT specialist | Dr. Gadi Lenz | IoT centric solutions, platforms and architectures for Smart Cities with a focus on mobility and EVs |
|---|--------------------------------------|---------------|--|

INTRODUCTION – The eMaaS project



The eMaaS project has received funding from the ERA NET COFUND
Electric Mobility Europe (EMEurope)



Project consortium



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The Netherlands



the urban institute®

Germany & Hungary

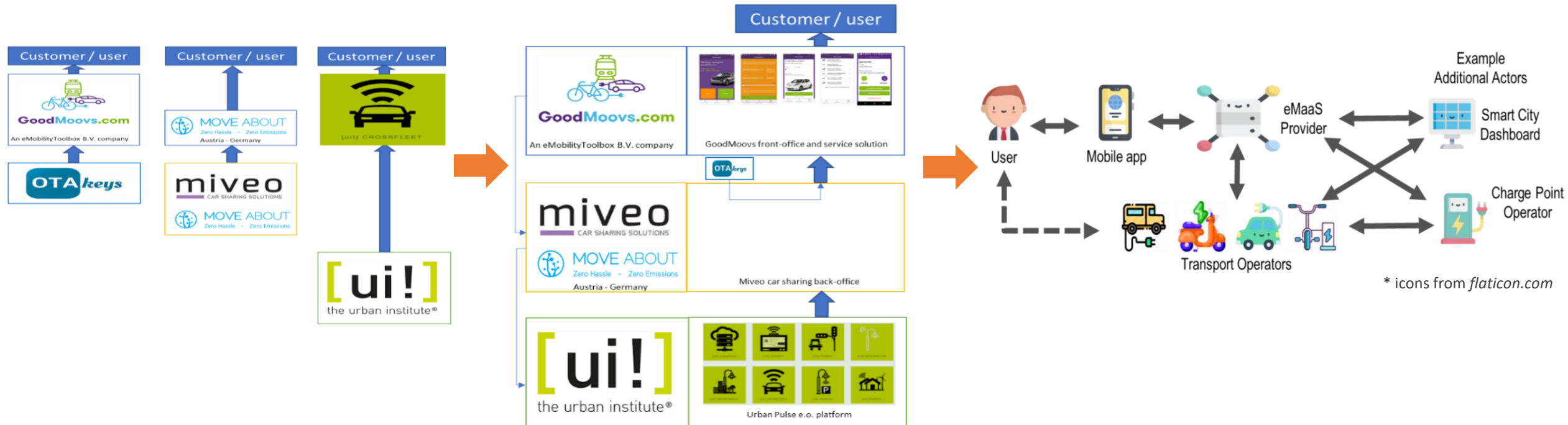


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INTRODUCTION – The eMaaS project

From isolated solutions → To integrated solutions → To a stand-alone eMaaS solution



Mobility as a Service (MaaS) – Literature Review

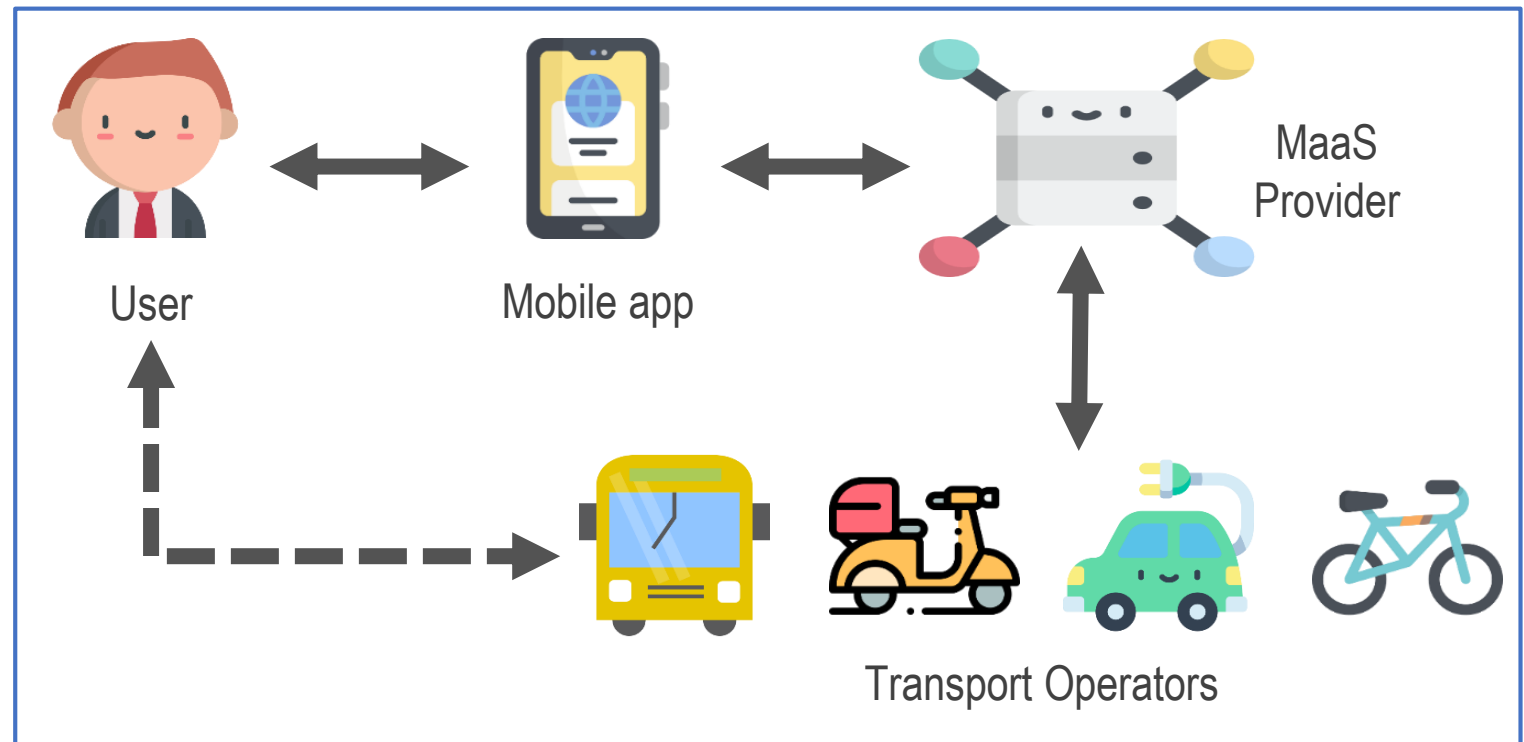
MaaS Definitions

- **Hietanen, S. (2014):** “*Mobility as a Service (Maas) is a mobility distribution model in which a customer's major transportation needs are met over one interface and are offered by a service provider. Typically, services are bundled in to a package - similar to mobile phone price-plan packages”*
- **Burrows et. al. (2015):** “*The provision of transport as a flexible, personalised on-demand service that integrates all types of mobility opportunities and presents them to the user in a completely integrated manner to enable them to get from A to B as easily as possible”*
- **MaaS-alliance (2017):** “*the integration of various forms of transport services into a single mobility service accessible on demand [...] through use of a single application to provide access to mobility, with a single payment channel [...] to meet all users' mobility needs”*
- **Herrlin (2018):** “*MaaS is the idea that we're moving away from privately owned modes of transportation and towards consuming transportation solutions as a service”*

Mobility as a Service (MaaS) – Definition

MaaS Definition elements

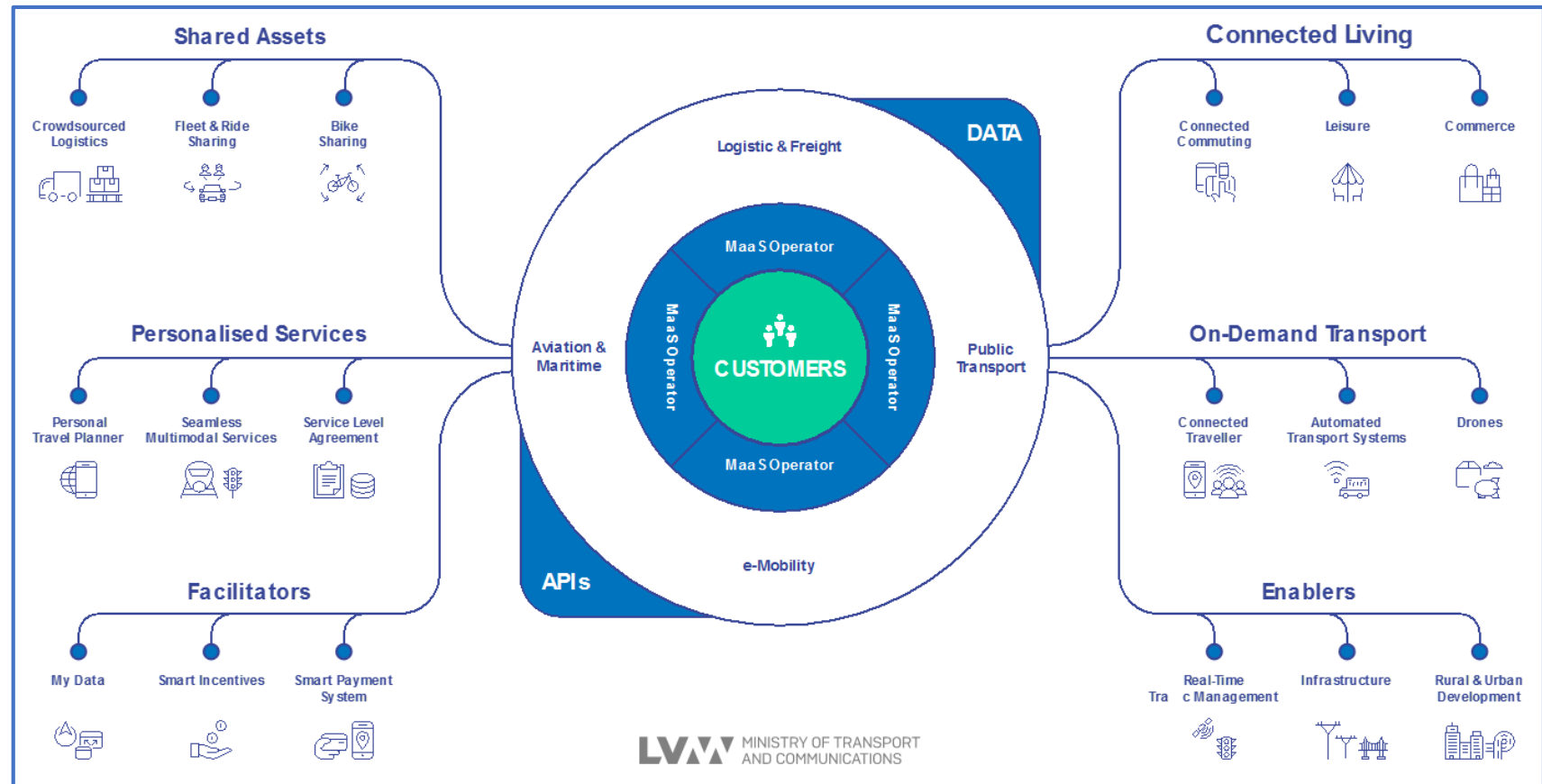
- ✓ Multimodal
- ✓ Seamless
- ✓ Personalized
- ✓ Single interface
- ✓ Data-driven
- ✓ On-demand
- ✓ Easy-to-use
- ✓ User-centred
- ✓ Payment integration



* Icons from flaticon.com

Mobility as a Service (MaaS) – Literature Review

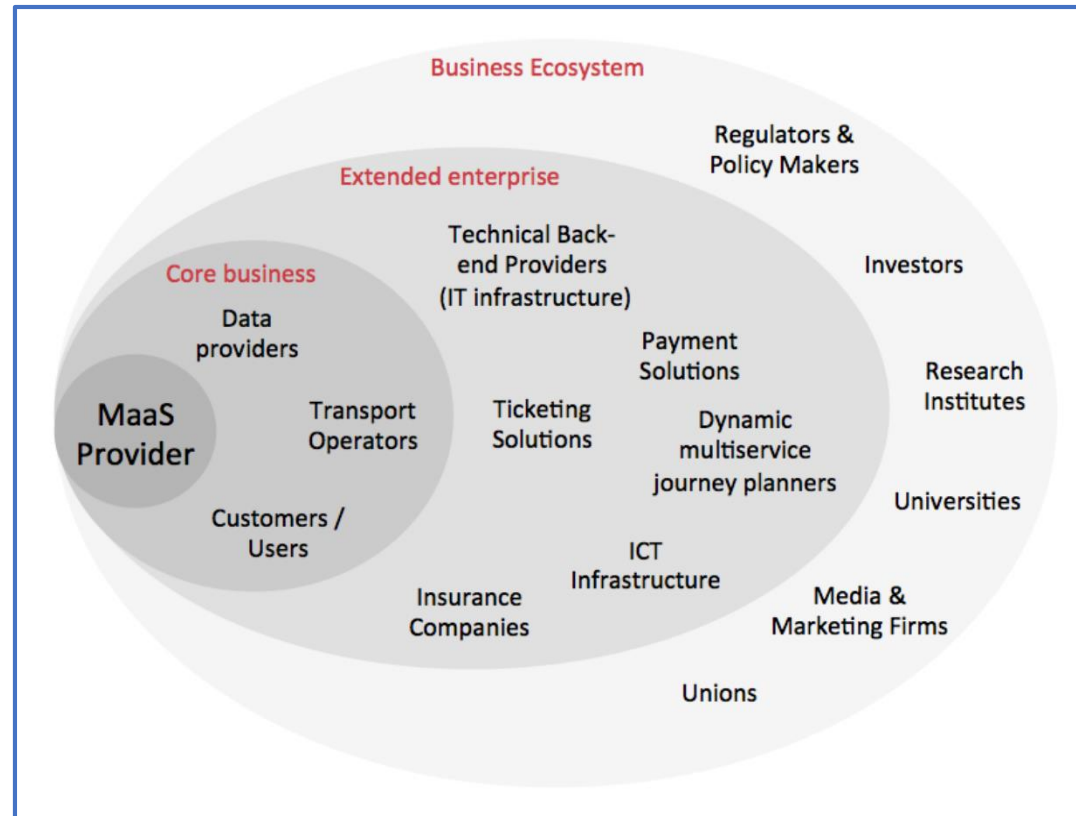
MaaS Ecosystem



Source: Huhtala-Jenks, K. (2017)

Mobility as a Service (MaaS) – Literature Review

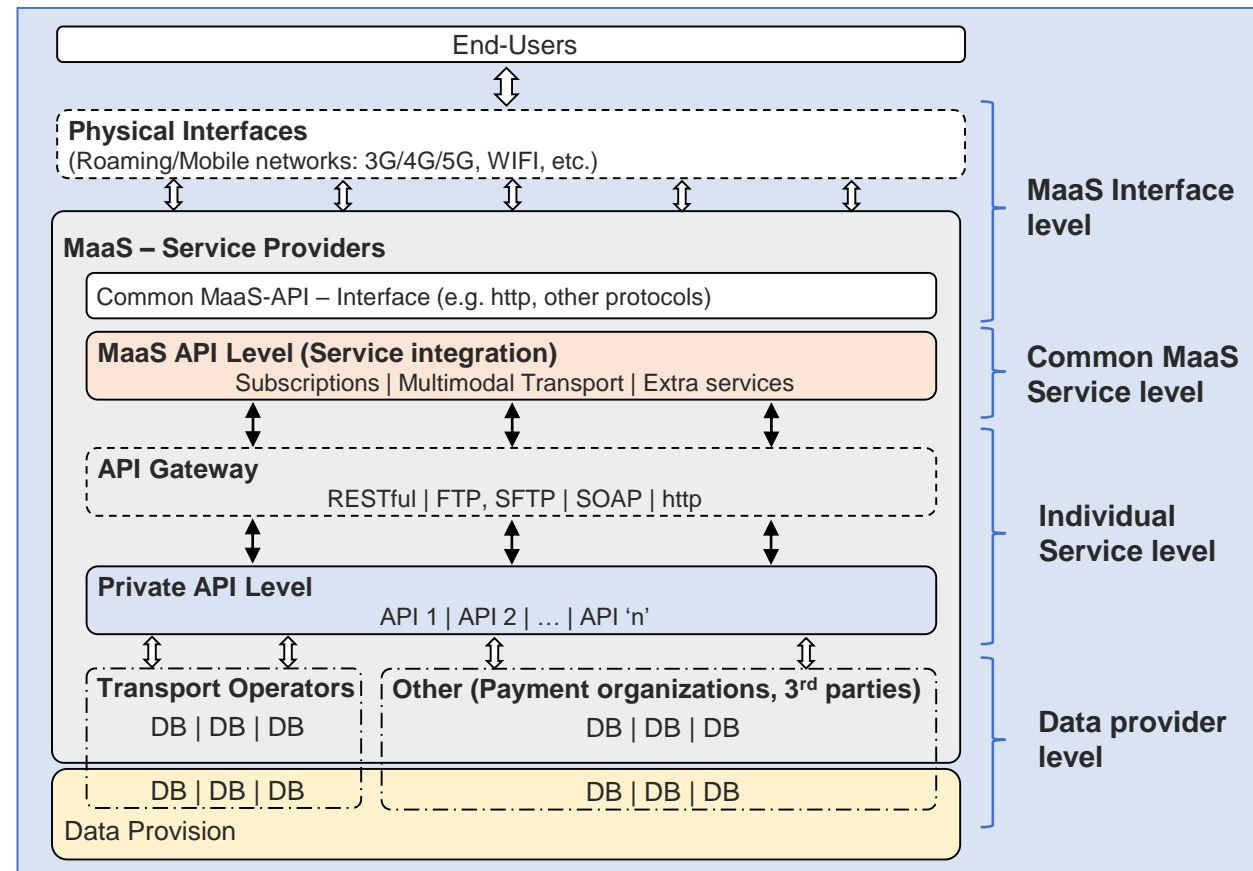
MaaS Business Ecosystem



Source: Kamargianni, M. and Matyas, M. (2017)

Mobility as a Service (MaaS) – Literature Review

MaaS System Architecture



Source: Adapted from König, D. et al. (2017)



electric Mobility as a Service (eMaaS) – Definition

$$\text{eMaaS} = \text{MaaS} + \text{EVs} ?$$

electric Mobility as a Service (eMaaS) – Definition

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The complementary goal of eMaaS, when compared to MaaS, is to provide users the possibility to go from A to B in an **eco-friendly** way. Therefore, eMaaS is meant to be **electric** and **shared**.

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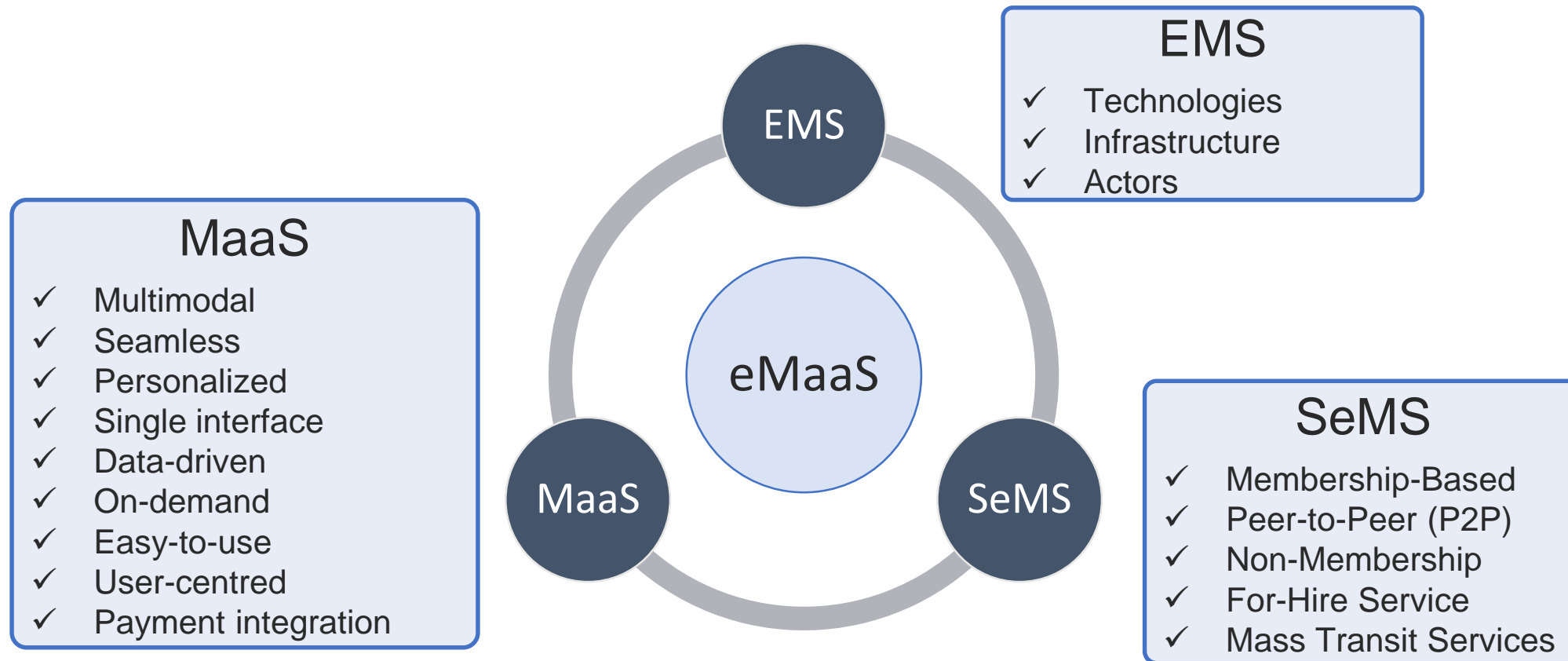
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$$\text{eMaaS} = \text{MaaS} + \text{EMS} + \text{SeMS} \quad \checkmark$$

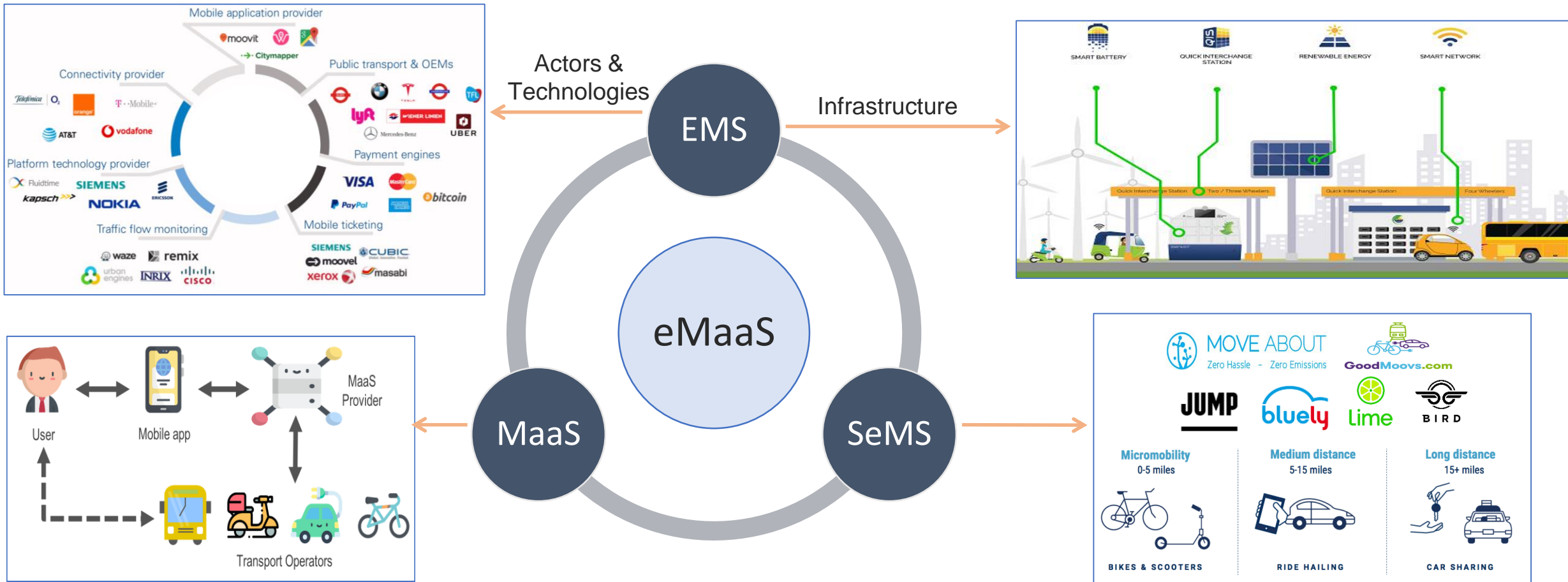
EMS = Electric Mobility Systems

SeMS = Shared electric Mobility Services

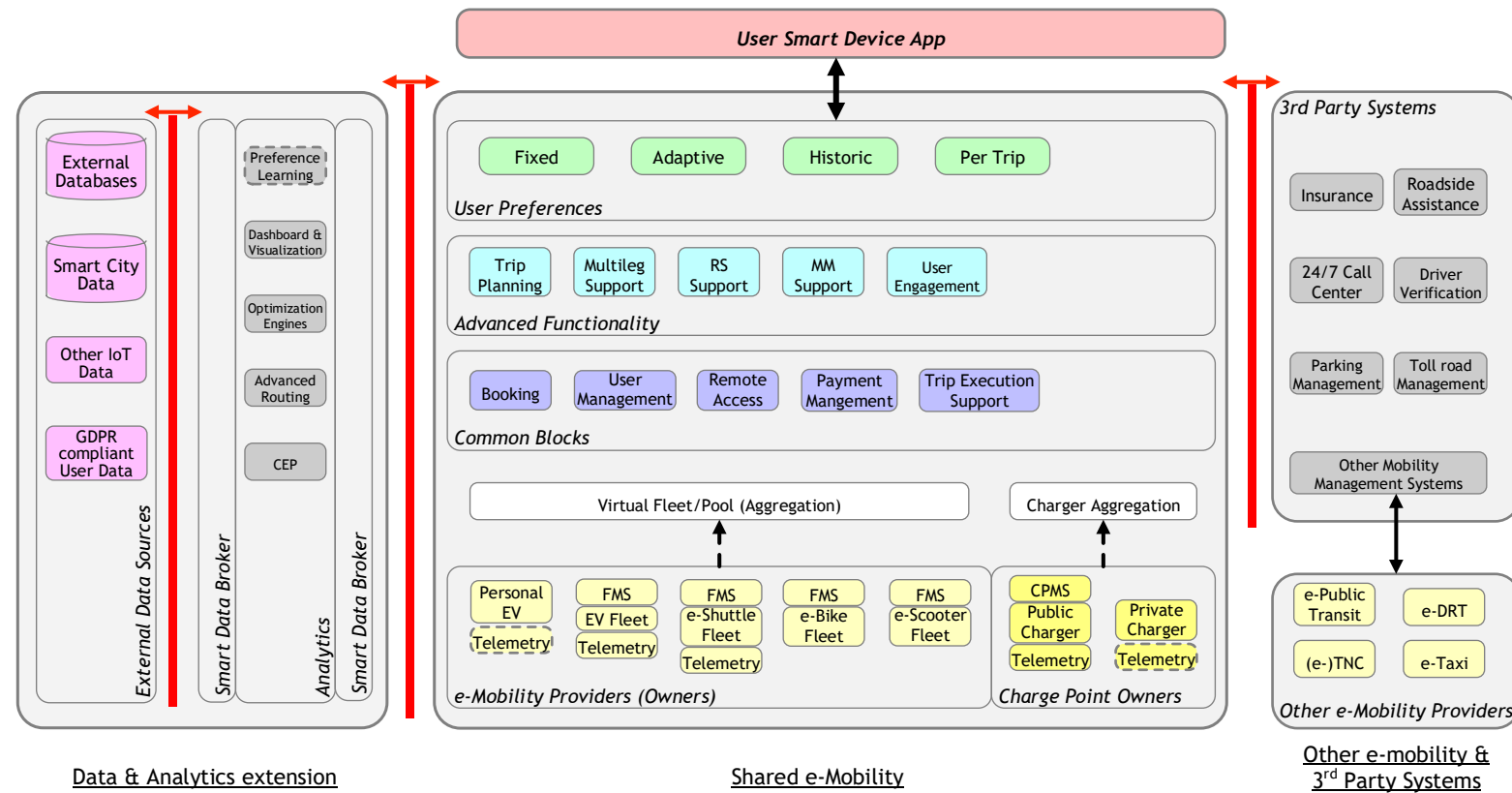
electric Mobility as a Service (eMaaS) – Ecosystem



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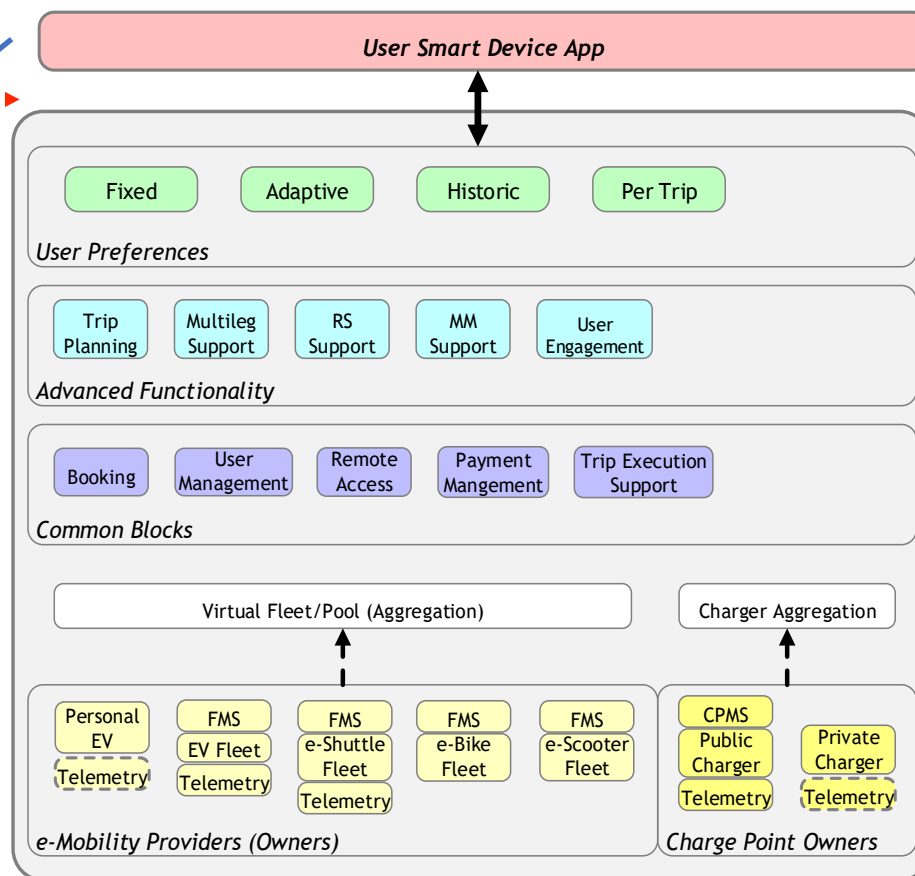


electric Mobility as a Service (eMaaS) – System Architecture

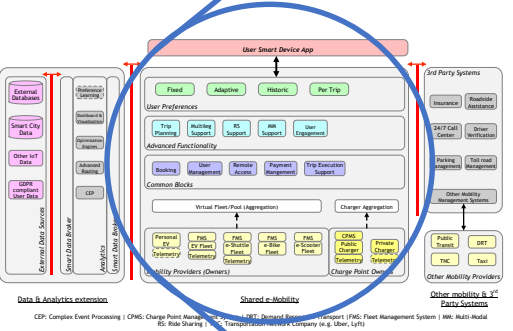


CEP: Complex Event Processing | CPMS: Charge Point Management System | DRT: Demand Responsive Transport | FMS: Fleet Management System | MM: Multi-Modal
RS: Ride Sharing | TNC: Transportation Network Company (e.g. Uber, Lyft)

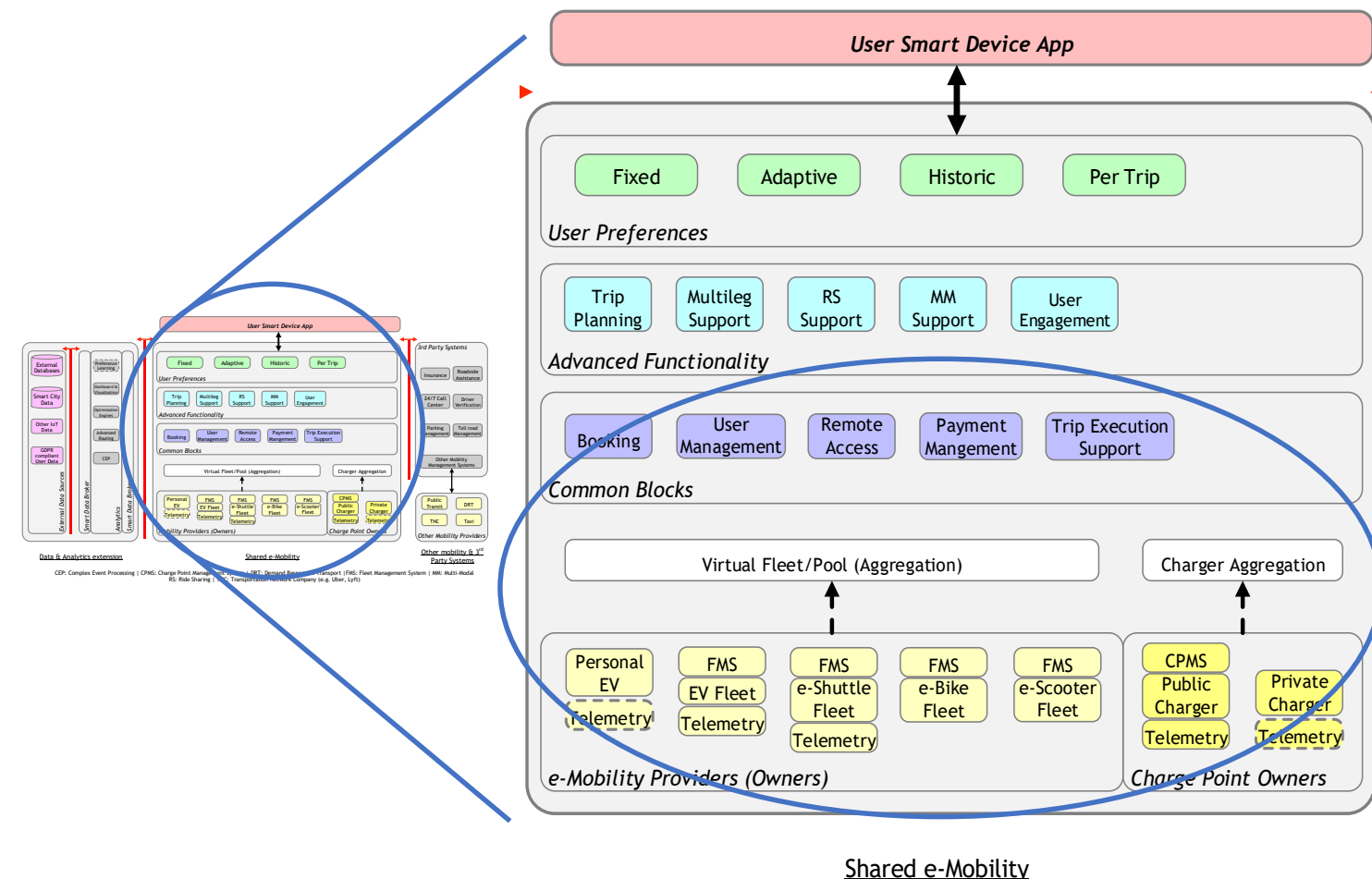
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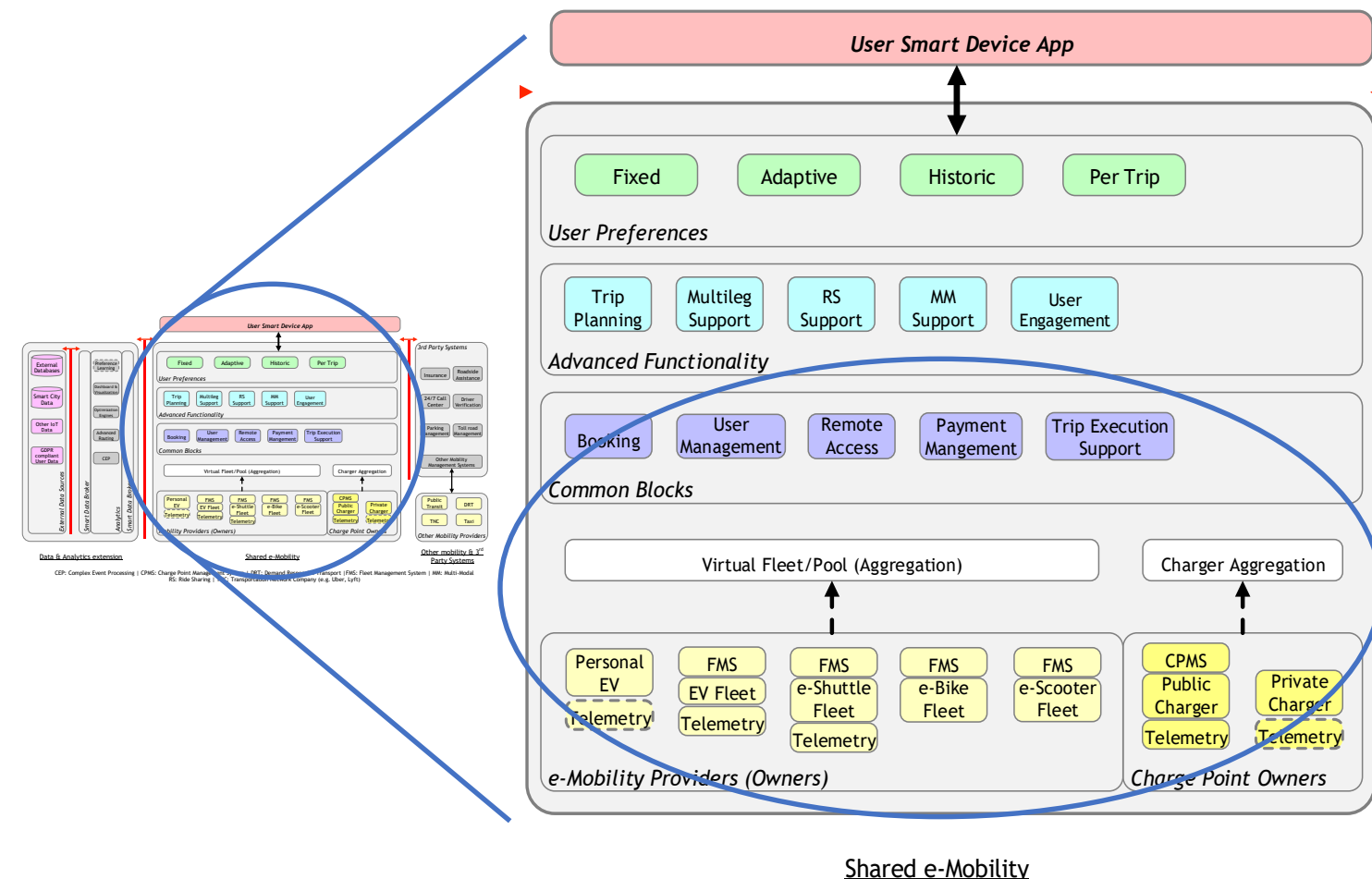
Shared e-Mobility



electric Mobility as a Service (eMaaS) – System Architecture



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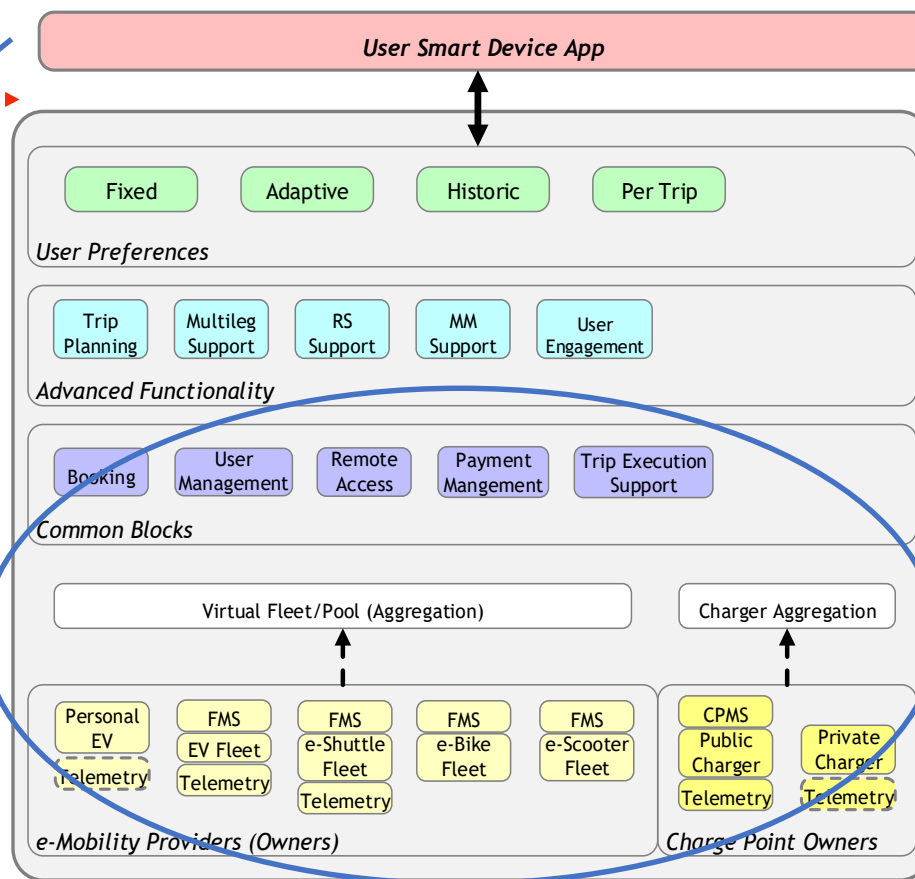


e-Mobility Providers - Owners of the vehicles

- Fleets (non-personal vehicles) can include FMS
- Personal EVs (and e-shuttle) fleets include telemetry hardware; private EVs **optional** telemetry hardware

Shared e-Mobility

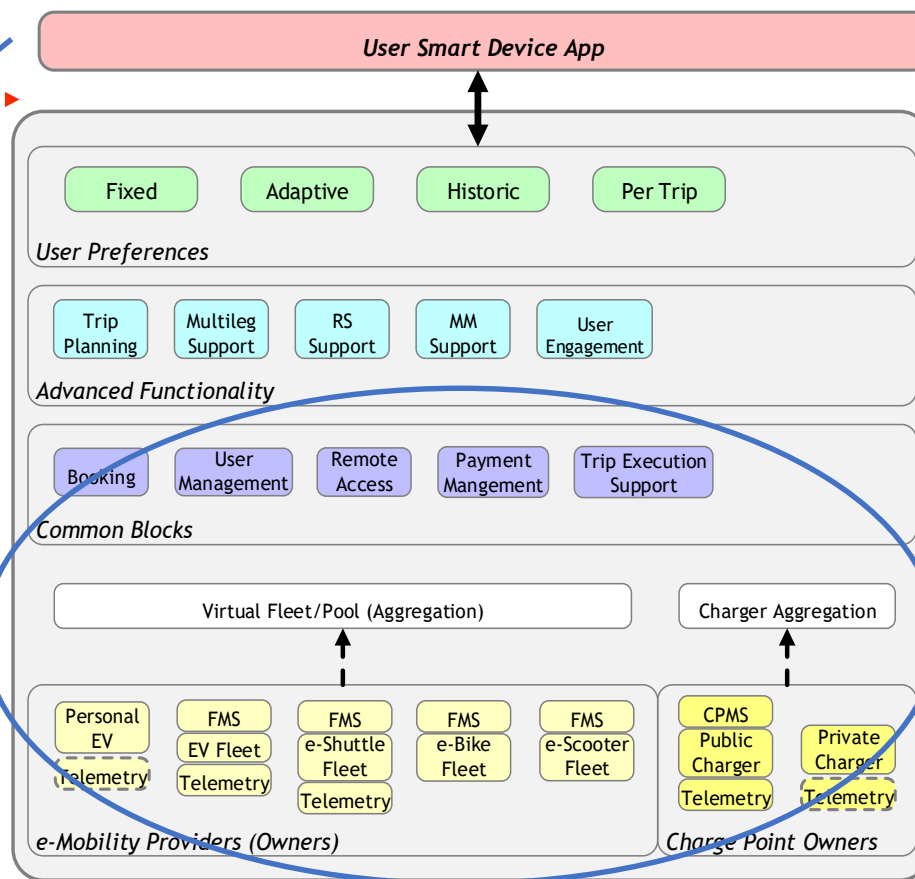
electric Mobility as a Service (eMaaS) – System Architecture



- Charge point owners**
- Public infrastructure, incl. CPMS with telemetry (charger related data)
 - Private chargers include **optional** telemetry
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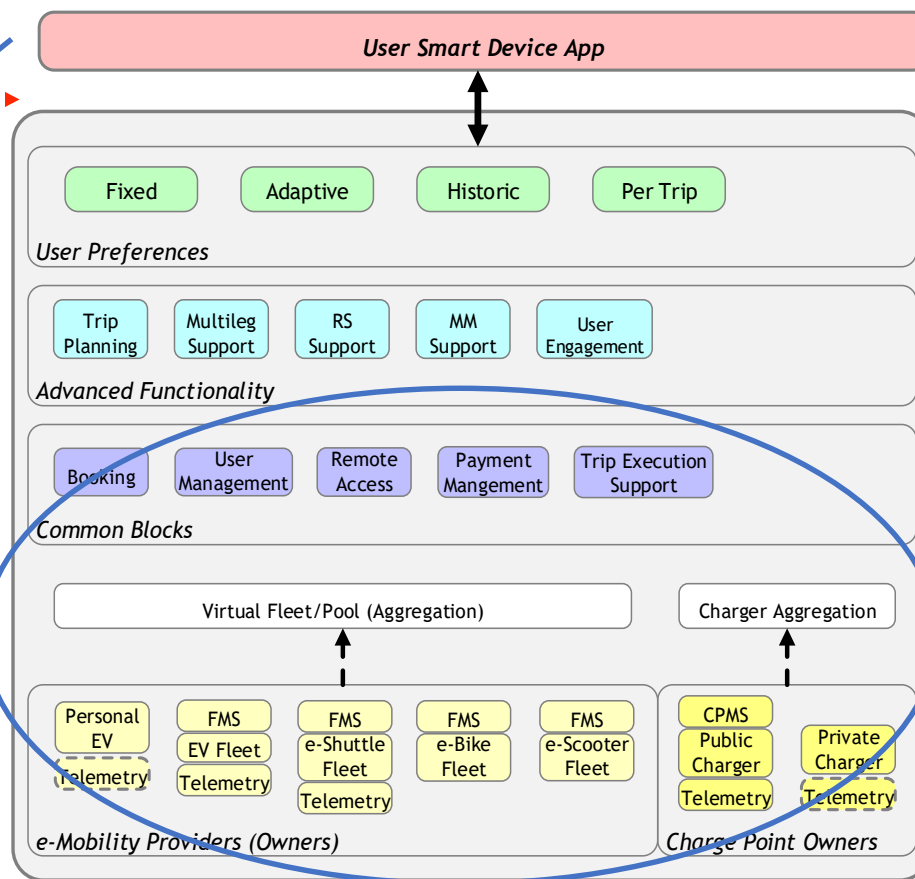
electric Mobility as a Service (eMaaS) – System Architecture



- Virtual Fleet Aggregation** - Pooling of multiple physical fleets into one virtual fleet for use by operators
- Charger Aggregation** - Facilitates seamless (vendor independent) charging
- Charge point owners**
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Shared e-Mobility

electric Mobility as a Service (eMaaS) – System Architecture



- Common Blocks – across all (or almost all) shared mobility solutions
- Booking: Handling of user reservations (including user preferences)
 - User Management: Incl. enrollment, preferences, incentive programs
 - Remote Access: smart phone/card lock/unlock access
 - Payment Management: All billing related functions
 - Trip Support: Before-, during- or after trip
 - Optionally by 3rd party

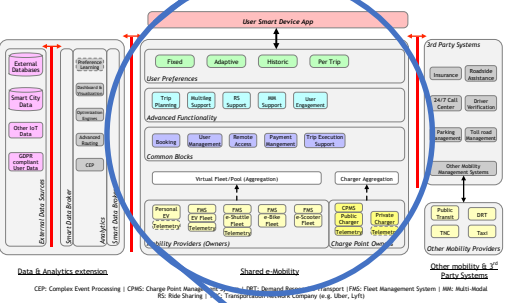
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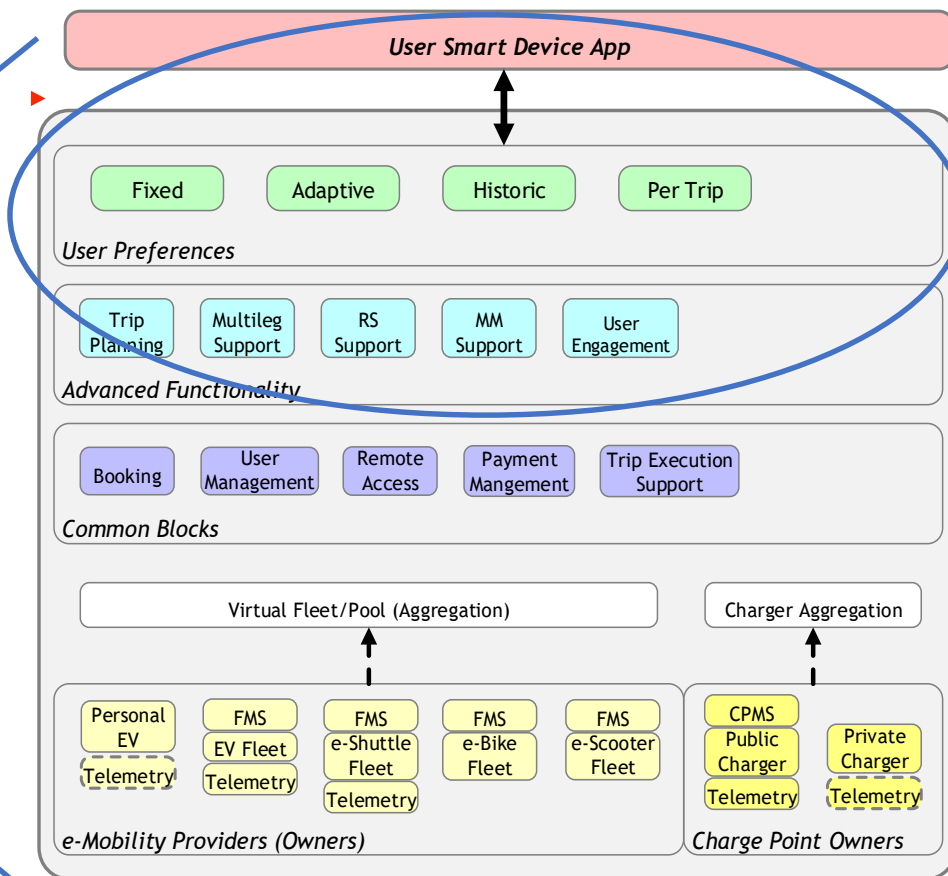
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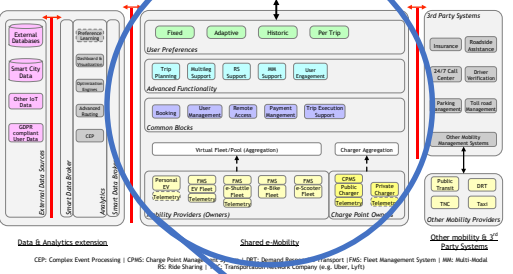
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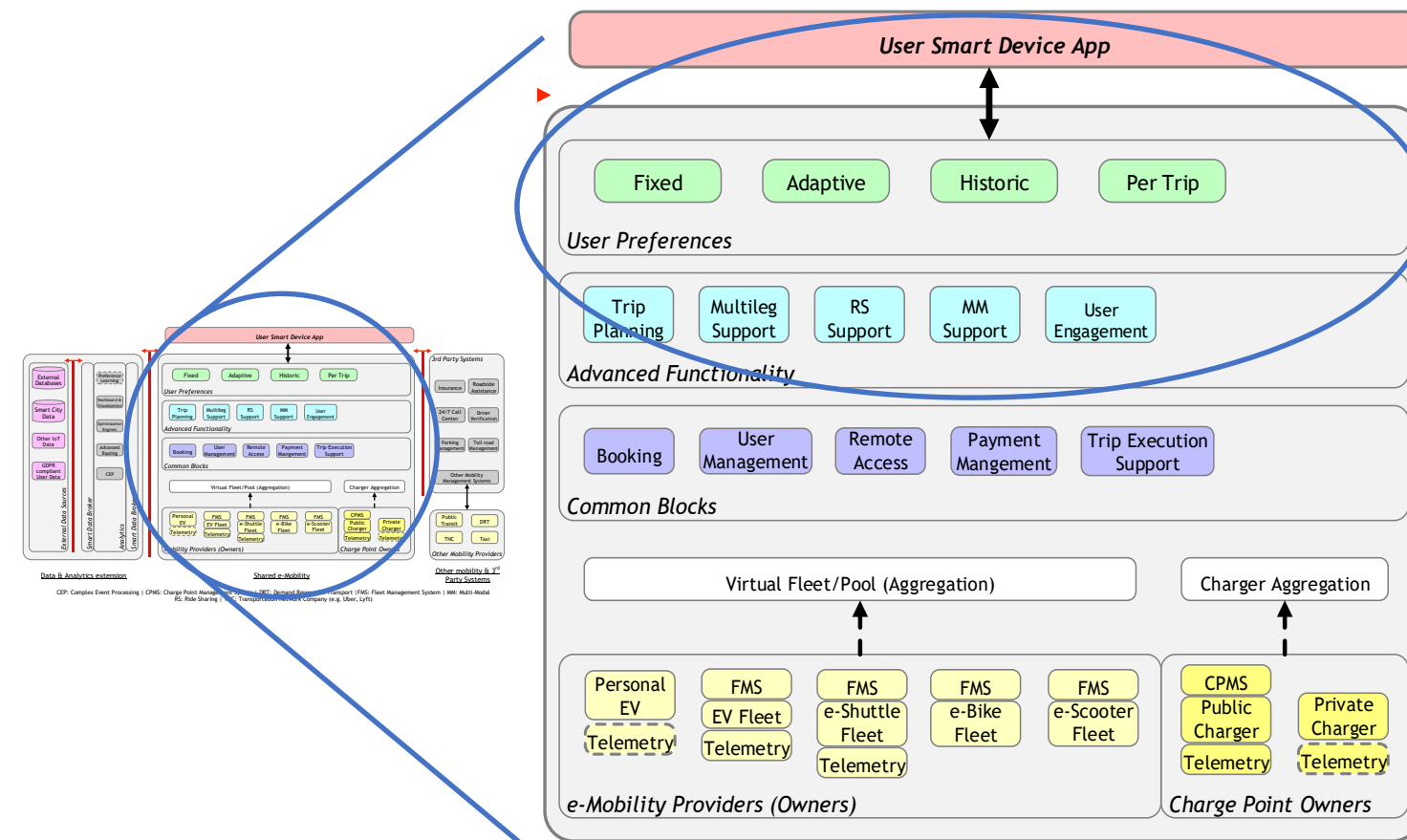
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Shared e-Mobility



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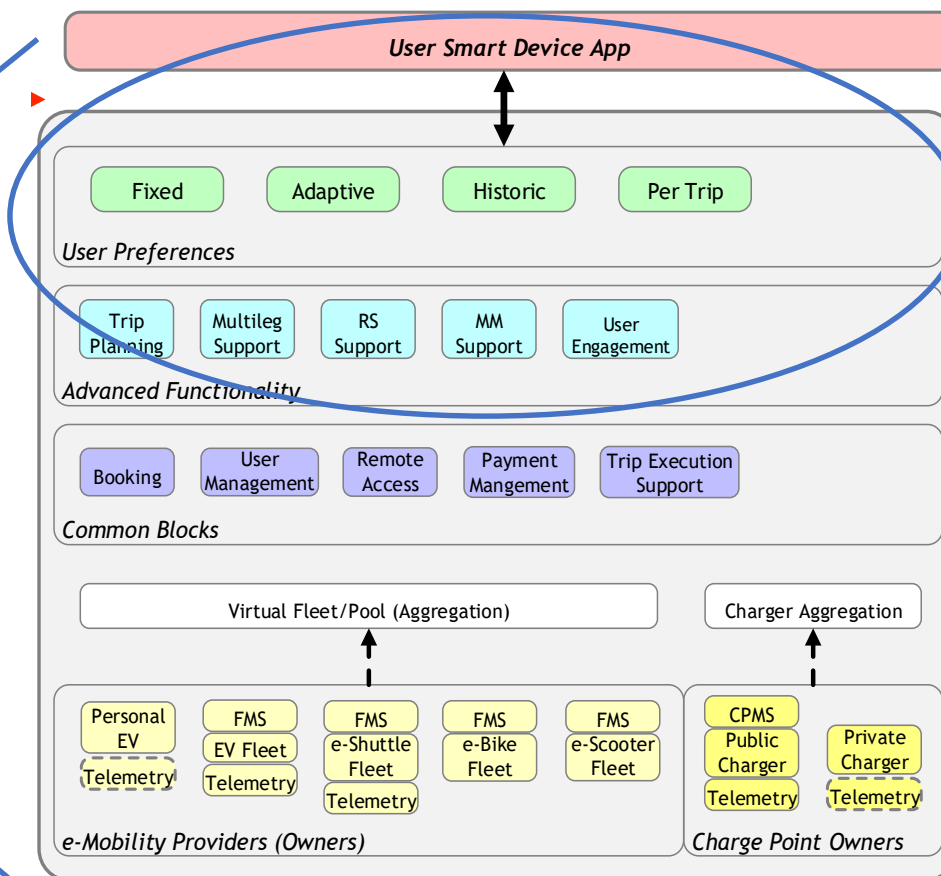


Advanced Functionality – To enhance shared e-mobility solutions

- Trip Planning: Routes, time/cost/traffic estimation, etc.
- Multi-leg Support: Enabling (and scheduling) multi-segment trip
- Ride Sharing Support: Enabling trips with multiple riders
- Multi-Modal Support: Interfaces and inclusion of additional transportation and mobility modes

Shared e-Mobility

electric Mobility as a Service (eMaaS) – System Architecture



User Preferences – Per each user or group of users

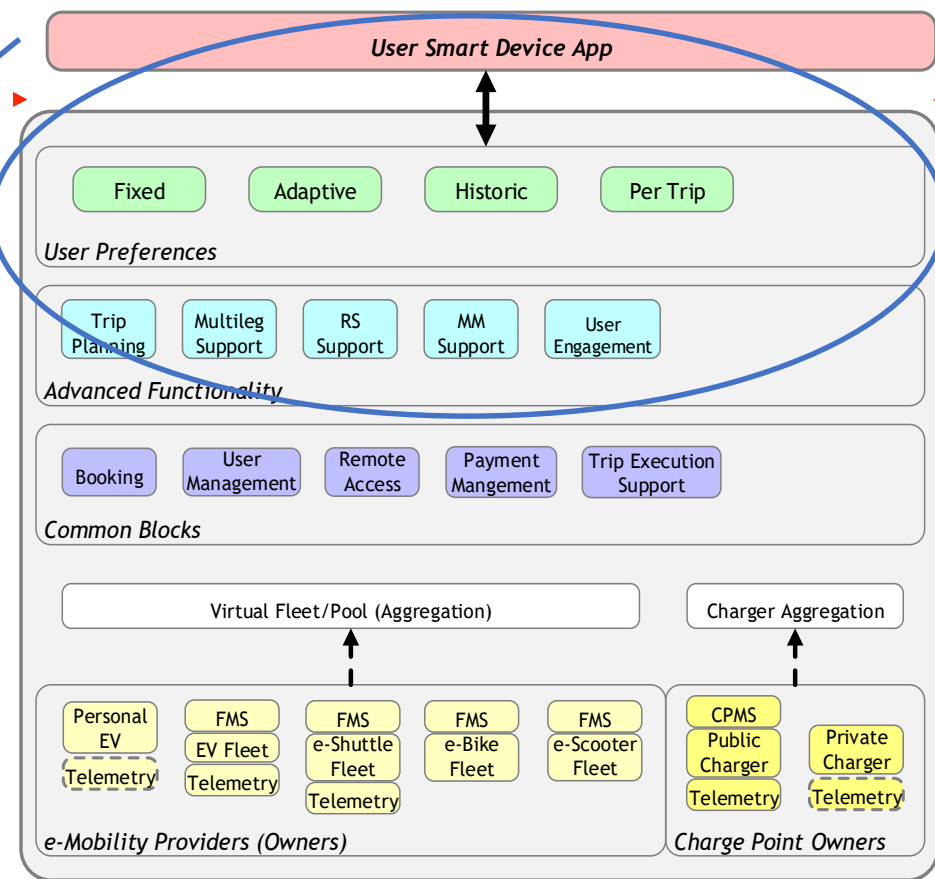
- Fixed: Long term (rarely changing)
- Adaptive: Automatically changing (e.g. based on season)
- Historic: Based on past choices (enable predictive capabilities)
- Per Trip: Preferences on time, range/distance, price, etc.

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Shared e-Mobility

electric Mobility as a Service (eMaaS) – System Architecture



User Smart Device App

- **Single** mobile app to **all** user eMaaS features and capabilities
- Including all preferences, bills, real time status

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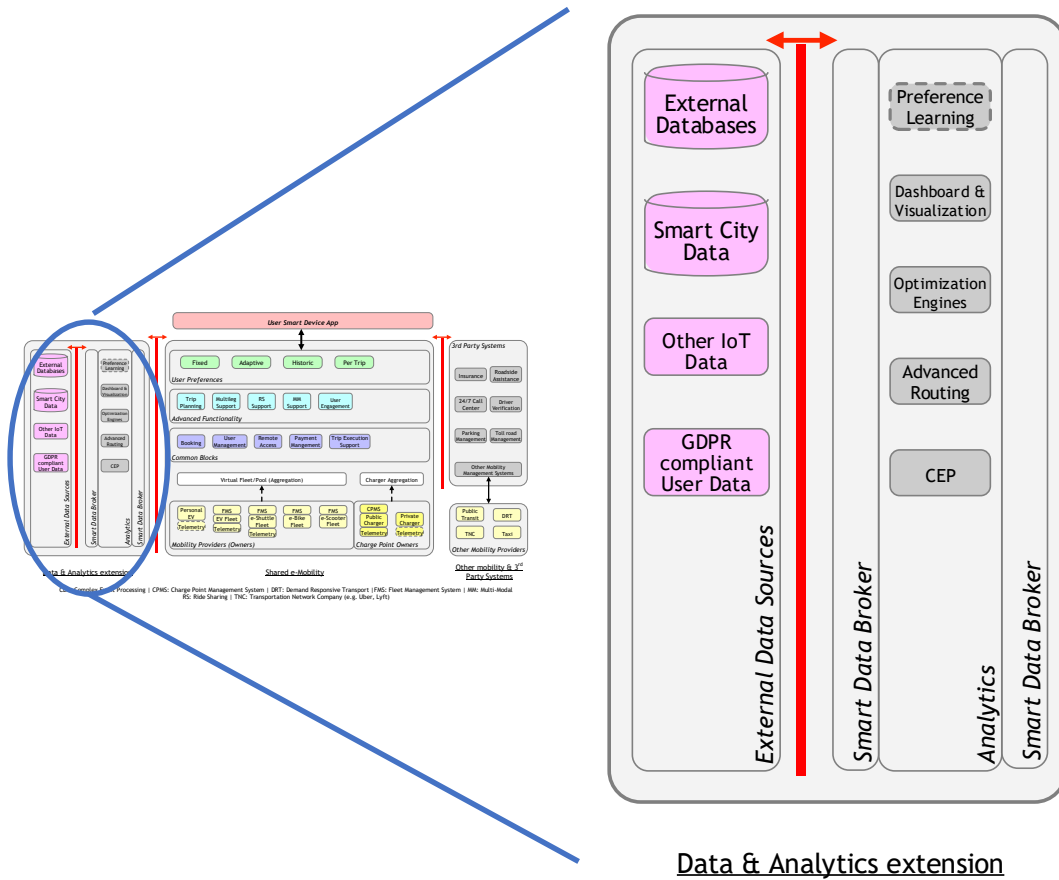
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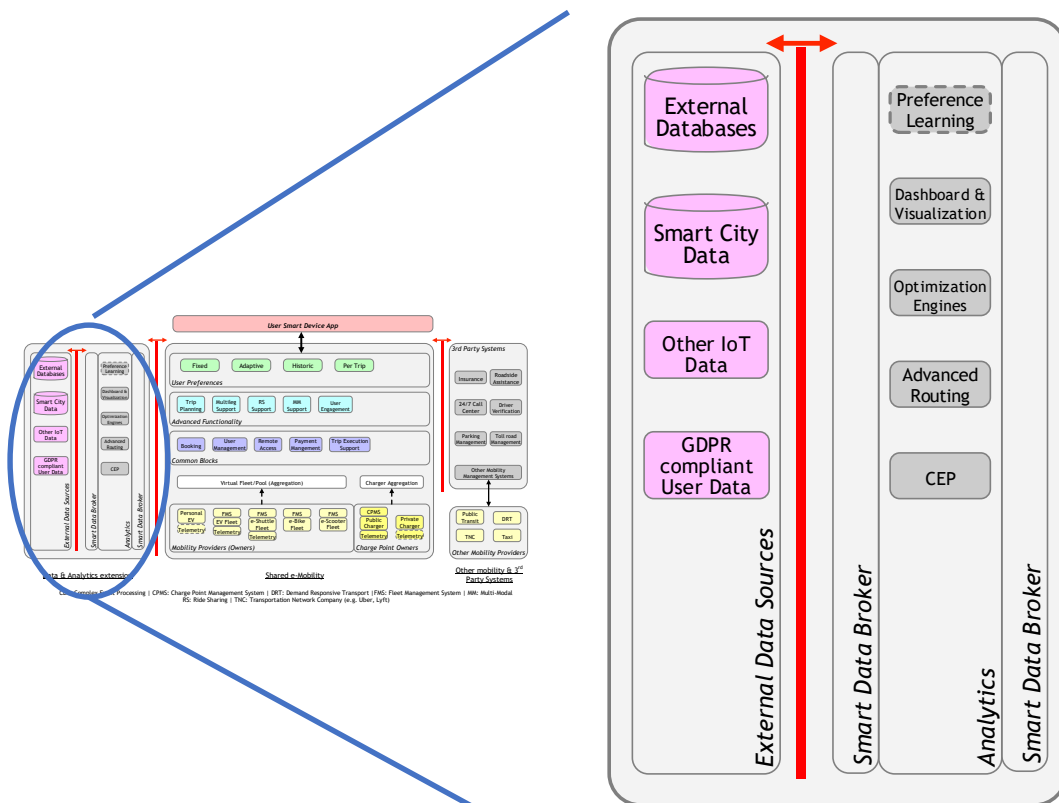
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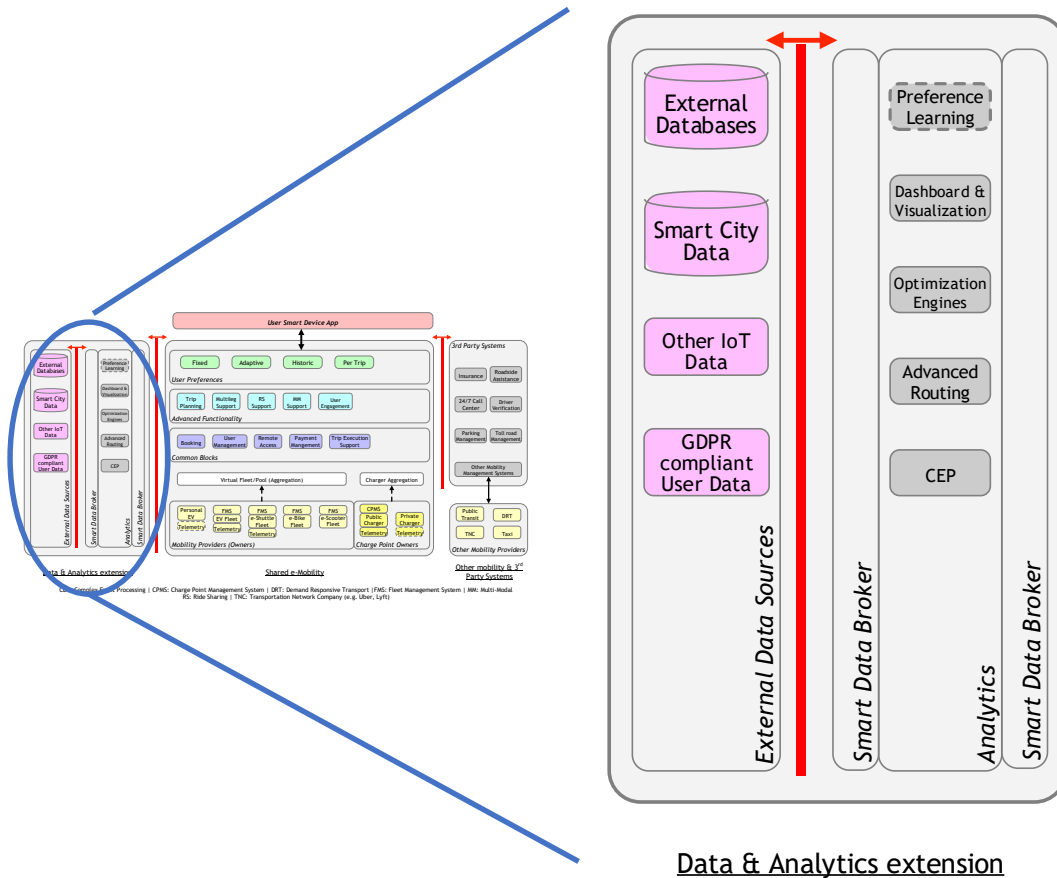
Data & Analytics extension

Smart Data Broker - Brokering between data sources using “adapters” (per data source type)

Analytics – To facilitate enhanced functionalities of baseline systems

- Complex Event Processing: Processing of streaming (real time) data
- Advanced Routing: Dynamic and adapting to (near) real time changes
- Optimization Engines: For scheduling, route planning, charging during trip, etc.
- Dashboard and Visualization: Visualization tools both for operators and (app) users
- Preference Learning: Of user behavior, trends, patterns - For enhanced predictive capabilities

electric Mobility as a Service (eMaaS) – System Architecture

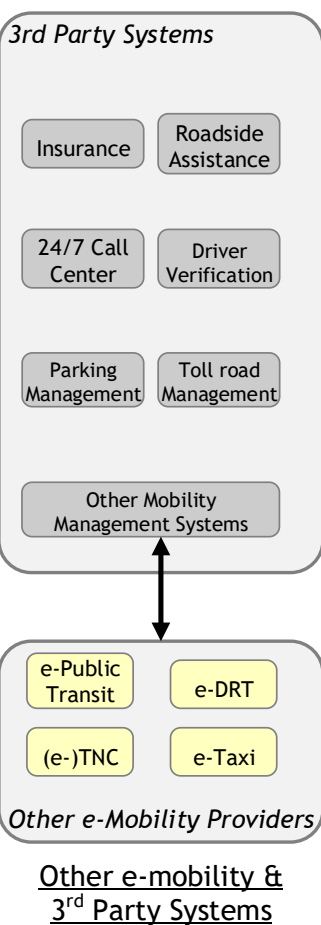
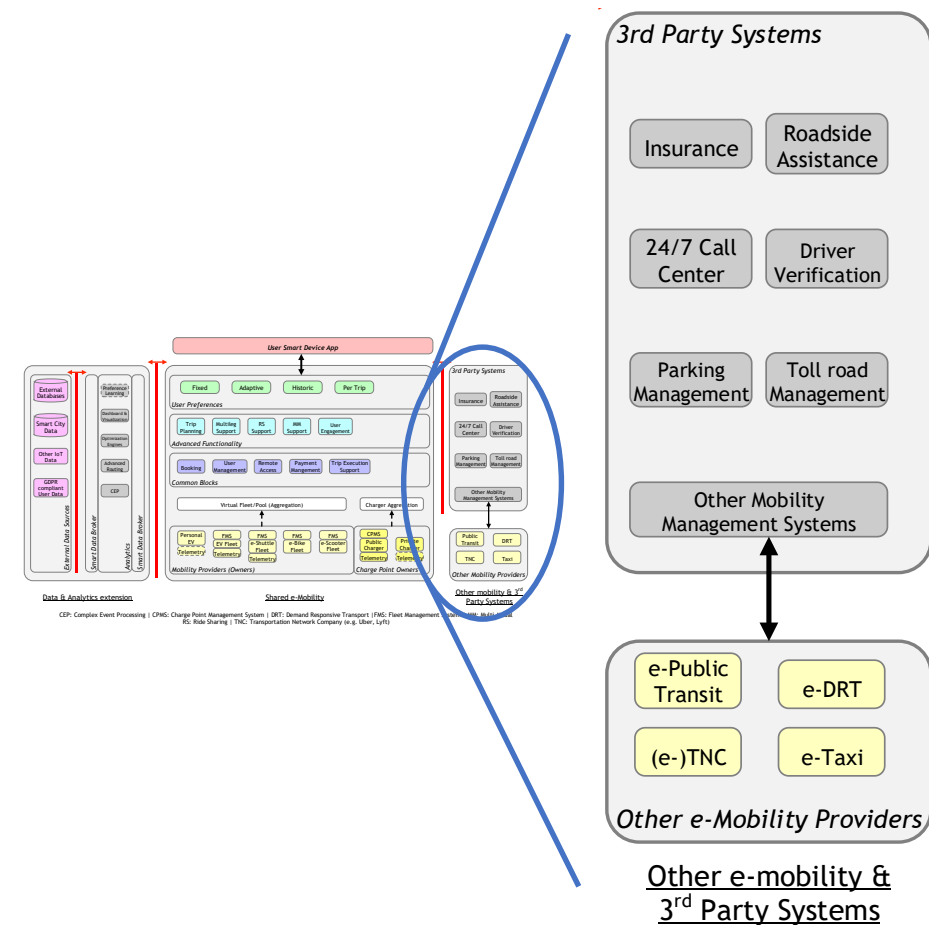


- External Data Sources** - For delivering advanced data services and enhanced features
- External Databases: Any third party database with relevant data (mostly relational)
 - Smart City Data: Available Open Data both historic and near real time; city proprietary data
 - Other IoT Data: Third party, accessible IoT devices data (mostly streaming and real time)
 - GDPR Compliant User Data: Data that users are willing to share subject to GDPR

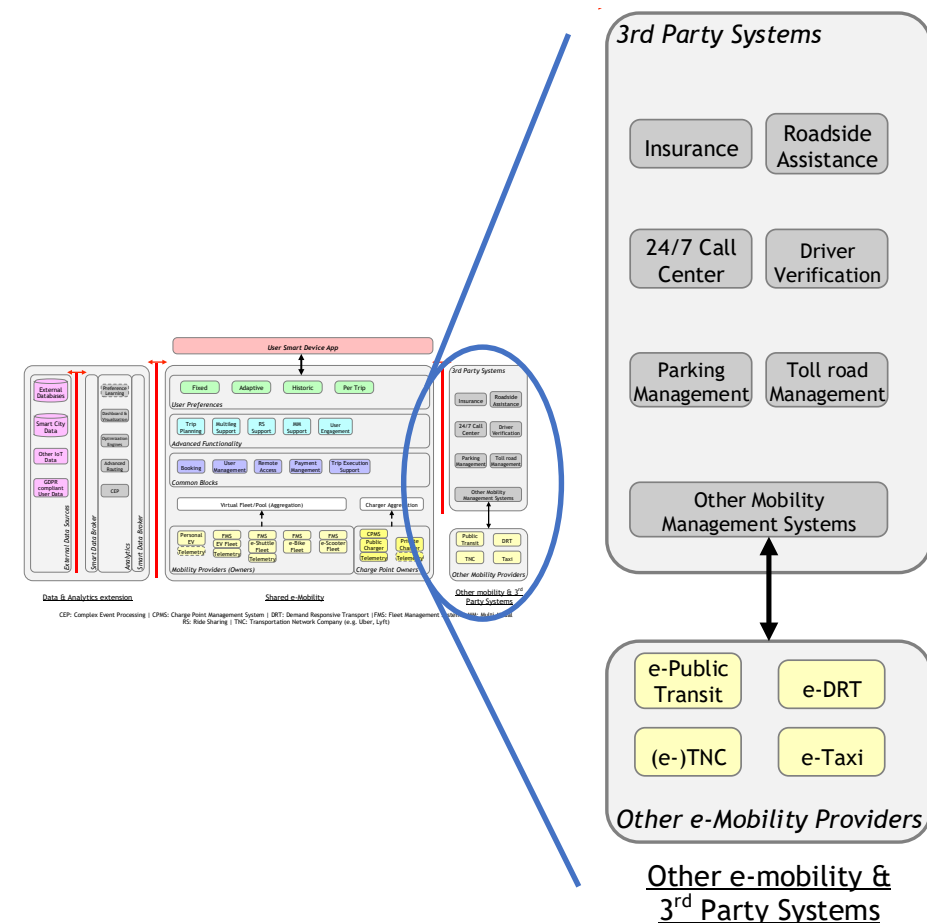
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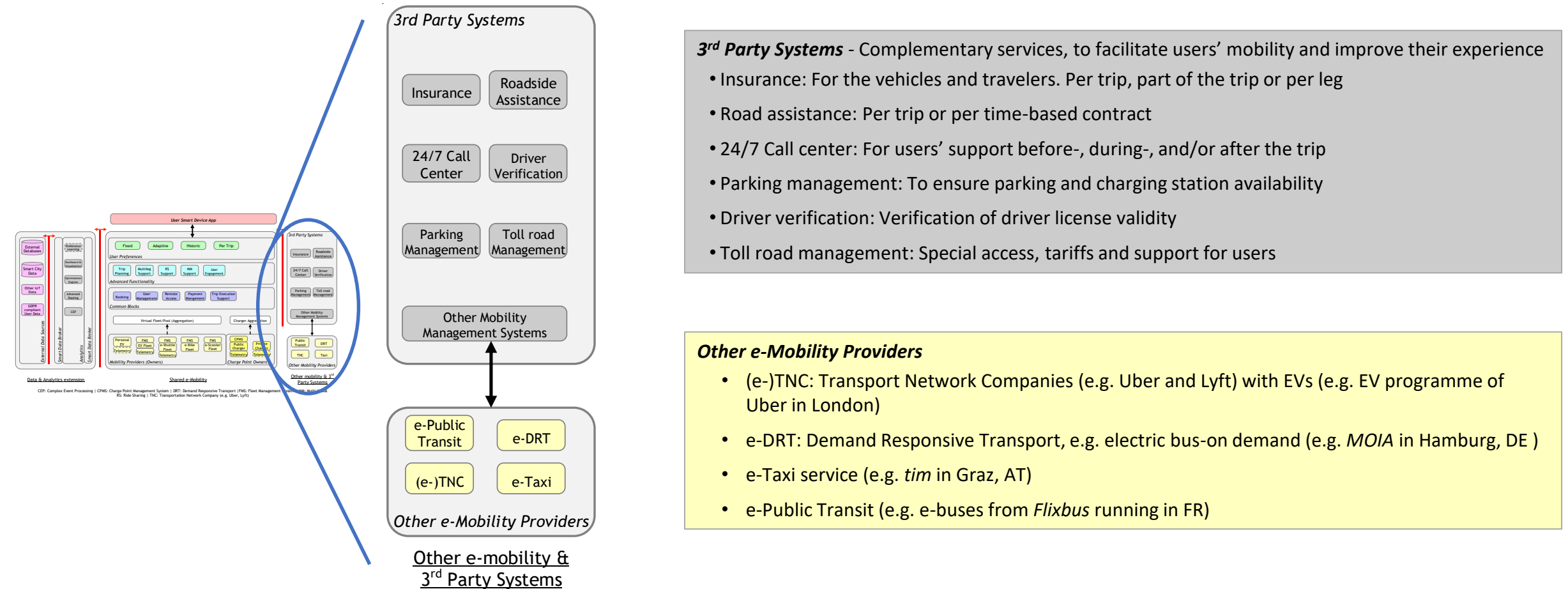


electric Mobility as a Service (eMaaS) – System Architecture



- Other e-Mobility Providers**
- (e-)TNC: Transport Network Companies (e.g. Uber and Lyft) with EVs (e.g. EV programme of Uber in London)
 - e-DRT: Demand Responsive Transport, e.g. electric bus-on demand (e.g. *MOIA* in Hamburg, DE)
 - e-Taxi service (e.g. *tim* in Graz, AT)
 - e-Public Transit (e.g. e-buses from *Flixbus* running in FR)

electric Mobility as a Service (eMaaS) – System Architecture



TAKEAWAYS

- Current state of the art regarding (e)MaaS ecosystems and systems architectures is fairly limited
 - Some examples can be found in literature (incl. functional MaaS models, e.g. SMILE project)
- eMaaS is a concept that builds upon the MaaS model
 - MaaS ecosystem and MaaS system architectures serve as a foundation for the development of eMaaS and its system architecture
 - The addition of the eMaaS concept over MaaS is that the former **guarantees eco-friendly mobility while offering at least the same benefits** as the latter
- Having a clear overview of the elements in the eMaaS ecosystem and in the system architecture helps in the development of eMaaS by **identifying the requirements, functions, stakeholders and interfaces** that need to be covered when developing the eMaaS services



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Thank you for your attention!

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