MARCH 9			
Program	**Speaker**	**Title**	**Abstract**
Plenary 1 – Autonomous Mobility	**Joseph Sifakis** (Université Grenoble Alpes, FR)	Rigorous modeling and validation of autonomous driving systems	**Abstract :** Autonomous driving systems (ADS) are probably the most difficult systems to model and validate because they are built from heterogeneous components subject to temporal and spatial dynamism. These characteristics make the application of formal methods and verification in particular prohibitive. We present a framework for modeling ADSs that relies on a formal definition of maps representing the physical environment in which agents evolve. The maps are directed metric graphs whose nodes represent the positions and edges of road segments, with additional semantic information about traffic signals and junction types. An ADS is a dynamic system with a set of agents moving on a map according to a given scenario defined by the agent's initial state and the routes to their respective destinations. Its behavior for a given scenario is the set of timed sequences of the agents' global states. We use a first-order linear temporal logic to specify the properties of the system. In particular, we show that traffic rules can be specified as formulas of this logic. We show how this framework can be implemented in a test environment integrating a Simulator, a Scenario Generator that drives the simulation process, and a Monitor that verifies at runtime the observed behavior of the system with respect to a set of properties. We propose a method to generate sets of scenarios based on coverage criteria and applied to different types of junctions. We show that systematic exploration of risky situations allowed us to discover many flaws in a real simulator that would have been very difficult to find by a random exploration process.
	Talk 1 : **Christian Schindler** (Aachen University, DE)	The Aachen Rail Shuttle (ARS) – Development of Rural Areas with Driverless Rail Buses	**Abstract :** Due to the climate change many countries have rediscovered the railway as a transport means to reduce CO2-emissons. Therefore the attractiveness of rail transport has to be improved. Especially in rural areas the rail bound service is poor nowadays and people are forced to use their private cars. The presentation will explain the need for alternative rail bound public transport on secondary lines in rural areas and propose how this could work. I also explains that, despite of former very successful vehicles for this kind of operation, today there is no such vehicle on the market.

			The presentation proposes a battery powered, autonomous rail bus with a new vehicle concept as one solution for rail transport in rural areas.
	Talk 2 : **Charles Lesire** (Office National d'Etudes et de Recherche Aérospatiales, FR)	Skill-based design of dependable autonomous robot architectures	**Abstract :** Software architectures for autonomous systems are generally structured with 3 layers: a decisional layer managing autonomous reasoning, a functional layer managing reactive tasks and processing, and an executive layer bridging the gap between both. The executive layer plays a central role, as it links high-level tasks with low-level processing, and is generally responsible for the robustness or the fault-tolerance of the overall system. This talk presents a development process and toolchain for such an executive layer, structured using skills, i.e., elementary functions or services provided by a system. The talk will present the Domain Specific Language to model skills, as well as methodologies and tools for fault-tolerance analysis and verification by model-checking of the skill-based architecture.
Plenary 2 – Safety	**Antoine Rauzy** (Norwegian University of Science and Technology, NO)	Assessing safety and security of autonomous mobile systems: Are we ready?	**Abstract :** Assessing the safety and security of autonomous mobile systems raise new challenges. Two questions in particular must focus our attention: First, conversely to systems industry dealt with so far, autonomous mobile systems are deformable. Their architecture varies through their mission. This may not be true for each system individually, but this is certainly true if we consider fleet of such systems. Second, consequences of cyberattacks must imperatively be taken when looking at the safety of autonomous mobile systems. This talk aims discussing problems and potential solutions to tackle these issues.
	Talk 3 : **Ruth Taylor** (Marine & Coastguard Agency, UK)	Maritime Autonomy and Remote Operations - Development of Regulation	**Abstract :** Progress is being made at a great pace to support and enable the use of autonomous vessels with the appropriate regulation, both in the UK and internationally. The Maritime and Coastguard Agency is now updating regulations to enable the safe operation of smaller (under 24m) MASS in the UK and have started to develop the regulatory framework required for all MASS to operate safely in UK waters. There are opportunities for cross-domain collaboration, however the unique domestic and international regulatory arrangements have to be taken into account. The MCA will give insight into the regulatory updates and how they will support autonomous vessels in the UK, in addition to presenting our approach to supporting industry and the identification of cross-domain opportunities.

	Talk 4 : **Vaibhav Puri** (Rail Safety & Standards Boards, UK)	Risk-driven approaches to the design of safe learning-enabled systems	**Abstract :** When is a cake really a biscuit and why does it matter? The pathway to developing sector specific rules for compatibility and safe integration to support validation and acceptance, and what we can learn from the evolution of rules for conventional systems. At a basic level, a truly 'autonomous system' can decide for itself what to do and when to do it, with no human intervention and learn from its environment and the interactions with that environment. To reach true autonomy, a system in most cases evolves through stages from human operated to fully autonomous. Given the complexity of railway systems and their environment, it is likely that any autonomous system will need to be integrated with other systems that are at different stages of their evolutionary journey. Therefore safe integration is along three axis -(a) the axis of technical system into which an autonomous system is introduced in terms of the scope and scale of autonomy (some functions to the whole system); (b) the axis of the evolution of the overall system as it transitions from the autonomous system as an isolated actor to a fully populated autonomous population with non-autonomous actors; and (c) the axis of how autonomy is dealt with in terms of safety integrity (how do you bring the system back to safe operation where autonomy misbehaves and how contingencies are managed). The third element is critical as arguably the most sophisticated autonomous system (the human) is already in the system environment and there are lessons to be learnt from how human error and performance degradation is dealt with. Note that surely the objective is to introduce new systems that are considerably safer than current ones! With that in mind, the role and nature of sector specific standards and regulations that need to be developed will be discussed, focussing on their role as mechanisms for describing, categorising, and defining compatibility and acceptance rules.
Plenary 3 – Industry	**Emmanuel Arbaretier** (Airbus Protect, FR)	IVVQ for autonomous systems : what are the main 5 pillars of this multi disciplinary challenge ?	**Abstract :** Autonomous systems such as autonomous vehicles, busses, flynings taxis or drone face new deadlocks in the way their safety or security property may be prooved :based on the state of the art, this presentation will enumerate how complementary and multi disciplinary activites can be dimensioned and coupled together so that to constitute a relevant rationale for performance justification and demonstration framework.
	Talk 5 : **Ansgar Radermacher** (CEA)	Model-driven development of safe autonomous systems.	**Abstract :** The development of autonomous systems has to face several challenges, notably the respect of safety requirements (as well as security related ones, but this is not the focus of this talk), distributed and potentially heterogeneous platforms and the integration of AI

			components. Model driven approaches enable the analysis of potential hazards and propagation of faults. Hazards can be identified in the context of tasks that are specified using behavior trees. A behavior tree can then include counter measures for potentially dangerous situations. An example of such a situation is an out-of-distribution sample that is wrongly classified by an AI based perception. This situation can (likely) be detected based on good uncertainty estimations. Code generation from the model for middlewares such as ROS reduces the implementation effort and assures that model and code are synchronized. The execution of behavior trees at runtime is more flexible than hard-coded behavior and can include counter measures for dangerous situations.
	Talk 6 : **Jean Daniel Sülberg** (German Aerospace Center, DE)	Testing and Verification of Innovative (Air) Mobility technologies: How can test centers facilitate development and certification?	**Abstract :** With the rise of new unmanned aircraft, new regulations and procedures have to be developed for their certification. Whether it is a mission based development, the verification of algorithms in safety cases or the testing of novel technologies, new approaches have to be found for all. This presentations aims to showcase current regulatory development as well as dive into the possibilities and challenges presented by higher degrees of automation. Moreover real life lessons learned from the operation of a Test Center for UAS/IAM are shared to assess the enabling role test sites can have for the certification of autonomous technologies.

MARCH 10			
Program	**Speaker**	**Title**	**Abstract**
Plenary 4 - Verifications	**Louise Dennis** (University of Manchester, UK)	Verifying Mission Level Decision-Making	**Abstract :** This talk will look at the use of model-checking to verify the choices made by a cognitive agent in control of decision making within an autonomous system. It will consider the assumptions that need to be made about the environment in which the agent operates in order to perform that verification and how those assumptions can be validated via runtime monitoring. Lastly it will consider how compositional techniques can be used to combine the agent verification with verification of other components within the autonomous system.
	Talk 7 : **Justin Dauwels** (Technische Universiteit Delft, NL)	Perception error modelling for autonomous driving	**Abstract :** Although virtual testing of Autonomous Vehicles (AVs) has been well recognized as essential for safety assessment, AV simulators are still undergoing active development. One particularly challenging question is to effectively include the Sensing and Perception (S&P) subsystem into the simulation loop. In this talk, we define Perception Error Models (PEM), a virtual simulation component that can enable the analysis of the impact of perception errors on AV safety, without the need to model the sensors themselves. We propose a generalized data-driven procedure towards parametric modeling and evaluate it using Apollo, an open-source driving software, and nuScenes, a public AV dataset. Additionally, we implement PEMs in SVL, an open-source vehicle simulator. Furthermore, we demonstrate the usefulness of PEM-based virtual tests, by evaluating camera, LiDAR, and camera-LiDAR setups. Our virtual tests highlight limitations in the current evaluation metrics, and the proposed approach can help study the impact of perception errors on AV safety.
	Talk 8 : **Simon Rößner** (TÜV Süd Auto-Service GmbH, DE)	Challenges and Status of International and European Standardization to Support the Application of AI-Techniques in Systems with Autonomous Capabilities	**Abstract :** As an introduction to the topic the presentation discusses the stakeholders of standards and how standards may serve those stakeholders including legal aspects in terms or product safety and liability. We review the current status of regulations directly or indirectly affecting the discipline of artificial intelligence (AI) looking at the major markets USA, Europe and China. Based on the European approach we outline the importance of standards particularly for the field of AI. An overview over several closed and ongoing standardization activities, will lead us to a review of ongoing

			activities towards the ISO PAS 8800 'Road Vehicles – Safety and artificial intelligence'. This example highlights the challenges and open issues in terms of standardization of AI-techniques in systems with autonomous capabilities. We close the presentation by revisiting what those challenges imply for the usage of those new AI-standards also in terms of product safety and liability
Plenary 5 – Testing	**Andrea Leitner** (AVL, AT)	Data-driven development and validation of automated vehicles	**Abstract :** Assisted driving functions are introduced in more and more vehicle variants and even first automated driving applications have found their way into series vehicles. New regulations enable type approval for conditional automated driving up to 130kph. But, they require a lot of information and effort.One important aspect is to understand and structure the operational design domain. This includes driving behavior in a certain region, weather conditions, lane markings, special kinds of vehicles, etc. To make sure that the operational design domain is understood and that the system is able to cope with all peculiarities, a lot of data is required. Data-driven development can support in various parts of the development process. But collecting and managing data is costly. It will be discussed what the requirements for the data are and how one can make use of the data.
	Talk 9 : **Xiaowei Huang** (University of Liverpool, UK)	Algorithmic Perspectives on Certification of Machine Learning	**Abstract :** Machine learning has been proven practical in solving complex problems that cannot be solved before but was also found to be not without any shortfall. Therefore, before its adoption in safety critical applications, machine learning and machine learning enabled systems need to be certified, that is, a written assurance (i.e., a certificate) is provided to justify that it meets specific requirements. This talk will provide an overview on the certification of machine learning, from the algorithmic perspectives in dealing with the vulnerabilities of machine learning. This includes the efforts on falsification, explanation, verification, enhancement, reliability estimation, and runtime monitoring, in dealing with known risks in the machine learning development cycle, such as generalisation, uncertainty, robustness, poisoning, backdoor, and privacy-related attacks.
Plenary 6	**Bruno Monsuez** (ENSTA Paris, FR)	What if "Verification of Autonomous Decision Software" is not decidable?	**Abstract :** Autonomous Systems are seen as an evolution of automated systems. In fact, this is only partially true, some autonomous systems are automated systems with some additional functionalities that provide partial autonomous decision. However, the current advance in artificial intelligence pushes the design of new systems that are real (fully or partially) autonomous systems and not simply enhanced automated systems.

			The emergence of those autonomous systems poses a lot of questions regarding the possibility of verifying and qualifying the decision taken or computed by those systems. For automated systems, methodology for verifying and qualifying automated systems have been developed to ensure the development of safe and reliable systems. However, those methodologies are only partially relevant when trying to qualify autonomous systems. Qualifying an Autonomous System goes much beyond the question of qualifying an automated system. It is about the decision as well as about the computing process that generates the decision. In this talk, we first present what makes the qualification of a decision as well as the computing process that generates the decision so difficult and we finally ask ourself, how can we address the problem of designing safe and reliable autonomous systems, if proving that the decision is a good decision or the computing process that generates this decision is not decidable.
	Talk 10 : **Subramanian Ramamoorthy** (University of Edinburgh, UK)	Risk-driven approaches to the design of safe learning-enabled systems	**Abstract :** Achieving safe and robust autonomy is the key bottleneck on the path towards broader adoption of autonomous technologies in the automotive and aerospace sectors. This calls for approaches that embody safety by design, which can be hard to do because of the difficulty of describing all the edge cases. We advocate a risk-driven approach to design, connecting models of perceptual error with allocation of training budgets to sensitive regions of the controller parameter space. Related to that, we consider how testing strategies can be adapted to focus attention on similarly crucial regions, in addition to other forms of coverage based metrics. We conclude with some discussion of how these examples could be generalised towards a broader framework