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Gerpisa
THE INTERNATIONAL NETWORK OF THE AUTOMOBILE

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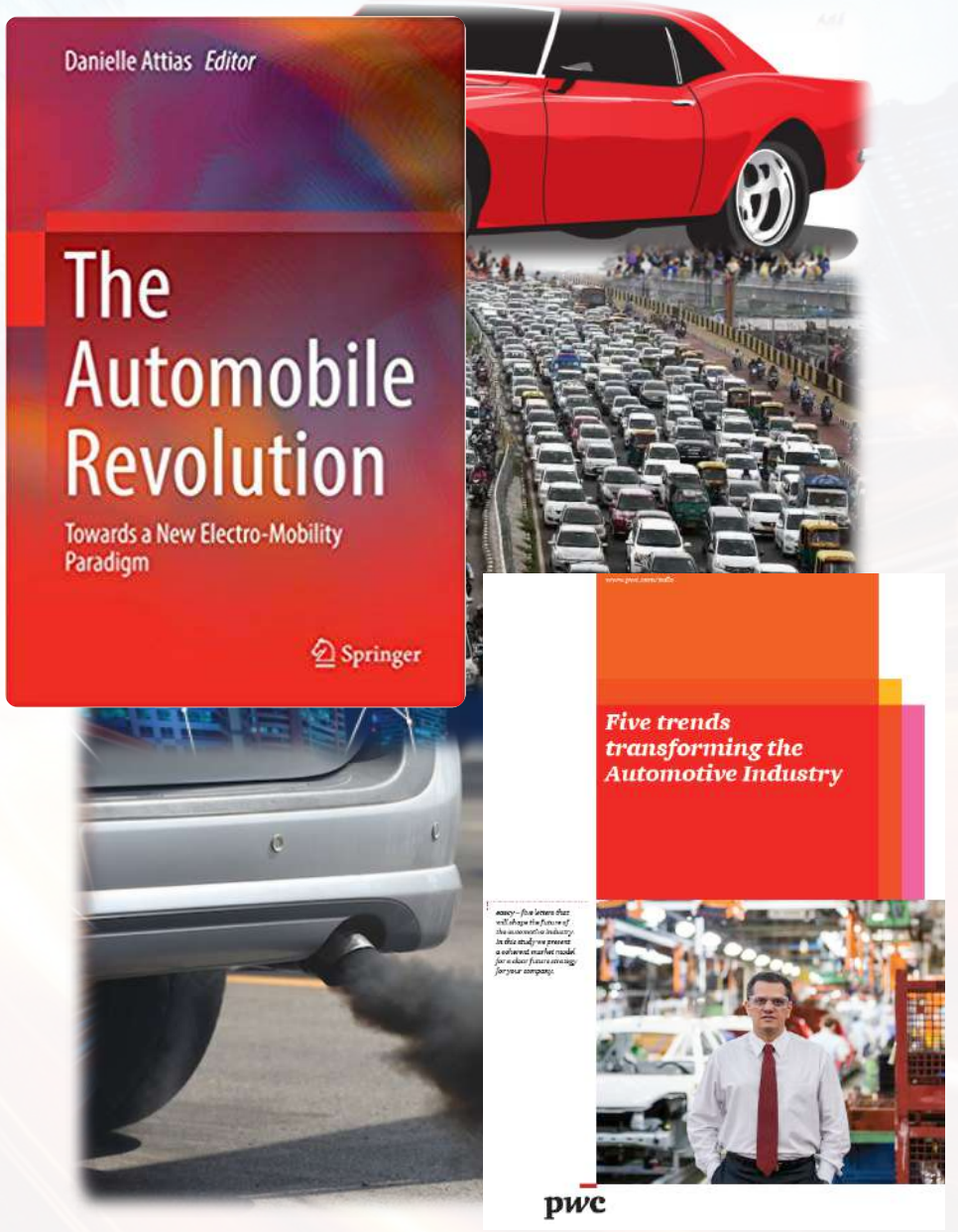
International benchmark on experimentations with Autonomous Shuttles for Collective Transport

Fabio ANTONIALLI


INTRODUCTION

Research context

- More than ½ of world's population living in urban areas...
  - Mobility → key factor affecting citizens well-being;
- Current mobility paradigm:
  - Reaching its environmental, economical and social limits.
- Mobility is on a verge of a revolution:
  - On-demand mobility, autonomous driving, dynamic pricing and electrification → change the way people commute.
  - Vehicles will be: E A S C Y



Research context

- However…
  - Fleets of autonomous cars → likely not be seen on roads right away.

- AVs may firstly be authorized for collective transportation:
  - Offering first- and last-mile solutions and on-demand microtransit commute.

Research aim

Perform a worldwide benchmark on the experimentations with Autonomous Shuttles for Collective Transport.


RESEARCH
METHODS

Research design

- Quali/quanti exploratory study.
- Starting point for experimentations' query:
  - Charlet & Chaufrein (2017);
  - Hottentot, Meines & Pinckaers (2015);
  - Mira-Bonnardel & Attias (2018).
- Snow-ball sampling technique and saturation criteria:
  - Data collection on academic and grey literature;
  - Structured and non-structured data;
  - On-line query: September 2018;
  - Validation with the Atlas for AVs (Aspen Institute).

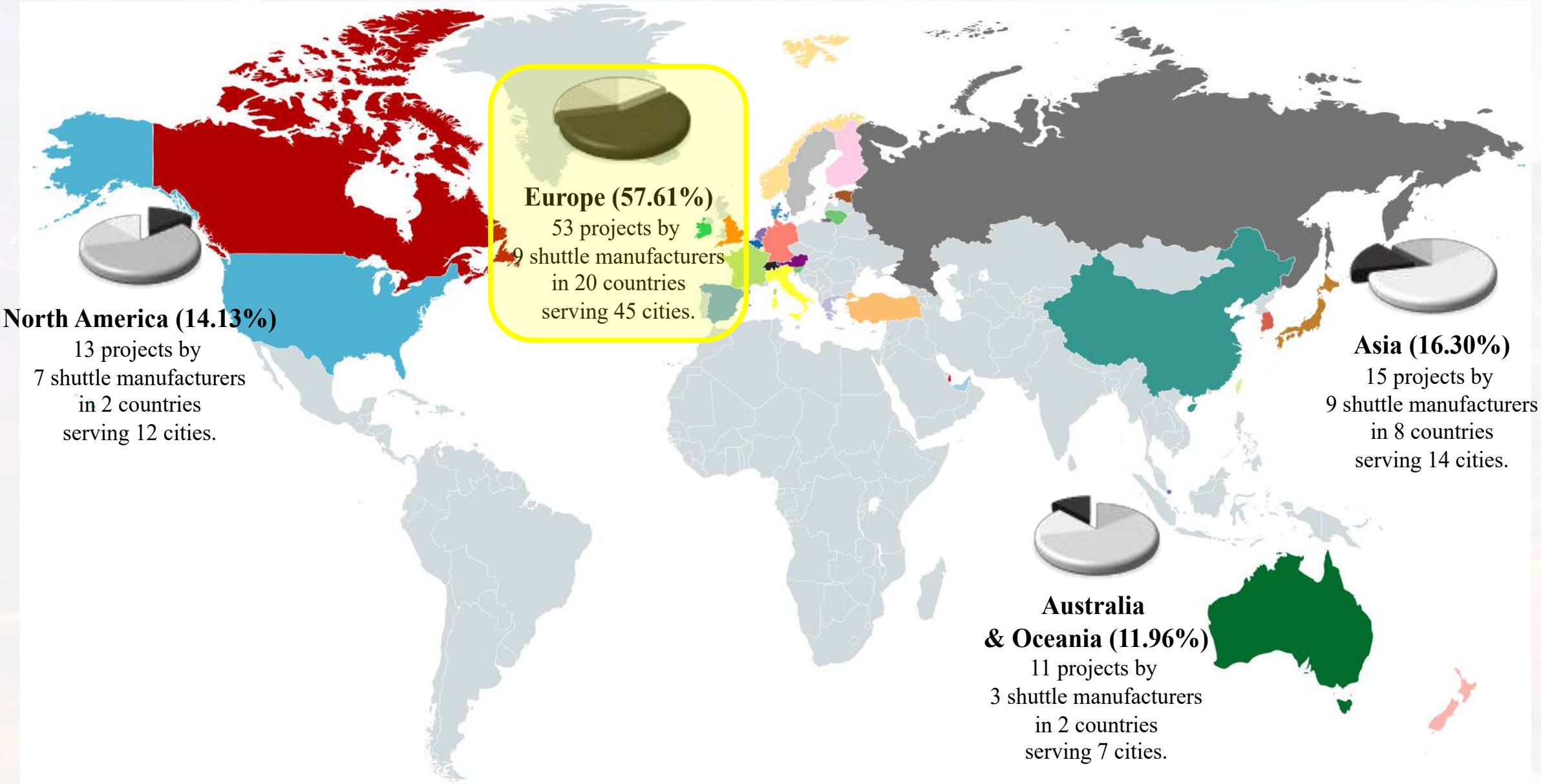
- Research corpus:
  - 92 experimentations.
- Driverless cars (up to 5 passengers) and AVs for cargo transport were not considered in the study.

RESULTS & DISCUSSION

Overall results

- From the 92 experimentations:
  - 50 finished
  - 31 running
  - 11 yet to start

- Projects unfold in:
  - 78 cities on
  - 32 countries
  - Enabled by 20 shuttle manufacturers


Europe (57.61%)
53 projects by
9 shuttle manufacturers
in 20 countries
serving 45 cities.
North America (14.13%)
13 projects by
7 shuttle manufacturers
in 2 countries
serving 12 cities.
Asia (16.30%)
15 projects by
9 shuttle manufacturers
in 8 countries
serving 14 cities.
Australia
& Oceania (11.96%)
11 projects by
3 shuttle manufacturers
in 2 countries
serving 7 cities.
Australia
Austria
Belgium
Canada
China
Denmark
England
Estonia
Finland
France
Germany
Greece
Ireland
Italy
Japan
Lithuania
Luxembourg
Netherlands
New Zealand
Norway
Qatar
Russia
Singapore
Slovenia
South Korea
Spain
Sweden
Switzerland
Taiwan
Turkey
United Emirates
United States

European lead in experimentations

	City	Country	Num. of projects	Total
1	Salzburg	Austria	1	2
2	Vienna		1	
3	Brussels	Belgium	1	2
4	Han-sur-Lesse		1	
5	Aalborg	Denmark	1	2
6	Copenhagen		1	
7	London	England	3	3
8	Tallinn	Estonia	1	1
9	Espoo	Finland	1	5
10	Helsinki		2	
11	Tamper		1	
12	Vantaa		1	
13	Civaux	France	1	8
14	La Rochelle		1	
15	Lyon		1	
16	Paris		4	
17	Sophia Antipolis		1	
18	Bad Birnbach	Germany	1	7
19	Berlin		1	
20	Enge-Sande		1	
21	Frankfurt		2	
22	Hamburg			
23	Lahr		1	
			1	

	City	Country	Num. of projects	Total
24	Trikala	Greece	1	1
25	Dublin	Ireland	1	1
26	Oristano	Italy	1	1
27	Vilnius	Lithuania	1	1
28	Luxembourg	Luxembourg	1	1
29	Amsterdam	Netherlands	1	4
30	Delft		1	
31	Rotterdam		1	
32	Wageningen		1	
33	Kongsberg	Norway	1	3
34	Olso		1	
35	Stavanger		1	
36	Russia	Kazan	1	1
37	Ljubljana	Slovenia	1	1
38	San Sebastian	Spain	1	2
39	Talavera de la Reina		1	
40	Stockholm	Sweden	1	1
41	Fribourg	Switzerland	1	6
42	Geneva		1	
43	Lausanne		1	
44	Neuhausen Rheinfall		1	
45	Sion		1	
46	Zug		1	

European lead in manufacturing

	Shuttle provider	Shuttle name	Continent of origin	Country of origin	Experimentations				
					Finished	Running	Yet to start	Sum	Total by continent
1	Shenzhen Haylion Tech.	n/a	Asia	China	0	1	0	**1**	5
2	Yutong	n/a			1	0	0	**1**	
3	Hino Motors	n/a		Japan	0	0	1	**1**	
4	AICT	n/a		South Korea	0	1	0	**1**	
5	IETT	n/a		Turkey	0	0	1	**1**	
6	Westfield	Harry	Europe	England	1	0	0	**1**	80
7	Ultra Global PRT	HeatrowPods			0	1	0	**1**	
8	***EasyMile***	***EZ10***		France	***26***	***7***	***1***	***34***	
9	***Navya***	***Arma***			***13***	***16***	***2***	***31***	
10	Lohr	i-Cristal			0	0	1	**1**	
11	Robosoft	n/a			4	0	0	**4**	
12	IAV	n/a		Germany	0	0	1	**1**	
13	2getthere	Parkshuttle		Netherlands	1	2	3	**6**	
14	Kamaz	Kamar 1221 Shatl		Russia	1	0	0	**1**	
15	HMI	Ohmio LIFT	Oceania	New Zealand	0	1	0	**1**	1
16	Auro Robotics	Polaris GEM	North America	United States	1	0	0	**1**	6
17	Fisker	Orbit			0	0	1	**1**	
18	Local Motors	Olli			2	0	0	**2**	
19	May Mobility	GEM e6			0	1	0	**1**	
20	Optimus Ride	n/a			0	1	0	**1**	
Total					**50**	**31**	**11**	**92**	

Main OEMs

	 **EZ10 by EasyMile**	 **ARMA by Navya**	 **OLLI by Local Motors**
Capacity:	12 passengers (6 sitting and 6 standing)	15 passengers (8 sitting and 7 standing)	12 passengers (6 sitting and 6 standing)
Cruising speed:	20 km/h	25 km/h	12km/h
Maximum speed:	40 km/h	45 km/h	40 km/h
Propulsion engine:	Electric	Electric	Electric
Length:	3,93 meters	4.75 meters	3.90 meters
Width:	1,99 meters	2.05 meters	2.05 meters
Height:	2,75 meters	2.55 meters	2.50 meters
Vehicle cost:	200,000 to 220,000€. ($223,180 to $245,498)	200,000€ ($223,180)	212,690€ ($250,000)
Maintenance costs:	30,000€/year ($33,477/year)	90,000€/year ($101,511/year)	n/a

Nature of deployments

- Showcases → 20.88%
- Trials → 69.23%
- Regular services → 9.89%
  - Rivium & Masdar City

Prevailing business model and target audience

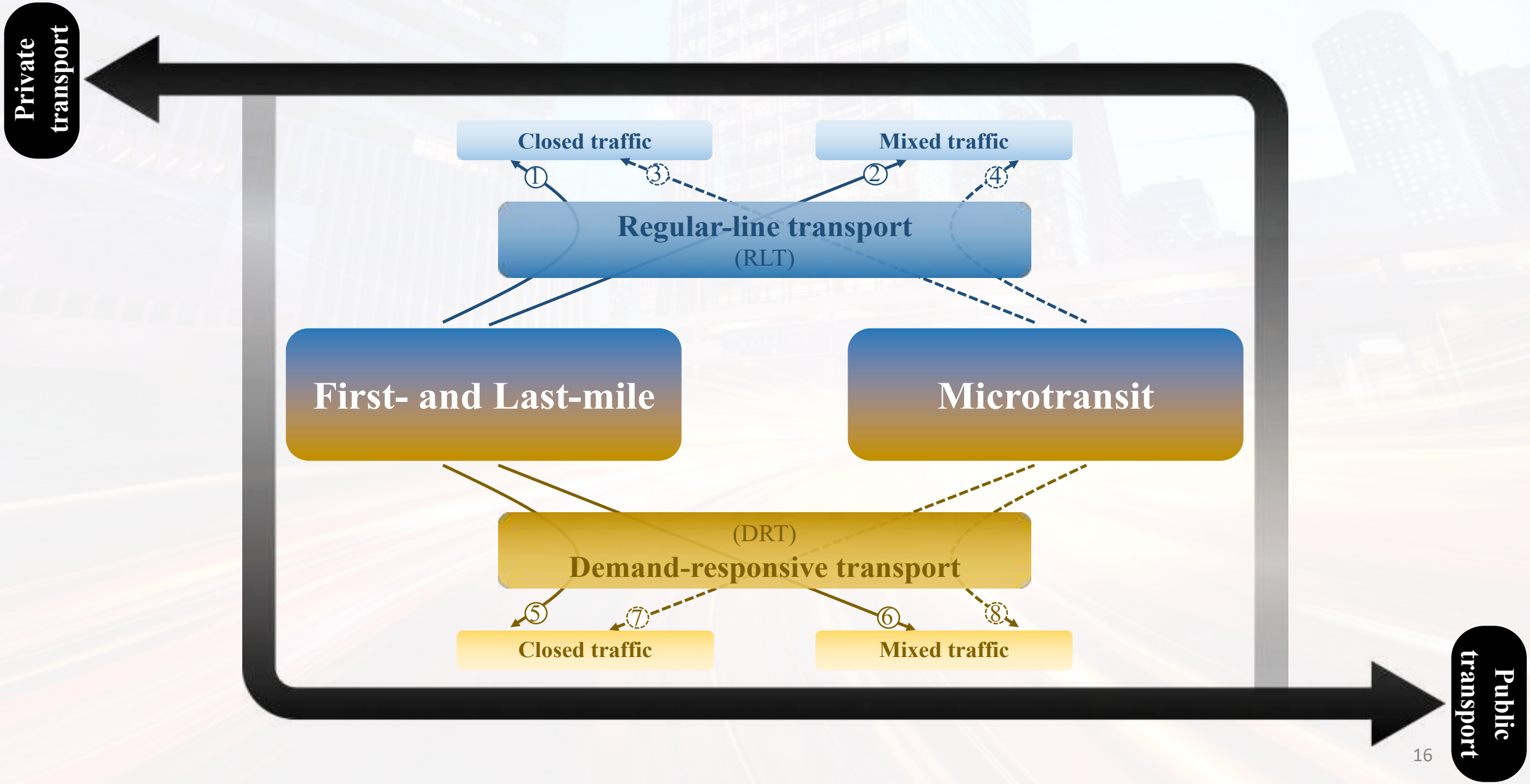
- Private transport → 3.45%
- Public transport → 96.55%
  - Commuters: 65.52%
  - Fairs: 3.45%
  - Tourists: 8.05%
  - Airports: 10.34%
  - Universities: 9.20%

Classification within urban transport

- Regular-line transport (RLT) → 91.21%
- Demand-responsive transport (DRT) → 4.40%

- First- and last mile commute → 44.57%
- Microtransit commute → 55.43%

Typologies of uses for ASCTs



Typologies of uses for ASCTs

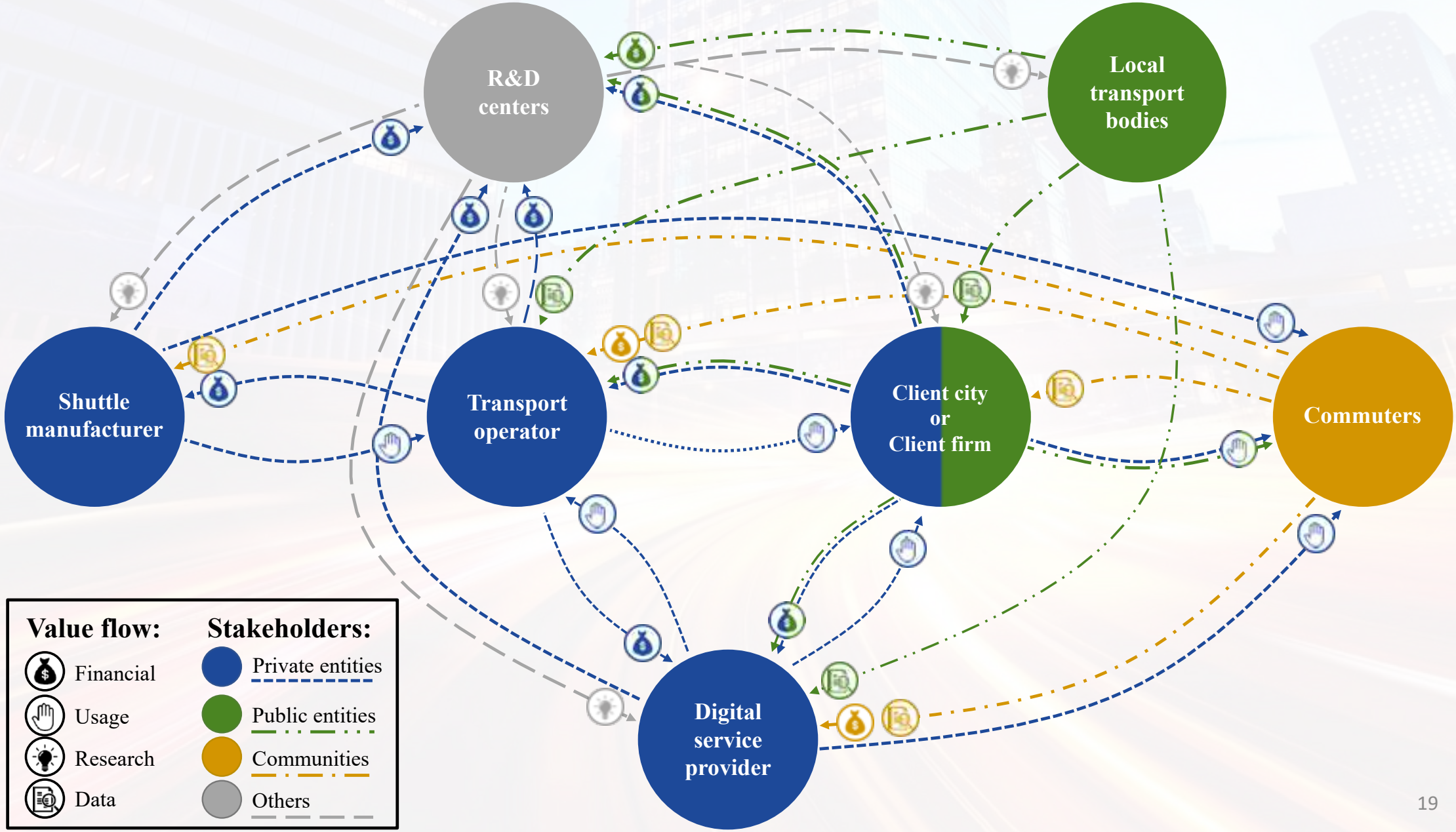
Typologies of uses for ASCTs		Private transport		Public transport	
		Number of experiments	%	Number of experiments	%
1	First- and Last-mile RLT in closed traffic	0	0,00%	23	25,84%
2	First- and Last-mile RLT in mixed traffic	1	33,33%	17	19,10%
3	Microtransit RLT in closed traffic	2	66,67%	18	20,22%
4	Microtransit RLT in mixed traffic	0	0,00%	21	23,60%
5	First- and Last-mile DRT in closed traffic	0	0,00%	1	1,12%
6	First- and Last-mile DRT in mixed traffic	0	0,00%	1	1,12%
7	Microtransit DRT in closed traffic	0	0,00%	4	4,49%
8	Microtransit DRT in mixed traffic	0	0,00%	4	4,49%
Total		**3**	**100,00%**	**89**	**100,00%**

Factual KPIs

Key-Performance Indicator	Possible metrics	Category
Battery range	Number of kilometers traveled on a single charge	Economic-centered
Vehicle's traveled distance	Number of kilometers traveled per shuttle	Economic-centered
Shuttle's occupancy	Number of passengers per shuttle and per ride	Economic-centered
Commute costs	Overall costs involved in operating and maintaining the shuttle per kilometer traveled	Economic-centered
Safety	Number of accidents/incidents per kilometer traveled	User-centered
Commute travel time	Average time spent in the commute	User-centered
Commute price	Average price per trip	User-centered
Waiting time	Average waiting time (in minutes) to get on board the shuttle	User-centered
Travel time efficiency	Expected departure and arrival time	User-centered

- Needs further development:
  - Mainly on accessing social-psychological KPIs
  - Unified Theory of Acceptance and Use of Technology (UTAUT)
    - Insights from CityMobil2 (Madigan et al., 2017; Alessandrini, 2016).

Main stakeholders and value flow




CONCLUDING
REMARKS

Concluding remarks

- 92 experimentations;
- 78 cities;
- 32 countries;
- 20 shuttles' manufacturers.

- European lead on number of experimentations and shuttles' R&D:
  - 9 manufacturers responding to 80 of the 92 deployments;
  - Highlights to the French: Navya and EasyMile

- 69.23% classified as trials; 20.88% showcases and, 9.89% regular services;
- 91.21% RLT; 4.4% DRT; 4.4% both;
- 8 typologies (divided into first- last-mile & microtransit and RLT & DRT);
- KPIs and stakeholders flow models.

Limitations and future studies

- Difficulty in obtaining data:
  - Prevalence of secondary sources;
  - Unstructured data;
  - Language barriers.

- In-depth research is needed:
  - In-depth studies on selected projects;
  - Focus on economic and social aspects;
  - Technology push perspective & consumer acceptance.

Fabio ANTONIALLI
fabio.antonialli@centralesupelec.fr
fantonialli@gmail.com