Centre for Connected and Autonomous Vehicles

CCAV - Cohort Event

November 2024

https://iuk.ktn-uk.org/

Innovate UK | Business Connect

About Us

We are part of **Innovate UK**, the UK's innovation agency. Innovate UK Business Connect exists to connect innovators with new partners and new opportunities beyond their existing thinking.

Accelerating ambitious ideas into real-world solutions.

Our Purpose & Vision

- We create diverse connections to drive positive change.
- To establish a network of innovators so powerful its ideas will change the world.

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Our Strategy

Positive Change

We create diverse connections to drive positive change

Deep Expertise

We have wide-ranging expertise and convene the expertise of others

Powerful Connections

We drive powerful connections with business at the heart of what we do

Future Shaping

We shape the innovation communities of the future

Our People

We provide an exceptional place of work for our exceptional people

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Our Network

46,229
Unique Organisations

72%
Small

15%
Medium

13%
Large

335,478
innovators

Every university in the UK

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Welcome to the CCAV Cohort Event – HOUSEKEEPING.

CAM MAILING LIST

Innovate UK | Business Connect

AGENDA

09:40 - CCAV Introduction

10:00 - Automated Vehicles Act Update

10:20 - CAM Pathfinder Update

10:40 - Coffee Break

11:10 - Mass Transit Feasibility Studies

11:30 - Introductions and updates

BSI – Nick Fleming

IMechE- Rob Porter

11:40 - Introductions to the Cohort Event

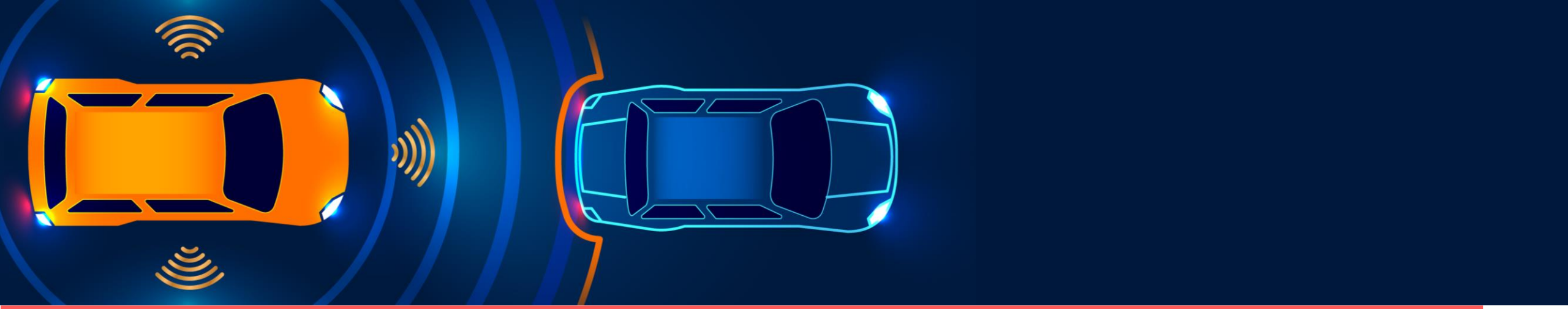
12:10 - Lunch

13:00 - Innovate UK – Horizon Europe new competition call opportunities + Liftango

13:45 - Zenzic updates.

14:15 - Project CERTUS.

14:45 – 17:00 Final Remarks , closing and post-event networking



CCAV Introduction

- Simon Connick, Head of CCAV
- Michael Talbot, Deputy Head of CCAV

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CAM Cohort Event- CCAV Intro
Simon Connick

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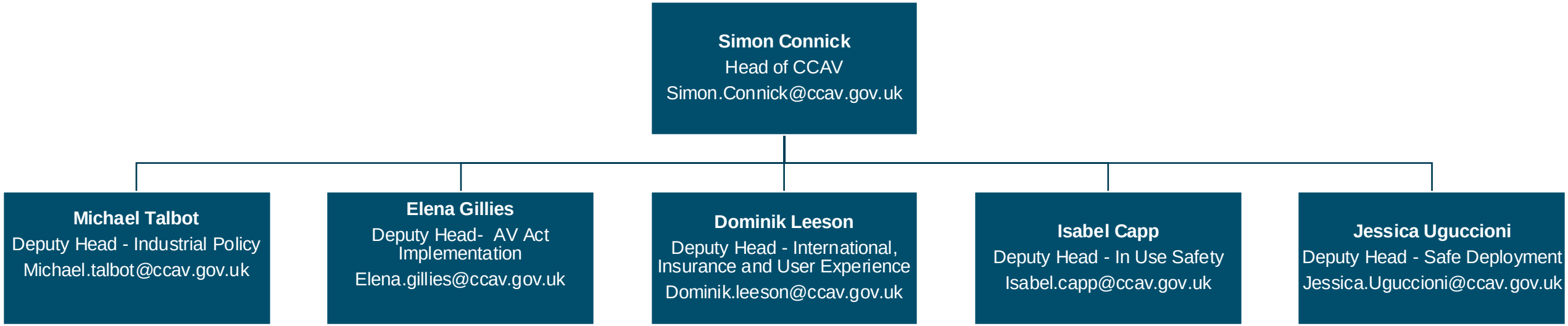
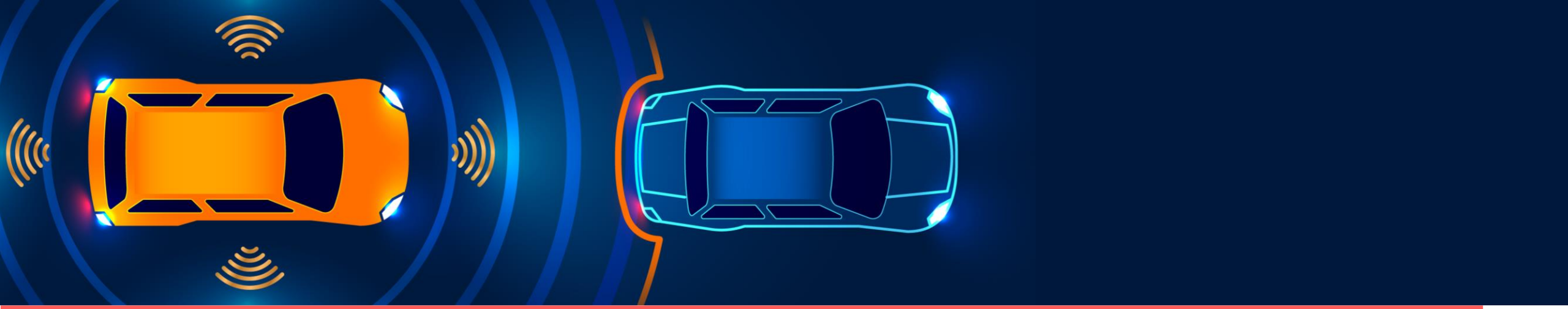
CCAV Organisational Chart





Automated Vehicles Act Update

- Jessica Uguccioni, Deputy Head, AV Deployment
- Dominik Leeson, Deputy Head, International
- Marty Zekas, AV Act Implementation Lead

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CAM Cohort Event- AV Act Implementation

Jessica Uguccioni, Deputy Head, AV Deployment
Dominik Leeson, Deputy Head, International
Marty Zekas, AV Act Implementation Lead

Agenda

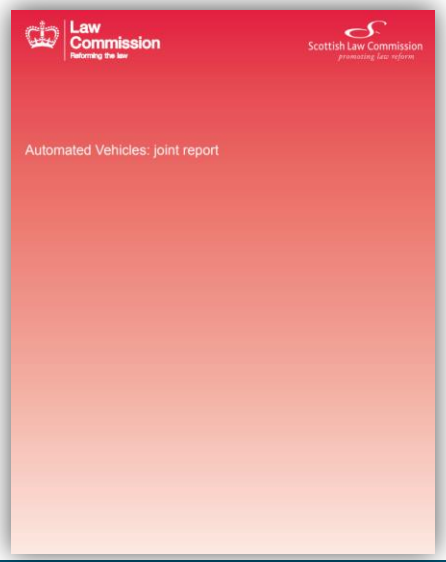
- 1. AV Act Context
- 2. AV Act Content
- 3. UN + Domestic Regulations
- 4. AV Act Implementation + timelines

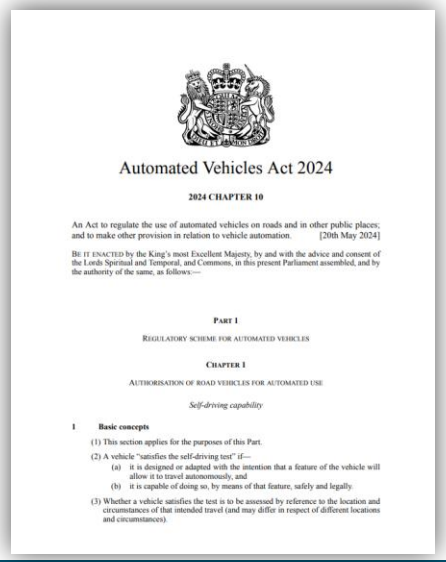
Automated Vehicles Act 2024 | Context

The ambition for the framework for the future regulatory regime for Automated Vehicles was set out between 2022-2024.

2022- Connected and Automated Mobility 2025 White Paper sets out ambition for realisation of self-driving vehicles in the UK

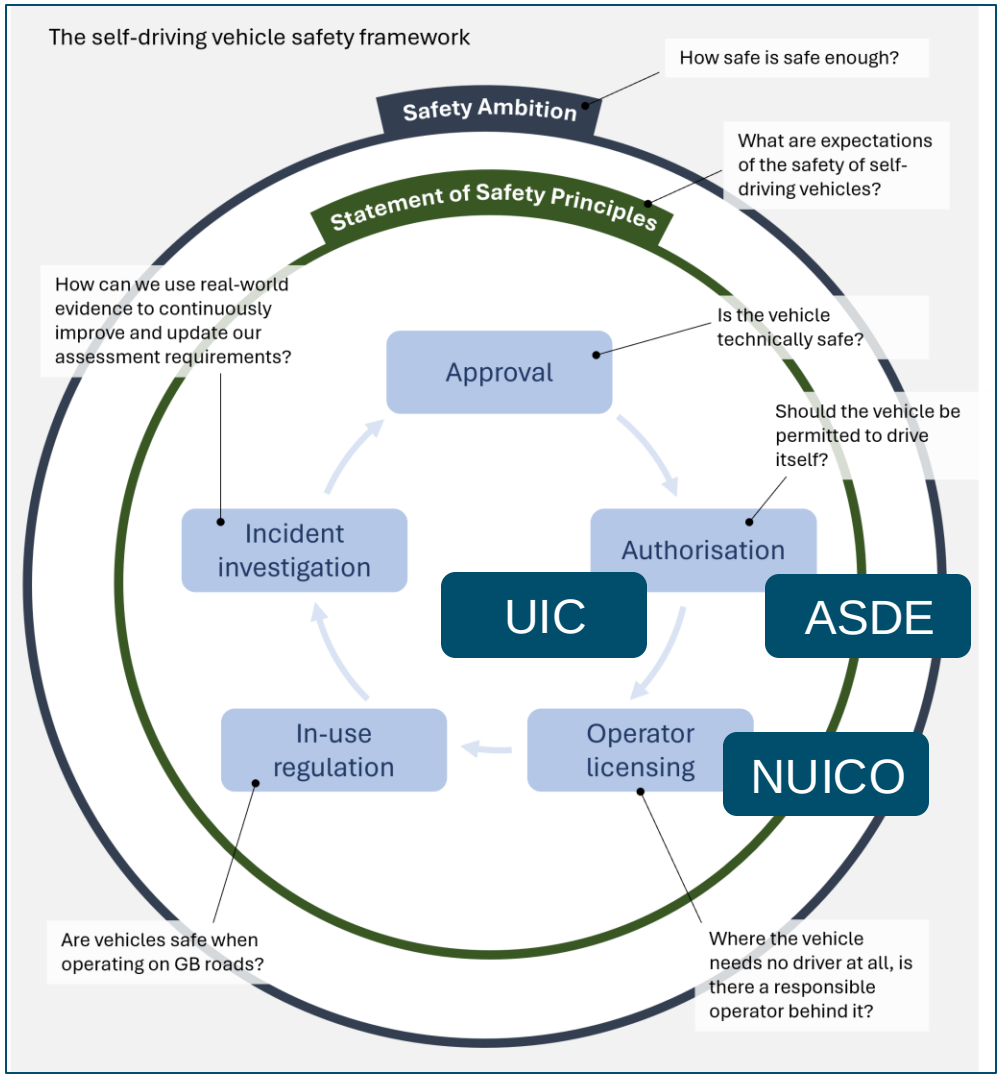
Law Commissons' of England, Wales and Scotland Report on Self Driving Vehicles 2022, leading to **the Automated Vehicles Act 2024**





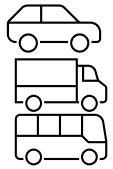
The Automated Vehicles Act 2024 contains several key elements

- Safety
- Liability
- Misleading Marketing
- Licencing of automated passenger services



Role of UN Automated Driving Systems (ADS) Regulations

Aim Deliver a harmonised and mutually recognised approval regulation for *automated driving systems* by June 2026 (estimated to enter into force **Jan 2027**).



Scope includes cars, vans, trucks and buses. Permit approval of varied operational design domains and include systems which do and do not issue transition demands.

Agreed by 'contracting parties' (countries) to the 1958 and 1998 agreements, supported by industry.

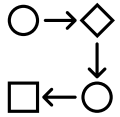
Representatives from Canada, China, European Commission, France, Germany, Japan, Netherlands, South Korea, Sweden, UK, USA, industry, academia, and other advocate groups.

ADS Regulations- Content Under Development

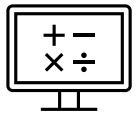
Performance of the Dynamic Driving Task (DDT) - The DDT requirements cover ADS control of the vehicle and safe operation in traffic. Requirements include compliance with traffic rules, avoiding collisions, and avoiding unreasonable disruption to the flow of traffic

User Interactions - The user requirements cover the HMI, information to be provided to users, transitions between the ADS and users, and measures to avoid mode confusion.

In Service Monitoring and Reporting (ISMR) - Requires the manufacturer to monitor the performance of their vehicles post deployment and to notify and report on incidents which occur in use.



Safety Management Systems (SMS) - covers the safety processes of the manufacturer's organisation to develop and deploy a safe product.



Virtual testing credibility assessment - This section covers how the manufacturers should show their simulations are credible and match reality.

Safety case approach – The manufacturer will submit a safety case claiming and arguing with supporting evidence that the ADS is free from unreasonable risk and meets each requirement of the regulation.

What next for AV Act Implementation?

Policy Development and Engagement

Developing policy positions through stakeholder engagement and multiple rounds of consultation.

- First of two rounds of consultation on Statement of Safety Principles – from Spring 2025
- Misleading Marketing Consultation - Spring 2025
- First of two rounds of consultation on Main Regulations* from 2nd Half 2025

Delivering National Regulation

Ensuring timely passage of secondary legislation and statutory guidance.

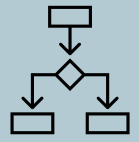
- Statement of Safety Principles in force- early 2027
- AV Main Regulations* in force – 2nd Half 2027

International Engagement

Working with international (UNECE) partners to harmonise vehicle type approval regulations for self-driving vehicles.

- Close working with DfT International Vehicle Standards Colleagues
- UNECE ADS Regulation comes into force - early 2027

Operational Delivery

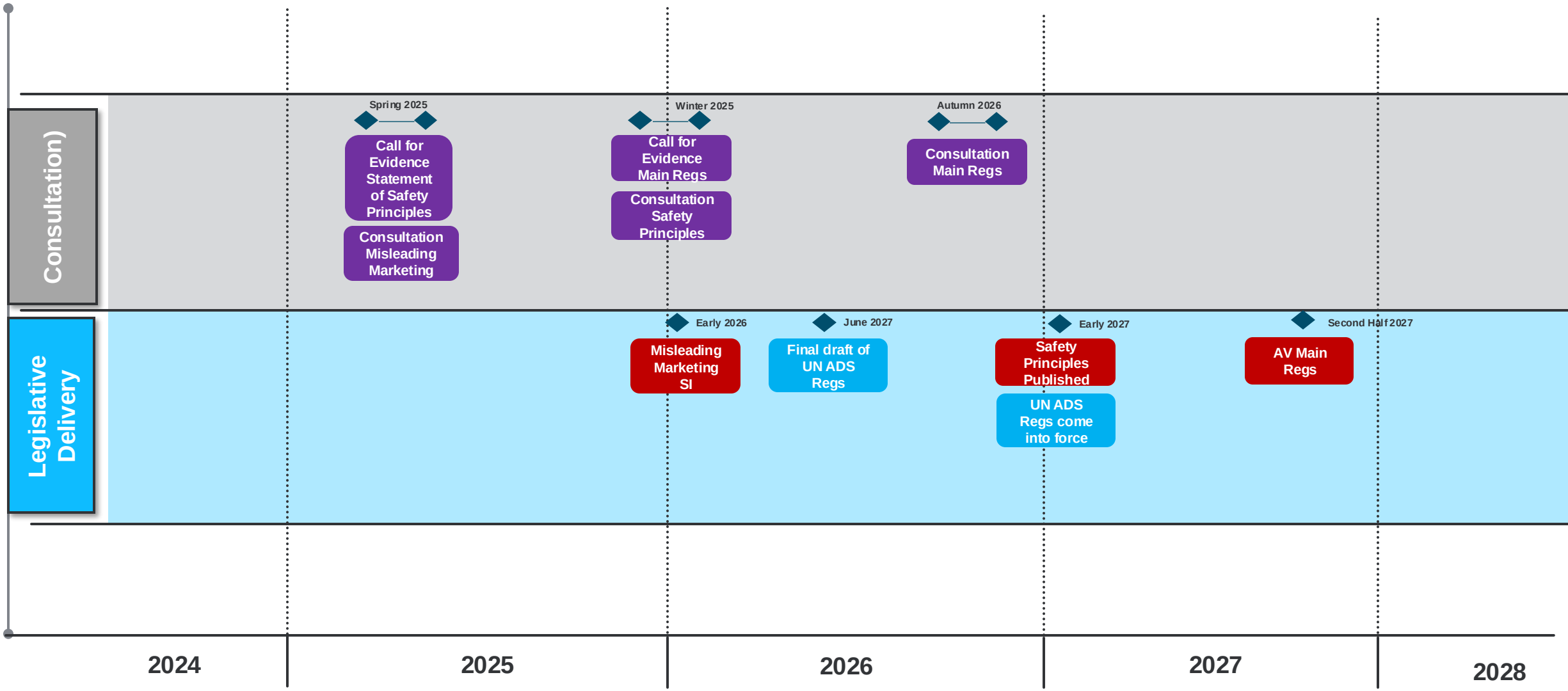


Ensuring smooth customer journey with clear access points for industry.

- Working with the VCA on development of approval/authorisation procedures
- Building wider customer journey for the AV framework

* Will include incident investigation, monetary penalties, authorisation, in-use regulation, permits for automated passenger services, no user-in-charge licensing and remote operations, information sharing, user-in-charge and transition demands)

Indicative Critical Path for Implementation



Key

Consultation/Call for Evidence

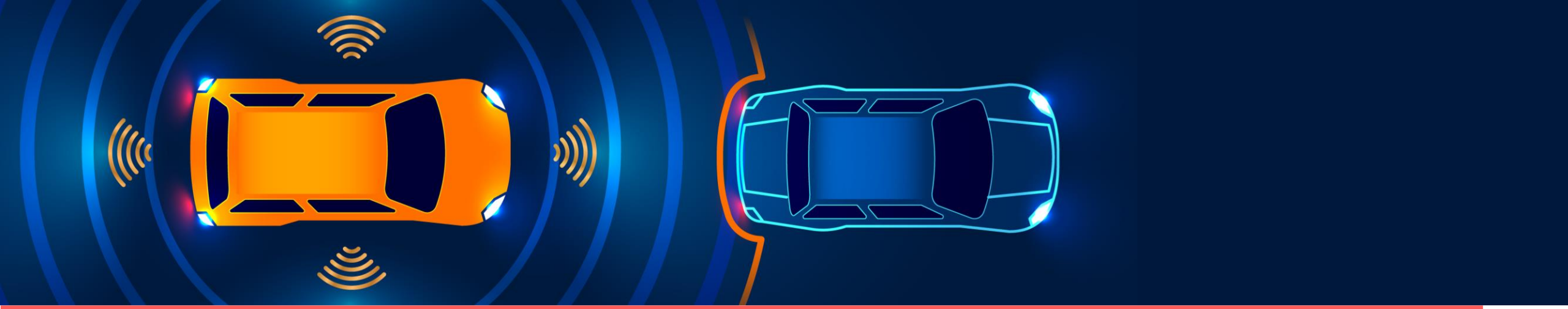
SI

International Regs

* Will include incident investigation, monetary penalties, authorisation, in-use regulation,permits for automated passenger services, no user-in-charge operator licensing and remote operations, information sharing, user-in-charge and transition demands)

Get in touch

enquiries@ccav.gov.uk



CAM Pathfinder Update

- David Webb, Head of Innovation
- Michael Talbot, Deputy Head, CCAV

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CAM Update

- David Webb | Head of Innovation | Centre for Connected and Autonomous Vehicles (CCAV)

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Fred Bowron
Industry Policy Advisor
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- Budget 2024
  - Industrial Strategy
- CCAV Funding
  - FY2025/26
    - Commercialising CAM Extensions
    - CAM Pathfinder Initiation Programme
      - Collaborative R&D
      - Feasibility Studies

SMMT and DfT (inc. CCAV) visit to VW's Mobility as a Service offering in Germany

DBT & the Budget

- Growth is the number one mission of the government.
- The new Industrial Strategy is central to that Growth Mission and the Green Paper (published 14 October) sets out our vision for a modern Industrial Strategy, “Invest 2035”.
- Invest 2035 will provide a credible, 10-year plan to deliver the certainty and stability businesses need to invest in the high-growth sectors that will drive our growth mission.
- These eight high growth sectors include Advanced Manufacturing and Digital and Technologies and this focus will enable them to adapt and grow, and to lead in new sectors, with high quality, well-paid jobs.
- As part of the Industrial Strategy, government will also support: Net zero, Economic security and resilience, and Regional Growth

- For areas of the Industrial Strategy led by DBT, Autumn Budget 2024 confirms:
- **Advanced manufacturing sector support to unlock investment across the UK**, including £975 million dedicated to the aerospace sector and **over £2 billion for the automotive sector up to 2030**.
- DBT’s settlement provides small businesses with the support they need to start up and grow in the UK, creating jobs and prosperity for people all over the country. The Budget confirms:
- Over £1 billion across 2024-25 and 2025-26 for the British Business Bank to enhance access to finance for small businesses, including over £250 million each year for small business loans programmes, including Start Up Loans and the Growth Guarantee Scheme.
- Over £200 million for wider small business support including continued funding for practical support through Growth Hubs and Help to Grow Management.

Invest 2035: the UK's modern industrial strategy

- The industrial strategy is the UK government's proposed 10-year plan for the economy. It aims to deliver the certainty and stability businesses need to invest in the high-growth sectors and drive long-term economic growth.
- We want to hear your views on the proposals.
- The final industrial strategy will be published in spring 2025, alongside the multi-year spending review.
- This consultation closes at **11:59pm on 24 November 2024**

DBT Auto Germany Trade Mission

- The Department for Business and Trade (DBT) is pleased to invite you to express your interest in attending an automotive technology supplier trade mission to Germany
- The following areas of interest:
  - AI
  - Semiconductors
  - Next Generation Sensing Technology
  - Hydrogen Propulsion
  - Battery Technology
- Due to the tight timescales, completed documents by **Wednesday 25 November**.
- DBT hosted TEAMs briefings on the 7th (tomorrow!) and 14th
- Speak to me today if you're interested!

CAM Pathfinder – Initial Funding

- CCAV has secured funding to support the CAM Sector in FY2025/26 (April 2025 to March 2026)
- Ahead of a further Spending Review in the spring CCAV will commit to
- **Commercialising CAM Extensions**
  - Funding to enable the extension of select Commercialising CAM projects through to March 2026
  - Extensions will only be funded up to each projects GOL
  - PCR process to be announced ASAP
- **CAM Pathfinder – Enhancing CR&D**
  - Up to £6m of funding available to enhance the current Commercialising CAM offerings
    - Enabling ‘Autonomy Ready’ Vehicle Platforms
    - Enabling the safe removal of the safety driver
    - Supporting early commercialisation opportunities for CAM and CAM Technologies, Products, and enabling Services
  - **Only open to current Commercialising CAM projects**
  - Projects can bid for up to £1m of grant funding

- **CAM Pathfinder – Feasibility Studies**
  - Up to £2m of funding available to explore
    - Technical Concepts
    - Business Case Development (Barriers)
    - Commercial Feasibility (near term opportunities)
  - **Open Competition**
  - Projects can request up to £250,000 of grant funding

- We are not funding projects that are:
  - connected vehicle technologies which are not specific to automated vehicles.
  - micro goods vehicles, indoor or pavement-based robots or vehicles
  - technologies specific to rail vehicles, water-borne craft, drones, or aircraft
  - developing advanced driver assistance systems (ADAS) or Driver Control Assistance Systems (DCAS) unless there is a clear route to full vehicle automation.

Questions & Comments

- **CAM Pathfinder – Enhancing CR&D**
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Mass Transit Feasibility Studies

- Fred Bowron, Industry and Commercial Policy Advisor

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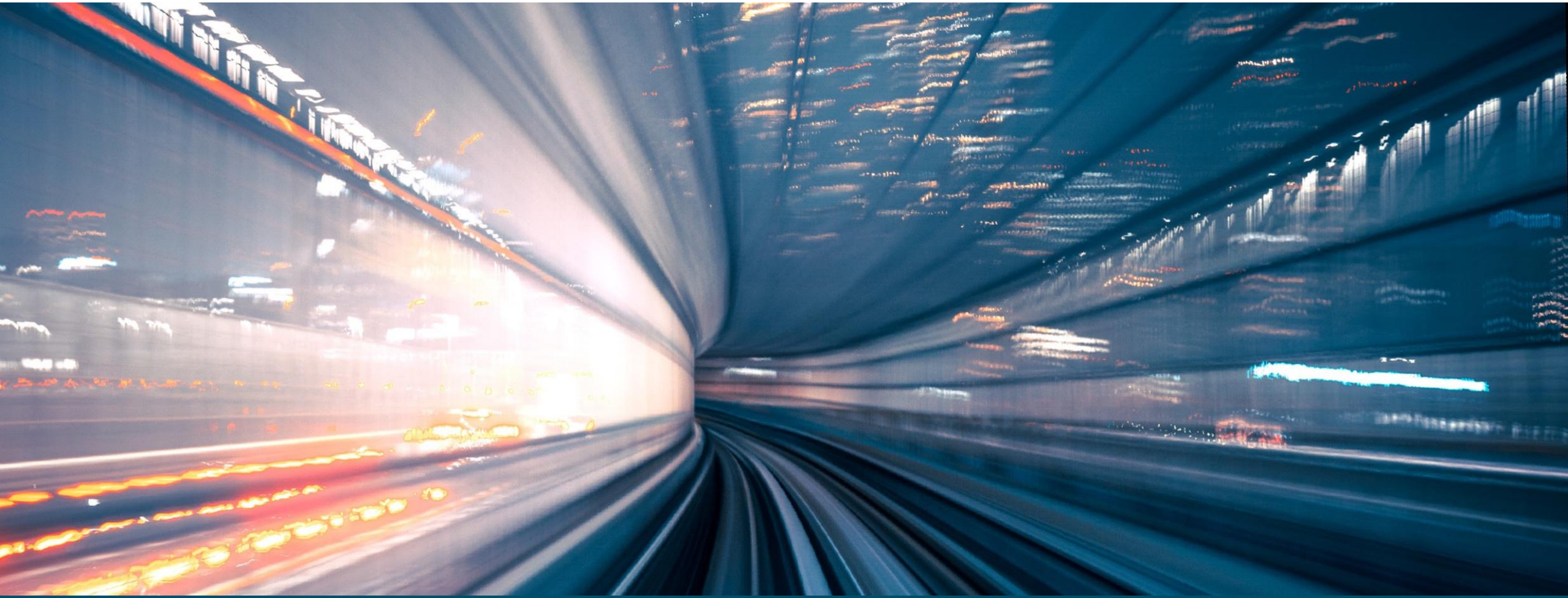
CCAV CAM Mass Transit Feasibility Studies Overview

Fred Bowron



November 24

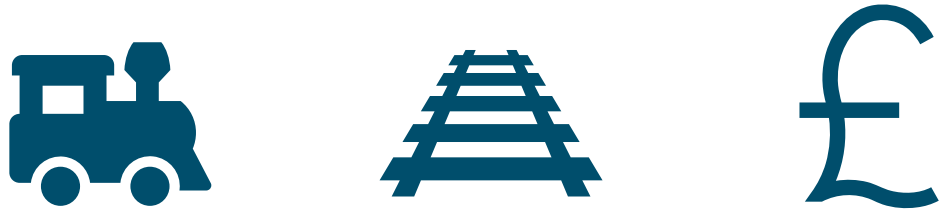
Context

What is Mass Transit?

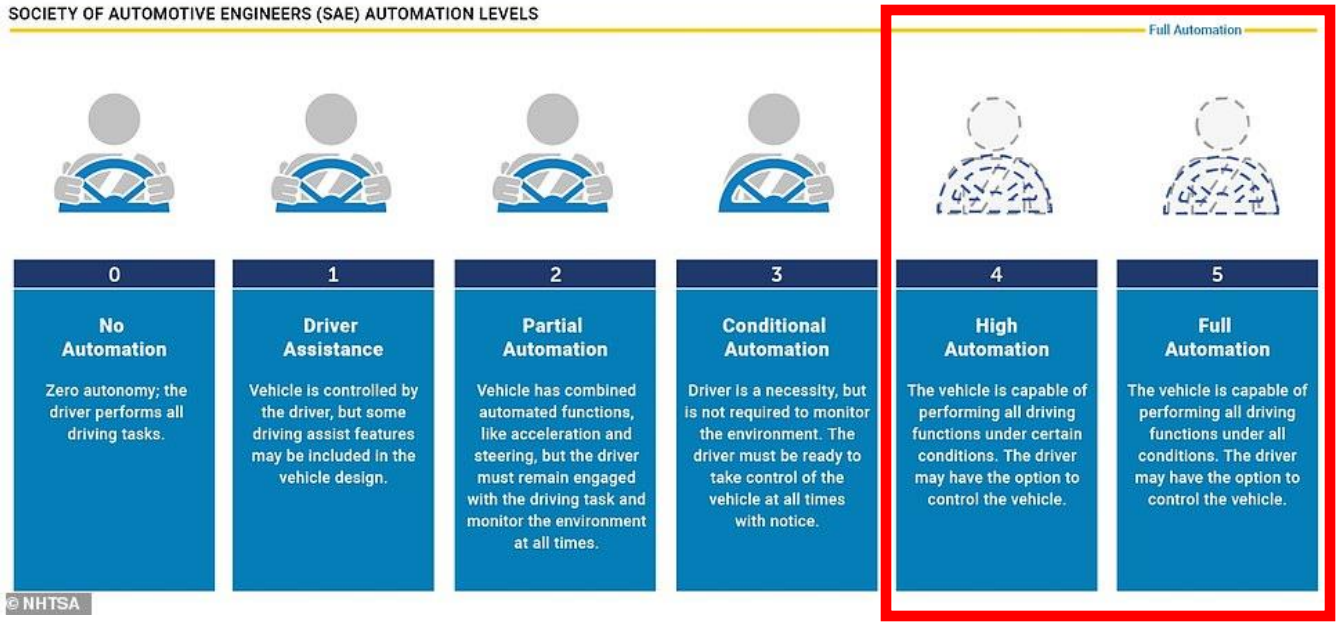
- Shared public transportation system.
- A large number of people are carried from one place to another.
- Within a single vehicle or combination of vehicles.
- On a defined route.

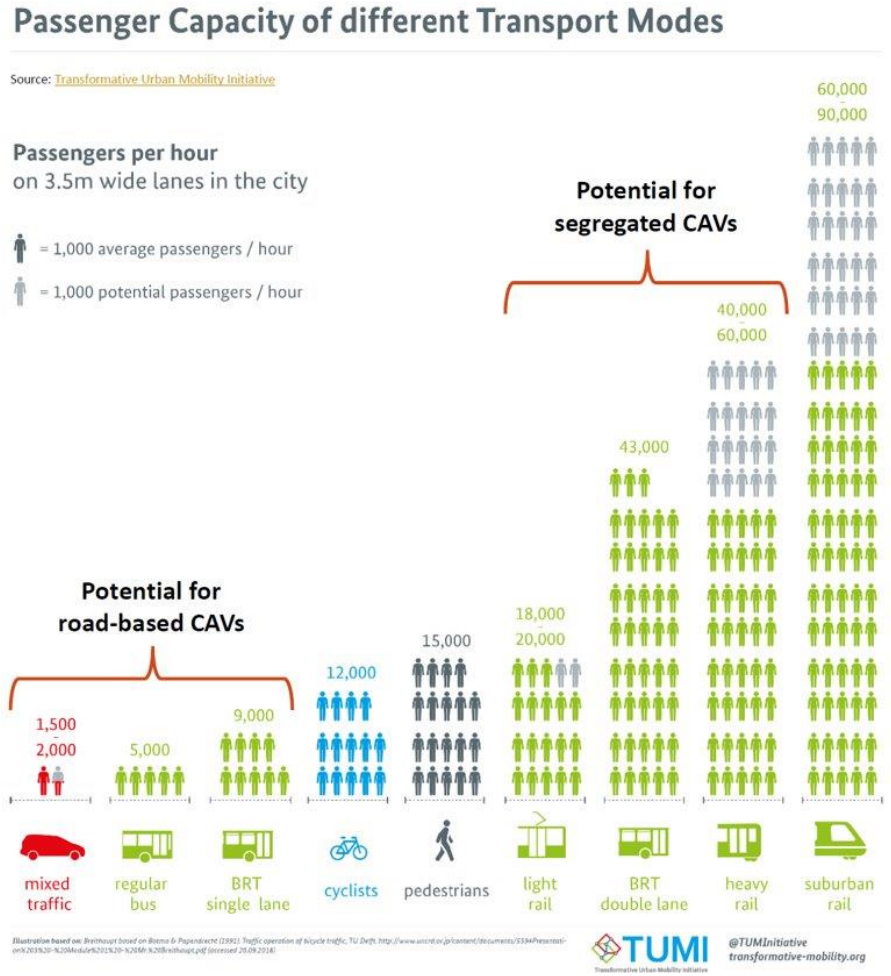
Beeching Cuts *and* Restoring Your Railway:

- 150–300 miles per year between 1950 and 1961, 1,000 miles (1,600 km) in 1964, ended in 1970s.
- Many redundant structures from closed lines remain.
- Many places without sufficient public transport provision.
- Are (re)new(ed) rail lines the right solution in every case?



What do we mean by CAM Mass Transit?





Is CAM feasible as a mass transit solution in the UK?

Competition 1.
- On physically segregated infrastructure.
- Routes not open to public access
- Passenger services only

Competition 2.
- Public spaces
- Private or segregated spaces
- Passenger and optional logistics services

Design, delivery and operational cases for a CAM mass transit service

Solve real-life transport problems, where traditional services are not viable

Encourage active transport and public journeys (acceptability, accessibility, inclusivity)

Consider how the service could be improved or expanded in the future

On a specific UK route currently underserved by public transport

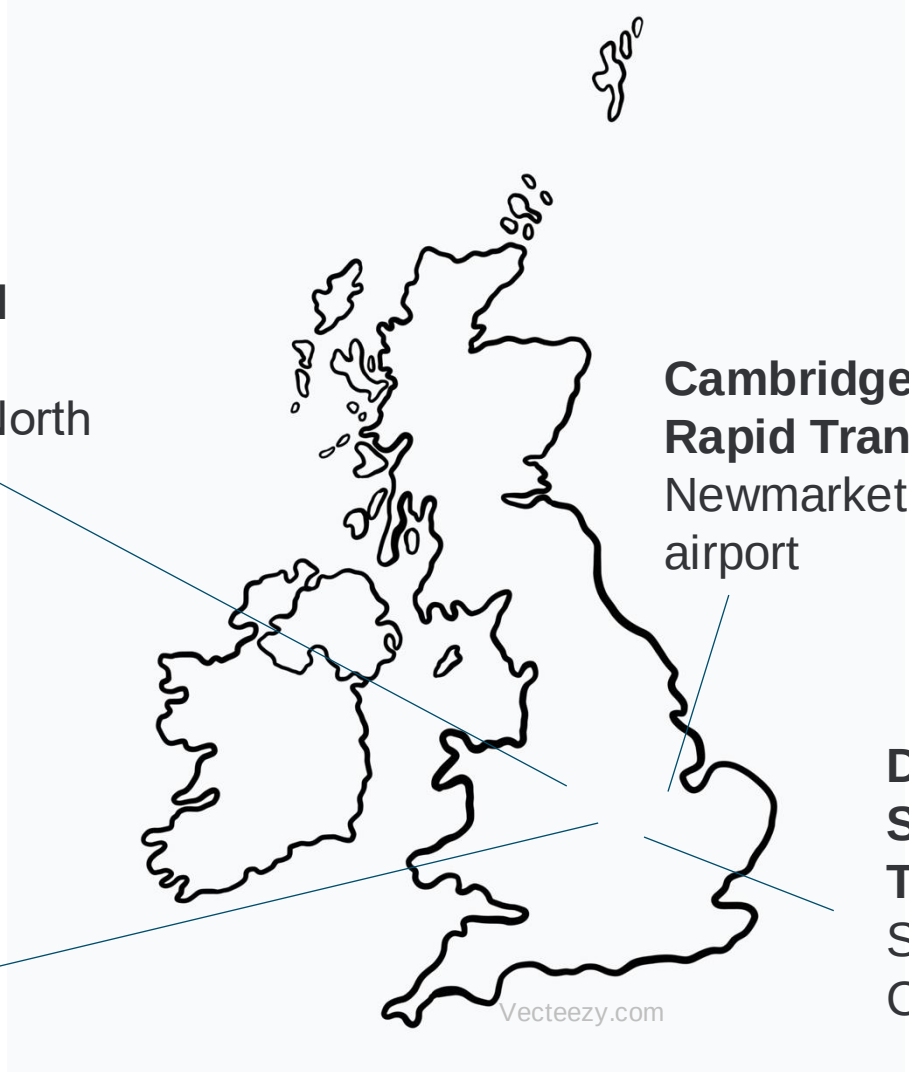
How the service could be delivered and operated as part of a transport network → Costs

Benefits ← How the service would provide better outcomes than traditional modes

Meet legal, regulatory, (personal) safety, and (cyber) security requirements

Projects – Competition 1: Passenger Services

East Birmingham North Solihull Automated Shuttle Service:
East Birmingham and 'The Hub' North Solihull (airport, HS2, National Exhibition Centre)



Cambridge Autonomous Rapid Transport:
Newmarket park and ride to airport

Milton Keynes Advanced Very Rapid Transport:
Corridors extending out to a radius of 25-30 km around Milton Keynes

Dedicated Driverless Spaces for Integrated Mass Transit:
St Albans Abbey Line Conversion, Hatfield - Hertford

Projects – Competition 2: Mostly Passenger Services

Commercialising Connected and Automated Vehicle Services in the Scottish Highlands and Islands (Inverness and Isle of Skye):
Inverness College University of the Highlands and Islands Campus to key locations in Inverness; connect ferry passengers to public transport at Uig Pier, Isle of Skye

Dromos Connected and Automated System (Bolton):
Decommissioned railway corridor connecting the Bolton Transport Interchange to the Royal Bolton Hospital

Blythe Rural Automated Vehicle Operations (West Midlands):
Shuttle service on M42 from Blythe Valley Business Park to the UK Central Hub

Autonomous Healthlink (Northumberland):
Segregated route between Seaton Delaval Station to the Northumbria Specialist Emergency Care Hospital in Cramlington, may explore logistics too

HertsLynx Connected and Automated Mobility On-Demand:
Maylands to Harpenden Station and St Albans

Integrated Mixed Traffic Mobility for Hertfordshire Essex Rapid Transit:
Watford and St Albans town centres

Thoughts Six Months In

- Hurdles
- Safety, Safety, Safety
- Where might CAM fit in the Mass Transit Landscape?

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Introductions and updates

- BSI – Nick Fleming
- IMechE- Rob Porter

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BSI

Nick Fleming, Director,

Transport & Mobility, BSI Standards

BSI Flex Standard 1888: Minimal risk events (MRX) for AVs

- It introduces a **revised concept for Minimal Risk Event (MRX)** as a combination of Trigger Event, Minimal Risk Maneuver (MRM) and Minimal Risk Condition (MRC).
- It proposes a **framework based on relative risk and overall safety**, to enable the lowest risk MRM to be chosen. It aligns implicitly with the **UK AV Act**, but it can be applied globally.
- BSI Flex 1888 is **free to download** and open for public comment and feedback **until the 17th November.**

Looking for more resources?

- Explore our evolving suite of **ten industry-led standards,** downloaded in 55 countries. it is **free to download** and is informing international standards.
- **BSI Flex 1886 and 1887** are among the newest additions, providing guidance on system aspects and human factors for **remote operations.**
- A **database of over 300 relevant CAM standards**, with filters to guide the user through key themes.
- Our **Standardization Roadmap** soon to be refreshed with updated references and new recommendations.

For any questions: cav@bsigroup.com

FORMULA STUDENT: ARTIFICIAL INTELLIGENCE

Institution of MECHANICAL ENGINEERS

06 Nov 2024 – CAM Cohort

Rob Porter
Associate Director
IMechE

Improving the world through engineering

FORMULA STUDENT: ARTIFICIAL INTELLIGENCE

Delivering a pipeline of industry-ready CAM graduates

- Skills-focused student competition
- Organised by Institution of Mechanical Engineers (IMechE)
- Silverstone Circuit, July 2025
- Static and dynamic tasks
- 200+ competitors per year… and growing!
- Made possible by generous grant from CCAV
- Strong support from industry and academia
- **If you’re not coming here to recruit your grads, whyever not?**


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DJ RACECARS

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Innovate UK – Horizon Europe new competition call opportunities

- Louise Mothersole, IUK
- Ben Ross (Liftango)

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Horizon Europe National Contact Points (NCPs)

Team of national advisors, appointed by the Government, to support organisations to successfully participate in Horizon Europe by:

- Raising Awareness of the programme
- Helping you find the right Topic
- Identifying the best ways to find partners
- Navigating the EU funding & tender opportunities portal
- Developing the proposal
- Answering any other Horizon Europe related questions

Top Tip – get to know your NCP

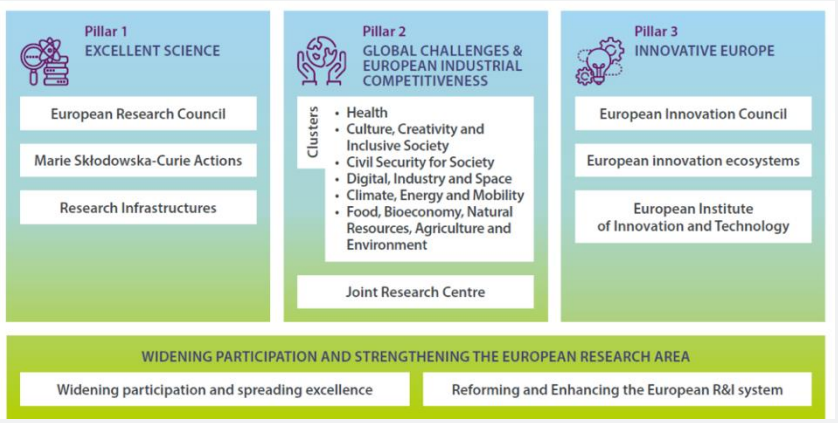
Find National Contact Points from all participating countries

UKRI Innovate UK

What is Horizon Europe?

- Horizon Europe is the current EU's Framework Research and Innovation funding programme.
- It is the largest R&I funding programme in the world, with a budget of over £81bn for 2021-27

- The programme is divided into **three main parts - Pillars**:
  - Pillar 1 supports excellence in science;
  - Pillar 2 focuses on solving global challenges through collaborative research & innovation; and
  - Pillar 3 supports business growth and competitiveness.



- Other parts of Horizon also include support for research infrastructure and widening participation.
- Key priority areas include food, bioeconomy, climate change, health, digital, **transport and mobility**, space, energy, industry, civil security and humanities. The programme is open to all types of organisations of all sizes.

UKRI Innovate UK

UK is a ‘Country Associated to the Programme’

- ‘the Programme’ is Horizon Europe, i.e., UK is an Associated Country (AC) from the 2024 Work Programme onwards
- UK contributes funding to the programme:
  - EU decides where to allocate UK government contribution (paragraph 50 of Regulation establishing Horizon Europe)
- Except in a very few Topics that are restricted (and clearly marked as such):
  - UK organisations **are** fully eligible to coordinate projects
  - UK organisations **are** classed as one of the minimum required ‘three different legal entities from three different eligible countries’, as long as at least one consortium member is also from a Member State
  - Successful UK organisations **are** funded by EU as project participants/beneficiaries
- The UK is not the only Associated Country, there are currently 19 and more are negotiating association (South Korea will associate from 2025 onwards). A full list can be seen here

UKRI Innovate UK

Why International collaboration is important

- Solve global grand challenges through collaborative R&I
- Collaborate with world leading organisations to learn from the best
- Access cutting edge technologies, infrastructure, talent & markets
- Contribute to the dialogue on standards, regulations and research policies
- Ensure that technology development aligns with global marketplace
- Collaborative relationships frequently become commercial ones – developing system solutions in supply chain partnerships
- **Creating jobs, growth and stronger supply chains**

UKRI Innovate UK

Connected, Cooperative and Automated Mobility

- CCAM is a Co-Programmed Partnership
- The members of the partnership association wrote the initial Topic descriptions before the Programme Committee (PC) review
- If you join the partnership association:
  - You will be invited to be part of the drafting team for the next Work Programme
  - You will know what the Topics are likely to be well before the delegates to the PC
  - You will be ‘rubbing shoulders’ with your counterparts from across Europe. These will include competitors and potential customers as well as possible partners for collaboration.
  - **Almost every** autonomous vehicle innovator from across Europe is a member already
  - You will have an opportunity to shine – to show the others in the room that they need you in their consortium if they stand any chance of winning
  - For example, University of Warwick are already part of six Horizon Europe CCAM projects

UKRI Innovate UK

DRAFT CCAM Topics – all 100% funded for everyone. Opening April 2025

Topic Title	Number of Projects	Budget per Project
Advancing remote operations to enable the sustainable and smart mobility of people and goods based on operational and societal needs	2	€6m
Preparing for large-scale CCAM demonstrations	1	€4.5m
Next-generation environment perception for real world CCAM operations: Error-free and secure technologies to improve energy-efficiency, cost-effectiveness, and circularity	2	€4m
Integration of human driving behaviour in the validation of CCAM systems	1	€5m
Approaches, verification and training for Edge-AI building blocks for CCAM Systems	1	€4m
Federated CCAM data exchange platform	1	€4m

UKRI Innovate UK

Innovate UK

Questions?

Louise.Mothersole@IUK.UKRI.ORG

CulturalRoad: Cocreate, Embrace

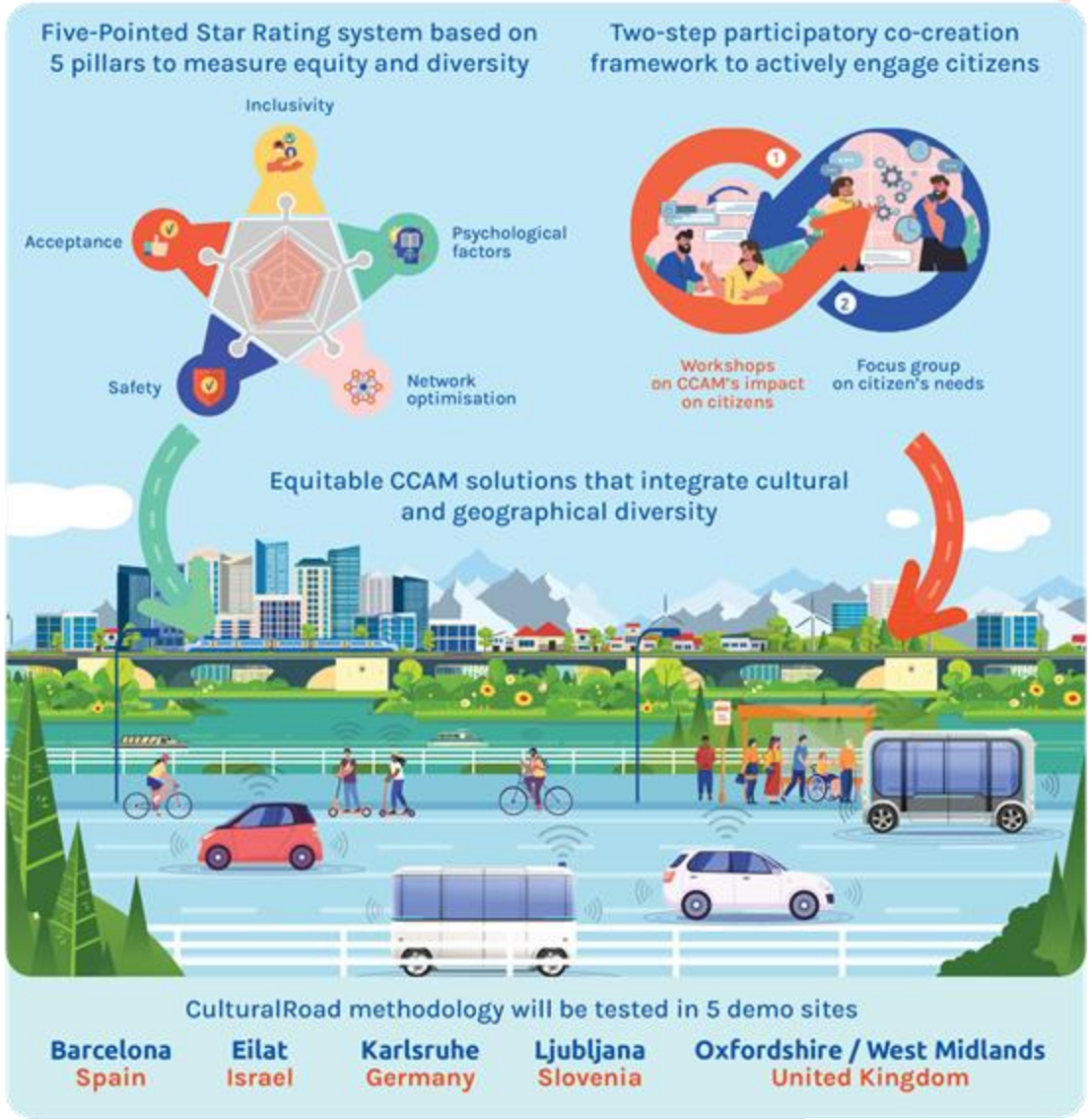
CulturalRoad is funded by the European Union. As part of UK Research and Innovation (UKRI), under the UK government's Horizon Europe funding guarantee [grant number 12760405].

Liftango will be utilising their on-demand platform to support in the development of new methodologies for the fair deployment of CCAM (Connected, Cooperative, and Automated Mobility) services.

CulturalRoad in a nutshell

- 18 partners
- 36 months (1 May 2024 – 30 Apr 2027)
- 5 demo sites
- Horizon Europe programme
- Launched under the CCAM Partnership

Find out more!



Funded by the European Union

The Benefits

What we hope to achieve:

- Having the ability to test, research and apply our technology in different use cases where there are perhaps new market dynamics supports our ability to build a more appropriate technology roadmap which is in tune with future developments.

- Being part of a large consortium across Europe also means we'd hope to further develop our network, with new potential partners, clients and critically continue to collaborate with academic institutions.

Why Horizon 2020 Funding

- For Liftango working in a consortium with public and private sector provides an excellent platform to develop our technology and capabilities across a broader range of use cases.

- This gives our organisation the opportunity to work in an environment where we can research, test and innovate

- European and Innovation funding is an important part of our approach to ensure that our technology evolves with new market dynamics.

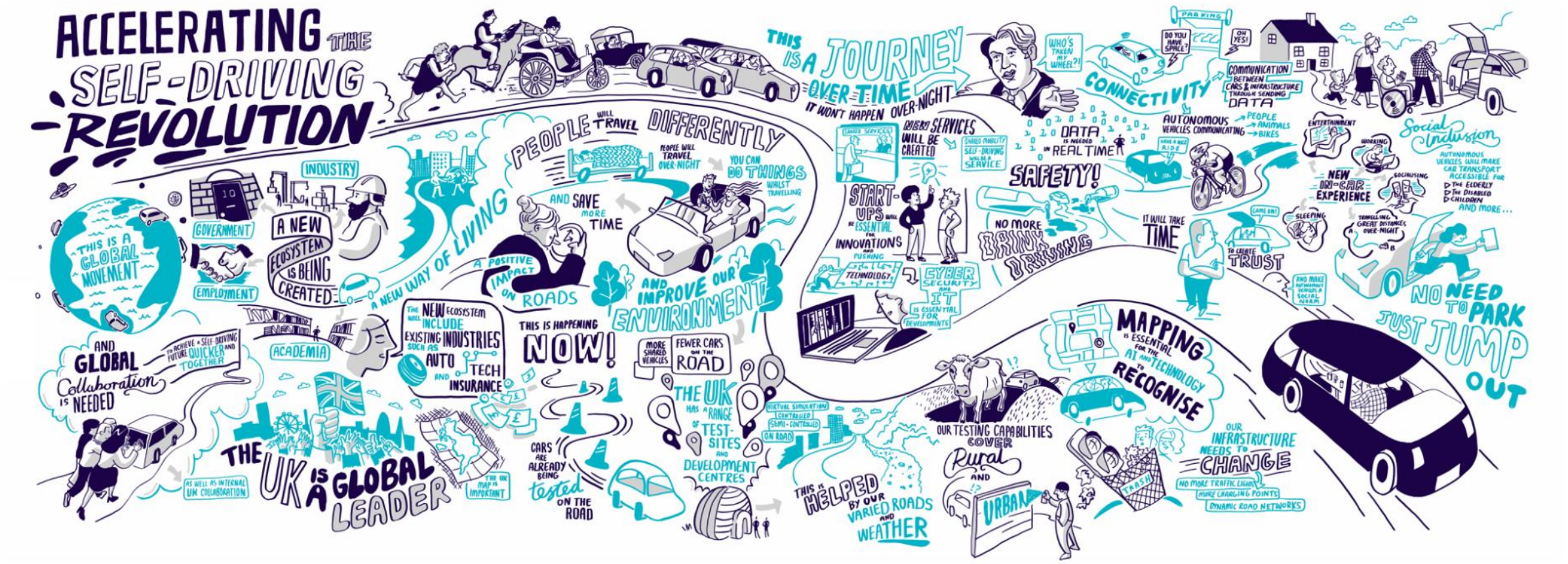
- The opportunity to work with 5 large public sector authorities across 5 demonstration sites, as well as 10+ other key technology partners

Zenzic updates

- Mark Cracknell

Centre for Connected and Autonomous Vehicles

UKRI Innovate UK | Business Connect



CCAV CAM Cohort
Zenzic 2024 Update

ZENZIC

Zenzic: Championing the UK Connected and Automated Mobility ecosystem

Created to bring together industry, government, and academia to enable the development and deployment of CAM in the UK.

Insights

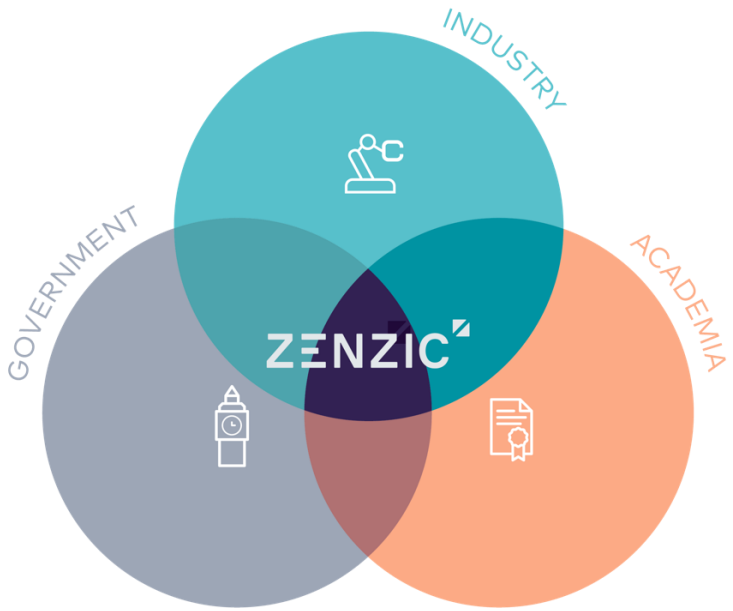
Hold the strategic vision and roadmap for the UK CAM ecosystem, providing informed guidance to government, industry and academia.

Innovation

Channel investment into targeted CR&D into late-stage tech and CAM Scale-Up programmes accelerating new technology the CAM market opportunity.

Collaboration

Provide the trusted brand and front door to a collaborative CAM supply chain, promoting and driving inwards investment.



Effective Innovation relies on both Insights and Collaboration.

ZENZIC

(2022-2025) £66m Commercialising CAM programme

CAM TESTBED UK

Eight core testing facilities

1. Assured CAV
2. Midlands Future Mobility
3. Convex
4. UTAC
5. Smart Mobility Living Lab
6. Catesby Tunnel
7. Tees Valley Combined Authority
8. North East Automotive Alliance

CAM DEPLOYMENT UK

Six commercial self-driving passenger and freight deployments

1. Cavforth
2. Harlander
3. V-CAL
4. City of Smart Sunderland
5. Project Scale
6. Project Connector

CAM MASS TRANSIT UK

10 projects studying self-driving tech for mass transportation

1. EBNS Automated Shuttle
2. Milton Keynes AV Transit
3. Cambridge Autonomous RT
4. Dedicated Driverless Spaces HERT
5. Integrated Mixed Traffic Mobility HERT
6. HertsLynx CAM On-Demand
7. Blythe and Rural AV operations
8. Dromos CAM system
9. Autonomous Healthlink
10. Scottish Highlands CAV Services

CAM SUPPLY CHAIN UK

Thirteen supply chain projects

1. AIM-DBW
2. Autonomous Airports
3. CERTUS
4. DeepSafe
5. Driven by Sound
6. DriveSafeAI
7. evolvAD
8. High-Perfomance Imaging Radar (HPIR)
9. Photonic Inertial Sensors for Automotive (PISA)
10. Sim4CAMSens
11. StreetCAV
12. Systems for Autonomy in Fail-operational Environments (SAFE)
13. Torque Overlay Automated Steering Technology (TOAST)

Centre for Connected and Autonomous Vehicles

UKRI Innovate UK

ZENZIC

New partners joining the network

Catesby Tunnel

A unique and cost-effective testing environment

Repeatable, private, accurate, efficient and accessible. Catesby Tunnel is a worldwide benchmark for vehicle testing, capable of providing accurate and affordable full-scale aerodynamic and performance data.

It's real value is that it provides both real-world and highly repeatable conditions for testing.

- **Rural**
- **Tunnel**
- **Cyber security**
- **Sensor testing**
- **Connectivity**
- **High speed**

ZENZIC

CAM TESTBED UK

Teesside Freeport Digital Testbed

Testing zone with a private 5G network covering the airport

Set up by Tees Valley Combined Authority - a partnership with five local authorities. The group's aim is to drive economic growth, create jobs and transform Tees Valley. The facilities will offer flexible configurations using portable buildings, and moveable gantries on which the technology can be fixed.

- **5G enabled testbed targeting logistics & trade technologies**
- **Access to an International Border**
- **Includes the Airport campus**
- **Opportunity for International services as Electronic Trade Documents Bill becomes the global norm**

ZENZIC

CAM TESTBED UK

National Innovation Centre for Connected & Automated Logistics

Port testbed in a Centre for Logistics Innovation

CAL has potential to transform logistics in environments as diverse as maritime ports, industrial facilities and retail hubs as well as the connections between these.

The North East Automotive Alliance's objective is to develop a National Innovation Centre for Connected and Automated Logistics (NICCAL), which builds upon the North East's CAL capability, utilises the region's unique assets and expertise, and expands the UK CAV Testbed ecosystem to establish the UK a world leader.

- **Port testbed**
- **5G test track**
- **Controlled environment**
- **Located within the NE Investment Zone Knowledge Anchor in Sunderland**

ZENZIC

CAM TESTBED UK

2024 CAM Scale-Up UK Selected SMEs

BLUESKEYE AI

DEONTIC

maaind

Moonbility

Opteran

SAIF

UK CAM Supply Chain Report

Identifying the UK CAM Supply Chain – an industry report

Understand and map the landscape of CAM UK supply chain ecosystem

Develop a framework to provide greater clarity on the areas of investment, opportunities and strengths in the UK

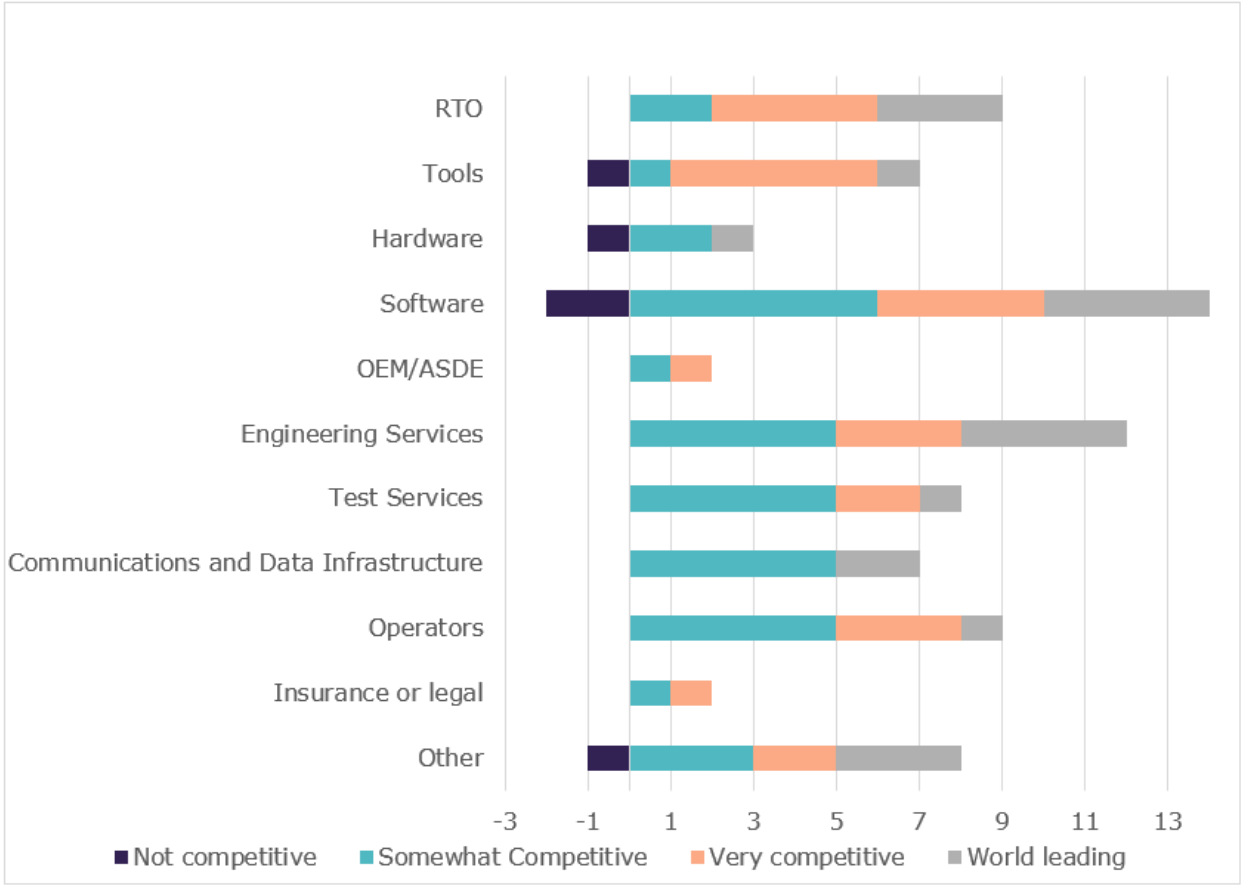
ZENZIC

automotive council UK

AESIN
AUTOMOTIVE ELECTRONICS INNOVATION

Previous Findings

Figure 3.4: View on UK competitiveness by primary category



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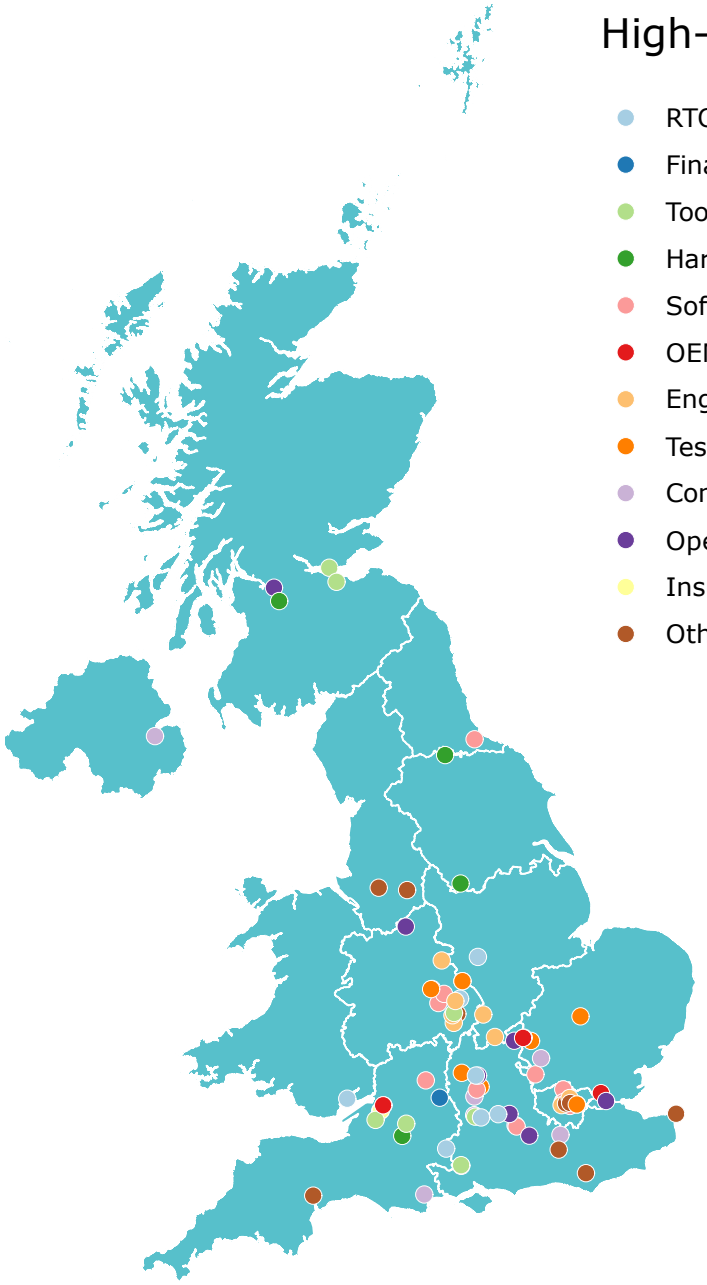


Source: Author generated. Contains OS data © crown copyright 2022

Where do YOU fit in?

ZENZIC

Roadmap 2035

The UK Connected and Automated Mobility Roadmap to

2035

Executive Summary | Building on from the 'Roadmap to 2030'

Key priorities for the CAM Roadmap to 2035

- A programme of regulatory developments
- Identification of requirements of data
- Investment in public 5G & future infrastructure
- Greater industry engagement with insurance
- Skills and education
- Industry and operator awareness
- Whole lifecycle costs for CAM services
- Public confidence in CAM

CAM Applications

Off-highway (without public access) vehicles and services

The vision for off-highway CAVs is to create vehicles that can operate safely and efficiently in controlled environments which are off the public roads, including private sites, and remote and hazardous environments such as mines, construction sites and agricultural fields. The ultimate goal is to improve safety, increase productivity and reduce costs for industries that rely on off-highway vehicles, while also reducing the overall environmental impact, and improving the working environment for the operators.

Freight & Logistics (F&L) vehicles and services

The vision for CAVs for freight & logistics is to provide safe, efficient, and cost-effective transport of goods over both short and long distances. Short-haul connected and automated freight vehicles might include delivery robots or small vehicles that can transport goods within a city or neighbourhood or larger vehicles transporting goods. Long-haul connected and automated F&L vehicles might include vehicles such as heavy goods vehicles (HGVs) and light goods vehicles (LGVs) that can transport goods across the UK. By changing the demand for human drivers, these vehicles are expected to reduce transport costs and increase efficiency, at the same time reducing emissions and improving road safety. Ultimately the goal is to create a more sustainable and reliable freight transport system which benefits businesses and the public alike.

Personal mobility vehicles and services

The vision for connected and automated passenger vehicles is to have vehicles that can operate without human intervention, using sensors, cameras and advanced algorithms to safely and efficiently transport passengers to their desired destination. The goal is to improve safety, reduce traffic congestion, and increase accessibility for individuals who are unable to drive themselves. Ultimately the aim is for an enjoyable travelling experience.

Public transport vehicles and services

The vision for connected and automated public transport systems is to provide safe, efficient and affordable transport options for large numbers of people, using vehicles that operate without human drivers. These systems are expected to reduce traffic congestion, improve mobility and increase accessibility to transport, while also lowering emissions and reducing energy use. They may include vehicles with varied capacity of people such as buses, shuttles, and pods that are connected through a central control system, allowing for optimised routeing and scheduling. Ultimately the goal is to create a more sustainable and equitable transport system, one which benefits all members of society.

CAM Enablers

Verification, validation and assurance services

The vision is for the UK to be leading the way in developing and delivering assurance standards, services, and processes. This is critical for reassuring a range of stakeholders – from the public and government to industry and insurers – that self-driving vehicles are indeed safe and secure. This will position the UK as a leader in the provision of product development assurance, pre-certification, and whole-life assurance.

Infrastructure and data services

The vision for data services is to enable the design, operation, maintenance and widespread utilisation of the network so that it can support the safe, secure and efficient movement of people and provide an environment in which commercial services will develop and grow.

Key priorities for CAM Infrastructure & Data Services to 2035

- Identify use cases and stakeholders for data packages
- Creation of data standards and data sharing frameworks
- Understand the current planned coverage and infrastructure strategy
- CAM inclusion in the National Digital Twin programme
- Standardisation and maintaining HD-maps in real-time
- Collaboration with different stakeholder groups
- Identify the gap in skills

Thank you

zenzic.io

Project CERTUS

- Aaron Mandalia
- William Latham

Centre for Connected and Autonomous Vehicles

UKRI Innovate UK Business Connect

Project CERTUS

(Commercialising CAM-Supply Chain)

Aaron Mandalia and William Latham

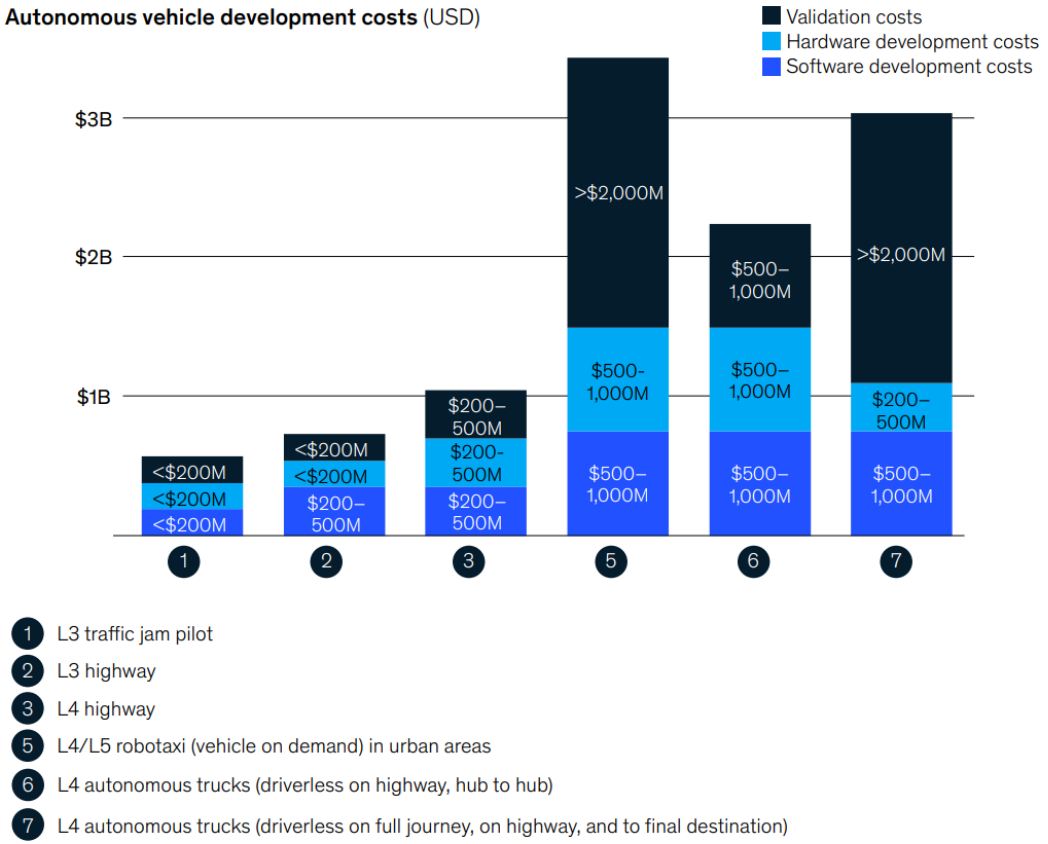
2024

- Introduction to CERTUS
- Problem Background and CERTUS Process
- Video Demonstration and Findings
- Bonus Topics

The V&V Challenge

- Validation costs range from 27% (② L3 highway) to 50% (⑤ L5 self-driving) of total self-driving vehicle development costs.
- The average across all autonomy types is **41%**
- The validation cost for a level 3 autonomous vehicle is estimated to be <£350m, whereas the validations cost for a self-driving vehicle could be >£2bn.

Source: McKinsey Report 2022: What's next for autonomous vehicles?



Polestar IPG CATAPULT Connected Places Coventry University A HORIBA COMPANY MIRA

Reduced Effort

Polestar forecast a 40% reduction in V&V effort

Scenario Generation

Novel approach to scenario generation

CERTAS

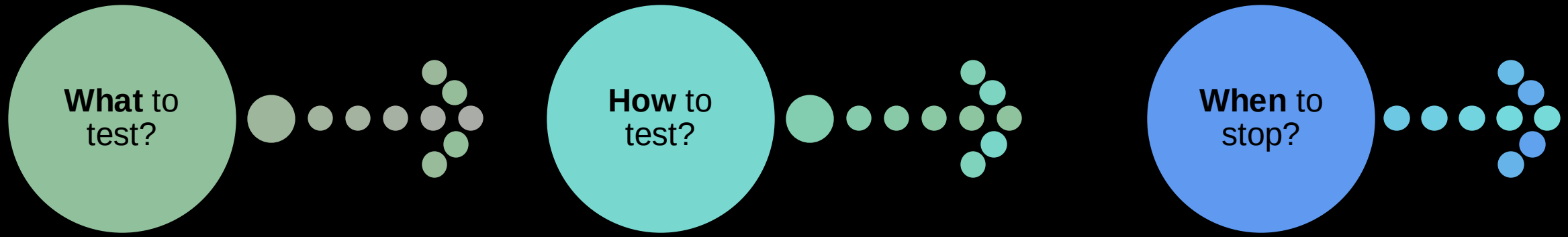
Data Analysis

Combines multiple metrics to give contextual insights into system performance

Supports Existing Methodologies

Compliments alternative approaches such as brute force and scenario libraries

The Key Questions That Certus Addresses

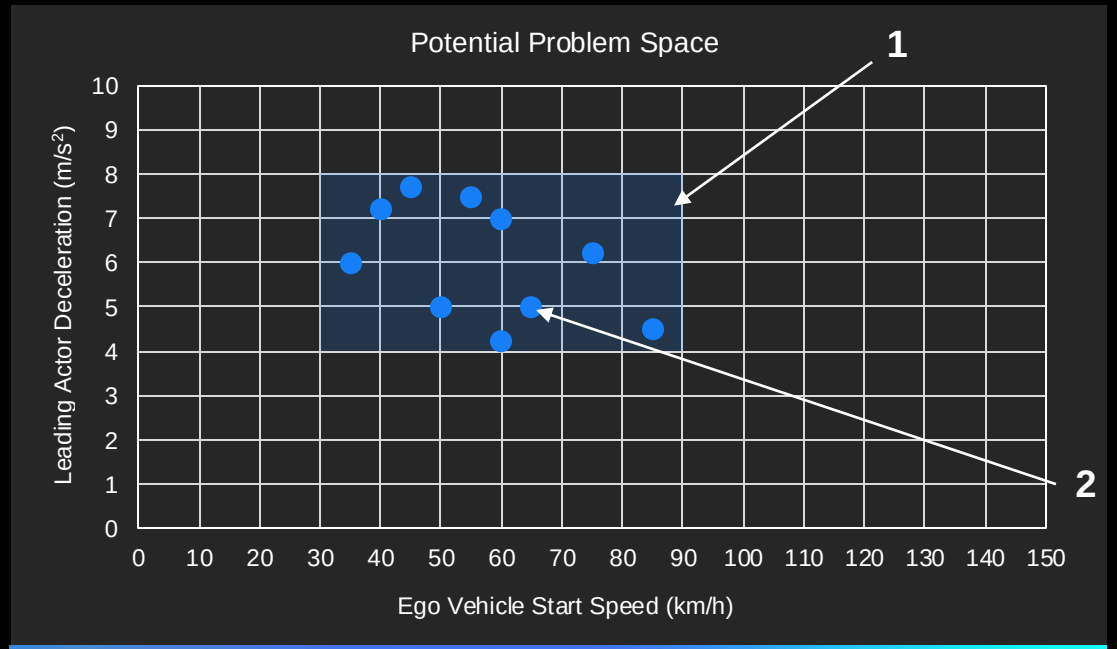


HORIBA MIRA's propriety tools and techniques bring efficiencies of up to 40% to the validation and verification of automated driving systems by addressing three key questions; What to test? How to test? and When to stop?

The metrics and oracles that have been developed analyse system performance to understand critical attributes such as safety, comfort, and progression, providing invaluable insights into the test data that has been generated, using an iterative scenario-based testing approach.

Where you have active deployments gathering data through mileage accumulation, this approach can also be applied to quantify the level of coverage that has been achieved so far, with the insights used to generate a bespoke scenario-based test programme to target unseen scenarios to rapidly increase coverage and confidence in the system performance.

Functional, Logical and Concrete Scenarios



1. Logical Scenario Bounds
2. Concrete Scenario

Autonomous emergency braking. Leading actor performs an emergency stop.

Functional Scenario

provides a general scenario description

Ego Speed: 30-90 km/h
Actor deceleration: 4-8m/s²

Logical Scenario

sets parameter bounds

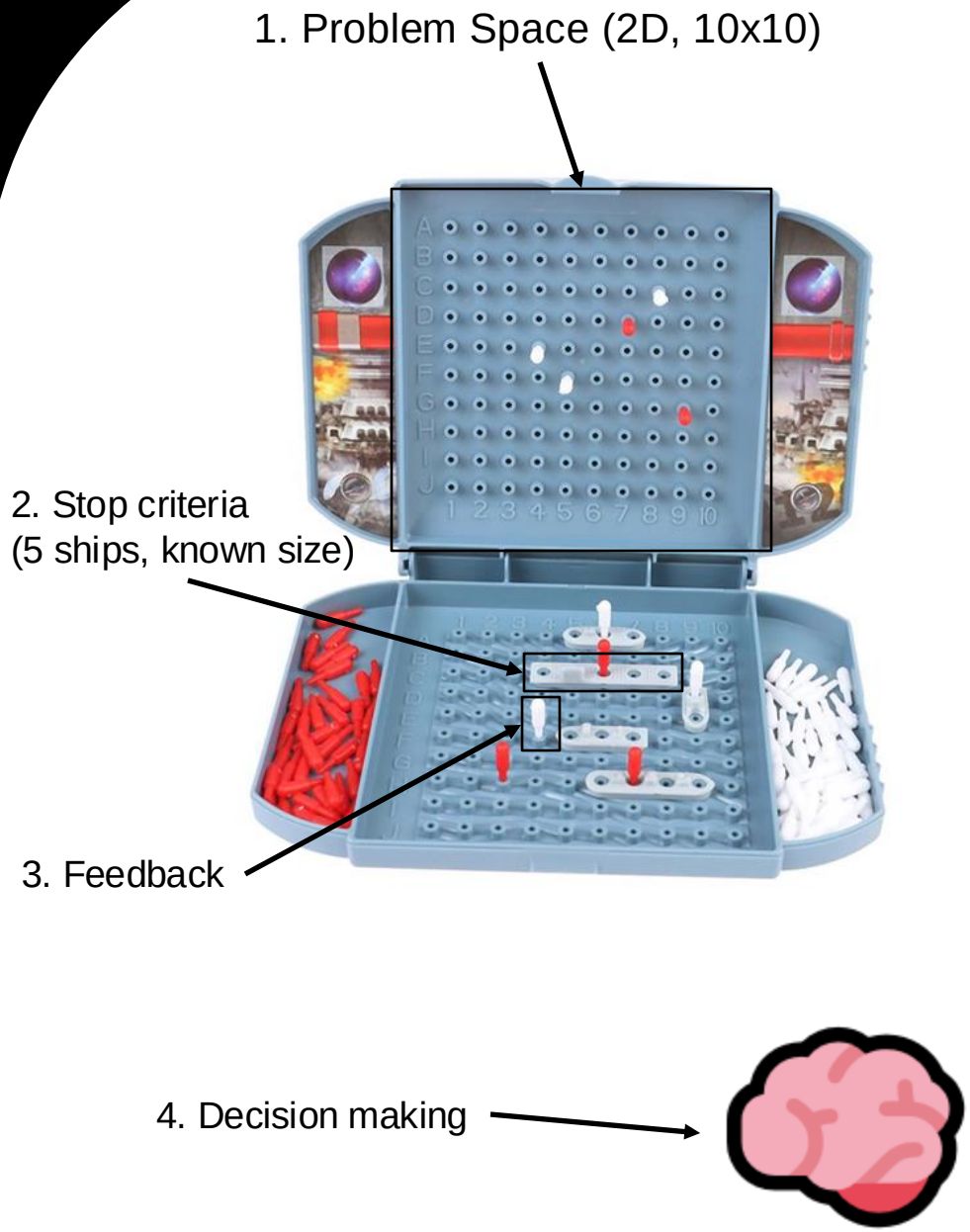
Ego Speed: 65 km/h
Actor deceleration: 5m/s²

Concrete Scenario

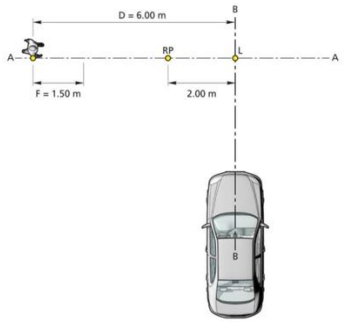
sets definitive parameter values

Battleships

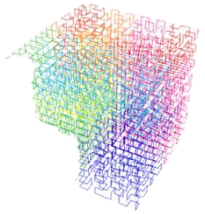
Battleships	CERTUS
Problem Space	
2d (10x10)	Nd (variable between scenarios)
Stop Criteria	
Ships – known number/shape	Termination criteria
Feedback Process	
Direct	Test creation / execution
Decision Making	
Brain	Algorithms



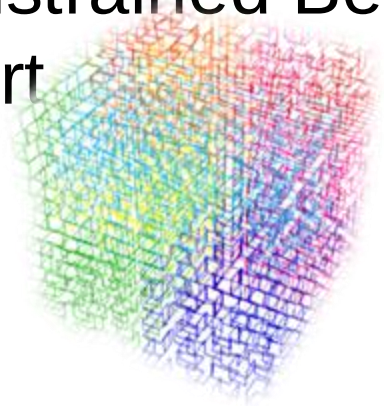
The World's too Big and too Loud



NCAP



Constrained Best Effort



Full Factorial

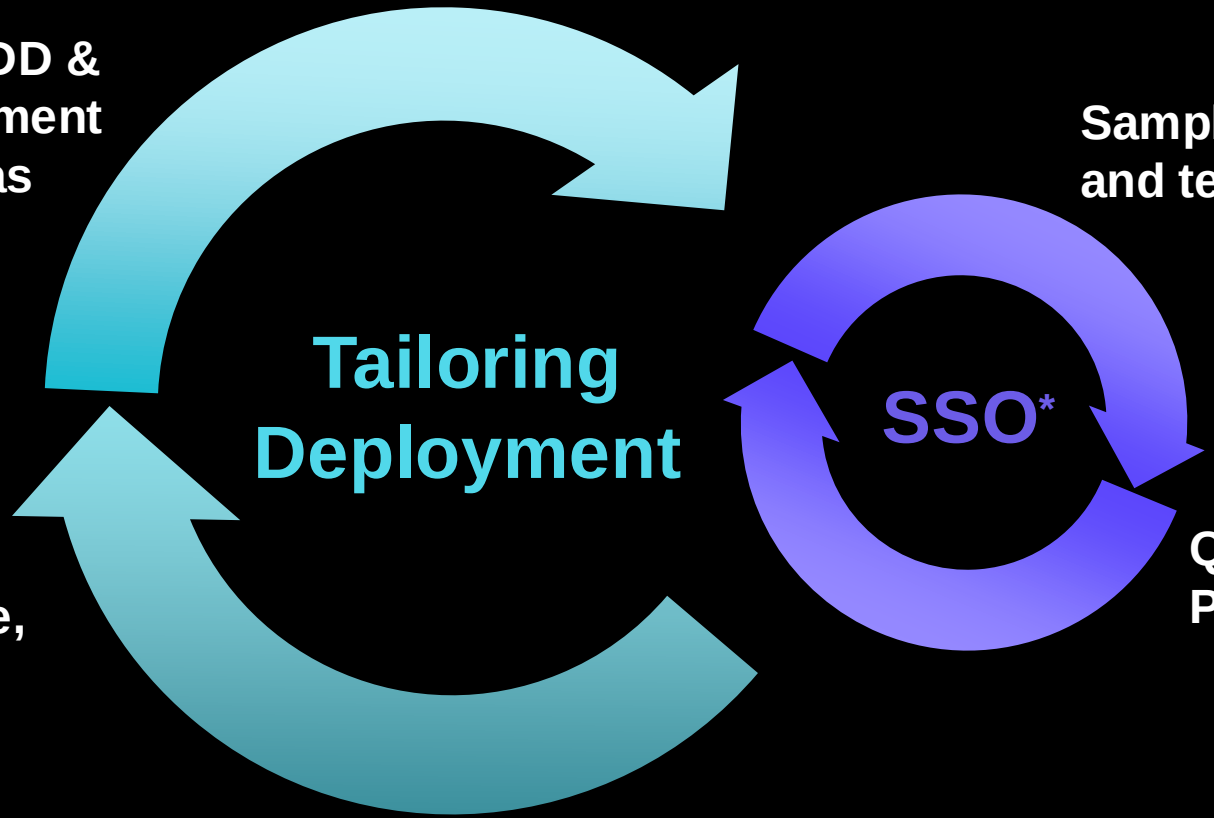
Scope 21,600
Coverage ~300 (1.4%)

Scope ~50 million
Coverage ~1-10 million (20%)

Scope billions

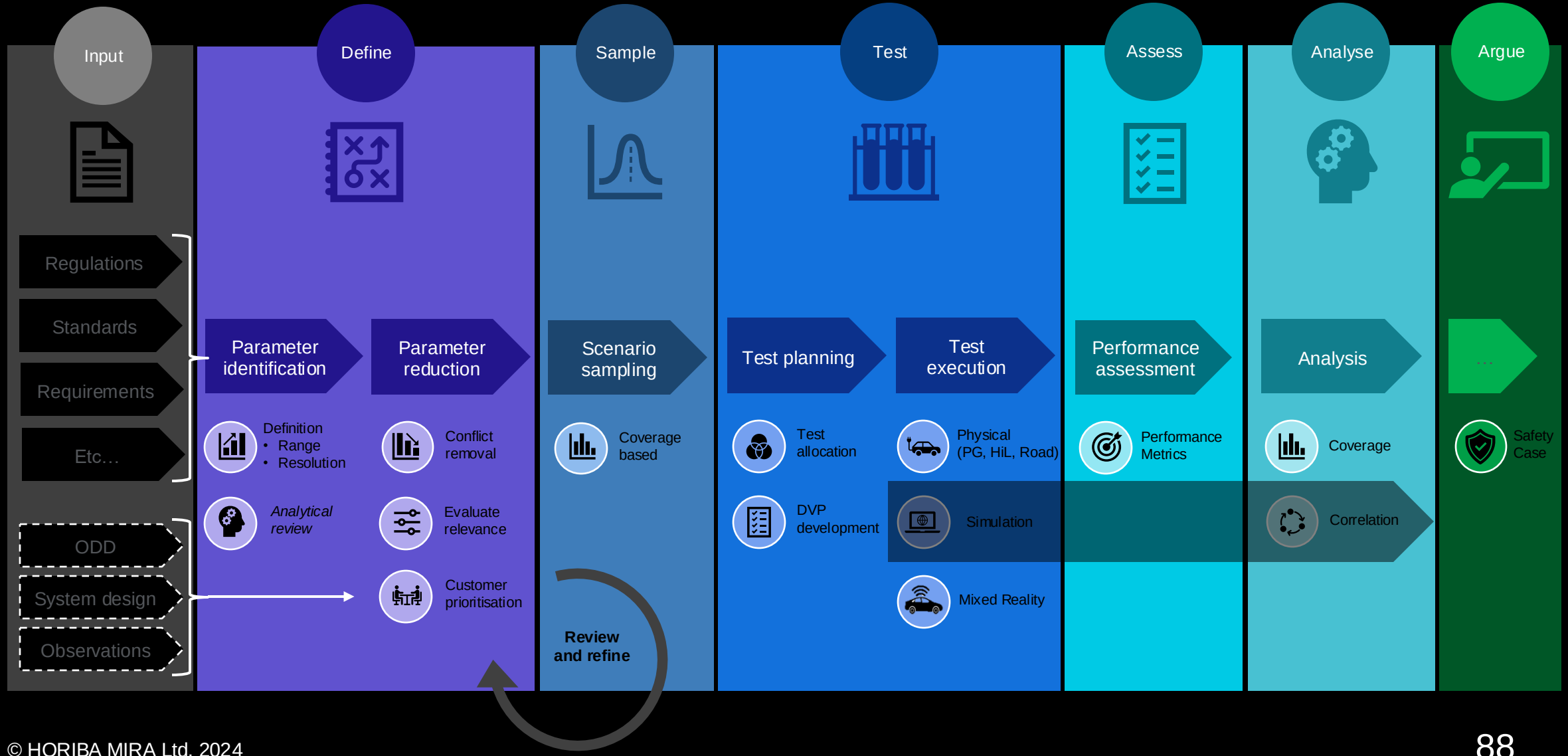
The CERTUS Approach

Customer Feature → V&V Specification → V&V Implementation → Product Acceptance & Release



*Search Space Optimisation

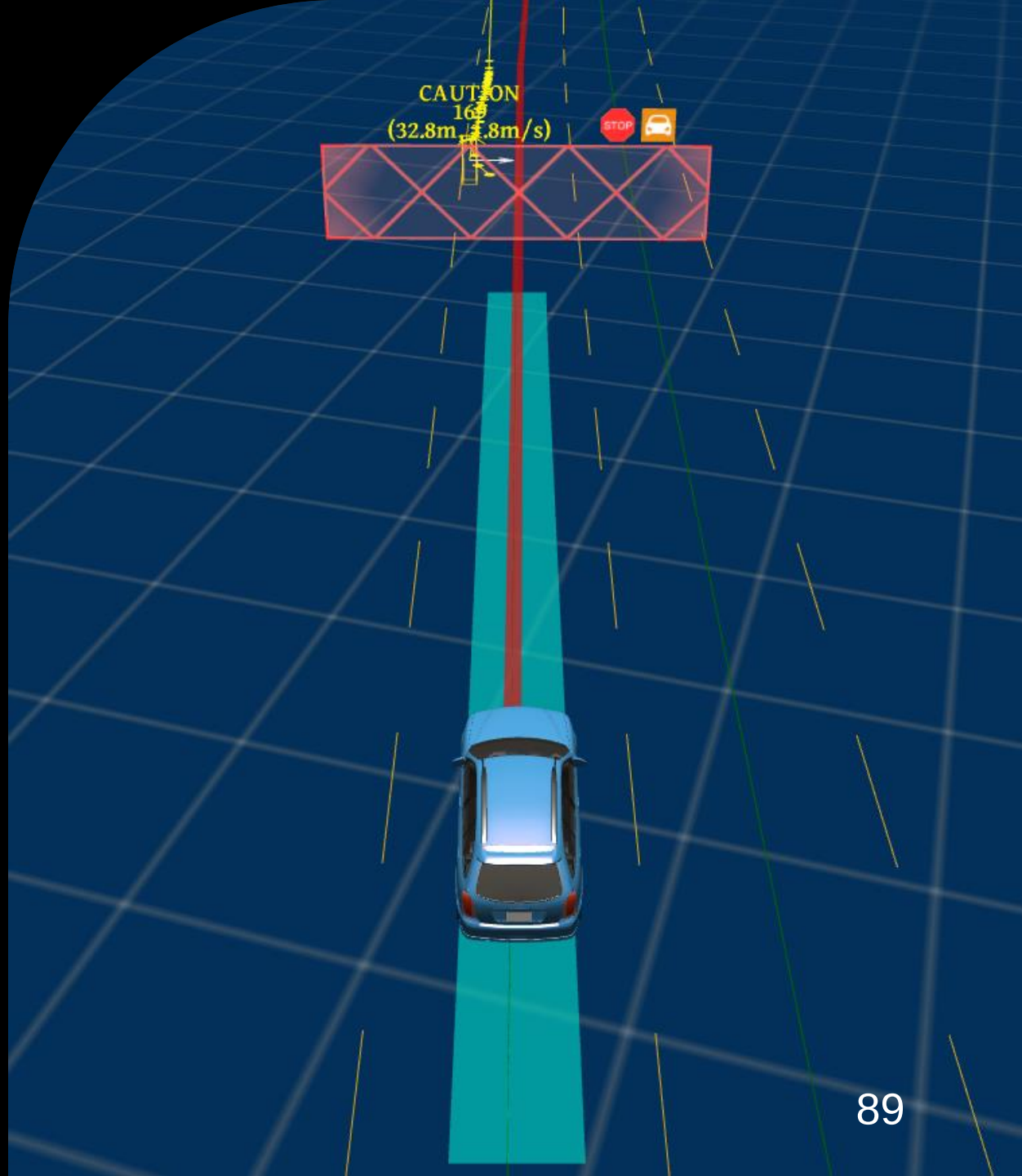
V&V Workflow



Representative ADS

Baidu 百度 | apollo

- China’s no.1 search engine
- Opensource (Apache 2.0) ADS
- “Ten years of L4 technology accumulation”
- It’s impressive
- Receives sensor data; sends actuation



Environment Simulation

IPG CarMaker

- High fidelity simulation
  - Infrastructure (see notes)
  - Sensor
  - Dynamics
  - Actors
  - Etc.
- Sends sensor data; receives actuation
- The road captured in the above image is a section of the “Assured CAV City Circuit” digital twin. The digital twin was created using a lidar scan of its real-world counterpart; thus, it has a very high fidelity.

Integration, Test Automation, SSO & Analysis

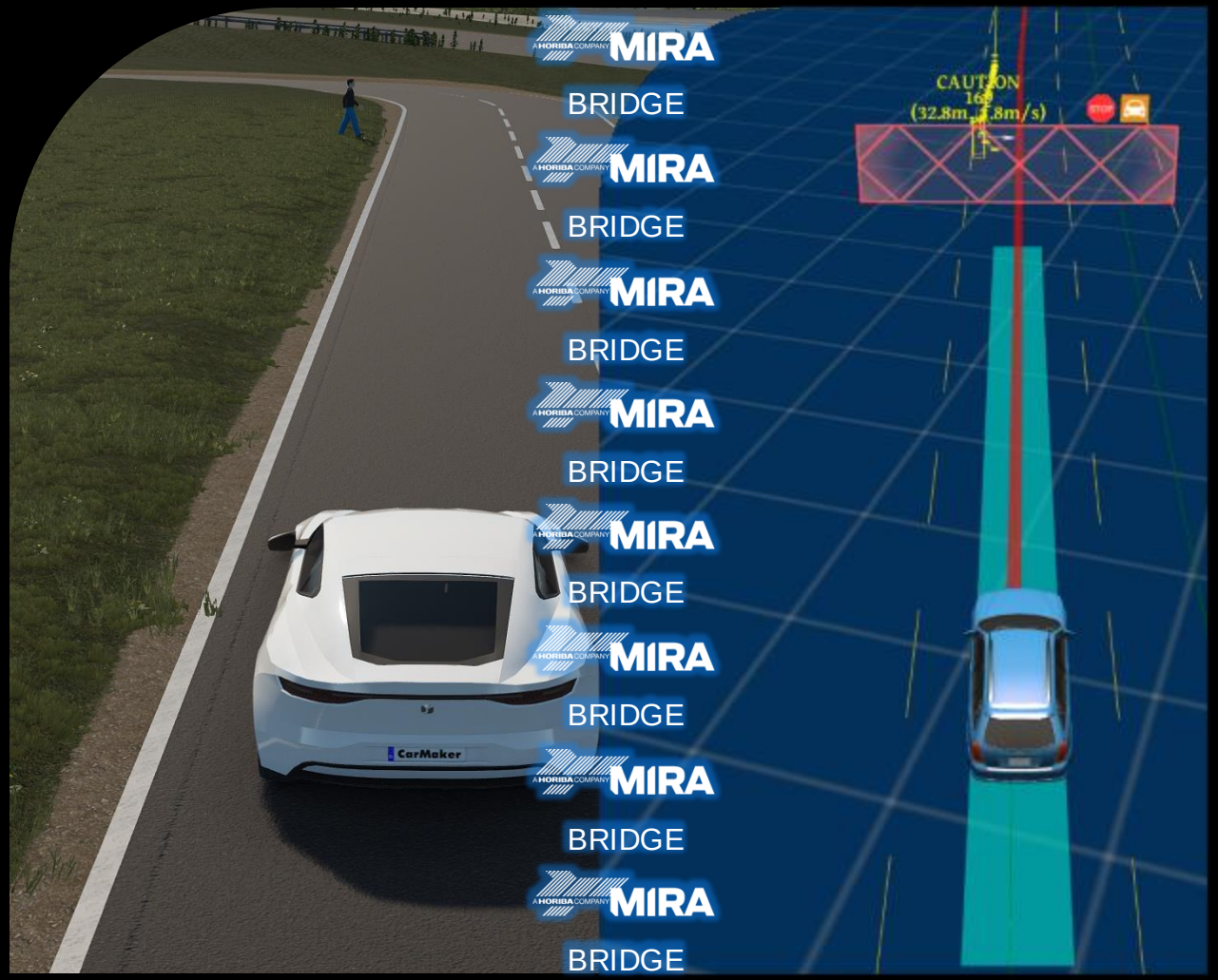
- Powerful tools
- Complex integrations
- No silver bullets
    - Process, expertise and infrastructure needed

The “bridge” is a simplification: in truth, it encapsulates HORIBA MIRA’s toolchain, integrations and processes, which enables us to co-simulate Apollo and CarMaker.

Co-Simulation

- “Bridge” enables “co-simulation”
  1. CM sensors -> Apollo
  2. Apollo makes decisions
  3. Apollo actuation -> CM model
  4. CM advances
  5. CM sensors -> Apollo…
- So, what’s the scenario?

  The ego vehicle (integrated with Apollo) progresses along the road section. A pedestrian walks out in front of the ego. The ego should recognise the pedestrian and brake appropriately, thus – if possible – avoiding a collision. There are two logical parameters: 1. the distance between the ego and the pedestrian at which point the pedestrian crossing manoeuvre is triggered; 2. the time it take for the pedestrian to complete the crossing manoeuvre (the crossing distance is 10m).



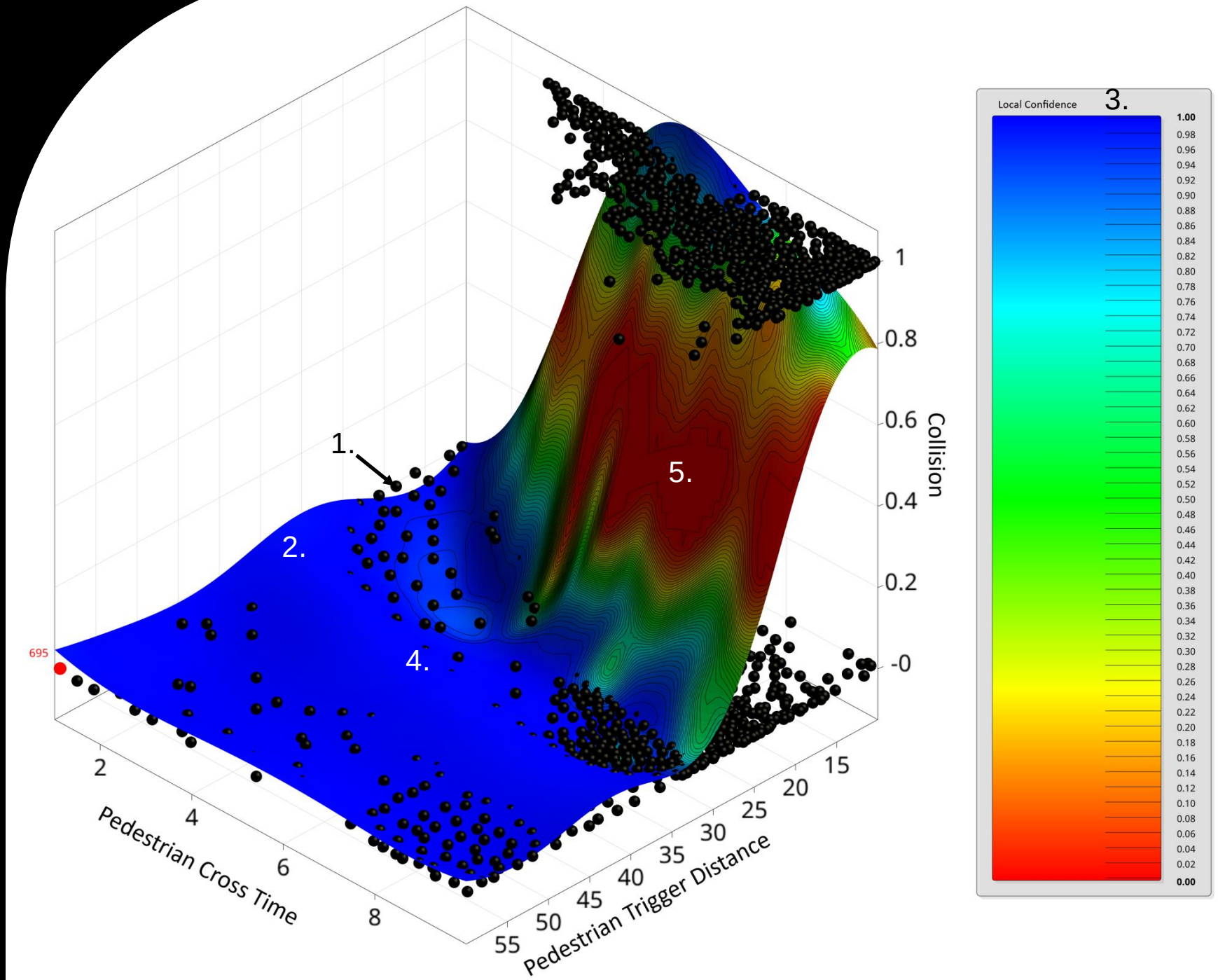
Performance Analysis and Investigation

- It's not just "pass/fail"…
- …it's also "how do we add value"
- What part of the problem space is safe?
- What's causing failure?
- How do we remedy?

Performance Model

1. Simulated result
2. Response surface
3. Local prediction confidence
4. “~0% collision chance” & “~100% confidence” region
5. “significant collision chance” & “~0% confidence” region

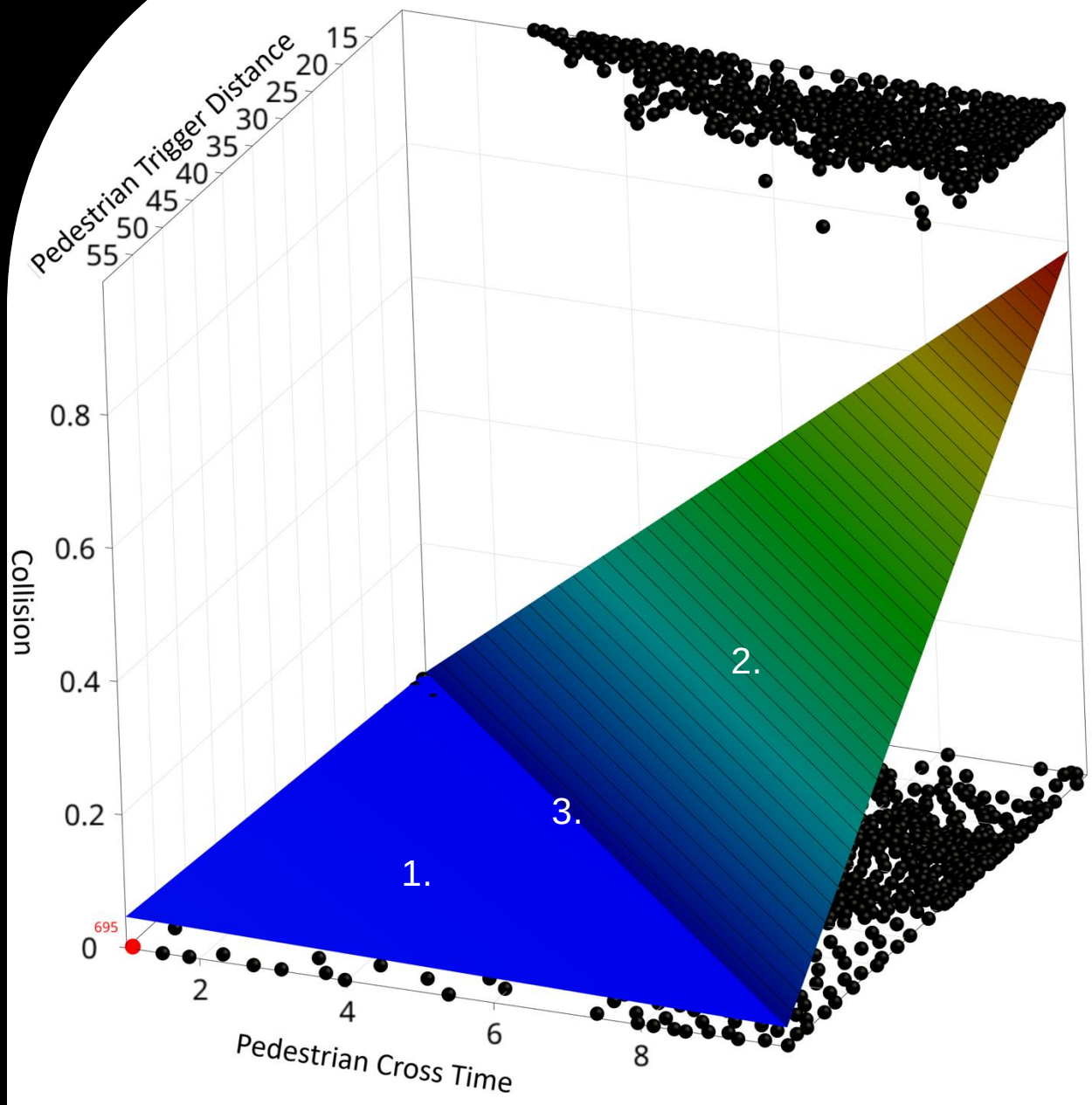
“Response surface”: predicts the response for a set of given inputs. This predictive model enables us to avoid exhaustive testing.

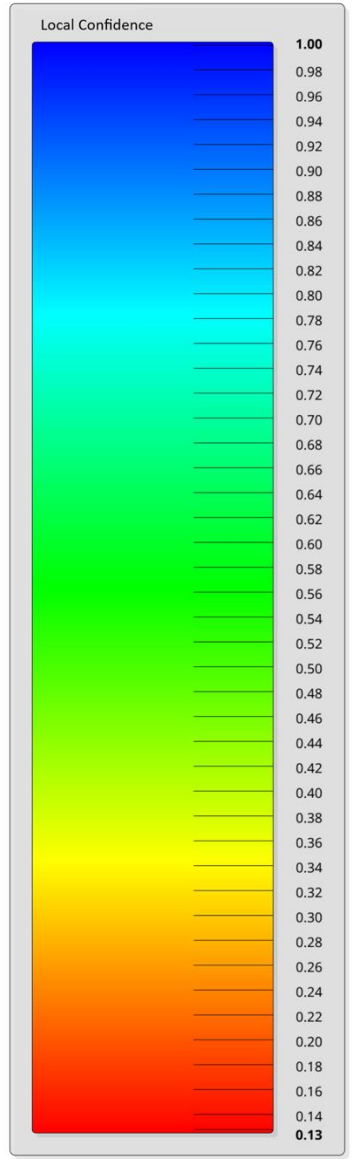


Performance Model (low res)

- Lower visualisation resolution
  - Easier to observe trends
  - Lose nuance

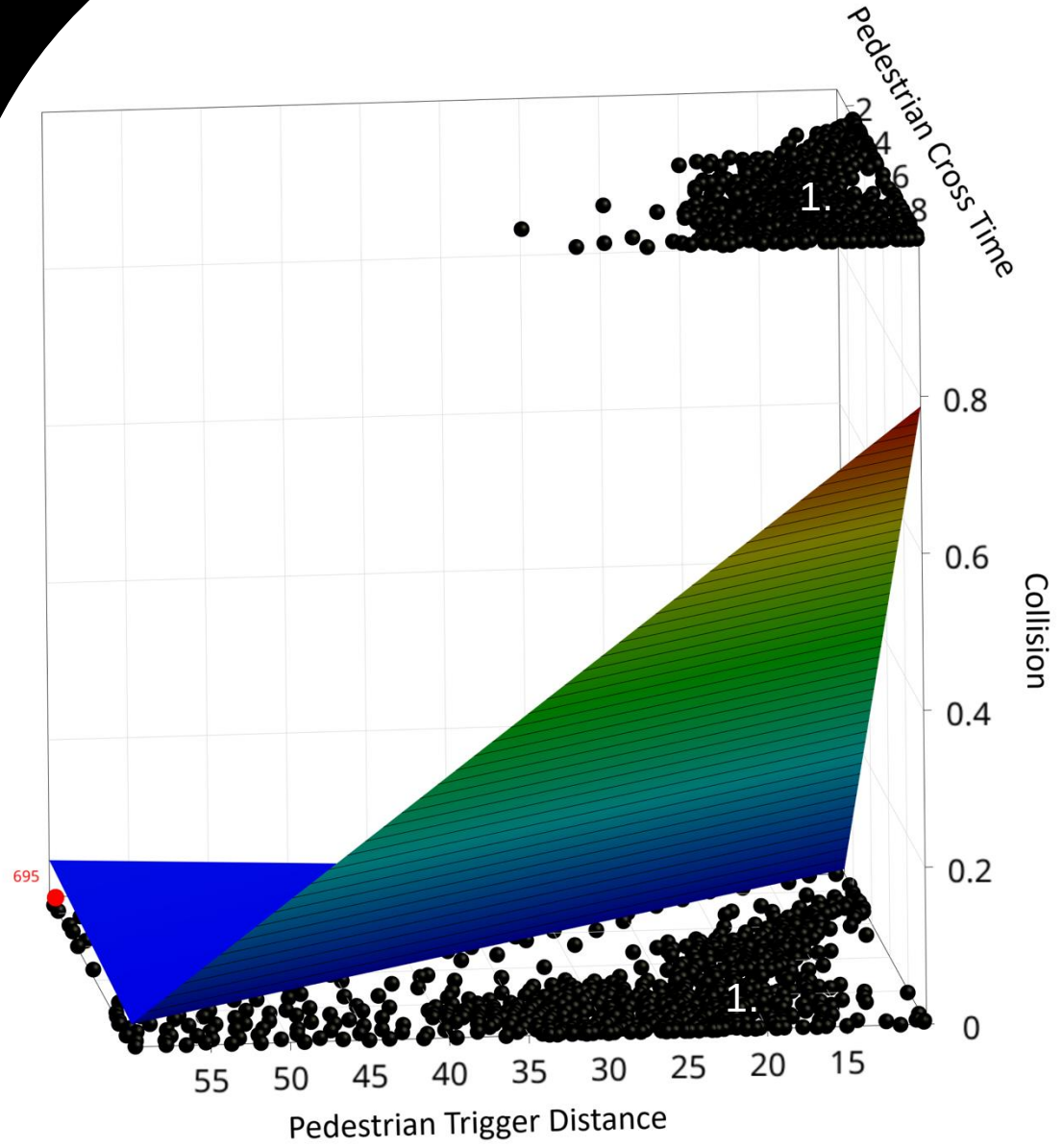
1. Safe region
2. Unsafe region
3. Boundary

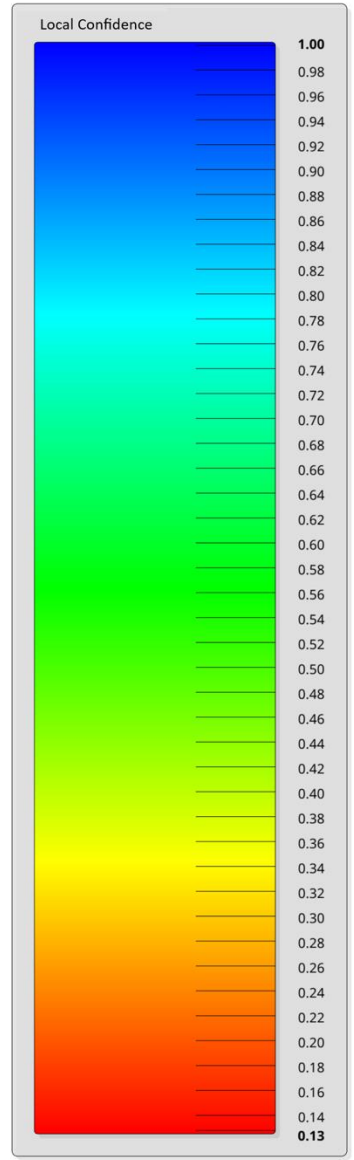




Performance Model (low res 2)

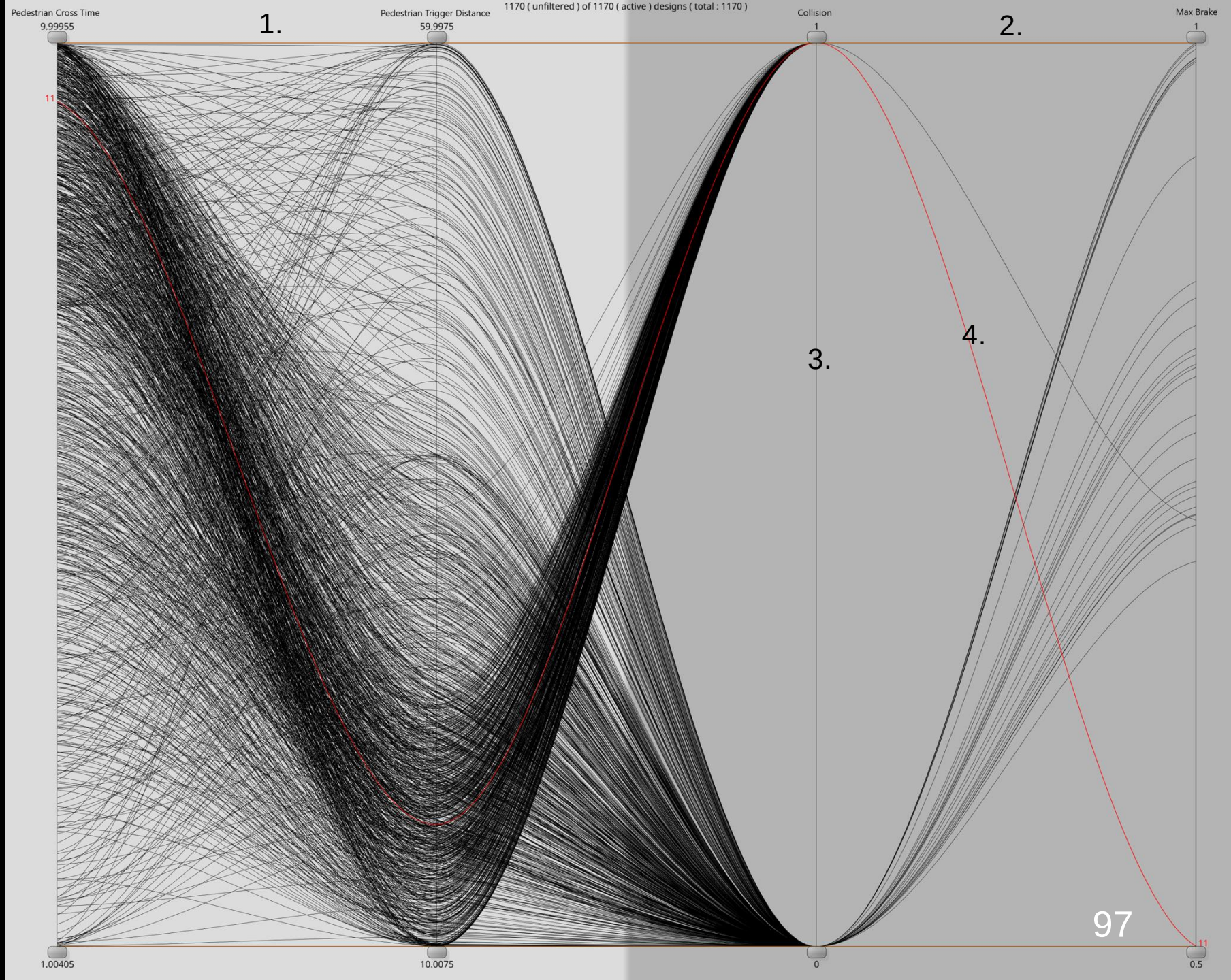
1. Strange clusters in “unsafe” region
   - Implies non-deterministic behaviour
   - Inconsistent region = unsafe region





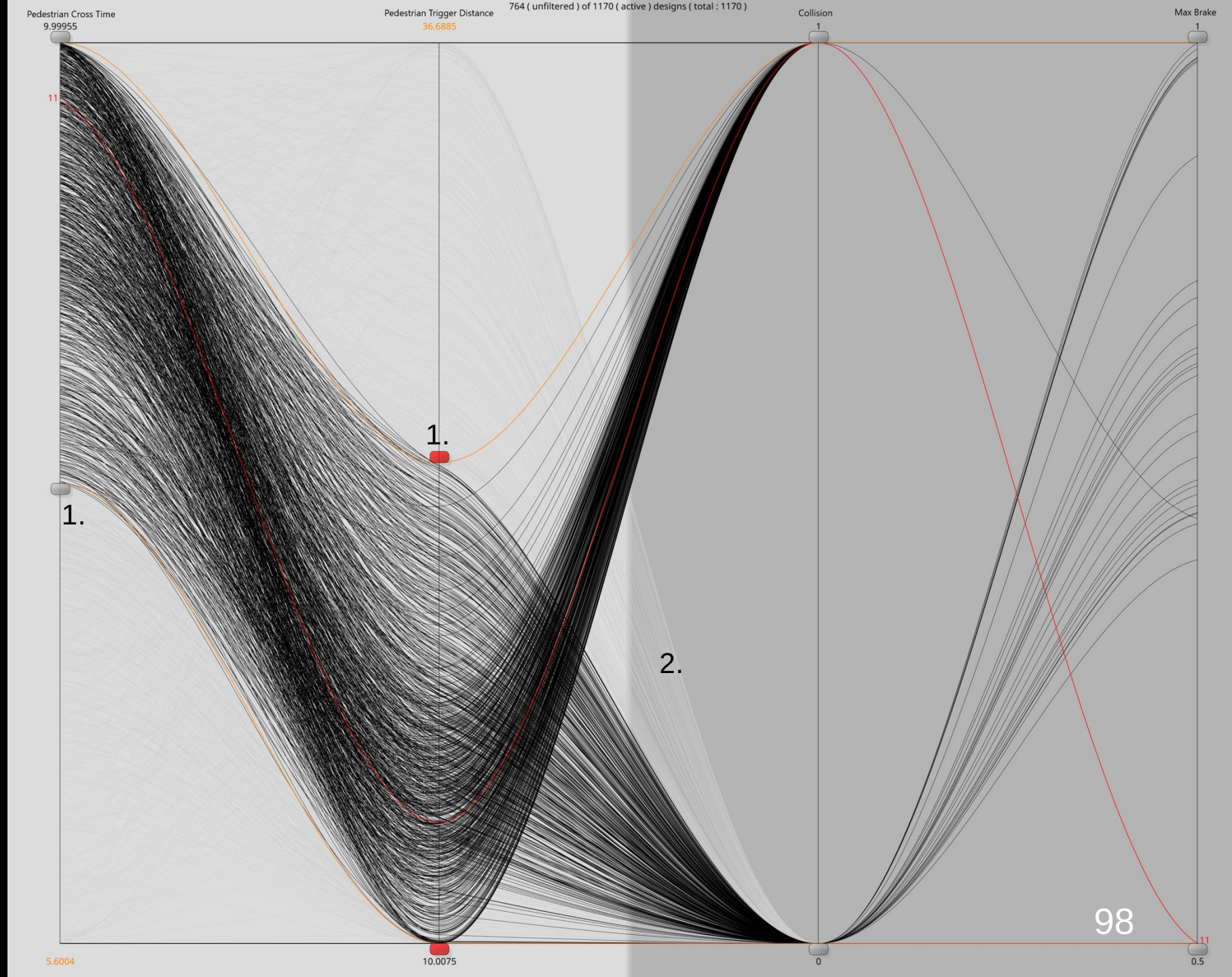
Parallel Axis Plot

1. Inputs
2. Outputs
3. Axis
4. Concrete scenarios



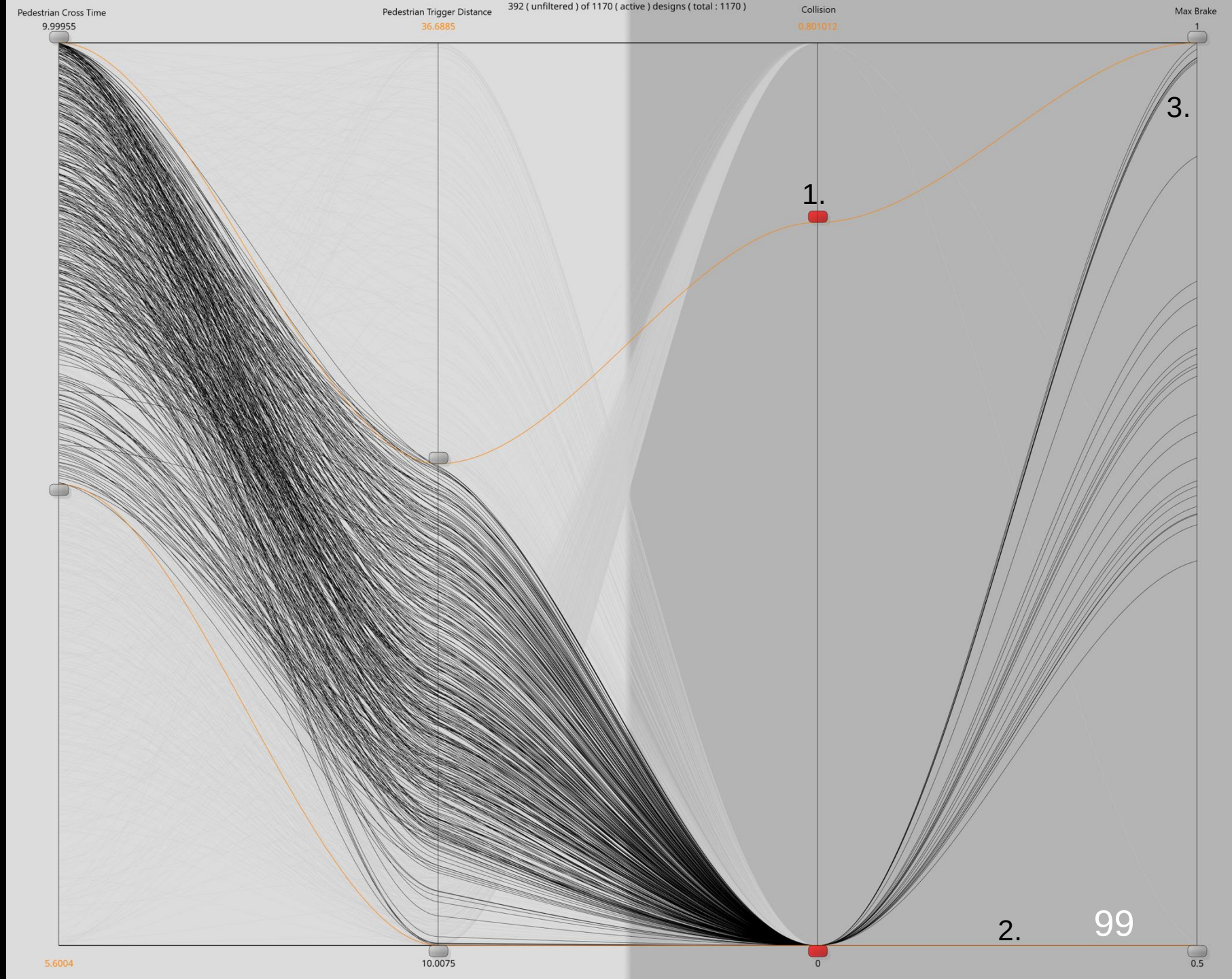
Parallel Axis Plot

1. Filtering axis
2. “Filtered out” concrete scenario



Parallel Axis Plot

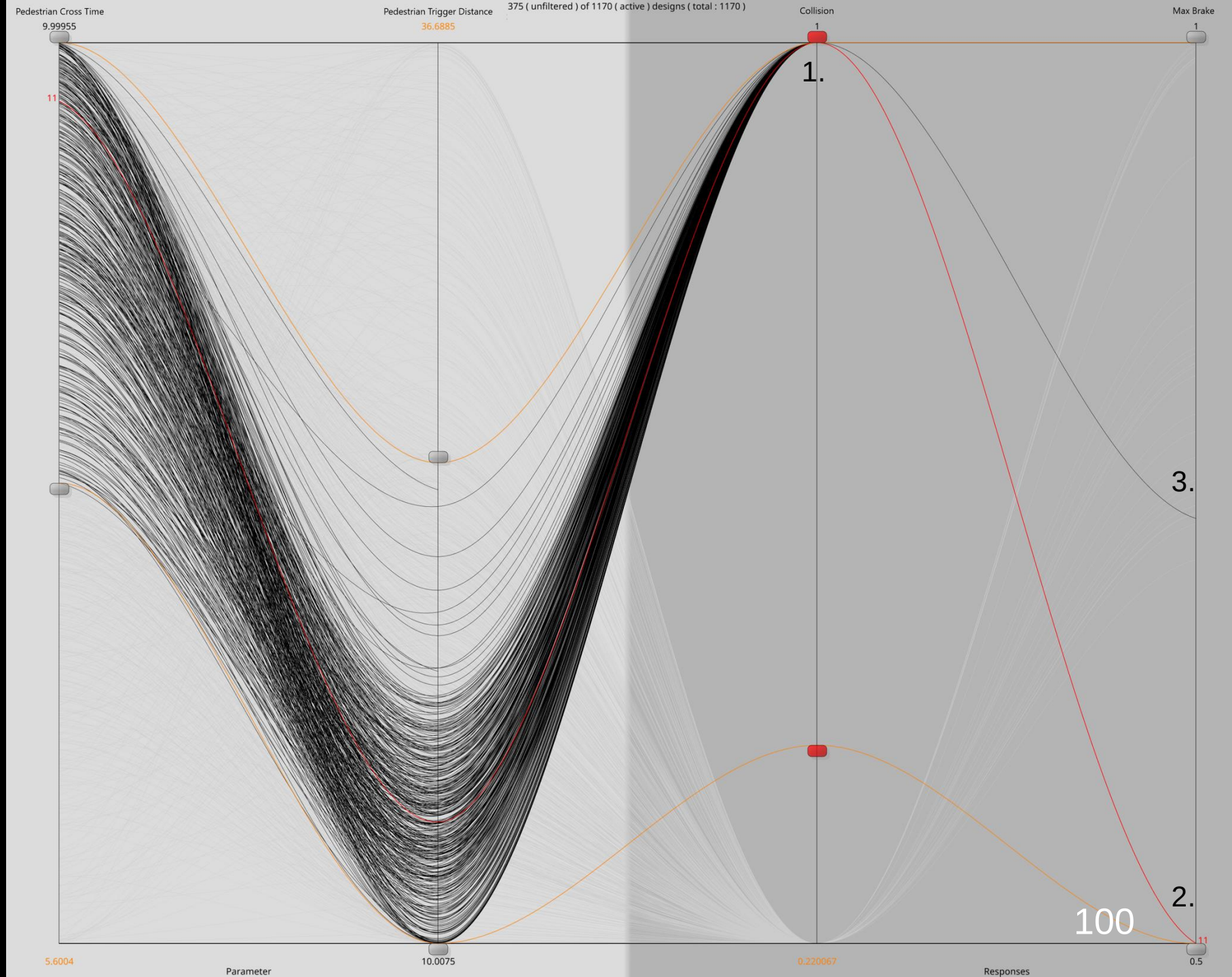
1. Filtering **out** collisions is interesting…
2. …Apollo mostly applies 50% brake…
3. …But sometimes it brakes heavily



Parallel Axis Plot

1. Filtering **in** collisions is really interesting…
2. …Apollo rarely applies > 50% brake…
3. …and it never brakes > 75%

Weird, but why?

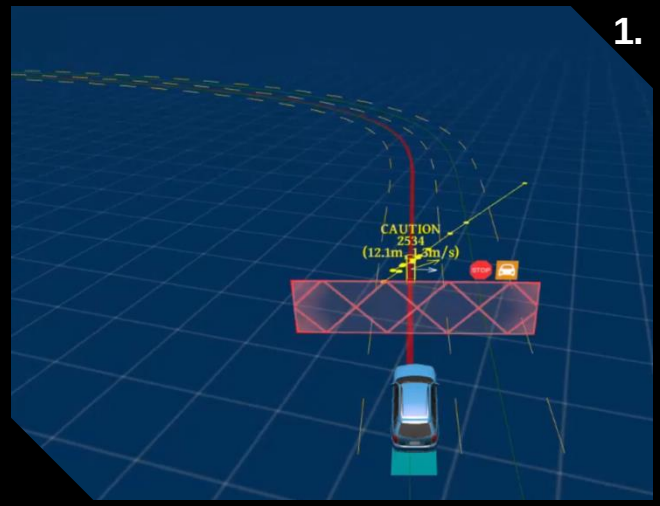


Holistic Testing/Analysis Matters

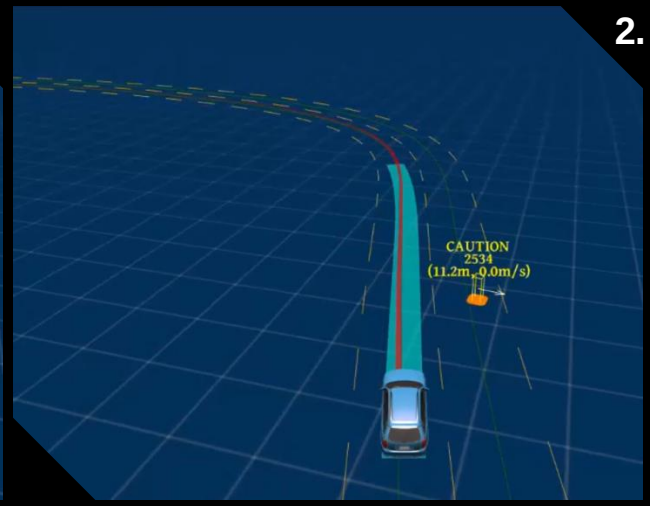
1. Apollo detects pedestrian and brakes
2. No collision
3. Apollo fails to detect pedestrian's direction
   - Apollo miscalculates pedestrian's path
   - Incorrect braking profile
4. Collision

"No-collision" concrete scenario

1.

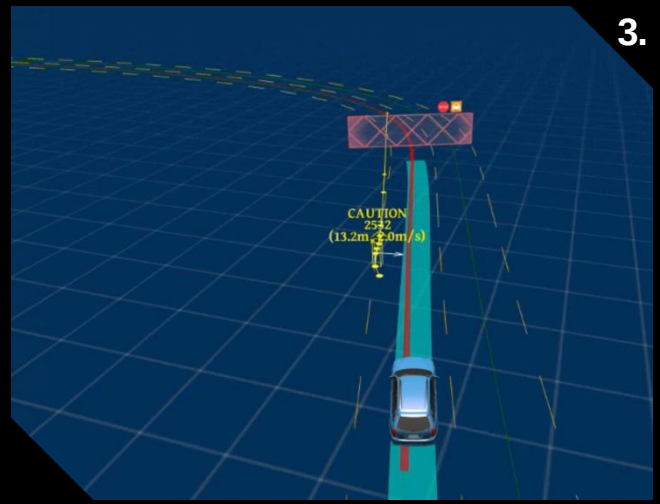


2.

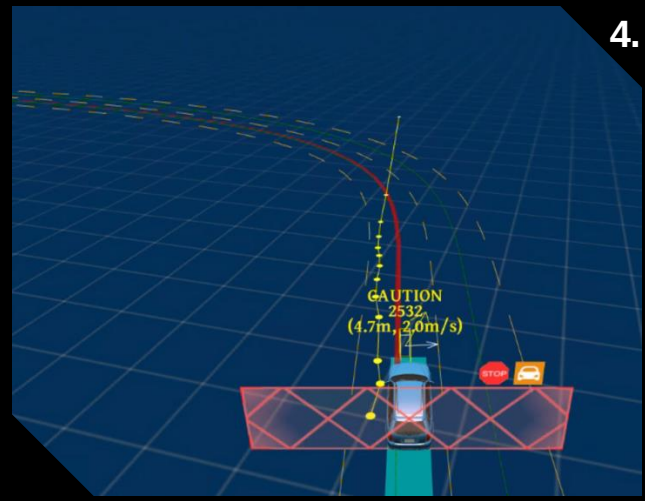


"Collision" concrete scenario

3.

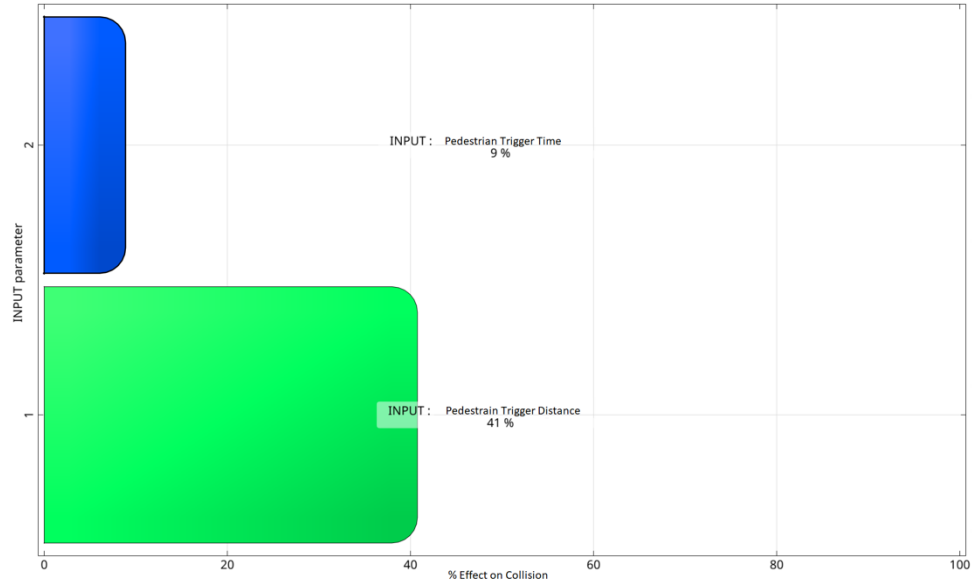


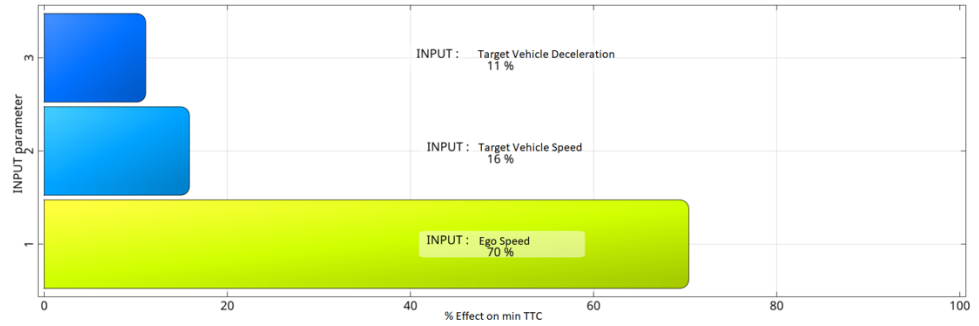
4.

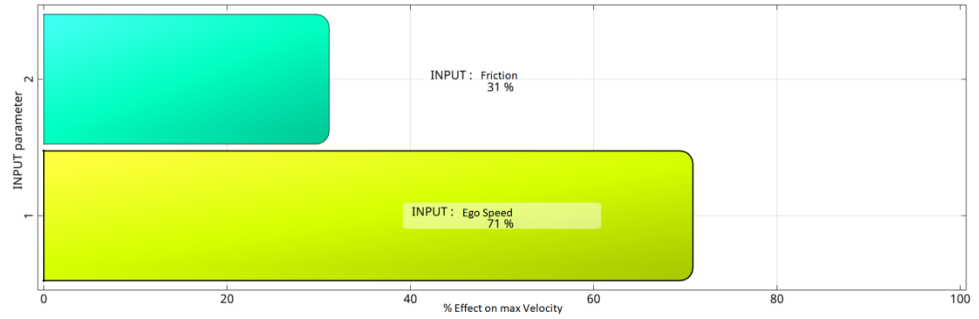


Maximising Safety Investment Value

- Parameter affects on outcomes vary
- Insignificant params are removed
- Efficient investment saves money
- Overinvesting in one area denies investment where it's needed

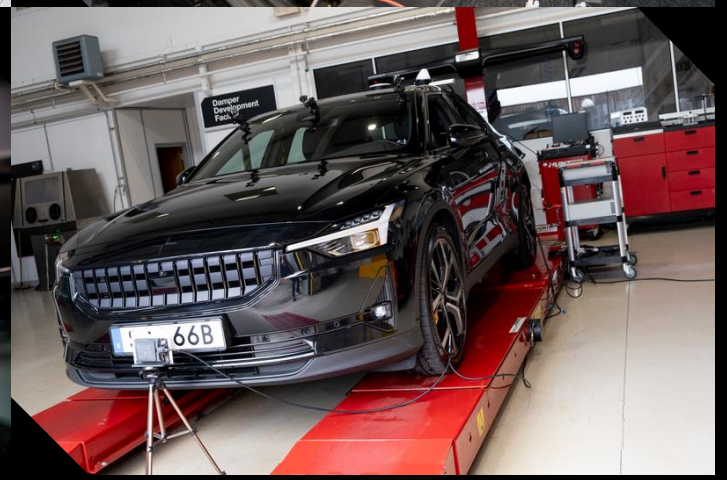






Physical Testing

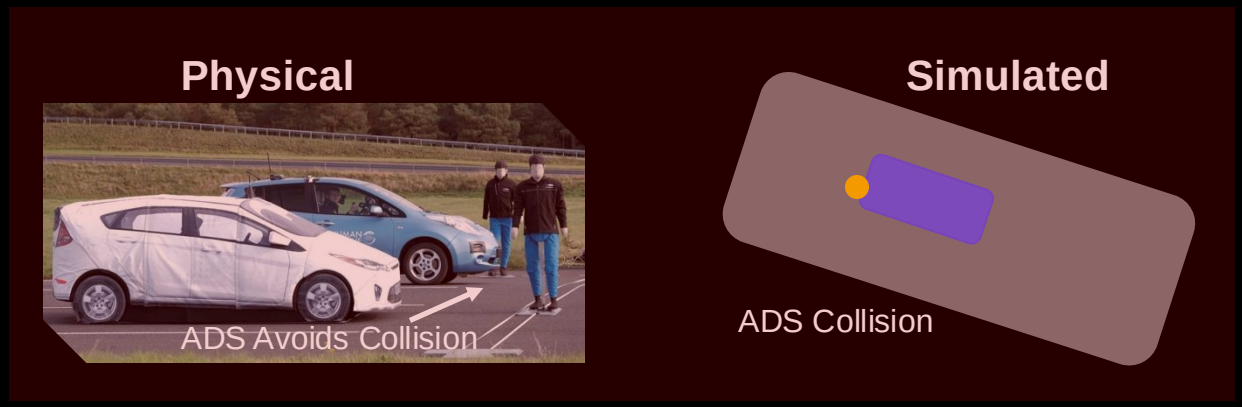
- Photos from July 2024
- Integrating Apollo and sensors into Polestar platform
- We can compare sim and physical results…



Correlation

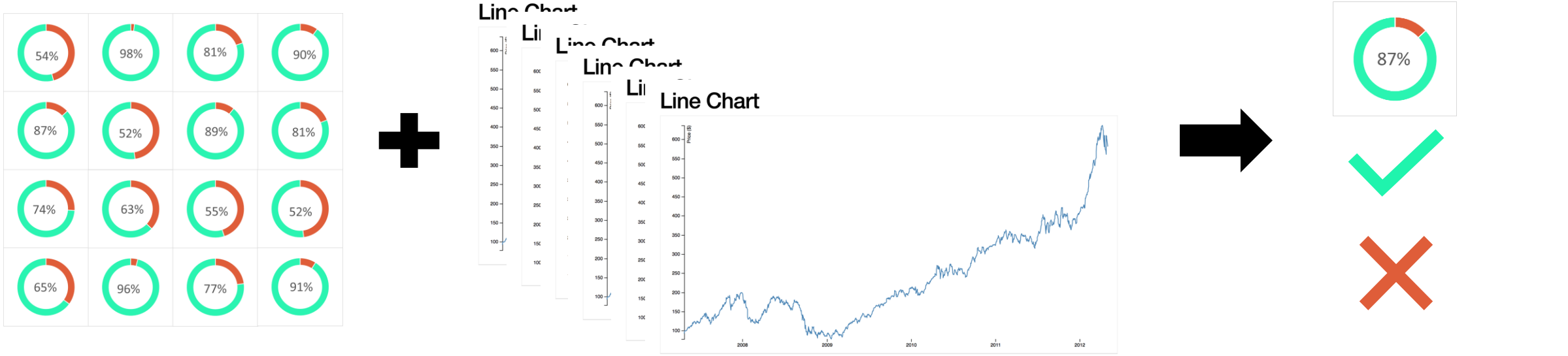
- Simulation can only approximate reality
- Evidence of correlation validates simulation
- “Multi-pillar” safety case
  - Pure simulation
  - Mixed reality
  - Proving Ground scenarios
  - Public Road testing
  - In-service monitoring

Bad Correlation



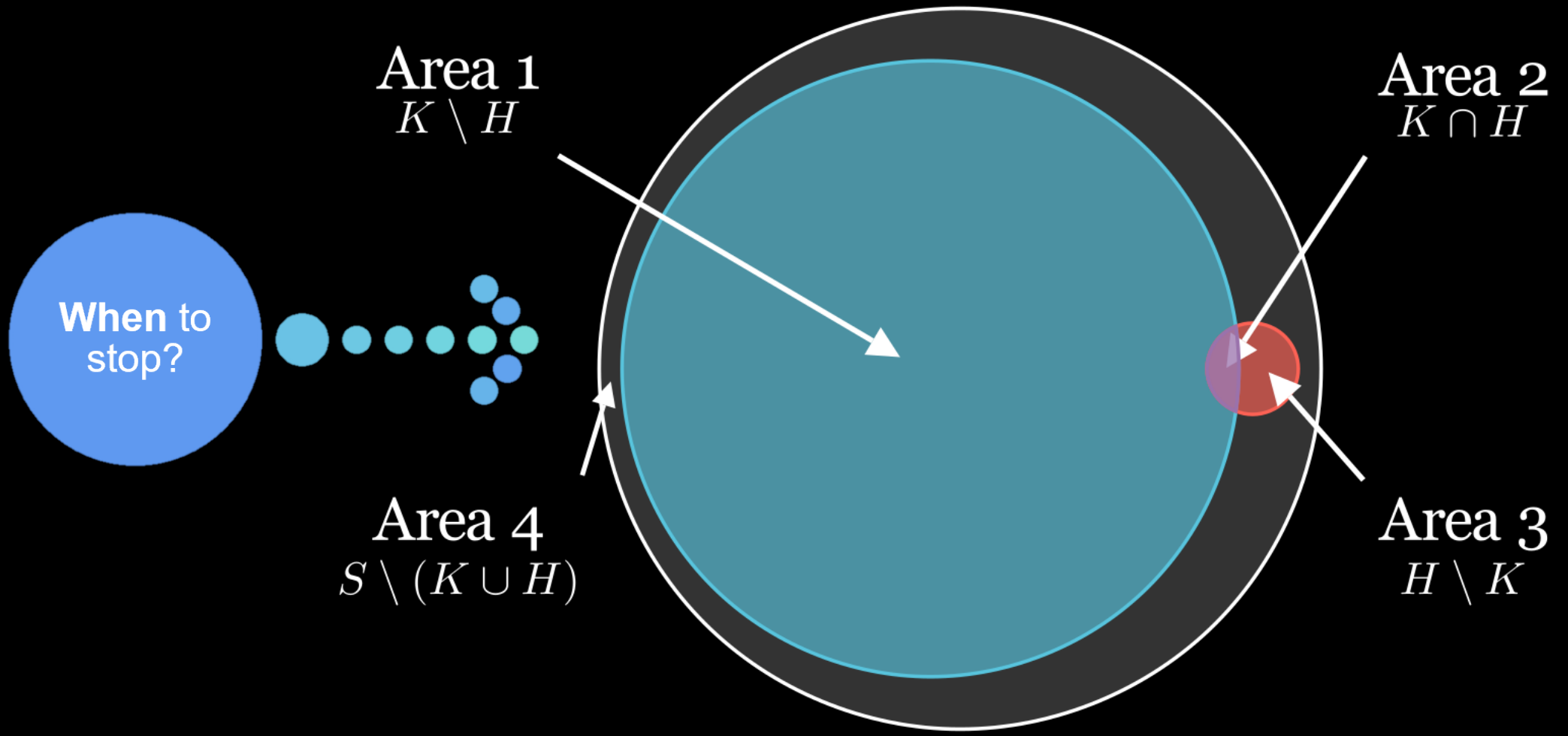
Good Correlation

Other Areas: Oracles



- Certus Oracles combine different metrics
  - (time series and per scenario)
- Outputs a single pass / fail mark
- “the whole is greater than the sum of its parts”

Other Areas: Quantifying Risk



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Final Remarks , closing and post-event networking

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