

# Collection of research gaps – identified from discussion sections IV through VII

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The tables presented below provide the basis for conducting the research gap analysis for our survey paper titled: "The Road to Safe Automated Driving Systems: A Review of Methods Providing Safety Evidence". For each discussed method, the eight challenges of Sec. III are classified as either a **FC** (fundamental challenge), **O** (obstacle) or **U** (unclear) (as per TABLE V in the survey paper) result in a separate row in the table below. Further, for each such row a gap is identified by consulting the discussions of sections IV through VII. Subsequently, the raw identified gaps are collected and eventual connections to similar considerations between different rows, relating to the same method as well as other methods, are given. The table below presents this intermediate step of identified gaps before they are collected into categories and formulated as proper research questions, as presented in Sec. IX-B of the survey paper.

Notably, for operational data collection none of the eight challenges has been identified as posing significant obstacles or unclarities. However, there are other short-comings of this method highlighted in Sec. VI.A that warrant considerations for using this method to provide safety evidence for the ADS.

			Classification	Identified gap	Research gap category
	Method	Challenge			
Design techniques	Operational design domain	C-U-env	FC	Completeness and appropriate spec.	IX-B1
		C-U-inter	FC		
	Hazard and risk assessment	C-U-env	FC	Completeness of hazards	IX-B1
		C-U-inter	FC		
		C-B-resp	FC		
		C-B-func	FC		
		C-B-adapt	O		
		C-reqs	O	How to automate usage of data to bridge high integrity requirements and support agile	IX-B2
		C-agile	U		
	Process arguments	C-U-env	FC	Quantitative contributions with safety evidence	IX-B2
		C-U-inter	FC		
		C-B-resp	O		
		C-B-func	O		
		C-B-adapt	O		
		C-reqs	O		
		C-AI	U	Processes for AI/ML	IX-B2
		C-agile	O	How to integrate processes with an agile release cycle, alt. Produce adequate safety evidence from within an agile cycle?	IX-B2
	Contract-based design	C-U-env	FC	Unable to formalise completely (joint with formal;rt_cert)	IX-B1
		C-U-inter	FC		
		C-B-resp	FC		
		C-B-func	O	Scalability of method (with CBD;arch.;formal;run-time cert.;degradation;PCS)	IX-B5
		C-AI	O	Contracts for AI	IX-B4
	Supervisor architectures	C-B-func	O	Scalability of method (with CBD;arch.;formal;run-time cert.;degradation;PCS)	IX-B5

	Method		Classification	Identified gap	Challenge category
		Challenge			
Verification and validation methods	Field operational tests	C-U-inter	O	Scalability/how to leverage (jointly with EVT)	IX-B3
		C-B-resp	O		IX-B5
		C-reqs	FC		
		C-agile	FC	How to use FOTs within an agile framework of release?	IX-B5
	Extreme value theory	C-U-inter	O	How to collect closed loop data? (jointly with FOT)	IX-B3
		C-B-resp	O		
	Scenario-based V&V	C-U-env	FC	Completeness of scenario space	IX-B1
		C-U-inter	FC		
		C-B-resp	FC	Testing of relevant scenarios considering tactical decisions	IX-B3
		C-reqs	O	How to ensure coverage of rare scenarios?	IX-B2
		C-AI	C	Non-interpolatable results from testing	IX-B4
	Formal methods	C-U-env	FC	Unable to formalise completely (joint with formal;run-time cert)	IX-B1
		C-U-inter	FC		
		C-B-resp	FC		
		C-B-func	O	Scalability of method (with CBD;arch.;formal;run-time cert;degradation;PCS)	IX-B5
		C-reqs	O	How to mitigate the specification gap?	IX-B1
		C-AI	O	Soundness and completeness for AI-components? Esp. rel. high dependability reqs.	IX-B4

	Method	Challenge	Classification	Identified gap	Challenge category
Run-time risk assessment	Operational data collection	N/A		Appropriate leading safety metrics for operational data connected to safety	IX-B2
	Threat assessment	C-U-env C-U-inter	O O	How to capture uncertainties of C-U-env and C-U-inter?	IX-B2
	Out-of-distribution detection	C-reqs	O		
	Dynamic risk assessment	C-B-resp	U	Impact from tactical decisions? (jointly with PCS;DSM)	IX-B3
		C-B-adapt	U	How well does DRA accommodate degradations?	IX-B2
		C-reqs	U	How to ensure integrity of run-time methods? (jointly with OoD;DSM)	IX-B2
		C-AI	U	How to derive quantitative risk metrics for AI/ML-components? (with DSM)	IX-B4

Run-time (self-)adaptation	Degradation strategies	C-B-func	O	Scalability of method (with CBD;arch.;formal;run-time cert;degradation;PCS)	IX-B5
		C-agile	O	How to facilitate frequent releases when considering proper analysis of degradations strategies	IX-B5
	Runtime certification	C-U-env	O	Unable to formalise completely (joint with formal;run-time cert)	IX-B1
		C-U-inter	O		
		C-B-resp	O		
		C-B-func	O	Scalability of method (with CBD;arch.;formal;run-time cert;degradation;PCS)	IX-B5
	Dynamic safety management	C-B-resp	O	Impact from tactical decisions? (jointly with PCS;DRA)	IX-B3
		C-reqs	O	How to ensure integrity of run-time methods? (jointly with DRA;OoD)	IX-B2
		C-AI	O	How to derive quantitative risk metrics for AI/ML-components? (with DRA)	IX-B4
	Precautionary safety	C-B-resp	U	Impact from tactical decisions? (jointly with DRA;DSM)	IX-B3
		C-B-func	U	Scalability of method (with CBD;arch.;formal;run-time cert;degradation;PCS)	IX-B5
		C-agile	U	How can PCS help support frequent releases?	IX-B5