

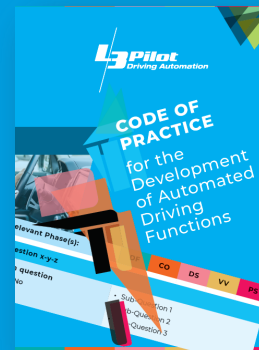


Code of Practice for the development of Automated Driving Functions

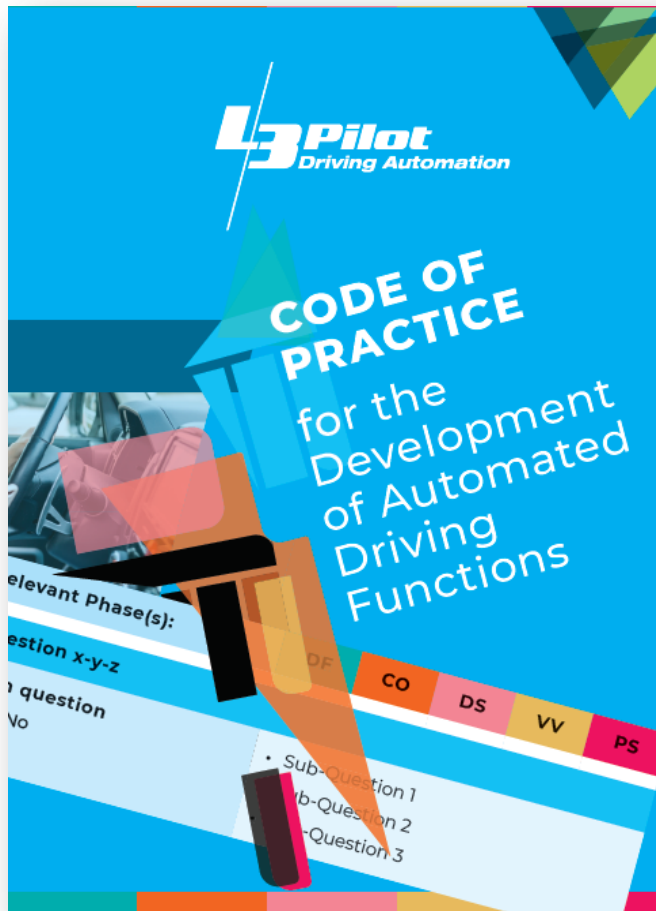
L3Pilot Final Event

Yves Page, Renault

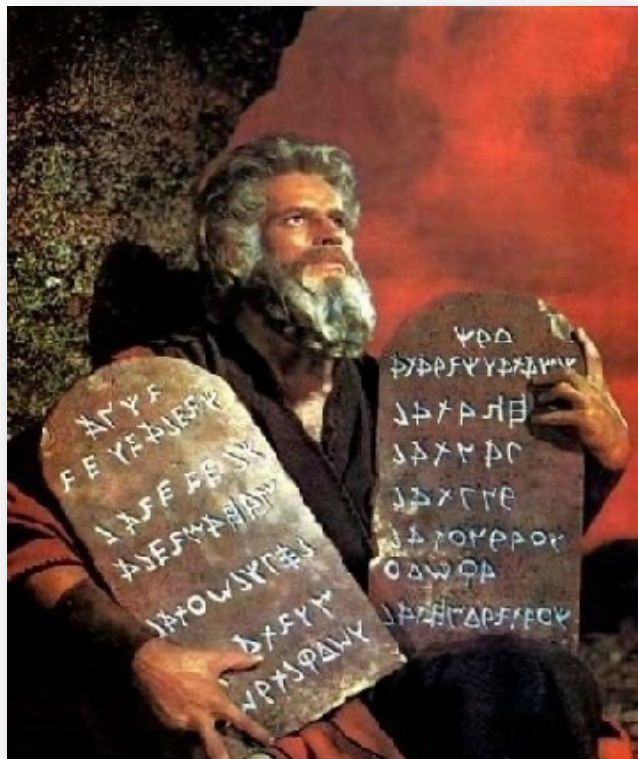
On behalf of all co-authors (Yu, Thibault, Felix, Moritz, Frederik, Fabio, Stefan, Andreas, Jorge, Giancarlo, Elias, Michele, Silvia, Qi, Oliver, Adam, Stuart, Johannes, Frank, Ulrich, Roland, Elisabeth)



Foreword(s)

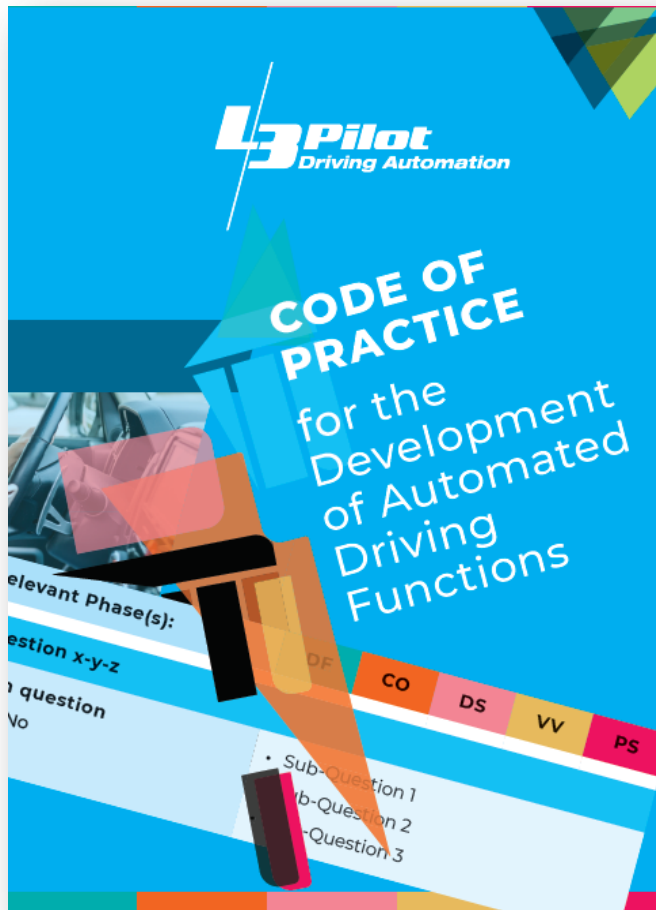


- What do we mean by “Code” ?
- What do we mean by “Code of Practice”?



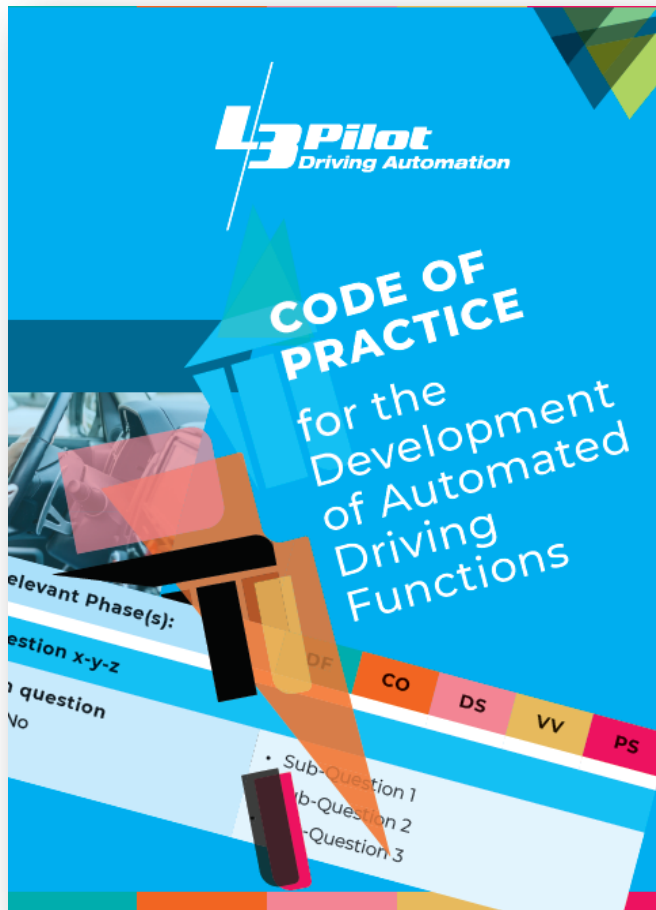
- What is a Code?

- A **set of rules** of behaviour, **practices** or **conventions** in society, formalised or not (e.g. dress code)
- A **document** (book or other) where these rules are written (e.g. mining code)
- An **algorithmic rule** for converting pieces of data into another form or representation, possibly for confidentiality purposes (e.g. selecting the first letter of each word) the result of applying this rule to an item of information.



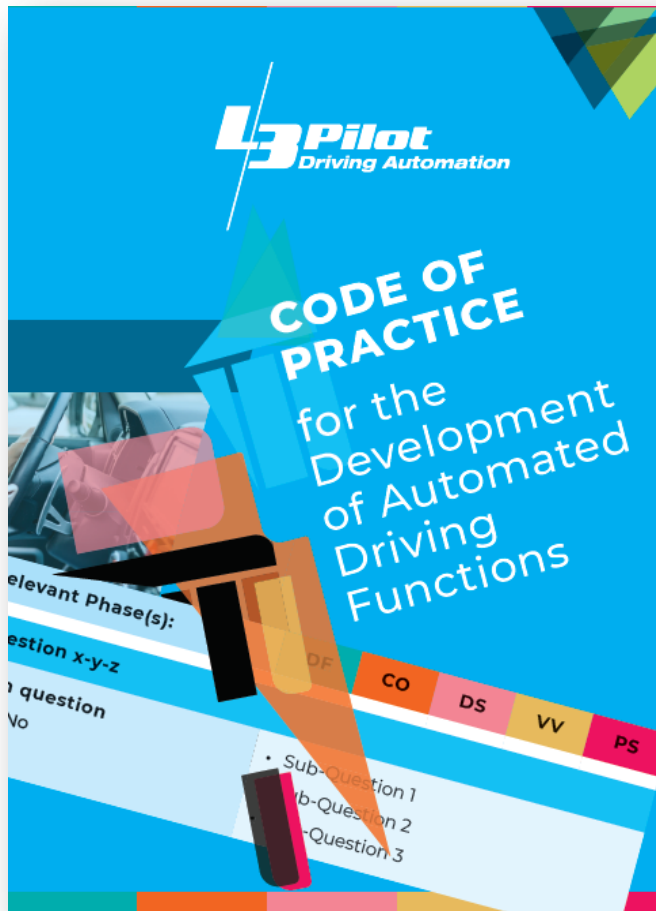
- What do we mean by “Code” ?

A document (book or other) where **good practices** are written



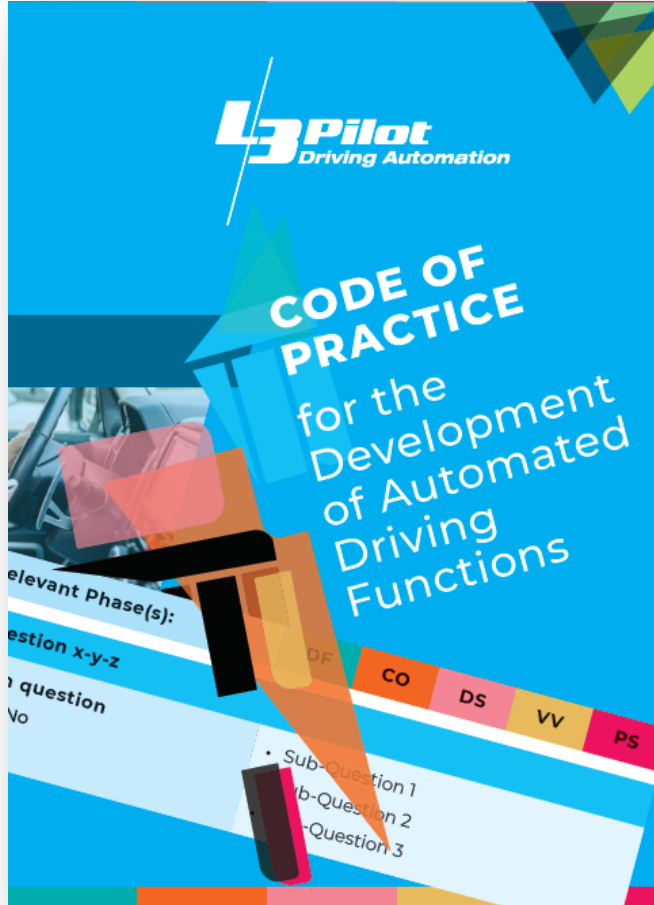
- What do we mean by “Code of Practice” ?

The Code of Practice for the Development of Automated Driving Functions provides comprehensive guidelines for supporting the design, development, verification and validation of automated driving technologies.



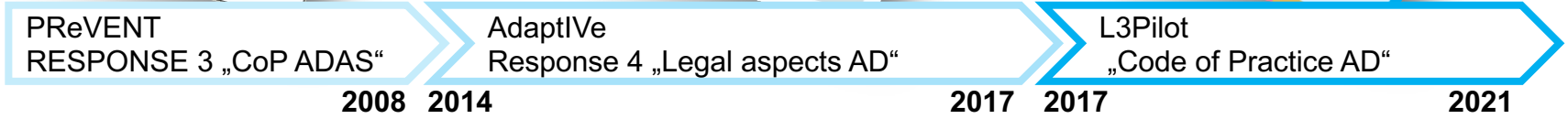
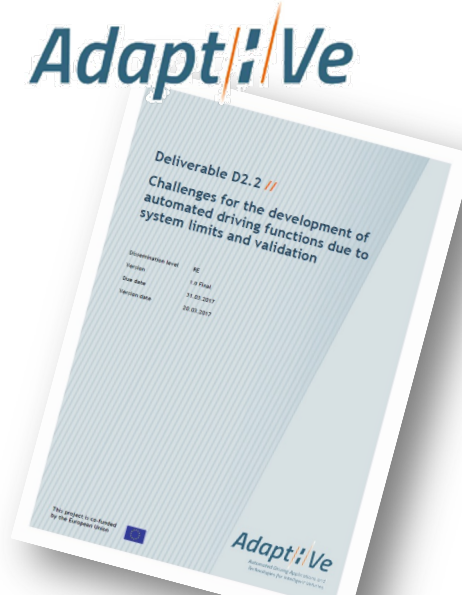
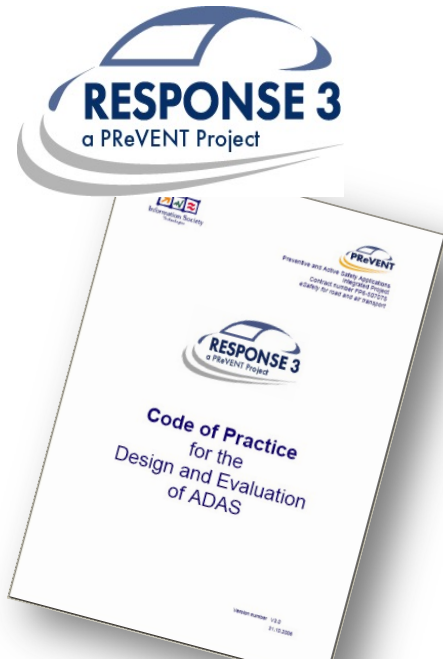
- What do we mean by “Code of Practice” ?

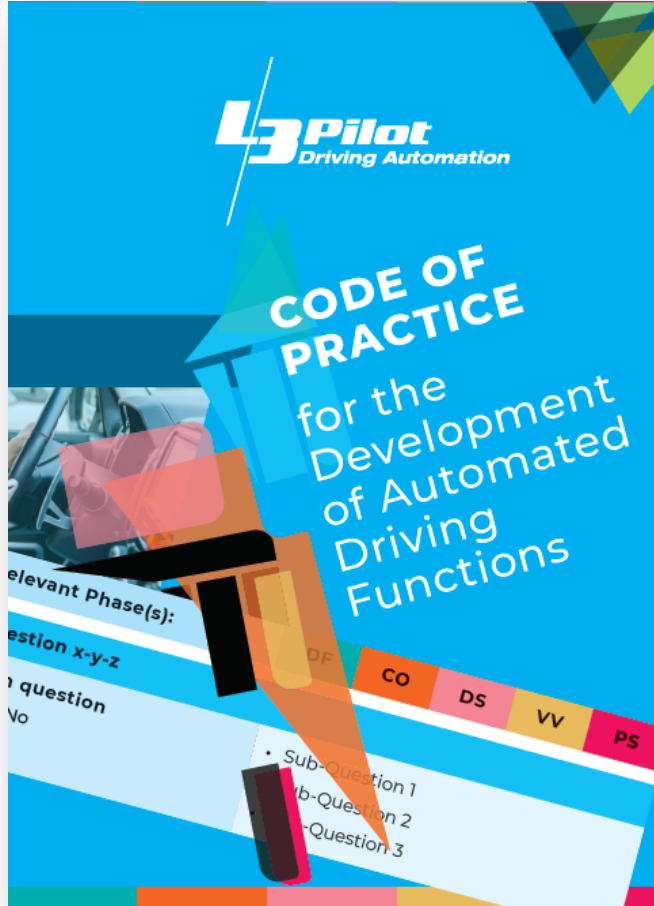
- 1 Collection of best practices
- 2 Typical process for the development and release of ADF
- 3 Safety aspects and methods to confirm a safe operation of ADF
- 4 Checklists, references



- Do we start from scratch ?

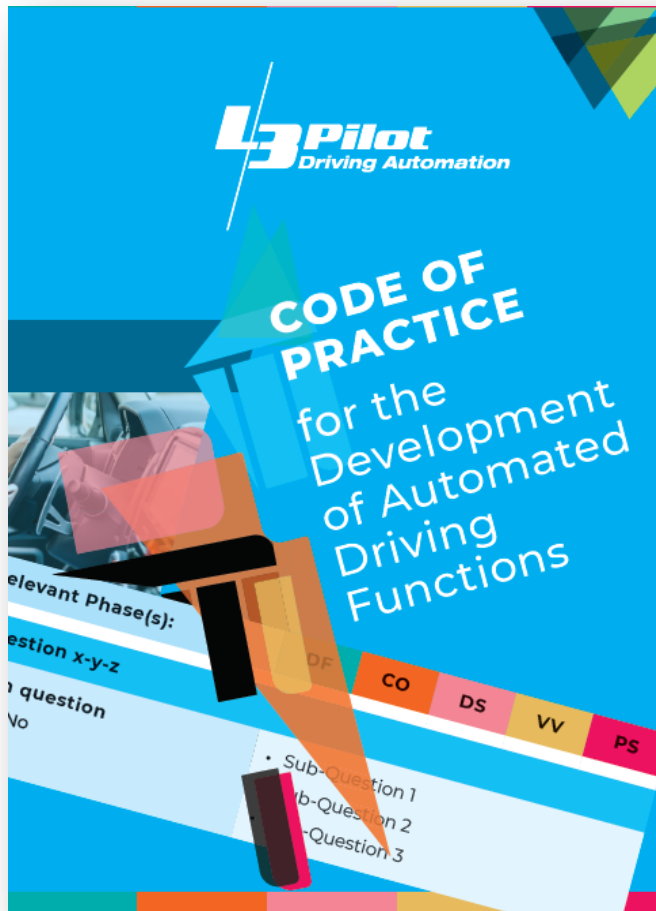
No, the story commenced in the 2000s





- Who is it for ?

Who is it for ?



Vehicle Manufacturers, Suppliers



Insurance bodies



Public Authorities



Academics

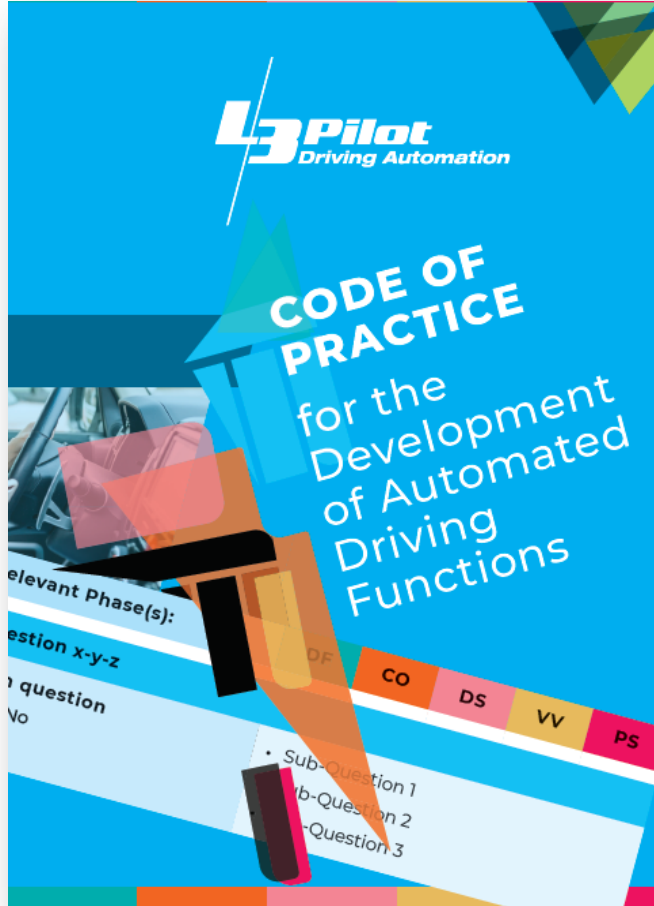


Regulation & Type approval bodies



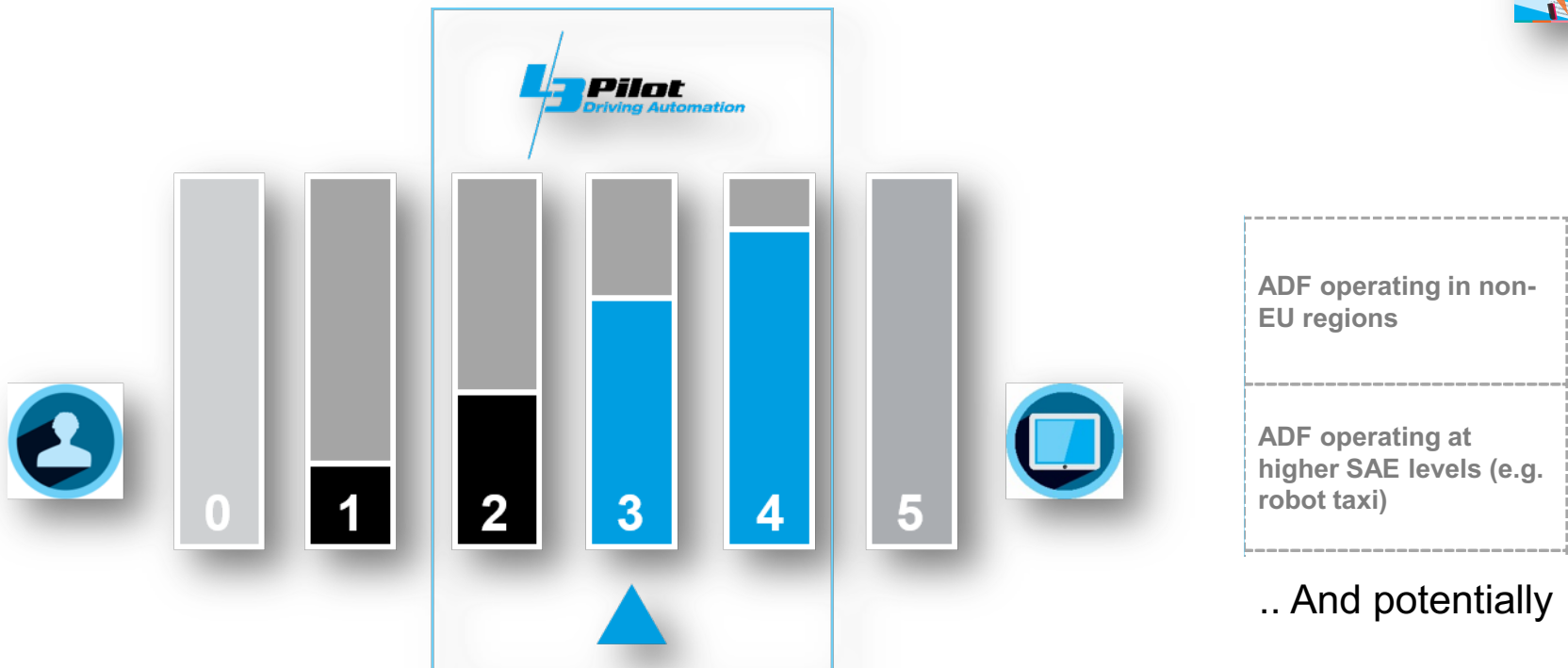
General Public





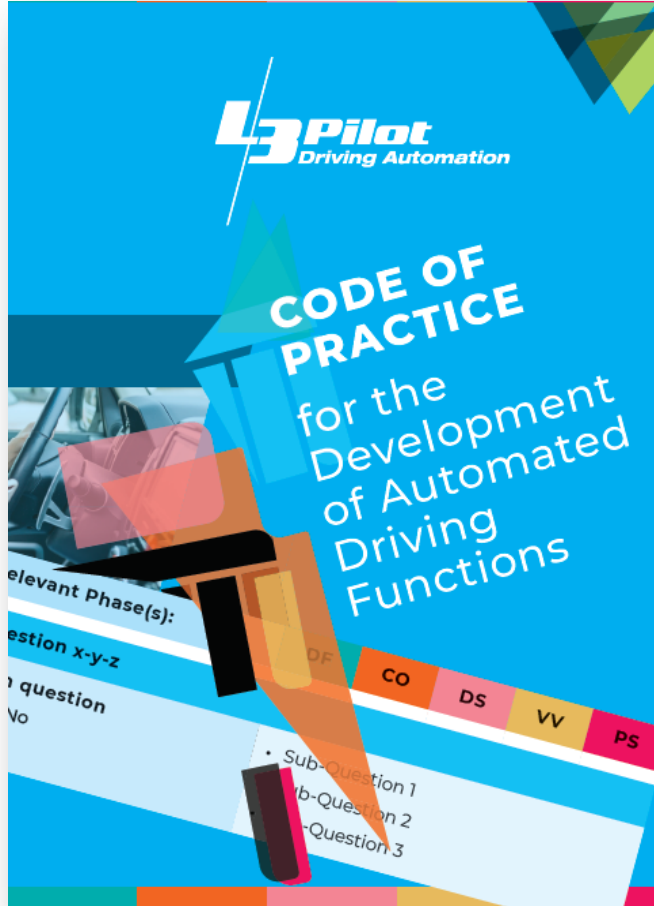
- Scope of CoP-ADF

Scope of the CoP-ADF



Motorway, Urban areas and Parking










- What will you find in?

Contents



- 1 5 categories
- 2 22 Topics
- 3 155 Questions (and even more sub-questions)
- 4 References to standards

Category		Topics
Overall Guidelines & Recommendations		<ul style="list-style-type: none"> Minimal Risk Manoeuvre Documentation Existing Standards Testing (including Simulation)
ODD Vehicle Level		<ul style="list-style-type: none"> Requirements Scenarios and Limitations Performance Criteria and Customer Expectations Architecture
ODD Traffic System & Behavioural Design		<ul style="list-style-type: none"> Automated Driving Risks and Coverage of Interaction with Mixed Traffic V2X Interaction Traffic Simulation Ethics & other Traffic related Aspects
Safeguarding Automation		<ul style="list-style-type: none"> Functional Safety Cybersecurity Implementation of Updates Safety of the intended Functionality Data Recording, Privacy and Protection
Human-Vehicle Integration		<ul style="list-style-type: none"> Guidelines for HVI Mode Awareness, Trust & Misuse Driver Monitoring Controllability & Customer Clinics Driver Training & Variability of Users



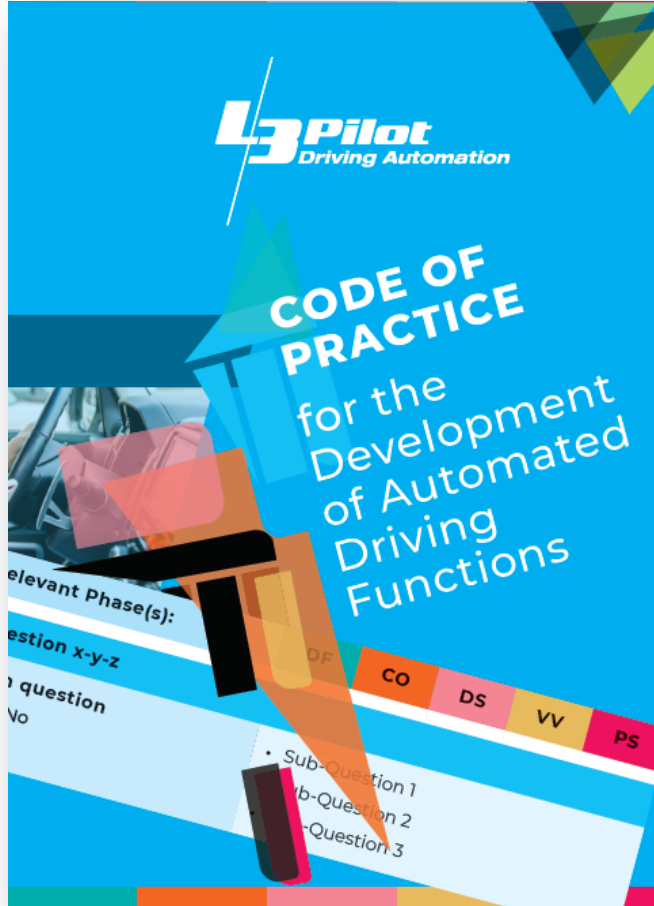
... All over the development process...



Structure of the questions

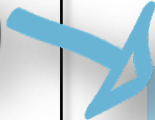


Relevant Phase(s):	DF	CO	DS	VV	PS
Question x-y-z					
Main question Yes / No	<ul style="list-style-type: none">• Sub-Question 1• Sub-Question 2• Sub-Question 3				



- Examples

Category	
Overall Guidelines & Recommendations	
ODD Vehicle Level	
ODD Traffic System & Behavioural Design	
Safeguarding Automation	
Human-Vehicle Integration	



Relevant Phase(s):	DF	CO	DS	VV	PS
Question 0-2-2		Topic: Documentation			
<p>Is a documentation and reporting process in place with regard to assessing, testing and validating the ADF capabilities as well as design decisions?</p> <p>Yes / No</p>		<ul style="list-style-type: none"> • Is a process established to document the performed tests and pass/fail compliance? • Is a process established to document updates of the test plan? • Does the documentation format comply with requirements of external stakeholders? • Is a safety argumentation (analogous safety case in ISO 26262) set up and described? 			

Category	
Overall Guidelines & Recommendations	
ODD Vehicle Level	
ODD Traffic System & Behavioural Design	
Safeguarding Automation	
Human-Vehicle Integration	

Relevant Phase(s):	VV
Question 1-3-5	Topic: Performance criteria and customer expectations
<p>Is a process established to understand how customer expectations can be satisfied?</p> <p>Yes / No</p>	<ul style="list-style-type: none"> Does the process consider how customer expectations and capabilities change based on their driving experience in automated driving mode? Does the process consider how customer expectations evolve based on their driving experience in manual driving?

Category	
Overall Guidelines & Recommendations	
ODD Vehicle Level	
ODD Traffic System & Behavioural Design	
Safeguarding Automation	
Human-Vehicle Integration	

Relevant Phase(s):	DF	CO	DS	VV	PS
Question 2-1-1 Topic: Automated driving risks and coverage interaction with mixed traffic					
<p>Are the risks of the ADF within its ODD considered?</p> <p>Yes / No</p>					
<ul style="list-style-type: none"> • Are the risks at entry to and exit from the ODD considered? • Are the risks from infrastructure or other road users considered? • Are unspecified or unexpected events identified from studies in real traffic? • Does the HARA consider unspecified or unexpected events? • Are the function limitations within the ODD considered? • Is the recording of ADF accident data or disengagements utilised to help identify risks? • Is there a mechanism for the publication or sharing of disengagements with a third party? 					

Category	
Overall Guidelines & Recommendations	
ODD Vehicle Level	
ODD Traffic System & Behavioural Design	
Safeguarding Automation	
Human-Vehicle Integration	

Relevant Phase(s):	CO	VV
Question 3-3-7	Topic: Implementation of updates	
<p>Is a method implemented to notify the user and OEM of each successful update installation?</p> <p>Yes / No</p>	<ul style="list-style-type: none"> As part of the notification process is the user advised on the expected duration of the installation? 	



Category	
Overall Guidelines & Recommendations	
ODD Vehicle Level	
ODD Traffic System & Behavioural Design	
Safeguarding Automation	
Human-Vehicle Integration	

Relevant Phase(s):

CO

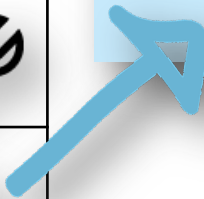
Question 4-1-2

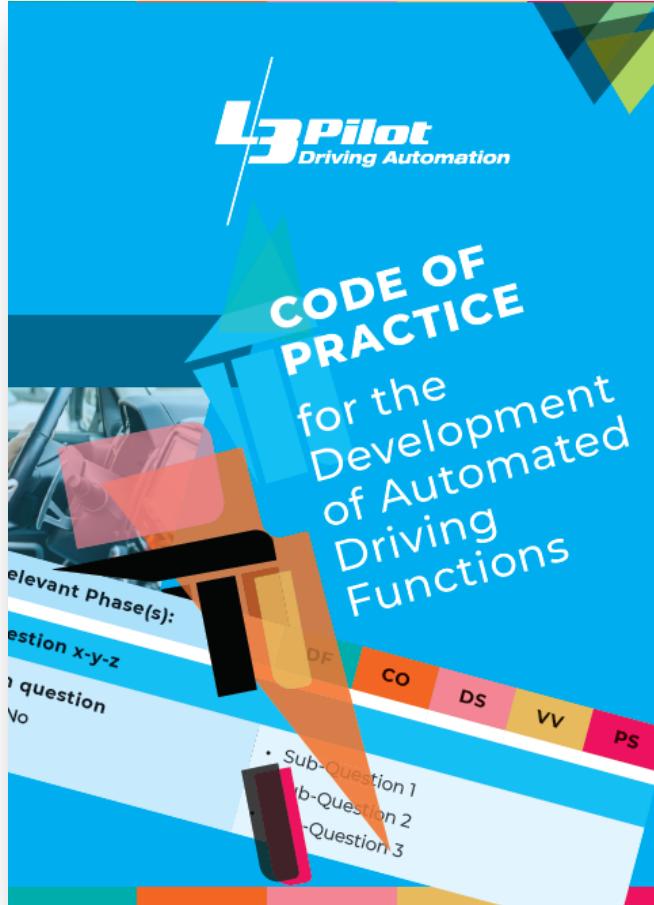
Topic: Guidelines for HVI

Are unintentional activations and deactivations of the ADF prevented?

Yes / No

- Are the ADF controls designed so as to reduce accidental activation / deactivation?
- Is the ADF able to determine accidental activations / deactivations vs intentional ones?
- Is a fall-back considered for the case where an accidental deactivation occurs and the driver is not in the loop?





- References

Main references

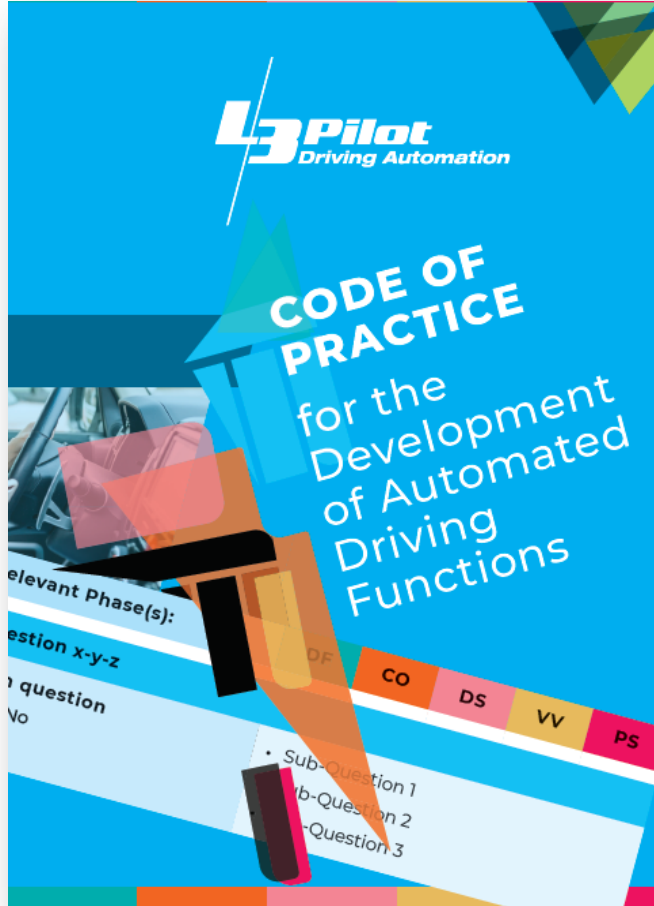


But also, many other ones

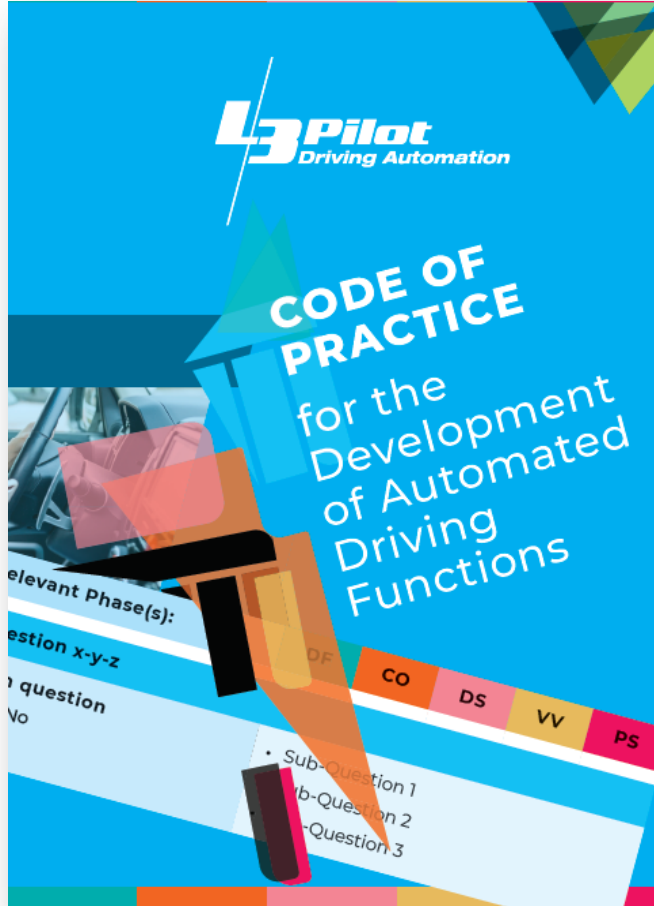


Reference	Relevant topics in CoP-ADF	Reference	Relevant topics in CoP-ADF
Abbinck, D., Carlson, T. et al. (2018) "A Topology of Shared Control Systems - Finding Common Ground in Diversity", IEEE Transactions on Human-Machine Systems, Volume 48, Issue 5	4.3 Driver Monitoring	Di Fabio, U., Broy, M., Brünniger, R. et al. (2017). "Ethic commission: automated and connected driving", Report of ethics commission appointed by the federal minister of transport and digital infrastructure.	4.3.4 Ethics & Other Traffic-Related Aspects
Abdukhaleq, A. (2017). "A system-theoretic safety engineering approach for software-intensive systems". Dissertation, University Stuttgart	4.2 Cybersecurity	ENISA, "ENISA Good practices for Security of Smart Cars", European Union Agency for Cybersecurity (ENISA 2019).	4.2 Cybersecurity 4.3 Implementation of Updates
ACEA (2019). "ACEA Principles of data protection in relation to connected vehicles and services", ACEA Report.	4.5 Driver Training of Users	Flemisch, F., Abbinck, D., Itoh, M. et al. (2016). "Shared control is the sharp end of cooperation: Towards a common framework of joint action, shared control and human machine cooperation", 13th IFAC Symposium on Analysis, Design, and Evaluation of Human-Machine Systems HMS 2016.	4.2.3 Performance Criteria and Customer Expectations
ACEA (2017). "ACEA principles of Automobile Cybersecurity", ACEA Report.	4.21 Requirements	Ford (2018). "A matter of trust - Ford's approach to developing self-driving vehicles", Ford safety report.	4.5.2 Mode Awareness, Trust & Misuse 4.5.5 Driver Training & Variability of Users
ASAM OpenDrive (2020). (https://www.asam.net/standards/detail/opendrive/)	4.5.1 Guidelines for HMI	Forster, V., Hergeth, S., Naujoks, F., Kirms, J. F., & Keintz, A. (2019). Empirical Validation of a Checklist for Heuristic Evaluation of Automated Vehicle HMI: In International Conference on Applied Human Factors and Ergonomics (pp. 3-14). Springer, Cham.	4.5.1 Guidelines for HMI
ASAM OpenScenario (2020). (https://www.asam.net/standards/detail/openscenario/)	4.5.2 Mode Awareness	Fridman, L., Brown, D. E., Glazer, M., Angell, W., Spencer, D. et al. (2019). MIT Advanced Vehicle Technology Study: Large-Scale Naturalistic Driving Study of Driver Behavior and Interaction with Automation. IEEE Access, vol 7, pp 102021-102038.	4.5.3 Driver Monitoring
ASAM XIL Standard (2020). (https://www.asam.net/standards/detail/xil/)	4.5.3 Driver Monitoring	Gellerman, H., Swanberg, E., Kotiranta, R., Heinig, I. et al. (2017). "Data sharing framework", FOT-Net Deliverable D3.1.	4.4.5 Data Recording, Privacy and Protection
ASAM XIL Standard (2020). (https://www.asam.net/standards/detail/xil/)	4.5.3 Driver Monitoring	General Motors (2018). "2018 self-driving safety report", GM safety report.	4.5.2 Mode Awareness, Trust & Misuse 4.5.5 Driver Training & Variability of Users
Bernard, Y., Chen, H., Koskinen, S., Innamaa, S., et al. standards/detail/xil/)	4.5.3 Driver Monitoring		
Bongler, K., Drüke, J., Hoffmann, S., Manstetten, D. & Neukum, A. (2018). UR: BAN Human Factors in Traffic. In Approaches for Safe, Efficient and Stress-Free Urban Traffic. Springer, Wiesbaden, Germany.	4.5.3 Driver Monitoring		
Bonneton, J.-F., Cerry, D., Danaher, J. et al. (2020). "Ethics of connected and automated vehicles report", Horizon 2020 Commission Expert Group to advise on specific ethical issues raised by driverless mobility (E03659), Publication Office of the European Union, Luxembourg.	4.5.3 Driver Monitoring		
Botta, M., Cancelliere, R., Chignone, L., Tangio, F. et al. (2019). Real-time detection of driver distraction: random projections for pseudo-inversion-based neural training. Knowledge and Information Systems, Volume 60, Issue 3, pp. 1549-1564.	4.5.3 Driver Monitoring		
Brusque, C., Bruyas, M. P., Carvalhal, J., Cozzolino, M., et al. (2007). "Effects of system information on drivers' behaviour", INERTS Synthesis No 54.	4.5.3 Driver Monitoring		
BSI/PAS 1983 (2020) "Operational Design Domain (ODD) taxonomy for an automated driving system (ADS) - Specification", British Standards Institution.	4.5.3 Driver Monitoring		
CAMPBELL, J., BROWN, J., CRAVING, J., RICHARD, C. et al. (2016). "Human Factors Design Guidance for Driver-Vehicle Interfaces", NHTSA report DOT HS 872 360.	4.5.3 Driver Monitoring		
CATAPULT Transport Systems (2017). "Market Forecast for connected and autonomous vehicles", Report of the European Communities.	4.5.3 Driver Monitoring		
CUSC (2018). "European Statement of Principles on the design of human-machine interface" (ESOP 2006).	4.5.3 Driver Monitoring		
CUNNINGHAM, M. L., BEGAN, M. A. (2018). Driver distraction and inattention in the realm of automated driving. IET Intelligent Transport Systems, vol. 12, no. 6, pp. 407-413, 8 2018.	4.5.3 Driver Monitoring		
DEPARTMENT OF TRANSPORT (DOT) (2015). "The pathway to driverless cars: a code of practice for testing", Report of Department of Transport.	4.5.3 Driver Monitoring		
BIENZWEISER, J., COUSIN, C., DESCHAMPS, V. et al. (2017). "Legal aspects on automated driving", Adaptive Deliverable D2.3.	4.5.3 Driver Monitoring		

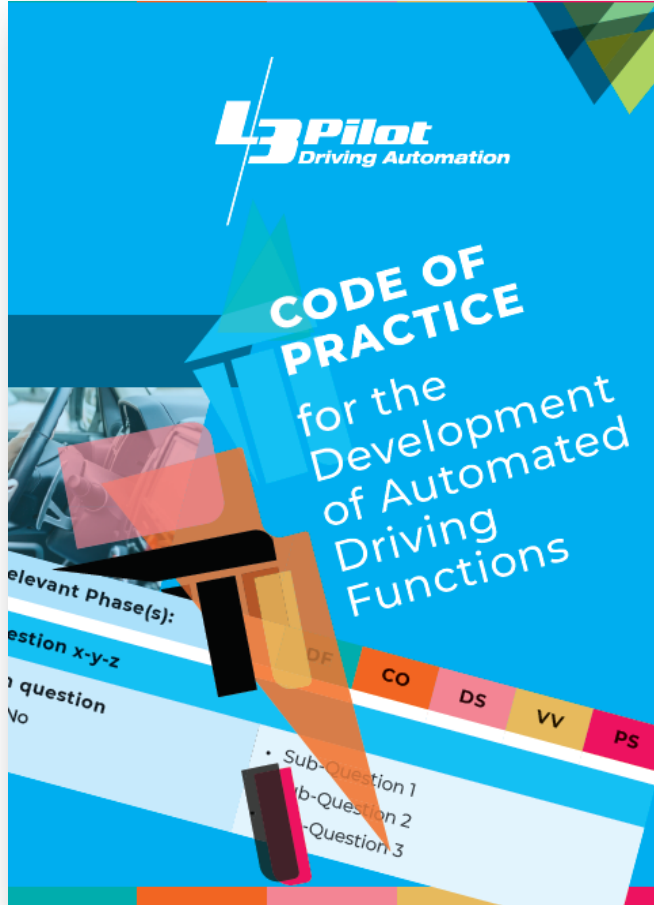




- Afterword



- Scope of the CoP-ADF is not to provide technical solutions, but to support the development of ADF by ensuring that relevant aspects have been considered.
- The purpose of the questions is to make the developers and other relevant stakeholders aware of certain aspects and to ensure that reasons for decisions are taken and documented.



- No single approach for the implementation of safe ADF
- Neutrality in terms of technology
- This CoP-ADF presents a trade-off between detailed information and broad understanding
- Automated driving is a rapidly evolving technology: state-of-the-art needs to be continuously updated



Thank you for your kind attention.

Yves Page
Renault
yves.page@renault.com



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