











CERTUS: an automated AD/ADAS V&V toolchain

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The Problem



CERT S Introduction – V&V Workflow Define Sample **Test** Assess Analyse Argue Regulations Standards Parameter Parameter Performance Scenario Test Test Analysis Identification Reduction Sampling **Planning** Execution Assessment Requirements Definition Physical (PG, HiL, Road) Conflict Performance Test • Range Coverage Coverage etc. Removal Allocation Resolution Evaluate Analytical Simulation Correlation development Relevance Review **ODD** Customer System design Mixed Reality Prioritisation Review Observations and Refine









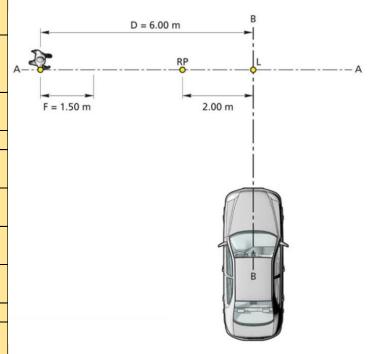




CERT S Introduction – Logical Scenario Example

- **Functional Scenarios** provide a general description
- Logical **Scenarios** set parameter bounds
- Concrete **Scenarios** set definitive parameter values

| Parameter | Range | Resolution | Value |
|----------------|--|------------|------------|
| Ego velocity | [1080] km/h | 10km/h | 30km/h |
| Road | [Dry; Wet] | - | Dry |
| condition | | | |
| Road | [None; Dashed lane markings] | - | None |
| Markings | | | |
| Angle of | [Straight; Curve 22.5/Radius 30; Curve 30/Radius 30; Curve | - | Straight |
| approach | 22.5/Radius 50; Curve 30/Radius 50; Turn into left side-road; | | |
| | Turn into right side road] | | |
| Obstruction | [None; Parked vehicle; Façade] | - | None |
| Scenery | [Open field; Complex City Environment] | - | Open field |
| | | | |
| Number of | [02] | 1 | 1 |
| actors | | | |
| Actor initial | [Nearside; Farside] | - | Nearside |
| location | | | |
| Туре | [Adult; Child; Infant; Cyclist; E-Scooter; Bobby Car] | - | Adult |
| Clothing | [Standard; Hi-Vis; Dark] | | Standard |
| Actor velocity | [3; 5; 8; 15] km/h | | 5km/h |
| Offset | [None (false positive); 25%; 50%; 75%] | - | 50% |
| Illumination | [Day-Bright; Day-Overcast; Night-Unlit; Night-1 light; Night-5 | - | Day- |
| | lights] | | Overcast |
| Precipitation | [Clear; Light rain; Heavy rain] | - | Clear |















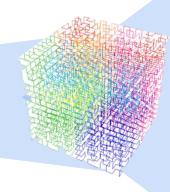
CERT S Introduction – Orders of Magnitude



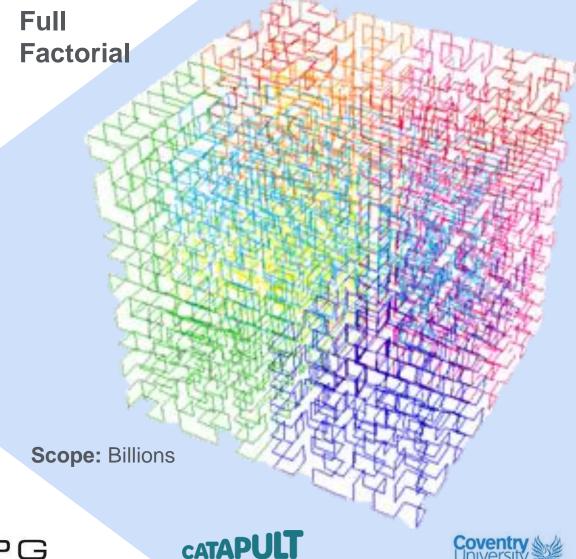
NCAP

Scope: 21,600

Coverage: ~300 (1.4%)



Scope: ~50 million











The Solution



CERT S Project Objective

A toolchain and service to deliver efficient verification & validation for automated driving systems through intelligent & targeted scenario generation, analysis and reporting.

The results support the CAM supply chain, and assist regulators and insurers by answering key questions:











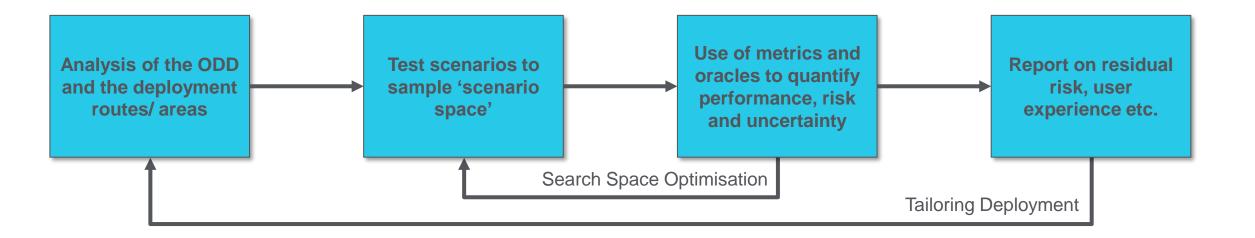


Customer Feature

V&V Specification

V&V Implementation

Product Acceptance & Release





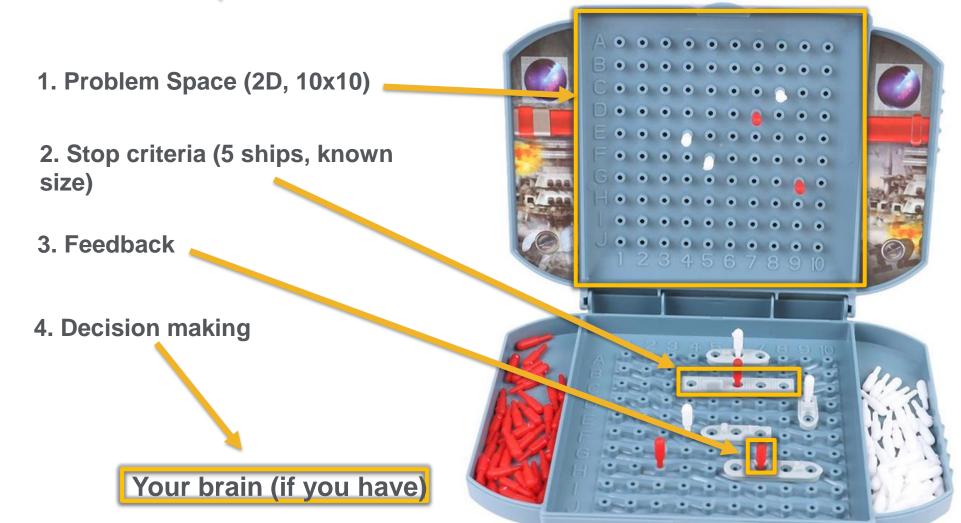








CERT S Battleship Analogy















CERT S Battleship Analogy

| Battleship | CERTUS | | |
|--------------------------------|---------------------------|--|--|
| Problem Space | | | |
| 2D (10x10) | Known, not constant | | |
| Stop Criteria | | | |
| Ships – known number and shape | TBD | | |
| Feedback Process | | | |
| Direct | Test creation / execution | | |
| Feedback | | | |
| Yes / No | Metrics / Oracles | | |
| Decision Making | | | |
| Brain | Algorithms | | |















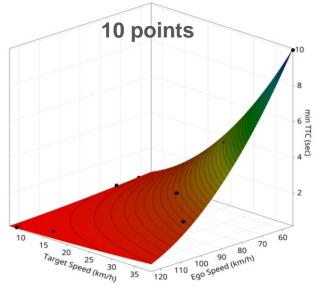
CERT Search Space Optimisation (what to test next)

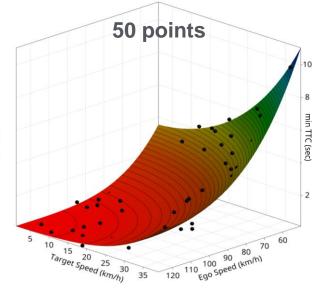


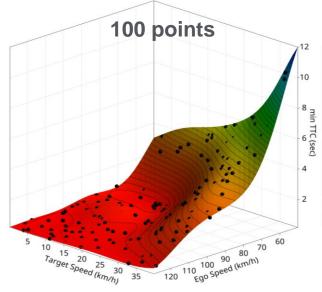


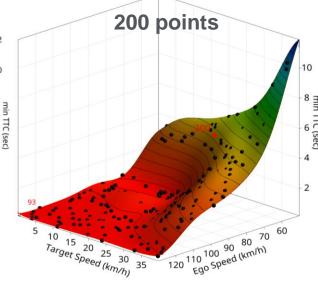
























Takeaways



CERT S Core Innovations

- Developed to test self-driving feature for a global OEM (Polestar).
- Intelligent scenario selection based on parameter sensitivity & search space
 optimisation each scenario getting you closer to your answer.
- Automated tool for identifying compliant / non-compliant areas for deployment based on the ODD.
- Novel mixed reality test environment to fuse physical and virtual scenarios.















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A&P

