Fully automatic railway operation: Concept and Conditions

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Structure

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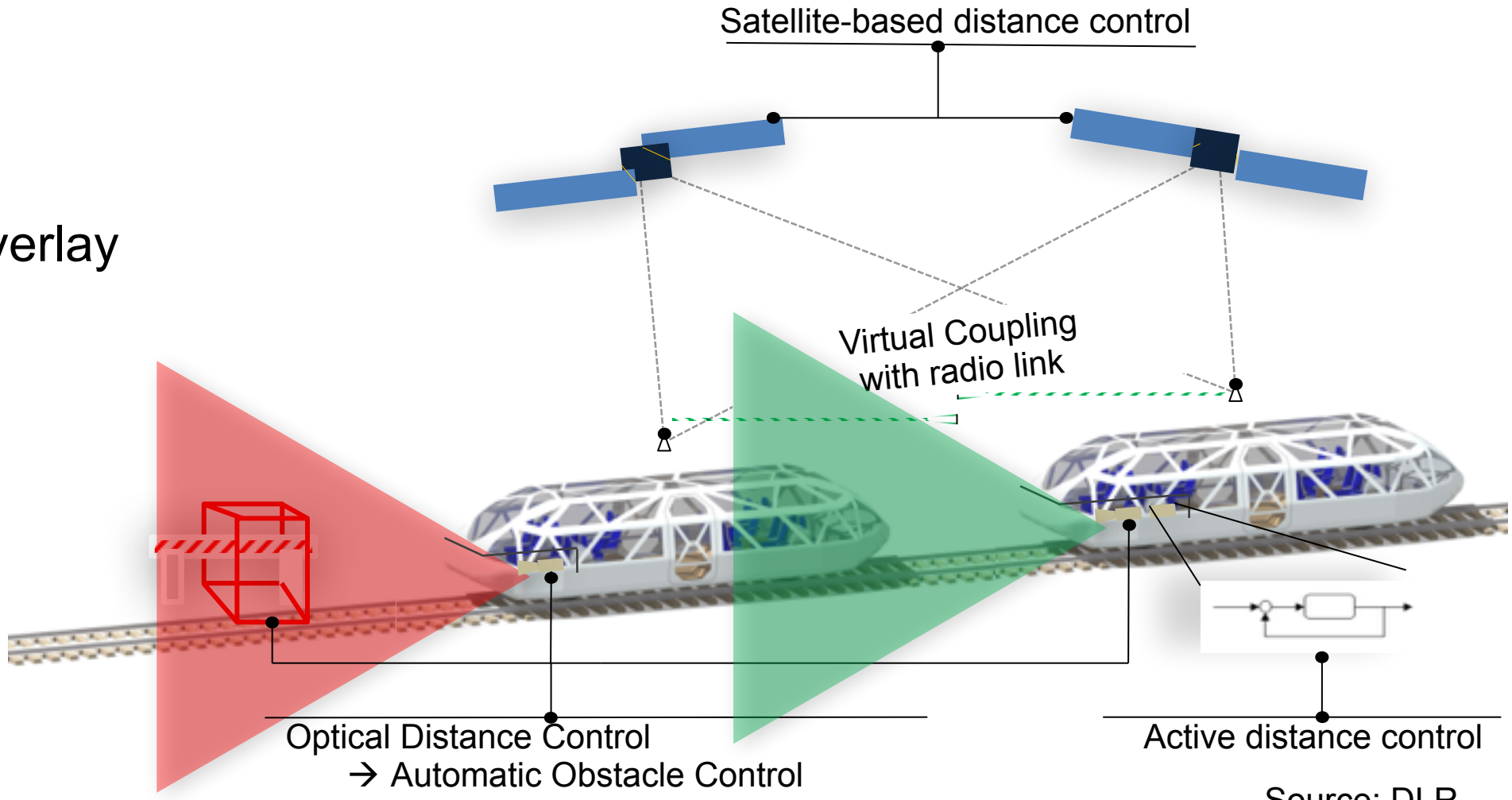


Source: DLR

Introduction

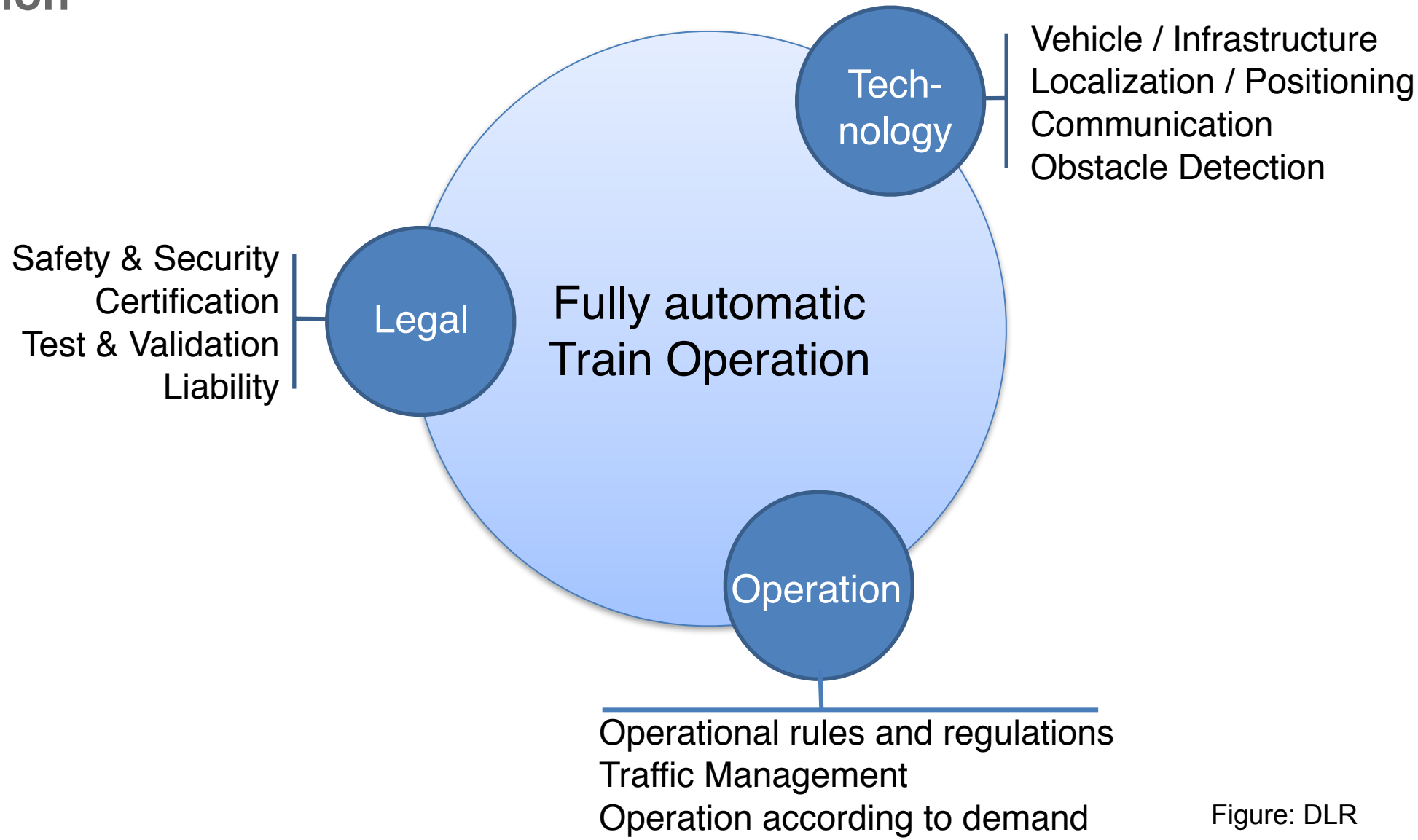


Figure: DLR

Introduction

- Fully automatic train operation is proven in use for Metro and VAL
- Typical well defined and separate infrastructures
- Standardised in IEC 62267 (2009)
- For normal railways less defined and more complex environment and operational conditions

Source: IEC 62267 (2009)

Basic function of train operation		Non-automated train operation	Semi-automated train operation	Driverless train operation	Unattended train operation
		NTO	STO	DTO	UTO
		GOA1	GOA2	GOA3	GOA5
Ensuring safe movement of trains	Ensure safe route	S	S	S	S
	Ensure safe separation of trains	S	S	S	S
	Ensure safe speed	X	S	S	S
Driving	Control acceleration and braking	X	S	S	S
Prevent collision with obstacles or persons		X	X	S	S
Supervising passenger transfer		X	X	X or S	S
Operation a train	Put in or take out of operation	X	X	X	S
	Supervise the status of the train	X	X	X	S
Ensuring detection and management of emergency situations		X	X	X	S and/or staff in OCC
Note X = responsibility of operations staff (may be realised by technical system) S = realised by technical system					

Concept: Overlay / Evolution

- The Train fulfils current standards and operational requirements and is equipped with a regular train control system as e.g. European Train Control System (ETCS)
- Evolutionary development starting from up-to-date automation and driver assistance systems (as e.g. German “Automatische Fahr- und Brems-steuerung - AFB)
- Continuous development up to higher levels of automation using the driver for supervision in intermediate steps
- Prospectively the operations control center can remotely control (“drive”) the train in the case of disturbances

Photo: bigbug21, wikiepedia

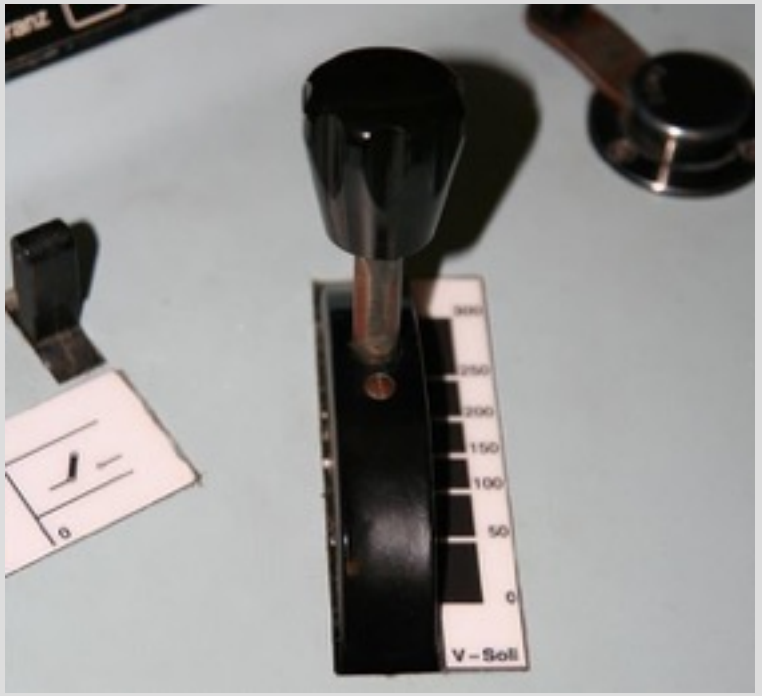


Photo: S. Ingolstadt, Wikipedia

Concept: Intermittent

- **Global approach: Starting the automation in segments, where full automation is less difficult to implement:**
  - Fully automatic operation on track segments, where few and higher automatic elements are
  - The driver runs the train on the more complex segments (e.g. station entry)
- In the first step the driver supervises the automation. In further steps the driver could leave the drivers cabin and will be alerted by a portable device
- Prospectively the operations control center can remotely control (“drive”) the train in the case of disturbances

Bilder: DLR

Concept: Reductive

Objective: Reduction to the absolute necessary with respect to operation, so:

- No or minimal special cases in operation (and engineering)
- No drivers desk – only remote control
- No (or only minimal) fallback procedures
- Consequent elimination of the human driver (present in the train) from all legislative and operational rules and regulations
- Consequent Design of Station Layout, Tracks and Vehicles for full automations

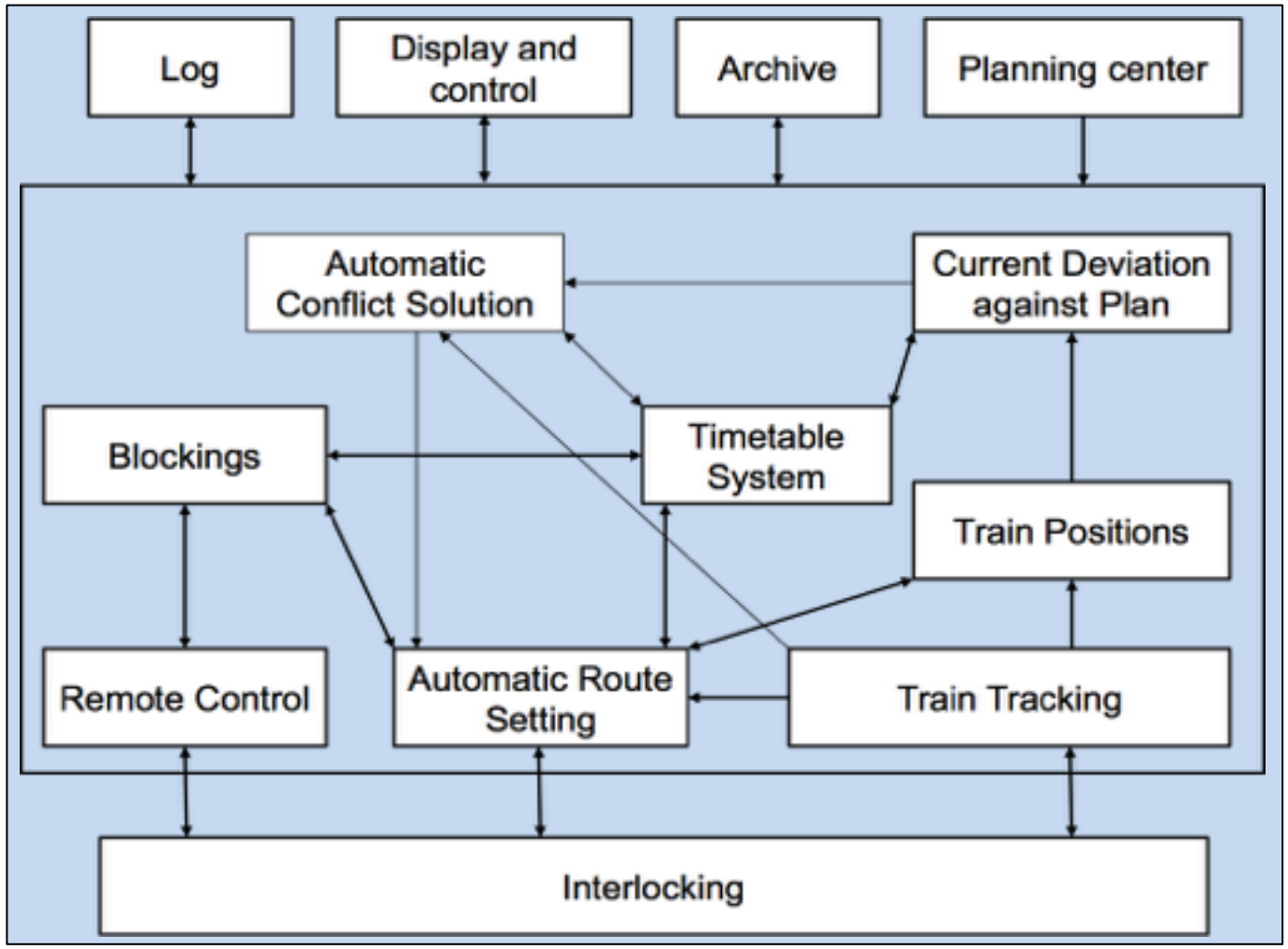
Photo: Occitandu34, wikiepedia

Photo: J.G.H. Jähnick, Wikipedia

Operational Aspects

- **Fully automatic operation proven in use for Metros**
- Operational handbooks typically contain a “hidden engine driver” – actions to be taken by the driver under normal or disturbed conditions
- Existing operational concepts for fully automatic train operation normally use reduced sets of manoeuvres
- Operational rules need to be adopted to fully automatic operation. Especially in fall-back situations

Source: W. Mücke (2008)



Technical and Functional Aspects

- Many technologies are available and proven in use or prototypically tested
- Modern continuous train control systems as the European Train Control System (ETCS) Level 2/3 are a solid base to start with
- System architectures are proven in use
- Some major issues are still to be solved:
  - Reliable and precise localisation
  - Reliable communication
  - Obstacle detection
  - Cyber security

Functional Issue	TRL	Status
Automatic speed supervision	9	e.g. ETCS
Speed control, automatic acceleration and braking	9	
Route setting and protection	9	e.g. interlocking
Train-autonomous localisation	7 – 8	
Train integrity for multiple units	9	Proven in use
Train integrity for freight trains	4 – 6	Not globally solved
Obstacle detection	5 - 7	Still under evaluation

Conditions: Legal Aspects

- Well-defined safety and certification standards …
- … but different by country
- Unequal requirements to technology and safety according to penal law and civil law

	Functional and certification step	Remark / Example
1	Technology evaluation without safety responsibility	Already today
2	Local and temporal automatic driving with driver on board	E.g. with portable control device
3	Full automatic operation with driver on board	E.g. with portable control device
4	Full automatic operation with driver remote for the case of disturbance	E.g. in the operations control centre
5	Full automatic operation without driver	

Conditions: Legal Aspects

- Well-defined safety and certification standards …
- … but different by country
- Unequal requirements to technology and safety according to penal law and civil law
- The legal obligations need to be followed as well as reliability needs to demonstrated to gain confidence

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Conclusion and Perspective

Conclusion

- Many Technologies are there – localisation, obstacle detection and cyber security are the main issues to be solved
- Operational and especially legal conditions are major challenges, which need to be solved

Perspective

- The sector has accepted the challenge
- Fully automatic railway operation will bring new use cases and business cases

Fully automatic railway operation: technical, operational and legal aspects

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