MANTRA

Main results

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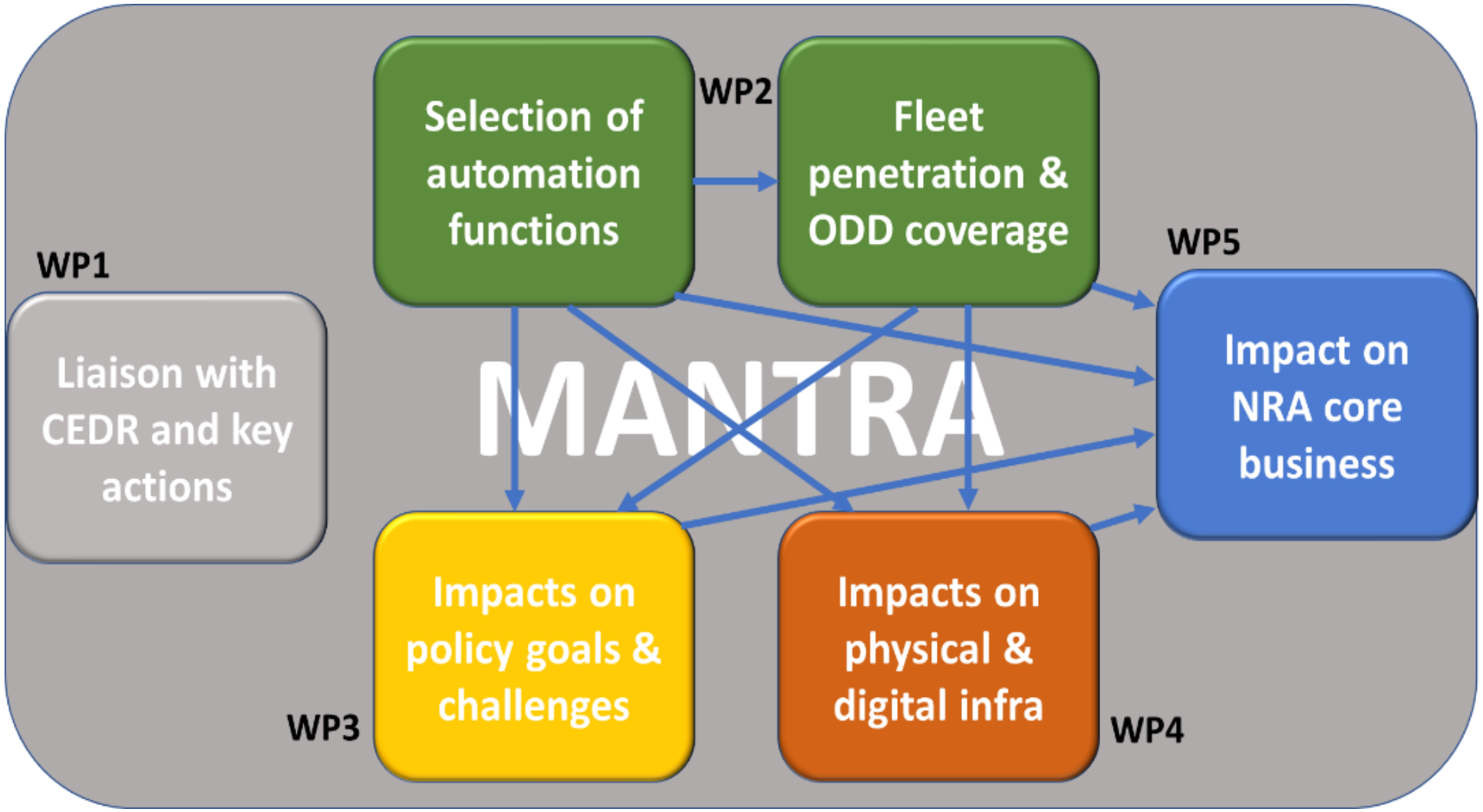
The project

- MANTRA = Making full use of Automation for National Transport and Road Authorities
- MANTRA responds to the question posed in CEDR Automation Call 2017 Topic A: How will automation change the core business of NRA's
- Duration: 1 Sep 2018 – 31 August 2020

Project structure & use cases



Use cases in analysis

- Highway autopilot/ chauffeur
- Highly automated (freight) vehicles on open roads including platooning
- Commercial driverless vehicles as taxi services
- Driverless maintenance and road works vehicles
  - Safety trailers
  - Winter maintenance vehicles

Vehicle km (flow) penetrations (D2.1)

MANTRA Use case	Fleet	Vehicle km penetration (%)			
		2030		2040	
		Low	High	Low	High
Highway chauffeur and autopilot	Cars	1.3	6.6	11.1	47.2
Automated freight vehicles	HGVs	0.8	5.1	12.4	59.5
Robot taxis	Taxis	0.0	8.6	5.7	72.6
Automated winter maintenance vehicles	Maintenance HGVs	0.0	1.3	6.9	24.0
Automated roadworks safety trailers	Safety trailers	3.9	8.9	14.7	39.7

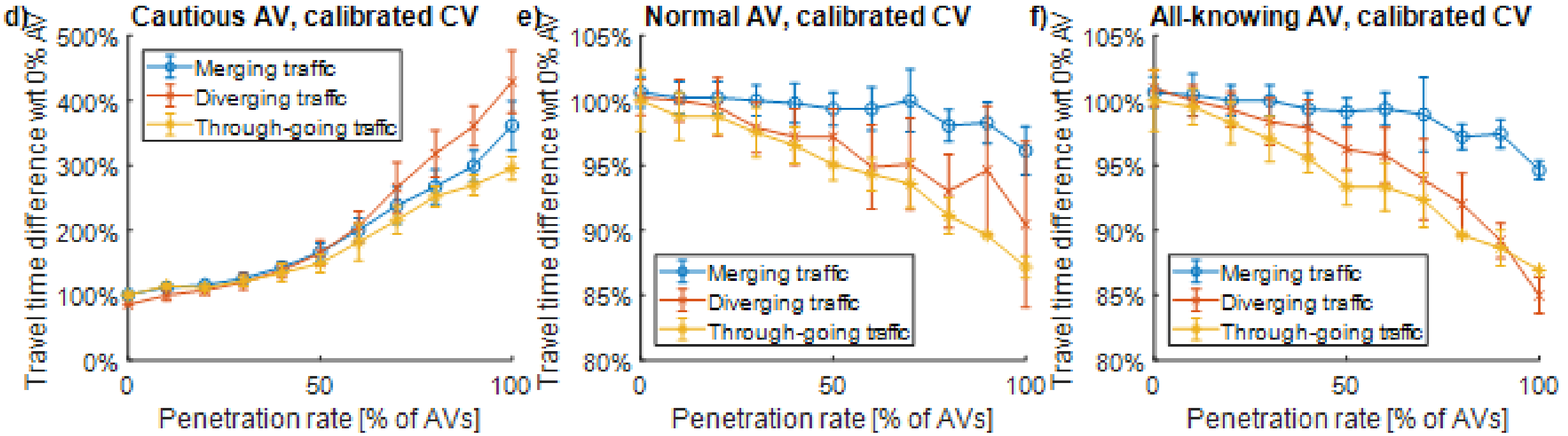


Figure 3.17 Comparison of different AV driving logics (cautious, normal, all-knowing) and different conventional vehicles (default, calibrated), modelled on a weaving section with a 300m taper lane and 0.85 flow/capacity ratio.

Headway for Avs: Cautious 1.5 s – Normal 1.0 s – All-knowing 0.6 s

Road operator related ODD attributes

ODD attribute	Physical / Digital infrastructure	Static / Dynamic
Road	Physical	Static
Speed range	Physical	Static
Shoulder or kerb	Physical	Static
Road markings	Physical	Static
Traffic signs	Physical	Static
Road equipment	Physical	Static
Traffic	-	Dynamic
Time incl. light conditions	-	Dynamic
Weather conditions	-	Dynamic

ODD attribute	Physical / Digital infrastructure	Static / Dynamic
HD map	Digital	Static/ Dynamic
Satellite positioning	Digital	Static
Communication	Digital	Static
Information system	Digital	Static
Traffic management	Digital	Dynamic
Infrastructure maintenance*	Physical/Digital	Dynamic
Fleet supervision*	Digital	Dynamic
Digital twin of road network*	Digital	Dynamic

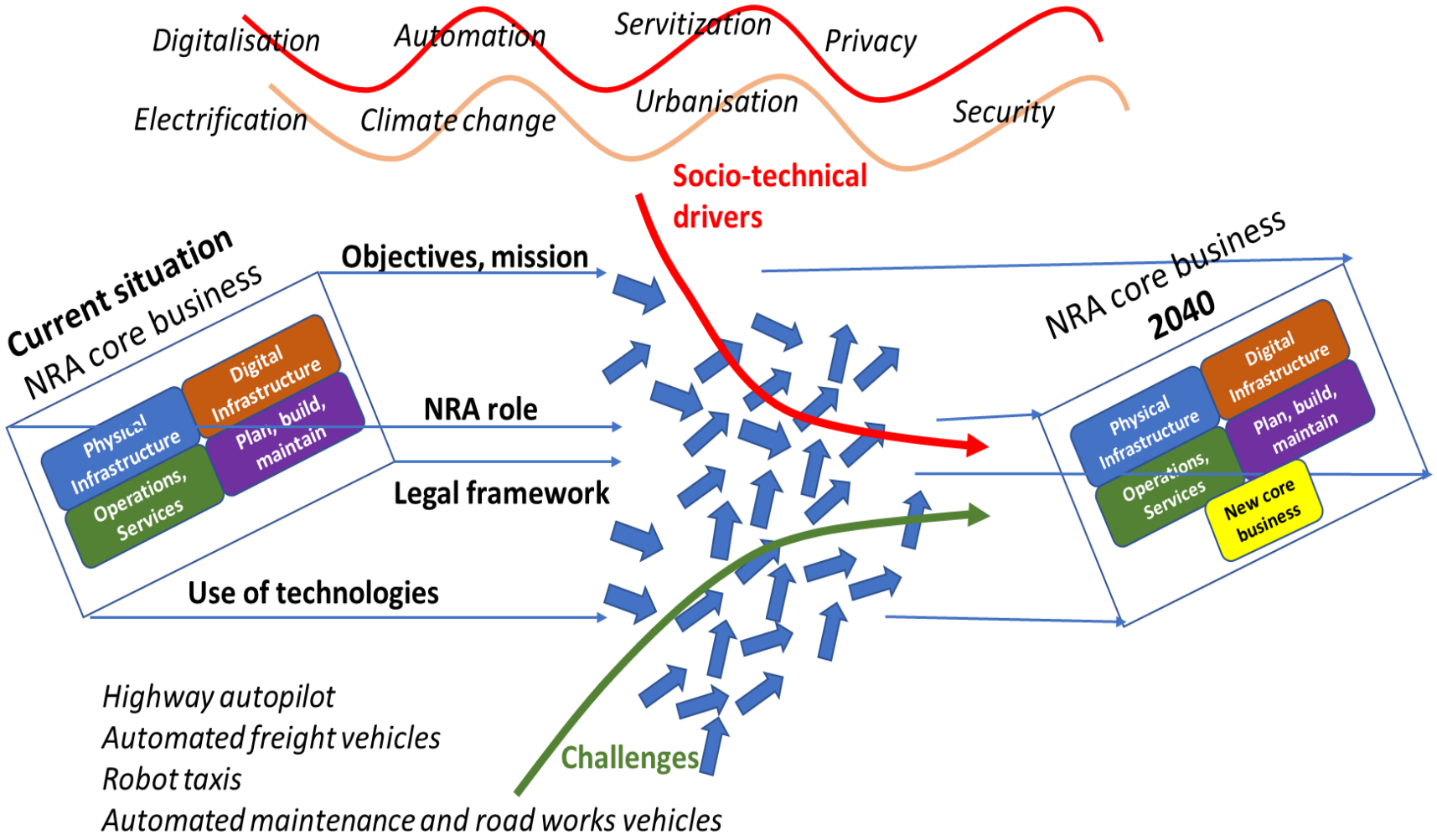
* Added by MANTRA on the basis of input from EU EIP and CEDR workshops

Results on unit costs:

Costs can be quite high esp. for phy-sical infra (D4.2)

ODD attribute	Detailed feature	Unit cost range estimate (deployment)	O&M annually
Shoulder or kerb	Safe "harbours"	40-100 k€/km where needed	8 %
	Passenger pick-up/drop-off point	2-5 k€/point where needed	10 %
Markings and signs	Enhanced maintenance of markings, signs & signals	0.1-0.2 k€/km/a	included
Road furniture	Landmarks for positioning enhancement	4-6 k€/km where needed	10 %
	Signs and/or barriers for access control	15-90 k€/km where needed	8 %
	Game fences	20-30 k€/km where needed	2 %
Traffic management	Standardized marking & efficient management of road works zones, incident/event sites, toll plazas	3-5 k€/km/a	included
	Adaptation of traffic centres, systems and services	10-90 k€/km	8 %
Maintenance	Enhanced snow-removal	2-2.5 k€/km /a (2-lane roads) 3-4 k€/km/a (motorways)	included
HD map non-LIDAR	HD Maps or road areas, infra, equipment	3-4 k€/km	8 %
	HD Maps of road structures for maintenance purposes	5-7 k€/km	8 %
	Road areas & environment	1-3 k€/km/a	included
HD map LIDAR	Road areas & environment with LIDAR point clouds	3-6 k€/km/a	included
GNSS land stations	Satellite positioning enhancement with land stations	0.4-2 k€/km	8 %
Longer range V2I	Base station (micro or macro)	35-40 k€/station/a (macro) 8-10 k€/station/a (micro)	included
Short range V2I	Roadside station	15 k€/km	8%
	Connecting to trunk communication network and servers	fibre optics 20 - 100 k€/km	8 %
Problem and regulation information	High quality real-time situational picture & rules and regulations	Interurban 0.4-0.8 k€/km/a urban 0.1-0.2 k€/km	included
Road works information	VMS/C-ITS warnings	0.5-0.9 k€/km/a	included

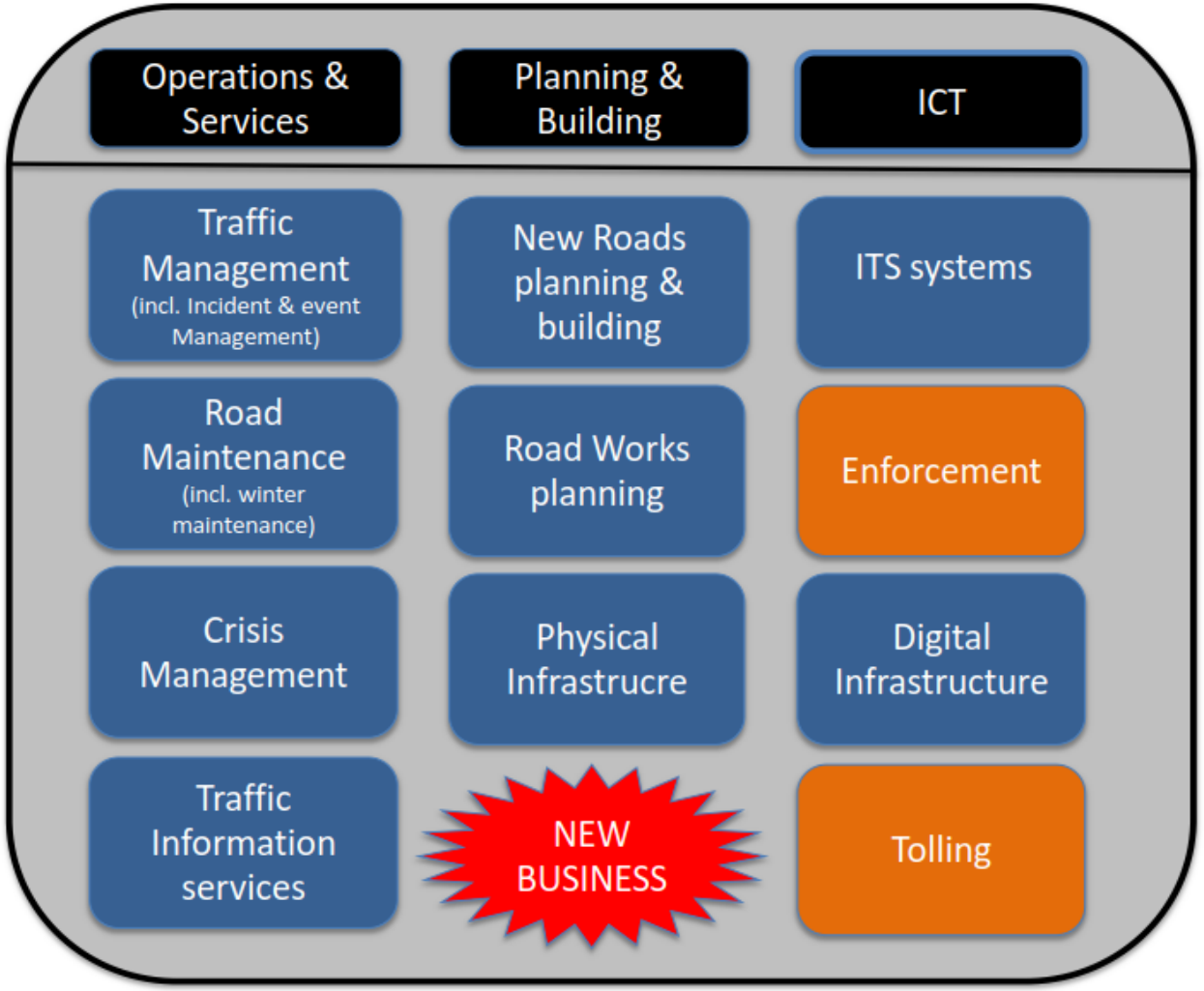
Adaptations to NRA core business – approach (D5.2) MANTRA



- Input from previous work in MANTRA
- Desktop analysis
- PEB workshop on 13 March 2020
  - » 92 actions
- Survey of priorities directed to NRAs and experts- deadline 30 April
- 45 responses
  - » 22 priority actions

Core business areas of road operators

- Physical road infrastructure
- Digital infrastructure
- Operations and services
  - » incident and event management
  - » crisis management
  - » traffic management and control
  - » road maintenance
  - » winter maintenance
  - » traffic information services
  - » enforcement
  - » road user charging
- Planning, building, heavy maintenance
  - » new roads planning and building
  - » road works planning and management
  - » heavy maintenance planning
- New business.



Description of priority actions

TM2	Digitalise traffic rules and regulations
Business area	Traffic management and control
Description of action	The rules and regulations including current traffic management measures in force need to be digitised and made available to automated vehicles and other stakeholders in need of this information such as fleet operators and managers, police, rescue organisations, and security establishments. Specific access points to digital traffic rules and regulations (e.g. a Trusted Electronic Regulations Access Point) and ODD related infrastructure attributes need likely to be set up to facilitate the cooperative traffic management in practice as well as to provide this necessary safety-relevant information to automated vehicles in a comprehensive manner. The rules need to included restrictions imposed to the automated use of vehicles or specific use cases due to inappropriate MRMs or other reasons. High level data security is necessary for these access points.
Timeframe	2021-2025 Studies, pilots, cross-sectoral agreements, standardisation (METR standardisation already commenced); pilot deployments by fore-runners 2026-2030 Deployment; development and standardisation of Trusted Electronic Regulations Access Points or similar
Aspect of CAD affected	Planning of routes and target speeds
Stakeholders affected	Ministries, road authorities and operators, transport safety agencies, traffic management operators, police, OEMs, fleet operators and managers, ADS developers and providers, drivers and users of connected and automated vehicles
Legal prerequisites	European regulation is needed to mandate the setting up, maintaining and operating access points for digital traffic rules and regulations with specific quality and coverage.
Responsibilities	Owner/champion: Ministry or a road safety agency under it; necessary stakeholders: traffic managers, road authorities and operators, OEMs, ADS providers, fleet operators and managers, police; Other stakeholders: drivers and uses of connected and automated vehicles
Role of CEDR/NRAs	NRAs to participate in studies and pilots as well as deployment depending on their national role.
Risks involved	Risk of vendor-specific solutions.
Other relevant aspects	Physical signs are still needed as long as the system includes human driven vehicles and other human road users.

Classification of priority actions

- Actions with no regret – actions useful also for human-operated vehicles to be carried out due to present needs and other developments;
- Study and learn – actions to find out more about the technology, operation, benefits, costs and implementation issues in order to understand the potential, restrictions and feasibility of automated driving;
- Key actions for deployment – actions to safeguard NRA interests and with major future impact on NRA investments and operations.

- Most actions primarily in the "*Study and learn*" category

No regret actions

- Machine readability and digital twins of road signs (PI2)
- Road markings of sufficient retro-reflectivity in different conditions (PI3)
- Provision of road network related data to HD maps (DI2)
- Human resources with digital expertise (DI5)
- Digitalisation of incident and traffic management plans (IM2)
- Digitalisation of traffic management centres (TM3)

Study and learn actions 1/2

- Ensuring up-to-date content of HD maps (DI1)
- Cybersecurity issues for connected and highly automated vehicles (DI3)
- Information provision on incidents, events and crises (IM1)
- Harmonised marking of incident sites to be correctly recognised by AVs (IM3)
- Cooperative traffic management concept (TM1)
- Digitalise traffic rules and regulations (TM2)
- Improved information quality for automated vehicles (TI1)

Study and learn actions 2/2

- Standard communication protocols related to automated vehicles (TI2)
- Provision of hybrid C-ITS traffic information services (TI3)
- New infrastructure and regulations for traffic law enforcement (EN1)
- Environmental enforcement utilising geofencing and other tools (EN2)
- General physical road design changes (NR1)
- Harmonised management of road works sites (RW1)
- Awareness by automated freight vehicles of their own gross weight and individual axle loadings in order to determine ODD (new)

Key actions for deployment

- Optimal minimum risk manoeuvres and providing infrastructure for them (PI1)
- Digital twins for road transport system including ODD and ISAD information (DI4)
- Legal framework for driverless maintenance vehicles (MA1)

Deliverables

D2.1	Vehicle fleet penetrations and ODD coverage of NRA-relevant automation functions up to 2040
D3.1	Intermediate report of the state of the art on the impact of automated and connected vehicles
D4.1	Intermediate report on infrastructural consequences
D3.2	Impacts of automation functions on NRA policy targets
D4.2	Infrastructural consequences of connectivity and automation, and recommendations for their implementation
D5.1	Draft road map - road operator core business affected by connectivity and automation
D5.2	Road map for developing road operator core business utilising connectivity and automation

Project web site: www.mantra-research.eu