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

J. Roberto Reyes García | Steven Haveman | Maarten Bonnema
University Of Twente, The Netherlands

Gadi Lenz
Urban Software Institute GmbH, Germany
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  From literature review
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eMaaS ecosystem and architecture – EVS 32 Lyon – Roberto Reyes
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• Takeaways

Focus of this presentation

Authors proposition

From literature review

eMaaS ecosystem and architecture – EVS 32 Lyon – Roberto Reyes
INTRODUCTION – About us

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

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<tr>
<td>Associate Professor</td>
<td>Dr. Ir. Maarten Bonnema</td>
<td>Chair of SEMD and Project Supervisor</td>
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<tr>
<td>PostDoc Researcher</td>
<td>Dr. Ir. Steven Haveman</td>
<td>Lead Researcher - Systems Engineering and Systems Modeling Research</td>
</tr>
<tr>
<td>Junior Researcher</td>
<td>J. Roberto Reyes García</td>
<td>Research on Data Driven Architectures and Knowledge Sources for Electric Mobility Systems</td>
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Urban Software Institute GmbH

<table>
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<tr>
<th>Role</th>
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</tr>
</thead>
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<tr>
<td>Technologist – IoT specialist</td>
<td>Dr. Gadi Lenz</td>
<td>IoT centric solutions, platforms and architectures for Smart Cities with a focus on mobility and EVs</td>
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INTRODUCTION – The eMaaS project

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

Project consortium

- Universidad de Twente, The Netherlands
- UI! The Urban Institute, Germany & Hungary
- Move About, Austria & Sweden

eMaaS ecosystem and architecture – EVS 32 Lyon – Roberto Reyes
INTRODUCTION – The eMaaS project

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

INTRODUCTION

The eMaaS project

From isolated solutions

To integrated solutions

To a stand-alone eMaaS solution

* icons from flaticon.com

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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 into 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

Mobility as a Service (MaaS) – Literature Review

MaaS Business Ecosystem

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

\[ \text{eMaaS} = \text{MaaS} + \text{EVs} \]

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**.
electric Mobility as a Service (eMaaS) – Definition

eMaaS = MaaS + EVs? ✗

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.

eMaaS = MaaS + EMS + SeMS ✓

EMS = Electric Mobility Systems
SeMS = Shared electric Mobility Services

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electric Mobility as a Service (eMaaS) – Ecosystem

- Technologies
- Infrastructure
- Actors

EMS

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

SeMS
- Membership-Based
- Peer-to-Peer (P2P)
- Non-Membership
- For-Hire Service
- Mass Transit Services
electric Mobility as a Service (eMaaS) – Ecosystem
electric Mobility as a Service (eMaaS) – System Architecture

User Smart Device App

- Fixed
- Adaptive
- Historic
- Per Trip

User Preferences

- Trip Planning
- Multileg Support
- RS Support
- MM Support
- User Engagement

Advanced Functionality

- Booking
- User Management
- Remote Access
- Payment Management
- Trip Execution Support

Common Blocks

- Virtual Fleet/Pool (Aggregation)
- Charger Aggregation

e-Mobility Providers (Owners)

- Personal EV (Telemetry)
- FMS EV Fleet (Telemetry)
- FMS e-Shuttle Fleet (Telemetry)
- FMS e-Bike Fleet
- FMS e-Scooter Fleet

Charge Point Owners

- CPMS Public Charger (Telemetry)
- Private Charger (Telemetry)

3rd Party Systems

- Insurance
- Roadside Assistance
- 24/7 Call Center
- Driver Verification
- Parking Management
- Toll road Management

Other Mobility Management Systems

- Other e-Mobility Providers
- e-Public Transit
- e-DRT
- e-TNC
- e-Taxi

Data & Analytics

- External Databases
- Smart City Data
- Other IoT Data
- GDPR compliant User Data

Smart Data Broker

- Preference Learning
- Visualization
- Optimization Engines
- Advanced Routing
- CEP

Analytics

- External Data Sources
- Smart City
- Other IoT
- GDPR compliant

User

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Other Mobility Management Systems

- Other e-Mobility Providers
- e-Public Transit
- e-DRT
- e-TNC
- e-Taxi

External Data Sources

- Charge Point Owners
- e-Mobility Providers (Owners)
- EV Fleet
- FMS
- e-Bike Fleet
- FMS
- e-Scooter Fleet
- Public Charger

Per Trip

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)
electric Mobility as a Service (eMaaS) – System Architecture

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- Personal EV Telemetry
- FMS EV Fleet Telemetry
- FMS e-Shuttle Fleet Telemetry
- FMS e-Bike Fleet
- CPMS Public Charger Telemetry
- Private Charger Telemetry

e-Mobility Providers (Owners)

- Charge Point Owners

Shared e-Mobility
electric Mobility as a Service (eMaaS) – System Architecture
e-MaaS ecosystem and architecture – EVS 32 Lyon – Roberto Reyes

**e-MaaS System Architecture**

- **User Smart Device App**
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  - Historic
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  - Trip Planning
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  - TNC Support
  - User Engagement

- **Advanced Functionality**
  - Booking
  - User Management
  - Remote Access
  - Payment Management
  - Trip Execution Support

- **Common Blocks**
  - Virtual Fleet/Pool (Aggregation)
  - Charger Aggregation

- **e-Mobility Providers** (Owners)
  - Personal EV
  - Fixed EV Fleet
  - Fixed Telemetry
  - FMS
  - e-Shuttle Fleet
  - e-Scooter Fleet
  - e-Bike Fleet
  - CPMS
  - Private Charger

- **Shared e-Mobility**

**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

**External Data Sources**
- MM: Multi-Modal
- RS: Ride Sharing
- TNC: Transportation Network Company (e.g. Uber, Lyft)

**Other Mobility**
- 3rd Party Systems
  - Parking
  - Toll road Management Systems
  - Transit
  - Roadside Assistance

**Other e-1st Party Systems**
- 3rd Party Systems
  - Insurance
  - Call Center

**WEB Link**
- [Website Link](#)
electric Mobility as a Service (eMaaS) – System Architecture

**User Smart Device App**
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- Trip Planning
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- FMS EV Fleet Telemetry
- FMS e-Shuttle Fleet Telemetry
- FMS e-Bike Fleet
- FMS e-Scooter Fleet
- CPMS Public Chargers Telemetry
- Private Charged Telemetry

**Charge point owners**
- Public infrastructure, incl. CPMS with telemetry (charger related data)
- Private chargers include optional telemetry

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**Shared e-Mobility**

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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

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  - User Management
  - Remote Access
  - Payment Management
  - Trip Execution Support

- **Virtual Fleet/Pool (Aggregation)**

- **Charger Aggregation**

**e-Mobility Providers (Owners)**

**Shared e-Mobility**

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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

Virtual Fleet Aggregation - Pooling of multiple physical fleets into one virtual fleet for use by operators

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electric Mobility as a Service (eMaaS) – System Architecture

User Smart Device App

User Preferences

Fixed Adaptive Historic Per Trip

Advanced Functionality

Trip Planning Multileg Support RS Support MM Support User Engagement

Booking
User Management Remote Access Payment Management Trip Execution Support

Common Blocks

Virtual Fleet/Pool (Aggregation) Charger Aggregation

e-Mobility Providers (Owners)

Charge Point Owners

Shared e-Mobility EVA 32 Lyon – Roberto Reyes

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electric Mobility as a Service (eMaaS) – System Architecture

**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
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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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

**User Preferences** – Per each user or group of users
- Fixed: Long term (rarely changing)
- Adaptive: Automatically changing (e.g. based on season)
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**Shared e-Mobility**
- e-Mobility Providers (Owners)
- Charge Point Owners

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electric Mobility as a Service (eMaaS) – System Architecture
electric Mobility as a Service (eMaaS) – System Architecture

**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

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

**Analytics** – To facilitate enhanced functionalities of baseline systems
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electric Mobility as a Service (eMaaS) – System Architecture

3rd Party Systems
- Insurance
- Roadside Assistance
- 24/7 Call Center
- Driver Verification
- Parking Management
- Toll road Management
- Other Mobility Management Systems
- Other e-Mobility Providers
  - e-Public Transit
  - e-DRT
  - (e-)TNC
  - e-Taxi
- Other e-mobility & 3rd Party Systems
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

3rd Party Systems

- Insurance: For the vehicles and travelers. Per trip, part of the trip or per leg
- Road assistance: Per trip or per time-based contract
- 24/7 Call center: For users’ support before-, during-, and/or after the trip
- Parking management: To ensure parking and charging station availability
- Driver verification: Verification of driver license validity
- Toll road management: Special access, tariffs and support for users

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)
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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
Thank you for your attention!

J. Roberto Reyes García
Junior Researcher Electric Mobility System
j.r.reyesgarcia@utwente.nl
REFERENCES


