Overcoming the safety and security barriers to autonomous vehicle deployment

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Capri Consortium

£4.2 million of funding from:

- Innovate UK
- Centre for Connected & Autonomous Vehicles
- Industry

Pilot scheme that could pave the way for the use of connected and autonomous vehicles to move people around airports, hospitals, business parks, shopping and tourist centres.

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Capri Vision

To build passenger, regulatory and market trust in autonomous pods as a practical, safe and affordable way to travel.

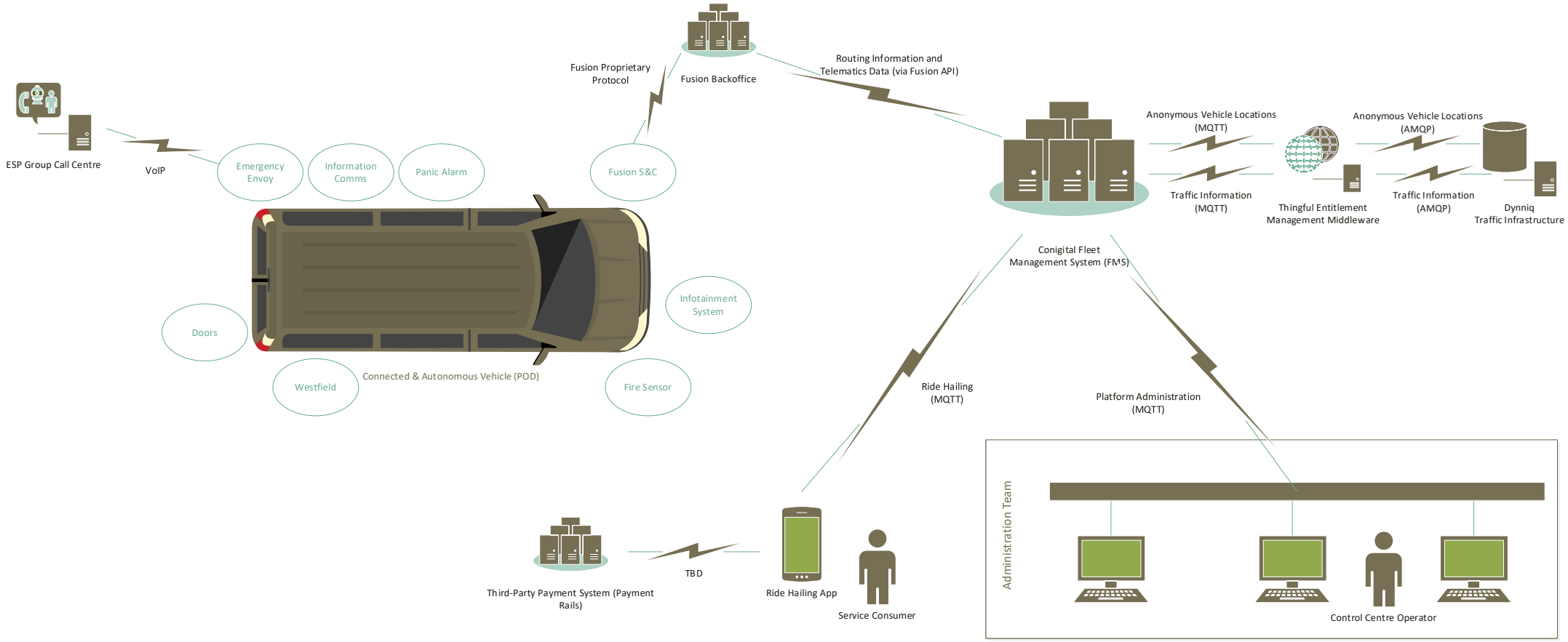
Reducing the barriers to market for a commercial autonomous pod service by:

- Devising a procedure to certify the operational safety of autonomous pods
- Assessing the infrastructure requirements for deployment
- Addressing the legal and regulatory barriers to commercial use
- Co-designing a service blueprint with real user input
- Preparing a business case to support investment decisions

This presentation focuses on Cyber Security and how it could impact operational safety.

Capri Architecture

The Capri POD is connected to an Internet-based Fleet Management Systems.



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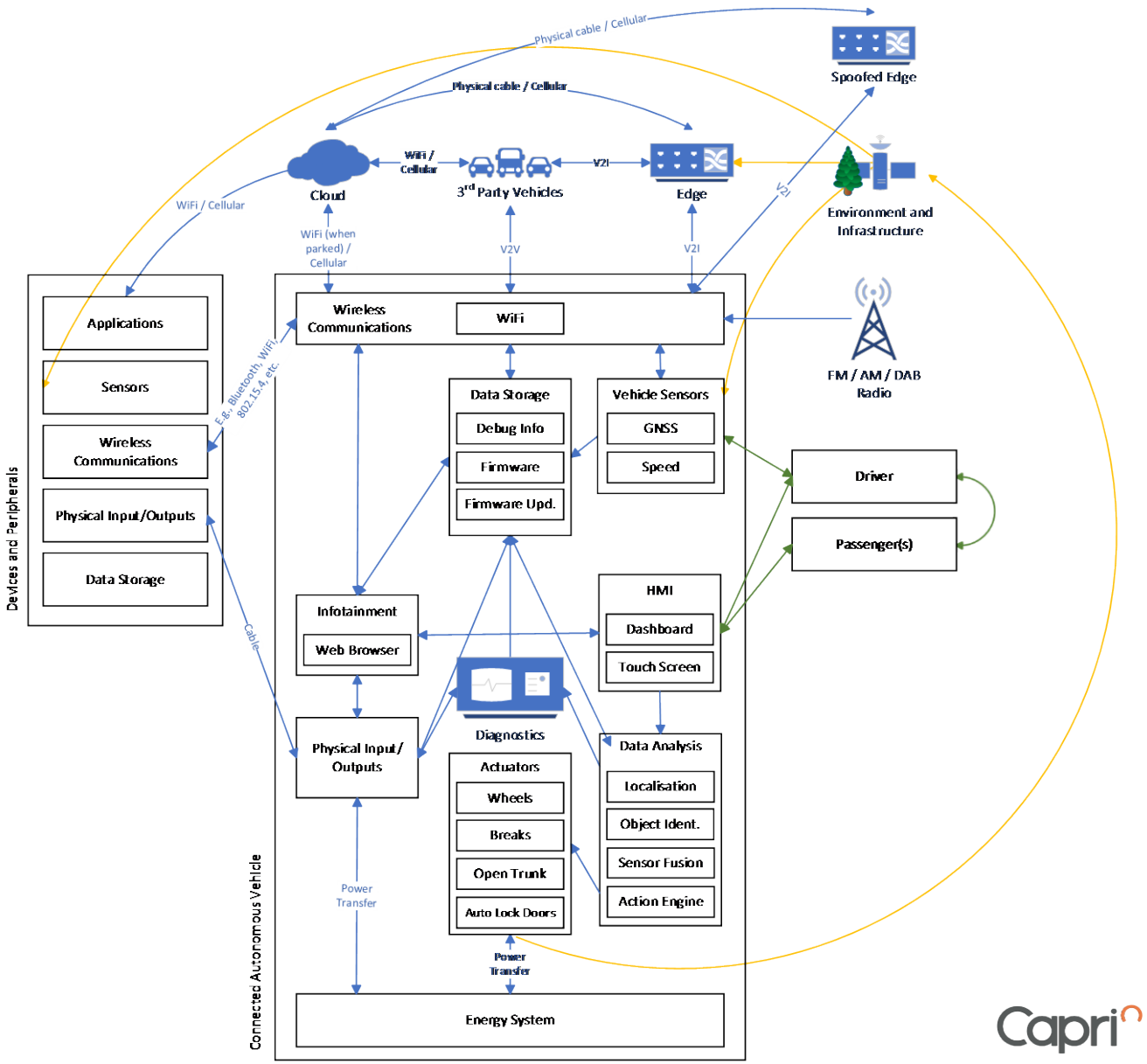
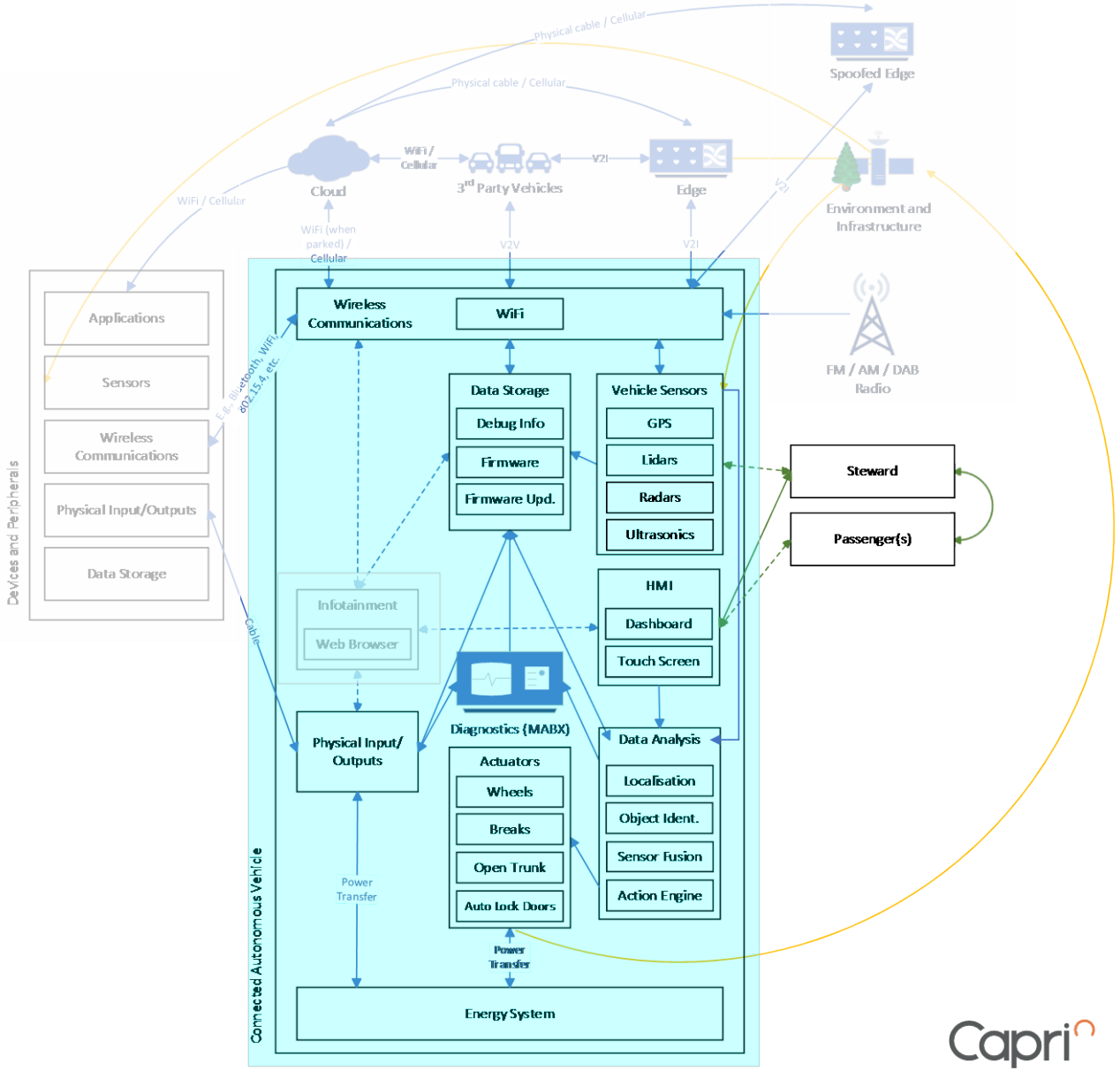
Cyber Security: CAV Reference Architecture

- A general CAV reference architecture that can understand CAV components, their functionalities and technologies in operation
- Identify the attack surfaces (potential threats) for components, functionalities, and technologies
- Shaping the focus of testing and validations through identifying most relevant threat agents and their goals



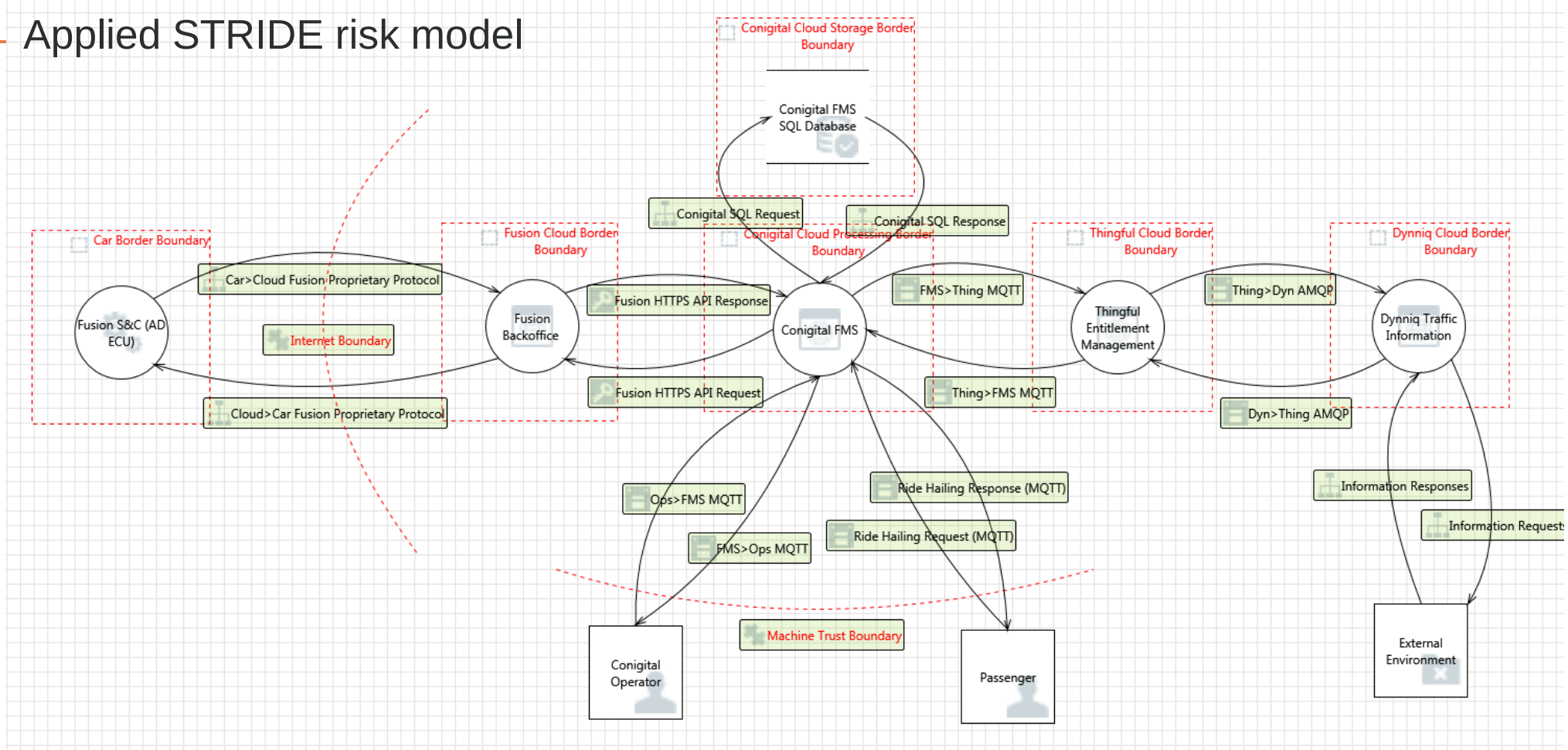
CAPRI Internal POD Architecture

- Remove irrelevant components and functions (POD has no Infotainment; having a steward instead of the driver for safety control only)
- Elaborating components and functions (adding Lidars, Radars and Ultrasonic sensors)
- Main threat agents: organised crime, hacktivists, transport infrastructure attackers, mischief makers



Cyber Security: Threat Modeling – Cloud

- Threat Model: Derived from NCC Group Automotive threat model
- Applied STRIDE risk model



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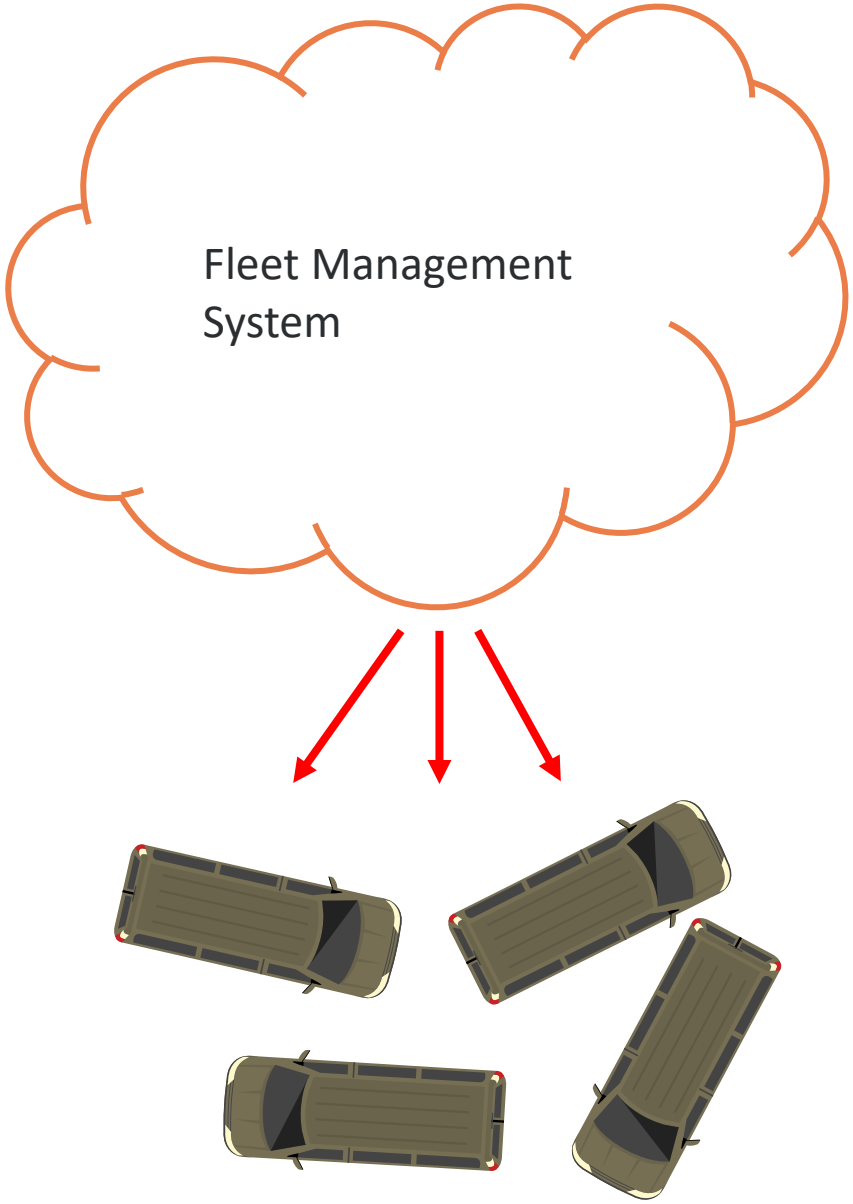
Cloud Security Scenario

Assume Fleet Management Systems is compromised…

- What happens when STOP signal is sent?
- What happens if STOP signal is sent at a time when it would leave the POD in a dangerous position?
  - E.g., middle of a busy intersection
- Can you send all PODs to the same point, then tell them to stop?
  - Denial or Service

Capri approach: Simulation



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Testing & Validation: Developing Knowledge of Attack and Defence Potential

For each attack, testing and validation should investigate the following essential knowledge:

- Attack potential: minimum requirements for the attack to be successful: Elapsed time, expertise, knowledge, opportunity, equipment
- Defence potential: available controls and their effectiveness
- High probability threat agents and their relevant goals to initiate that attack

Three levels of testing:

- Theoretical analysis
- Simulation
- Trial
- → Balance between testing resource and requirements

Trial testing issues:

- Public trial vs private trial: Closer to reality but may have safety impact
- Proprietary testing issue: Cooperation via fuzzing test

Attack surface	Threat modelling: STRIDE					
	Spoofing	Tampering	Repudiation	Information disclosure	DoS	Elevation of Privilege
Camera	M3	M2	M2	M3	M3	N/A
GPS	M3	M2	M2	M3	M3	N/A
Radar	M3	M1	M1	M1	M3	N/A
Lidar	M3	M1	M1	M1	M3	N/A
Blindspot sensors	M3	M1	M1	M1	M3	N/A
Ultrasound sensors	M3	M1	M1	M1	M3	N/A
Decision making system	M3	M2	M2	M3	M3	N/A
Curtis controller	M3	M2	M2	M3	M3	N/A
MABX	M3	M2	M2	M3	M3	N/A
Digital Concentrator Measurement Unit	M3	M2	M2	M3	M3	N/A
Cradle point	M3	M2	M2	M3	M3	N/A
Tire sensors	M3	M2	M2	M3	M3	N/A
		M1: Analyis		Completed		
		M2: Simulation		In Progress		
		M3: Trial		Planning		
				Not Applicable		

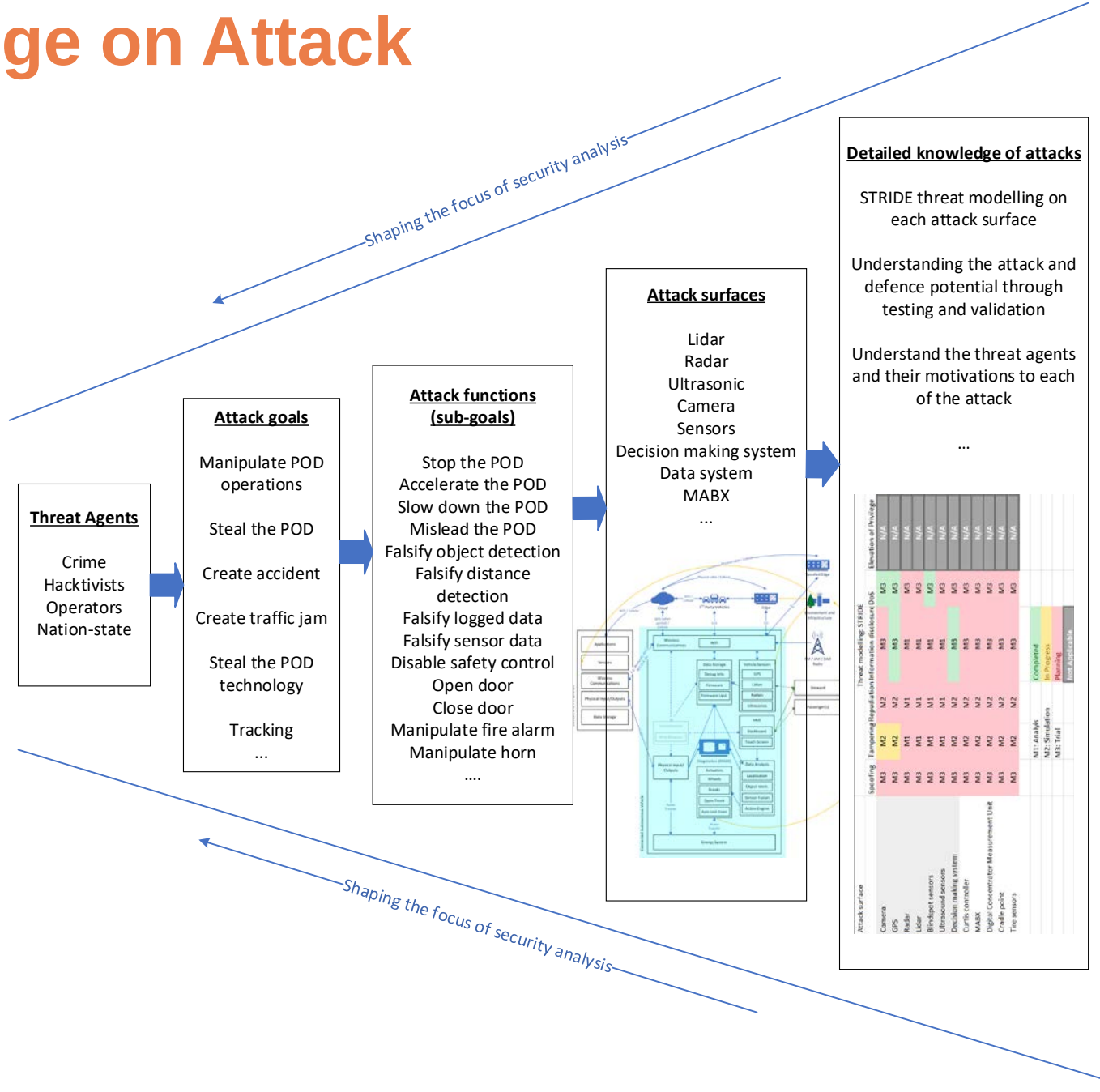
Example of a typical testing plan and management

Manage the Knowledge on Attack

Issue of large and expanding attack surfaces

- Analysing all the attacks is infeasible
- Attack tree to shape the focus of security analysis
- Attacks come from several threat agents, aiming at specific functions and surfaces

→ Identifying the most likely threat agents and goals to reduce the set of attacks to analyse



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Dynamic Risk Consideration: Environment and System State

Environment risks can either reinforce or reduce vehicle risks, because they have:

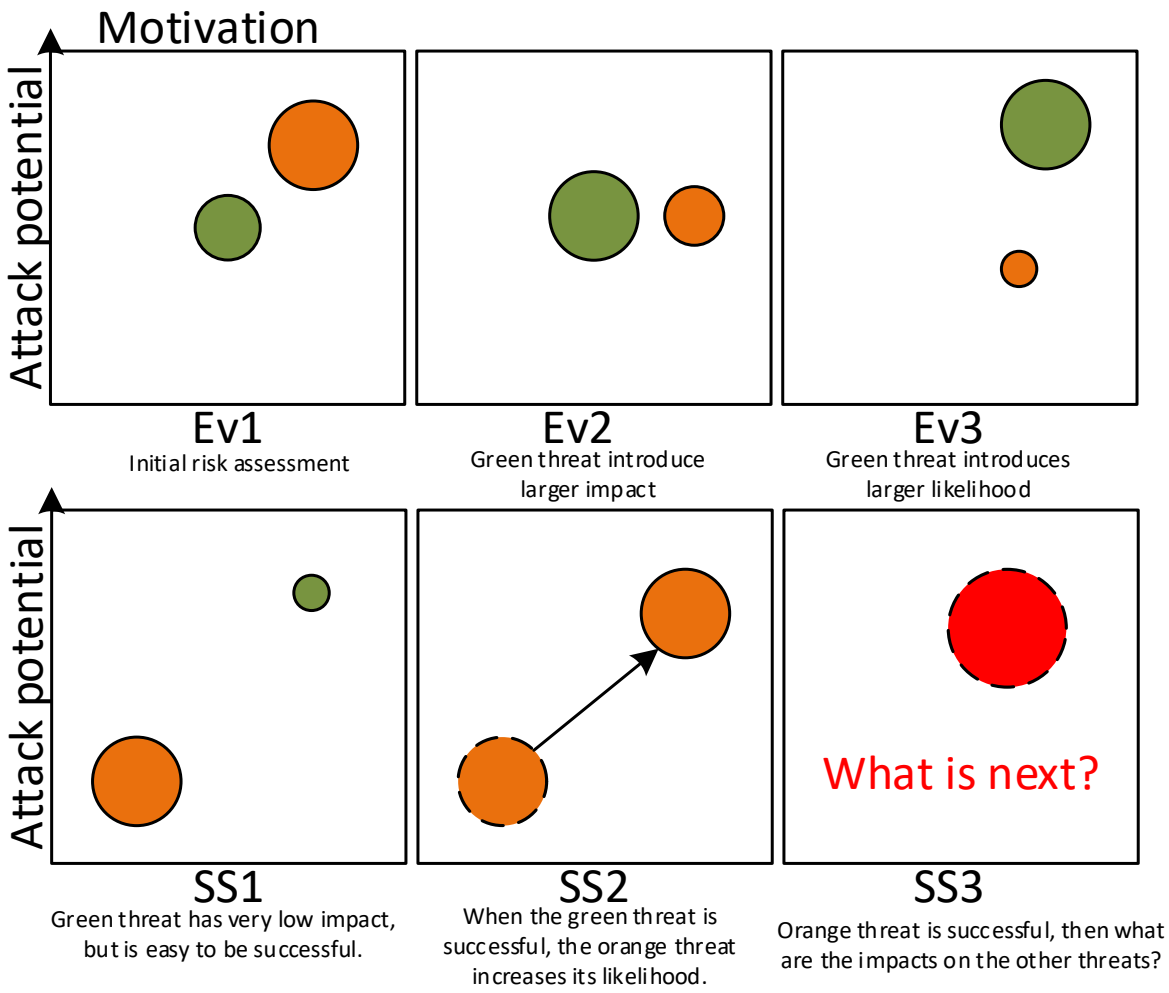
- Impacts on attack and defence potential
- Impacts on threat agents and their motivations.

System's security state affects risk assessment

- Vulnerabilities in one surface may open the chances for attacking other (linked) surfaces.

Effective dynamic risk assessment at scale:

– Maintain risk profiles of environments and system states to reuse the analysis

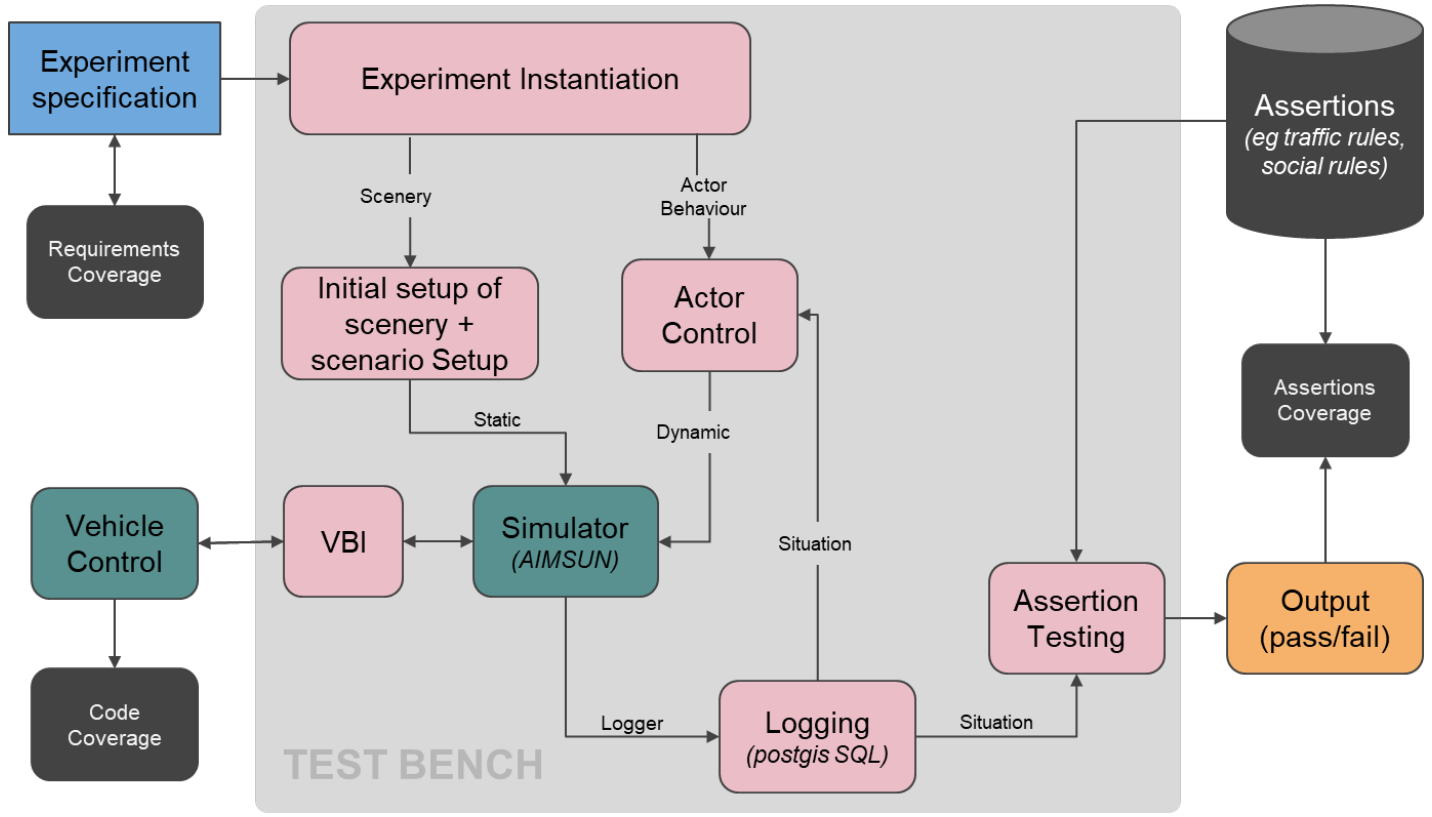


Simulator Testbench: Safety and Cyber Security

Objectives
- Codify corner cases from accidentology & security, measure coverage
- Automate checking for correctness
- Control simulation and communications with POD

Concerns
- Fidelity
- Hitting corner cases
- Pass/fail automation

Solution
- Correlation with real world trials
- Constrained random test generation
- Intelligent, model-based test generation (e.g. agent-based or formal methods-based) for corner cases
- Assertions and functional coverage



Summary

Final trials:

- Queen Elizabeth Olympic Park
- Jan 2020

Blend of approaches to assure Cyber Safety

- Traditional threat assessment
- Simulation
- Trial

Results will feed longer term pilots

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Thank you

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For more information: http://caprimobility.com/

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