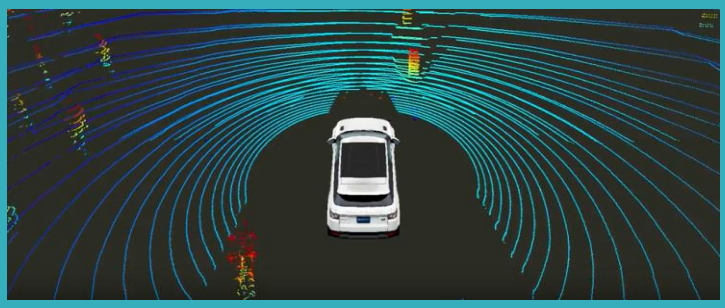
UK Connected & Autonomous Vehicle Research & Development Projects 2018



Centre for Connected & Autonomous Vehicles

enquiries@ccav.gov.uk

www.gov.uk/ccav

@ccavgovuk

The Government believes that connected and autonomous vehicles (CAVs) have the potential to profoundly change the way we travel, making road transport safer, smoother and more accessible.

To this end, CCAV, a joint BEIS-DfT policy team, was established in 2015 to secure the UK's position at the forefront of this change for the safe development, production and use of this technology.

By working closely with industry, academia and regulators, it aims to make the UK one of the world's premier development locations for connected and automated vehicles.

Contents

Projects Clustered By Thematic Area: Navigating This Booklet

Projects are in **Bold** where thematic area is a primary objective or theme.
Projects are in *Italics* where thematic area is a secondary objective or theme.

Vehicle Technologies

Control Systems

INTACT (p16), **INSIGHT (p17)**, **ROBOPILOT (p41)**, **StreetWise (p44)**, **MuCCA (p38)**, **Project Synergy (p39)**, **HumanDrive (p37)**, **SiDeCAA(p60)**, **LAMBDA-V (p65)**, *AMPS (p23)*

Human-Machine-Interface

Project Synergy (p39)

Component Technologies

Pathway to ACV (p19), **ESCIPODS (p36)**, **NIVMS (p47)**, **AID-CAV (p53)**, *Quantum Based Sec. Comms (p48)*, *AIR.CAR (p40)*

Vehicle Localisation

Atlas (p23), **Road Accid. 3D Recon. (p27)**, **RECAPD (p49)**, **Anytime, Anywhere Locn. (p46)**

General Target Sensing, Detection or Recognition

INSIGHT (p17), **SAAV (p22)**, **Vote3Deep (p50)**, *MOVE_UK (p18)*, *CASS-DV (p47)*, *On Highway/Off Highway Comms (p66)*

Machine Vision

Road Accid. 3D Recon. (p27), **Effic. Comp. Vision (p25)**, **StreetWise (p44)**, **Anytime, Anywhere Locn. (p46)**, **Removing HGVs From HS (p67)**, *AVP (p55)*,

Sensor Fusion

SAAV (p22), **MuCCA (p38)**, **RECAPD (p49)**, **AutopleX (p56)**, *CASS-DV (p47)*, *CORAM (p63)*

Radar

Investig RadarTech for Envir. Map (p22), **Advancing UK AV Radar ST (p45)**, **All Weather L.R. Obs Dect (p62)**

Lidar

Enab.Afford. Auton. Using Hyb. Dense Vision (p25)

Non-Car Applications

Pods

CAPRI (p32), *GATEway (p10)*, *UK Autodrive (p11)*, *INTACT (p16)*, *INSIGHT (p17)*, *Project Synergy(p39)*, *ESCIPODS (p36)*, *SWARM (p42)*, *SHIFT (p52)*, *MultiCAV (p58)*

Buses

CABS FS (p46), **T-CABS (p61)**, *MultiCAV (p58)*

Delivery Vehicles

Pathway to ACV (p19), *ROBOPILOT (p41)*, *Removing HGVs From HS (p67)*

Motorcycles

AMPS (23)

Agriculture

On Highway/Off Highway Comms (p66)

Communications / Data / Security

Communications Technologies

FLOURISH (p14), **5G mmWave (p45)**, **Feas. Study on Polar Codes for 5G (p64)**, **5G AtC (p62)**, *Connected Car Data CNBM (p24)*, *Atlas (p23)*

Connectivity & Connectivity Applications

UK Autodrive (p11), **i-Motors (p15)**, **ACCRA (p31)**, **Project Alloyed (p48)**, **Project Synergy (p39)**, *Con-FIDE (p34)*, *On Highway/Off Highway Comms (p66)*, *CORAM (p63)*, *AutopleX (p56)*, *AVP (p55)*

Mobility as a Service (MaaS)

MERGE Greenwich (p33), *MultiCAV (p58)*, *SHIFT (p52)*, *MaaS:CAV (p65)*, *ParkAV (p66)*, *StreetWise (p44)*

Fleet

TALON (p20), *SWARM (p42)*, *NIVMS (p47)*

Insurance

VENTURER (p12), *MOVE_UK (p18)*, *StreetWise (p44)*

Other / Specialist Services

Road Tolls, Taxes, etc.: **Costing Mobility (p50)**

Road Environment Inspection: **CASS-DV (p47)**

Influencing the Human Driver: **Con-FIDE (p34)**

Introduction

A revolution in mobility is coming

We are on the cusp of profound changes in the ways people and goods move around, changes driven by extraordinary innovations in engineering, technology and business models. The introduction of CAVs presents us with exciting and potentially transformational opportunities.

The UK is at the centre of this global opportunity

This revolution brings significant opportunities for safety, mobility, and the efficiency of our transport system. In the Industrial Strategy the UK Government committed to the Future of Mobility Grand Challenge to make the UK world leaders in the movement of people, goods and services.

The UK's Centre for Connected and Autonomous Vehicles has an active programme to support development and deployment of CAVs in the UK.

Founded in 2015, the CCAV works with government, industry, academia and regulators – such as International Vehicle Standards – to make the UK one of the world's premier development locations for CAVs. To support this vision, and to ensure the UK is ideally placed to take advantage of, and capitalise on both its strengths and opportunities, CCAV currently focuses its work on three areas:

Regulation – ensuring a welcoming regulatory framework to keep the UK at the forefront of real-world testing, and using automated vehicle technology

Research and Development – collaborative R&D grants for developing cutting edge technologies

Testing infrastructure – match funded grants to develop world leading testing ecosystem that's easy to access

The aim of this booklet

Since 2014, government has invested significantly into the research and development of CAVs – we have already invested £120m in CAV projects, with a further £68m coming from industry contributions.

This funding is truly collaborative, supporting over 70 projects with more than 200 partners from organisations including automotive manufacturers, universities, insurance companies, high tech entrepreneurial businesses and research organisations to mention just a few. The nature of emerging CAV technology requires participation from very many disparate sectors to come together to explore, develop and deploy the solutions of the future.

This booklet presents a short summary of the majority of the projects we fund. Our hope is that this booklet will be used as a resource for those seeking future collaborators, partners and solution providers and demonstrates the range and complexity of the issues being addressed by the ongoing projects.

Four Cities Trials – Driverless Cars

Instigated in 2014, before the creation of the Centre for Connected and Automated Vehicles, this was the first competition to be focussed on research and development of a future autonomous transport system.

The Scope was outlined as follows:

“This competition is focused on delivering robust town/city-based consortia that are capable of proving how driverless vehicles will be integrated in a real-world environment.

Successful projects will demonstrate close collaboration with partners such as technology developers, supply chain companies and manufacturers.

Each trial must enable both the demonstration of passenger cars (M1 vehicles under the EU classification) that can operate part of the time on roads without driver control and at least one other form of ground-based urban transportation (excluding light rail, heavy rail and guided rail systems) that can operate part of the time without driver control.”

Project: GATEway

One line: Driving the Automated Vehicle Revolution in the UK

Total funding amount/ total grant amount: £5,311,000

Executive summary:
Led by TRL, the GATEway Project is a world-leading research programme which has demonstrated the use of automated vehicles for 'last mile' mobility, seamlessly connecting existing transport hubs with residential and commercial areas using a zero emission, low noise transport system.
Connected and autonomous vehicles present new opportunities for individuals, businesses and society as a whole. In order to ensure that these opportunities are maximised, an understanding of how such vehicles might fit in within cities and how they might enable better, more inclusive mobility is vital. With a focus on people the project has been ground-breaking in the way it invited the public to experience prototype technologies in a real world setting, complete with pedestrians, cyclists, rain and snow. This provided a unique opportunity to understand the perceptions, attitudes and usage intentions based on direct experience of a fully autonomous vehicle (AV), engaging over 32,000 members of the public.

Milestones/Timeline:
Since commencing in 2015. the GATEway project has invited the general public to participate in three discreet use case trials; automated valet parking, driverless grocery deliveries and a shuttle service, all taking place in Greenwich, London at the Smart Mobility Living Lab. Qualitative research has been conducted by TRL, the UK's Transport Research Laboratory, the University of Greenwich, Commonplace and the Royal College of Art, developing a plethora of research and commercial outputs exploring how we feel about using and sharing space with self-driving vehicles.
The final trial was completed in March 2018. Reporting and outputs from the project will be available from Spring 2018.

Project Innovations:
The project has not only seen London and the UK emerge as a world leader in automated technology, but has provided valuable sociological insight into how potential users of automated vehicles respond to them, in a real-world environment, ensuring that the anticipated benefits to mobility can be maximised.

The project has enabled consortium partners to understand the technical, cultural, societal and legal challenges and barriers to adoption of automated vehicles. GATEway has inspired industry, public bodies and the wider public to engage with autonomous transport technology.

The GATEway Project paves the way for the Smart Mobility Living Lab (SMLL), a world-leading test bed to benchmark Connected and Autonomous Vehicles in a complex and urban environment. The SMLL will enable transport manufacturers to develop new mobility solutions and rigorously test them in a wide variety of complex and dynamic city environments.

GATEway Consortium partners:

TRL – The Future of Transport; Royal Borough of Greenwich; Royal College of Art – Postgraduate Art & Design; University of Greenwich; RSA; O2; Westfield; Commonplace; Heathrow – Making every journey better; GOBOTIX LTD; Fusion Processing; dg:Cities; Imperial College London; OXBOTICA – robotics & autonomous systems; Shell

Contact: Amy Woodward
awoodward@trl.co.uk
Video:
The GATEway Project: This is just the beginning.
IWebsite:
www.gateway-project.org.uk

Milton Keynes leading the way in partnership with Coventry and the motor industry

Total funding amount
UK Autodrive is the largest of three separate consortia that are currently trialling automated vehicle systems as part of the government's "Introducing driverless cars to UK roads" competition. The project is jointly funded by government and industry, and delivered by the UK's innovation agency, Innovate UK, with the total investment adding up to approximately £19.4 million.

Executive summary
UK Autodrive is a consortium of leading technology and automotive businesses, forward thinking local authorities and academic institutions who are working together on a major three-year UK trial of autonomous vehicle and connected car technologies. The trial will culminate in a series of urban demonstrations on selected public roads and footpaths in the host cities of Milton Keynes and Coventry. As well as showcasing the latest technology, UK Autodrive will also investigate other important aspects of automated driving – including safety and cyber-security, legal and insurance issues, public acceptance for connected and autonomous vehicles and the potential business models for turning automated driving systems into a widespread reality.

Timeline with milestones/deliverables
Autumn 2016
– First public attitude survey
– First track-based connected and autonomous car demonstrations
– Development and production, and first testing of pods
Summer 2017
– Second track-based connected and autonomous car demonstrations
– Start of in-theatre pod testing in Milton Keynes
Winter 2017
– First connected and autonomous car demonstrations in Coventry
Spring 2018
– Start of self-driving pod field trials
– Second connected and autonomous car demonstrations in Milton Keynes
Summer/Autumn 2018
– Full public pod (low-speed autonomous transport system) trial in Milton Keynes
– Final public connect and autonomous car demonstrations in Coventry and Milton Keynes

Project Innovations
To publically demonstrate connected and autonomous passenger car technology, together with a new 'pod' based autonomous transport system in city environments. To determine what cities need to do in order to promote the use of connected and autonomous vehicles, whilst understanding what benefits the new technologies could bring to the urban environment.

List of partners

Project lead
Tim Armitage (Arup)
E: tim.armitage@arup.com
T: +44 121 213 3311

VENTURER is a £5 million research and development programme aimed at investigating the barriers to the adoption of Connected and Autonomous Vehicles (CAVs) in the UK. The project, led by Atkins, is formed of 10 organisations spanning the public, private and academic sectors.

The **VENTURER** partners have developed several capabilities during the project, including:

- Technology: cutting-edge technology has been developed and tested, including a CAV simulator, vehicle-to-infrastructure communications, situational awareness sensor technology and a systems interface.
- Regulation and research: consultancy services related to CAVs and the wider transport system, CAV modelling, insurance and legal expertise and user behavioural response analysis.
- Delivery: the trialling of CAVs in realistic simulation and controlled urban environments.

Project Milestones:

July 2015	Summer 2016	Spring 2017	Winter 2018	July 2018
Project Starts	Trial 1	Trial 2	Trial 3	Project Ends

Objectives:

Develop an understanding of the public acceptance, legal and insurance blockers to CAVs.

Develop a centre of excellence for the trialling of CAV technology.

Test cases developed by social, legal and insurance experts and evaluated using a fully immersive simulator and controlled road network.

Successes:

- Undertaking CAV trials, including testing a planned handover of control between a vehicle and a driver, and the interaction of a CAV with other vehicles.
- Gaining deep understanding of public perceptions and acceptance of CAVs.
- Conducting research to tackle social and regulatory challenges
- Creating opportunities for investment in the region and strengthened local supply chain.
- Developing and demonstrating CAV expertise in the South West region.

www.venturer-cars.com **@Venturer_Cars**

Carolyn.Mitchell@atkinsglobal.com

Connected & Autonomous Vehicles 1 (CAV1)

Building on the government's 'Introducing driverless cars to UK roads' collaborative research initiative, this competition aimed to encourage development of connected and autonomous vehicles, focusing on three themes – connectivity, autonomy and customer interaction – along with catalysing new business models.

The competition scope sought proposals that fell into one or more of the following thematic areas for both collaborative R&D and feasibility studies:

- Connectivity
- Autonomy
- customer interaction

flourish

EMPOWERMENT THROUGH **TRUSTED** SECURE MOBILITY

FLOURISH is a multi-sector collaboration, helping to advance the successful implementation of Connected and Autonomous Vehicles (CAVs) in the UK, by developing services and capabilities that link user needs and system requirements. The three year project, worth £5.5 million, seeks to develop products and services that maximise the benefits of CAVs for users and transport authorities. FLOURISH is funded from the government's £100m Intelligent Mobility fund administered by the Centre for Connected and Autonomous Vehicles and delivered by the UK's innovation agency, Innovate UK.

Summer 2016 Project Start

Summer 2017
Simulator Trial 1

Spring 2018
Simulator Trial 2
Car Based Trial 1

Summer 2018
Pod Based Trial 1
Car Based Trial 2

Autumn 2018
Simulator Trial 3

Spring 2019
Pod Based Trial 2

Summer 2019 Project End

Objectives

- Develop an understanding and articulation of user needs and expectations of CAVs.
- Develop usable adaptive interfaces, performance certification processes, products and services that enable secure, trustworthy and private technology within CAVs.
- Capitalise on the data created by CAVs to develop innovative new tools and products.
- Leverage existing investment in the Bristol and South Gloucestershire region to expand validation and test capabilities in both urban and inter urban networked environments.

Challenges

- Developing a deep understanding of consumer demands and expectations, including the implications and challenges of an ageing society.
- FLOURISH will address vulnerabilities in the technology powering CAVs, with a focus on the critical areas of cyber security and wireless communications.

Project successes

- Collaboration and knowledge sharing.
- Development of market leading CAV products and services in two main areas:
  - Connectivity including security and data management and analysis; and
  - Customer interaction.

Partners

SNC·LAVALIN · ATKINS · AXA · aimsun. · AIRBUS · South Gloucestershire Council · react ai · University of BRISTOL · designability · UWE Bristol · dynniq · CATAPULT Transport Systems · CARDIFF UNIVERSITY · PRIFYSGOL CAERDYDD · ageUK · OPM · BRISTOL CITY COUNCIL

Supporting Partners

brl Bristol Robotics Laboratory · Burges Salmon

Contact: contactus@flourishmobility.com **Or visit: www.flourishmobility.com**

i-Motors

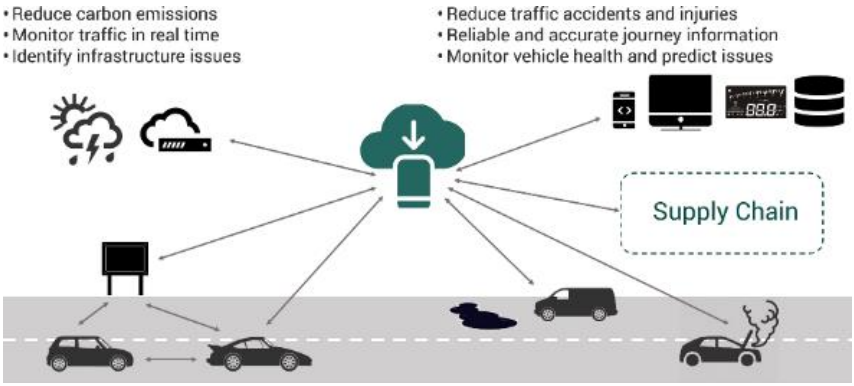
Predictive Contextual Intelligence in Connected and Autonomous Vehicles

Total funding:

£1,380,168

Total grant:

£1,097,135



The i-Motors project seeks to standardise the way in which connected and autonomous vehicles talk to one another and to other machines, and how the data is stored and processed to maximise value. The i-Motors team will use patented Tensor technology, allowing data to be collected and analysed at greater speeds. These data can then be combined with other data sources such as weather and traffic reports, easing congestion and increasing safety through real-time updates and route planning. Contextual intelligence combined with machine learning at both the vehicle and cloud side, capturing and understanding data about both vehicles AND drivers, will enable many use cases to be addressed.

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
Identification of the needs of a range of stakeholders	Terrestrial M2M extension / Space Based M2M Adaptation complete	Analyses on the driving task results complete	GNSS highly accurate IRU Integration	Scalable platform to store vehicle data			M2M platform prototype complete
		Report on M2M platforms and EU recommendations for V2X communications		Dynamic predictive and on the fly maps / contextual intelligence		Identification and prioritisation of different factors influencing user's trust	PoC Demonstrator complete
		Integration and test plans complete				Telematics dashboard complete	Project final report & dissemination
		CAN Bus interface complete				GNSS corrections using GSM/GPRS and satellite communications / sensor integration systems and algorithms	
		Minimum required industry standards for positioning, navigation and connectivity defined					

Project Innovations

Objectives: Communication between vehicles, Processing of information from various sources, Delivery of secure and trustworthy information to drivers using a timely and safe method, Delivery of security and safety information to the automotive sector

Challenges: Scalability and latency, Connectivity issues, Cost versus connectivity

Successes: Resilient, highly scalable platform architecture, Patentable IP (driver ID based on driving style for example), Encouraging research on driver trust and acceptance

control f1

The University of Nottingham
UNITED KINGDOM · CHINA · MALAYSIA

INFOHUB Ltd.

Huduma

dale.reed@controlf1.co.uk

http://www.i-motors.cloud/

INTACT

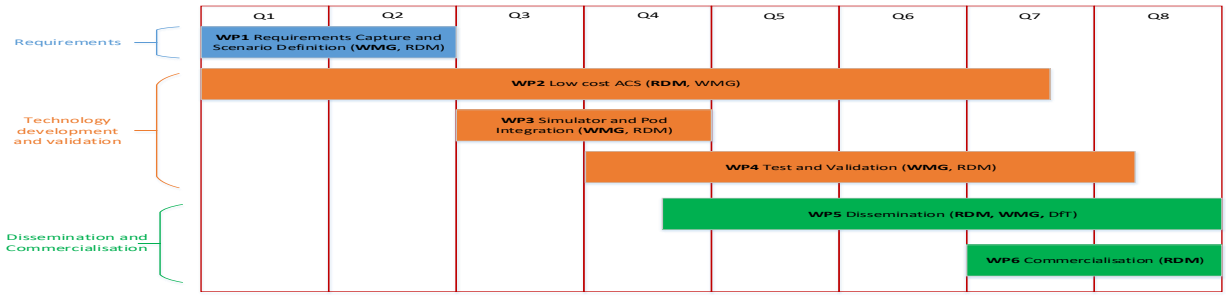
INnovative Testing of Autonomous Control Techniques

INTACT is delivered within 24 months with a budget of £1,085,228

Grant of £553,075 to RDM

Grant of £323,692 to WMG

This project facilitates a collaboration between RDM and Warwick University researchers, who are developing a novel simulator concept, to enable the design, test and evaluation of a reduced cost and optimised ACS in a safe, repeatable, controlled and scientifically rigorous environment.



- Research of passenger interactions, public interactions, perception and acceptance in 3xD Simulator
- Publication of technical papers to provide evidence for future policy frameworks
- Low Cost Autonomous Control System refinement and validation

RDM GROUP

WMG
THE UNIVERSITY OF WARWICK

Contact: sbrewerton@rdmgroup.co.uk

INSIGHT

To enhance the journey and experience for mobility and visually impaired

Total funding amount/ total grant amount
–

£1,564,330

Objectives
To upgrade an existing POD design with advanced sensors to detect and recognise pedestrians, cyclists, mobility scooters and other road users. Develop and test vehicle and service interfaces for visually impaired people. Develop Georgie phone app and a 4D tactile display to aid communication and POD use for the visually impaired. Develop fleet management system for User, OEM and Operators.

Challenges
Developing the safety cases, and upgrading the pod to work in densely populated area
Integrating technology to aid visually impaired into vehicle and fleet management software.

Key Deliverables
Worlds First 4D Tactile Display integrated into an Autonomous Car.
Two PODs that are able to navigate in dense populated areas
Effective social inclusion of visually impaired through the Technology.

Further information from:
pod@westfieldavs.com
Project website:
http://insight-cav.com

Milestones:
June 2016 – Project Start
April 2018 –start of trials
June 2019 – Project End

List of partners

Fusion Processing

BIRMINGHAM CITY University

Heathrow
Making every journey better

Innovate UK

CONIGITAL

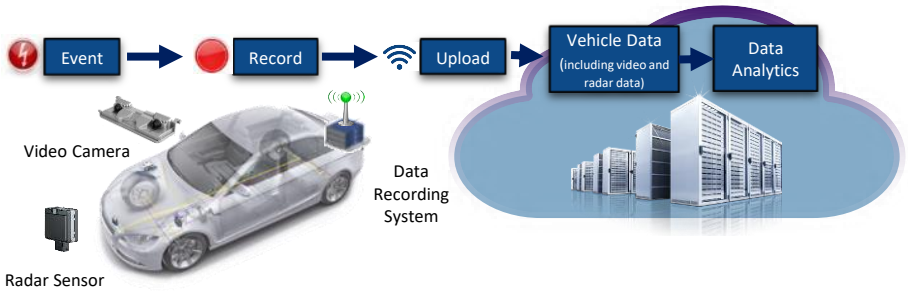
MOVE_UK

"Accelerating automated driving by connected validation and big data analysis"

Estimated Project Cost: £5.5m

UK government grant: £3.4m

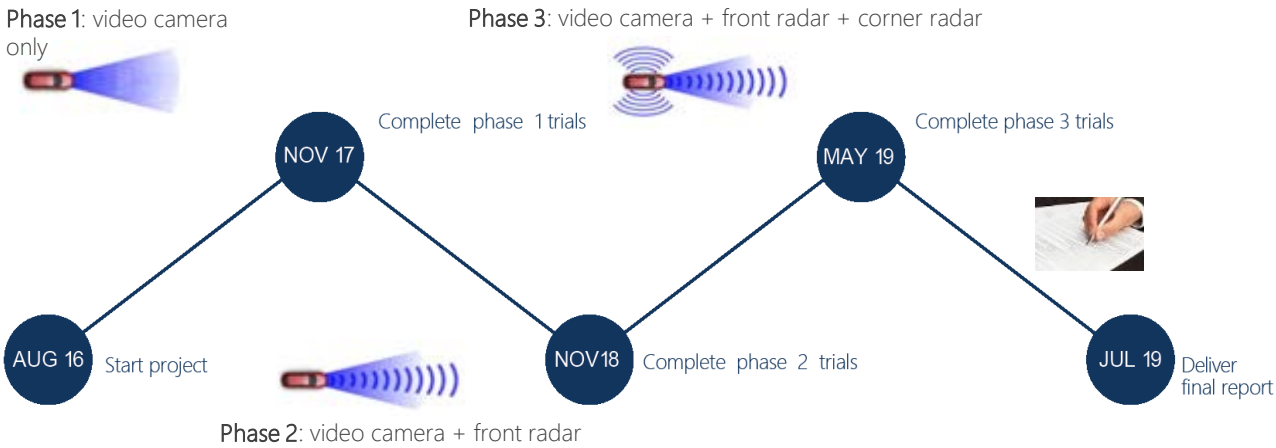
Centre for Connected & Autonomous Vehicles



SUMMARY

MOVE_UK is a project designed to accelerate the development, market readiness and deployment of Automated Driving Systems (ADS) through connected systems validation and big data analysis. The project began in August 2016 and will conclude in July 2019.
The project involves the trial of a new, more efficient, method of ADS validation using a small fleet of Land Rover production vehicles driven in real world conditions on the roads of Greenwich, London. The trial vehicles are fitted with a number of advanced driver assistance systems, and the new validation method focusses on 'intelligent' recording of specific events which are relevant to the development and validation of future ADS.

TIMELINE



SUCCESSES

- Phase 1 trails successfully completed
- Phase 2 trials well underway
- Over 45,000 miles covered by vehicle fleet
- Over 80 event triggered video sequences collected
- Over 46,000 separate speed limit sign detections recorded

PARTNERS

BOSCH
TRL
JAGUAR
LAND ROVER
THE FLOOW
Direct Line Group
ROYAL borough of GREENWICH

Project Lead: Simon Morley Simon.Morley@uk.bosch.com Website: www.move-uk.com

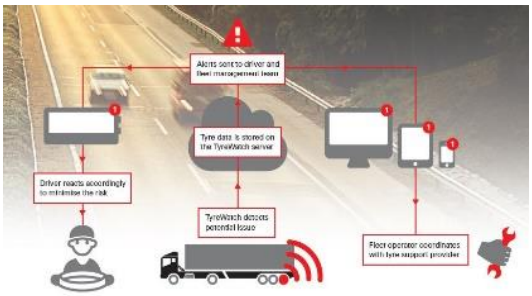
Pathway to Autonomous Commercial Vehicles

Tyre Telematics for the Logistics and PSV Sector

Total Funding Amount\Total Grant Amount –

£1.2 MILLION

Project Number 102585 – CAV1



List of partners

Tructyre Commercial Tyres | RL AUTOMOTIVE | UNIVERSITY OF PORTSMOUTH | CATAPULT Satellite Applications

Executive summary

Through development of specialist software and connectivity, the management of the wheel position for commercial vehicles in the logistics and PSV sectors will operate in a safer working and efficient environment for autonomous mobility.

Timeline with milestones/deliverables

May 2016 - Project commenced
July 2016 - Live populated database
Dec 2016 - Successful prediction of tyre faults
Mar 2017 - Successful live demonstration
Sept 2017 - Successful prediction of tyre faults
Mar 2018 - Demonstration of final project

Project Innovations

A projected 1% improvement in fuel efficiency through Improved tyres pressure management, reduced roadside breakdowns by 90%, which cost on average £136,000 to the UK GDP. Through predictive time to failure software and algorithms. Hybrid\GPS switch for the use in autonomous vehicle management

glenn@tructyre.co.uk – www.tyrewatch.co.uk

TALON

Tools for Autonomous Logistics Operation & maNagement

Total Grant Amount: £3.2m

Fast, city-scale, data driven simulations to support both strategic & operational decision making and enhanced fleet management.

Milestones

- ✓ June 2016 – Project commenced
- ✓ Feb 2017 – First software release
- ✓ August 2017 – First trial begins
- ✓ October 2017 – Second software release

May 2018 – Second Trial begins
May 2019 – Project close

Objective
Develop software to optimise the operations of connected autonomous vehicle fleets at city scale

Challenges
Assimilation of many different data sources
Simulation scaling for city operations
Real-time deployment of decision support-system

Project Successes
More efficient fleet operations
Enables City Authority planning
Improved fleet user experience

Immense Simulations www.immense.ai

UK CITE

Connected Intelligent Transport Environment

Funding

Total Project Value	£7.1M
IUK CCAV Funding	£3.4M
Partner Funding	£2.2M
HE Funding	£1.5M

Executive Summary

A project to create one of the world's most advanced environments for connected and autonomous driving. The globally unique UK Connected Intelligent Transport Environment (UK CITE) will enable automotive, infrastructure and service companies to trial connected vehicle technology, infrastructure and services in real-life conditions on 40 miles of roads within Coventry and Warwickshire. The project will establish how technology can improve journeys, reduce traffic congestion and provide in-vehicle entertainment and safety services through better connectivity.

Milestones/Deliverables

Jun 2016 – Project commenced
Jun to Nov 2016 – System definition
Q1 to Q2 2017 – Bench testing
Q4 2017 to Q2 2018 – Track testing
Q2 2018 – Infrastructure install complete
Q2 to Q4 2018 – Road testing
Dec 2018 – Project finish

Infrastructure will remain open and available for other users for a minimum of 2 years after the UK CITE project has finished.

Objective:

To trial multipath broadcasting of functionality, safety and convenience features using multiple communication methods (e.g. ITS-G5 (DSRC) 802.11p, LTE, LTE-V and Wi-Fi)

USE CASES:

- Emergency Electronic Brake Lights
- Emergency Vehicle Warning
- Traffic Condition Warning
- Roadworks Warning
- In-Vehicle Signage (virtual gantry)
- Floating Car Data (fog, rain, ice)

Project Lead: Claire Lewis clewis22@visteon.com www.UKCITE.co.uk

Investigating the use of Radar Technology for Environment Mapping

Feasibility study addressing the issue of reliable localisation and navigation for autonomous vehicles in all weather and environmental conditions

Total grant amount: £157,723

Objectives

To determine whether a compact radar sensor, with a narrow azimuth beam width and a wider elevation beam width, can be developed for autonomous vehicle mapping.

Executive summary

Just as with human drivers, a vehicle must know its precise location in order to know how it should behave, where it should go next and what challenges may lie ahead. Navtech Radar is investigating the feasibility of producing a radar based system that will provide equivalent information to the lidar technology currently being used in order to provide a sensor that is reliable in all weather and light conditions.

Timeline

September 2016 – Project launch
November 2016 – Initial feasibility report
January 2017 – Prototype component performance report
April 2017 - FPGA test report
August 2018 – Prototype built for testing
January 2018 – Processing board development complete
March 2018 – Results evaluation

Project Lead: Lizzie Turner
Email: Elizabeth.turner@navtechradar.com
Website: www.navtechradar.com

SAAV

Situational Awareness for Autonomous Vehicles

SAAV (Situational Awareness for Autonomous Vehicles) is a project to explore the feasibility of implementing a generic set of hardware and software processing IP suitable for situational awareness systems for autonomous vehicles.

Objectives:
Assess feasibility of a providing a generic set of hardware and software IP for situational awareness systems that is efficient and flexible, and can be configured easily for any vehicle. Development of vehicle with sufficient capability to demonstrate the IP set.

Milestones:
- April 2016 – Project start
- June 2016 – components sourced
- September 2016 – basic vehicle operation demonstrated
- December 2017 – advanced situational awareness capability integrated
- March 2017 – final project outputs

Challenges:
- Build of low cost demo vehicle
- Achieving highest levels of situational awareness processing performance with very small battery
- Achieving a solution that will be usable by those without detailed domain knowledge

Project successes:
- Build and operation of low cost demonstration vehicle
- Integrated situational awareness processor IP for high efficiency processing of optical and radar data streams.

Contact point and weblink:
Leon Wildman contact@aptcore.com
www.aptcore.com

ATLAS

Navigation for Autonomy

Total grant offered: £174,596

Total project cost: £227,698

Objectives :

How do CAVs acquire and use authoritative reference data (off-line) and crowd-sourced dynamic content (live data) to understand geographic context for safe navigation and operation.

How is the complete system of vehicle and cloud data stores constrained by the likely communication infrastructures?

Executive summary: The Atlas Project studied the feasibility and requirements of the technologies and services needed to deliver autonomous navigation 'anywhere' in a safe, reliable and resilient manner. The project specifically studied the navigation, mapping, data, communications, and processing requirements, identifying the on-vehicle and infrastructure elements required to support autonomous navigation. The project also considered how data can be re-used for the planning of urban environments more suited to autonomy. The consortium partners who collaborated on this project were: Ordnance Survey (lead), Gobotix Ltd, Oxford Technical Solutions Ltd, Transport Research Laboratory, Sony Europe Ltd, Royal Borough of Greenwich and the Satellite Applications Catapult.

Timeline with milestones/deliverables

The three principal deliverables from Atlas were:

1. Detailed modelling of data flows constrained by the use case environments, to assess the situations in which data transfer on and off a vehicle is possible.
2. Conceptual system design for a vendor-neutral cloud-based system for data exchange, with processing services to support autonomous navigation, including control components for road authorities.
3. Implementation plan for a follow-on phase to build and demonstrate the system in a realistic road trial.

Contact point and weblink:
Jeremy Morley - Chief Geospatial Scientist
jeremy.morley@os.uk
Owain Hale-Heighway – Project Lead
Owain.Hale-Heighway@os.uk

Autonomous Motorcycle Platform Study

Developing the foundations for autonomous motorcycle control

Total Project Cost £234,287 / Grant £180,207

Objectives

Develop a test platform to enable future autonomous motorcycle development.

Establish technical foundations for autonomous motorcycle control.

Executive summary: The project successfully addressed the challenges of developing and demonstrating a passenger carrying autonomous motorcycle test platform – usable for both control development and passenger trials. An advanced non-linear motorcycle dynamics simulation model was utilized as part of a design methodology that realized a robust motorcycle stabilization and trajectory control strategy. Full by-wire controls, including automatic stand operation, were integrated on the motorcycle and novel autonomous motorcycle test protocols were developed. Exploration of the commercial opportunities revealed the hitherto unrealized dominant role expected for leaning narrow track vehicles in autonomous urban taxi applications. Early exploitation in proving ground applications is underway.

- May 2016 Kick-off
- Aug 2016 Test Hardware Installed and Simulation Model Developed
- Jan 2016 Platform Concept Design Finalized
- Apr 2016 Autonomous Platform Control Demonstration & Final Report

Contact:
Dr Torquil Ross-Martin
Torquil@AutoRDlimited.com

www.autordlimited.com

Connected Car Data

Creating New Business Models

Total funding amount/ total grant amount: £240,113/£168,079

Objectives:

Design, develop and test an early stage prototype of an IoT system capable of discovering and accessing sensor data feeds from a telematics system in a fleet of cars on demand, using a decentralised system design

Executive summary

This project assesses the feasibility of real-time vehicle data sharing within a decentralised system of data producers and consumers, making use of data from the connected car. We demonstrate a system
for making vehicle data accessible to a variety of third parties through an Internet of Things (IoT) system that mediates via a decentralised system, with drivers' explicit consent and incentivisation.

Timeline with milestones/deliverables

•Technical design documentation - May 2016, • Data entitlement system for discovery and access - MVP demo - Oct 2016
• Data owner system interface for entitlement management - MVP demo- Dec 2016
• Project completion - Feb 2017

Contact point and weblink
usman@thingful.net
www.thingful.net

Driver Experience BaseD learning system for Autonomous Cars

Total funding amount/ total grant amount

£ 222,534/£173,953

Objectives:

- Vehicle instrumentation and recording (video and telemetry)
- Monitor and record real world driving scenarios
- Analysis of real world driving as inputs for decision making
- Decision making framework
- Evaluation and dissemination of the impact human driver behaviour can aid decision making

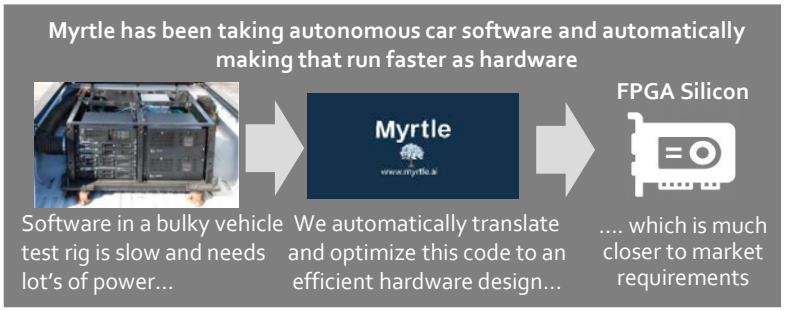
Executive summary

DEBDAC investigates means to, improve and evaluate autonomous vehicles decision-making capabilities taking into account human driver behaviour. This aims to address adopted issues in transition environments, i.e. where manual driven and autonomous vehicles co-exist. This project uses insight from mass telematics data to influence the decision making of a vehicle to 'normalise' and improve decision making in line with exemplar human behaviour.

Challenges: Use of existing driving data, evaluating inputs to decision making.
Project outcomes: in wider usage and bringing new ways of looking at autonomous risk

Project Contact
sam@thefloow.com

Efficient Computer Vision ADAS Hardware for CAV



- *Funding Amount:* £147,147
- *Project Cost:*£210,210
- Project Lead – **Myrtle.AI**

Custom computer chips will eventually contain all the 'smarts' of self-driving cars. However, producing a silicon chip is a slow process. Our project has shown how advanced computer code can be automatically turned into efficient FPGA chip designs. This allows companies developing autonomous car software to quickly produce testable, commercial hardware designs. Our work means that safety improvements should appear in mass produced cars sooner.

Project Duration 12 months:

- Develop automatic compiler ability to handle stencil-based line buffered operations.
- Implement optical flow, corner and edge detection algorithms in high level language
- Develop compiler support for efficient, optimised FPGA silicon output algorithm designs
- Evaluate algorithm performance across multiple devices - CPU, GPU and FPGA
- Produce statistics and report on compiler efficiency and FPGA utilisation.

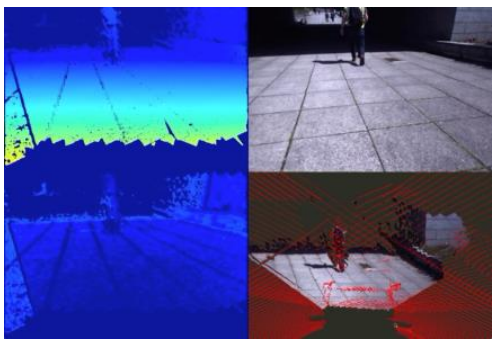
Bringing the next generation of Advanced Driver Assistance Systems (ADAS) hardware to automobiles is complex, expensive, iterative and slow. Development and rollout in the marketplace is further slowed by the high standards naturally required by the car industry. A major consequence of this situation is that advanced computer vision algorithms, which are used in other industries for human safety, are not appearing as quickly as they should within the increasingly connected cars on the roads today. This project is to explore the feasibility of developing a new technology in real-time image processing to drastically reduce the iteration times of producing ADAS hardware. The project will produce hardware versions of key algorithms using our software and evaluate the efficiency of our new process. If successful this project would see the UK well-placed to be at the forefront of owning the IP within all the chips in future car models and leading the way in making our roads safer.

www.myrtle.ai brian tyler,
brian@myrtlesoftware.com

Enabling Affordable Autonomy Using Hybrid Dense Vision

Reducing the reliance on high cost lidar for autonomous operation

Total grant amount: £173,664



Objectives

The main objective of this project was to reduce the reliance on high cost lidar for autonomous operation. We compared the results of lidar, stereo-camera and fused data to find the optimal balance between cost, accuracy and reliability on which we can operate an autonomous vehicle safely and efficiently. We tested and validated our system on many kilometres of data in urban and off-road environments.

Project Successes

Design and build of data collection vehicles to provide sufficient data for this project
Already collected data in key environments including urban and off-road data and started the initial assessment of such environments
Efficient knowledge transfer from the ORI research group to Oxbotica
Successfully processing data and making changes to improve efficiency

Timeline with milestones/deliverables

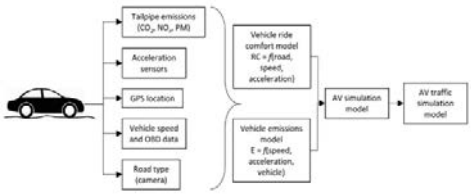
- Specification & development
- Mapping, baseline & data collection
- Analysis & simulation
- Field trials, concept demonstrator

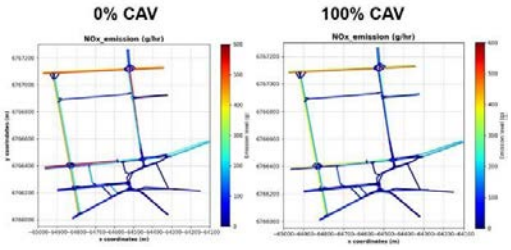
Contact point and weblink
Caterina Linegar, Project Manager,
Oxbotica www.oxbotica.ai

OVARE: Optimised vehicle autonomy for ride and emissions

Optimising the driving style of CAVs for passenger ride comfort, vehicle fuel consumption and emissions, or journey time and speed

Objective was to use simulation to demonstrate the concept of consumers interacting with CAVs to optimise the journey for different preferences including journey time, ride comfort and emissions. Funding: £247,618.





Executive summary

The collaboration between Emissions Analytics and the Centre for Transport Studies, Imperial College London, combines access to a range of vehicles for testing, expertise in vehicle emissions measurement, innovation in sensor development and expertise in the simulation of AVs. New measurements of ride comfort and emissions used to develop models that can be used in further simulations of passenger-AV interactions. CAVs with V2I and V2V capability were simulated in a traffic micro-simulation environment. Significant emissions reductions and air quality benefits could be achieved with smoother driving CAVs.

Timeline with milestones/deliverables

Completed in 2016. Deliverables: (i) develop a novel vehicle ride quality sensor; (ii) collected ride comfort measurements and emissions data for >20 different vehicles; (iii) developed models for the prediction of ride comfort and emissions for different driving behaviours; (iv) demonstrated the network effects of customer preferences on road transport emissions and air quality through traffic simulations.

Dr Marc Stettler
Centre for Transport Studies, Imperial College London
m.stettler@imperial.ac.uk
http://www.imperial.ac.uk/transport-studies/transport-and-environment/

EMISSIONS ANALYTICS
Imperial College London

People in Autonomous Vehicles in Urban Environments (PAVE)

Exploring the feasibility of using the UKAEA's 200 acre fenced site at Culham as a test site for Connected Autonomous Vehicles.

Total funding / total grant : £247,159 / £190,067

The project was completed in January 2017.

In so far as Oxbotica now operate L4 vehicles on the site and Culham (in conjunction with Millbrook Proving Ground) is part of the UK CAV testbed, the project is viewed as an unqualified success.

In addition to delivering an open-access capability the project:

Socialised the role that Culham could play as a fenced test site as part of a Closed-Fenced-Open CAV UK test and validation strategy.

Detailed preparation for use of autonomous cars at Culham including associated use cases were derived. The vehicles operate within a defined set of processes, on the Culham site and future use cases have been elaborated which mean that the site is able to test on an open-access basis.

Amey have become aware of the benefits associated with the use of autonomous service vehicles and are looking at ways of taking this interest further.

Oxbotica has deepened its understanding of the requirements of CAV technology and the responsibilities associated with running this technology.

Through involvement with plans for the development of the Culham Smart Community, Didcot Garden Town and Smart Oxford the team have introduced thinking on the potential impact CAV could have on future communities to substantial real-world projects at an early stage.

We have gained insight into people's perception of CAV and the quantified survey data collected should provide a basis for future public surveys/consultations.

Garry Staunton, Lead Technologist, RACE, Culham Science Centre, Abingdon, Oxfordshire, Ox14 3DB
E: garry.staunton@ukaea.uk
W: http://www.race.ukaea.uk/projects/pave-autonomous-vehicles/

Animation: https://www.youtube.com/watch?v=nYtuvQM5AZw

SIEMENS Westbourne Engagement RACE amey OXBOTICA

Simple, low-cost, compact and precise localisation for highly autonomous vehicles

Total funding amount/ total grant amount

£174,679 feasibility projects with funding support of £122,288

Objectives: Build a prototype, demonstrate vehicle localisation, develop route to market.

Project Innovations and Challenges

1. A novel and complimentary solution for localisation using ground surface fingerprint
2. Use of biologically inspired “event camera” sensors
3. Addressing underlying assumption that a patch of road surface segments unique
4. Real time acquisition and processing
5. Sensor effectiveness in weather/conditions
6. Commercial barriers to entry
7. Cost of map building for all roads

Executive summary

Autonomous vehicles need to know their location relative to the road but GPS is often not accurate enough and has failure cases. Most solutions being developed and tested today use rich 3D maps of the environment to determine the vehicle position to within a centimetre or so but the technology can be expensive, process intensive, bulky and power hungry. Our innovation is to measure the fine 3D geometry of a small patch of road surface below the vehicle and use this as a 'fingerprint' to uniquely determine the vehicle's location.

Project Contact
info@machineswithvision.com
www.machineswithvision.com

Durham University

machines with vision

Road Accident 3D Reconstruction

A dashboard camera to create a 3D reconstruction of a road accident

Total funding amount/ total grant amount

£17,273

Objectives:

To develop a demonstration unit to test the feasibility of an advanced dashcam that can track the 3D trajectory of a car involved in an accident

Executive summary

The objective was to advance dashcams with a novel data logging capability that reconstructs the 3D vehicle trajectory during a road accident, without using information from global positioning systems or any on-board vehicle instrumentation or control systems. First, a prototype was produced sensors, processing board and software were integrated into device that could be fitted to a car using suction cups. Second, the prototype was demonstrated in a set of initial car trials using an autonomous vehicle in repeatable trials performing a range of manoeuvres. It is our opinion that the project has made a significant impact on dashcam technology as we have demonstrated that dashcams can indeed provide independent accurate vehicle trajectory information of moments leading up to and including a road accident.

Timeline with milestones/deliverables

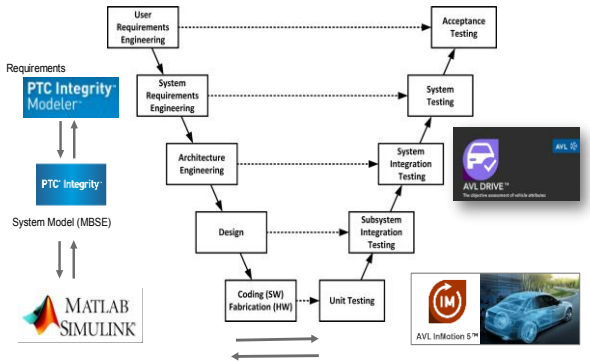
The project took place between 1st April and 30th June 2016. The key milestones were a series of trials utilising an autonomous Toyota Prius and the final milestone was a demonstration for both Innovate UK and press at Roke’s site in Romsey. The key deliverable was the demonstration system and the data from the trials.

Contact point and weblink
Dr. Dean Thomas
Roke Manor, Old Salisbury Lane, Romsey, Hampshire, SO51 0ZN
Dean.Thomas@roke.co.uk
www.Roke.co.uk

Roke
Part of the Chemring Group

VEDAS

Virtual Validation Environment for Driver Assistance Systems



- **Project Value:**
- £248,174
- **InnovateUK Funding:**
- £124,087

Executive summary:

Advanced Driver Assistance Systems (ADAS) features are becoming increasingly complex, with greater influence to the vehicle control task. Thus, the challenge of ensuring robust performance is becoming more challenging.

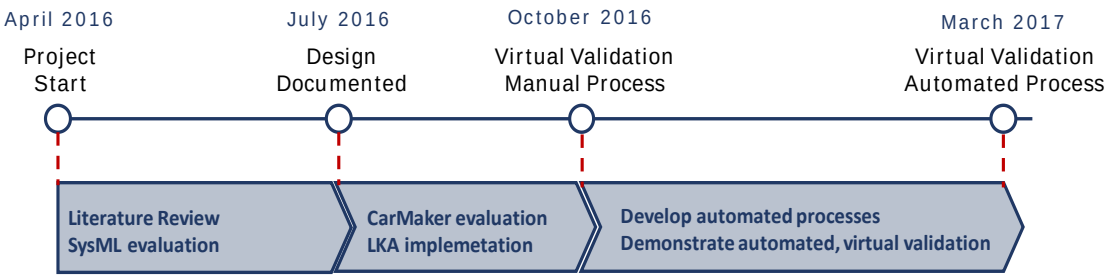
This project assisted in determining the feasibility of an advanced vehicle-in-the-loop test cell by researching and developing a number of key building blocks needed in order to realise the benefits of such a test cell.

Specifically, an improved systems engineering approach was developed, including automated and linked methods to generate test plans from the requirements, to implement these into a virtual environment, and to determine the results of those tests. A virtual calibration process was also investigated.

Success in this project has led into a collaborative research project, 'SAVVY', which will aim to demonstrate the process applied to a virtual validation facility.

Project Innovations

In this project, AVL used their experience in development and validation of production ADAS features, identifying opportunities to address challenges facing this industry. Processes identified and tools brought into the development strengthen our ability to deliver robust development of future ADAS and Autonomous Driving systems.



List of partners

AVL

Independent CAV1 Feasibility Project

Stuart Rowell, AVL stuart.rowell@avl.com

Connected & Autonomous Vehicles 2 (CAV2)

CAV2 was launched in November 2016. Project proposals had to come up with technical solutions for CAV features that will provide real-world benefits to users. This included how these vehicles would work as part of a wider transport system.

Proposals where the commercial benefit is clear were actively sought.

Again, both collaborative research and development projects and feasibility study projects were welcomed.

Proposals were invited across 4 streams:

- Stream 1 – Grand Challenge to develop and test a highly automated vehicle (SAE Level 4) capable of operating in different environments
- Stream 2 & 3 – Collaborative R&D and Feasibility Studies
- Stream 4 – Shorter, fast impact, industry-led CR&D, focus on one or more of the following priority areas:
    - Connected powertrain for more efficient energy use
    - Autonomous control for more efficient energy use
    - Business model innovation and trialling through growing supply chain relationships in the UK

5StarS - Automotive Cybersecurity Through Assurance

Total funding amount/ total grant amount

£ 1 500 000 / £ 806 000

Timeline
1 July 2017 – 30 June 2019

Executive summary
The rapidly proliferating wireless connectivity and automation of road vehicles offers many benefits to society, and significant commercial opportunity, but also brings a potential explosion of cybersecurity threats.

5StarS partners HORIBA MIRA, Ricardo, Roke, Thatcham Research and Axillium Research will together deliver the *Automotive Cybersecurity Through Assurance* project.

The project will:

- Research and develop an innovative assurance methodology to assure that vehicles and their components have been designed and tested to the relevant cybersecurity standards throughout their lifecycle;
- Research and develop a consumer and insurer oriented rating framework, analogous to existing Euro NCAP type ratings for vehicle safety, clarifying cybersecurity risk for the insurance industry;
- Align with relevant existing and emerging international standards and regulations.

Best practices from other sectors will be leveraged to address the challenge of establishing meaningful ways of providing cybersecurity assurance to consumers, unlocking the benefits of connected and autonomous vehicles.

Contact point
Paul Wooderson paul.wooderson@horiba-mira.com Web https://5starsproject.com/

ACCRA

Autonomous & Connected vehicles for CleaneR Air

Total funding amount/ total grant amount

£1.5 Million (across consortium partners)

Executive summary

ACCRA is a 12-month research and development project, due to be completed in June 2018.
The project aims to improve air quality in urban areas by developing a system capable of allowing remote control of a hybrid vehicles energy management system to ensure it is running in zero emissions mode whilst in a designated Dynamic Control Zone (DCZ). This area can be adjusted in location, size and time duration according to the real-time emission and air quality status in accordance with a defined Air Quality strategy.
The project will demonstrate this capability using a 7.5t Range Extended Electric Vehicle (REEV) in Leeds during May 2018.

Objectives

ACCRA will develop a system capable of allowing remote control of a vehicles energy management system to ensure it is running in zero emissions whilst in a designated Dynamic Control Zone (DCZ).
This area can be adjusted in location, size and time duration according to the objectives of the air quality management authority. The DCZ adjustment will be based on the real-time status of air quality in the management area which is monitored by an array of sensors and future predictions of the air quality based on weather and traffic data.
The project will demonstrate this capability in a 7.5t Range Extended Electric Vehicle (REEV) in the proposed study area in Leeds.

Key Successes

- A system able to connect vehicles, city air quality sensors and city traffic management systems.
- The development of the concept of dynamic Low Emission Zones – strategies to determine where they should be at a given time.
- Measurement of real-time air quality and present findings through simulation to inform dynamic zone strategies.
- Use of on-vehicle emissions measurement to feed into real-time decision making (active geo-fencing)
- Indirectly control select vehicles (REEV) to switch their running mode in designated zones.
- On-road demonstration of vehicle-to-city interface and dynamic zones.
- Specified roadmap for exploitation of technical, commercial and legislative enhancements to inform future strategies.

List of partners

dynniq energising mobility
TEVVA MOTORS
CATAPULT Transport Systems
cenex
EARTH SENSE
Leeds CITY COUNCIL

https://www.campaigns.dynniq.co.uk/accra/

Capri

Synopsis

CAPRI is a consortium of experienced partners from industry, academia, public sector authorities and local government, working together to deliver a complete pod on demand mobility service. Led by AECOM, the consortium is taking forward current research and development work on Connected and Autonomous Vehicles and is leading the way to the new generation of pods that will be capable of seamlessly transferring between the on-road and pedestrian environments.

Objectives:

Collate sufficient evidence from the deployment trials and simulation testing to support pods becoming a recognised vehicle classification for use on public roads.

Develop and deliver sustainable business models for an integrated end to end mobility service to transform travel.

Harness Vehicle to Everything (V2X) connectivity to enhance the pod journey experience.

Lead the way to the new generation of pods capable of safely operating within normal traffic on public roads.

Challenges:

Verifying and validating the safety and security of the next generation of pods for both the on and off road environment.

Engaging with stakeholders to collate sufficient evidence to support pods as a new vehicle classification.

Success:

Building public confidence in pods as a safe, secure and viable connected mobility service using sustainable and clean energy.

Engaging with a range of stakeholders to test the use cases for pods to deliver end-to-end mobility solutions.

Progress UK based CAV innovation across the consortium with the support of government investment to generate jobs and support the economy.

Enable consortium partners such as AECOM to lead on understanding and designing how CAVs can and will shape and change our built environment in the future.

Milestones:

October 2017:
Project Start

May 2018:
Trial to test & validate pod performance at Filton Airfield

October 2018:
First public trial of pods – supporting public use of a car park in South Gloucestershire

May 2019:
Second public trial of pods – complex densely populated pedestrianised routes at Queen Elizabeth Olympic Park

January 2020:
Third and final public trial of pods – complex on-road navigational route at Queen Elizabeth Olympic Park

March 2020:
Project completion

AECOM · Loughborough University · South Gloucestershire · Fusion Processing · aimsun · dynniq · AXA · ESP Group Life made simple · NEXOR · Queen Elizabeth Olympic Park · Yotta · CONIGITAL · Heathrow · thingful · TVS · University of Bristol · UWE Bristol · WMG

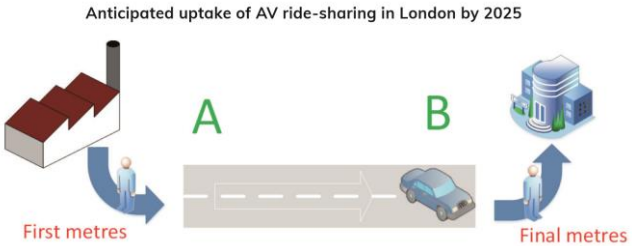
For more information contact:
george.lunt@aecom.com

merge GREENWICH

The MERGE Greenwich Project

Timeline: 01/07/2017 – 30/6/2018

Total Grant £728,975



Executive summary

MERGE Greenwich is a ground-breaking project, led by global mobility services operator Addison Lee, which aims to re-think urban transport. Jointly funded by the government and by leading industry partners, the project will simulate how passengers can cut their transport costs and journey times by sharing driverless or autonomous vehicles (AV) with other passengers, and how these vehicles can be integrated with buses, tubes and trains. Over the next twelve months, the £1m MERGE Greenwich project will analyse Londoners' travel habits and design a blueprint for a scalable, commercially viable AV ride-sharing services to fit into the city's public transport strategy and plans.

Based at the Smart Mobility Living Lab: London, the 12-month MERGE project will be delivered by an Addison Lee led consortium, and will use the Royal Borough of Greenwich to model, test and assess options.

The MERGE Greenwich project will simulate how AV's can deliver commercially viable services that complement and enhance existing transport solutions. The consortium will investigate ways to improve travel around cities, reduce total vehicle journeys and emissions, using innovative developments in electric and autonomous vehicles.

The project will focus on the social, commercial and infrastructural challenges posed by AVs, and will consider the safety, accessibility, environmental and ride-sharing, factors of autonomous public transport.

The project will deliver a comprehensive simulation showing how AV ride-sharing can be integrated into the transport system; alongside detailed analysis of the benefits to communities and the environment through reduced emissions and journey times. An overall business model, including vehicle requirements and possible barriers to adoption will also be published. From this, real-world AV ride-sharing testing could be carried out which will provide the crucial next step towards mass roll out of AVs.

- Report - MERGE Greenwich. The future of urban transport. Oct 2017
- Report - One in three London car journeys could be replaced by Autonomous Vehicles 2025 Oct 2017
- Report - Anticipated uptake of Autonomous vehicle ride-sharing Oct 2017
- Survey: MERGE Greenwich Consumer Research Nov 2017
- Report - Customer Attitudes to AV ride-sharing April 2018

List of partners

ADDISON LEE

Ford

dg:Cities

TRL

CATAPULT Transport Systems

Immense Enabling Intelligent Mobility

www.mergegreenwich.com **mailto:** merge@AddisonLee.com

ConFIDE
World-first Connected Vehicle Platform

Total funding amount/ total grant amount

£1.8 Million project costs

£1 Million Grant

Executive summary - The project will develop Lightfoot Connected Car technology, which will be the only technology in the world that will fit to ANY car and truly connects it to the driver, in turn connecting the driver to an entire driving ecosystem that gives a vast array of social, economic and health benefits, making motoring cheaper, safer and greener for all.

Timeline with milestones/deliverables

Oct 2017 – Web & server work complete, Nov 2017 – Eco-system compiled, Nov 2017 – First prototypes assembled Dec 2017 – Real world Beta testing begins, July 2018 – Beta prototypes reviewed, Feb 2019 – Final testing & validation

Project Innovations

- Connectivity
- Artificial Intelligence
- Hardware Size Reduction
- Features & Functionality
- Privacy & Security
- Driver Rewards Platform

List of partners

lightfoot Rewarding better drivers

iAM RoadSmart

University of Bath

SECURIOUS Data and cyber security

revolve

Dan Regan – dan.regan@lightfoot.co.uk – www.lightfoot.co.uk

Insuring, Ensuring and Exporting Fleet Wide Level 4 Connected Autonomy

Total grant amount

£8,612,991

Timeline with milestones/deliverables

- July 2017 – Project initiation
- August 2017 – Finalised OS platform design
- January 2018 – Completion of V2X development
- June 2018 – Vehicle commissioning compete
- March 2019 – Trial planning complete
- June 2019 – Finalised connected risk approach
- June 2019 – Completion of data gathering
- June 2019 – Completion of road vehicles trials
- October 2019 – Finalised L2-L4 Selenium development
- November 2019 – Final trial complete
- December 2019 – Project completion

Executive summary

DRIVEN is an ambitious project that will see a fleet of fully autonomous vehicles being deployed in urban areas and on motorways, culminating in multiple end-to-end journeys between London and Oxford. No connected and autonomous vehicle trial at this level of complexity and integration has ever been attempted anywhere in the world

Project Innovations

Objectives

- First fully integrated autonomous control system platform for on-demand, insurance-driven, L4 operation of a connected autonomous vehicle
- Fleet of autonomous vehicles operating multiple journeys between Oxford and London.
- Connected risk management to optimise overall autonomous fleet safety and operation
- Secure distributed data sharing

Challenges

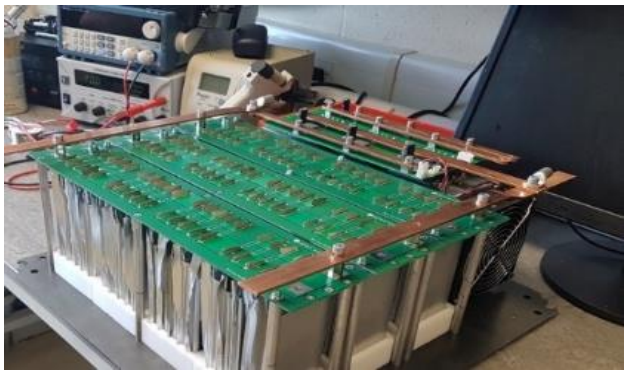
- Reliable and robust communication across a fleet of autonomous vehicles given bandwidth constraints
- Keeping costs viable without any loss in performance
- Integrating cybersecurity, insurance and data sharing into one system

Caterina Linegar, Project Manager, Oxbotica
Weblink: drivenby.ai

Escipods

To develop novel and innovative solutions for clean and efficient urban transport through the use of emerging technologies.

Total grant amount:
£1,086,452



Objectives

The project looks to develop existing autonomous vehicles for higher efficiency and extended range. This will be achieved by developing a new hybrid graphene supercapacitor / Lithium-Ion battery system for deployment in the PODs. The Consortium will be: Creating a CAN based wiring loom along with a new Automotive ECU to streamline the build of the vehicle and to reduce the bill of materials cost. Increasing the vehicle operational use by minimising downtime for charging. Build vehicle operational models to able the maximise efficiency when deploying in different use cases.

Challenge

Decrease the charging time from hours to minutes for the vehicles.

Deliverables

The project will be building and trialling two Autonomous Pure Electric Graphene/Lithium Powered demonstrators

List of partners:

Milestones:

Dec 2017 – Start of Project
Dec 2018 - Trials Start
Feb 2019 – Project End

Further information from:
pod@westfieldavs.com
Project website: https://westfieldavs.com/

HUMAN DRIVE

Using machine learning to develop natural, human-like vehicle control

The HumanDrive project will develop prototype Autonomous Vehicles (AVs) with the aim of successfully demonstrating a lengthy end-to-end journey in a variety of settings, including country roads, high-speed roundabouts, A-roads and motorways in live traffic. The AV's are being subjected to a variety of different environmental conditions. The system will be developed and subjected to a robust testing process using a range of facilities, including simulation, hardware in the loop (HIL), private test track and on public roads. Trials on the public roads will be designed to test the AVs in a range of different scenarios.

The BIG Ambition

Grand Drive

100%
Autonomous Drive

One of the key innovative aspects of the project will be the development of an advanced vehicle control system, designed to allow the vehicle to emulate a "natural" driving style using machine learning and developing an Artificial Intelligence (AI) to enhance the user comfort and experience of AVs.

- Diverse group of partners, with world class expertise
- Using machine learning and developing AI to enhance the comfort and experience of AVs with Human like control
- Technology/vehicle will function in a variety of scenes and environmental conditions
- Consideration of the complete connected and autonomous vehicle ecosystem (e.g. Cyber security, testing, safety case, support of Councils/road operator)
- Bringing global industry to the UK and building an industrial supply base
- Conclude the project with a Grand Drive demonstration of around 200 miles
- Conduct 100% autonomous Grand Drive, equivalent to the higher levels of automation

Media Enquiries: Humandrive@ts.catapult.org.uk

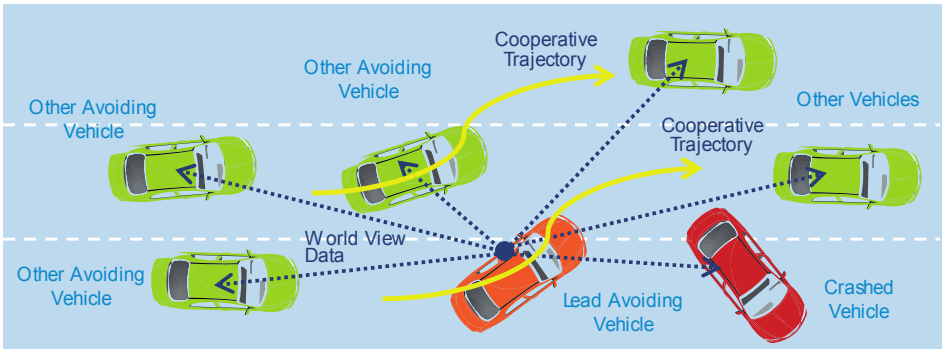
NISSAN HITACHI Inspire the Next Cranfield University MIRA aimsun. UNIVERSITY OF LEEDS ATKINS highways england CATAPULT Transport Systems SBD

MuCCA

Multi-Car Collision Avoidance: using connectivity and autonomy to minimise the damage in high-speed, multi-vehicle traffic accidents

Motorway pile-ups are costly both in financial terms and in terms of human lives. MuCCA is a £4.6m, 30-month project supported by Innovate UK, which will develop a next-generation driver aid that aims to avoid multi-car collisions on motorways. If an accident cannot be avoided, the MuCCA system will attempt to minimise its consequences (both injuries and damage).

These goals mean the project will implement, test and refine solutions to many of the technical challenges that face fully autonomous cars. These challenges include sensor systems, machine learning, vehicle-to-vehicle communications and vehicle control systems.



Key Innovations:

- Cooperative decision and trajectory control for complex collision avoidance
- Prediction of human-controlled vehicle paths
- Shared sensor-agnostic worldview
  - Match data from other connected vehicles to sensed vehicles
  - Merge sensor data from other vehicles
- Develop insurance logging capability to support event reconstruction
- Integrated simulation environment to evaluate complex crash scenarios
- Cyber-security assessment for common requirements
- Multi-vehicle system validation on a test track

Outline Project Plan

Start: Planned August 2017

System Definition

System Development

Virtual Test Environment Development

System Test & Assessment

End: Planned January 2020

@Muccaproject

Muccaproject

Project Lead: guillermo.tejera@idiada.com

Web: mucca-project.co.uk/mucca-project.com

Media enquiries: Mucca.project@ts.catapult.org.uk

Applus IDIADA

CATAPULT Transport Systems

COSWORTH

Cranfield University

Westfield

SBD

We work with Innovate UK

Synergy

To trial innovative technology in multi-vehicle platoons and develop an in -vehicle virtual concierge and airport check-in facility.

Total grant amount:
£3,737,419

Objectives

To introduce user experience and vehicle technologies to operate connected autonomous cars and PODs in a platoon formation at Manchester Airport. The project will trial a virtual concierge to aid partially sighted users and enhance the journey for normal users who are able to check-in, buy duty free and conduct in vehicle security checking on the journey to and from the airport.

Challenges

To facilitate inclusive accessible transport for the mobility and visually impaired and reduce road transport emissions around Greater Manchester
To develop secure vehicle to vehicle and vehicle to infrastructure communications.
To integrate with airport and airline systems to enhance the user experience

Deliverables

3 Westfield Vehicles demonstrating platooning 1m apart at 70mph
3 Westfield PODs Platooning 1m apart at 15mph
An in-vehicle Virtual Concierge / assistant

Milestones:

Nov 2017 – Project Start
Dec 2018 – POD and platoon trials at Manchester airport
June 2019 – POD / GTM concierge and platoon trials
April 2020 – Project Completion

List of partners

Westfield
CONIGITAL
Fusion Processing
cisco
manchester airport
Manchester Metropolitan University
Harper Adams University
Transport for Greater Manchester
Innovate UK
Heathrow Making every journey better
Manchester City Council
Stockport Metropolitan Borough Council

Further information from: pod@westfieldavs.com
Project website: http://synergy-cav.com/

AIR·CAR

Powered by Tantalum

Estimating real-time NOx emissions from engine data

£1.1M Grant to **Tantalum**

£2.2M Project

£300k Grant to **ICL**

The environmental effects of road transportation has become of increasing concern, fuelled by a greater understanding of the health impacts and recent vehicle emissions scandals. Drivers, businesses and city authorities want to improve air quality.

Air.Car will enable them to measure and therefore manage and mitigate their transport emissions and advise cleaner routing and journeys.

Timeline

Project Starts
July 2017

Vehicle Testing
July 2017 to Sept 2018

Installation of Trial Devices
December 2017 - April 2018

Alpha NOx Algorithm Developed
March 2018

NOx Algorithm and Emissions Models Refined and Verified
March - December 2018

Project Innovations

Challenge to understand different OEM emissions reduction strategies

Objective to develop real-time emissions estimation from engine data

Success is the development of services to measure, manage and mitigate vehicle emissions and exposure to poor air quality

Success is new traffic emissions models

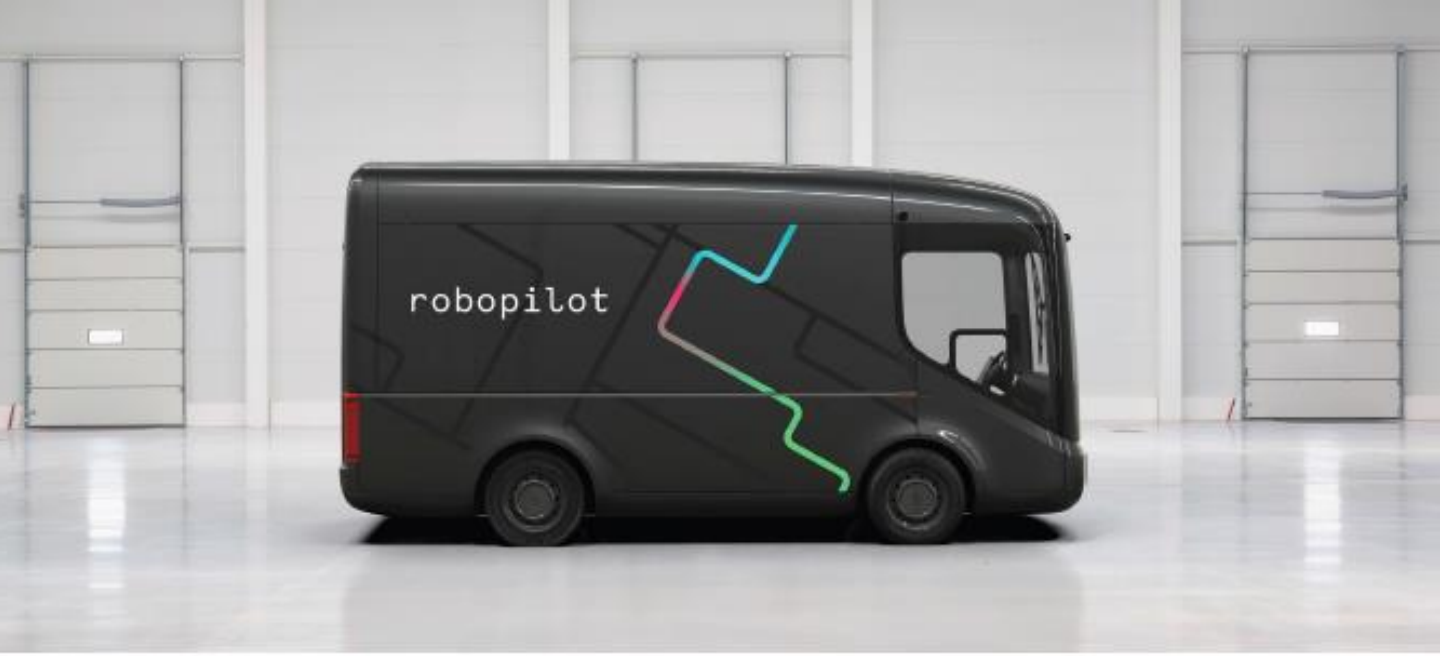
Partners

Imperial College London

Centre for Connected & Autonomous Vehicles

Innovate UK

Contact: air.car@tantalumcorporation.com **Or visit:** www.tantalumcorporation.com



robopilot

Executive Summary

The ROBOPILOT platform will develop & demonstrate autonomous driving functionality for ARRIVAL's Truck. It brings advanced technology developed by ARRIVAL as technical partner for the Roborace autonomous race series to the traditionally conservative commercial market.

Objectives

- Demonstrate 10 miles of autonomous driving at SAE Level 4 on mixed roads in ARRIVAL's Truck
- Demonstrate zero occupancy capability that can be applied in controlled non-road environments
- Apply a robust verification and validation process and tool set to the autonomous functionality
- Integrate security by design and conduct a rigorous assessment to demonstrate robustness
- Improve market knowledge and public perception of autonomous driving systems.

Contact

Project Lead

Nick Clay
Clay@arrival.com

PR

Dan Hauck
dan@arrival.com

Project Innovation

ROBOPILOT will use the considerable expertise of the project partners to develop and deliver a full assessment of vehicle safety, cyber security evaluation and hardening, and an innovative approach to verification and validation of the autonomous decision-making algorithms. Demonstration of SAE Level 4 autonomy will be over a 10-mile route on mixed public roads in South Gloucestershire, and of driverless parking/manoeuvring in UPS depots.

Challenges

- Navigating complex traffic scenarios
- Adapting to adverse weather conditions
- V2X connectivity and network availability

Timeline

Sep '18
Autonomous Function Phase 1 Demo - CMS, 360 view

Oct '18
Autonomous Function Phase 2 Demo - LDW

May '19
Autonomous Function Phase 3 Demo - Autopark, AEBS

Nov '19
Autonomous Function Phase 4 Demo - ACC, Lane Change, TSA

Feb '20
Autonomous Function FINAL EVENT - Zero Occupancy depot movements and 10 miles mixed roads driving

ARRIVAL Ltd | Registered in England & Wales | Company number: 09475811
Registered office: 2 Banbury Cross, Southam Road, Banbury Oxon OX16 2DJ

SWARM

Self-organising Wide area Autonomous vehicle Real time Marshalling

SWARM is delivered within 24 months with a budget of £1,986,677

Grant of £976,301 to RDM

Grant of £550,038 to WMG

Grant of £41,902 to MKC

The project enables the development of a novel, machine based, vehicle supervision system that significantly increases the safety and integrity of a fleet of autonomous vehicles
The project demonstrates the supervision technology applied to a fleet of autonomous PODs, in Milton Keynes.

Work Package Task	Owner	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
WP1: Project Management	RDM/WMG								
WP2: Human Factors for Social Pods	WMG								
2.1: User requirements for SWARM algorithm	WMG								
2.2: HMI evaluation (interior and Exterior)	WMG								
2.3: Best practice for control rooms	WMG/RDM								
2.4: Hidden needs analysis	WMG								
WP3: SWARM Algorithm development	WMG								
3.1: Initial development	WMG								
3.2: Code development phase 1 (Optimised)	WMG								
3.3: Code development phase 2 (Refined)	WMG								
3.4: Future scenarios, low costing and security	WMG								
WP4: Low cost communications development	RDM/WMG								
4.1: Develop optical wireless (OW) transmitter	WMG/RDM								
4.2: Integrate OW into Pod	RDM/WMG								
4.3: Initiating mesh networking of the OW link	RDM								
4.4: Cyber security analysis	WMG								

- Demonstrate a safe, affordable, reliable and efficient Pod service in Milton Keynes
- Address the issues of Tele-supervision and infrastructure
- Measure the impact of adding a fleet of Pod vehicles to a Shared Space
- Provide a reference framework on which to build a CAV fleet management standard

RDM GROUP

WMG
THE UNIVERSITY OF WARWICK

milton keynes council

Contact: sbrewerton@rdmgroup.co.uk

SAVVY

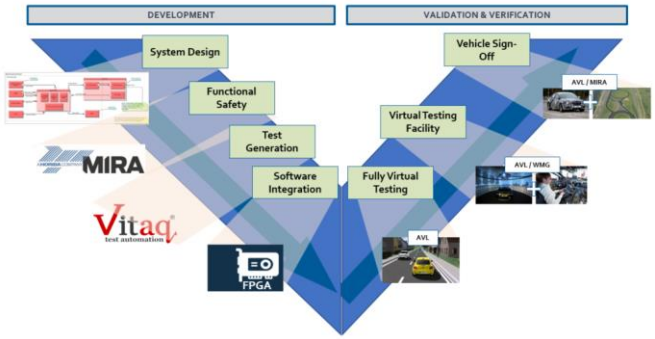
Smart ADAS Verification and Validation Methodology

Project Value:

£1,918,443

InnovateUK Funding:

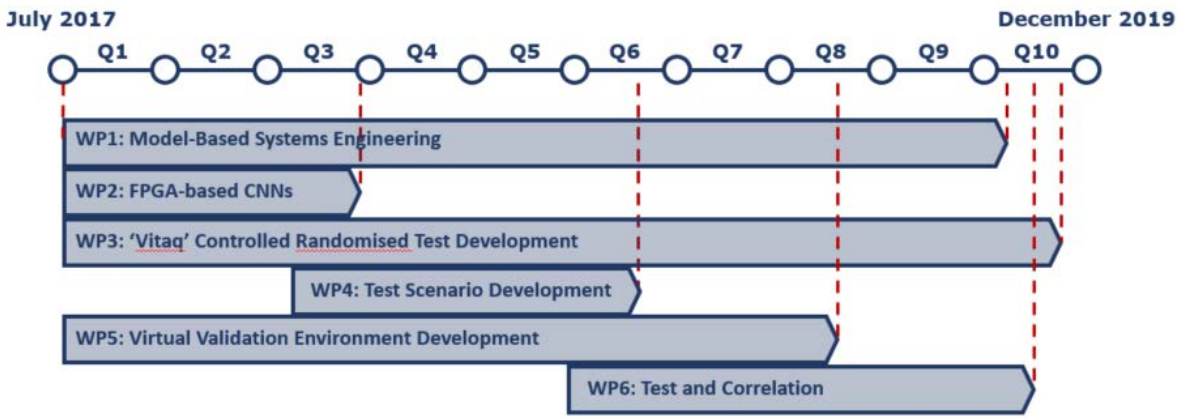
£1,222,721



Executive summary:

The need for more advanced processes and development methodologies to support the verification and validation of highly autonomous vehicles is well known. This project brings together work from previous Innovate-funded feasibility projects to demonstrate the development of ADAS control systems employing Convolutional Neural Networks (CNNs), including their validation in virtual environments. Within this project:

- the feature requirements will be developed using a robust, traceable SysML-based systems engineering approach,
- developing the safety process for more autonomous vehicles including Safety Of The Intended Function (SOTIF),
- including the deployment of CNNs on a Field-Programmable Gate Array (FPGA),
- with test plans supported through the development and use of controlled randomised test software,
- to be finally implemented in a vehicle tested in a controlled, virtual environment.



Project Innovations

Specific innovations include:

- Automated execution of virtual testing
- Controlled, randomised test tools
- Automated deployment of CNNs to FPGAs
- Extension of the safety standards for CAVs
- State-of-the-art virtual test facilities

List of partners

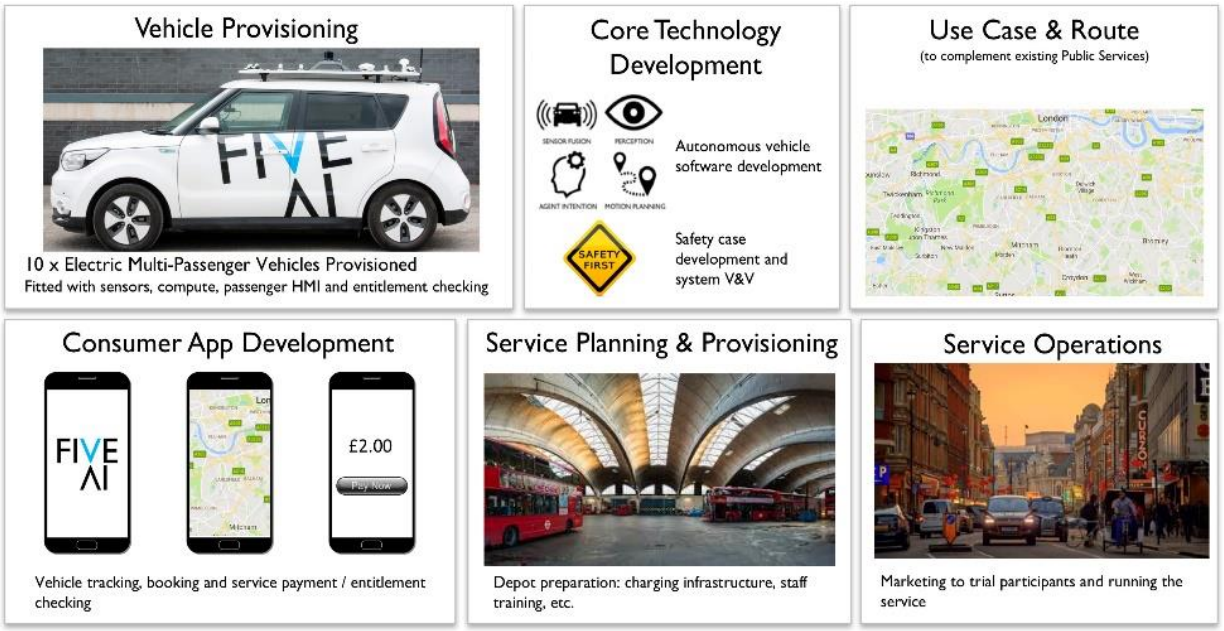
AVL, WMG THE UNIVERSITY OF WARWICK, Vertizan, Myrtle, MIRA

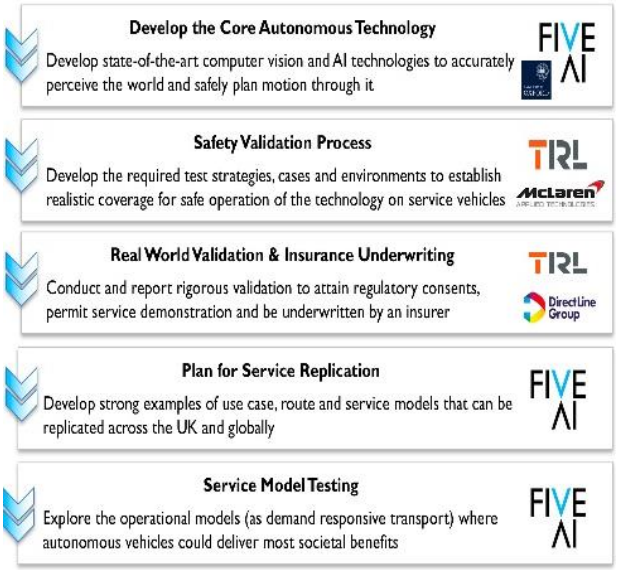
Stuart Rowell, AVL stuart.rowell@avl.com

STREETWISE

Total Grant: £12.776M

StreetWise aims to develop and demonstrate the technology, safety validation methods, insurance and service models for delivering an autonomous personal mobility solution targeted at replacing the urban commuter car. The project will show that the technology is now sufficiently mature to be safe in urban environments, sufficiently intelligent to co-exist with human drivers, road users and pedestrians and will demonstrate how we can use this technology to build compelling service offers to recover commuting time, reduce commuting costs, cut accident rates, reduce congestion and cut emissions.





The StreetWise project will be delivered by a consortium led by FiveAI - a company specialising in perception and artificial intelligence technologies - working in collaboration with the Torr Vision Group at the University of Oxford, Britain's leading personal motor insurer, Direct Line Group, the Transport Research Laboratory, McLaren Applied Technologies and Transport for London.

Contact: luis.barreto@five.ai

5G mmWave Connectivity to Cars

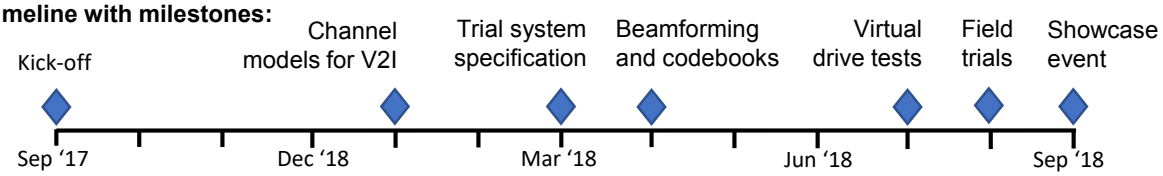
Millimetre-wave communications for motorway-speed V2I

Total grant amount: £195,873

Objectives:
Model the channel between the Road Side Unit (RSU) and vehicle in a motorway scenario
Demonstrate reliable data delivery at gigabits per second speed to a vehicle

Executive summary:
This technical feasibility study considers evaluating and enhancing the performance of 5G millimetre-wave (mmWave) communications for Vehicle to Infrastructure (V2I) applications. Use of mmWave is explored for high data rate delivery in a motorway-speed scenario, establishing feasibility of the technology for mobility applications. Using Road Side Units (RSUs) spaced regularly along the road, data rates in the order of gigabits per second are anticipated. To overcome the high path loss at mmWave frequencies, adaptive beamforming will be used to focus signals to and from the vehicle. The project will perform real world radio channel measurements leading to data trials using a suitable demonstration system.

Timeline with milestones:



Contact point:
Tom Mizutani, Jaguar Land Rover
tmizutan@jaguarlandrover.com

Advancing UK Autonomous Vehicle Radar Sensing Technology

Navtech Radar will work with Oxford Robotics Institute (ORI) to develop an all-weather sensor to provide adequate situational awareness for significantly improving capabilities and safety of autonomous driving pods.

Total grant funding: £95,302 / £50,508

Objectives: To access the feasibility of an all-weather sensor that can provide an adequate level of spatial discrimination for ORI's perception algorithms. Navtech Radar will design and build a demonstration prototype radar, whilst ORI develop integration and navigation code based on the radar data. Data collection and testing will then be carried out in collaboration between partners, resulting in a feasibility report

Executive summary
Recent trials by ORI found autonomous pods were effectively blind at junctions and could not see obstacles or pedestrians around corners or in poor weather. Navtech Radar will therefore work with ORI to develop a radar sensor that will provide the required data. Navtech will work to develop a radar based mostly on existing technology adapted for an automotive demonstrator for the environmental perception application. ORI will develop the automation control and perception algorithms and then the two partners will then work together to test the demonstration prototype, analysing the data and developing code to test the suitability of the sensor.

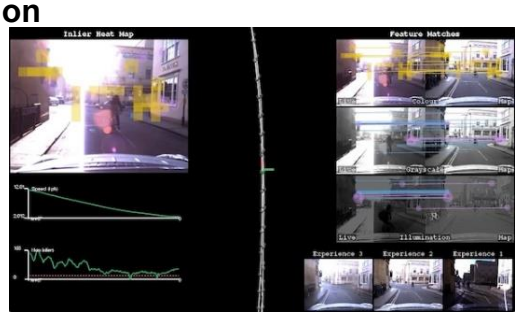
Timeline
August 2017 – Project Launch
September 2017 – Specification development complete
March 2018 – Full software test using simulated scenarios
June 2018 – Deliver radar prototype to ORI
September 2018 – Final feasibility report

Project Lead: Lizzie Turner
Email:
elizabeth.Turner@navtechradar.com
Website: www.navtechradar.com

Anytime, Anywhere Low Cost Localisation

Down-costing Oxbotica's localisation system, Dub4, to enable future mass market adoption

Total grant amount: £159,592



Objectives:

Autonomous vehicles require precise and continuous localisation in different surroundings, terrain, weather and at all times of the day. This project is about performing vast-scale, vision-only localisation using Oxbotica's Dub4 software, on low-cost hardware.

Executive summary

Oxbotica's algorithms will be tuned for operation on a low-cost hardware platform with no loss in performance.

Timeline with milestones/deliverables

- Hardware installed in host vehicle
- Initial system evaluation completed successfully
- Camera Rig specification confirmed
- Software optimisation complete and specification for compute confirmed
- Platform integration complete and localisation performance confirmed
- Successful demonstration of Dub4 performance for AV localisation and vehicle tracking
- Final Report determining Technology and Commercial Road Map Complete

Caterina Linegar, Project Manager,
Oxbotica
www.oxbotica.ai

Cambridge Autonomous Bus Service Feasibility Study

Investigating autonomous buses for Cambridge

Total funding £249,701

Total grant £190,745

The Cambridge Autonomous Bus System Feasibility Study will examine the opportunity to use new electric, autonomous mini-buses to provide much needed transport links between Cambridge's science campuses, park & ride locations and rail stations. These vehicles and special paths could provide a significant improvement in traffic congestion, improve air quality, and solve serious work commute difficulties for residents in the Cambridge region.

Timeline with milestones/deliverables

The shuttle design will complete by October 2017, the associated control system requirements by April 2018 and the design of the pathways, options and recommendations for further work by May 2018.

Project Innovations

The objective of the project is to scope out a vehicle to run on both the guided busway between Trumpington Park and Ride site and Cambridge Central Station and a second route from Whittlesford Parkway station and

Aside from the expected engineering challenges, objectives involve integration of the self-driving pods within the existing Cambridgeshire transport ecosystem allowing passengers to seamlessly move from other transport modes to the pod.

Project website www.aurrigo.com/cabsfs

CASS-DV: Connected Autonomous Sensing Service Delivery Vehicle

Using data derived from autonomous vehicles to complete asset inspections19

Total funding amount
£245,840

Objectives: To understand the value of LiDAR in completing road asset inspections.

Executive summary

CASS-DV explores how AVs can be used to complete service tasks for companies like Amey. The initial proposal highlighted a number of key areas including waste collection and street cleansing, however, following detailed benefit analysis, road asset inspection was selected as the focus area, centring on road quality and street furniture locations. Working closely with Yotta to create a baseline of how current inspections are completed, CASS-DV compares LiDAR data derived from the vehicle to data gathered from current inspection processes to understand whether this data can aid asset inspectors in completing their road management tasks more efficiently.

Timeline with milestones/deliverables

Use Case Definitions	Sensing & Analytics Requirements Defined	Vehicle Requirements Defined	Test Vehicle Build Complete	Trial of Test Vehicle Complete	Final Report
Aug 2017	Nov 2017	Dec 2017	Feb 2018	Jun 2018	Jul 2018

Contact point and weblink
David Trousdale
(david.trousdale@amey.co.uk)
Garry Staunton (garry.staunton@ukaea.uk)
http://www.race.ukaea.uk/projects/cass-dv/

List of partners

amey RACE

NiVMS

Non Intrusive Vehicle Monitoring System

Total funding amount £ 244,671

Total grant amount £ 161,605

Objectives: This 18 month feasibility study seeks to establish the technical and commercial potential of harnessing GIS processing and machine learning to provide predictive maintenance, improved diagnostics and location based intelligence.

Executive summary

The NiVMS feasibility study is a collaboration between the automotive technology start-up AutoTrip whose existing product range includes automated business mileage reclaim services and UK's first fully electric vehicle car club, E-Car Club (a EuropCar Company). From exposure to inefficiencies in the rental sector (~1.6m UK cars), and also to the efficiencies software solutions can unlock, AutoTrip has designed a proprietary solution combining a number of in-car sensors, cloud computing and machine learning algorithms with the intention of offering fleet operators across the rental, leasing and hire segments improved data on vehicle condition from which a number of business benefits are anticipated.

Timeline with milestones/deliverables

Data collection and parsing – Nov 2017 • System Architecture – Feb 2018 • Prototype algorithm developed – May 2018 • Operating statistics obtained – July 2018 • Impact analysis – Aug 2018 • Refined technology roadmap – Sept 2018 • Business Plan developed – Oct 2018

Contact point and weblink

www.autotrip.co.uk
anil.nair@autotrip.co.uk
james@autotrip.co.uk

List of partners

autotrip ecar A Europcar Company

Project Alloyed

Seamless. Intelligent. Fast. Safe. Independent. Exciting

Total funding amount/ total grant amount –

Objectives: Project Alloyed aims to conduct a feasibility study covering the technical and commercial viability of building a platform that (1) Provides a network-agnostic 'platform' that enables seamless V2X communications ready for existing and future access technologies (2) integrates with existing and emerging in-car systems addressing mechatronics, HMI, entertainment & Information (3) Enables 'open' or 'closed' access to applications and service providers for multiple use-cases.

Executive summary

Project Alloyed will study and build technologies for vehicles of the future that will enable uninterrupted access to networks regardless of where you are, provide valuable data from within your car and it's immediate surroundings and allow you to enjoy your favourite Apps and new services

Timeline with milestones/deliverables

1. Kick-off meeting, august 2017. 2. Technology Use-Case Development 3. System Requirements specifications 4. System Architecture 4. Proof of Concept Demonstrator 5. Business Planning & Go To Market 6. Fund Raising

CONSORTIUM MEMBERS

epitomical · ch2m · VIVACITY · UNIVERSITY OF SURREY · Coventry University · SIEMENS · AXXELTROVA · SHERIDANS · HONDA · TRL THE FUTURE OF TRANSPORT

https://alloyed.epitomical.com Danish Alam – dalam@epitomical.com, Krishnan Prageeth – praggeth@epitomical.com

Quantum-based Secure Communication for CAVS

Investigating quantum technology to stop hackers hijacking CAVs

Total funding amount/ total grant amount: £137,650/ £113,913

Objectives: This study aims to test the technical and commercial feasibility of applying quantum technology to CAVs.

Timeline with milestones/deliverables

12 month program to assess feasibility of QRNG-ECU:

- QRNG-ECU prototype – wk. 26
- Report on vehicle specification requirements – wk. 31
- Market assessment report – wk. 31
- QRNG-ECU test & assessment report – wk. 51

Executive summary

The Systems Security Group at Coventry University's Institute for Future Transport and Cities (FTC) and cybersecurity start-up Crypta Labs, aims to improve CAV security and consequently the safety of their drivers and passengers. The weakest link in current encryption systems is a reliance on numbers which are not truly random and which can put the vehicles at risk of being hacked. Crypta Labs has developed a Quantum Random Number Generator (QRNG) based on the randomness derived from the quantum properties of light. This project will assess the technical and commercial feasibility of applying Crypta Labs' system to connected and autonomous vehicles ahead of the company rolling out and commercialising its technology internationally.

List of partners

Crypta Labs

Research Institute Future Transport and Cities | Coventry University

Contact Point and Weblink
Prof. Siraj Ahmed Shaikh, Coventry University
s.shaikh@coventry.ac.uk / 07939 233 995

Joe Luong, CEO, Crypta Labs
joe@Cryptalabs.com / 02036000072

RECAP
Requirement Evaluation of CAV Location Performance and Platform Development

Total funding amount/
total grant amount

£197.4 k Grant

Location and sensing form two important components of CAV. Current sensing techniques have limitations when driving environments become "featureless" under bad weather conditions. The mass-market location techniques such as GNSS using code measurements and its integration with INS are unable to guarantee the required CAV location performance. RECAPD will focus on defining relevant parameters and R&D of an innovative location platform through identification of real-world location issues on a mix of UK roads.

Objectives:
The overall objective is to speed CAV deployment through Proof of Concept (PoC) of technical solutions that address essential real-world location issues to improve CAV autonomy and connectivity.

Milestones:
- Definition of required CAV location performance parameters
- Determination of the sensor system and sensor integration
- Develop processing modules and "smart" switch algorithms
- Field testing and RECAPD platform verification

Project Challenges
The main challenges that we predict are around how to design a cost effective REDCAPD location platform integrating different sensors for auto manufacturers and how to develop the innovative algorithms to be able to switch to a most appropriate positioning module according to different driving environments.
4 main CAV driving scenarios that will be classified in RECAPD project, and RECAPD is expected to use low-cost single frequency carrier phase GNSS receivers combined with NRTK, INS RFID DSRC technologies to provide ubiquitous positioning solutions.

List of partners

UBIPOS UK LTD.

The University of Nottingham
UNITED KINGDOM · CHINA · MALAYSIA

Project lead: Jun Ye, UbiPOS UK LTD –
jun.ye@ubipos.co.uk

S-CAN Project

Hardware-based Secure CAN

Total funding amount/ total grant amount:
£249,683

Objectives: The S-CAN project aims to establish a hardware-secure in-vehicle communications protocol over the industry-standard Controller Area Network (CAN).

S-CAN PROJECT

Executive summary
As cars are equipped with ever greater numbers of electronic units, they face a growing threat of cyber attacks which, if the communication between components in the vehicle is targeted, could have potentially catastrophic consequences.
To protect against such threats, the S-CAN project is a Feasibility Study that aims to establish a hardware-secure in-vehicle communications protocol over the industry-standard Controller Area Network (CAN).

Timeline with milestones/deliverables
September 2017- Project start
February 2018 - Evaluation of designs complete
June 2018 – Build of test environment complete
September 2018 –Project completion

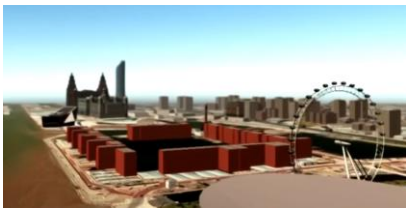
List of partners

CyNation SECURING A CONNECTED WORLD
Vventures

Contact point and weblink
Shadi A. Razak
shadi.Razak@cynation.com
https://www.cynation.com/industries/automotive/

COSMO

Using machine learning and AI to explore systems for costing and managing mobility as a service



Funding: £222,800

Objective:COSMO allows autonomous cars in a city to choose and change routes based on factors such as potential journey time, pollution and congestion.

Executive Summary

COSMO uses autonomous car technology to calculate the real cost of driving: its impact on the environment, pedestrians and commuters. Each road has a live price attached to it (its 'bid' price), which can change throughout the day, such as during the school run. A pollution tax would also be applied, which varies between cars and increases towards a city centre. Car users are incentivised to opt for routes that minimise the time, pollution and cost of a journey, by opting into a credit/bidding system. COSMO updates its road simulations and information (costings, accidents, peak traffic flow or events) in real time, which allows users to update their routes accordingly and realistically.

Timeline with milestones/deliverables

Route choice factors selected → Bidding system that vehicles use to make a route decision → Finalisation of bidding system → Ability to spawn sets of cars and dynamically add events → Ability to save and compare simulation with others

Contact point and weblink
Phone: 01517095443
Website: http://www.cgasimulation.com/
Twitter: @CGAsimulation

List of partners

UNIVERSITY OF LIVERPOOL CGA SIMULATION

Vote3Deep

Transferring technology from lab to vehicle for high performance, real-time object detection

Transferring a deep-learning research solution,Vote3Deep, from server-grade to portable systems ready for integration in connected and autonomous vehicles
Total grant amount

£196,598

Objectives: To achieve a commercially viable solution, software must be able to run in real-time with extremely high accuracy, on low cost hardware. The translation of this research solution into a commercially viable product will be enabled through a detailed test programme at RACE (UKAEA), Culham where it will be trialled extensively both statically by RACE, and in-car in a secure environment by Oxbotica.

Executive summary

This project intends to assess the feasibility of transferring a deep-learning research solution,Vote3Deep, from server-grade to portable systems ready for integration in connected and autonomous vehicles.
To enable autonomy, we need fast and accurate detection of objects.

Timeline with milestones/deliverables

- Vote3Deep concept proven on portable system
- Successfully integrated with tracking system
- Vote3Deep prototype proven on portable system
- Meets performance targets in validation scenario
- Development pathway defined

OXBOTICA

RACE

Caterina Linegar, Project Manager,
Oxbotica
www.oxbotica.ai

Connected & Autonomous Vehicles 3 (CAV3)

CAV3 was launched in July 2017. These projects focus on business opportunities or real customer problems, with a clear commercial benefit. The aim is to support concepts that will become future core technologies in 2020 to 2025.

Again, both collaborative research and development projects and feasibility study projects were welcomed.

The scope of this competition required the projects to:

- focus on on-highway vehicles or PODs (L, M or N category vehicles), or off-highway vehicles
- support the development of solutions for SAE level 4 automation and above, if focused on delivering autonomy (either directly or supporting autonomy through connectivity)
- include a final report and a dissemination plan
- show a clear route to market.

SHIFT

A radical mode SHIFT away from cars to an Integrated Autonomous Mobility Service

Total funding amount/ total grant amount –

£3.9m

Pioneering a fully integrated approach to Autonomous mobility services across the business model/service/operational/vehicle layers to find a cost effective functional solution that benefits both cities and its people.

Timeline with milestones/deliverables
Project Start – April 2018
Trial vehicle commissioning complete - February 2019
Trial starts – March 2019
Trial Complete - September 2019

Project Innovations

1. Small road efficient CACV's, NOT conventional OEM vehicles

2. Autonomous Mobility Service integrated with public transport reducing VMT/cars on the road

3. Active data sharing with TfL, improving experience for individuals and the city.

aiPod

OXBOTICA

Imperial College London

Contact point and weblink
Kate Jack
Aipod.com

AID-CAV

Advanced Integrated Dynamics for Connected and Autonomous Vehicles

Project cost;

£4,393,360

Grant;

£3,147,718

AID-CAV will develop vehicle dynamics control technologies and techniques specifically for autonomous vehicles. These include a novel control framework and algorithms (to ISO26262) as well as steering and braking systems that will operate “by wire”. These will enable future customers to build and test a wide range of autonomous vehicles – from light quadricycles via passenger cars to small commercial vehicles – quickly, inexpensively and safely.

June 2018 – Background research complete
September 2018 – Concept systems fitted to mule vehicle
October 2019 – Prototype systems built & bench tested
February 2020 – Prototype systems fitted to mule vehicle
April 2020 – Mule vehicle commissioned, tested and demonstrated

The technologies being developed in AID-CAV (hardware, software and “expert driver” control algorithms) are innovative in themselves, but integrating them with a holistic view gives the opportunity for additional benefits. These benefits include improved speed of response, increased vehicle dynamic capability and inherent redundancy in case of damage or failure.

Project partners:

- Delta Motorsport
- Alcon Components
- Titan Motorsport & Automotive
- Potenza Technology
- Cranfield University
- University of Warwick

Nick Carpenter, Delta Motorsport; nick@delta-motorsport.com

ALEAD - Artificial Learning Environments for Autonomous Driving

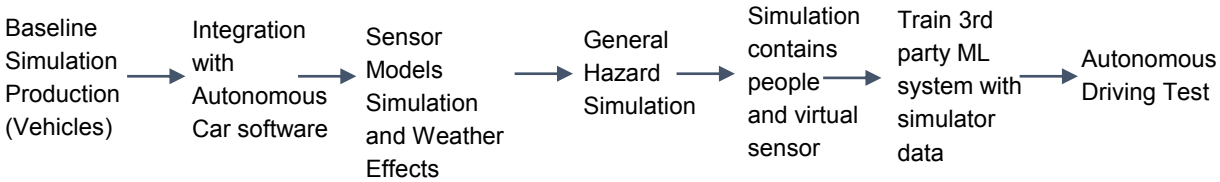
ALEAD is a digital environment that provides Autonomous Vehicles a virtual space to learn in and so saves money and time for the companies developing those systems.

Total funding
£998,000

Total grant £746,000

CGA Simulation worked with University of Liverpool (UoL) to create a simulated driving environment for testing and teaching autonomous vehicles. Based around industry standard software components, including Unity 3D graphics engine, it will interface with Baidu Apollo open driving solution and the Robot Operating System (ROS). CGA Simulation and UoL believe good simulation environments can, to a large extent, replace the need for live trials in initial product development/ testing. Using parallel simulation/training environments, it's possible to train systems at a rate millions of times faster than running live trials, whilst training for extreme events (rare but significant risks and stress tests for autonomous vehicles.) By project end, CGA will have produced a testing environment that encompasses sensors, vehicle modelling, and an example autonomous driving system.

Timeline with milestones/deliverables



Phone: 01517095443
Website: http://www.cgasimulation.com/
Twitter: @CGAsimulation

UNIVERSITY OF LIVERPOOL

FUTURE CODERS

CGA SIMULATION

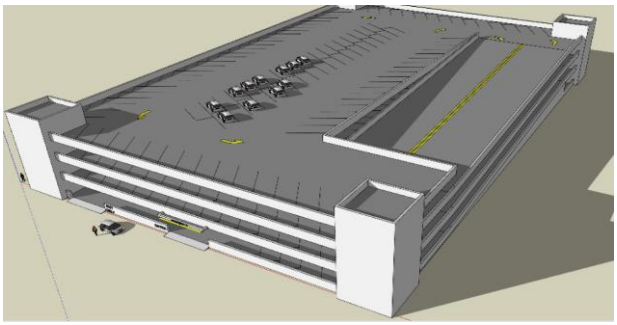
Autonomous Valet Parking

Developing a scalable low cost solution

As autonomous vehicles start to become a reality, one of the unanswered questions remains - where and how will those cars park?

With this £1.2M project Parkopedia is looking to deliver a proof-of-concept self-parking vehicle that will fulfil the valet function by navigating the vehicle to an open parking space, executing the parking manoeuvre automatically with no human involvement and responding to a summon request by navigating the vehicle back to the driver in the drop-off zone.

To enable this AVP demonstration, Parkopedia is partnering with Transport Systems Catapult to develop a safety case and understand the impact of autonomous valet parking, and the University of Surrey to research the mapping and localisation requirements for the maps and navigation software that will power these autonomous vehicles.



Primary objective:
Create high definition parking maps
for navigation and localisation.
Secondary objective:
Demonstrate AVP capability in a multi-storey car park.

Milestones:
Oct 2018 - Data Capture
Jan 2019 - Car Park Ready
Jun 2019 - Nav. Complete
Jan 2020 - Dev. Complete
Mid 2020 - Demonstrations

Parkopedia
Helping You Park

CATAPULT
Transport Systems

UNIVERSITY OF SURREY

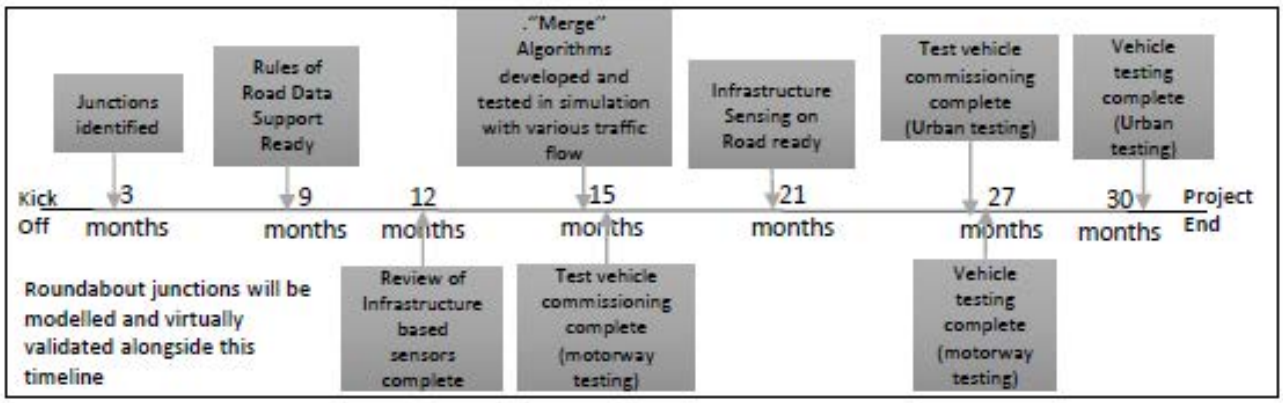
Contact: Brian Holt brian@parkopedia.com

AutopleX

Autonomous Cars Negotiating Complex Environments using V2X

Total Funding	£4.67m
Total Grant	£2.54m
Partner Funding	£2.13m

AutopleX is a project which enhances the autonomous car's vision and perception, allowing more efficient and effective traffic merging at difficult lane merge and roundabout junctions.
The project investigates combining vehicle external sensor information with map aligned infrastructure based sensing (sensing ALL road users) which can transmit in real time with detailed rules of the road conveyed using standard IOT methods.
Cyber security and data transmission will be considered and the use cases and possible road infra structure roll out recommendations will be made if value is proven.
The project will receive £2.54M total grant.



Project Innovations

- Detection equipment to detect ALL road users FUSED with ITS-G5 RSU low latency messaging
- Rules of road aligned to road authority (lane closures, restrictions, dynamic road position)
- In vehicle fusing time aligned data from 3 diverse data sources
- Merging algorithms modelled and verified using new tools and traffic simulations
- Standards associated with data transmission for infra structure based sensing and rules of road

Consortium Partners

JAGUAR, LAND ROVER, SIEMENS, INRIX, RICARDO, highways england, WMG THE UNIVERSITY OF WARWICK, TfWM, WEST MIDLANDS COMBINED AUTHORITY

Project Lead: Damian Ward, dward27@jaguarlandrover.com, www.jaguarlandrover.com

CORE SENSE

COgnitive REal time SENsing SystEm for autonomous vehicles

Total funding amount: £2,610,134

Total Project costs: £3,658,706

Executive summary:

To enable autonomy the sensing system should outperform the human driver in all situations by such parameters as speed of information processing, speed of safe path planning and reaction time, without the drawbacks of human behaviour such as tiredness, distraction, and physical limitations the environment. The project addresses a vital, yet not currently solved in the UK or worldwide. This project aims to develops a robust and reliable sensing system based on a sensor combination able to cope with **all weather or situation the vehicle meets**. Radar is relatively unaffected by dirt, rain, ice, snow, fog but its output is difficult to interpret to identify an object it is seeing.
This project aims to develop new techniques to extract, fuse and interpret sensor data in real-time in order to provide situational awareness with novel cognitive processing developed within the project.

Timeline with milestones/deliverables

Project duration 30 months:

-Optimization of DNN algorithms and embedded silicon design, interacting
-Optimizing, scheduling of existing JLR algorithms
-Assessment of OTS sensors to deliver adaptability of waveforms. Investigation of capabilities for adaptive radar waveforms using existing polarimetric multi-static 79 GHzlaboratory prototype.
-Data fusion, interacting with UoB, Myrtle and JLR.
-Vehicle control data to optimise path/route All collaborators are involved in.
-Demonstration, where JLR plays leading role.

Project Innovations

This proposal addresses the critical task of providing **novel sensing technology**, robust **in all weather and all-road conditions**, to deliver L4 and above autonomy. This will be achieved by introducing for the first time an integrated cognitive radar and video sensor able to handle large volumes of processing in real time.
Data will be presented in **a new 5D format** (range, angle, height, velocity, micro-Doppler) to enable fusing radar and video data in a common space not previously available in automotive radars, but vital to L4/L5 autonomy.

Lead organisation
Jaguar Land Rover Limited

Partners
University of Birmingham
Myrtle AI

Contact point and weblink: https://www.jaguarlandrover.com
https://www.birmingham.ac.uk https://www.myrtle.ai Project No: 104268

MultiCAV

Creating new travel solutions for Didcot

MultiCAV is a 30-month trial of passenger-carrying autonomous vehicles within Milton Park business park and on public highways in Didcot, providing links to local public transport at Didcot Parkway station. Funded by Innovate UK and commercial partners, the £3.9 million project will aim to develop the UK's first multi-modal Mobility-as-a-Service (MaaS) system with an integrated range of Level 4 and 5 autonomous electric vehicles.

Using real-world transport data, the project will assess user behaviour and commercial viability in order to determine a sustainable CAV-based multi-modal mobility solution for Milton Park and to realise the full potential of Didcot Garden Town. By establishing low cost transport alternatives scalable for the wider town, the project aims to improve quality of life, promoting easier shared mobility and greater social inclusion in a highly populated, growing area.

Objectives:

- Deliver the first mobility service using Level 4-5 autonomous vehicles on UK public highways in mixed traffic, integrated on one MaaS platform
- Develop a truly multi-modal MaaS platform which enables optimisation of the autonomous transport system in real time and provides personalised transport choices for individual users to improve their journeys
- Establish the operating standards for such services in the UK and worldwide, including systems and safety procedures
- Determine the optimum CAV-based transport solution for the region

Challenges:

- Reliance on data from other services within the transport network: corrupt data or failure to provide may occur
- Ensuring public safety when operating autonomous vehicles, including public highway operation as well as monitoring currently unknown public reaction to and perception of self-driving vehicles
- Supply and delivery within schedule of autonomous vehicles and MaaS platform
- Obtaining legal consent and regulatory approval to operate autonomous vehicles on public highways

Project milestones:

- Spring 2018: Project launch
- Summer 2018: Autonomous vehicles operating in mixed traffic
- Spring 2019: Autonomous vehicles operating on public highways subject to regulatory consents
- Autumn 2020: Project completion

Project lead:
John Birtwistle, First Group
John.Birtwistle@firstgroup.com
www.multicav.co.uk

Consortium members

RoadLoc

A development & test framework for ground-truth vehicle localisation

£767,504 collaborative R&D project with funding support of £547,872.

Building on success from previous CAV1 “PinPoint” project.

Where am I (really)? Developers of CAVs and associated technologies, and those validating future operational safety, need to objectively measure on-road performance at both a system-wide and per-component level.

This project sets out an innovative framework - consisting of a hardware sensor and analytics software - that can be used to measure the localisation of the vehicle between where it **thinks** it is, compared to where it **actually** is on the road. In order to:

- provide independent evaluation of on-board CAV vehicle localisation systems
- enable system-wide and per-component performance vs. cost optimization
- improve the accuracy of any secondary environment mapping functionality

July ‘18 Jumpstart → January’19 Refinement → July ‘19 Revision → January‘20 Evaluation

Project Innovations & Challenges

1. the further development of a robust physical sensor capable of operating accurately over a wider range of conditions, speeds and distance.
2. the quantitive evaluation of state-of-the-art vehicle localisation approaches, using varying sensor modalities, under variable environmental conditions.
3. the integration, packaging and evaluation of the novel localization sensor framework onto an operational test vehicle such that it can positively contribute to a wider CAV development agenda.

Project Partners

machines with vision

Durham University

JAGUAR

LAND ROVER

info@machineswithvision.com - www.machineswithvision.com

SiDeCAA

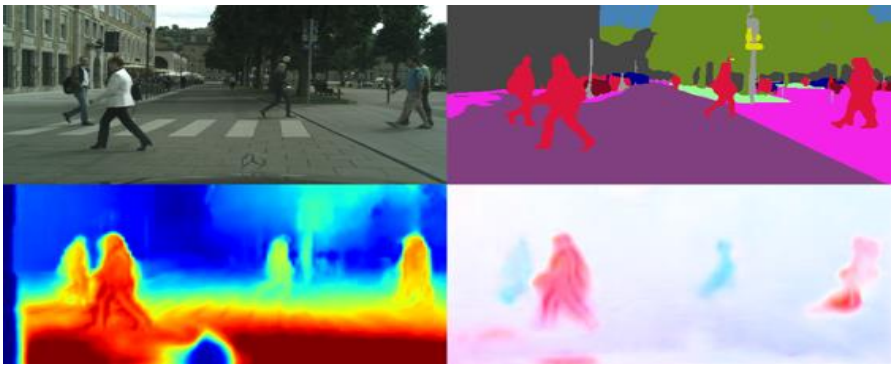
Silicon Designs for Core Autonomy Algorithms

Funding Amount:

£258,166

Project Cost:

£368, 808



Trained, deep learning algorithms, exhibit near human ability in analysing video image content vital for autonomous system behaviours.
However the current state-of-the-art only analyses single frames from a video stream, losing vital information. In a traffic environment of largely known fixed objects moving in mostly, well defined paths, this time based information is highly significant and should be processed to improve scene understanding and safety for autonomous vehicles.
Additionally, running such large AI networks on existing CPU or GPU processors does not meet the restricted power and performance criteria required by car makers.
Our collaboration with Wayve Technology will address all of these limitations and produce a new coherent image segmentation algorithm embedded in low power silicon for licensing in autonomous vehicles.

Project Duration 18 months:

- Design & train new coherent image segmentation algorithm
- Optimise and configure algorithm & pipeline for custom silicon implementation
- Publish statistics and performance characteristics
- Integrate ASIC libraries into pipeline and demonstrate ASIC capability
- Vehicle demonstrator and validation testing

This project will address the weakness in image segmentation algorithms, which allow cameras to ‘know’ what they are seeing, but lack awareness of earlier video frames. Our disruptive innovation will realize coherence in a new algorithm and implement this efficiently in silicon using new pipeline tools. We will extend our pipeline libraries to allow the creation of a new class of custom silicon (ASIC) designs. Myrtle's commercial focus is our compiler technology, taking trained AI networks and outputting efficient designs, automatically without using hardware engineers.

The outputs from our project would be papers at world renowned AI conferences, reproducible benchmark results quantifying the superiority of our approach and designs, clear demonstrators showing the excellence of UK engineering in CCAV markets and most importantly Level 4 silicon IP to license directly to OEMs.

Myrtle
www.myrtle.ai

www.myrtle.ai
brian tyler, brian@myrtlesoftware.com

WAYVE

Trumpington to Cambridge Autonomous Bus Service (T-CABS)

Developing the UK's first autonomous bus service

Total funding

£3,215,427

Total grant

£2,454,003

T-CABS is a 30 month project to develop the UK's first autonomous transport service. RDM group will develop a Level 5 autonomous 15 seater pod and demonstrate a real transport system for fare-paying passengers, offered during out-of-hours periods on the southern section of the Cambridge Guided Busway serving Trumpington Park and Ride, Cambridge Biomedical Campus and Cambridge Central Railway Station.

Providing a real transport service on today's highways, mixing autonomous vehicles with driven vehicles would be impossible in the near future. Because the busway is segregated from the highway, cyclists and pedestrians, this project will deliver real vehicles, transporting real passengers within 24 months.

Timeline with milestones/deliverables

Prototype shuttles will run on the busway from Easter 2019
The first passengers will be part of the trial phase from late summer 2019
The service will go live to members of the public from late spring 2020

Project Innovations
The objective of the project is to design and build a brand new 15 seat autonomous pod and run in autonomously on a pre-existing route.

Aside from the expected engineering challenges, objectives involve integration of the self-driving pods within the existing Cambridgeshire transport ecosystem allowing passengers to seamlessly move from other transport modes to the pod.

RDM Group, Coventry, UK

Smart Cambridge, delivered by Cambridgeshire County Council

Project website www.aurrigo.com/tcabs

5G Above the Cloud (AtC)
To deliver CAVs specific SA data with 100% coverage at 99.999% availability

Total funding amount/ total grant amount

250K GBP

Executive summary
The aim of this project is to test the technical feasibility of a system that will have the ability to maintain 5G Quality of Experience access to Situation Awareness data specifically tailored to CAVs.

It is vital to ensure that the resolution of data is appropriate to the environment as the demographics of a moving vehicle change particularly when outside of closed environments.

One year project starting second quarter 2018 19

Contact point and weblink

5GATC@gmx.com

List of partners
Intelcomm (UK) Ltd
University of Surrey
Robert Bosh Ltd
Modus Operandi Ltd

All-Weather, Long Range Obstacle Detection for Autonomous Vehicles
Investigating the feasibility of developing a radar-based system for autonomous vehicle sensing and perception

£174K / £249K

Objectives - investigate the feasibility of developing a radar-based system for autonomous vehicle (AV) sensing and perception, which will be robust and suitable for use in all weather and environmental conditions

Executive summary
The aim of this project is to investigate the feasibility of developing a radar-based system for autonomous vehicle (AV) sensing and perception, which will be robust and suitable for use in all weather and environmental conditions. In addition, a radar system will provide much longer-range detection than lidar or vision sensors, allowing the implementation of autonomy in large-scale applications, such as mining and agriculture, as well as enabling higher-speed autonomy

Timeline with milestones/deliverables
MST1 - Hardware installed in host vehicle, **MST2** - Initial System Evaluation completed successfully, **MST3** - Radar characterisation completed, **MST4** - Software optimisation complete and specification for compute confirmed, **MST5** - AV integration complete and obstacle detection performance confirmed, **MST6** - Successful demonstration of radar system performance for AV obstacle detection and tracking, **MST7** - Final Report determining technology and commercial road map complete, **MST8** - Project complete on time and budget

Contact:
info@oxbotica.com
Weblinks:
www.oxbotica.ai
www.navtechradar.com

List of partners

Certification of Autonomous Vehicles in Synthetic Environments

Towards a Certified Simulation Environment for CAV

Total funding amount/ total grant amount

£249k / £174k

Objectives

Ascertain feasibility of creating a certified simulation environment for CAV certification

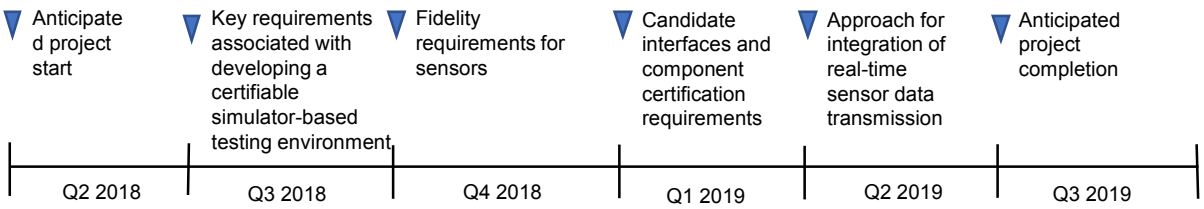
Executive summary

A key element supporting the introduction of Level 4/5 CAV will be the ability to independently certify that such systems are safe, reliable and secure.

Among the options for delivering certification is the use of synthetic environments. Conducting validation of vehicles in simulators enables the creation of an almost limitless number of testing scenarios that are flexible, repeatable and safe. Compared to real-world testing, simulated validation will enable vehicles to be tested rapidly and against a challenging set of conditions that would be difficult to replicate in real life.

This study will examine the pre-conditions required for creating such a testing environment, as well as considering the need for such a simulator to be independently certified as an appropriate means of evaluating the safety of CAV.

Timeline with milestones/deliverables



Timothy Coley – Product Specialist, XPI Simulation
timothy.coley@xpisimulation.com
www.xpisimulation.com

List of partners
XPI Simulation
Thales
Warwick University

CORAM

CONNECTED ON-ROAD AUTONOMOUS MOBILITY

CORAM will research how **'Look-Ahead'** and **'Non-Line-of Sight'** (NLOS) perception can be delivered to any Connected and Autonomous Vehicle (CAV) from infrastructure deployed sensors.

CORAM lead Propelmee, is an Autonomous Vehicle Technology company that is developing an Operating System to enable full autonomy for self-driving cars. CORAM brings together CAV expertise, state of the art CAV testing facilities and the CAV assets of two eminent partners; the Transport Systems Catapult and Cranfield University. CORAM will pave the way for infrastructure-based connectivity to enable safer on-road autonomy, culminating in a technology demonstration at Cranfield University's state-of-the-art (MUEAVI) research facility.

CORAM is a 13 month feasibility project running from 1st June 2018 to 31st June 2019.

CORAM will deliver a working prototype system demonstration at Cranfield University ground-breaking MUEAVI (Multi-User Environment for Autonomous Vehicle Innovation) test facility on Transport Systems Catapult autonomous test platform. The results will be captured in a report delivered at the end of the project.

For further information please contact Propelmee Founder & CEO Zain Khawaja at **zain@propelmee.com** or visit **www.propelmee.com**

Propelmee

Cranfield University

CATAPULT Transport Systems

Digital Connected Autonomous Vehicle (CAV) Proving Ground

Total funding amount / total grant amount

£ 244 632 / £ 174 971

Summary and project objectives: This project has the ambitious objective to establish the feasibility of building a CAV simulation platform that would enable plugging in external heterogeneous components such as electronic control units, autonomous driving modules, simulation software, sensor data and algorithms. Level 4 autonomy capability will be demonstrated through a hardware in the loop simulation solution emulating a real world scenario. Accelerated testing will be investigated by a novel modular approach that will use Big Data Analytics and causality analysis. A key feature of this platform is that it will be agnostic to the source of the component, that is have compatible functionality without forcing IP owners to disclose their protected methods and algorithms.

WP	Work package description	Start month	End month
WP1	Requirements definition	1	3
WP2	Architecture design	3	6
WP3	Interface design	4	7
WP4	Accelerated testing methods for CAVs	6	12
WP5	Proof-of-concept	9	12
WP6	Hardware in the loop demonstrations	13	17
WP7	Evaluation of accelerated testing	13	17

Point of contact:
Dr Pawel Jaworski pawel.jaworski@horiba-mira.com
https://www.horiba-mira.com/

Feasibility study on polar codes for 5G URLLC

Next generation error correction for ultra reliable low latency communication in connected and autonomous vehicles

Total funding amount/ total grant amount: £178,124

Objectives: Increase the error correction capability and reduce the processing latency of polar codes to meet the strict requirements of connected and autonomous vehicles.

Executive summary: One of the use cases of Fifth generation (5G) mobile communication is Ultra-Reliable Low-Latency Communication (URLLC), which will be a key enabler for Connected and Autonomous Vehicles (CAVs). These vehicles will be able to communicate with 10x better reliability and 10x better delay than ever before, allowing them to exchange life-saving messages, which can avert collisions. The ultra-high reliability of URLLC will be achieved using polar codes to provide error correction. However, polar codes are one the most computationally intensive processes in 5G mobile communications. Owing to this, vehicles will need to use dedicated hardware acceleration, so that polar coding can be completed quickly enough to support ultra-low communication delays. This project will conduct a feasibility study on the enhancement of the error correction capability and processing latency of hardware acceleration for polar codes.19

Timeline with milestones/deliverables:

Dr Taihai Chen, taihai.chen@accelercomm.com, AccelerComm Ltd.
Prof Rob Maunder, rm@ecs.soton.ac.uk, University of Southampton.
http://www.accelercomm.com

LAMBDA-V

Through better data processing and better devices, we can improve CAVS, networks & operations to build more business.

Total funding £244k

total grant £167K

Our objective is to understand the feasibility of processing existing massive datasets from vehicle fleets to model a generic human driver profile and how to extend that to algorithms for CAV rules. We want to see the feasibility of improving current technology and modelling to balance comfort, capacity and safety of CAVs, to ensure behaviour in traffic meets the needs of both highways authorities and CAV customers.

Our vision is to accelerate the potential benefits in safety and capacity of level 4/5 CAVs by using data on 'real world' behaviour of human driven vehicles to help define rules for CAV behaviour. We are testing if it is feasible to build these rules from mass datasets from existing vehicles, adding to the rules of the road knowledge about how humans drive and the impacts on traffic. These rules can be improved by microscopic modelling of vehicles interacting in a mixed fleet. This will also help tailor early CAV behaviour to match that of human drivers, improving confidence for early adopters.

12 month feasibility study starting May 2018: Key milestone is a feasibility report

Contact point:
harsha.bagur@cloudmade.com
Andy@whitewillow.biz

MaaS:CAV

Integration of CAVs into a MaaS platform

Total funding amount £45,012
total grant amount £204,726

Objectives:
This project is a technical feasibility study to enable the commercial deployment of autonomous systems as part of an integrated mobility system for the Culham Science Park and Science Vale area.
The outcome of this study will be useful to guide the integration of CAVs into a MaaS platform and how the associated government and industry business cases could be structured. The conclusions will have both immediate impacts to the area used for the study as well as being scalable across the Oxfordshire and applicable to similar regions in the UK and abroad.

Timeline with milestones/deliverables

1) ROI in installing CAV- enabling infrastructure

2) Benefits of integrating CAV with MaaS 3)

3) Business model for industry-local authority collaboration

4) Actionable insights into designing/implementing First/Last mile MaaS-CAV scheme

Contact point and weblink
Project Lead:
www.mobiliyoxford.com
hello@mobilityoxford.co.uk

On Highway / Off Highway Communications and safety system Analysis

Navigation of agricultural vehicle from farm to field

Total Project cost £158,064 / Grant £134,168

Objectives
Evaluate current legislation for autonomous vehicles
Evaluate the current " state of the art" navigation and communications hardware and software against requirements from legislation
Test and evaluate the most applicable navigation system in an on/off-highway environment

If agricultural mechanisation continues to innovate towards automation then machines large and small will inevitably need to use public highways to move from field to field due to the dispersed nature of agricultural farmland. The methodology to be applied is research led technology development, starting with a fundamental investigation into current agricultural and on-highway vehicle operating standards, state-of-the-art automation and vehicle to infrastructure (V2X) systems to identify the technologies most suitable for agricultural robots to operate at SAE level 4 autonomy in both field and road conditions. This research is not innovative but fundamental, to any innovative agricultural robotics platform that will use the public highway. The main focus of this feasibility study is to fully understand the crossover of technologies and communications that could enable agricultural robots to share the highway. In addition, these technologies may also enable autonomous farm machinery to work together safely in groups within agricultural fields.

June 2018	Kick-off
Sep 2018	Completed review of legislation and standards for CAV.
January 2019	Completed review of communications and navigation software and hardware.
March 2019	Testing of chosen autonomous navigation and communications hardware.
May 2019	Dissemination of project findings

Contact:
Clive Blacker
Clive@precisiondecisions.co.uk
www.precisiondecisions.co.uk

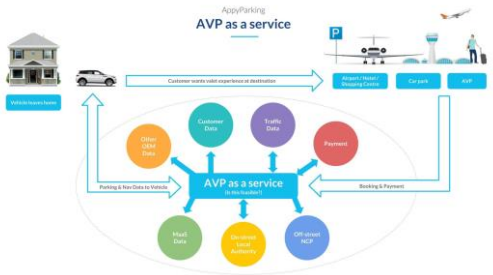
ParkAV

The Business and Data chain for Automated Valet Parking

Total funding amount/ total grant amount

£179,617 /£121, 722

Objectives – Examine the feasibility of a business model for public/ private sector automated parking



ParkAV will create a solution that blurs the divide between on and off-street parking for autonomous vehicles. Automated valet parking (AVP) is a key feature needed for level 4/5 CAVs and vital for Mobility as a Service. But once the customer is dropped off, where do vehicles go without clogging up the streets and who pays for the service? Public Sector on-street parking and Private Sector off-street car parks are different businesses and subject to different legislation, taxes, restrictions and tariffs. A traditional car park could transform into a drop off hub, releasing value in parking.

Timeline: 12 month study delivering a feasibility report, customer storyboard and business model

Contact point and weblink
Dan Hubert (CEO) Info@appyparking.com
Andy Graham (Project Manager) andy@whitewillow.biz
www.appyparking.com

List of partners

Removing HGVs from high streets with last-mile human interactions

Small last-mile delivery vehicles navigate around pedestrians to replace HGV deliveries

Total funding amount: 225k GBP

Objectives: Remove HGVs from high streets by replacing their regular deliveries to shops with autonomous small last-mile delivery vehicles.

City councils and urban housing developers around the world need methods to remove heavy goods vehicles (HGVs) from pedestrianized city centre shopping areas ("high streets"). Shops on high streets must regularly (a) receive deliveries and (b) have refuse collected, both by HGVs. Current advisory solutions include scheduling these vehicles at night, which creates night-time noise and emissions pollution making city centres less attractive for urban living; or where such pollution is critical due to existing urban living, expensive infrastructure solutions such as designing underground tunnels for delivery. Urban living is environmentally efficient, aids regeneration and reduces the UK's housing shortage, and is important to encourage. There is a clear need for alternative urban systems to move goods and refuse to and from high streets. Our alternative is a fleet of small, electric last-mile delivery vehicles, driving on regular routes around high streets and to HGV interchange areas positions around the edges of high streets. The vehicles can be summoned to stop at shops and at parked HGVs by the retailers, to load and unload Deliveroo-sized standard boxes of goods and refuse. Unlike previous projects, they operate in dense pedestrian crowds and translate into commercial implementations newly researched algorithms for pedestrian interactions from a state-of-the-art EU research project. Unlike pure robotics projects our partners study the effects on urban planning systems and credible route to market.

Milestones:
Vehicle build based on DriveDaddy’s electric scooter vehicle conversion, Virtual reality simulations of AV-pedestrian interactions
Urban planning infrastructure requirements ,University campus AV trial demos.

Project lead contact:
info@ibexautomation.co.uk
www.ibexautomation.co.uk

ARUP DRIVE DADDY LTD IBEX UNIVERSITY OF LEEDS

Connected and Autonomous Vehicles: Simulation & Modelling (CAV Sim)

This competition opened January 2018 and closed May 2018, the winners were announced July 2018.

Simulation and modelling is internationally recognised as a key capability for CAV development given the timescales involved in using traditional physical testing alone for proving the technology's safety.

CCAV and Innovate UK are funding a small number of projects focused on holistic simulation and modelling systems. These will develop simulation and modelling capabilities which look to accelerate the development and deployment of CAVs, and support the design of regulatory approval regimes that will be needed to deploy CAVs on public roads.

For further information on CAV Sim visit https://apply-for-innovation-funding.service.gov.uk/competition/103/overview

CO-existence Simulation MOdeling of Radars for Self driving (COSMOS)

Development of a sensor modelling simulation environment for Level 4 autonomy functions

Total funding/ government grant funding :£2.66m 24 Months

Executive summary: We will create a system-level sensor modelling simulation environment for L4 autonomy functions, where each part (sensors, propagation channels, interference effects and interactions between all) will be modelled to provide a verifiable performance metric in electromagnetically and physically dense environments representative of those in which CAVs will operate.

Project timeline/milestones

(**WP 1)** **CAV Sensors Modelling Gap Analysis**
(WP2) **Holistic Simulation Design**
(WP 3) **Holistic Simulation Implementation**
(WP 4) **Holistic Simulation Platform Integration**
(WP 5) **Test Cases Definition**
(WP 6) **Verification and Validation**
(WP 7) **Dissemination & Exploitation**

Project Innovations:

COSMOS approach will use a modular open architecture simulator, enabling integration
with other sensor system simulators and models of the relevant elements of highway/urban scenarios, external and electromagnetic environment, vehicle control system and dynamics.
Integration with optical sensor simulators will address fundamental limitation of vision sensors in adverse conditions through fusion with radar.
The simulation will generate evidence to supplement and extend controlled and public
environment testing, and enable performance limits to be established.
Simulation will be
validated by physical measurements at MIRA and Jaguar Land Rover test facilities.

JAGUAR LAND-ROVER

THE UNIVERSITY OF BIRMINGHAM

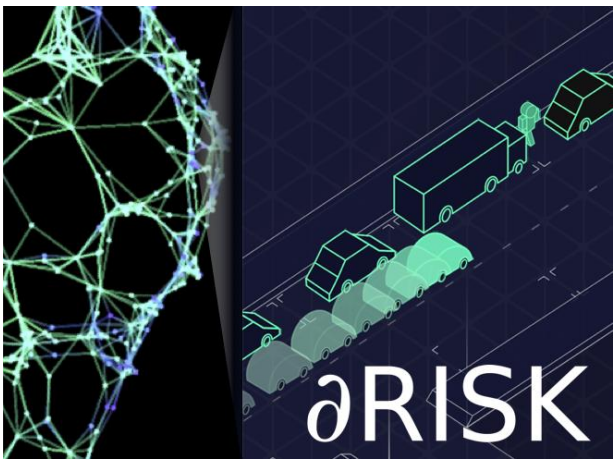
A HORIBA COMPANY MIRA

dRISK

Comprehensive knowledge graph feeding adaptive tests of the AV safety case.

£3m grant, £3.8m project

A multi-level framework with the capability to identify realistic edge-case test-scenarios from real and simulated data, human-driven fault-detection methodologies and public responses to connected autonomous vehicles (CAVs). This huge variety of data sources will be structured and fed into a comprehensive *knowledge graph* of all CAV risk scenarios. From there, representative test cases are drawn and fed into one of several physical and cyber- simulators which will directly test the vehicle control system (VCS).



Schedule:

Feb, 2019:
- First auditable, comprehensive taxonomy of CAV risk scenarios
- Prototype adaptive test gauntlet software complete
- Initial stakeholder engagement (e.g., crowdsourcing and Meridian test sites)

Early 2020:
- Advanced "Beta" safety testing platform for CAVs
- Physical testing of newly surfaced edge cases at SMLL:L

Sept, 2020:
- Offstreet safety test demonstration on Level 4/5 CAVs

Innovations:

- Use of AI and NASA-grade fault detection methods to integrate a wide variety of risk data, from CCTV video, to accident reports, to crowdsourcing from the ultimate stakeholder -- the UK citizen.
- Establishes a single, comprehensive human- and computer-readable representation of risk – the first *knowledge graph* for CAVs
- Application of this knowledge graph to adaptively test the vehicle control system (VCS)
- Development and adaptation of simulation capabilities at multiple levels: sensor, vehicle-level, traffic-level and cyber-level.
- Provides a comprehensive risk assessment framework to stakeholders (e.g. regulators) in a usable form

aiPod

TRANSPORT FOR LONDON

Imperial College London

ds:Cities

CLAYTEX

drisk.ai

Consortium Lead: aiPod LTD, www.aipod.com
Chess Stetson, Project Mgr., chess@aipod.com
Al Duncan, Public Relations, al@idealab.com

OMNICAV

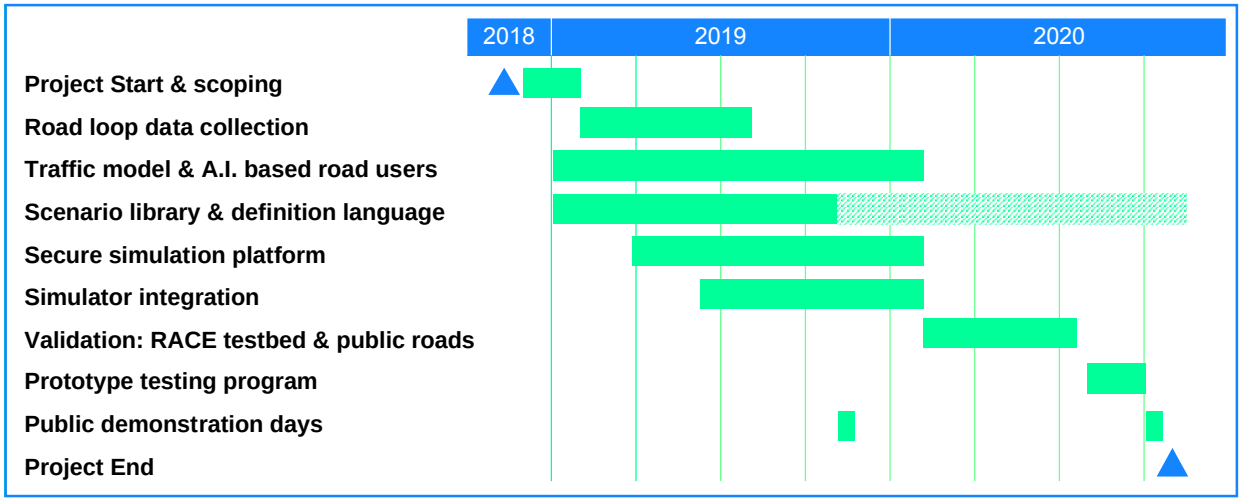
A holistic simulation & modelling system to enable "CAVs for all"

£2.7m grant, £3.9m project

VISION: To deliver CAVs for all

All potential end-users: a customer-centric approach engaging all end-users, from OEMs to insurers, in the consortium
All road environments: rural roads cover 93% of the UK but have never been studied in any existing simulation, delaying much needed autonomy for rural communities
All situations: a comprehensive simulation system combining driving and traffic simulations and AI-based smart actors with best-in-class scenario generation tools

The Road Loop



OmniCAV's innovations: state-of-the-art technology to build a **trusted, versatile testing environment** delivering **representative coverage of UK roads:**

1) Combining traffic simulation, driving simulation, and AI-based "smart actors" to recreate real-world edge cases
2) Integrating 3 state-of-the-art methods to create a best-in-class scenario library
3) Designing for a secure testing environment, with tamper-proof test inputs to provide an overall root-of-trust
4) Verifying the simulator against the real world to build confidence in simulation as part of an integrated testing program
5) Establishing best-practice for a scalable geospatial infrastructure to support and accelerate UK CAV testing

10 globally renowned organisations

Admiral · aimsun. · ARCADIS · Ordnance Survey · LATENT LOGIC · ARRIVAL · OXFORDSHIRE COUNTY COUNCIL · RACE · WMG THE UNIVERSITY OF WARWICK · XPI simulation

With support from Thatcham Research

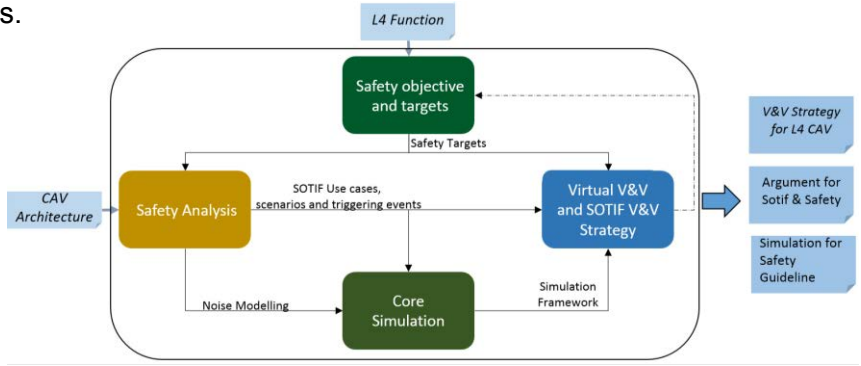
OmniCAV.com - OmniCAV@LatentLogic.com

Sim4SafeCAV: Simulation & Virtual Testing for Safe CAV

Total funding / government grant funding: £1,958,833 / £1,363,687

Executive summary:

Sim4SafeCAV will combine safety and simulation for SAE level 4 autonomous cars to significantly enhance safety analysis and use simulation to demonstrate achievement of safety targets.

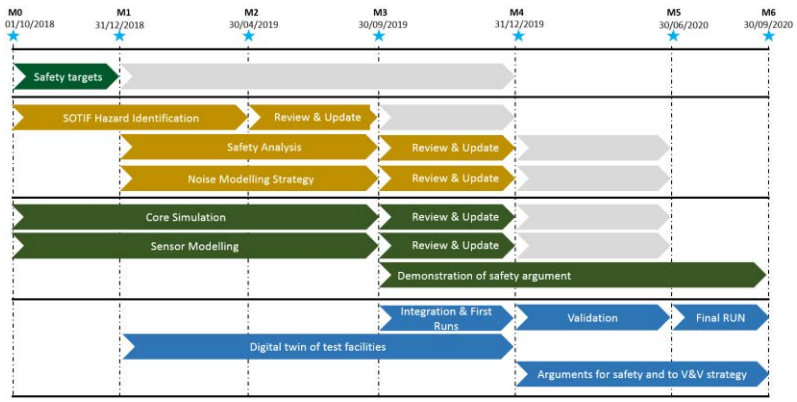


The outcomes will enable OEMs to establish which mix of sensors and systems can meet global safety requirements, creating efficiencies within the supply chain to accelerate products to market. The project is novel in combining Safety and Simulation activities to offer an innovative solution to meet the safety and the time to market objectives of L4 autonomous vehicles.

Milestones:

M0 – Project kick-off
M1 – Safety targets defined
M2 – SOTIF analysis complete
M3 – Complete safety analysis and simulation complete
M4 – Integration and trials complete
M5 – Simulation validation complete
M6 – V&V strategy development complete

Project timeline:



Project Innovations

We will innovate through:

(1) Enhancing the SOTIF (Safety Of The Intended Functionality) approach by developing new techniques for hazard identification and analysis (STPA, top-down, bottom-up analysis, noise analysis)
(2) Developing realistic models (e.g. sensor models at different fidelities)
(3) Setting up an advanced simulation framework for gathering evidence for SOTIF and for Safety Verification and Validation
(4) Enhancing the safety validation strategy and demonstrating how virtual testing can support the safety argumentation

Project lead:
Dr. Adam Adwan
Autonomous Driving Manager at JLR
aadwan@jaguarlandrover.com

S:CORE

Simulation of Complex Off-Road Environments
for Autonomous Vehicle Development

Total Project Size: £1.2M Funding : £0.9M

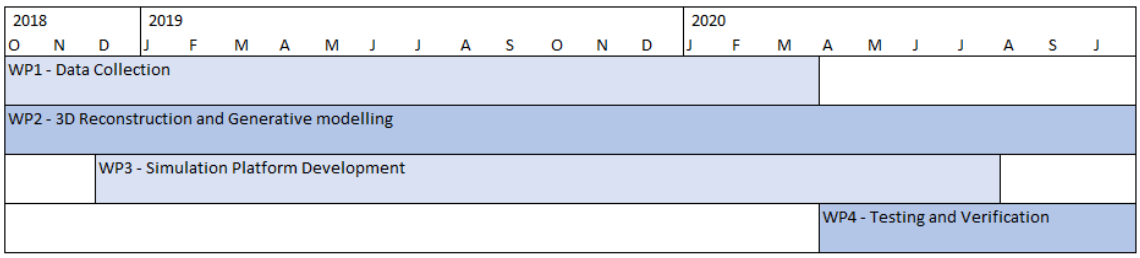
S:CORE - Simulation of Complex Off-Road Environments is a collaborative project lead by Dynium Robot, with UCL and Oxon.Tech.

The project will tackle the challenges of collecting large data sets from off-road, remote environments, generation of 3D models and development of algorithms for synthetic generation of environments and scenarios.

A simulation will be developed for training, testing and verification of off-road autonomous vehicle control systems in any remote setting.

Model verification and testing will be carried out in collaboration with RACE, part of the UKAEA.

Simplified Project Outline



Project Innovations

The project will generate innovation in areas of data storage and analysis, connected vehicle communications, autonomous vehicle localisation and mapping, computer vision technologies, AI, three-dimensional environment modelling and generation.

A purpose build sensor array will be developed for the collection of the environment data, and computing hardware and infrastructure will also be designed and deployed in the field.

The simulation will be able to model automotive grade sensors and the environmental inputs to the vehicle, requiring further novel development.

Dynium Robot

UCL

OXON TECH

VERICAV

VERIFICATION OF CONNECTED AND AUTONOMOUS VEHICLES

Evaluation of ADS Using Flexible & Optimised Virtual Testing

Total funding **£3.36m**

Government grant funding **£2.38m**

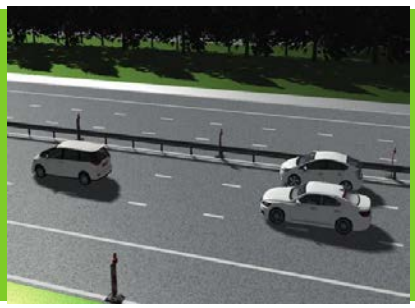
Executive summary

VeriCAV is a world class project to develop an integrated test framework to allow Automated Driving Systems (ADSs) to be efficiently validated in simulation. The eight project partners, led by HORIBA MIRA, will use their combined expertise in automotive, test engineering and simulation to build key UK capability in this important AV discipline.

Automated generation of complex driving situations will be used to test the ADS in a time-efficient manner and provide detailed evidence of ADS performance. VeriCAV will verify the framework by both testing in the simulation, and by performing physical correlation activities.

Project innovations

- Developing efficient automated testing in a simulated environment – with a 'closed-loop' capability to change test parameters to respond to test results.
- Smart actors based on cognitive models and machine learning to bring real-world behaviour into simulation.
- Developing and testing appropriate interfaces between the automated driving system and functions of the test framework.
- Supporting the validation and verification phase of prototype ADSs, allowing quicker turnaround from concept to final product; targeting a growing global CAV testing market.



Project timeline / milestones

Nov 2018	Project initiation
Feb 2019	Requirements and architecture phase complete
Nov 2019	First system integration milestone
July 2020	Main system integration milestone
Aug-Oct 2020	Verification and validation of test framework

Industry lead	HORIBA MIRA	Anisha Bharti	anisha.bharti@horiba-mira.com
Project lead	TSC	Andy Frost	andrew.frost@ts.catapult.org.uk
Dissemination lead	TSC	Liam Singleton	vericav-project@ts.catapult.org.uk

vericav-project.co.uk

Formula Student - Artificial Intelligence (FS-AI)

Inspiring the next generation of CAV engineers

Total funding/ government grant funding: £200,000.00

Executive summary

Run by the Institution of Mechanical Engineers (IMechE), Formula Student (FS) has provided a platform for University students to apply engineering theory in a real world, real project scenario for over 20 years. FS requires student teams to design and build a complete race car and compete against other teams from around the world at Silverstone each year.

In 2018 we have introduced FS-AI to challenge student teams to develop an AI driver capable of controlling a purpose designed FS car, the ADS-DV through a series of racing challenges. The ADS-DV, developed with funding from CCAV via Innovate UK. allows the students to focus on the task of creating control algorithms, which can be downloaded on to ADS-DV in order to complete a set of pre-defined AI missions. The software must be developed to enable OEDR, path planning, vehicle position and motion control.

As well as 'dynamic' (driving) events, there are a series of 'static' event categories, including the requirement for the students to also consider Real World Autonomous scenarios. The competition is designed to evolve to keep pace with the skills requirements of the UK AI sector.

FS produces some of the best 'industry ready' engineering graduates in the world. FS-AI will now extend this into the world of autonomy, producing software engineers ready to meet the ever growing demand for CAV skills to support the UK VM's and their supply chain.

FS-AI Consortium Partner

Centre for Connected & Autonomous Vehicles

Contact:
Lucy Killington, Project Leader
020 7304 6837
l_killington@imeche.org
www.formulastudent.com

Project Innovations

FS-AI is the first competition of its kind to provide a dedicated vehicle platform, the ADS-DV, lowering the barrier to entry for Universities for whom resources and budget would otherwise prevent participation.

Project timeline/milestones

With funding support from CCAV, the ADS-DV prototype was completed in time for a showcase event at Silverstone in July 2018 with the University of Edinburgh demonstrating their AI software. The students from Edinburgh successfully completed a full lap of the TrackDrive course with the ADS-DV.

In preparation for a full competition next year, the ADS-DV prototype is now being further developed to facilitate low volume manufacture. It will be supplied to order for Universities in the UK, Europe and the rest of the world to use as a dedicated platform for entry into a full competition in July 2019. Universities will select their own AI computer and sensor package to develop path-finding and machine learning algorithms in order to complete a pre-defined set of AI missions that make up the FS-AI rules and competition format. It is expected that orders will be accepted from October 2018 with the first vehicles being delivered to teams in early 2019. The competition period will run October-July on an annual basis.

Meridian and the UK Testbed Ecosystem

The Government has committed to investing £100m, which is being matched by industry, to create a world leading ecosystem for the testing and development of connected and autonomous vehicles in the UK; this is Testbed UK.

The first four infrastructure projects have been announced: £51m is being spent on two public testbeds in London and the Midlands and two controlled testbeds; a realistic urban testbed, and a limit handling track. These expand and complement the substantial existing infrastructure and capability in the UK. They are being brought under a single coordination body called Meridian.

Meridian was launched in September 2017 as the 'one stop shop' for the UK's CAV ecosystem; able to advise and put any organisation in touch with the right testing environments and testing consortia.

Meridian was established to facilitate partnerships and collaboration across sectors and, through access to funding, to secure the UK's position as a world leading testing and development ecosystem.

The CAV ecosystem that is growing in the UK, now led by Meridian, comprises well established world class testing facilities and proving grounds and also diverse public domain environments.

These environments range from rural to high density areas including Europe's only mega city, London.

This diversity is essential for comprehensive testing and development of connectivity and autonomy by vehicle manufacturers, transport operators and authorities who wish to develop their products, systems and services.

Meridian and the Testbed UK will take organisations through advanced development and validation through to certification of CAV systems.
That journey will include attention to connectivity and cooperation, regulation and standards, data exploitation and cyber security, and new service models.

In a global market estimated at £907 billion by 2035, the UK is providing an integrated capability which will help accelerate the adoption of CAV systems and ultimately increase safety and mobility around the world.

TIC-IT

The TIC-IT consortium, led by HORIBA MIRA in partnership with Coventry University, will establish a critical piece of testing infrastructure, which will form part of the world's most effective CAV testing ecosystem. The facility will create a purpose-built realistic, safe environment for testing CAVs up to the limit of their operability; a critical activity to ensure consumer confidence in the technologies. The test environment will be unique, enabling a wide range of CAV driving scenarios to be tested.

Millbrook-Culham Urban Test Bed

Millbrook and UKAEA's RACE are launching a unique, controlled to semi-controlled test bed representative of an urban environment. This addresses the critical need for a controlled, but realistic urban test environment that seamlessly connects with other CAV test functions and open road urban environments. The road and test track networks at Culham Science Centre and Millbrook Proving Ground respectively are being upgraded to capture the complexity of real urban contexts and to enable advanced connectivity testing, while being safe and secure for all users.

Midlands Future Mobility

Midlands Future Mobility is developing the infrastructure and environment that will enable the early deployment of new autonomous and connected technologies. By creating a unique set of services, we will enable innovators to bring products to market quicker and for public and private collaborators to shape the transport sector of tomorrow. Funded by industrial partners and Government we bring together experts from the infrastructure, transport, communications, automotive, local authority, and research sectors.

Smart Mobility Living Lab: London

A real-world testing ground for CAV mobility creating a safe trials environment that will provide: vehicle validation and customer verification, expertise on building CAV ready cities, access to flexible and customisable tech platform, MaaS trials & services (collection, storage, analysis and integration), and development of standards and approval processes. SMLL will establish core facilities including an operations control room, data network, roadside monitoring (inc CCTV, ground truth, V2X), mobile (pop-up) infrastructure, workshops and garages at two sites, multiple charging points, research centres, and open architecture vehicles.

Future Developments

This booklet will be updated as our portfolio of projects expands as we launch future competitions. The most recent of which are detailed below.

Current Funding Opportunities

Connected and Autonomous Vehicles 4 (CAV4)

CAV4 opened on 25 June 2018 and closes 19 September 2018

We expect to fund 2 to 4 high quality projects that can demonstrate UK capability and technologies to a global audience.

Pilot studies are expected to develop and then test connected and autonomous vehicles (CAVs) in a real-world public or semi-controlled environment, with at least a 6 month public trial. We are looking for ambitious proposals where the commercial benefit is strong and there is a clear route to a commercial operation after the project. As such, the projects should be large enough to test and demonstrate the underlying business and operating model.

Projects must be focused on developing and using SAE level 4 automation or above in the context of a new mobility service.

All projects must be collaborative, business led and conduct their research and development (R&D) in the UK.

For further information on CAV4 visit https://apply-for-innovation-funding.service.gov.uk/competition/182/overview

Meridian 2: Connected Vehicles Data Exchange

Meridian 2 opened on 4 June 2018 and closes 29 August 2018

CCAV in partnership with Meridian Mobility and Innovate UK, part of UK Research and Innovation, will invest up to £5 million in a single project. This is to develop one or more platforms for the exchange of connected vehicle data.

The aim is to create the world's most effective CAV testing ecosystem. The project will facilitate the exchange of data, to test, develop, demonstrate and exploit CAV opportunities. The platform should be adaptable to cope with increasing volumes and new types of data formats which are accessible and appropriate for users.

CCAV expects to support one project. Preference is given to projects that prove they can deliver operational facilities that complement or build on existing facilities within the UK CAV eco system. Projects will be supported through investment aid for research infrastructures. This is a type of state aid that allows grant funding to support the construction or upgrade of research facilities.

If your project size falls outside of our scope, contact support@innovateuk.gov.uk before you apply.

For further information on Meridian 2 visit https://apply-for-innovation-funding.service.gov.uk/competition/103/overview

Meridian 3: Autonomous Highway, Rural and Parking Test Facilities

CCAV will invest up to £25 million in partnership with Meridian Mobility and Innovate UK, part of UK Research and Innovation. This is to develop CAV testing infrastructure for autonomous parking and autonomous driving on rural roads and highways.

The aim is to create the world's most effective CAV testing ecosystem. This should be located in the defined geographical area, between the West Midlands and the South East as detailed in the competition scope.

CCAV expects to support up to 6 projects. Preference is given to projects that prove they can deliver operational facilities that complement or build on existing facilities within the UK CAV eco system.

Projects will be supported through investment aid for research infrastructures. This is a type of state aid that allows grant funding to support the construction or upgrade of research facilities.

If your project costs or duration fall outside of our scope, contact support@innovateuk.gov.uk before you apply.

For further information on Meridian 3 visit https://apply-for-innovation-funding.service.gov.uk/competition/172/overview

Centre for Connected
& Autonomous Vehicles

enquiries@ccav.gov.uk

www.gov.uk/ccav

@ccavgovuk

V3: September 2018