

ROAD INFRASTRUCTURE SUPPORT LEVELS FOR AUTOMATED DRIVING

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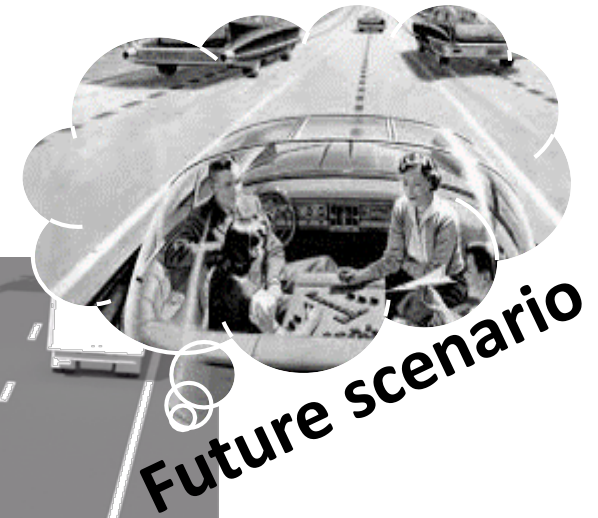
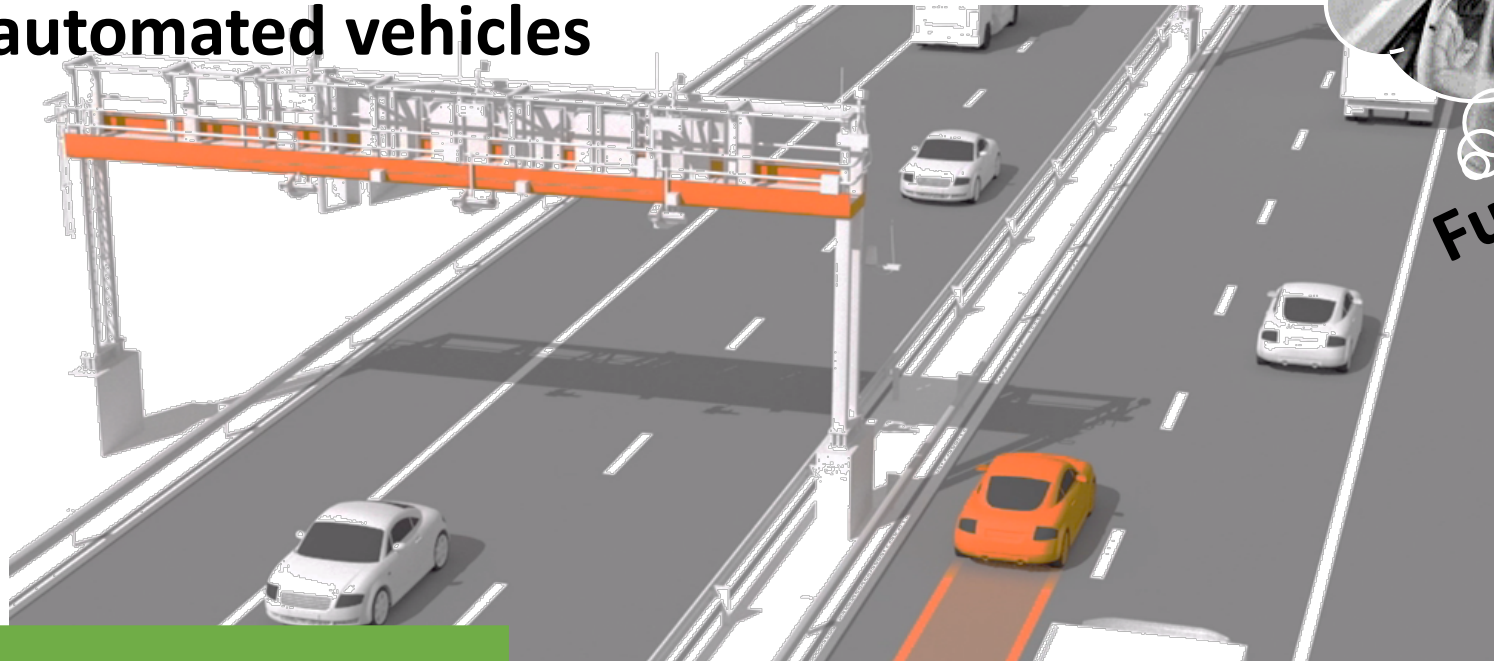


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AUTOMATED DRIVING IN MIXED TRAFFIC

First: mixed traffic of conventional, connected and automated vehicles



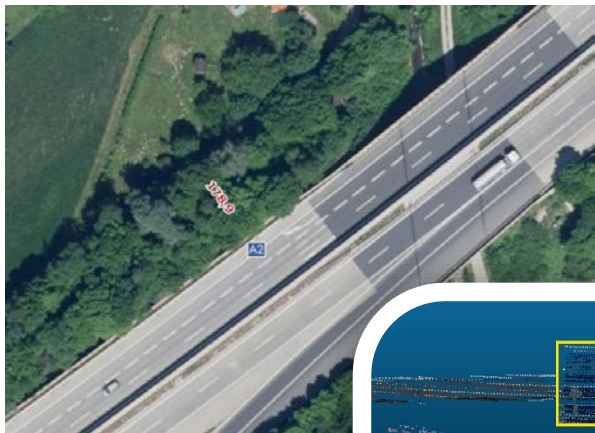
Safe and efficient traffic flow

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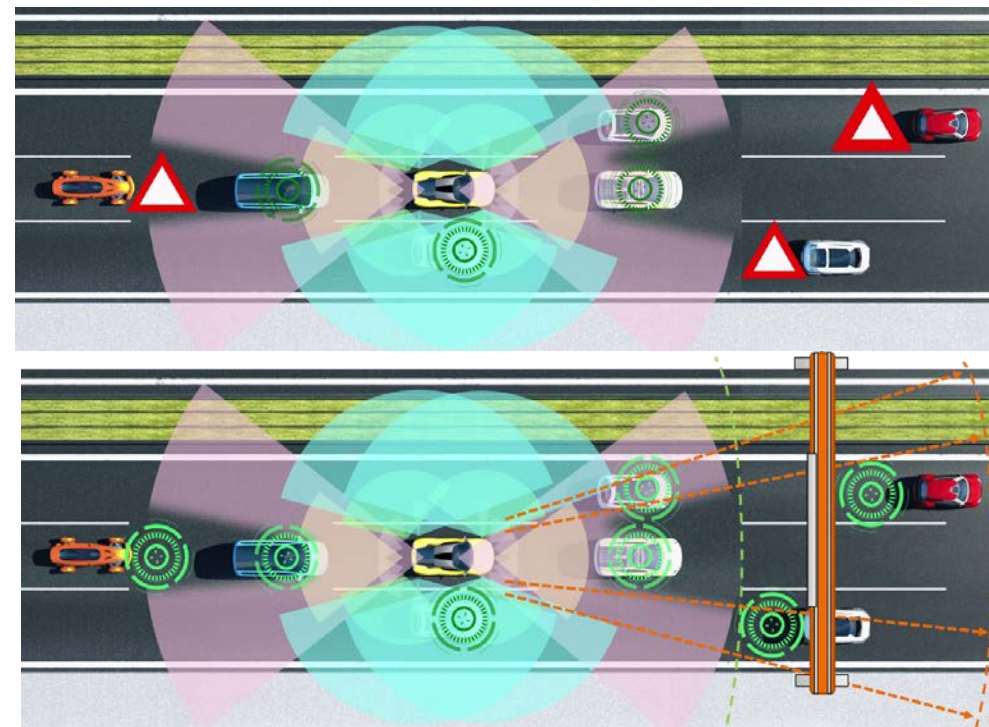


VEHICLES' PERCEPTION IN MIXED TRAFFIC

supported by map data



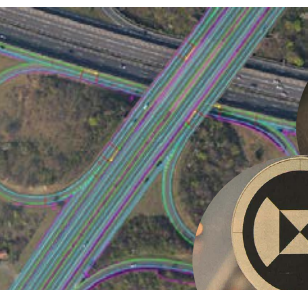
limited without additional (virtual)
sensors
e.g. road infrastructure data



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ROAD OPERATOR INFORMATION



Static data:
Lane markings, landmarks, map



V2X communication

- communication to indicate safety critical information
- guide vehicles through the traffic by using the information provided by infrastructure sensors

GNSS correction signals
Environmental perception

Readability of static message signs and VMS



Digital content of VMS, weather data, etc.



Dynamic data:
Incident data, position of roadwork zones, ground truth

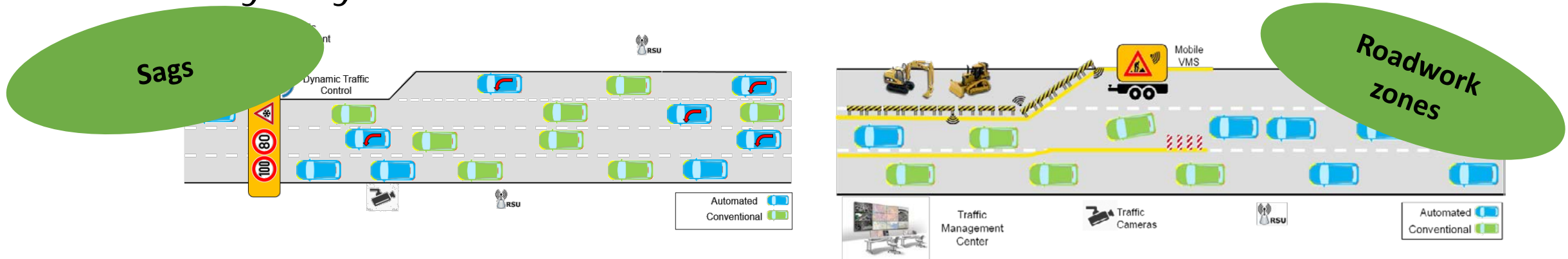


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AUTOMATED DRIVING MANOEUVERS IN MIXED TRAFFIC

In everyday mixed traffic situations like

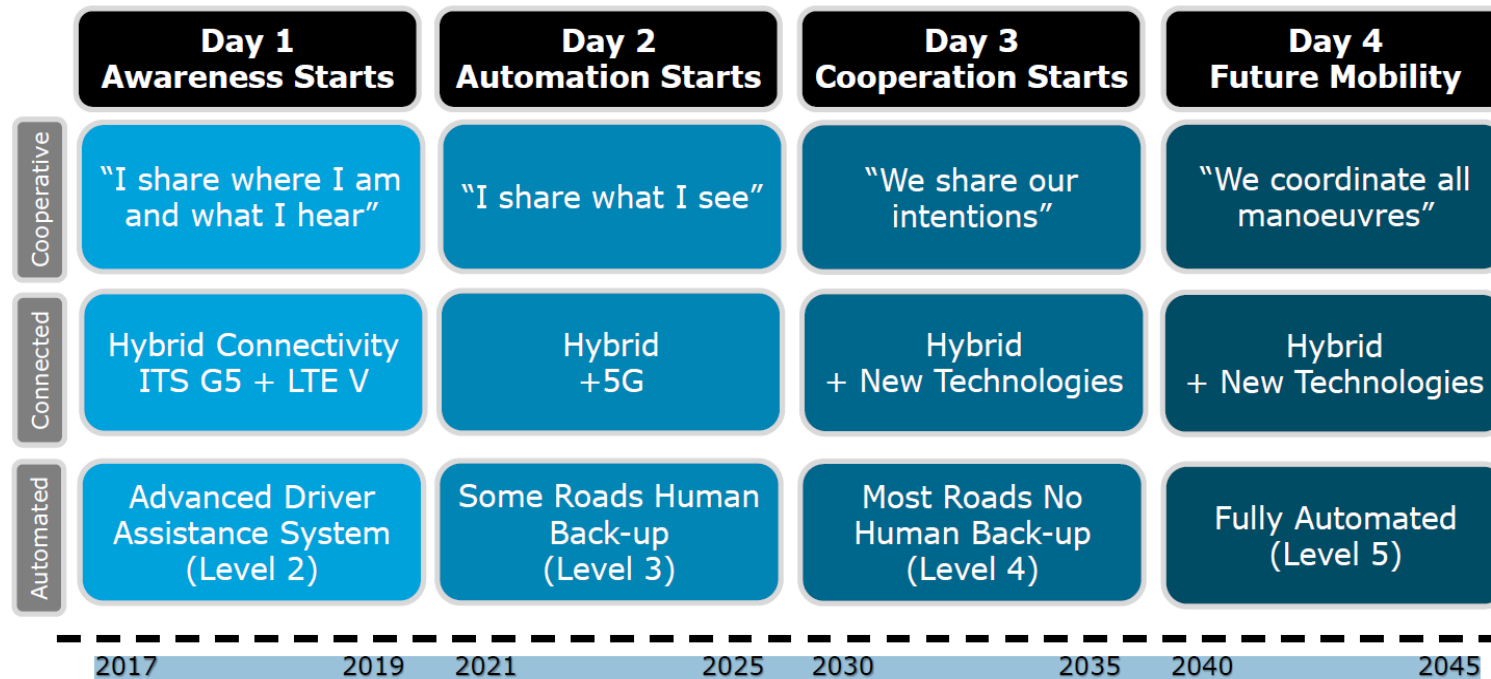


Infrastructure can support guiding automated and connected vehicles through the traffic flow by physical infrastructure elements and by infrastructure data sharing as a valid base for on-board decision making.

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INFRASTRUCTURE SUPPORT LEVELS - APPROACH



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INFRASTRUCTURE SUPPORT LEVELS FOR AUTOMATED DRIVING (ISAD)

	Level	Name	Description	Digital information provided to AVs			
				Digital map with static road signs	VMS, warnings, incidents, weather	Microscopic traffic situation	Guidance: speed, gap, lane advice
Digital infrastructure	A	Cooperative driving	Based on the real-time information on vehicle movements, the infrastructure is able to guide AVs (groups of vehicles or single vehicles) in order to optimize the overall traffic flow.	X	X	X	X
	B	Cooperative perception	Infrastructure is capable of perceiving microscopic traffic situations and providing this data to AVs in real-time	X	X	X	
	C	Dynamic digital information	All dynamic and static infrastructure information is available in digital form and can be provided to AVs.	X	X		
Conventional infrastructure	D	Static digital information / Map support	Digital map data is available with static road signs. Map data could be complemented by physical reference points (landmarks signs). Traffic lights, short term road works and VMS need to be recognized by AVs.	X			
	E	Conventional infrastructure / no AV support	Conventional infrastructure without digital information. AVs need to recognise road geometry and road signs.				

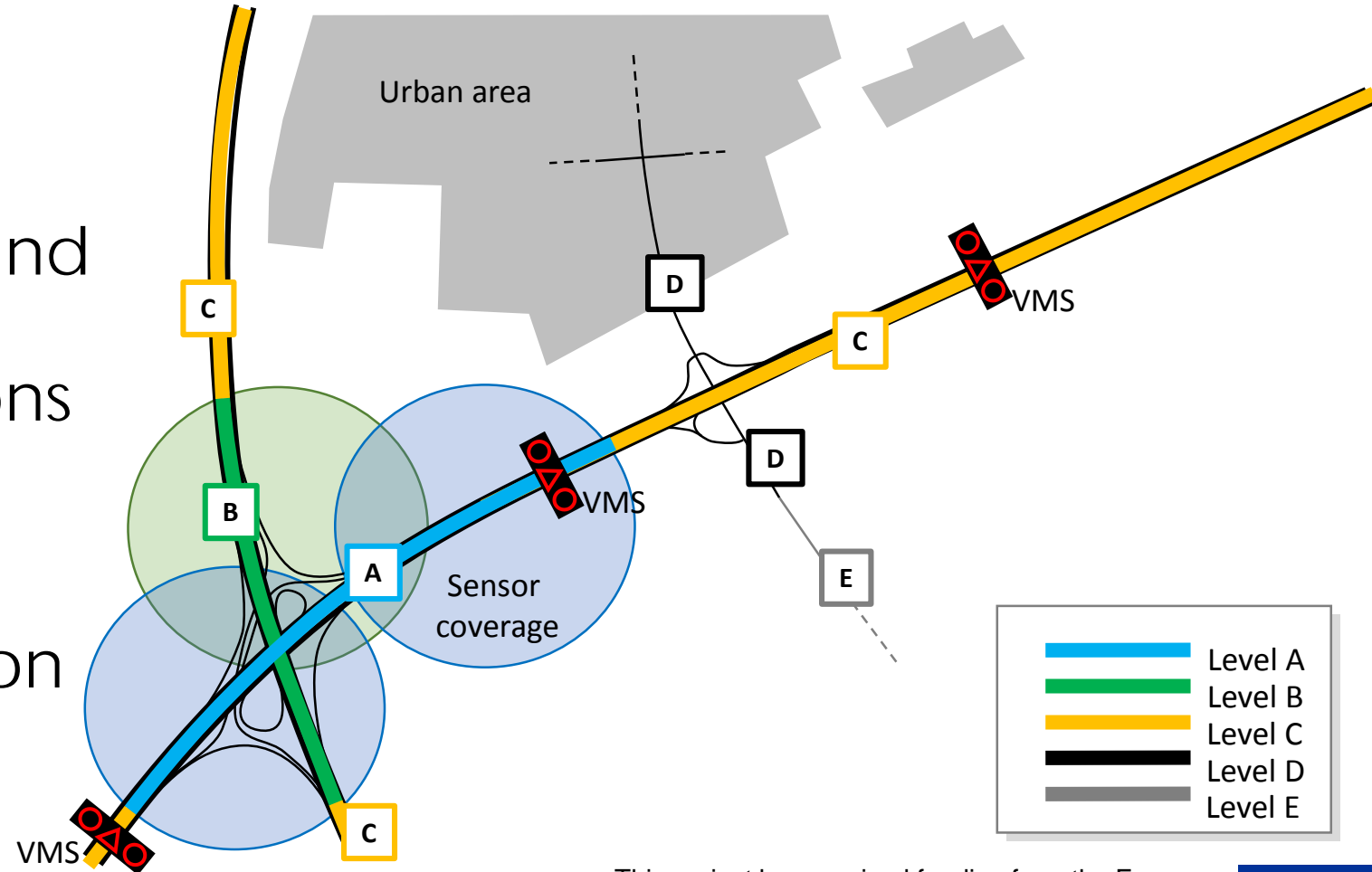
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ISAD ON SCHEMATIC ROAD SEGMENT

- Level of information and services different on-board vehicle decisions can be supported

→ Additional information for CAVs



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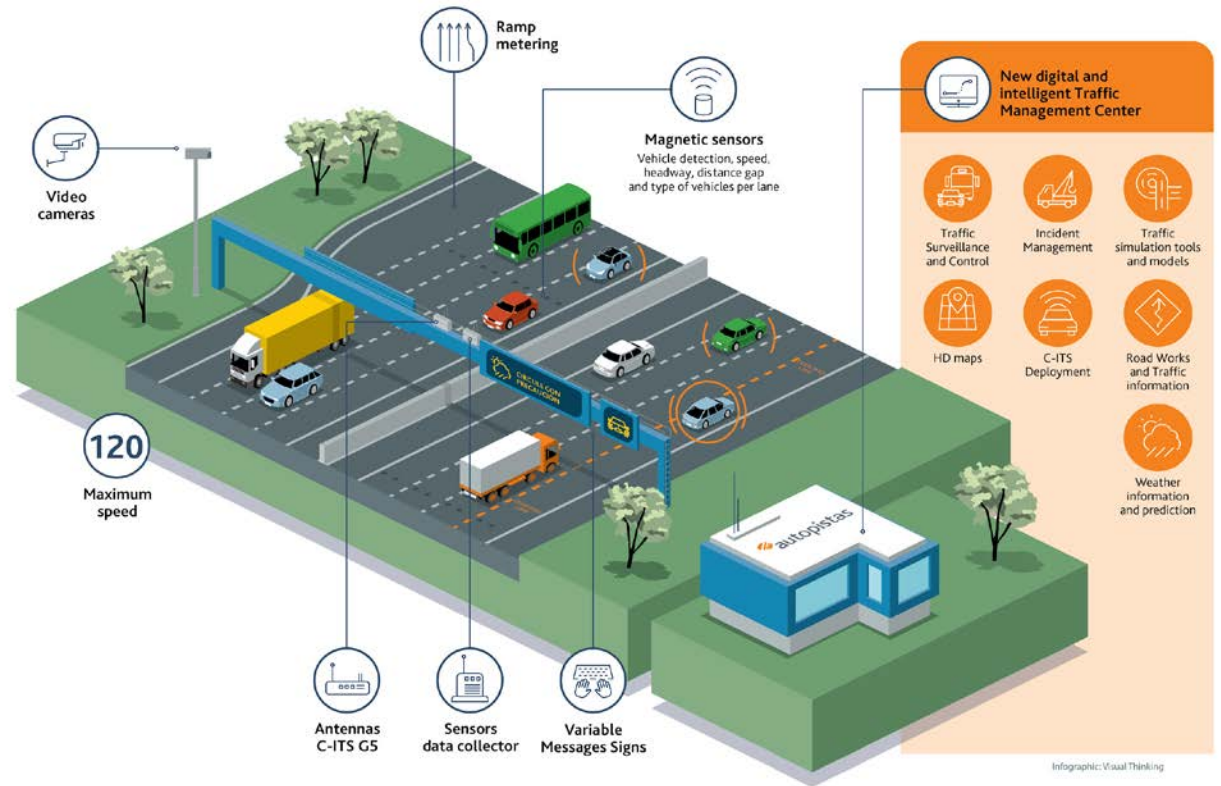
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Road infrastructure:

- Length: 20 km
- Lanes: 4+4
- Intersections: 4+4
- Exits: 4+4

Physical & digital infrastructure:

- Cameras: 8
- Traffic detection: 100 sensors
- Variable message signs: 7
- C-ITS G5 service: 10 RSUs
- DATEX II interface



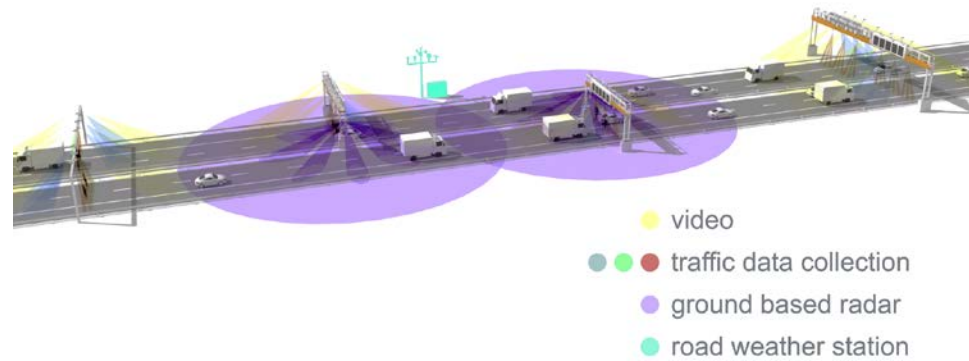
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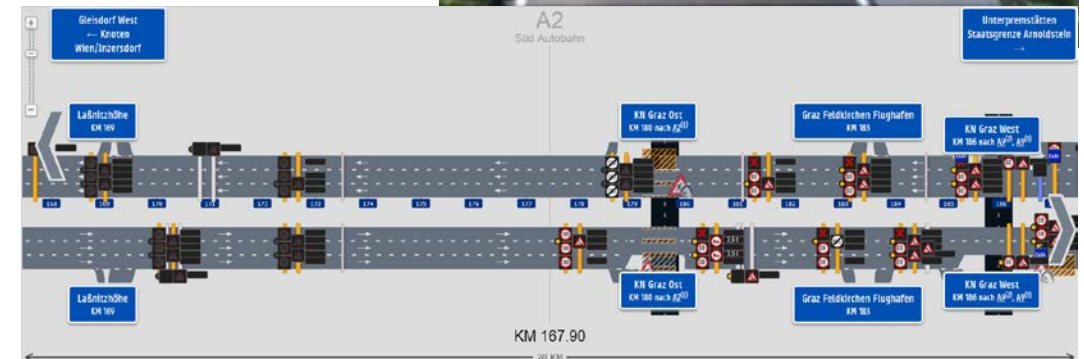
Road infrastructure:

- Length: 23 km
- Lanes: 3 + 3
- Intersections: 2
- Exits: 2



Physical & digital infrastructure:

- Cameras: 22
- Radar sensors: 3
- Traffic detection: 8 Gantries with traffic detection
- Variable message signs: 12
- C-ITS G5 service: 12 RSUs
- DATEX II interface



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CONCLUSION

- Road infrastructure can provide additional information for on-board decisions of CAVs
- A classification of infrastructure support is needed
 - common understanding between OEMs, automotive industry and road operators
 - More use-cases have to be defined to understand the potential of ISAD in mixed traffic

OPEN DISCUSSION



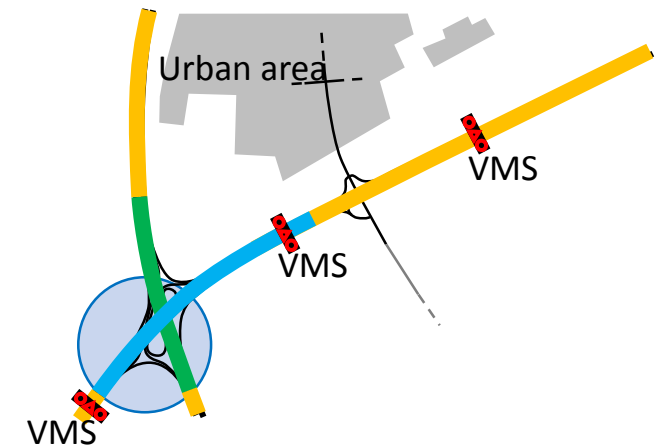
ISAD = Infrastructure support levels for automated driving



Anna Carreras and Xavier Daura



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