

MAKING MOBILITY HAPPEN.

today / tomorrow / together

HÜBNER EXPERT TALKS

**HIGH-CAPACITY BUSES: HOW PUBLIC TRANSPORT
VEHICLES WILL COVER FUTURE MOBILITY NEEDS**

UWE BITTROFF – HEAD OF DIVISION VEHICLE INTERFACE SYSTEMS BUS, DIVISION MOBILITY ROAD





HOW PUBLIC TRANSPORT VEHICLES WILL BECOME SUFFICIENT FOR FUTURE CAPACITY NEEDS



NEW DEMANDS FOR BRT SYSTEMS

HOW PUBLIC TRANSPORT VEHICLES WILL BECOME SUFFICIENT FOR FUTURE CAPACITY NEEDS



BRT is economic transportation for 30 years

- Growing population and increase in urbanization lead to growing demand for transport.
- Bus systems reach their limits in capacity.

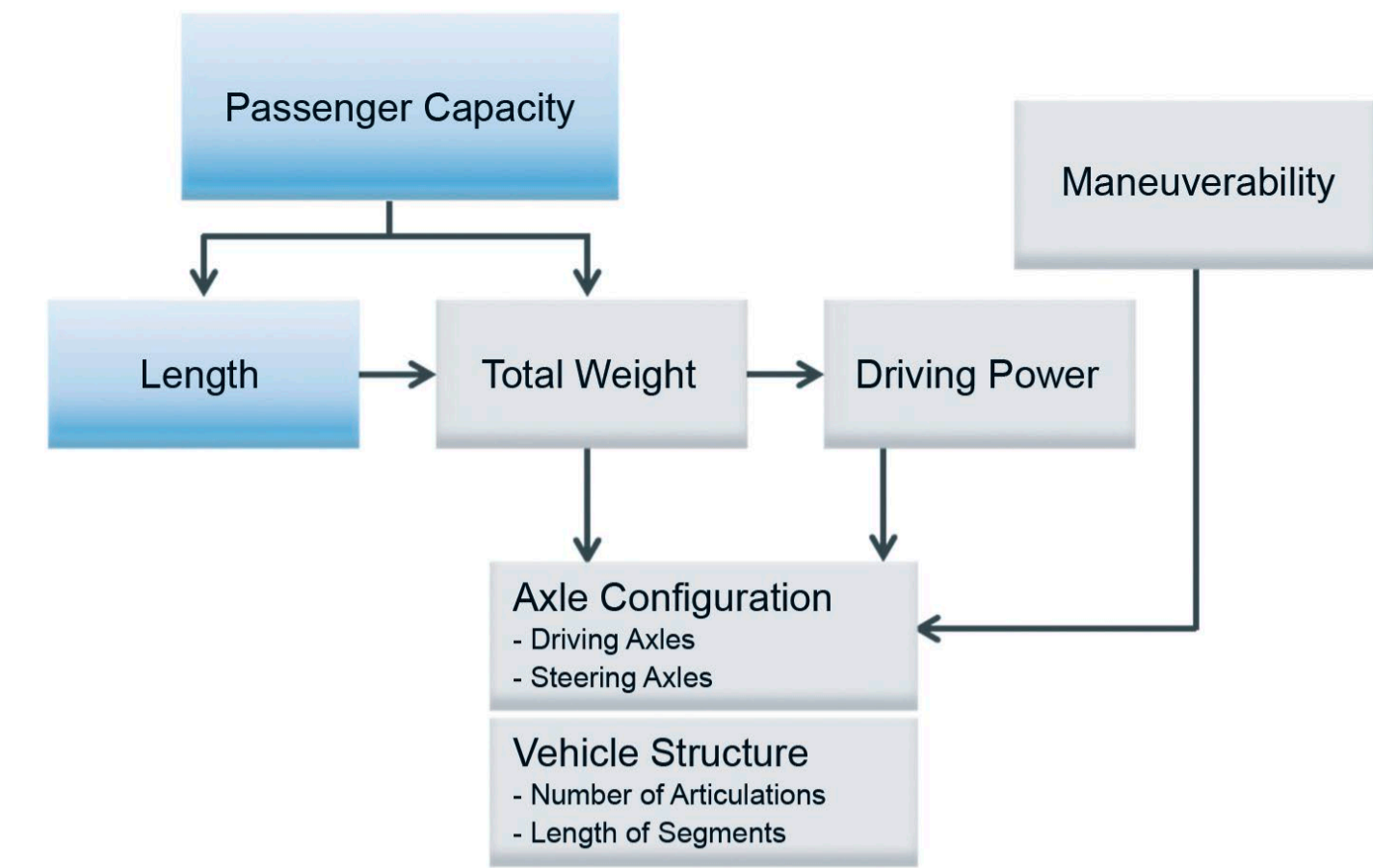
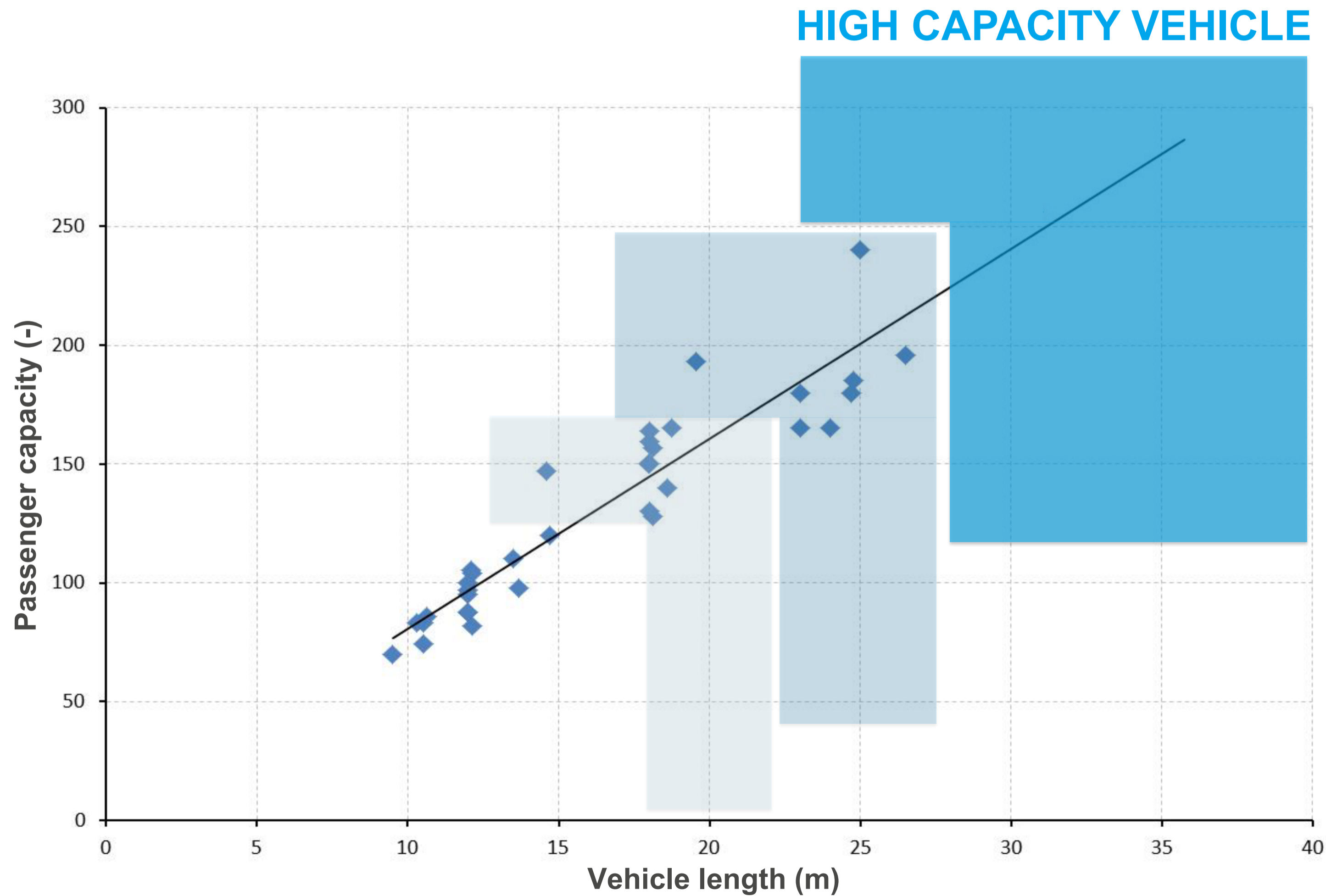
Need of new Vehicle Concepts

- New concepts must exceed existing vehicle capacities.
- Should be easy to integrate or compatible with existing infrastructure.



DEPENDENCY OF THE VEHICLE DESIGNS

PASSENGER CAPACITY AND VEHICLE LENGTH

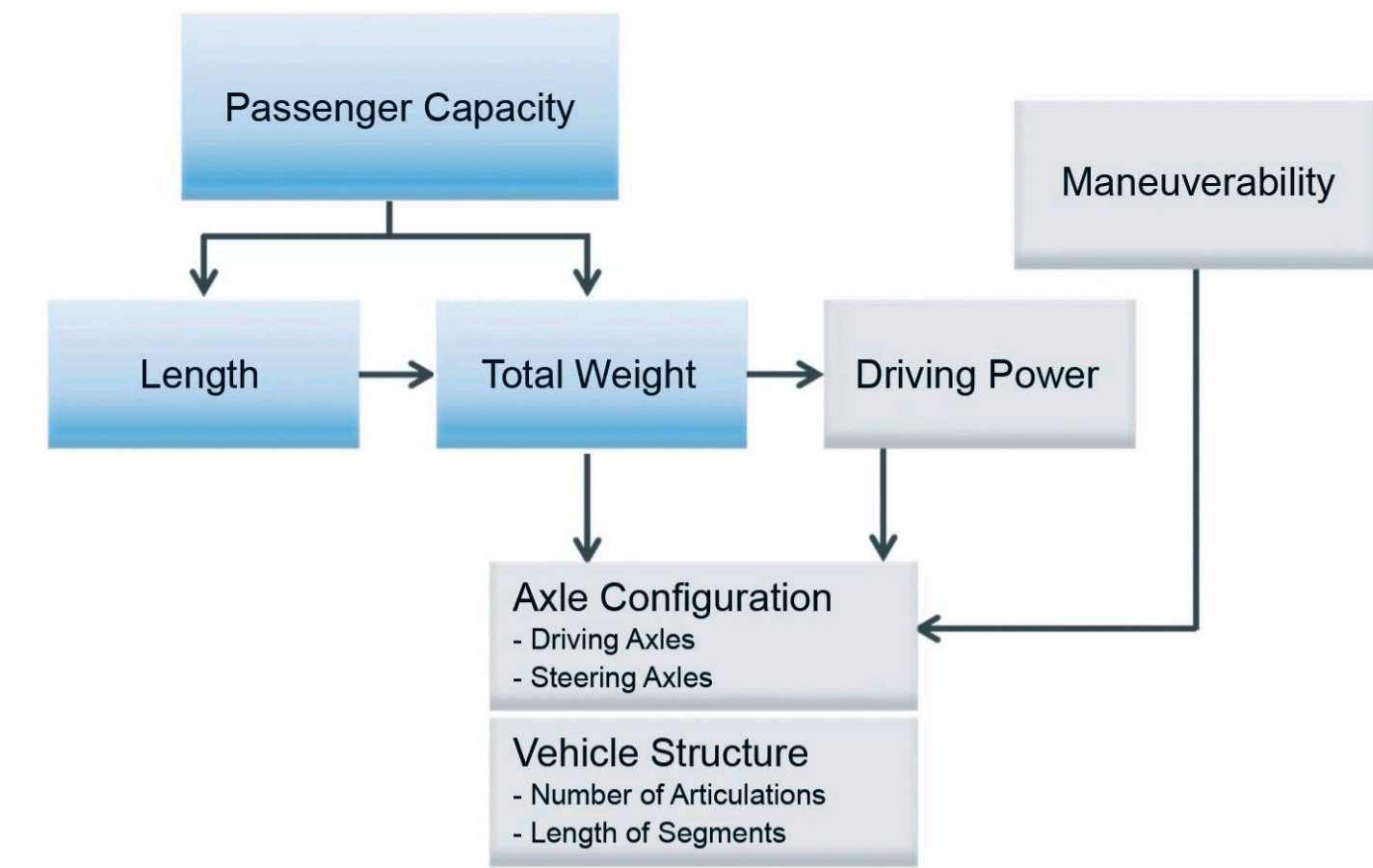
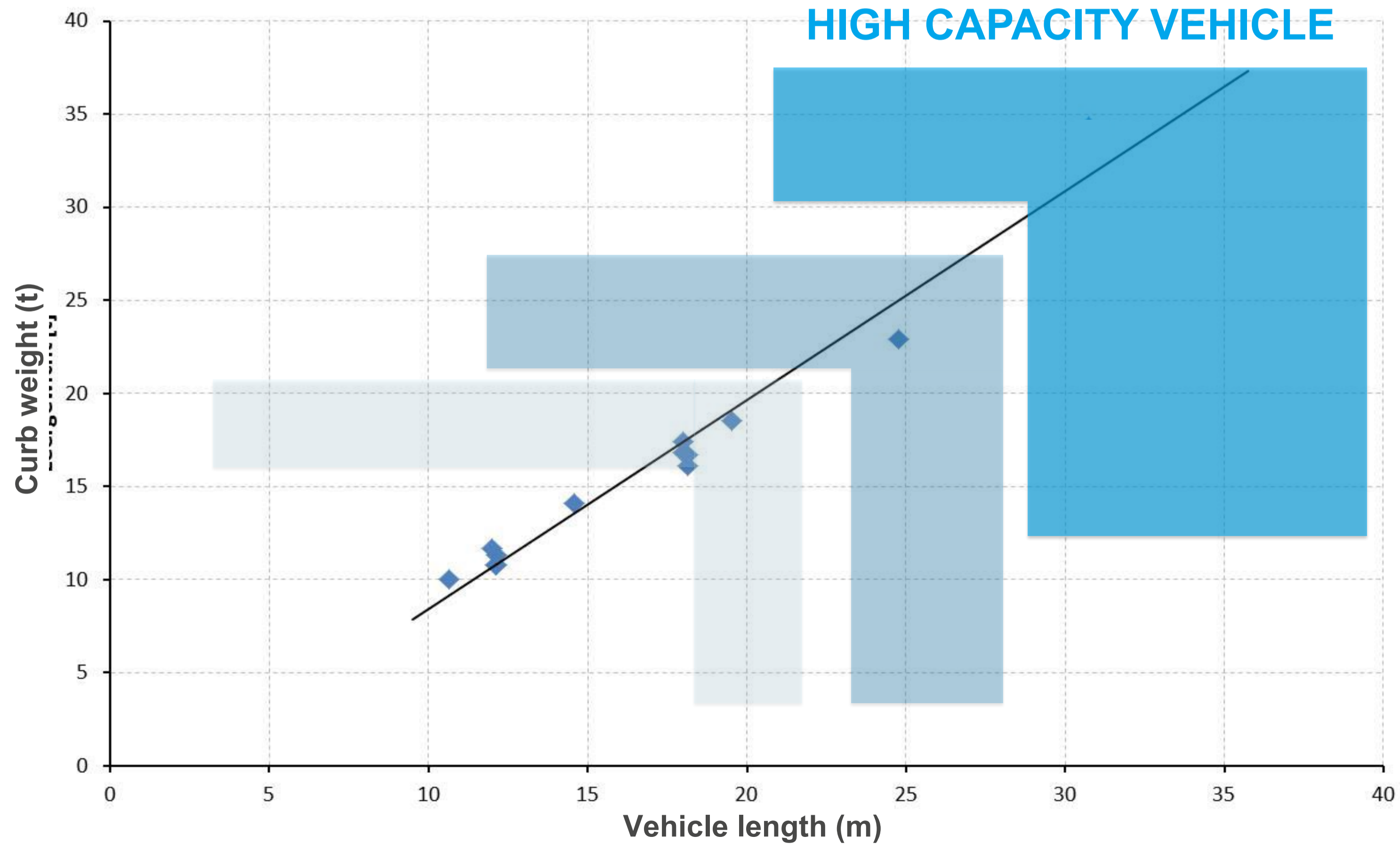


- High capacity bus
- Bi-articulated bus
- Articulated bus
- Existing buses



DEPENDENCY OF THE VEHICLE DESIGNS

VEHICLE WEIGHT AND VEHICLE LENGTH

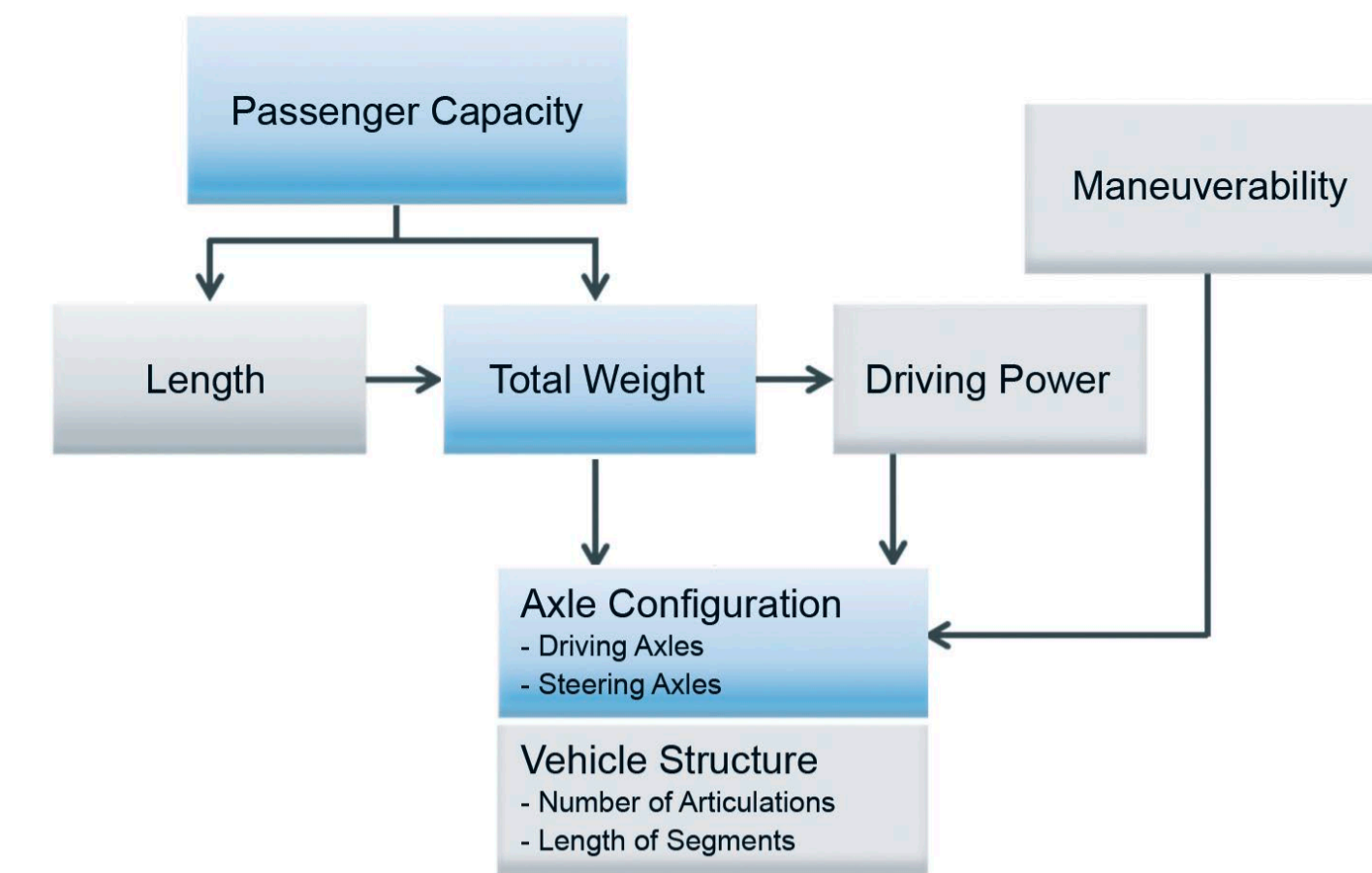
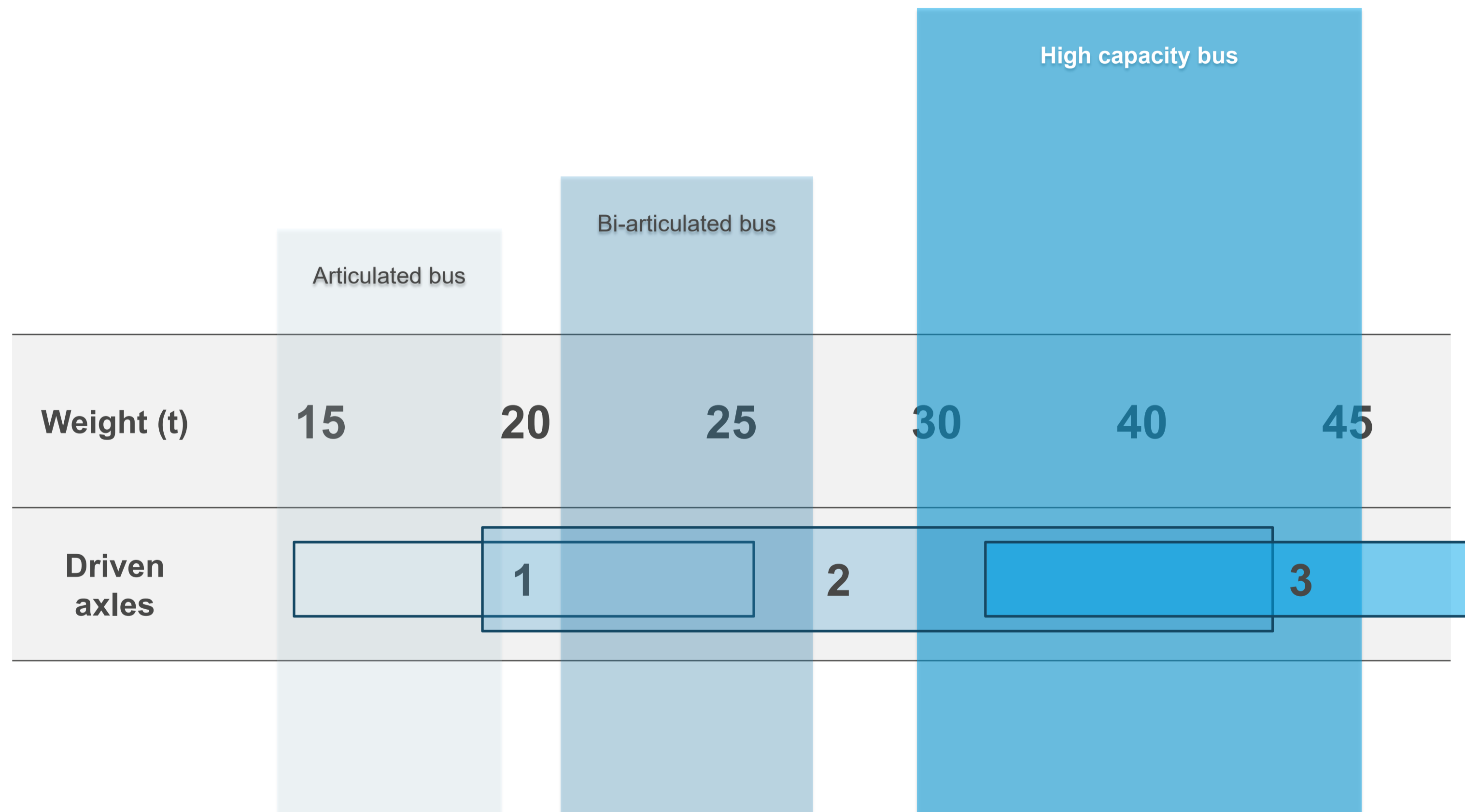


- High capacity bus
- Bi-articulated bus
- Articulated bus
- Existing buses



DEPENDENCY OF THE VEHICLE DESIGNS

VEHICLE WEIGHT AND NUMBER OF DRIVEN AXLES



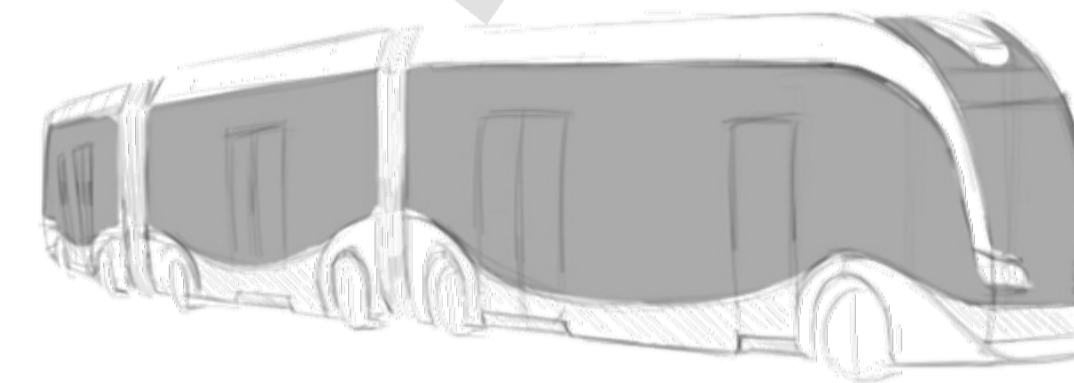
Electro Mobility is the key for more than one driven axle.

BACKGROUND

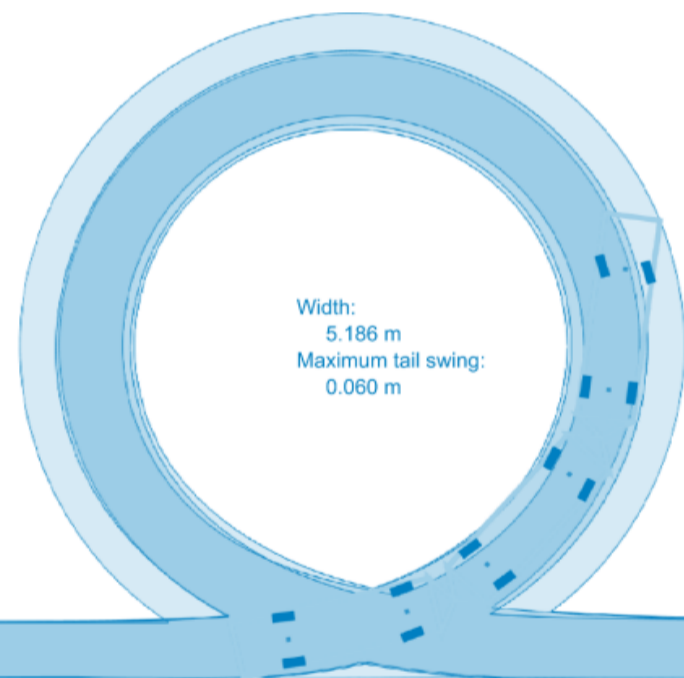
CORRELATIONS BETWEEN AREA OF APPLICATION AND VEHICLE CONFIGURATION



Infrastructure
Where does the vehicle drive?

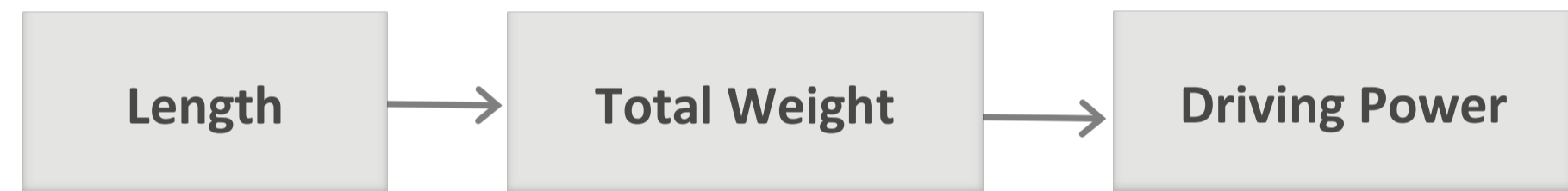


Vehicle
How does the vehicle have to be designed?



Maneuverability
• Turning Circle
• Tracking Stability
• Maximum Speed
• etc.

**Combine Axles
with excellent
maneuverability**



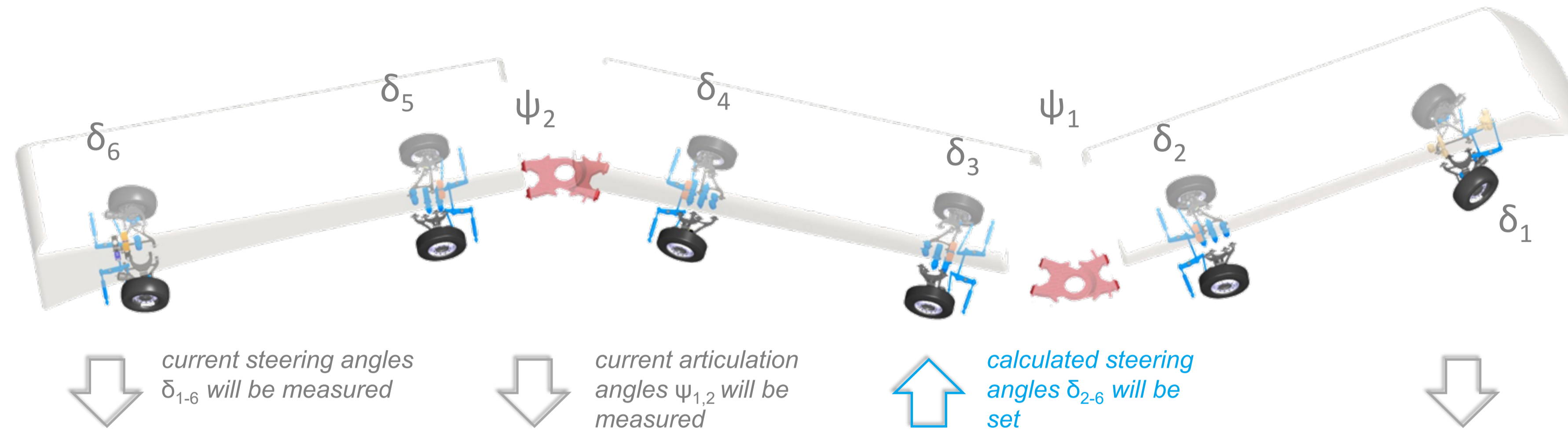
Axle Configuration
• Driving Axles
• Steering Axles

Vehicle Structure
• Number of Articulations
• Length of Segments
• Position of Axles

Driving Behaviour
How should the vehicle move?

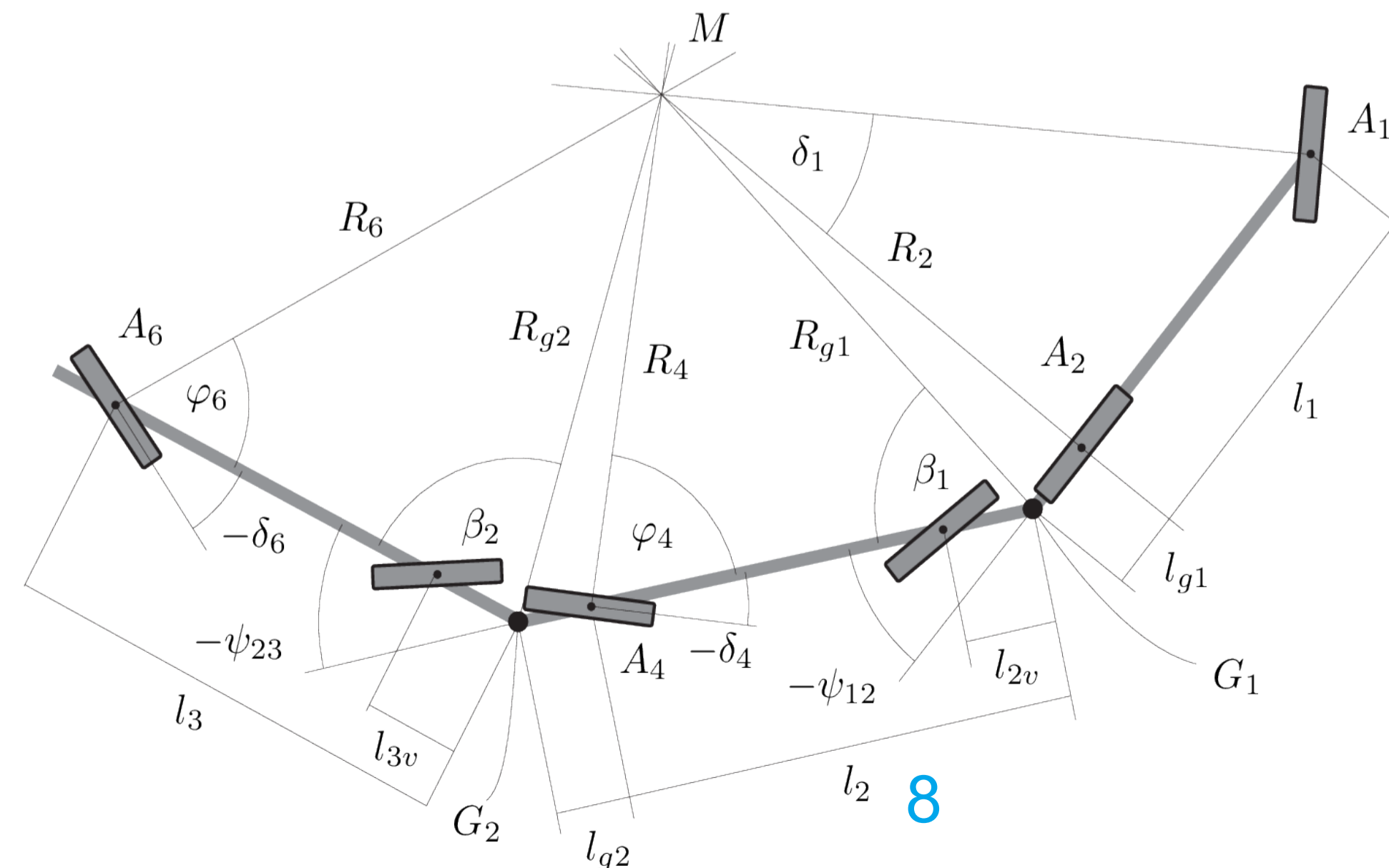


STEERING TECHNOLOGY IS KEY



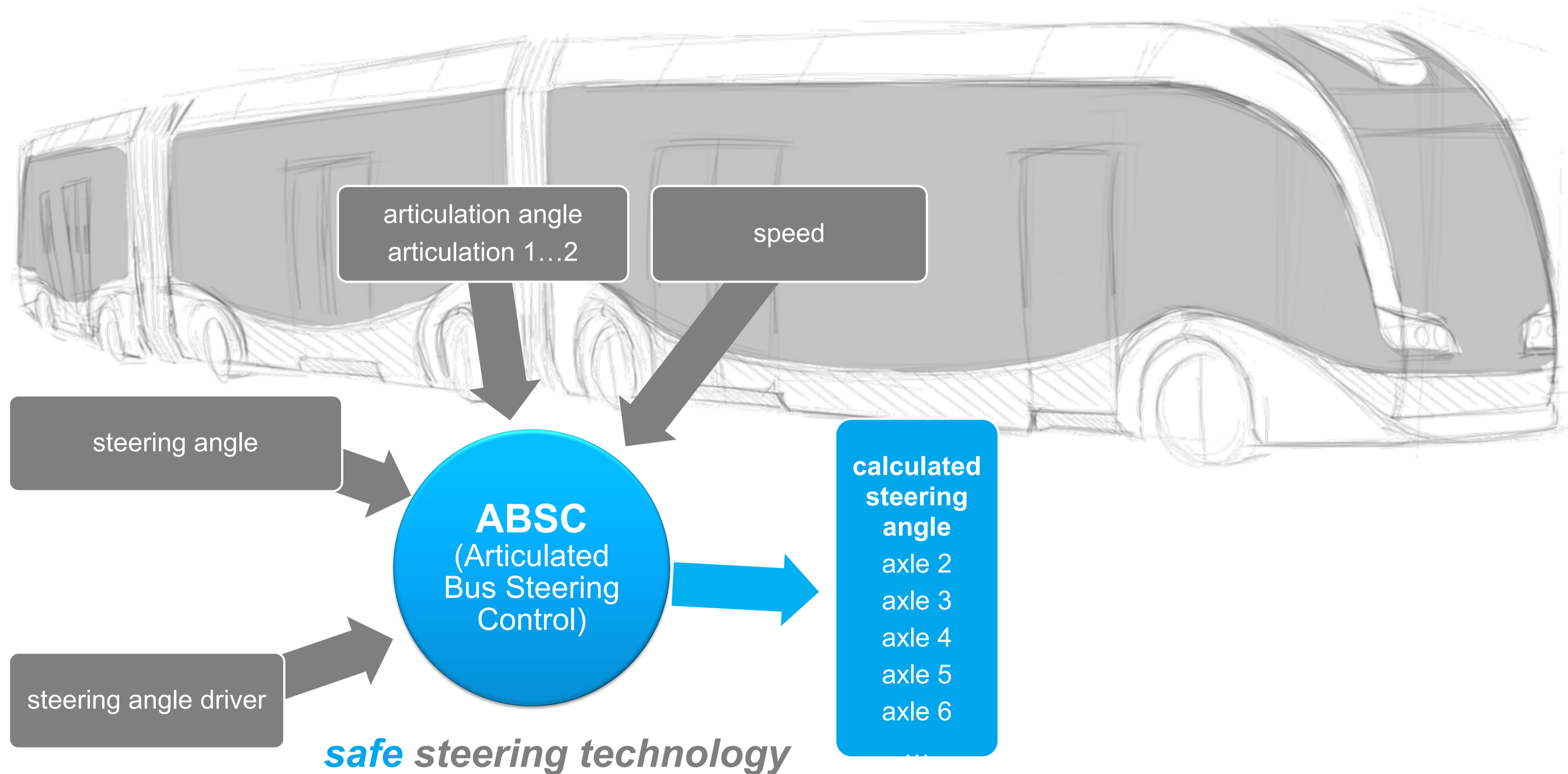
■ Vehicle features

- 36 m
- all axles steerable
- bi-directional, optional
- Algorithms suitable for vehicle control units
- minimal sweeping path
- Special articulation systems



HÜBNER – STEERING TECHNOLOGY FOR HIGH CAPACITY VEHICLES

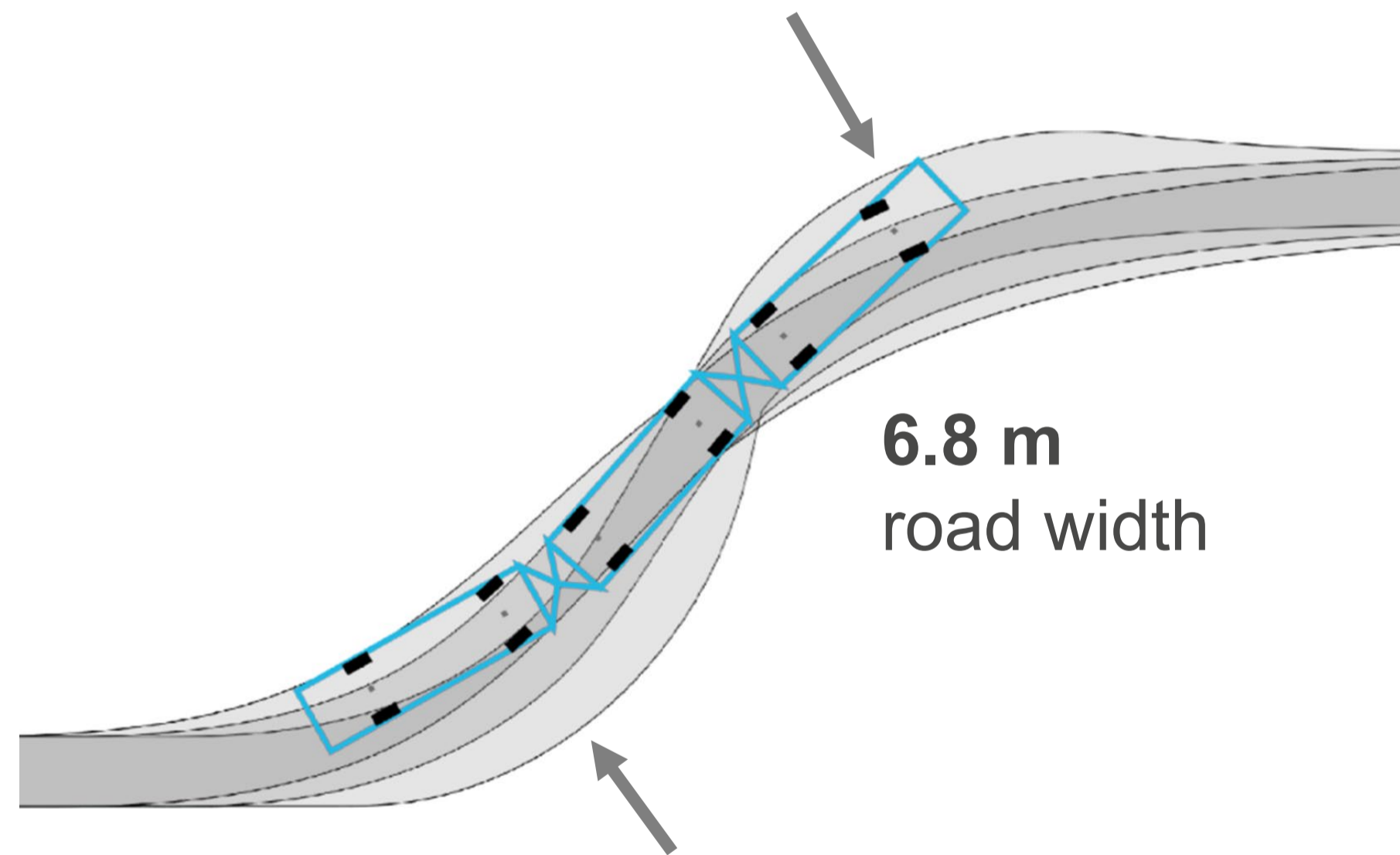
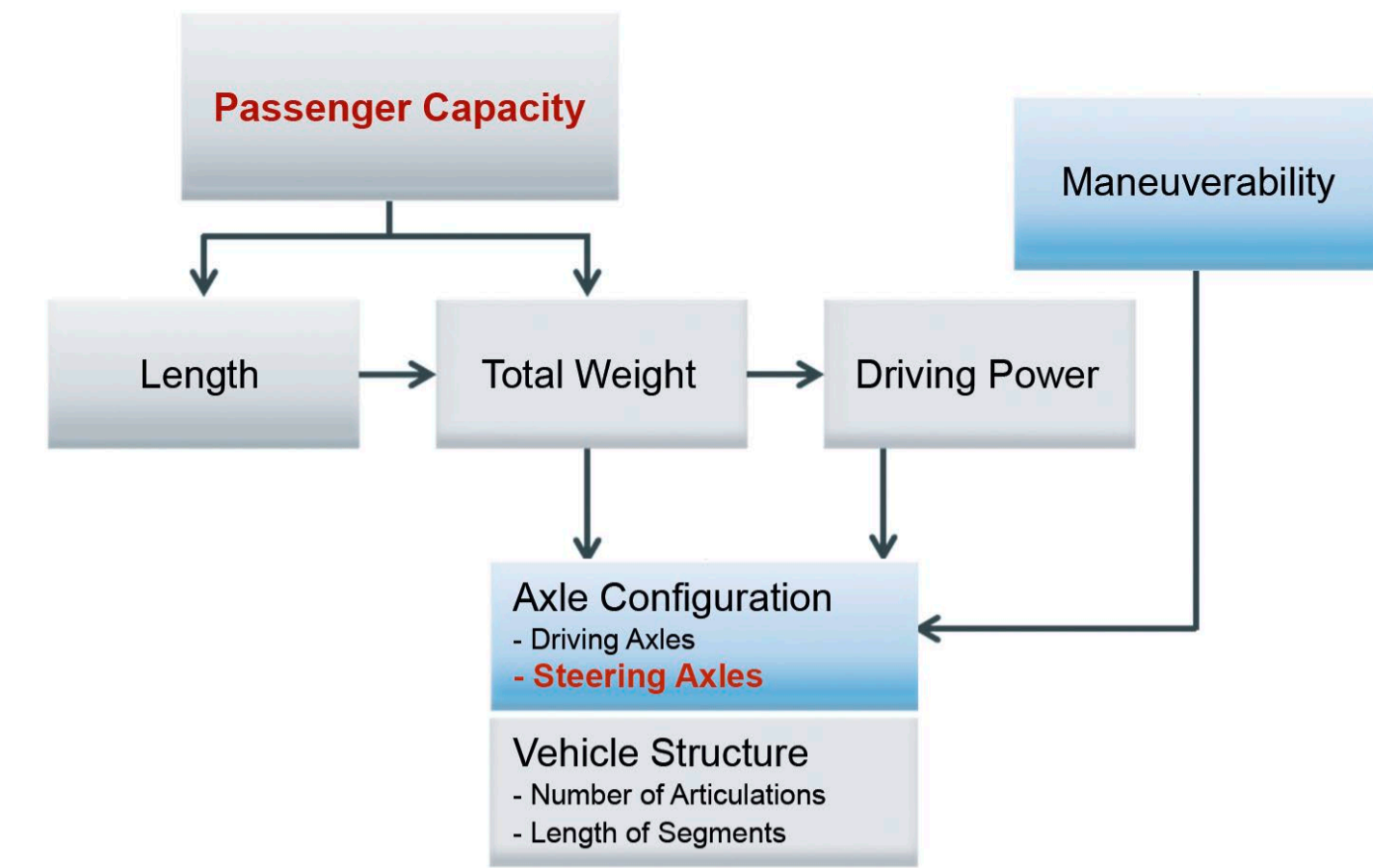
ABSC – ARTICULATED BUS STEERING SYSTEM



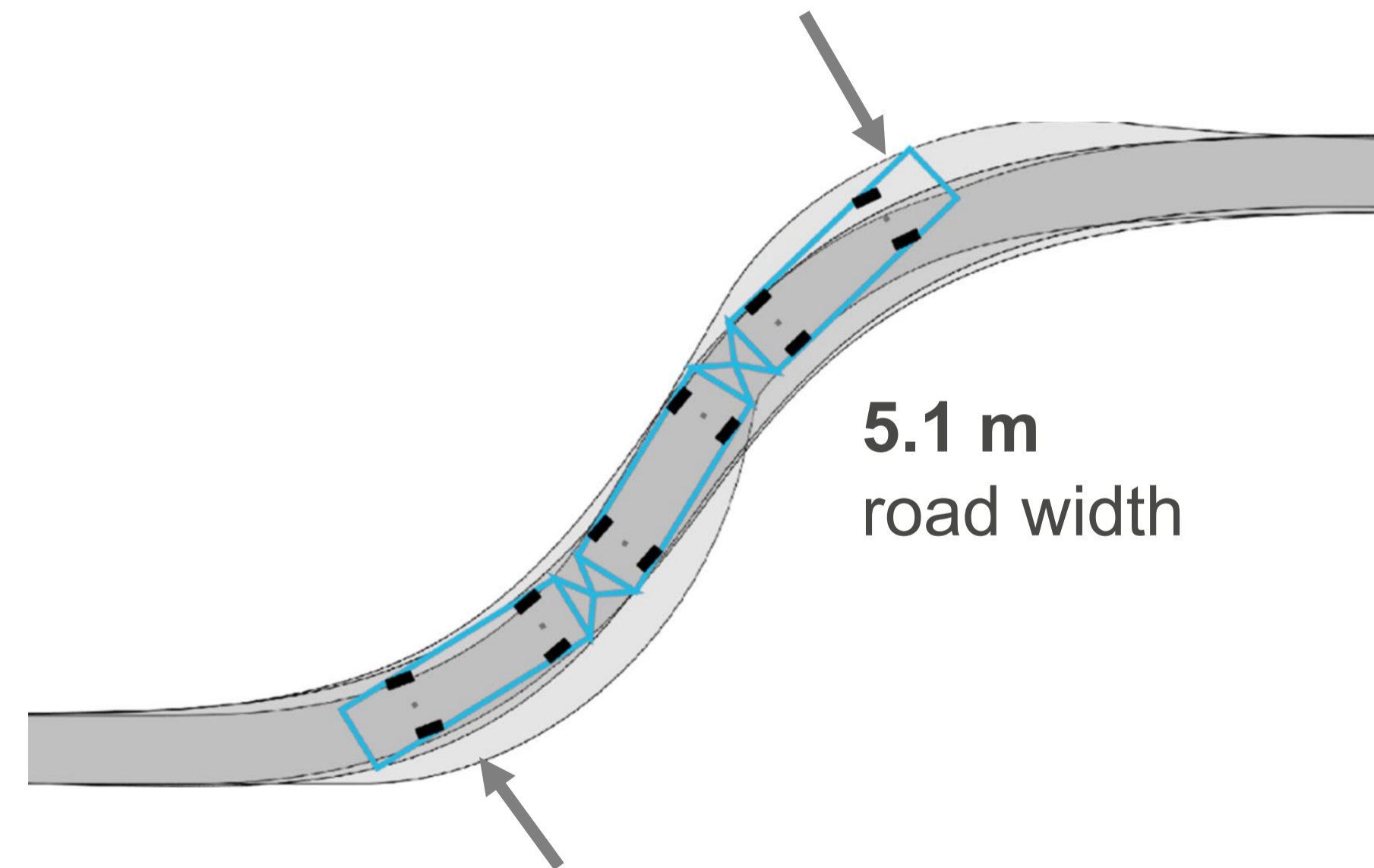
SIMULATION OF DRIVING DYNAMICS

2-2-2 CONFIGURATION - S-CURVE

The number of steered axles significantly determines the maneuverability of the vehicle.



Axle #6	Axle #5	Axle #4	Axle #3	Axle #2	Axle #1
-	steered	-	steered	-	steered



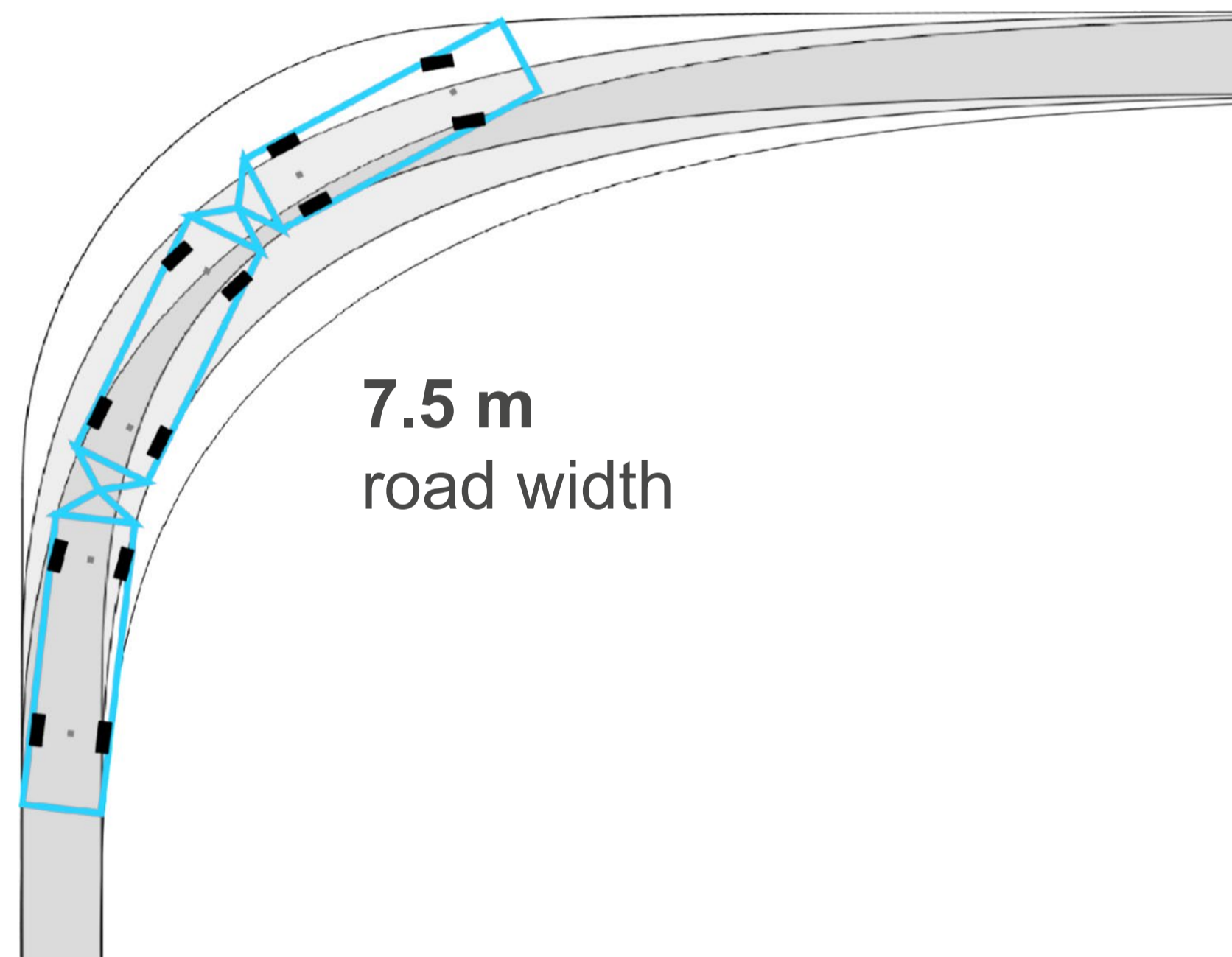
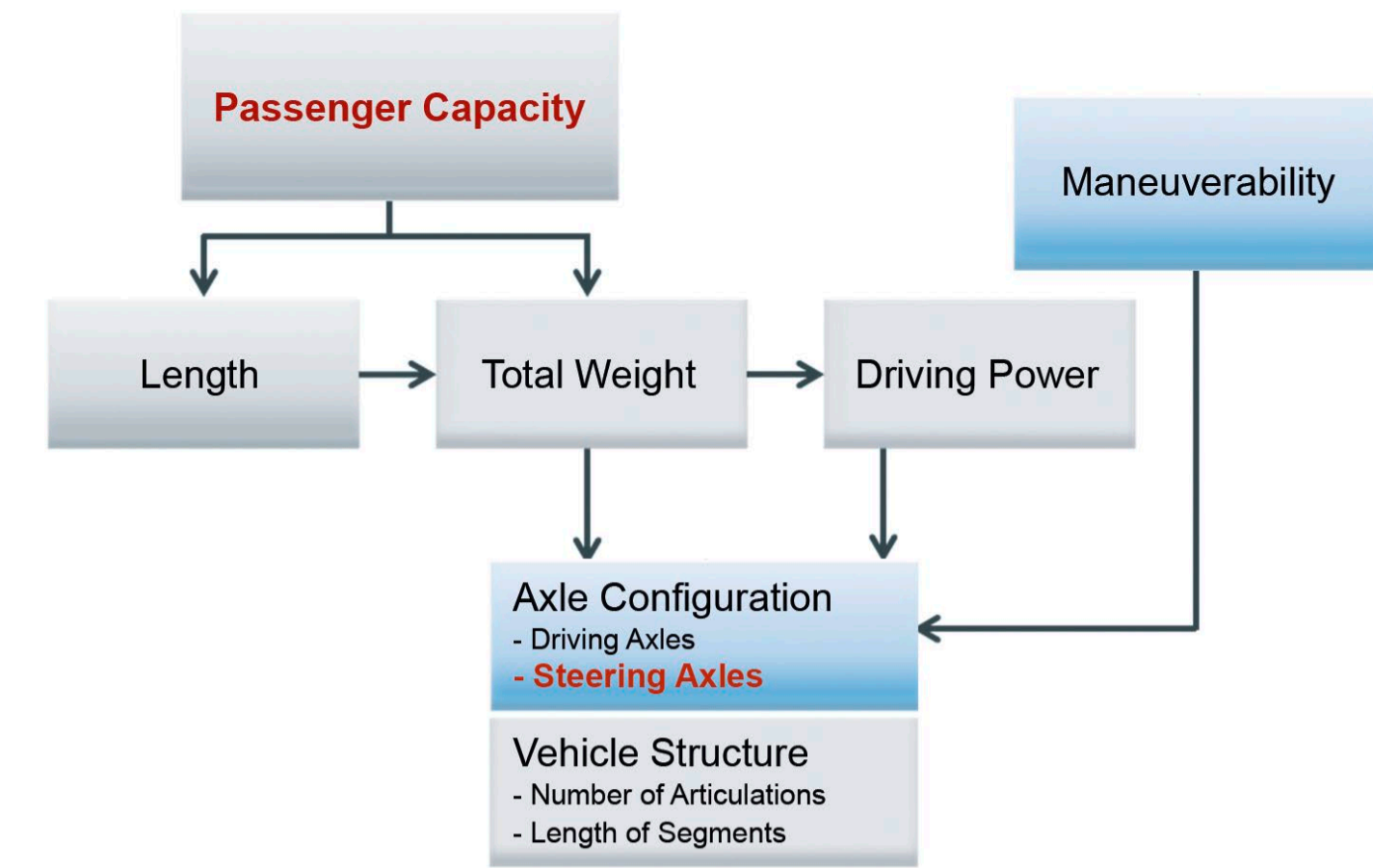
Axle #6	Axle #5	Axle #4	Axle #3	Axle #2	Axle #1
steered	steered	steered	steered	-	steered



SIMULATION OF DRIVING DYNAMICS

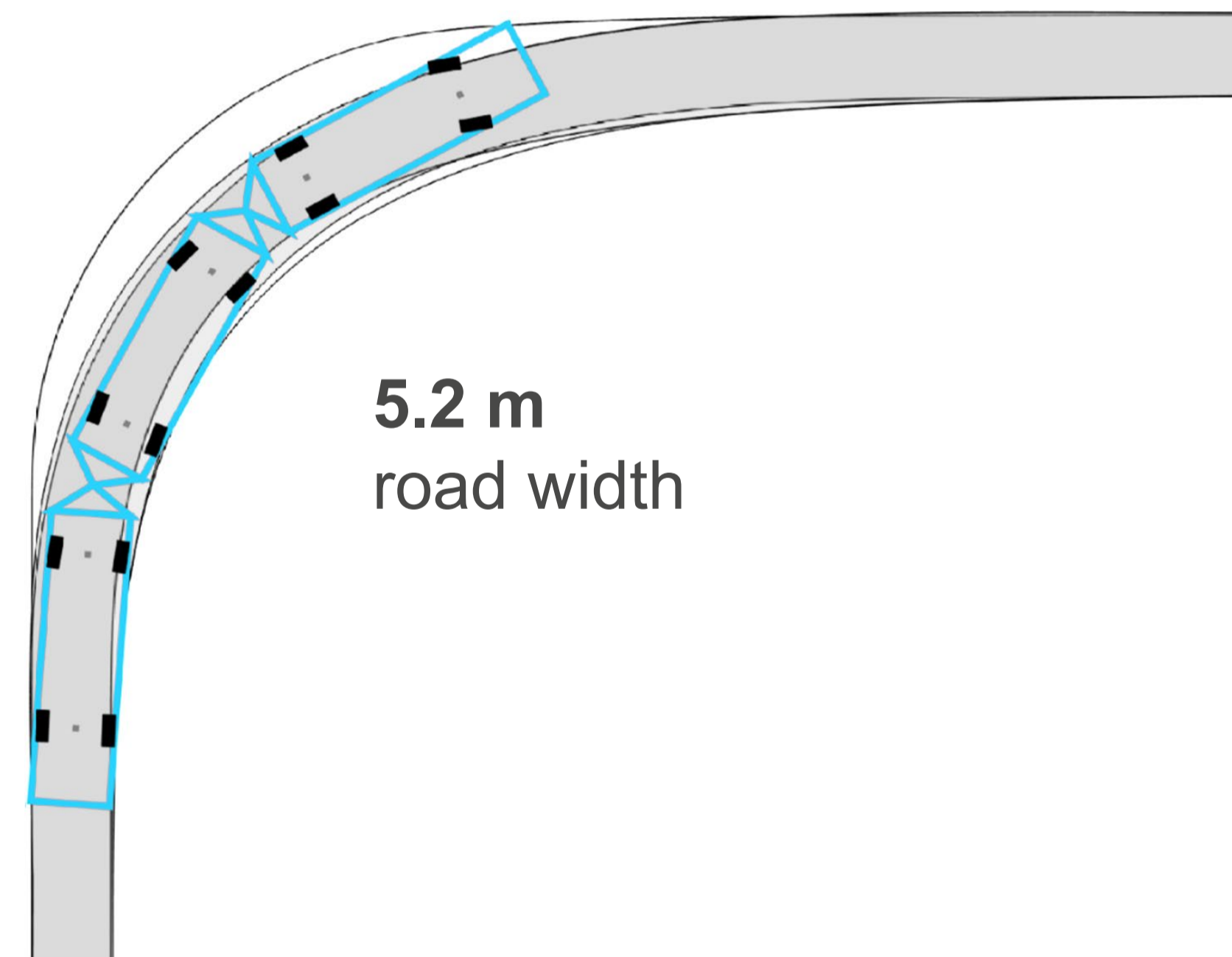
2-2-2 CONFIGURATION - RIGHT TURN

The number of steered axles significantly determines the maneuverability of the vehicle.



7.5 m
road width

Axle #6	Axle #5	Axle #4	Axle #3	Axle #2	Axle #1
-	steered	-	steered	-	steered



5.2 m
road width

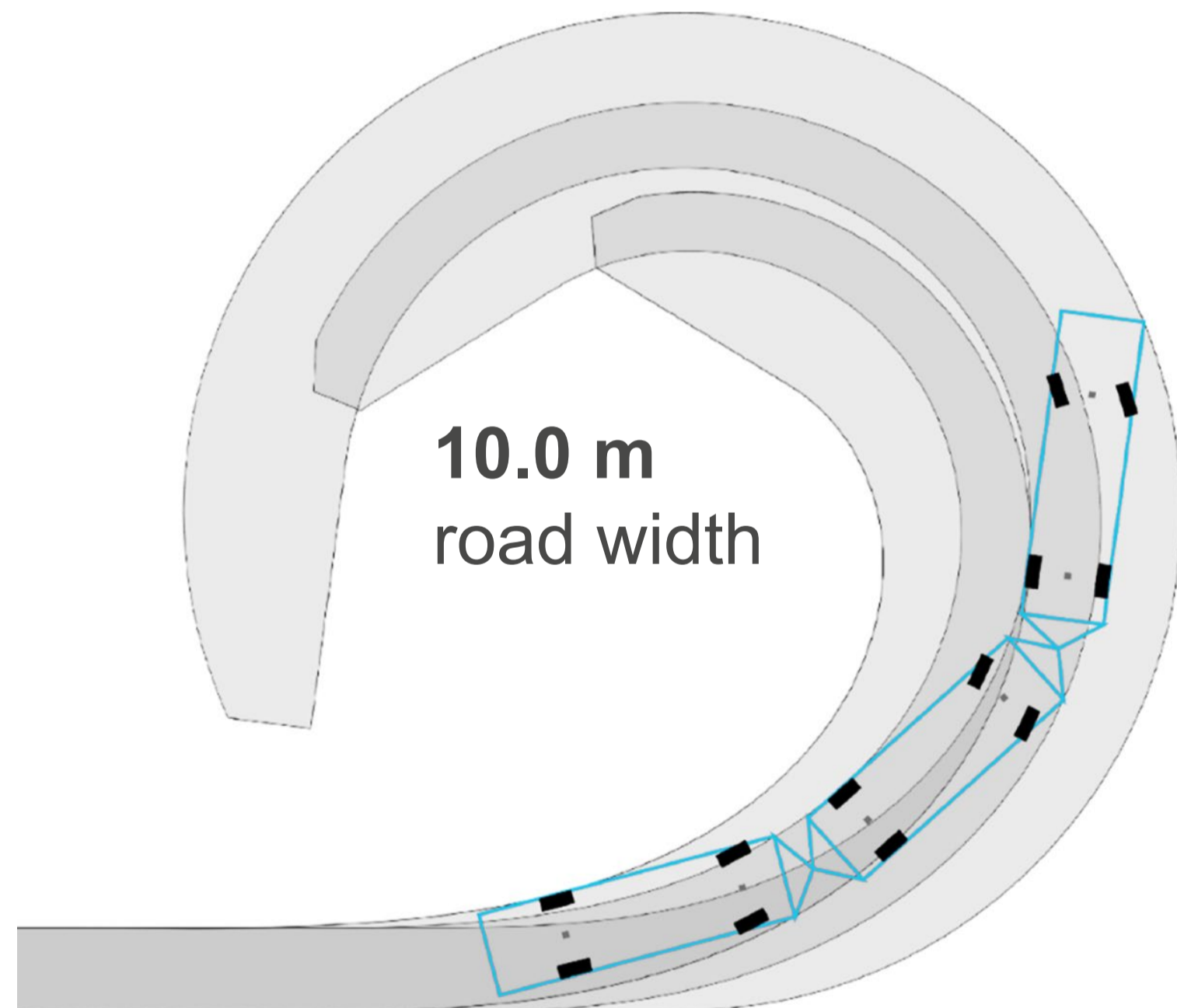
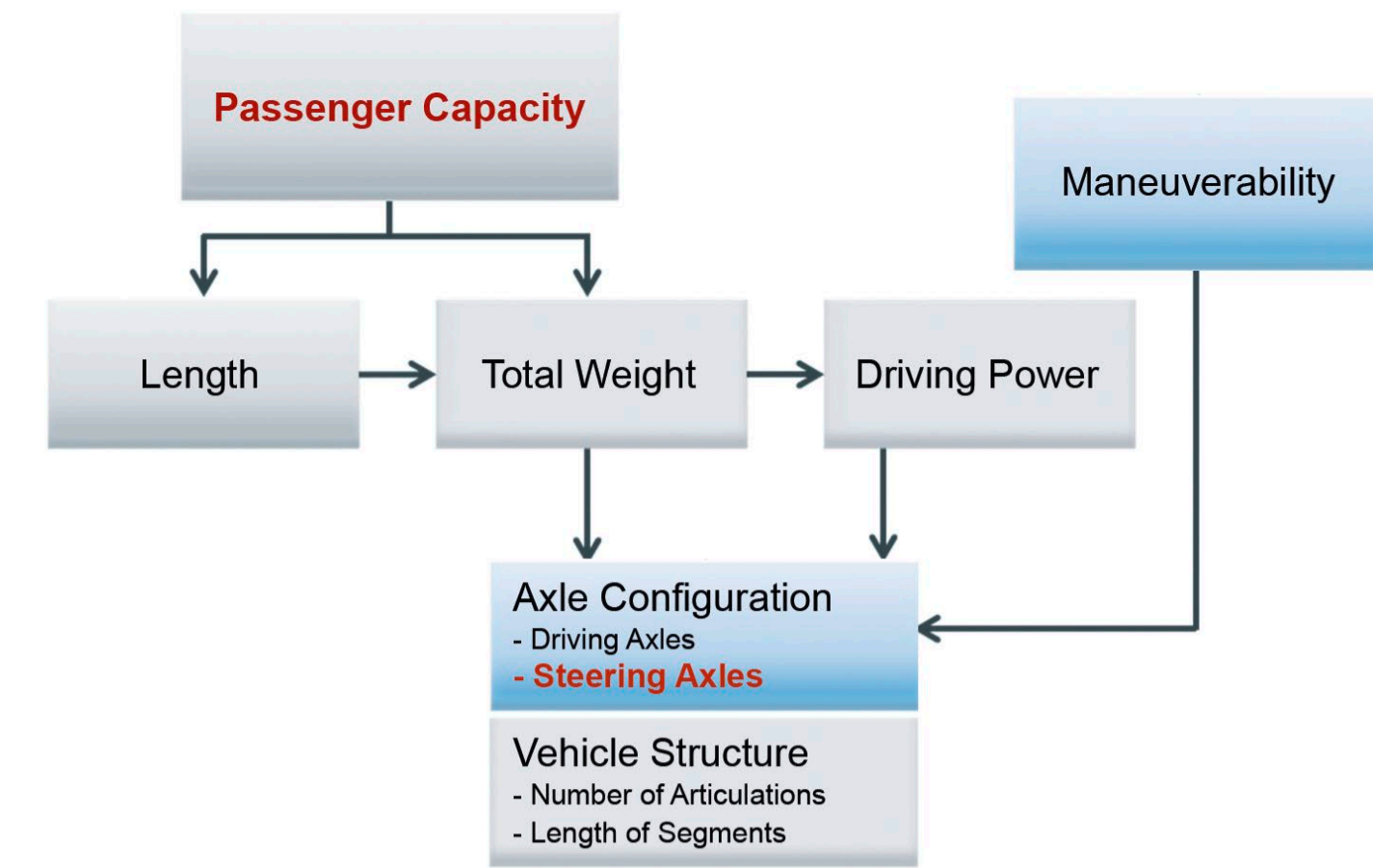
Axle #6	Axle #5	Axle #4	Axle #3	Axle #2	Axle #1
steered	steered	steered	steered	-	steered



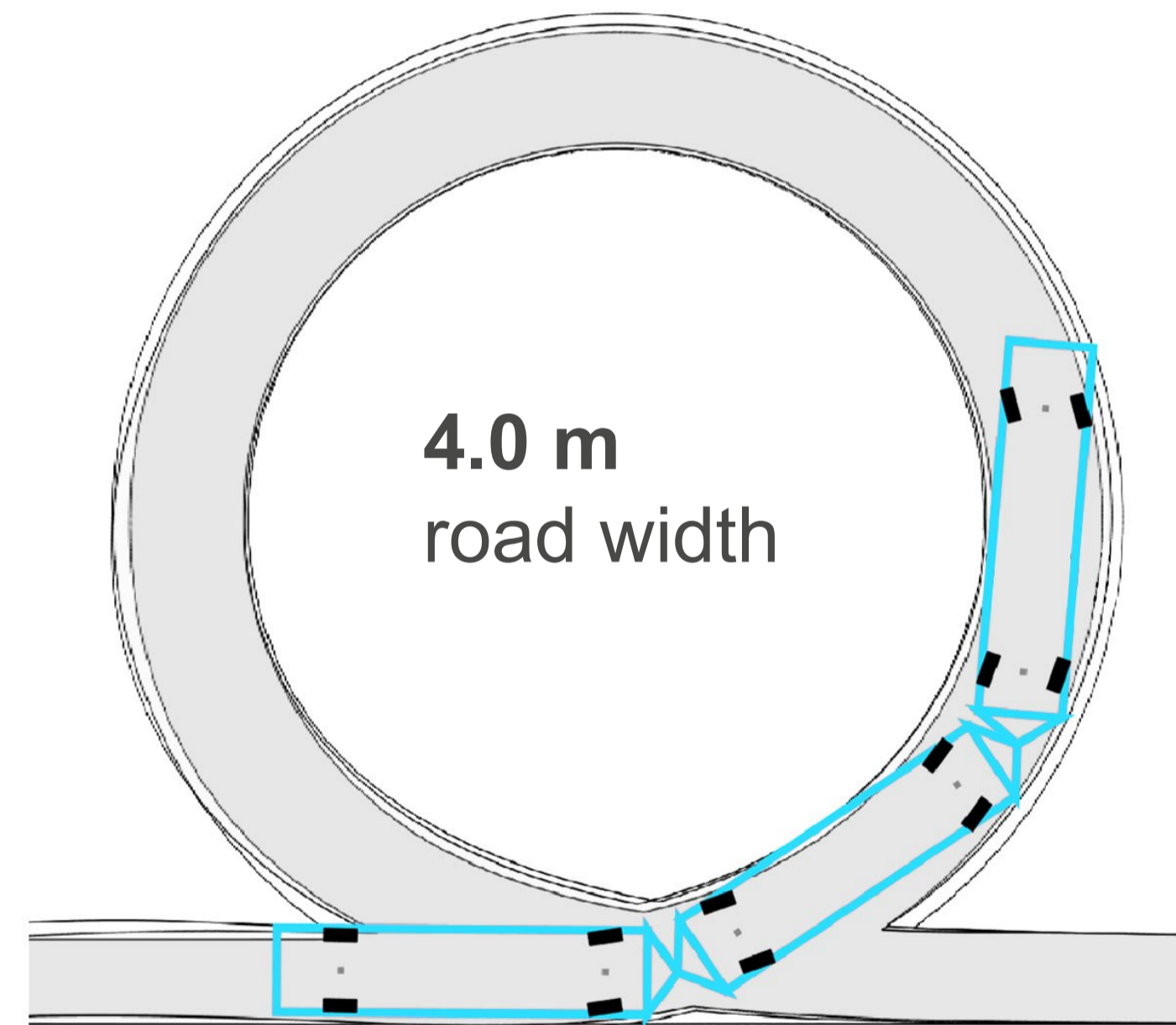
SIMULATION OF DRIVING DYNAMICS

2-2-2 CONFIGURATION – CIRCLE DRIVE

The number of steered axles significantly determines the maneuverability of the vehicle.



Axle #6	Axle #5	Axle #4	Axle #3	Axle #2	Axle #1
-	steered	-	steered	-	steered

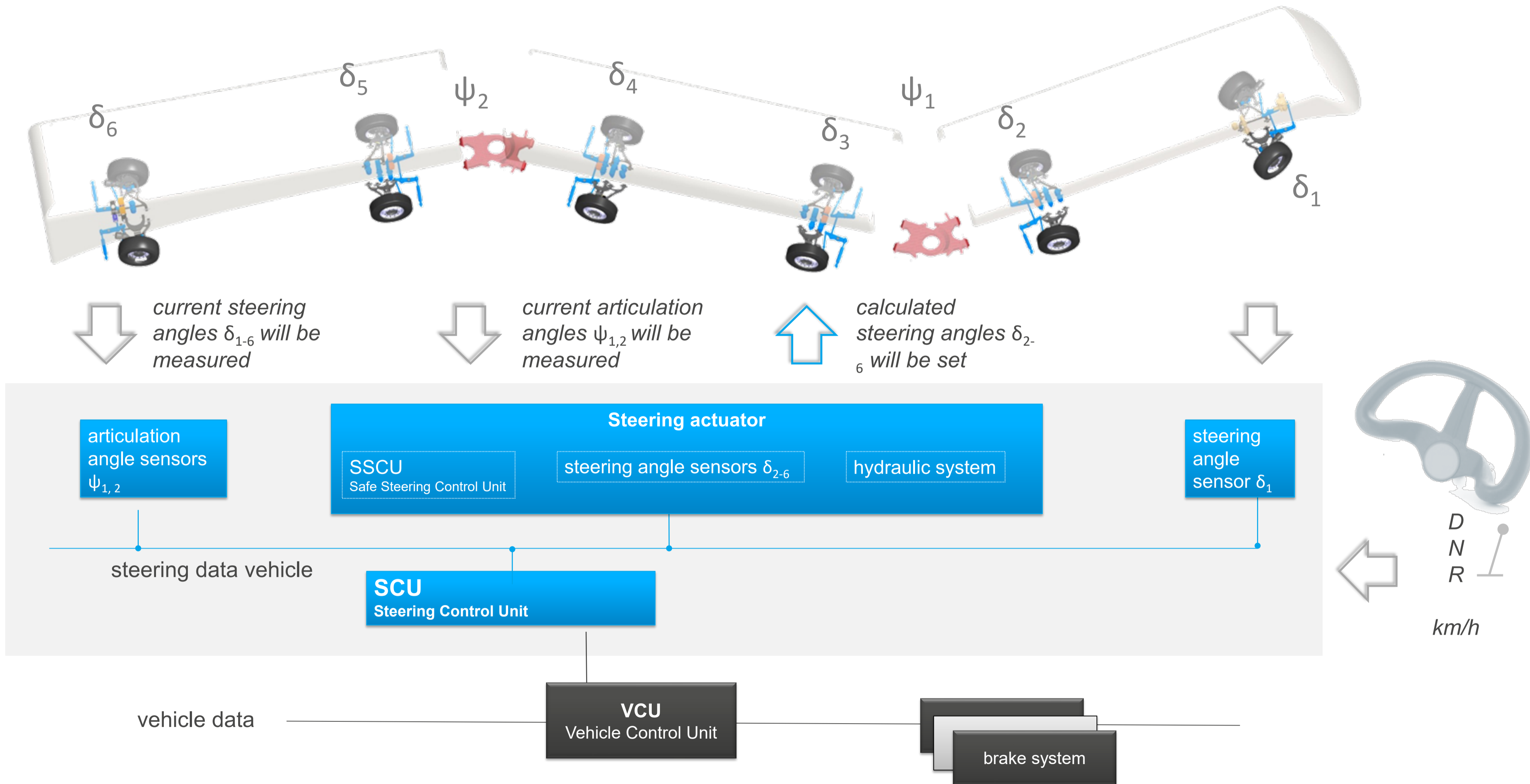


Axle #6	Axle #5	Axle #4	Axle #3	Axle #2	Axle #1
steered	steered	steered	steered	steered	steered



HÜBNER – STEERING TECHNOLOGY

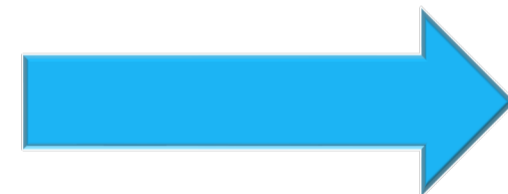
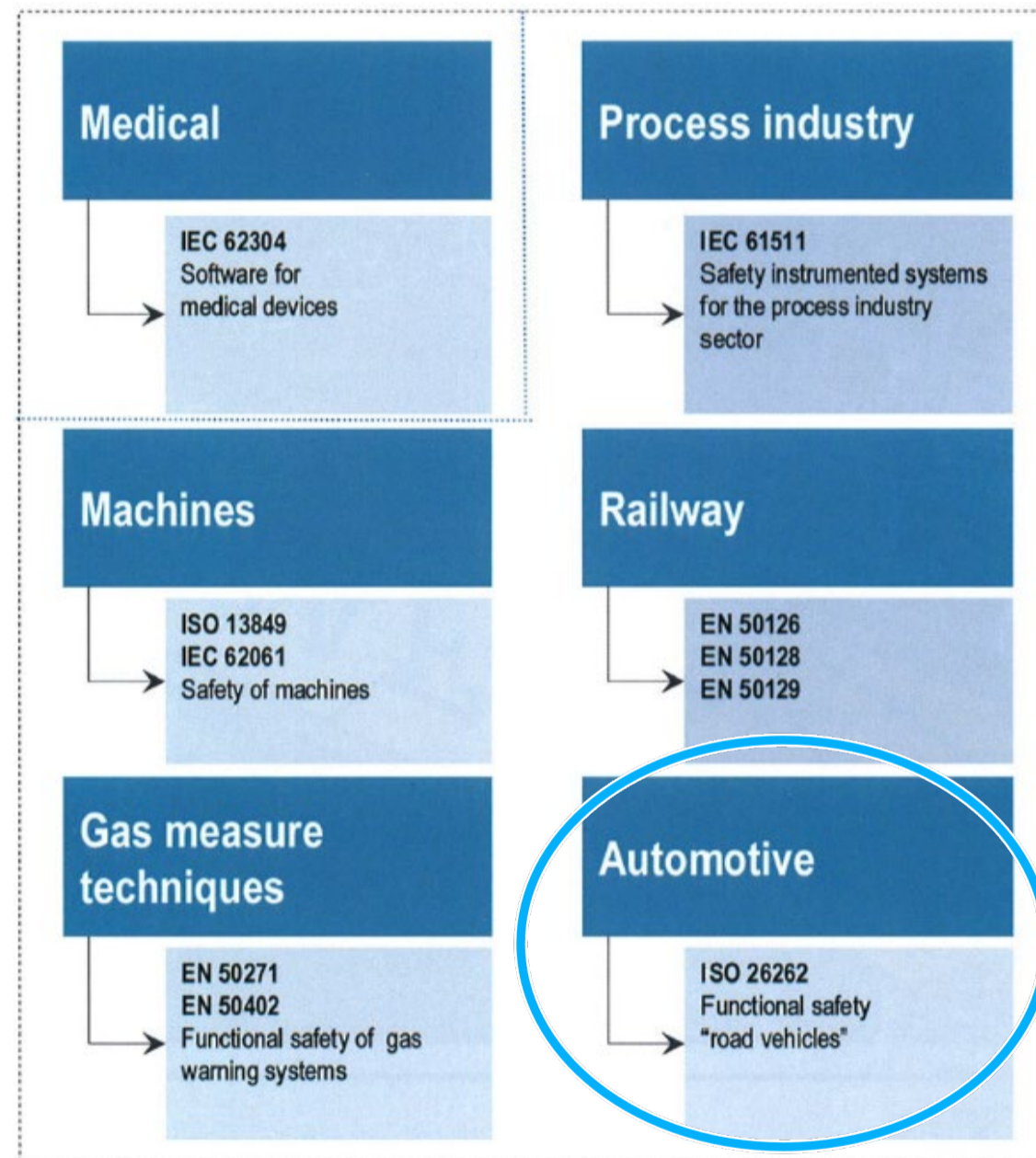
ABSC – SYSTEM ARCHITECTURE



HÜBNER – STEERING TECHNOLOGY

ABSC – MAKE IT SAFE

Norms for the functional safety of electric-electronic systems



ISO 26262 - Valid for the road vehicles sector

1. Vocabulary		
2. Management of functional safety		
2-5 Overall safety management	2-6 Project dependent safety management	2-7 Safety management regarding production, operation, service and decommissioning
3. Concept phase	4. Product development at the system level	7. Production, operation, service and decommissioning
3-5 Item definition	4-5 General topics for the product development at the system level	4-7 System and item integration and testing
3-6 Hazard analysis and risk assessment	4-6 Technical safety concept	4-8 Safety validation
3-7 Functional safety concept		7-5 Planning for production, operation, service and decommissioning
		7-6 Production
		7-7 Operation, service and decommissioning
12. Adaptation of ISO 26262 for motorcycles	5. Product development at the hardware level	6. Product development at the software level
12-5 General topics for adaptation for motorcycles	5-5 General topics for the product development at the hardware level	6-5 General topics for the product development at the software level
12-6 Safety culture	5-6 Specification of hardware safety requirements	6-6 Specification of software safety requirements
12-7 Confirmation measures	5-7 Hardware design	6-7 Software architectural design
12-8 Hazard analysis and risk assessment	5-8 Evaluation of the hardware architectural metrics	6-8 Software unit design and implementation
12-9 Vehicle integration and testing	5-9 Evaluation of safety goal violations due to random hardware failures	6-9 Software unit verification
12-10 Safety validation	5-10 Hardware integration and verification	6-10 Software integration and verification
		6-11 Testing of the embedded software
8. Supporting processes		
8-5 Interfaces within distributed developments	8-9 Verification	8-14 Proven in use argument
8-6 Specification and management of safety requirements	8-10 Documentation management	8-15 Interfacing an application that is out of scope of ISO 26262
8-7 Configuration management	8-11 Confidence in the use of software tools	8-16 Integration of safety-related systems not developed according to ISO 26262
8-8 Change management	8-12 Qualification of software components	
	8-13 Evaluation of hardware elements	
9. Automotive safety integrity level (ASIL)-oriented and safety-oriented analyses		
9-5 Requirements decomposition with respect to ASIL tailoring	9-7 Analysis of dependent failures	
9-6 Criteria for coexistence of elements	9-8 Safety analyses	
10. Guidelines on ISO 26262		
11. Guidelines on application of ISO 26262 to semiconductors		

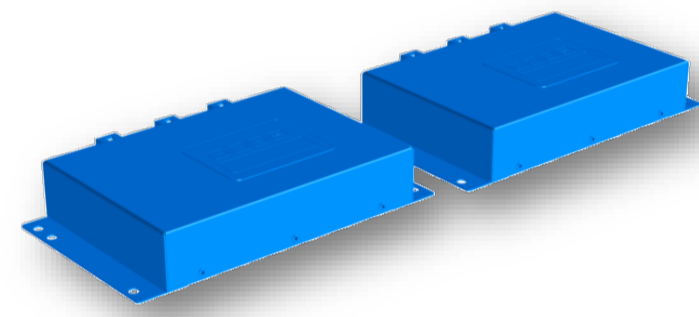
ISO 26262 addresses three Levels:

- Development & Production
- Management & QM
- Tools & Guidelines

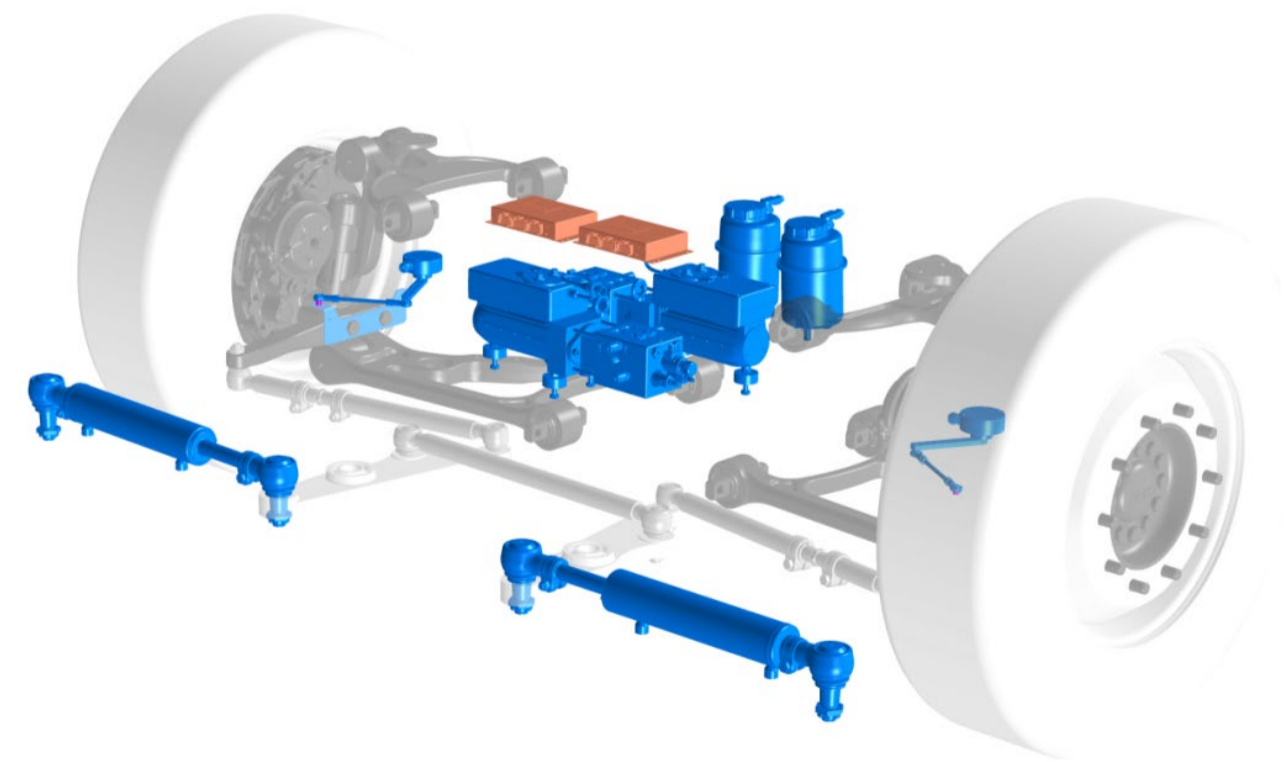


HÜBNER – STEERING TECHNOLOGY

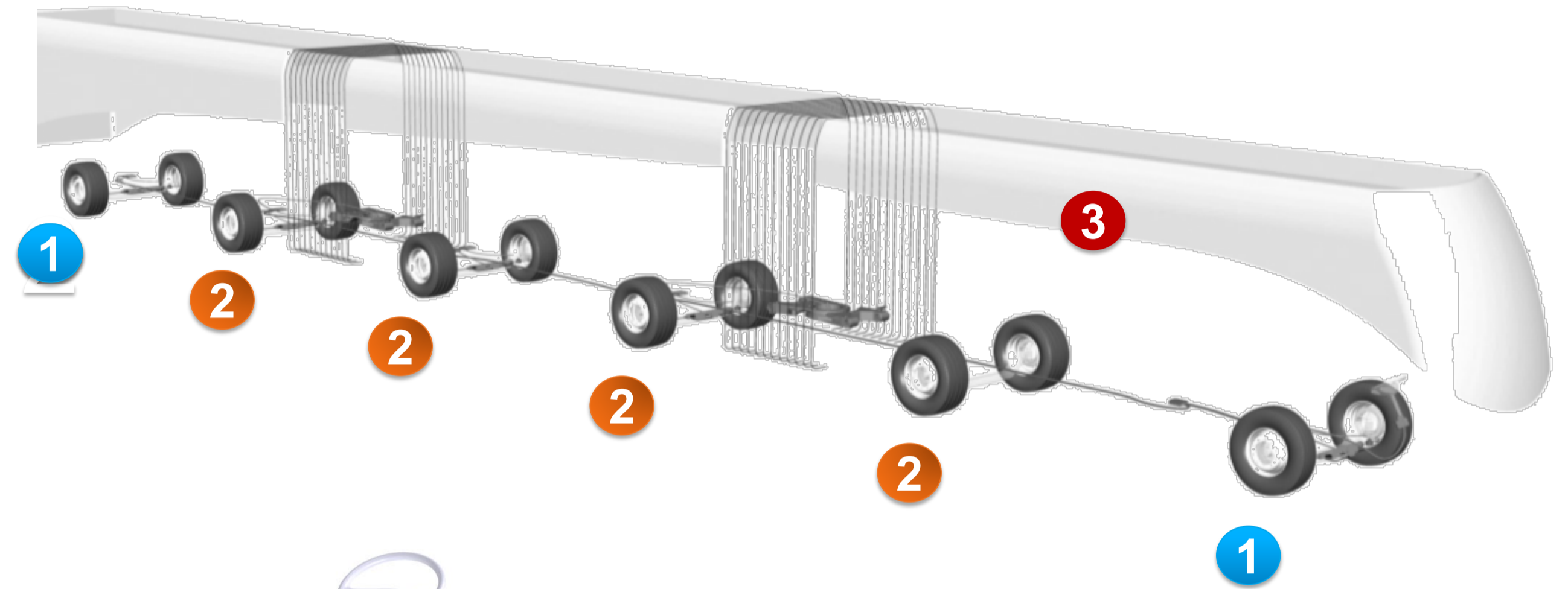
ABSC – MAKE IT FLEXIBLE



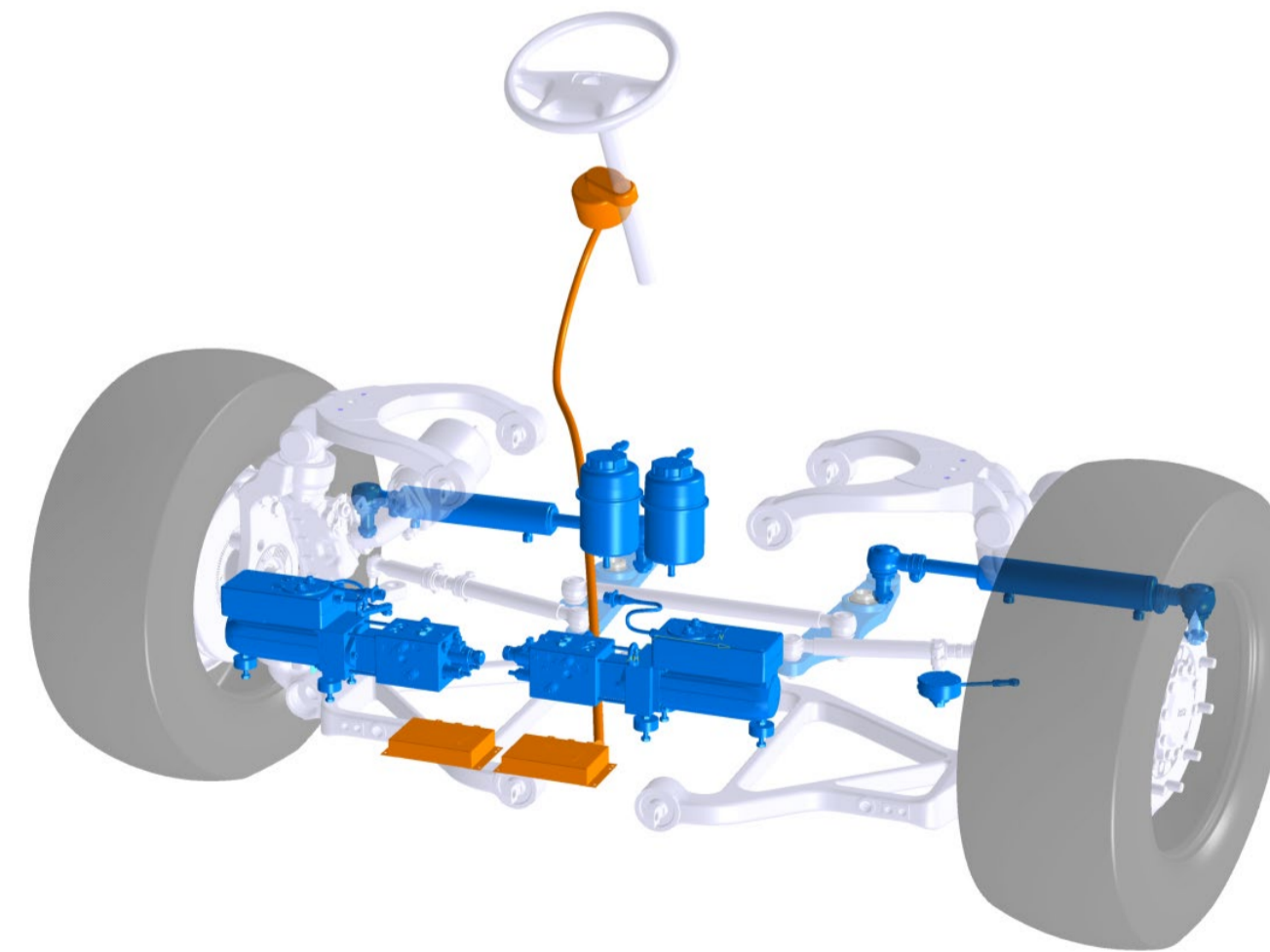
3 *Safe and intelligent steering control*



2 *Independent steering module axle B to E (Fail OP)*



bi-directional



1 *Independent steering module axle A & F with steer by wire option (Fail OP)*



HÜBNER – STEERING TECHNOLOGY

ABSC – MAKE IT HAPPEN



AutoTram Extra Grand
Germany 2012



Delight Tram / ART
China 2017

Proof of concept vehicles based on our steering expertise knowledge

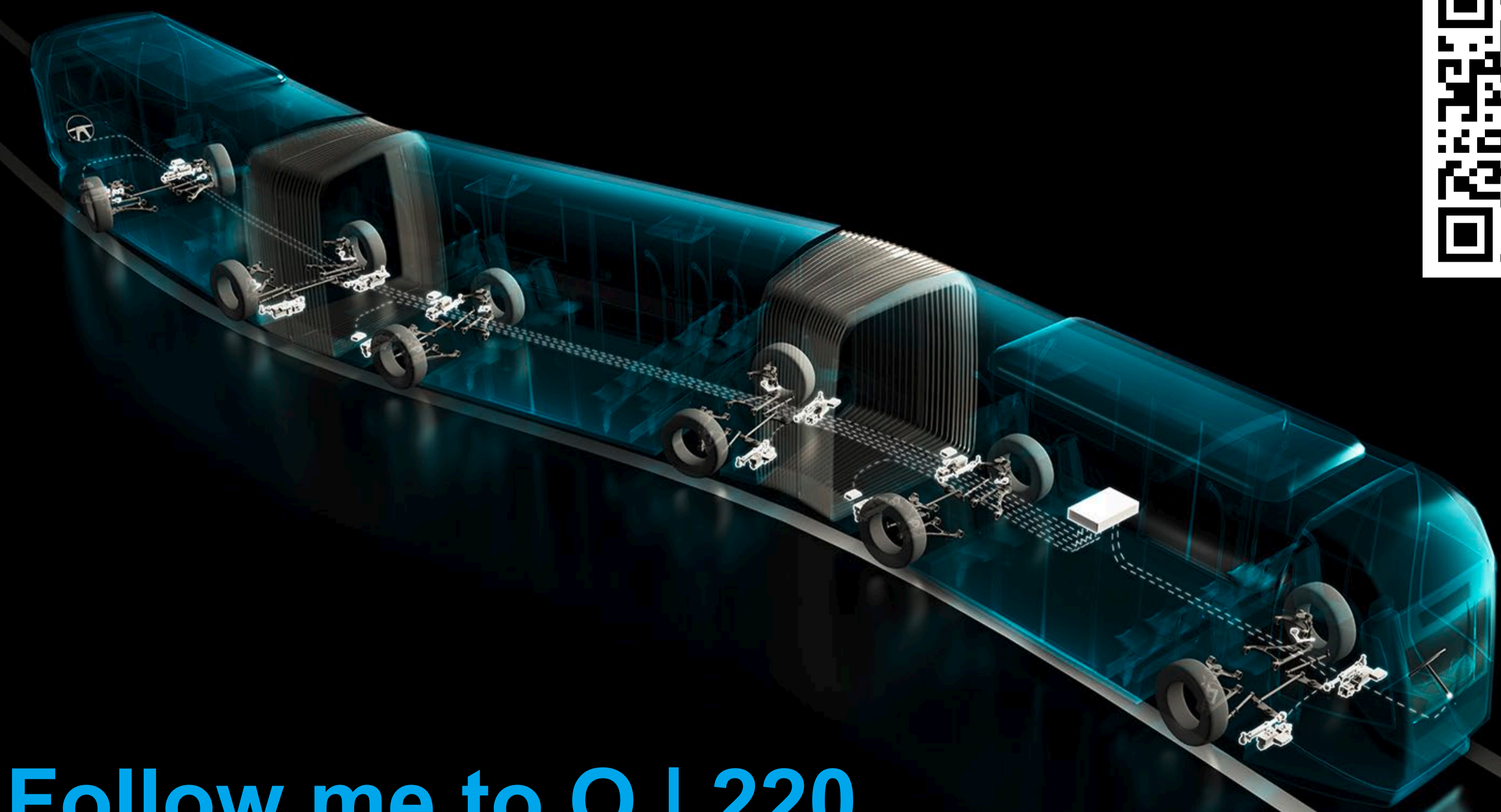


CCB2.0
China 2021



ESLTB (Energy Storage Long Trolley Bus)
China 2020





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