Model-Driven Testing of Cyber-Physical Systems with the Explicit Consideration of Uncertainty (U-Testing)

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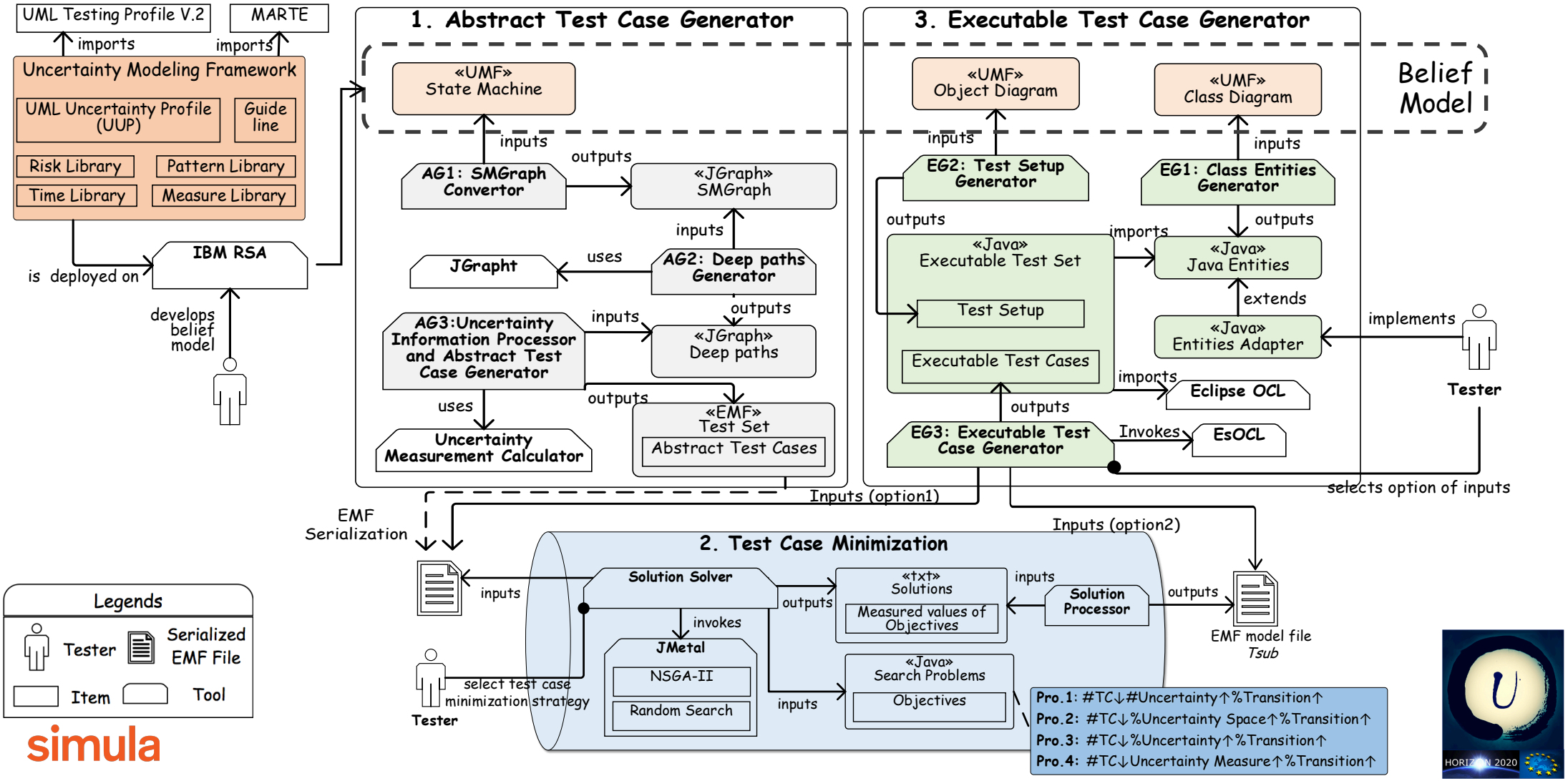
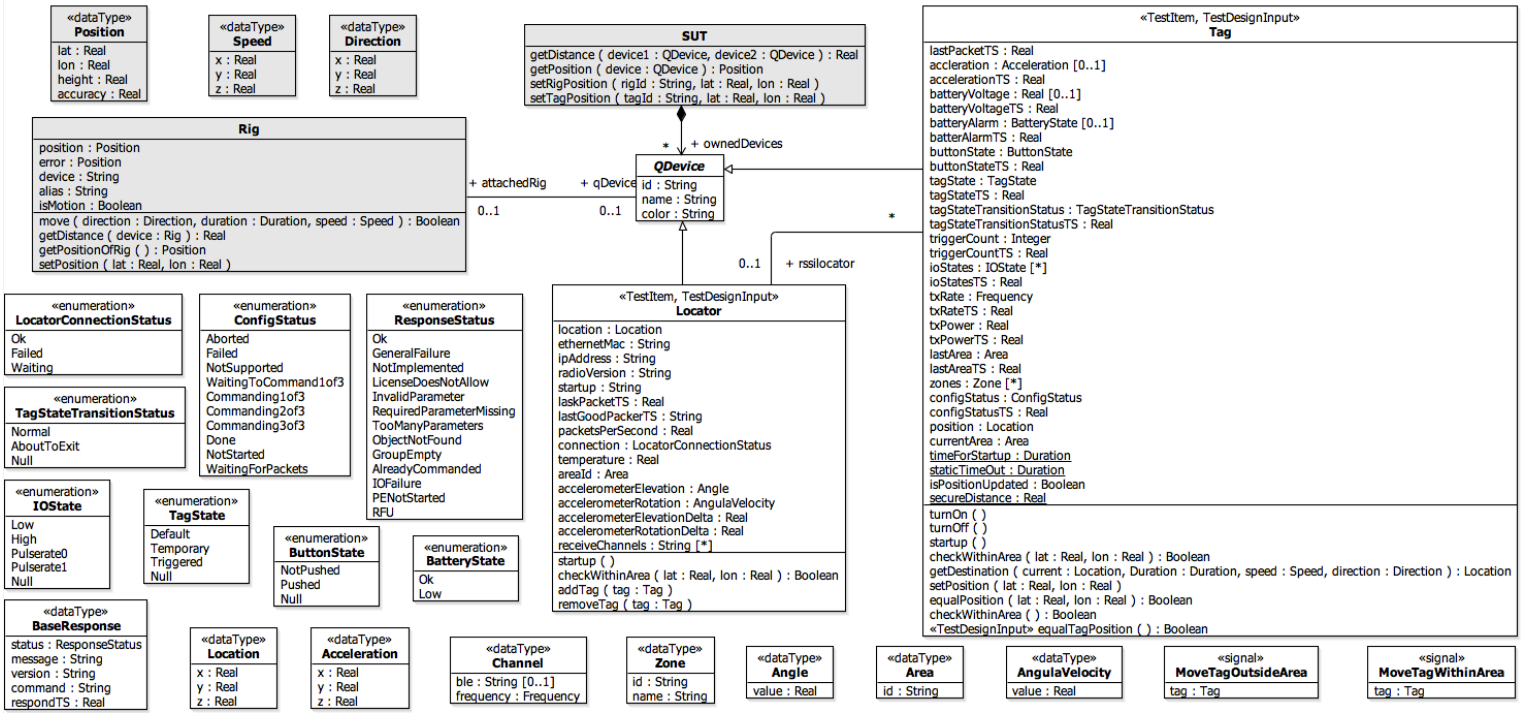
EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

UiO : University of Oslo
Faculty of mathematics and natural sciences

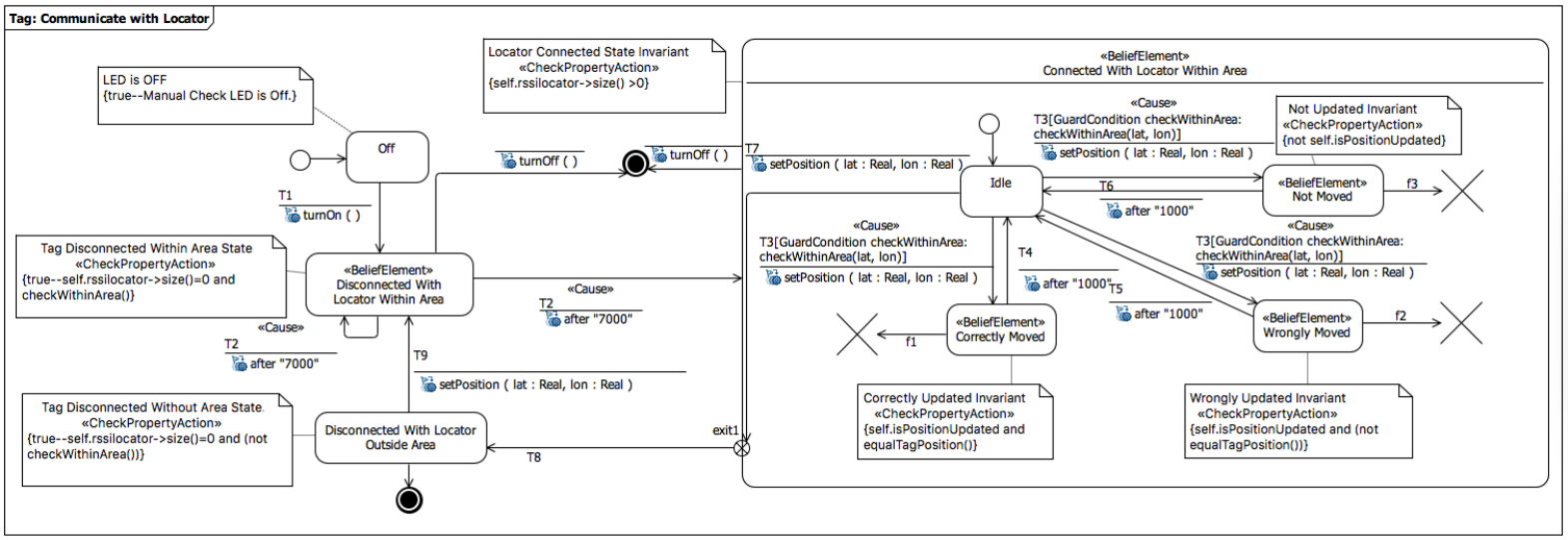
The overall approach of U-Testing has several steps.



Test Interfaces of the Geo Sports system and test infrastructure are captured as a set of class diagrams.



Expected behaviour of Geo Sports is modelled as a Belief State Machine.



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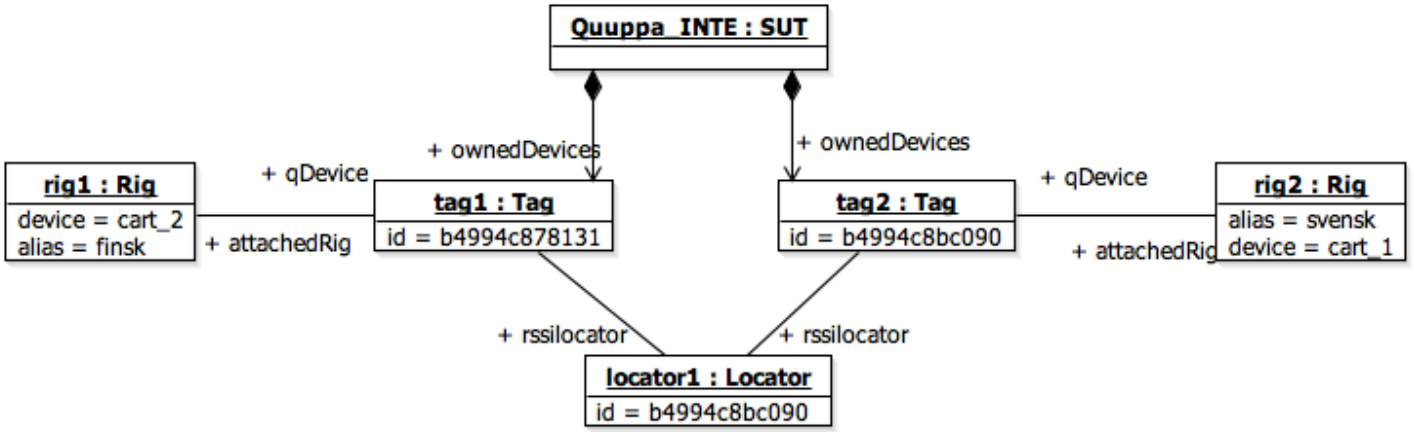
Test configuration is modelled as an object diagram.



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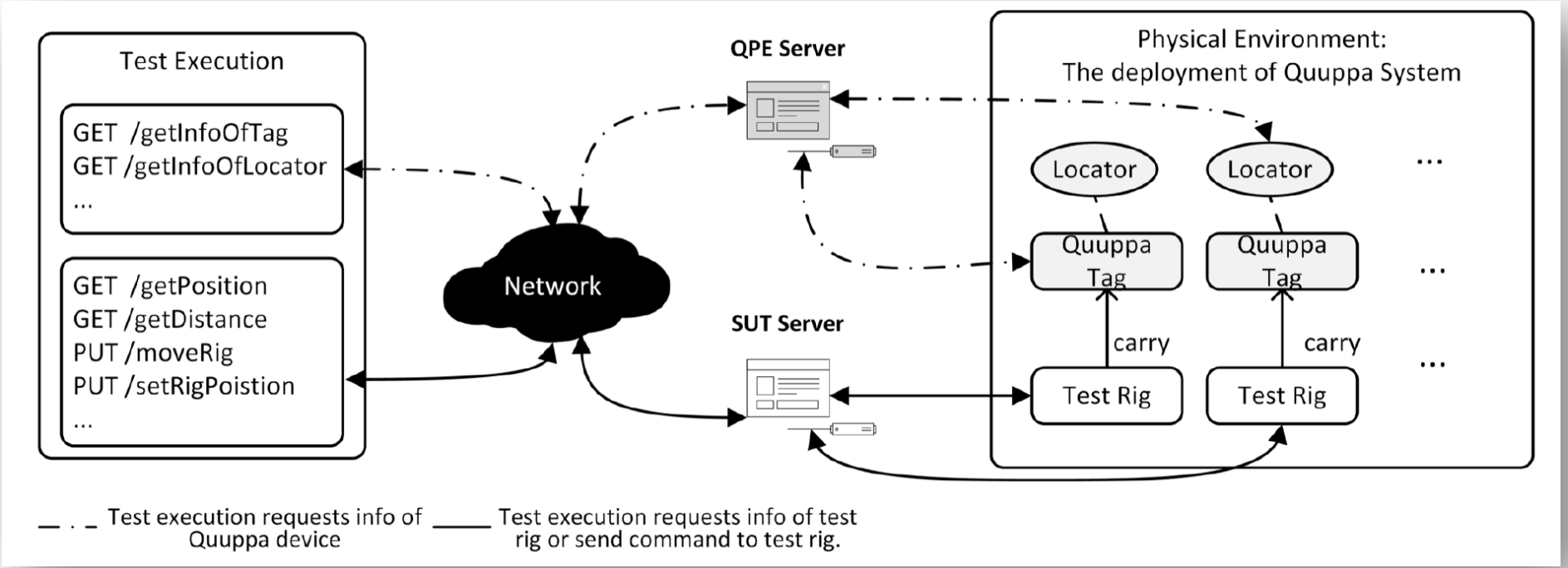
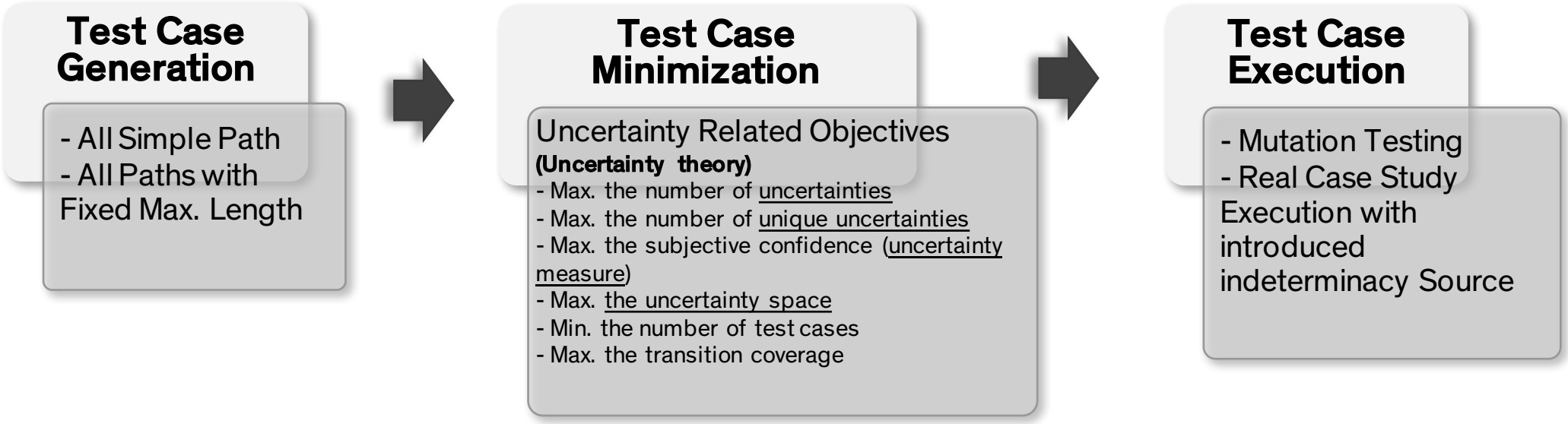
Automation of test execution is supported by test APIs implemented as REST APIs.



Integrating MBT, uncertainty theory, and multi-objective search (**NSGA-II**).



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All strategies are evaluated in terms of **cost, effectiveness, and efficiency**.

Test Case Generation → **Test Case Minimization** → **Test Case Execution**

Safe Home

	#TC		#Min. TC	%Min.	Mutation Score	Efficiency $\frac{\text{mutation score}}{PTM}$	Efficiency $\frac{\#\text{ of mutants killed}}{\text{time for executing test cases}}$
APL	**2**		-		8.9%		
APML	**1253**	#Uncertainty	490	60%	100%	2.5	0.06
		Uncertainty Space	136	80%	98%	8.8	0.22
		Uncertainty Measure	490	60%	100%	2.5	0.06
		Unique Uncertainties	109	91%	100%	11.2	0.27

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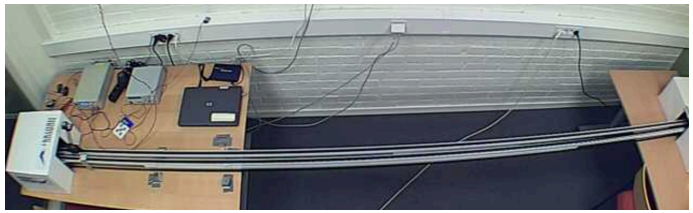
We apply the best strategy to test the real case study in terms of discovering uncertainties.

Test Case Generation → **Test Case Minimization** → **Test Case Execution**

GeoSports

	#TC		#Min. TC	%Min.	Observed Uncertainty	New Uncertainty
APML	**2085**	Unique Uncertainties	**336**	83.9%	**98**	**18**



- Test infrastructures have been built, which enable the **introduction of known indeterminacy sources**.
  - Signal Shielding box and Far From Locator
  - **Unknown indeterminacy sources**

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Acknowledgement






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References

- Man Zhang, Bran Selic, Shaukat Ali, Tao Yue, Oscar Okariz and Roland Norgren, **Understanding Uncertainty in Cyber-Physical Systems: A Conceptual Model**, 12th European Conference on Modelling Foundations and Applications (ECMFA), 2016. https://www.simula.no/file/u-modeltrfinalpdf/download
- Man Zhang, Tao Yue, Shaukat Ali, Bran Selic, Oscar Okariz, Roland Norgren, Karmele Intxausti, Santiago Charramendieta. **Specifying Uncertainty in Use Case Models in Industrial Settings**. Simula Research Laboratory, Technical Report 2016. https://www.simula.no/publications/specifying-uncertainty-use-case-models-industrial-settings
- Man Zhang, Shaukat Ali, Tao Yue and Malin Hedman. **Uncertainty-based Test Case Generation and Minimization for Cyber-Physical Systems: A Multi-Objective Search-based Approach**. Simula Research Laboratory, 2016. https://www.simula.no/publications/uncertainty-based-test-case-generation-and-minimization-cyber-physical-systems-multi
- Tao Yue, Shaukat Ali, Bran Selic, **Uncertainty Modeling**, Request for Information, Object Management Group, 2016, http://www.omg.org/members/cgi-bin/doc?ad/16-08-01.pdf
- Tao Yue, Shaukat Ali, Man Zhang and Dipesh Pradhan. **Standardization Bodies and Standards Relevant for Uncertainty Modelling**, Simula Research Laboratory, Technical Report 2016-05, 2016.https://www.simula.no/publications/standardization-bodies-and-standards-relevant-uncertainty-modelling
- Man Zhang, Shaukat Ali, Tao Yue and Roland Norgren, **Interactively Evolving Test Ready Models with Uncertainty Developed for Testing Cyber-Physical Systems**, Submitted to a Journal, https://www.simula.no/file/ist-u-evolvesubmittedtrpdf/download
- Man Zhang, Shaukat Ali, Tao Yue and Roland Norgren**. An Integrated Modeling Framework to Facilitate Model-Based Testing of Cyber-Physical Systems under Uncertainty**, Submitted to a Journal, Simula Research Laboratory, Technical Report 2016-02, 2016.https://www.simula.no/file/sosympaperfinaltrpdf/download

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