

“Technical Levels of Integration”



From Shared electric Mobility providers to electric Mobility as a Service players

J. Roberto Reyes García
03-December-2019

UNIVERSITY
OF TWENTE.

About me

University of Twente – Department of Design, Production and Management Systems Engineering and Multidisciplinary Design (SEMD) Group Electric Mobility Research 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	Marlise Westerhof, MSc	Research on User Centered Design for Electric Mobility Systems
	Junior Researcher	J. Roberto Reyes García	Research on Reference Architectures for data-driven systems and Electric Mobility Systems

About our project



The eMaaS project:

Develops and promotes an open ecosystem for eco-friendly Mobility as a Service



Our Goals:

- To support large scale adoption of EVs through new business models
- To connect EV sharing services to other eco-friendly modes of mobility



Project duration: 01/01/2018 – 01/06/2020



eMaaS project partners

Sweden

MoveAbout Sweden



Netherlands

GoodMoovs

University of Twente



UNIVERSITY
OF TWENTE.

Germany

[ui!] urban institute



Austria

MoveAbout Austria



Hungary

[ui!] urban institute Hungary Zrt.



MaaS vs eMaaS

2nd International Conference on Mobility as a Service



3-4

DEC

2019

Tampere, Finland

What is eMaaS?

MaaS vs eMaaS

eMaaS = MaaS + EVs ?

MaaS vs eMaaS

eMaaS = MaaS + EVs ? 

MaaS vs eMaaS

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 **shared** and **electric**

MaaS vs eMaaS

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

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 **shared** and **electric**

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

eMaaS = electric Mobility as a Service

MaaS = Mobility as a Service

EMS = Electric Mobility Systems

SeMS = Shared electric Mobility Services

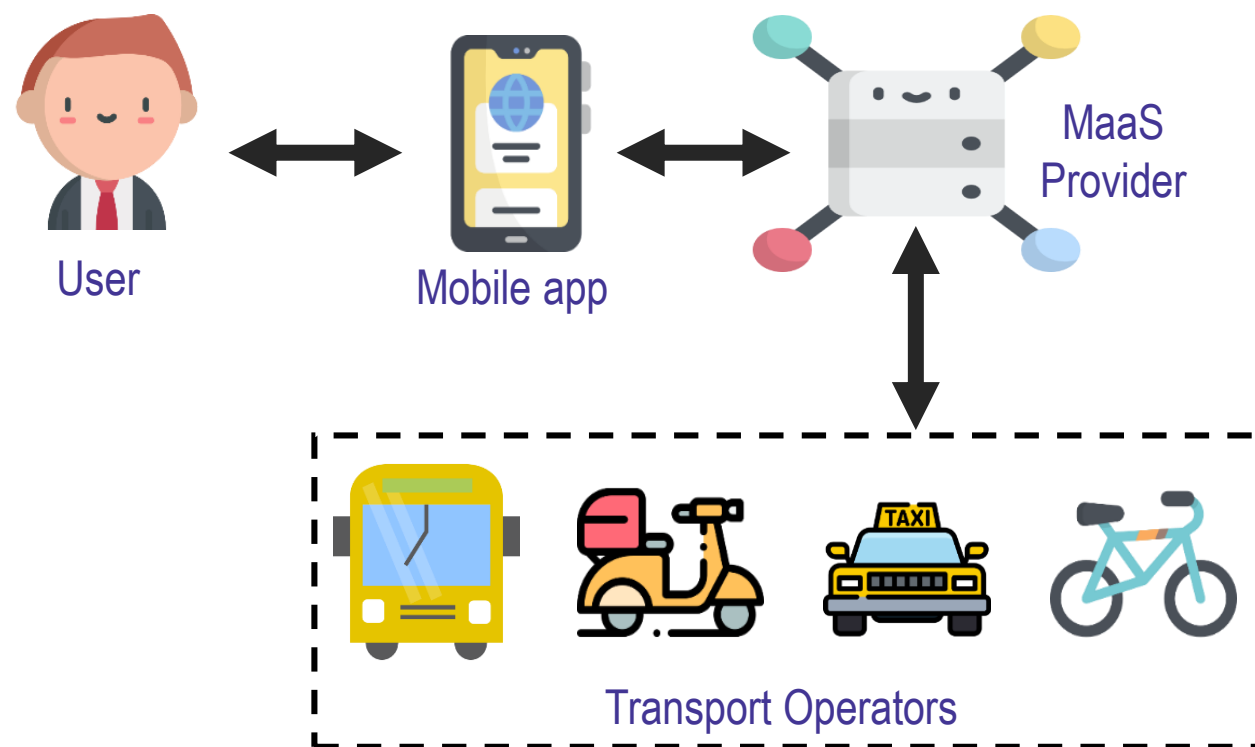
MaaS vs eMaaS

eMaaS = MaaS + EMS + SeMS ✓

MaaS vs eMaaS

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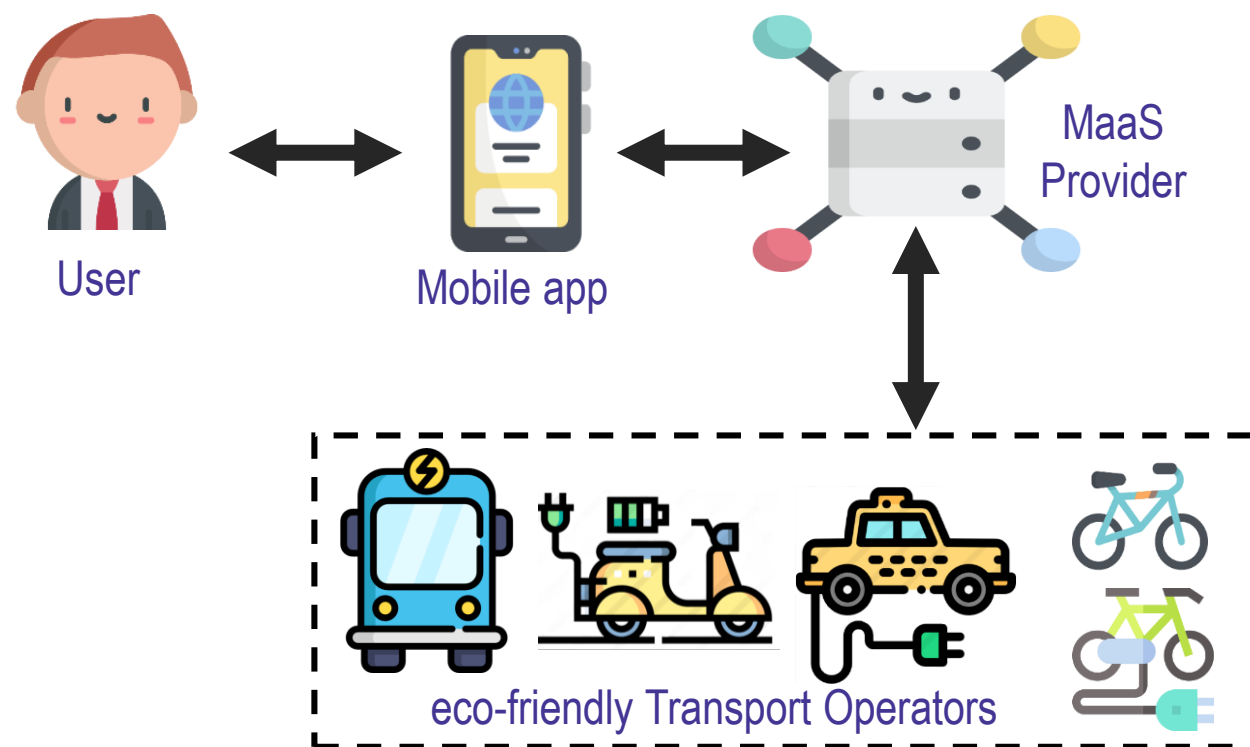
(Basic) Mobility as a Service ecosystem



MaaS vs eMaaS

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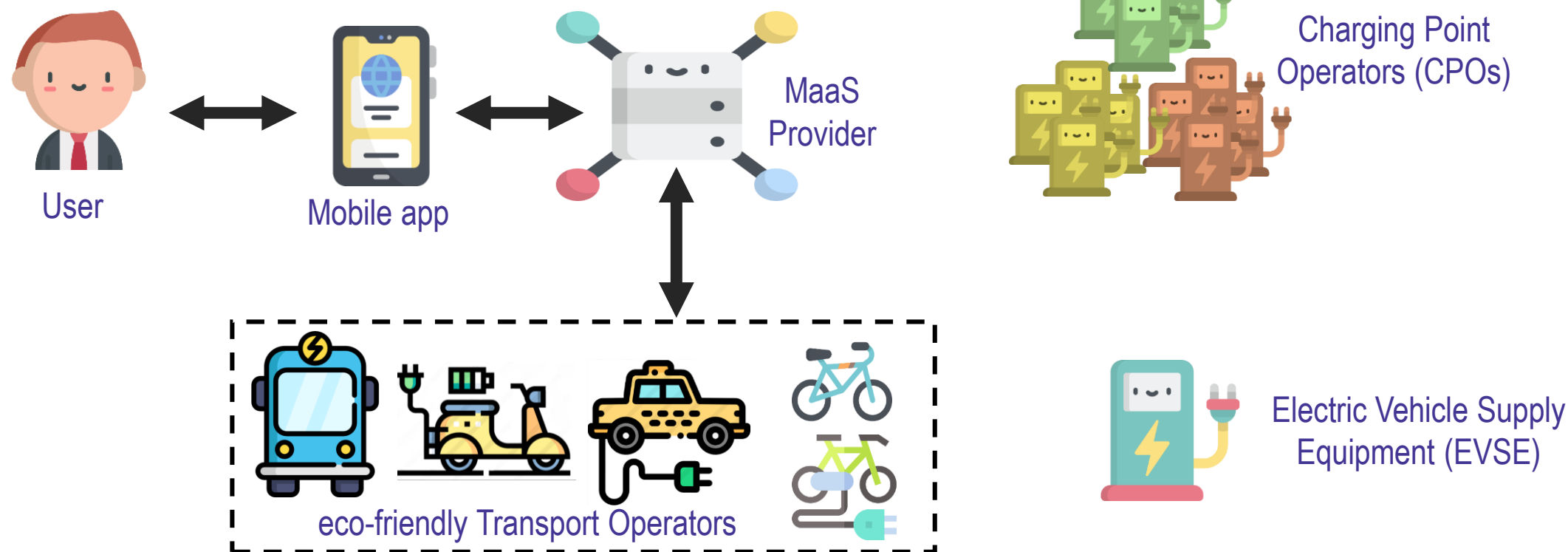
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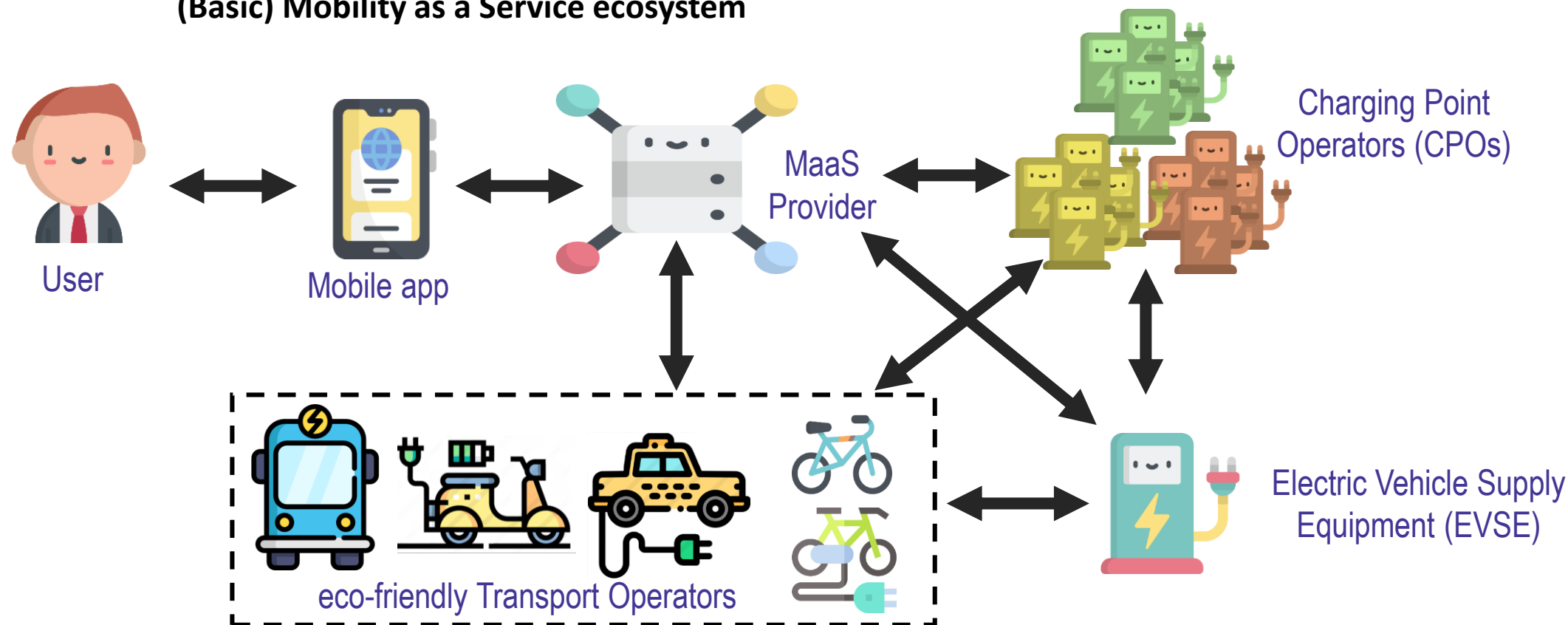
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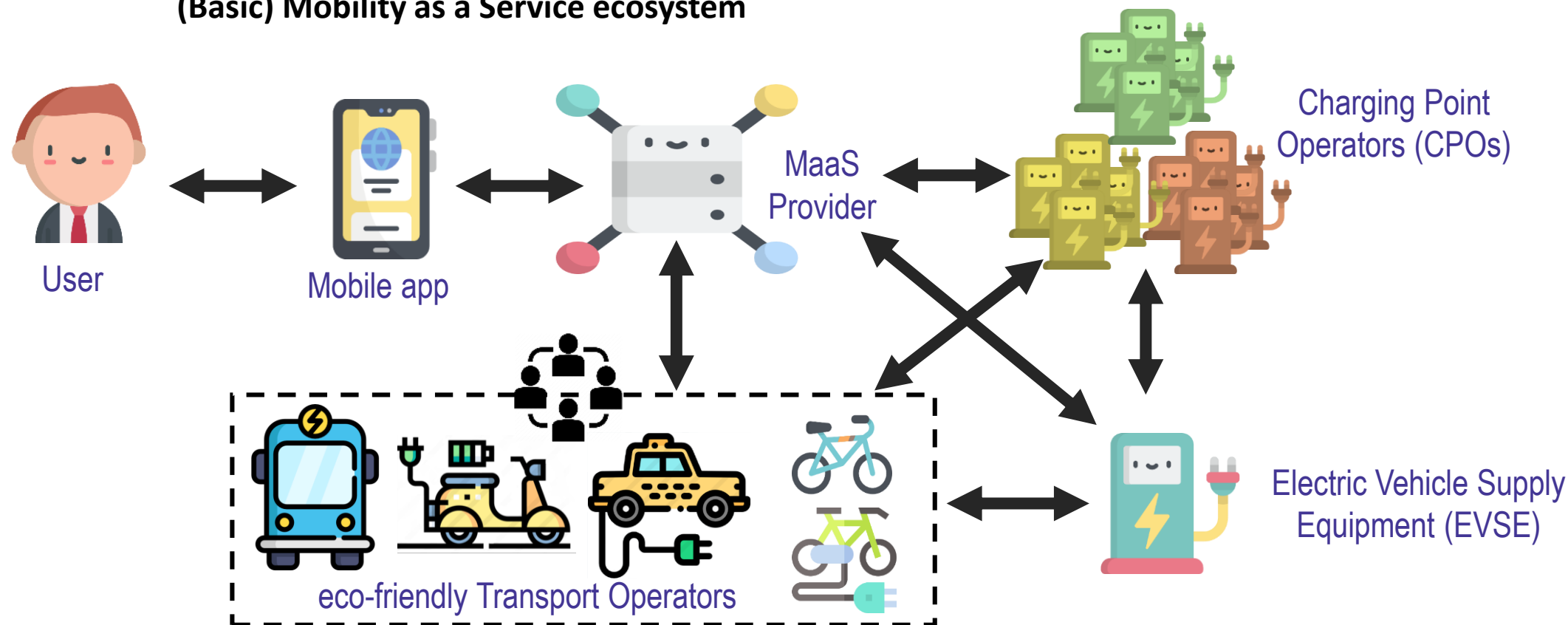
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MaaS vs eMaaS

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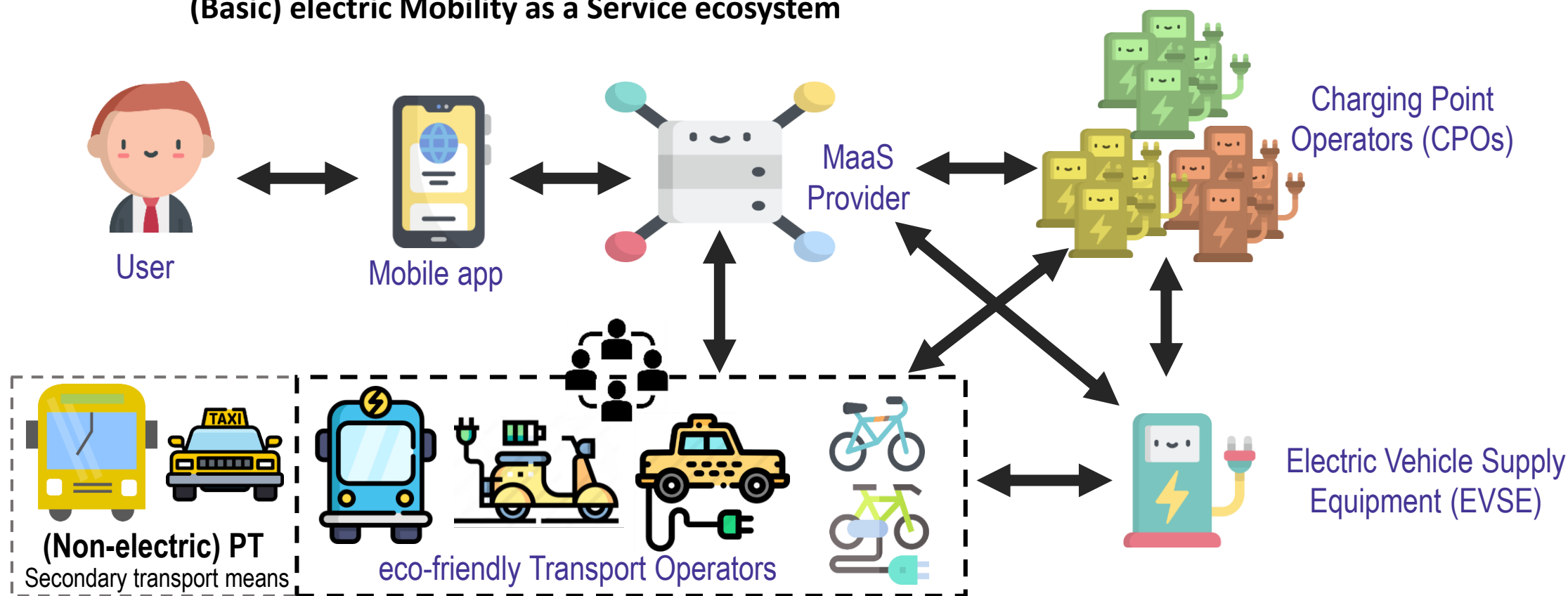
(Basic) Mobility as a Service ecosystem



MaaS vs eMaaS

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(Basic) electric Mobility as a Service ecosystem



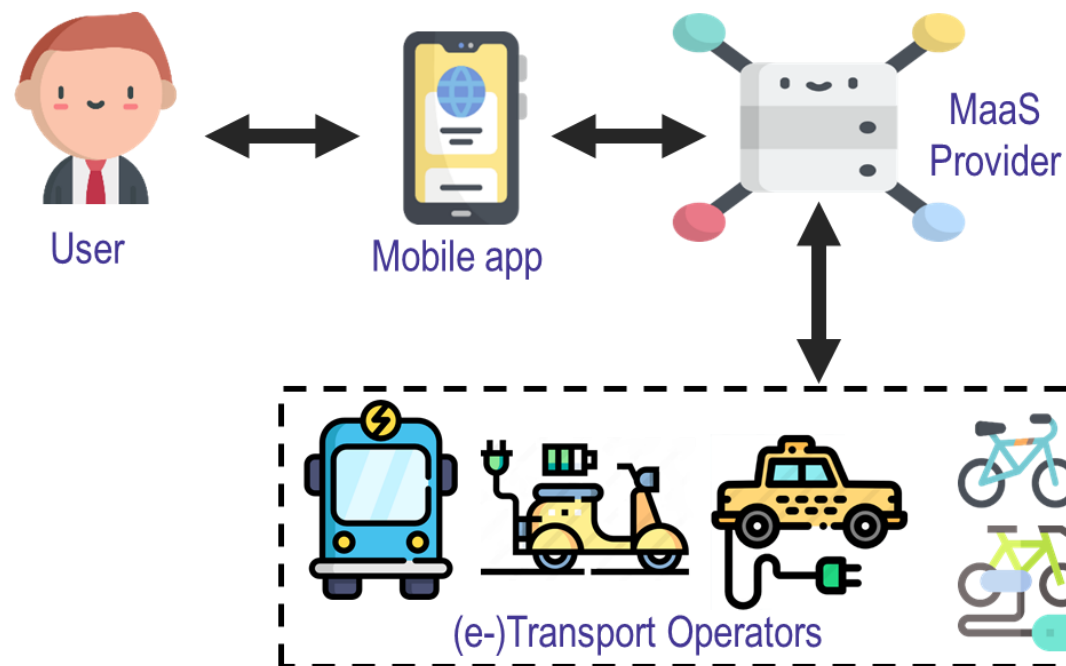
Research questions

1. What are the technical functionalities of Mobility Service Providers?
2. How can the level of integration of the technical functionalities of Mobility Service Providers be determined?
3. What is the Technical Level of Integration of Shared electric Mobility Providers currently operating in the European market?

Research questions

1. What are the technical functionalities of Mobility Service Providers?

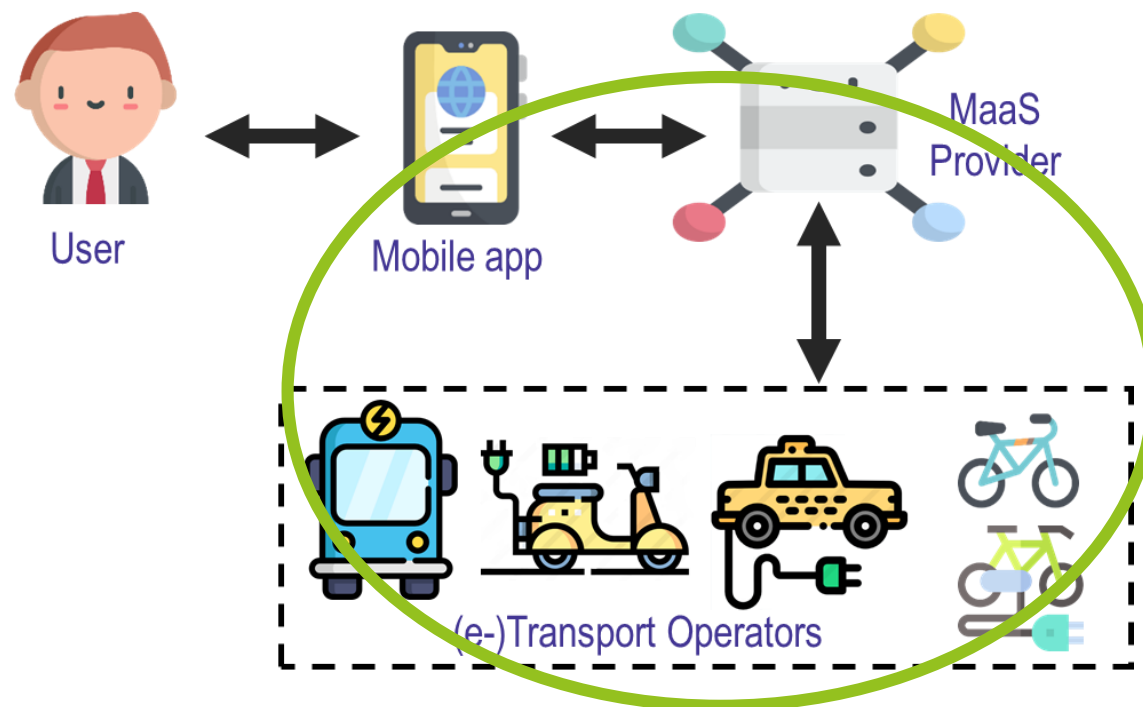
(Basic) (e)Mobility as a Service ecosystem



Research questions

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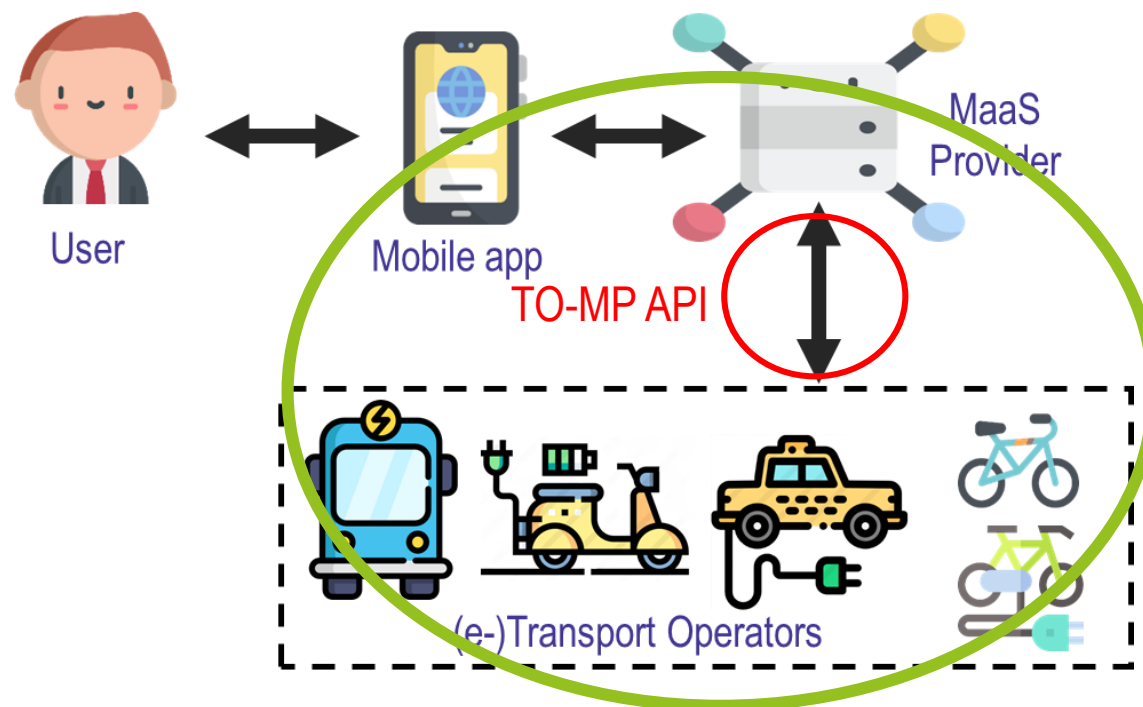
(Basic) (e)Mobility as a Service ecosystem



Research questions

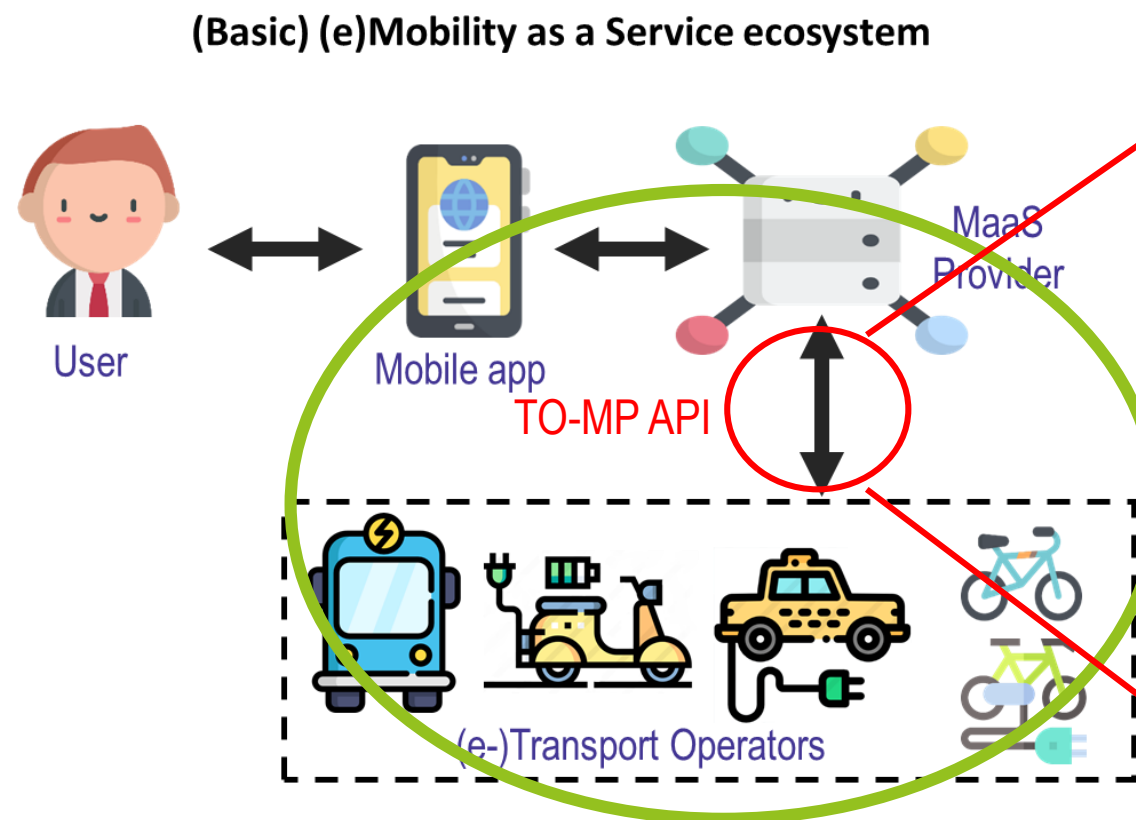
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(Basic) (e)Mobility as a Service ecosystem



Research questions

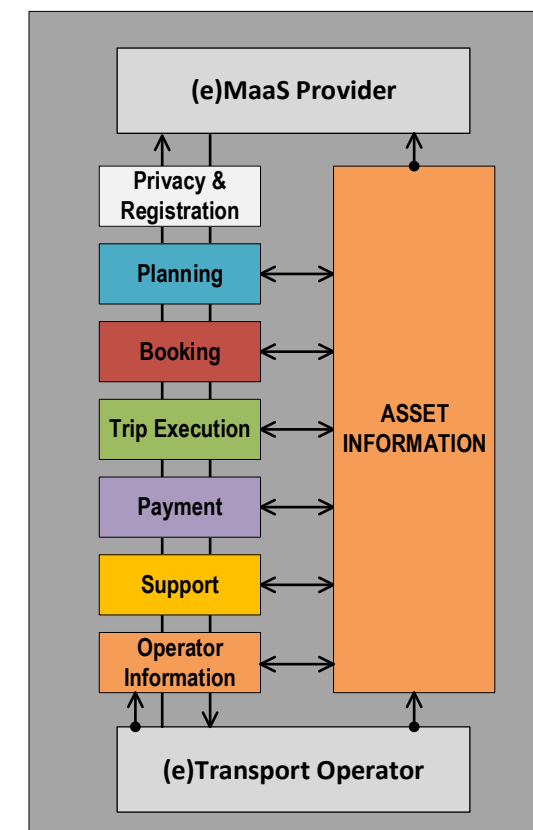
1. What are the technical functionalities of Mobility Service Providers?



* Icons from [flaticon.com](https://www.flaticon.com)

Transport Operator to/from MaaS Provider API

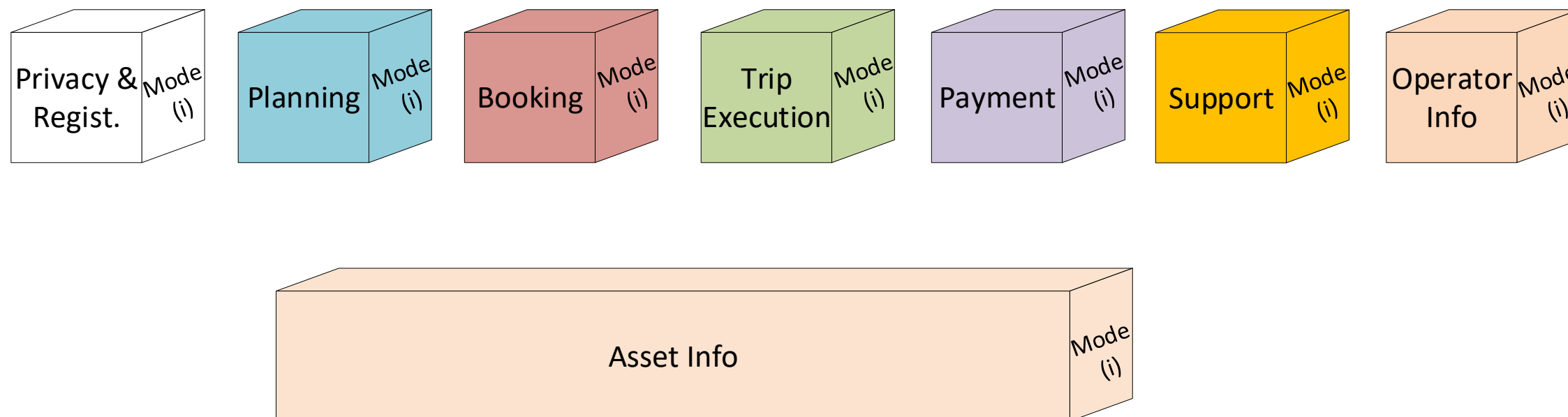
Functional Blocks



Research questions

1. What are the technical functionalities of Mobility Service Providers?

(e)MaaS functional blocks



Research questions

2. How can the level of integration of the technical functionalities of Mobility Service Providers be determined?

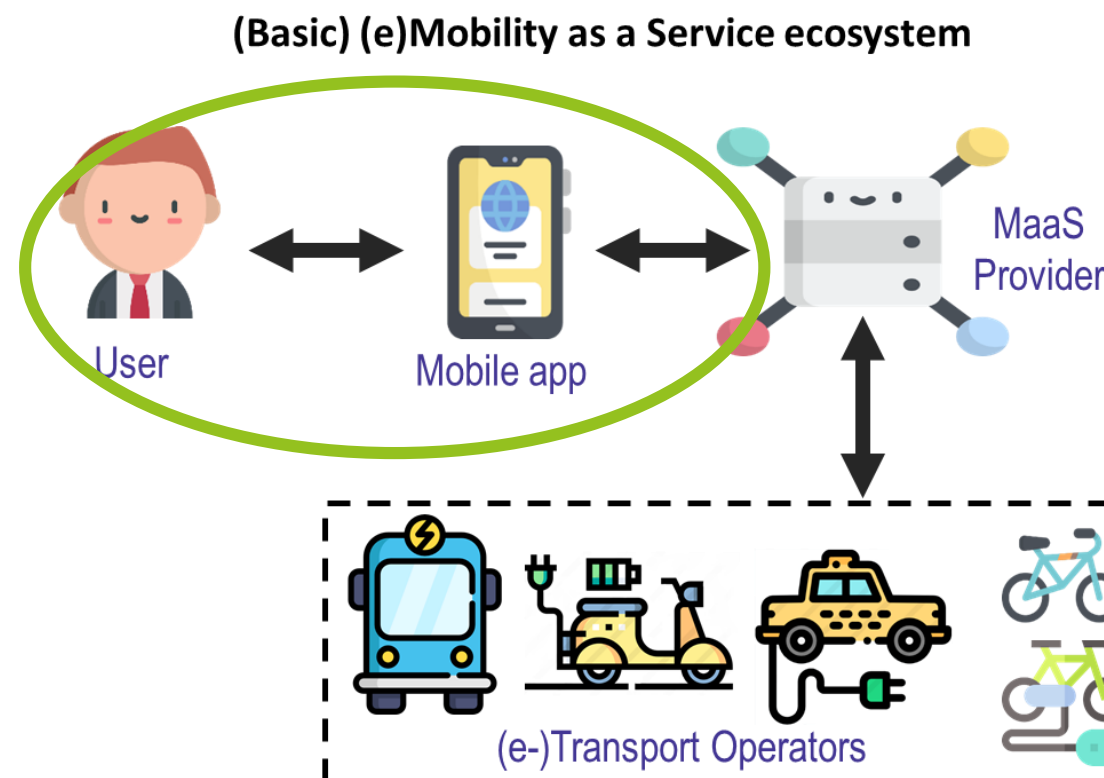
Previous works
on Levels of
Integration

Kamargianni et al. (2016)		Sochor et al. (2018)		Lyons et al. (2019)	
Level	Description	Level	Description	Level	Description
		0	No integration (single, separate services)	0	No integration: no operational, informational or transactional integration across modes
↓	Partial integration (partially possess ticket-, payment- and ICT-integration)	1	Integration of information (centralised information, and/or multimodal travel planners, and/or assistant)	1	Basic integration: informational integration across (some) modes
	Advanced integration (completely possess ticket-, payment-, and ICT-integration)	2	Integration of booking and payment (multimodal trips with single tickets)	2	Limited integration: informational integration across (some) modes with some operational integration and/or transactional integration
	Advanced integration with mobility packages			3	Partial integration: some journeys offer a fully integrated experience
		3	Integration of the service offer (bundled subscription based multimodal mobility service)	4	Full integration under certain conditions: some but not all available modal combinations offer a fully integrated experience
				5	Full integration under all conditions: full operational, informational and transactional integration across modes for all journeys
		4	Integration of societal goals (influencing user behaviour through incentives enabled by dynamic data sharing between transport planning and MaaS operators)		

Research questions

2. How can the level of integration of the technical functionalities of Mobility Service Providers be determined?

Previous works
on Levels of
Integration

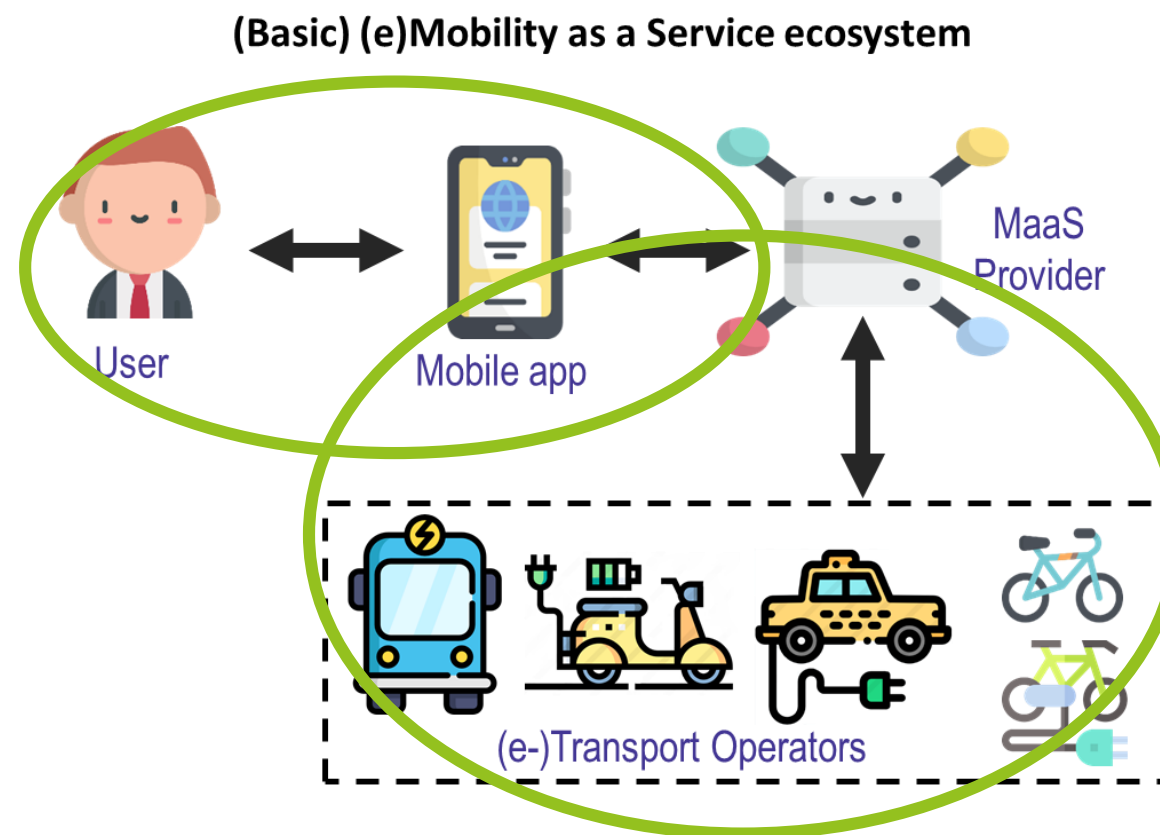


Focus more on the
user perspective, than
on the Mobility Service
Providers perspective

Research questions

2. How can the level of integration of the technical functionalities of Mobility Service Providers be determined?

Previous works
on Levels of
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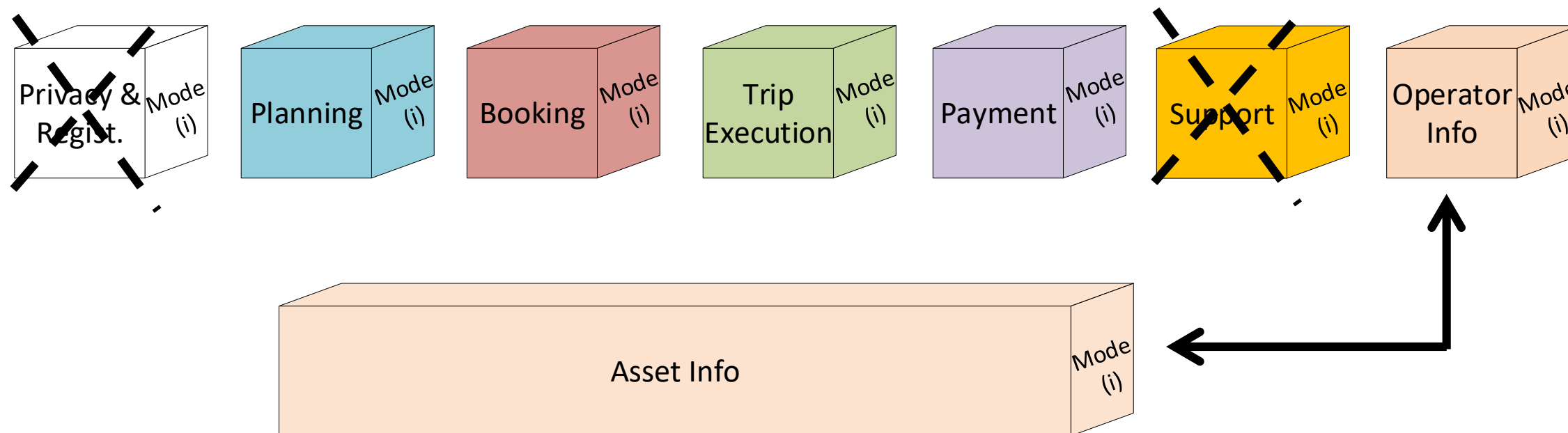


Focus more ~~on the~~
~~user perspective, than~~
on the Mobility Service
Providers perspective

Technical Levels of Integration (TLI) approach

From the Mobility Service Providers perspective

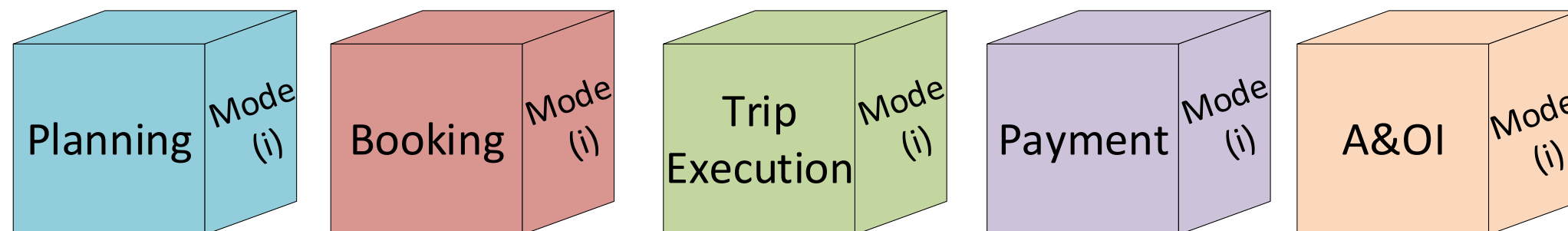
(e)MaaS core functional blocks



Technical Levels of Integration (TLI) approach

From the Mobility Service Providers perspective

(e)MaaS core functional blocks



How can the integration of these functional block be assessed?

The more functions integrated, the higher TLI

TLI approach – 5 levels of integration


Category (Level)
Only A&OI (0)
Low integration (1)
Medium integration (2)
High integration (3)
Full integration (4)




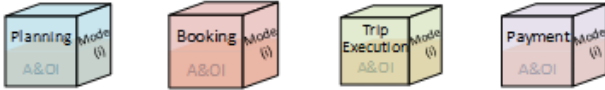
TLI approach – 5 levels of integration

Function Integration	Category (Level)
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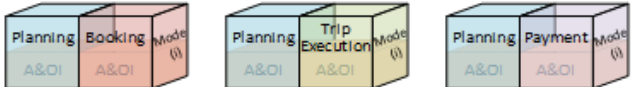
TLI approach – 5 levels of integration

Function Integration	Category (Level)	Technical Levels of Integration including only single modes of transport
<i>Non-integrated functions</i>	Only A&OI (0)	<p>0) Only Asset & Operator Information (A&OI)</p> 
<i>Single-integrated functions</i>	Low integration (1)	
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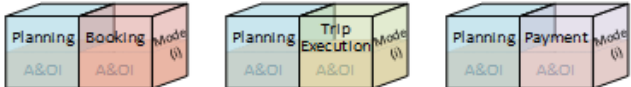

TLI approach – 5 levels of integration

Function Integration	Category (Level)	Technical Levels of Integration including only single modes of transport
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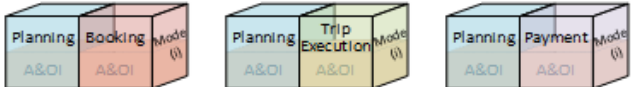


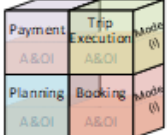
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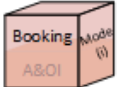

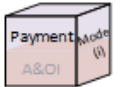
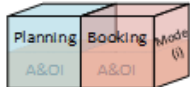
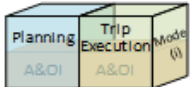
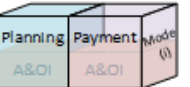
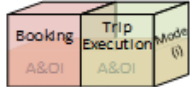

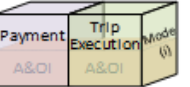





TLI approach – 5 levels of integration

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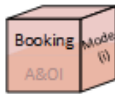

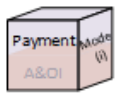




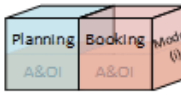



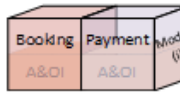




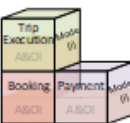

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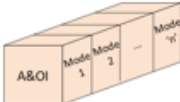








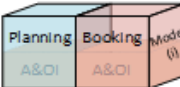
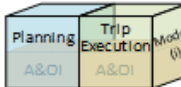

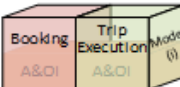


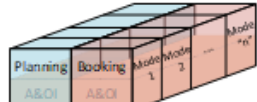
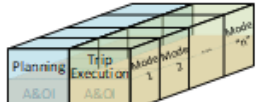





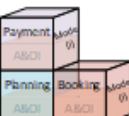

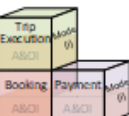
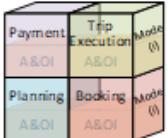
TLI approach – 5 levels of integration

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Four integrated functions	Full integration (4)	4) Planning and Booking and Payment and Trip Execution (Pl+B+P+TE) 	


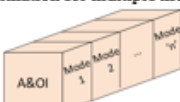

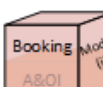







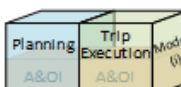

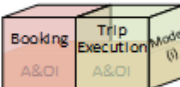





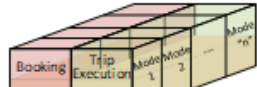

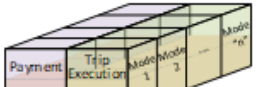
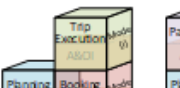
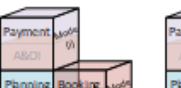
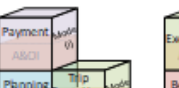
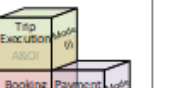






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Non-integrated functions	Only A&OI (0)	0) Only Asset & Operator Information (A&OI) 	0+) Only Asset & Operator Information for multiple modes of transportation (A&OI (M)) 
Single-integrated functions	Low integration (1)	1a) Planning (P)  1b) Booking (B)  1c) Trip Execution (TE)  1d) Payment (P) 	1a+) Planning for multiple modes of transportation (P (M))  1b+) Booking for multiple modes of transportation (B (M))  1c+) TE for multiple modes of transportation (TE (M))  1d+) Payment for multiple modes of transportation (P (M)) 
Two integrated functions	Medium integration (2)	2a) Planning and Booking (P+B)  2b) Planning and Trip Execution (P+TE)  2c) Planning and Payment (P+P)  2d) Booking and Trip Execution (B+TE)  2e) Booking and Payment (B+P)  2f) Payment and Trip Execution (P+TE) 	
Three integrated functions	High integration (3)	3a) Planning & Booking & Trip Execution (P+B+TE)  3b) Planning & Booking & Payment (P+B+P)  3c) Planning & Payment & Trip Execution (P+P+TE)  3d) Booking & Payment & Trip Execution (B+P+TE) 	
Four integrated functions	Full integration (4)	4) Planning and Booking and Payment and Trip Execution (P+B+P+TE) 	

TLI approach – 5 levels of integration

Function Integration	Category (Level)	Technical Levels of Integration including only single modes of transport	Technical Levels of Integration including multiple modes of transport
Non-integrated functions	Only A&OI (0)	0) Only Asset & Operator Information (A&OI) 	0+) Only Asset & Operator Information for multiple modes of transportation (A&OI (M)) 
Single-integrated functions	Low integration (1)	1a) Planning (P)  1b) Booking (B)  1c) Trip Execution (TE)  1d) Payment (P) 	1a+) Planning for multiple modes of transportation (P (M))  1b+) Booking for multiple modes of transportation (B (M))  1c+) TE for multiple modes of transportation (TE (M))  1d+) Payment for multiple modes of transportation (P (M)) 
Two integrated functions	Medium integration (2)	2a) Planning and Booking (P+B)  2b) Planning and Trip Execution (P+TE)  2c) Planning and Payment (P+P)  2d) Booking and Trip Execution (B+TE)  2e) Booking and Payment (B+P)  2f) Payment and Trip Execution (P+TE) 	2a+) Planning and Booking for multiple modes of transportation (P+B) (M)  2b+) Planning and Trip Execution for multiple modes of transportation (P+TE) (M)  2c+) Planning and Payment for multiple modes of transportation (P+P) (M)  2d+) Booking and Trip Execution for multiple modes of transportation (B+TE) (M)  2e+) Booking and Payment for multiple modes of transportation (B+P) (M)  2f+) Payment and Trip Execution for multiple modes of transportation (P+TE) (M) 
Three integrated functions	High integration (3)	3a) Planning & Booking & Trip Execution (P+B+TE)  3b) Planning & Booking & Payment (P+B+P)  3c) Planning & Payment & Trip Execution (P+P+TE)  3d) Booking & Payment & Trip Execution (B+P+TE) 	
Four integrated functions	Full integration (4)	4) Planning and Booking and Payment and Trip Execution (P+B+P+TE) 	

TLI approach – 5 levels of integration

Function Integration	Category (Level)	Technical Levels of Integration including only single modes of transport	Technical Levels of Integration including multiple modes of transport
Non-integrated functions	Only A&OI (0)	0) Only Asset & Operator Information (A&OI) 	0+) Only Asset & Operator Information for multiple modes of transportation (A&OI (M)) 
Single-integrated functions	Low integration (1)	1a) Planning (Pl)  1b) Booking (B)  1c) Trip Execution (TE)  1d) Payment (P) 	1a+) Planning for multiple modes of transportation (Pl (M))  1b+) Booking for multiple modes of transportation (B (M))  1c+) TE for multiple modes of transportation (TE (M))  1d+) Payment for multiple modes of transportation (P (M)) 
Two integrated functions	Medium integration (2)	2a) Planning and Booking (Pl+B)  2b) Planning and Trip Execution (Pl+TE)  2c) Planning and Payment (Pl+P)  2d) Booking and Trip Execution (B+TE)  2e) Booking and Payment (B+P)  2f) Payment and Trip Execution (P+TE) 	2a+) Planning and Booking for multiple modes of transportation (Pl+B) (M)  2b+) Planning and Trip Execution for multiple modes of transportation (Pl+TE) (M)  2c+) Planning and Payment for multiple modes of transportation (Pl+P) (M)  2d+) Booking and Trip Execution for multiple modes of transportation (B+TE) (M)  2e+) Booking and Payment for multiple modes of transportation (B+P) (M)  2f+) Payment and Trip Execution for multiple modes of transportation (P+TE) (M) 
Three integrated functions	High integration (3)	3a) Planning & Booking & Trip Execution (Pl+B+TE)  3b) Planning & Booking & Payment (Pl+B+P)  3c) Planning & Payment & Trip Execution (Pl+P+TE)  3d) Booking & Payment & Trip Execution (B+P+TE) 	3a+) Planning & Booking & Trip Execution for multiple modes of transportation (Pl+B+TE) (M)  3b+) Planning & Booking & Payment for multiple modes of transportation (Pl+B+P) (M)  3c+) Planning & Payment & Trip Execution for multiple modes of transportation (Pl+P+TE) (M)  3d+) Booking & Payment & Trip Execution for multiple modes of transportation (B+P+TE) (M) 
Four integrated functions	Full integration (4)	4) Planning and Booking and Payment and Trip Execution (Pl+B+P+TE) 	4+) Planning and Booking and Payment and Trip Execution for multiple modes of transportation (Pl+B+P+TE) (M) 

TLI approach application

3. What is the Technical Level of Integration of Shared electric Mobility Providers currently operating in the European market?

Previous research
on European
SeMPs

Rethinking transport

27–30 April 2020



Proceedings of 8th Transport Research Arena TRA 2020, April 27-30, 2020, Helsinki, Finland

Business models in the shared electric mobility field: A market overview towards electric Mobility as a Service (eMaaS)

J. Roberto Reyes García^{a*}, Steven Haveman^a, Marlise W. Westerhof^a, G. Maarten Bonnema^a

^aUniversity of Twente, Drienerlolaan 5, 7522 NB, Enschede, The Netherlands

TLI approach application

3. What is the Technical Level of Integration of Shared electric Mobility Providers currently operating in the European market?

136 European Shared electric Mobility Providers

Previous research on European SeMPs

Rethinking transport
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Micro (e-)mobility sharing



Multi Transport Integrators



(e-)car sharing



Multimodal Trip Planners



TLI approach application

3. What is the Technical Level of Integration of Shared electric Mobility Providers currently operating in the European market?

Function Integration	Category (Level)	Technical Levels of Integration including only single modes of transport	Technical Levels of Integration including multiple modes of transport
Non-integrated functions	Only A&OI (0)	0) Only Asset & Operator Information (A&OI)	0+) Only Asset & Operator Information for multiple modes of transportation (A&OI (M))
Single-integrated functions	Low integration (1)	1a) Planning (P) 1b) Booking (B) 1c) Trip Execution (TE) 1d) Payment (P)	1a+) Planning for multiple modes of transportation (P (M)) 1b+) Booking for multiple modes of transportation (B (M)) 1c+) TE for multiple modes of transportation (TE (M)) 1d+) Payment for multiple modes of transportation (P (M))
Two integrated functions	Medium integration (2)	2a) Planning and Booking (P+B) 2b) Planning and Trip Execution (P+TE) 2c) Planning and Payment (P+P)	2a+) Planning and Booking for multiple modes of transportation (P+B (M)) 2b+) Planning and Trip Execution for multiple modes of transportation (P+TE (M)) 2c+) Planning and Payment for multiple modes of transportation (P+P (M))
Three integrated functions	High integration (3)	3a) Planning & Booking & Trip Execution (P+B+TE) 3b) Planning & Booking & Payment (P+B+P) 3c) Planning & Payment & Trip Execution (P+P+TE) 3d) Booking & Payment & Trip Execution (B+P+TE)	3a+) Planning & Booking & Trip Execution for multiple modes of transportation (P+B+TE (M)) 3b+) Planning & Booking & Payment for multiple modes of transportation (P+B+P (M)) 3c+) Planning & Payment & Trip Execution for multiple modes of transportation (P+P+TE (M)) 3d+) Booking & Payment & Trip Execution for multiple modes of transportation (B+P+TE (M))
Four integrated functions	Full integration (4)	4) Planning and Booking and Payment and Trip Execution (P+B+P+TE)	4+) Planning and Booking and Payment and Trip Execution for multiple modes of transportation (P+B+P+TE (M))



128 European Shared electric Mobility Providers

Micro (e-)mobility sharing



Multi Transport Integrators



(e-)car sharing



Multimodal Trip Planners



Results – Overview

Technical Level of Integration (TLI) of European Shared electric Mobility Providers (SeMPs)

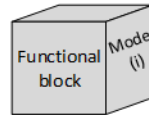
*Only A&OI**

*Non-integrated
functions*



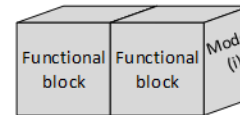
Low Integration

*Single-integrated
functions*



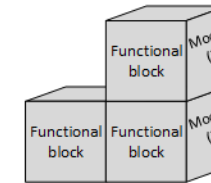
Medium Integration

*Two integrated
functions*



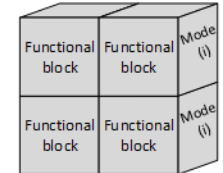
High Integration

Three integrated functions



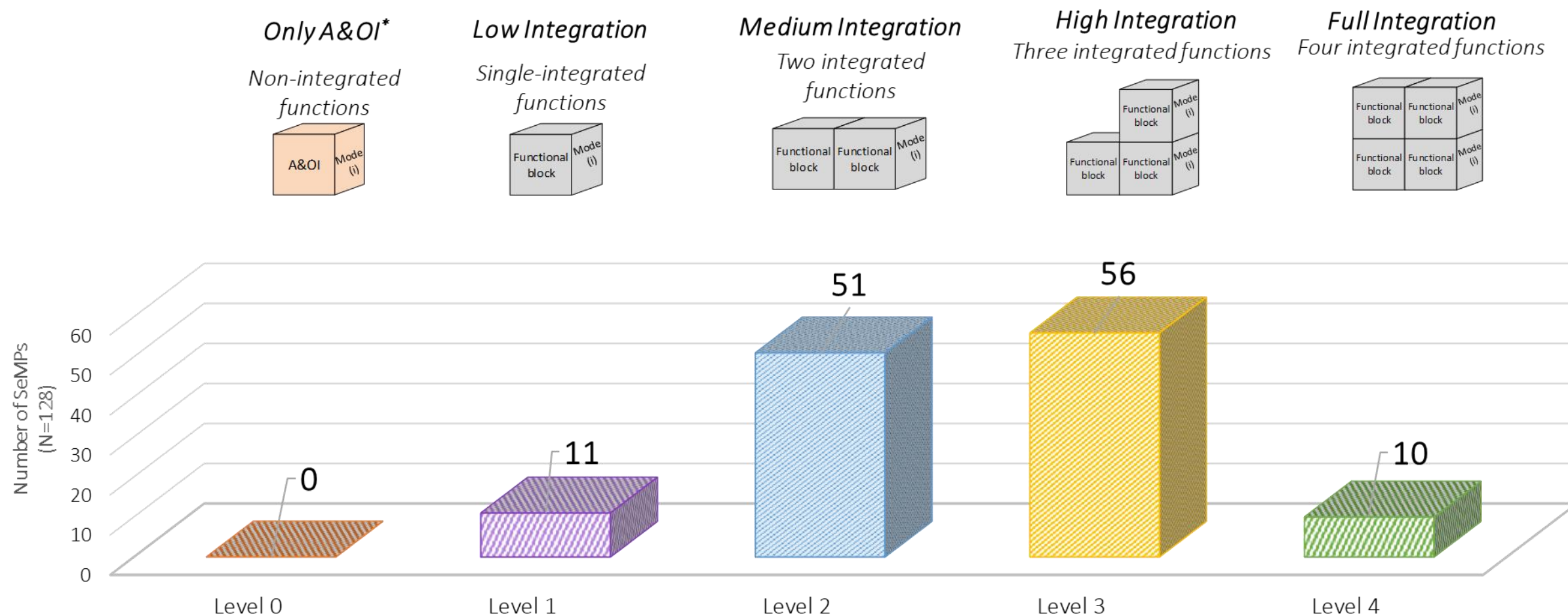
Full Integration

Four integrated functions



Results – Overview

Technical Level of Integration (TLI) of European Shared electric Mobility Providers (SeMPs)



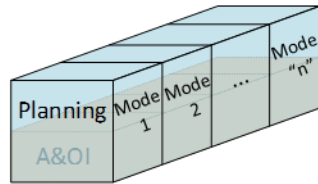
Results – Level 1

SeMPs with a Low Technical Level of Integration

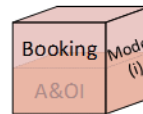
Results – Level 1

SeMPs with a Low Technical Level of Integration

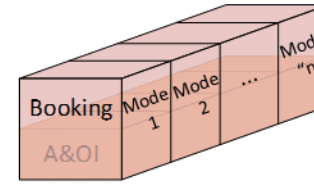
Planning (M)



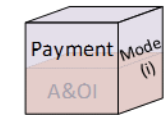
Booking



Booking (M)



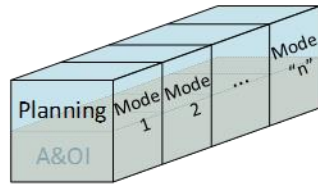
Payment



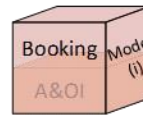
Results – Level 1

SeMPs with a Low Technical Level of Integration

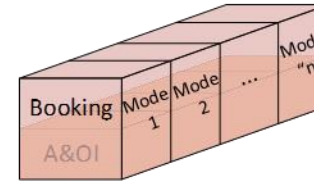
Planning (M)



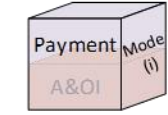
Booking



Booking (M)

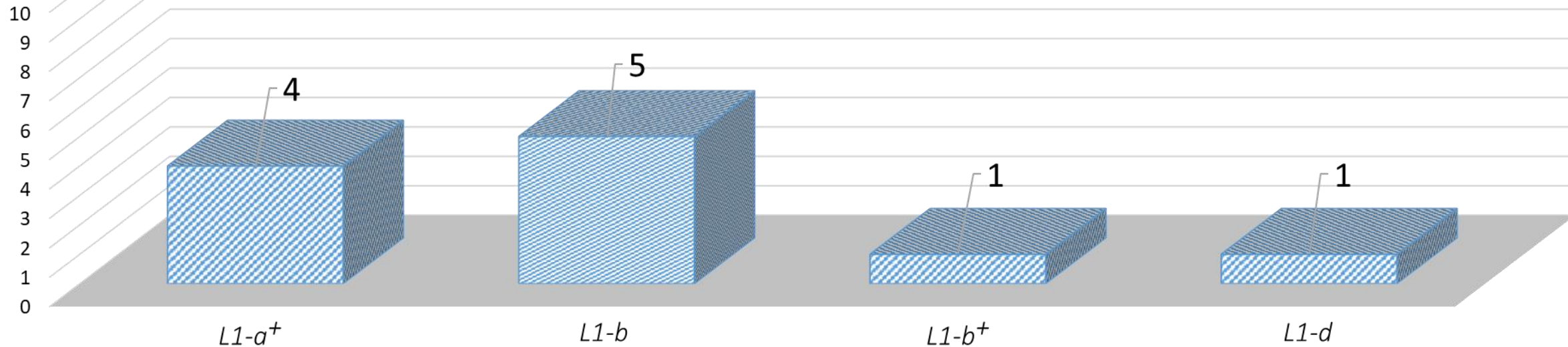


Payment



Number of SeMPs

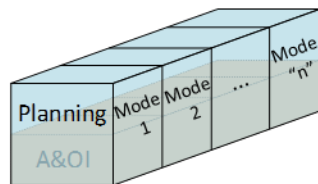
($N_{Total}=128$)
($N_{Partial}=12$)



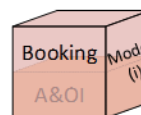
Results – Level 1 – Examples

SeMPs with a Low Technical Level of Integration

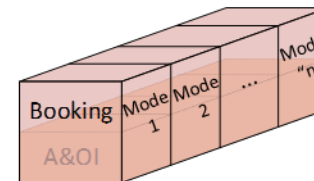
Planning (M)



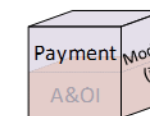
Booking



Booking (M)



Payment

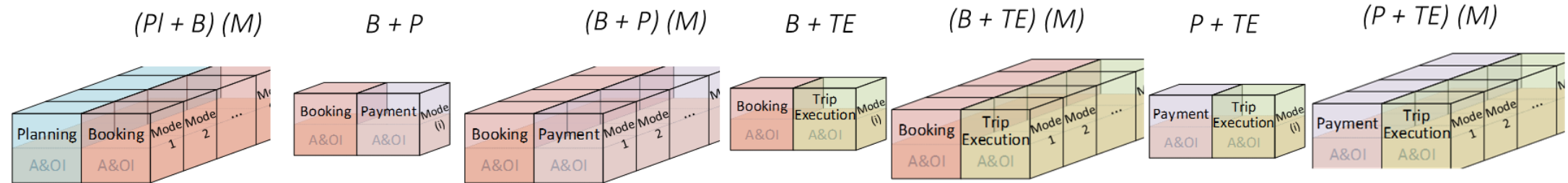


Results – Level 2

SeMPs with a Medium Technical Level of Integration

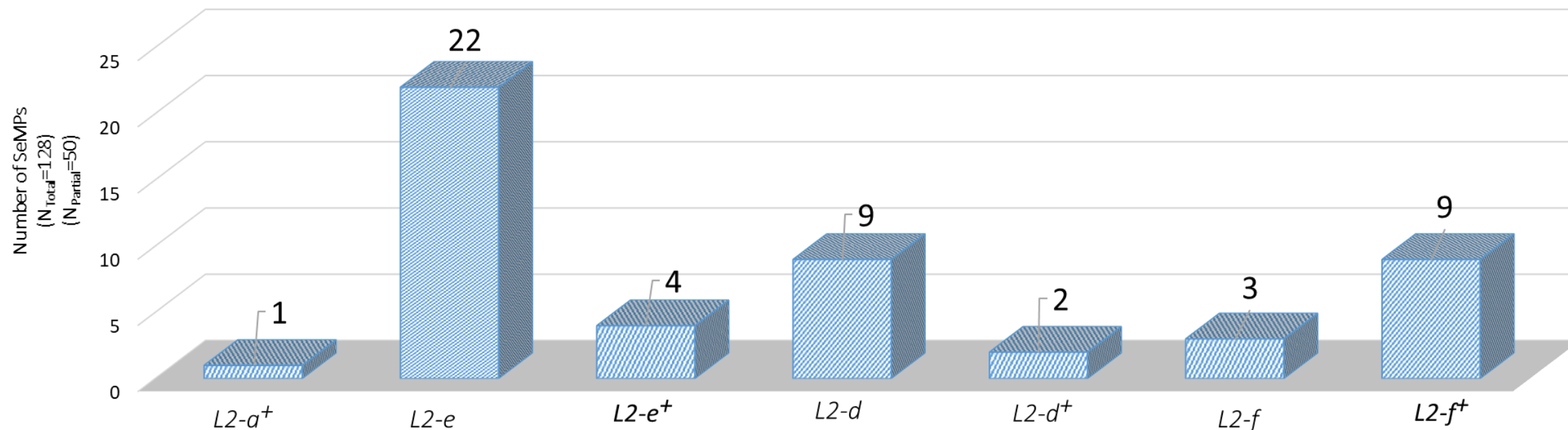
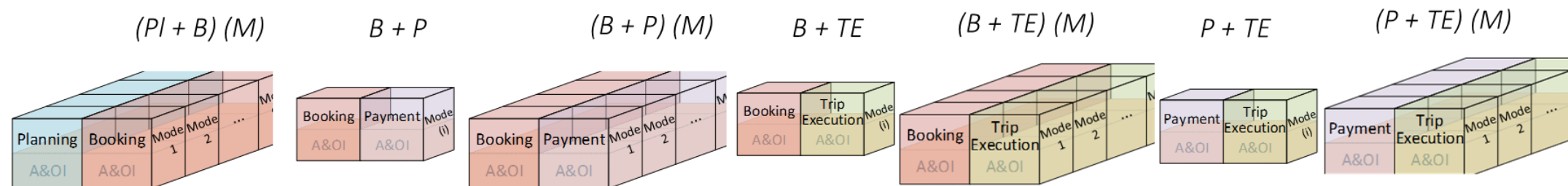
Results – Level 2

SeMPs with a Medium Technical Level of Integration



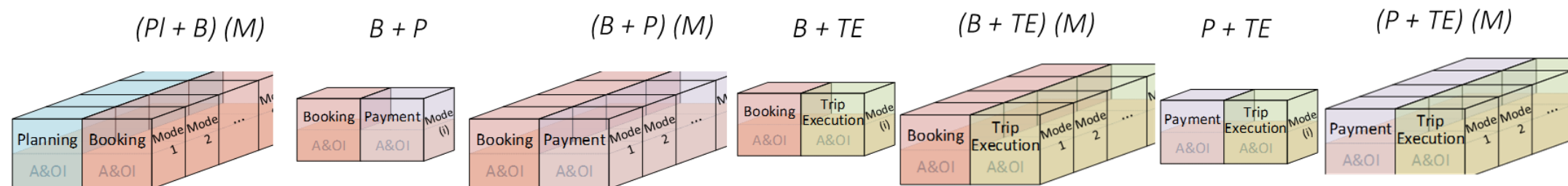
Results – Level 2

SeMPs with a Medium Technical Level of Integration



Results – Level 2 – Examples

SeMPs with a Medium Technical Level of Integration

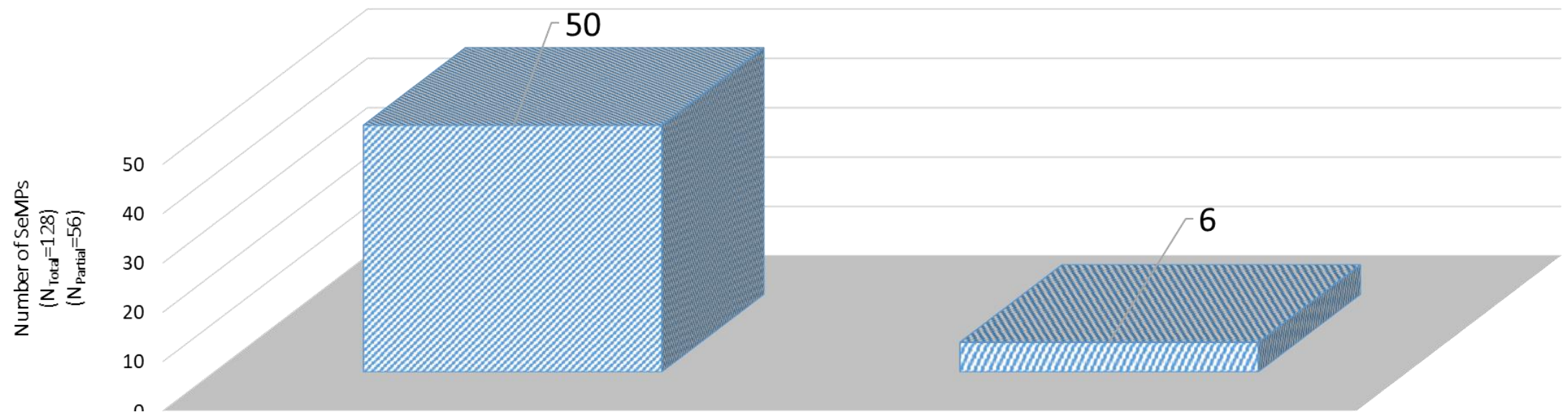


Results – Level 3

SeMPs with a High Technical Level of Integration

Results – Level 3

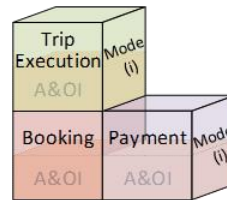
SeMPs with a High Technical Level of Integration



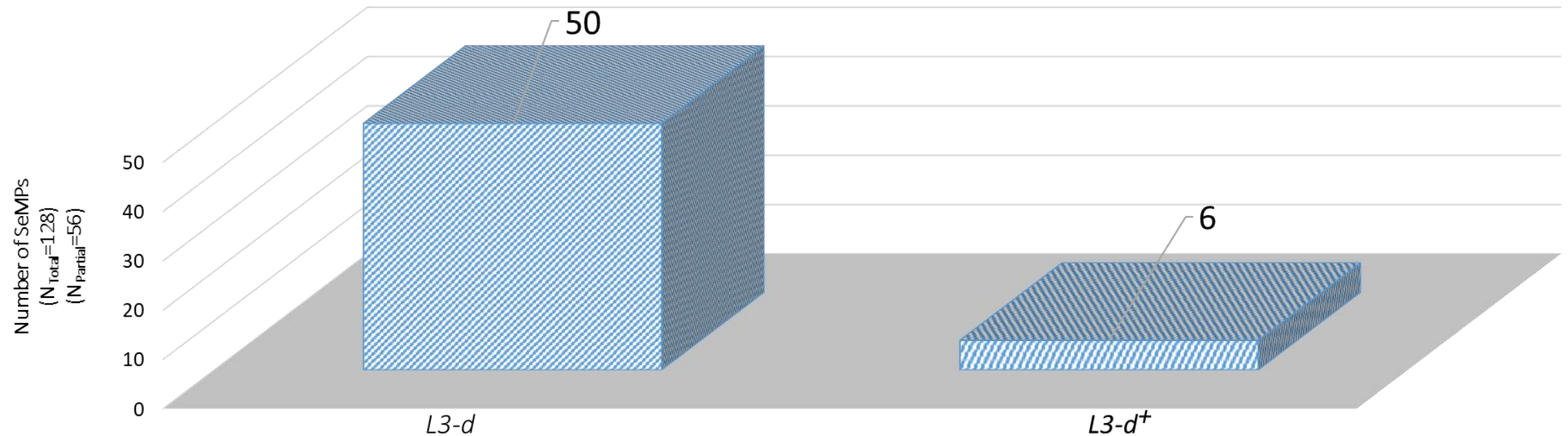
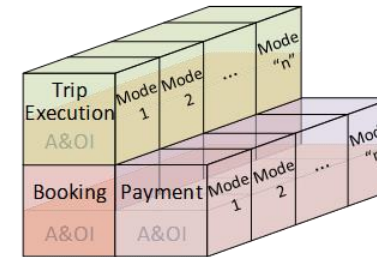
Results – Level 3

SeMPs with a High Technical Level of Integration

$B + P + TE$



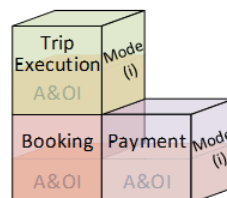
$(B + P + TE) (M)$



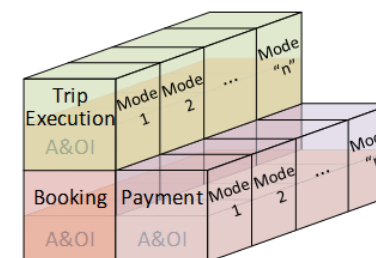
Results – Level 3 – Examples

SeMPs with a High Technical Level of Integration

$$B + P + TE$$



$$(B + P + TE) (M)$$



hiyacar



Nabobil
by getaround

Lime

UFO
DRIVE

BIRD

mywheels | sinds 1993

yélo

Cityscoot

aimo

goUrban

OLYMPUS

MOL LIMO

COUP

blinkee.city

JUMP

SeMPs with a Full Technical Level of Integration

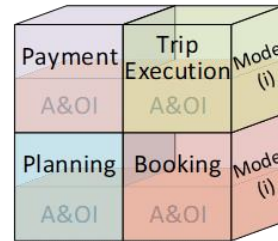
Payment	Trip Execution	Mode (i)
A&OI	A&OI	
Planning	Booking	Mode (ii)
A&OI	A&OI	

Payment	Trip Execution	Mode 1	Mode 2	...	Mode "n"
A&OI	A&OI				
Planning	Booking	Mode 1	Mode 2	...	Mode "n"
A&OI	A&OI				

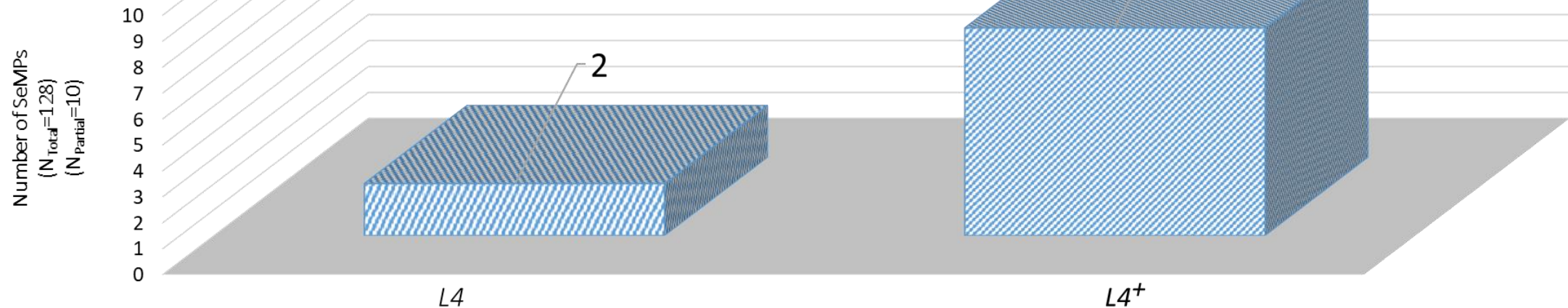
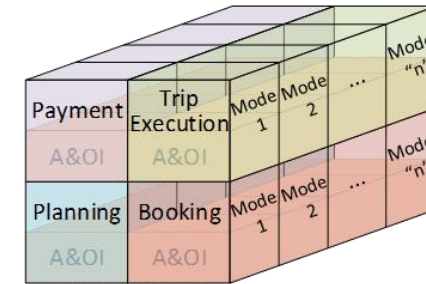
Results – Level 4

SeMPs with a Full Technical Level of Integration

$PI \ B + P + TE$

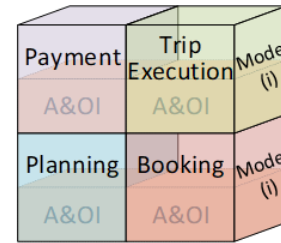


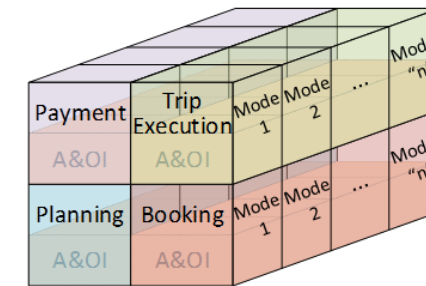
$(PI + B + P + TE) \ (M)$



Results – Level 4 – Examples

SeMPs with a Full Technical Level of Integration

$$PI + B + P + TE$$


$$(PI + B + P + TE) (M)$$


Remarks

- Although for eMaaS public transport is considered as a secondary means of transportation, PTOs are clearly leading the technical level of integration of (e)MaaS functionalities
- Because multimodal integration does not mean an extra functionality *per se*, in the TLI approach, multimodal offer does not mean a higher level in the scale
- Many SeMPs have more than one interface. Only the ones with more integrated functions were accounted for the results
- Some SeMPs have integrated multimodal capabilities but only for certain functions, in that case, the TLI does not offer a direct way to evaluate them. In this study,
 - 1) if most of the functionalities (>50%) are integrated for multiple modes of transport or multiple MSPs, then the MSP would be classified as if it would have all multimodal functions integrated
 - 2) if 50% (or less) of the functionalities are integrated for multiple modes of transport or multiple MSPs, then the MSP would be classified as if it would not have any multimodal functions integrated

Conclusions

1. The TLI approach offers an effective method to determine and easily visualize the level of integration of the technical functionalities of MSPs
2. The current state of the European Shared Electric Mobility (SEM) market already includes MSPs with a high- or even a full-level of integration with respect to their technical (e)MaaS functionalities
3. Integration for multiple modes of transportation is still lacking among most European SeMPs but the higher the TLI, the easier the integration of more transportation modes will be. Therefore, in order to become eMaaS players, MSPs should put more efforts on integrating as much functionalities as possible

Thank you for your attention!

Any questions?

Contact:

Roberto Reyes – j.r.reyesgarcia@utwente.nl

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