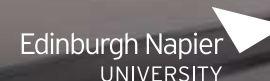


Launching the UK's First Autonomous Bus Service

(That's one where the vehicle can drive itself!)



A proud partnership between





db

Thank you
Co-designers!

How much do you know about them?

How do you feel about the idea?

Somebody is training an autonomous vehicle

Autonomous Vehicle

-Future is coming

We'll get used to it eventually.

Hopefully our country won't be facing it.

What are the risks? + what are the benefits?

FEARS

TO SEE!

Don't make so much noise!

How do

you do

it?

EMERGENCY?

TRUST YOU?

NEED SOMEONE ON BOARD?

-AUTONOMY

-THINGS

THAT

ARE

NOT

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SAME

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Introducing AB1 – Autonomous Bus No.1

The UK's first autonomous bus service.



A proud partnership between





autonomous bus



Stagecoach



Carla Stockton-Jones
UK Managing Director for Stagecoach

We are delighted to introduce the UK's first autonomous bus service, AB1. The team at Stagecoach, as well as our partners have worked incredibly hard, sharing their knowledge and passion for the project to achieve the service we are now about to launch.

For over 40 years we have been connecting communities up and down the country and pride ourselves on our innovative ideas, our passenger-first approach to new technology and our collaborative mentality. It is collaboration that has allowed us to be the first operator to offer this new technology to our customers.

It will allow communities in the East of Scotland to travel in a way that we expect will prove to be safer, greener and smarter as they commute to work or study, visit friends and family or pop to the shops.

"We look forward to welcoming you on board soon."



Kevin Stewart
Minister for Transport

I am delighted to see Project CAVForth progress to the launch of the live service. Our support for Project CAVForth demonstrates the Scottish Government's belief that a modern transport system is fundamental to sustainable and inclusive economic growth. We want Scotland to continue to be at the forefront in the development of Connected and Autonomous Vehicles and the start of this live trial will really help the country establish its credentials on the world stage.

Our involvement in Project CAVForth ensures that we are taking steps to be able to take advantage of the opportunities in research and development offered by the deployment of CAV technologies. Our involvement in Project CAVForth also ensures that we are taking steps to positively influence travel choices and behaviour, and it's pleasing that this will help make public transport journeys more attractive on this route.

"We are excited to see how this technology can help to support our vision for a sustainable, inclusive, safe and accessible transport system."

Introduction to project CAVForth and the AB1 bus service.

Autonomous Bus No.1 (AB1) is a new bus route running in East Scotland, joining Ferrytoll Park and Ride in Fife, with Edinburgh Park transport interchange.

This route is special because AB1 is the UK's first autonomous bus service, which means that the vehicles are able to drive themselves!

Launching this groundbreaking service has been a massive technical challenge and a collective effort that has seen industry partners work together under the project name CAVForth.

CAVForth was the result of a UK government competition run by the Centre for Connected and Autonomous Vehicles (CCAV), whose aim is to see the UK as a leader in developing and deploying this new technology. This competition enabled grant funding to be awarded to consortiums of partners to accelerate their research and development.

The funding was fiercely competitive, and entrants had to prove their ability and ambition to launch real-world autonomous transport services using UK technologies collaboratively.

Competitors were pitching for support to create something state-of-the-art, a world-first, that couldn't be financially viable or technically achievable for one company alone.

Project CAVForth successfully entered this competition and saw our team at Stagecoach collaborating with five other UK partners: Fusion Processing, Alexander Dennis Limited (ADL), Transport Scotland, Bristol Robotics Lab (BRL) and Edinburgh Napier University, sharing £4.6m in match funding, and proudly working together to deliver the world's most advanced autonomous bus trial.

The aim was to build on independent trials already carried out by the partners. 2018 saw Fusion, ADL and Stagecoach produce a prototype bus that could drive itself around a depot. It could get fuel, go through the bus wash and park itself up for the night, all at the push of a button. Stagecoach privately funded this early initiative, and CAVForth builds on this successful partnership.

Through our engagement with members of the public, our passengers, staff and industry stakeholders, we know there are many questions around autonomous technology: why should we trust it, what will it be like to use, where is the value in investing in it, as well as what are our plans for using it in the future?

This booklet aims to share our work on the CAVForth project by answering some big questions around autonomous vehicle technology while introducing AB1 to the world!

Contents

Our 10 most asked questions:

What is an Autonomous Bus?

How does an Autonomous Bus work?

How safe are Autonomous Buses?

How are we making sure that AB1 is as safe as possible?

What will it be like to ride/experience an Autonomous Bus?

Where will the UK's first Autonomous Bus service operate?

Why are Stagecoach trialling Autonomous Buses?

How will people respond to Autonomous Buses?

What does the future hold for Autonomous Buses?

When can I try the AB1 service or bring a Stagecoach Autonomous Bus to my region?

This booklet is for you if you want a deeper dive into the project.

For quicker answer to the same questions visit: stagecoachbus.com/autonomousbus



What is an Autonomous Bus?

Sometimes referred to as self-driving, driverless or robot-vehicles...

Autonomous vehicles are those that have been automated to be able to drive themselves by computer.

The autonomous capability of a vehicle can vary from a simple function such as cruise control or parking assist to complex systems that enable the vehicle to drive itself without any need for a human to touch the controls, or even pay attention.

AB1 uses vehicles capable of truly autonomous driving along the predetermined bus route with no need for human intervention or oversight.

Bus routes are well suited to autonomous driving as it is easier to 'teach' the technology to operate in a defined area, and bus services generally operate along a fixed route. Driving outside of a known area is much more complex for a self-driving system.

The vehicle will still need a driver's seat and controls for movement outside of the defined area. For example, our AB1 service will be driven manually from the depot to the route where the on board autonomous system will take over for the length of the shift; setting off, pulling in at stops and navigating the journey autonomously. The depot-to-route part of the journey could easily be automated in the future.

Throughout everything we do and have done on project CAVForth, the safety of our passengers and staff is our priority. As it is

still a trial, a trained Stagecoach safety driver will stay in the driver's seat, monitoring the technology throughout. They will be specially trained and ready to take control instantly if needed.

The AB1 service will be the first commercial autonomous bus in the UK and one of the first in the world to be a timetabled, registered service entirely open to the public – meaning that anyone will be able to walk up and experience a ride on an autonomous bus first-hand.

What technology are you using?

Stagecoach has partnered with UK based companies Alexander Dennis Ltd and Fusion Processing Ltd to deliver the project.

AB1 uses British-built Enviro200 single-deck buses built by ADL, the UK's leading bus and coach manufacturer, headquartered in Falkirk, Scotland, just 25 miles from the trial route. These vehicles have been digitised, meaning all systems in the vehicle cab can be controlled electronically.

Fusion Processing is a leading UK technology company with a decade of experience in sensing and high-speed processing technology. Fusion's products have been on the road since 2016. Their CAVStar® system, made up of sensors, communications units, computers and software, is retro-fitted to all five ADL buses operating on the route.

CAVStar® has been developed over many years for use on various vehicles, including electric pods, family cars, vans, people carriers, 4x4s, buses, trucks and much more.

Sensors & hardware specially designed for this vehicle type maximising field of vision and ensuring no blind spots

Full size bus capable of speeds of 50mph in Autonomous Mode

Primary and back-up systems for critical vehicle controls: steering, throttle and brakes as well as secondary power system and computer



On-board processing and control unit

Unique vinyl to stand out to passengers, pedestrians and other road users

How does an Autonomous Bus work?



Autonomous buses work by having the computer control the essential vehicle driving systems (accelerating, braking and steering) electronically.

They are programmed to continuously make decisions based on 3 questions that are being asked and answered in a loop hundreds of times every second:

- Where am I?
- What's around me?
- What should I do?

How does it know where it is?

The system uses, and constantly maintains, a 3D digital map of the route. It can identify where it is on that map by comparing the real world information it is picking up from a variety of sensors to what it expects to see. It can also use global positioning (GPS) information to aid in this.

How does it know what's around it?

Radar, Lidar, and visual sensors are all used to monitor what is going on in the world around the vehicle.

A fusion of inputs from each of these sensors is used to measure objects distances from the vehicle and their speed and direction. A bank of known shapes and movement patterns is used to identify what each object is and predict what it might do next.

The sensors are capable of identifying nearby vehicles, spotting traffic lights, reading road signs, tracking other vehicles and vulnerable road users, looking out for pedestrians and

much more. Some of these sensors are already available on modern cars and all are well tested for different industrial uses.

How does it know what to do next?

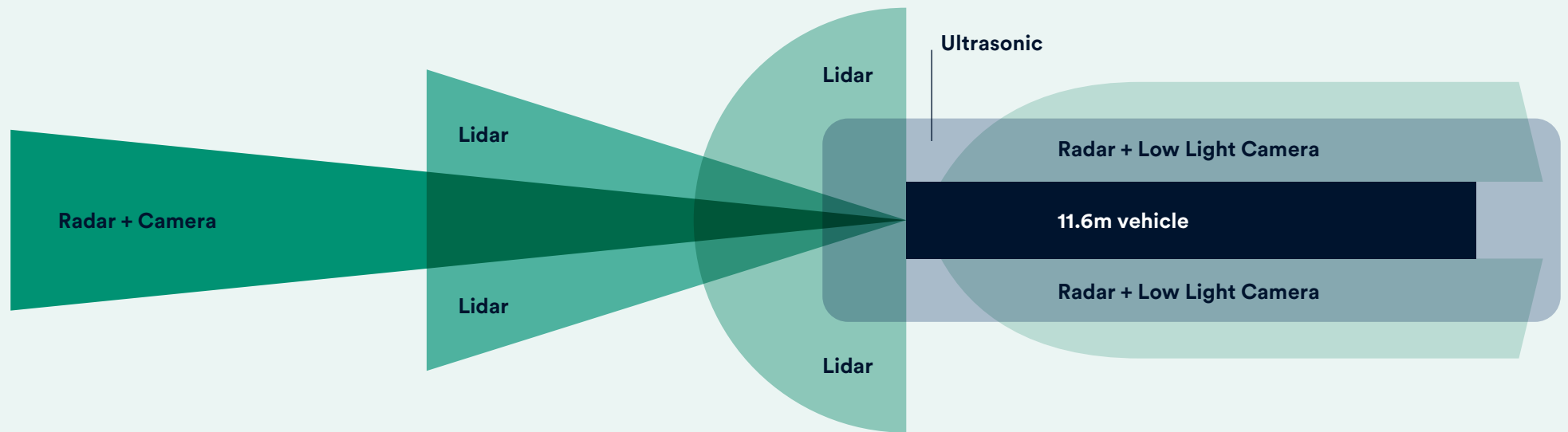
The system is programmed with specific governing rules to abide by, like following the most recent highway code, to progress along the route and to avoid risk of collisions.

Beneath these rules, sophisticated software processes all the live sensory input, plotting and updating the best path to follow, computing the correct driving actions needed to execute manoeuvres or maintain speed and road position.

It then sends these instructions to the electronic controls to accelerate, brake and steer to make the vehicle move.

This process is continuously happens for as long as the system is engaged.

The Fusion system, and the buses themselves, also have what's known in engineering as '**Full system redundancy**'. An independent backup component duplicates every critical piece of the autonomous driving system to ensure it can still operate in the event of a component, signal or power failure.



How safe are Autonomous Buses?

Autonomous buses allow the computer driving to see 360° at once, scanning its surroundings hundreds of times a second without blinking; the sensors enable it to see further than the human eye when conditions are bad, and the advanced processors allow it to react faster. The system doesn't get tired, stressed or distracted, and it is programmed to be risk-averse, meaning that...

...an autonomous system is designed to be safer than even the most experienced human driver.

The driving and decision-making system is made up of the accumulation of data from all the autonomous trips that have come before it. Much like how a learner driver becomes more competent, this system has already amassed a wealth of constant driving experience and been trained to deal with the weird and wonderful scenarios that occur in the real world. Suppose a new scenario is discovered, or a driving flaw is found, the entire system and all the vehicles in the fleet will learn from it at once. This means the technology will get safer and safer as the system is exposed to more real-world driving experiences.

Data from autonomous trials worldwide show that some types of collisions are completely eliminated when a computer is driving – for example, collisions resulting from hitting stationary objects or going off the road.

Collisions that other AV's have been involved in receive a lot of negative media coverage, but they are rare, and usually as a result of another human doing something wrong such as driving on the wrong side of the road, running through red lights, or have occurred when the vehicles were being driven in manual mode.

Statistically, buses are already the safest way to travel on the roads, rarely being involved in accidents. However, we see automation as a chance to reduce this risk even further and make our roads a safer place tying in with our sustainability goals which aim to see Stagecoach reduce avoidable accidents by a further 15% by 2026.

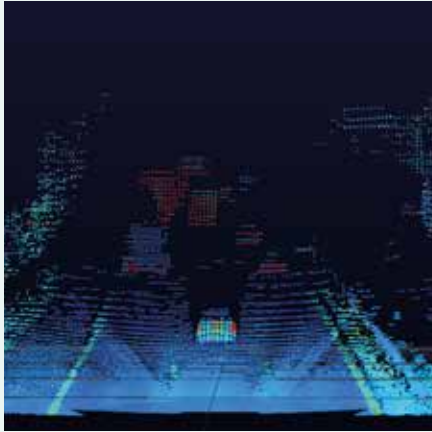
What if something goes wrong?

If something goes wrong and backup systems are required, the vehicle will bring itself to a safe stop.

The Fusion system can alert the on-board member of staff to the fault. It can self-diagnose and, depending on the criticality, decide on the safest course of action. This could mean coming to a safe stop in a predetermined location or continuing along the route. The vehicles will also be monitored from the Traffic Scotland National Control Centre.

The system has also been designed to be physically and digitally secure, meaning it has a range of fail-safes in place, monitoring for cyber attack or intrusion. An ongoing safety measure scans for threats and vulnerabilities and ensures that the security system is impenetrable.

In the extremely unlikely event of an incident involving an autonomous vehicle, there will be a wealth of data available to analyse to consider what happened, to learn from and to understand how a similar situation should be navigated by a system in the future – this way the system continuously learns from life on the road and will never make the same mistake twice.



Lidar

Light Detection and Ranging sensors (LIDAR) sends millions of laser pulses every second, detecting objects near and far. The network of these short and long-range sensors located around the vehicle creates a detailed point cloud of the environment and can pick up even small objects.



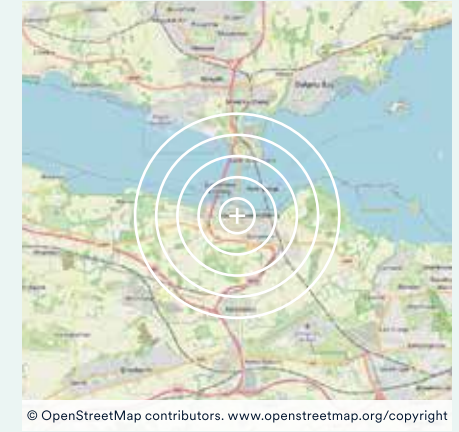
Radar

Radio Detection and Ranging sensors (RADAR) use radio waves to sense and track distant objects. They can determine in real-time the speed of moving objects and they work through fog, smoke, rain, and even dirt, allowing the vehicle to see in adverse and dark conditions.



HD Cameras

High Definition visual light cameras are strategically placed on every side of the vehicle. They provide wide-angle and long-distance road views and assist the vehicle in differentiating between objects. They read road signs, monitor traffic lights and detect lane markings.



GPS

Twin Global Positioning Systems (GPS) are placed on the vehicle's roof; they use satellite navigation to show where the vehicle is in the world working alongside an internal map.

The CAVStar system combines all the data being picked up by this array of sensors, and processes them at high speed to 'see' the world. The closest image to that, which is humanly understandable, would be a standard optical camera image; but viewed with 3D glasses to give it a better sense of range.

So, to the computer, it looks like moving through a 3D movie.

“

To the computer, it looks like moving through a 3D movie.

Jim Hutchison, CEO Fusion Processing

”

How are we making sure that AB1 is as safe as possible?

Our safety case is built to justify the claim that ‘Stagecoach’s Autonomous Buses are safe to operate on public roads’.

Proficiency	We have shown that the autonomous bus can drive itself, and that procedures are in place to make sure it is working properly during service.	Testing & Simulation A+	Track and Route Testing 	Operational Safety 40 years of experience	AV Deployment Standards
Fail-Safe	We have considered how the autonomous system will react when it encounters a problem, and have designed it so that if anything critical breaks, another part or process will still work as a back-up.	Functional Safety Standards ISO 26262 	Programmed Safe Stopping 	System Redundancy 	Safety Driver On Board
Continuous Improvement	We have done a lot of research, development and testing to make sure our systems are working properly and to the highest of standards.	Safety, Cyber & Ethics Committee 	Reporting & Feedback Loops 	Following CCAV Industry Best Practice 	Development Since 2016
Resilience	We have considered how to deal with issues that are not part of the design of the autonomous driving system itself.	Self-Checking System 	Secure & Defensive Design 	‘Additional’ Captain On Board 	Emergency Services & Transport Scotland Engaged
Trustworthiness	We have evidence that social and ethical considerations are being made and that we are being transparent with the public, stakeholders & regulators.	User Research & Service Design 	Transparent PR & Comms 	Approved Vehicle 	Independently Reviewed by Third Party Experts

Autonomous Vehicles are an emerging technology primed to disrupt how we think about travel and transport. The government and regulatory bodies recognises this and have implemented strict guidelines that must be adhered to for anyone to put an autonomous vehicle on public roads.

Standards, policies and procedures are constantly being created and updated to ensure that any technology going into production is fully compliant with the latest best practice.

Throughout CAVForth, we have been following the latest standards, guidelines and protocols set by UK Government and international regulatory bodies.

Our service Safety Case has also been audited by independent experts. The trial’s Safety Case is a formal document giving an insight into the workings of the technology and what it is programmed to do. It provides a framework to justifies our consortiums claim that, ‘CAVforth’s Autonomous Buses are safe to operate on public roads’.

To view visit www.cavforth.com

Our project is also governed by a Safety, Cyber and Ethics committee whose purpose was to vet and approve this Safety Case at different stages throughout the trials development. They were responsible for signing off the vehicles for on-road testing, then to carry staff, and only finally to carry passengers when the systems and vehicles have been proven to perform consistently as expected.

Simulation

Bristol Robotics Laboratory built a digital twin of the entire trial route area in detail as part of the project.

This was used to run many individual scenarios that are too dangerous to test in the real world.

Researchers are able to vary factors such as traffic density, type and weather patterns at the touch of a button and inject real-world challenging road situations to test the systems ability to deal with them safely and consistently.

Simulation is an essential tool to build confidence in the control systems abilities. It can condense many years of real-world driving experience into a short space of time.



Physical testing

The vehicles have been through a range of automotive tests to make sure their components, systems and performance meet the required standards.

We have done hundreds of hours of testing on the track, with models and real subjects being used to test different interactions with pedestrians, vehicles, objects and emergency manoeuvres.

The vehicles have also been running the route carrying only project staff to test that the system consistently delivers a smooth and efficient ride before we welcome passengers on board the service.



Operational safety

An essential guideline in the UK's code of practice for testing autonomous vehicles is that a human must monitor the system's driving ability 100% of the time, with the ability to intervene if necessary.

To comply with this, we will have a safety operative in the cab for the length of our trial, even though we are confident the vehicles are fully capable of making themselves safe in any eventuality without the need for human intervention.

The safety operative will be an experienced driver, specially trained to understand and monitor the systems. They will also be responsible for operational things like checking the sensors are clean and completing general vehicles checks at the start of every shift.

If the safety operative feels uncomfortable with how the system is responding or behaving, they will always have the ability to run the service in manual mode.



What will it be like to use an Autonomous Bus?

“

It's reassuring that someone will still be on the bus in case of an accident and for customer safety.

”

Riding on an autonomous bus will feel almost exactly like travelling on a traditional bus.

We expect people to be curious and excited, even a little nervous to begin with, and this to quickly turn into enjoyment and acceptance when the bus travels safely, and the service meets their needs and expectations.

The AB1 route and timetable will appear on traditional journey planner tools. Information will be available at stops along the route. The bus is a registered service and will stick to these timetables. Hailing the bus will be done as usual, with the bus stopping if people are waiting at each of the three stops.

We have engaged over 500 people as part of our design research programme, bringing people together to help us work out what it should be like to interact with an autonomous bus. We realised very quickly that people weren't ready to ride an unstaffed bus just yet, and there are many jobs other than driving that our staff do which passengers rely on and enjoy.

Will there still be staff on board?

For this reason, Stagecoach's vision for future full-size autonomous bus services still has a human on board responsible for customer experience. For the length of the trial, we will have a safety operative in the drivers' cab monitoring the driving. We will also have a 2nd member of staff on board; an autonomous bus 'Captain' who will be in the passenger area, able to take tickets,

answer questions, help with boarding and generally be a face for Stagecoach out in the community.

The Captain's role demonstrates what a future service might feel like when our specially trained staff members are free from the drivers' cab and can focus entirely on our passengers while the computer does the driving. Allowing them to take tickets while passengers are seated should speed up boarding significantly and make for a more comfortable experience for many passengers.

We still expect future bus Captains to be trained bus drivers, able to take control of the vehicle in the rare event that the computer system can't progress without manual intervention or if there is a diversion that would take the vehicle outside of the systems operating area.

Our research unearthed a range of exciting ideas and improvements that could be seen as autonomous buses are rolled out, but that were out with the scope of this project. Things like interactive eyes on the front of the vehicle to indicate its intentions or an on board heads-up display showing what the system is seeing and responding to.

We feel the Captains' role will have the most impact and is therefore being demonstrated as part of our live service. It will be like having a conductor on board, which we recognise was a big positive for passengers and communities. We also realise it brings a little bit of nostalgia to the future of bus travel.

– Ding Ding!

Will an Autonomous bus still be Accessible?

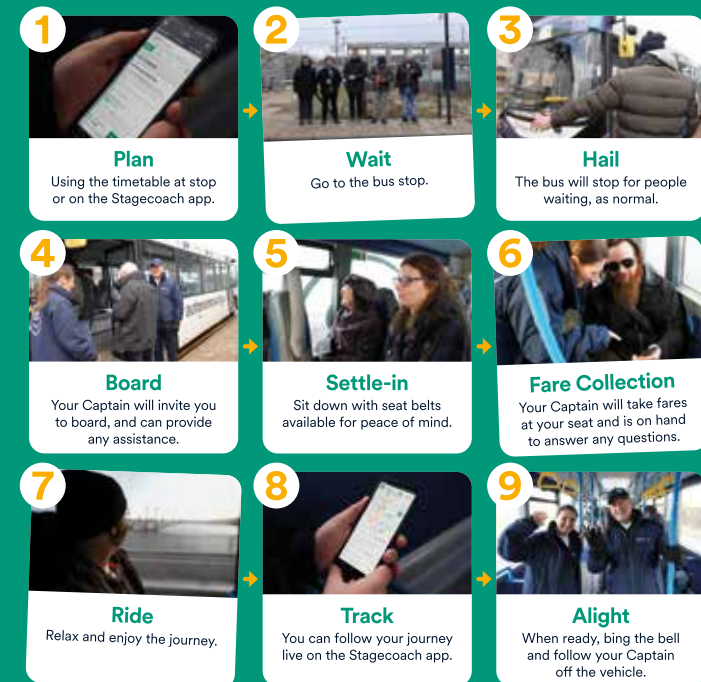
Our AB1 service will be a registered public service and will still be completely compliant with the Equalities Act. The trial vehicles are low floor with wheelchair spaces. The driving system will also mean that the vehicle will line up with the curb perfectly every time.

With the Captains on-board who will have been specially trained in disability and inclusion, they will be able to assist with boarding, alighting and in transit.

We think an autonomous service could be even more accessible than traditional modes. In the future, we can imagine the ability to contact the Captain of a desired service in advance to let them know a passenger's individual support needs so that we can best serve people in a way that works for them.



What will it be like using the AB1 service?



Take a selfie/share a tweet #StagecoachAb1



stagecoachbus.com

Where will the UK's 1st Autonomous Bus service operate?



Up to **20**
minute frequency

Capacity for over
10,000
passenger trips
every week

AB1 will run from Ferrytoll Park & Ride in Fife, along a 14 mile route that takes in the iconic Forth bridges on its way to Edinburgh Park. The service has one intermediary stop at Upper South Queensferry in both directions.

The route connects commuters, students, day-trippers and tourists. It is a brand new service linking Edinburgh Park to Fife by bus.

The service operates a full Monday – Sunday timetable at up to a 20 minute frequency. With up to four 36 seater buses in service at any one time, this gives capacity for over 10,000 passenger trips every week.

The busier journey south will take roughly 25mins and will be benefiting from using the new dedicated bus lanes, including at the busy Hermiston Gait roundabout. Northbound will also be around 25mins. At peak times, this could save commuters time, and the stress of finding parking when traveling to this bustling suburban development; comprising a mix of commercial, civic, residential and retail space.

The route itself is made up of A-roads, motorways, bus lanes and private land. It includes a range of complex traffic manoeuvres which will demonstrate the technologies capabilities. These include roundabouts, traffic lights, 'weaving' motorway lane changes, among others. The vehicles will travel in mixed traffic up to 50mph while contending with the changing Scottish weather.

To make the system as safe as possible and give it the best chance of a 'flawless' trial (with minimal need for intervention from a human to help the vehicle progress), the project has also seen some infrastructure improvements to the route.

This has included additional white lining in certain areas to help the vehicle to better position itself on the road. Technology in some traffic lights has been upgraded to digitally broadcast their status to the vehicle so it does not have to rely on sight alone.

We have benefited from the new M8 bus lane at Hermiston Gate, which speeds up all bus services on this corridor. An additional 6 CCTV cameras have been added to the existing coverage along the route to allow the safety operative to be alerted in advance of any breakdowns or accidents on the route for added assurance.

All these improvements, along with Transport Scotland's continuous monitoring capabilities at their National Control Centre overlooking the Forth Road Bridge, will improve the safety of this trial. They also demonstrate some of the improvements roads authorities can consider when preparing for the emergence of autonomous technology.



Additional CCTV Coverage



Live monitoring from Traffic Scotland's National Control Centre



Benefiting from new Bus Lane



Refreshed road markings

Why are you trialling Autonomous Buses?

Autonomous vehicles are tipped to offer many benefits to industry and society. From safer, greener roads, to better customer experience and improved access to transport, to lower operating costs.

The CAVForth project has allowed us to think about how an autonomous bus should work in practice in the case of a fixed route, express bus service. We will put our new service model into practice and monitor the technologies' performance throughout the trial. By comparing how it performs against existing manually driven routes, we will be able to establish if autonomous technology is worth the additional cost of implementation over traditionally operated bus services.

The partners involved will gain first-hand experience in launching and running this style of autonomous bus service. The individual organisations will learn from each other about what requirements their 'customers' have at each stage of the value chain, i.e. ADL and Fusion's joint need to provide after-sales, maintenance, training, and product liability to an operator.

The public have been able to help shape this service, and will have the chance to experience this new technology first hand. For some it will be a novelty and they will go on to tell future generations that they were one of the first to ride an autonomous bus in Scotland.

AB1 is also a new route for the local community, which brings new journeys that are made possible and offers another sustainable transport option for those in Fife and Edinburgh Park.

For UK PLC, the emerging autonomous vehicle market is massive worldwide, already estimated at many billions of £s, and growing exponentially. With our expertise in engineering and technology, UK suppliers are ideally placed to deliver into it. This is the reason the project is Government-backed; as...

... It could mean great things for the UK economically and socially, not just directly benefiting from seeing the technology on our roads, but also from delivering it to the world.

Some of the benefits we aim to monitor and evaluate include:

Benefit	Expected Improvement	Indicator
Safety	90% fewer 'at fault' accidents	Telematics driver score
Efficiency	10% greener	Fuel usage
Timeliness	5% more dependable	Adherence to timetable
Customer Experience	20% more joyful	Passenger surveys
Staff Satisfaction	20% more fulfilling	Staff survey
Loading Times	10% faster services	Spot checks across stops

We do not expect to see all the benefits of autonomous driving in an early trial like this. From an operational perspective, we will have two members of staff on board; we will have enhanced safety checks, reduced shift patterns, additional training, all on top of the ongoing R&D commitment. These factors will add to our understanding of the actual requirements to safely launch and operate a service like AB1 in other locations in the future.

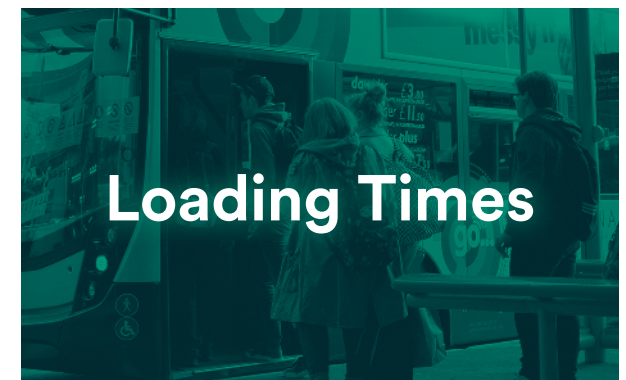
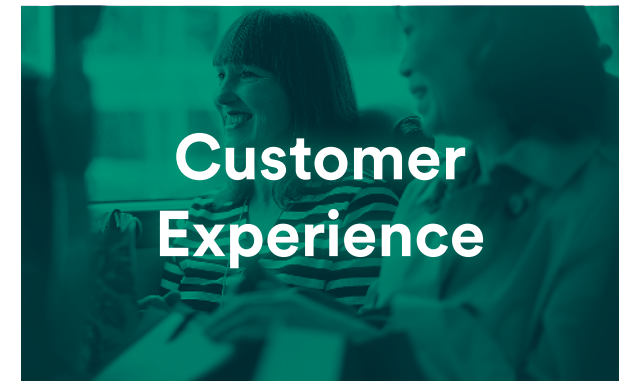
Fusion will monitor and record how their CAVStar® system compares to professional bus drivers from the technology side. They will be looking to gather further evidence that their product is safe and superior to a human driver. By doing this, they plan to capture enough evidence to help build trust and acceptance in the technology so that the decision makers around autonomous technology are more informed when it comes to considering future policies.

When these policies are in place, our group of UK partners will be ideally placed to deliver our products and services into this market, and we hope you will see more Stagecoach 'AB' services around the UK.

There are, of course, bragging rights that come with being first! Stagecoach has a strong history of trialling innovative projects; our partners, East Scotland and the UK are proud to make our mark on the world stage.

We will be sharing findings, insight and knowledge as we go, so watch this space.

www.CAVForth.com



How will people respond to Autonomous Buses?

Like anything new, we expect most people to be wary of autonomous technology, which is a perfectly natural human response.

In our early design research exploring peoples perceptions of autonomous buses, we learned that most peoples concerns fall into three broad thematic areas:

- feeling they can't **Trust** the technology
- not knowing what the **Customer Experience** will be like using an autonomous service
- concerns around the **Value** or lack of social benefit in investing in the technology.

“

I'd be scared in the beginning but it would be easier to accept if we know how it works.

”

We have been working to ensure that the service we have designed and the wrap-around information and support helps to answer these concerns. Some of the things we are doing include:

- implementing the Captains' role
- explaining how the technology works
- providing additional information across our channels and training our staff to answer questions on the service
- making sure that AB1 continues to be accessible and considering elements of the journey that might make people anxious
- designed an eye-catching livery, so the vehicle stands out on the road and is identifiable as autonomous to other road users
- using the prefix 'AB' making it apparent that the service is Autonomous on third party journey planners
- publicly sharing a vision for future autonomous bus including a range of ideas that didn't make it into the trial
- sharing much of our R&D openly to be transparent and encourage further innovation.

Data from previous 'gated' autonomous vehicle trials suggests that people quickly become comfortable using and trusting autonomous technology after having experienced it themselves.

Ultimately, we want to expose more people to the technology and let them try it themselves. Only by doing this and meeting their expectations can we build true acceptance.

The listed interventions will help raise awareness, encourage ridership, and offer reassurance which we hope will lead people to try the AB1 service for the first time.

With our five autonomous buses on the road, the expected media interest and the potential for over 10,000 journeys being made a week in East Scotland, we hope to generate a lot of public discussion.

Not everyone will be an early adopter, but we expect several regular commuters to rely on our AB1 service daily by the end of the project. Many more will have tried it for themselves and gone on to share their experience with friends and family.

Public Acceptance

Napier University has run public surveys considering how people feel about autonomous technology as part of the project. The pre-launch study of over 2000 people confirmed our assumptions, that there is little knowledge or exposure to the technology across our customer base, which is even more prominent in general society.

Due to the AB1 service being live, we expect to see a dramatic improvement in the awareness and acceptance levels towards autonomous buses in areas around the trial site. We aim to prove this by monitoring how the acceptance levels change after the service has been launched.

Influential Decision Makers

Napier Universities' Transport Research Institute is also engaging with the transport industry's influencers and decision-makers, considering what policymakers, transport planners, roads authorities, and community groups think about the technology.

Before launching our 'Vision' for a future autonomous bus service with a Captain on board, we learned that most influential stakeholders assumed the main benefits of autonomous buses were to reduce staff costs and enable new routes to become financially viable. We are showing that this is unlikely to be the case in this use case. However, there are other major demonstrable benefits.

We hope that AB1 becomes a case study in what is possible and generates a new interest

from the community who will ultimately approve their use on roads and guide industry perception.

What about driver jobs?

One of the most significant societal concerns is autonomous technology reducing driver jobs. Interestingly, it took 60 years from elevators being introduced for people to start boarding them without someone inside.

A bus service is a much more complex experience and with all the important jobs our people do aboard our buses, we believe the human element of our services will always remain an essential part of a bus journey with us.

“

Not bothered – if it still gets to where I want to go, on time I'm happy.

”



What does the future hold for Autonomous Buses?

When will Autonomous Buses be common on UK roads?

Pulling together the technology, regulation and business case to allow an autonomous vehicle on UK roads has been a cross-disciplinary ambition for a long time now.

A connected cohort of businesses, academics, and public servants across the UK are all working to drive forward different elements of a larger roadmap that all needs to happen before the rollout of the technology is genuinely possible. Many of whose work has enabled CAVForth in some way.

It includes critical elements like:

- developing manufacturing, supply chain and skills capabilities.
- safety, cyber, legal, ethical legislation, and standards.
- preparing infrastructure and the road networks, both physically and digitally.
- launching demonstrations and information campaigns to build awareness and acceptance.
- bringing everything together to create viable use cases with supporting business models.

Getting AB1 on the road demonstrates how an autonomous service can be made a reality. Still, it is very much a research and development project. It could still be many years before the remaining barriers to broader adoption are overcome.

Stagecoach is proud to be part of the UK's autonomous driving revolution. We intend to continue shaping how the ecosystem comes together to deliver value for our passengers, or people, and our business.

In 2022, our funders CCAV pledged £41.5m in competitive grant funding for new projects, which will help continue the UK's world-leading development.

“

In the UK, L3-L5 CAVs account for 36% of total annual sales by 2035, equating to vehicle sales of 1.36 million CAVs.

Connected Palaces Catapult,
Market Forecast for CAVs, 2021

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Where do autonomous buses fit into the future of transport and Stagecoach's strategy?

Public transport has a strong future as governments tackle the twin challenges of congestion and climate change. Stagecoach has been innovating in this field for over 40 years, and we don't intend to stop now.

Our exploration of automation, as well as other Stagecoach initiatives such as the roll-out of zero-emission buses or the launch of groundbreaking Demand Responsive Transport services, are all shaping how the future of transport works. If proven to deliver the benefits we expect, autonomous buses will become crucial to improving our offer as we continue to connect communities and bring people together across the UK.

In February 2023, it was announced that Stagecoach will be involved in 3 further CCAV funded projects across the UK. This will see us:

- extending the CAVForth route into Dunfermline bus station, making for a more complex and representative bus route in **CAVForth2**
- exploring autonomous urban shuttles in Sunderland city centre, through the **Sunderland Advanced Mobility Shuttle Project**
- and testing a fleet of connected autonomous vehicles in Cambridge with an on-demand service linking a business park with the wider public transport network in **Cambridge Connector**

These new projects reiterate our commitment to exploring this new technology, and total over £33million in collaborative UK R&D. They will form part of the most ambitious and advanced set of commercial, self-driving passenger operations anywhere in the world.

What happens when the trial ends?

AB1 is the first autonomous bus service in the UK. Our partnership now has the capabilities to deploy demonstrator services, and we very much intend to continue that journey by exploring new flagship routes.

If your city or region is interested in deploying the technology, please get in touch.

autonomous@stagecoachbus.com

As for the AB1 route, the additional CAVForth2 funding from CCAV will see the service running as a commercial autonomous service until early 2025 at a minimum, allowing us ample time to evaluate if the benefits associated with autonomous driving can be realised.

We hope that AB1 delivers a lasting route locally and is talked about globally long after the initial trial ends!

You can help us do that by sharing this booklet or joining us to experience the service for yourself.

Thanks a bunch!



“

By 2025, the UK will begin to see deployments of self-driving vehicles, improving ways in which people and goods are moved around the nation and creating an early commercial market for the technologies.

Government's 2025 Vision for CAM

”

Experience AB1 for yourself, the UK's first autonomous bus service.

stagecoachbus.com/autonomousbus

Educational visits & excursions welcome, contact us
in advance at: autonomous@stagecoachbus.com

Passes and concession cards accepted.

Interested in launching an Autonomous Bus near you?

Want more information from the industry side?

Get in touch with the consortium that made AB1
a reality. www.CAVForth.com





CAVFORTH

CONNECTED
AUTONOMOUS
VEHICLES

Who is behind the AB1 service?



Fusion Processing are world leaders in automated driving systems, situational awareness and control systems technology.

Fusion Processing's products have clocked up over 1.8 million kilometres of service. With numerous vehicles taking part in technology trials and commercial operations today, Fusion's systems are improving road safety and enabling smarter city traffic operations that are set to transform the automotive industry.

Throughout this trial Fusion will be monitoring their systems and working with Stagecoach to understand the real world benefits of choosing an autonomous bus model.

www.fusionproc.com



Stagecoach are the UK's largest bus operator, carrying around 3 million passengers a day and over a billion passengers every year.

We have been connect people to the places and people that matter most to them for over 40 years.

During project CAVForth, we have designed the customer experience, will operate the service and are monitoring the performance of the technology in comparison to our traditional bus services to understand how choosing an autonomous bus model can benefit passengers, society, our business and the environment.

www.stagecoachgroup.com



Alexander Dennis Limited is a global leader in the design and manufacture of buses, the UK's largest bus and coach manufacturer.

ADL's history and heritage of design, engineering and manufacturing excellence spans more than a century.

They have built the buses for this trial and collaborated with Fusion on the development and fitting of the autonomous sensing and control hardware.

www.alexander-dennis.com

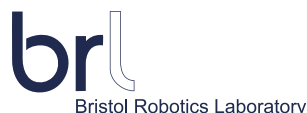




Transport Scotland is the national transport agency for Scotland. They represent the Scottish Government's belief that a modern transport system is fundamental to sustainable and inclusive economic growth and has the potential to deliver significant economic and societal benefits.

They are the roads authority responsible for most of the route, improving infrastructure and monitoring the service in real time. They will also be sharing the learnings from having a fleet of autonomous bus on Scottish roads.

www.transport.gov.scot



Bristol Robotics Lab/University of the West of England

Bristol Robotics Laboratory (BRL) is the most comprehensive academic centre for multi-disciplinary robotics research in the UK. It is home to a vibrant community of over 300 academics, researchers and industry practitioners who have been involved with Connected and Autonomous Vehicle Research since 2015.

Their focus is on validating CAV systems in simulation, testing thousands of scenarios making sure the technology responds as expected.

www.bristolroboticslab.com

Edinburgh Napier
UNIVERSITY



Edinburgh Napier University nurture talent and create knowledge that shapes communities all around the world. Their Transport Research Institute is Scotland's largest and longest established transport research group (Est. 1996).

Napier are responsible for monitoring the societal viewpoint which aims to understand how technology acceptance levels change as a result of having autonomous vehicles on Scotland's roads.

www.napier.ac.uk



Supported by Innovate UK

Innovate UK is part of UK Research and Innovation, a non-departmental public body funded by a grant-in-aid from the UK government.

They aim to drive productivity and economic growth by supporting businesses to develop and realise the potential of new ideas, including those from the UK's world-class research base.

They monitor and support the delivery of project CAVForth on behalf of the funding partner CCAV.

www.ukri.org



Centre for Connected
& Autonomous Vehicles

Funded by Centre for Connected and Autonomous Vehicles

The Centre for Connected and Autonomous Vehicles (CCAV) is a UK Government unit, part of the Department for Transport and the Department for Business, Energy and Industrial Strategy.

Established in 2015, CCAV is working with industry and academia to shape the safe and secure emergence of connected and self-driving vehicles in the UK.

The work undertaken by CCAV and its partners has already ensured that the UK has a proven track record in leading connected and self-driving vehicle innovation, enabling joint public and private investment of £440 million, £4.6million of which was invested to support the development of this demonstrator service).

www.gov.uk/ccav

Who were the first people to travel on AB1?

On Thursday 19th January 2023 at 10am, 23 passengers travelled on the CAVForth autonomous bus for the first time in a closed trial. The group was made up of local bus users and volunteers from our co-design panel who travelled the route to give feedback and share any views or improvements ahead of the full public launch of the service.

Fleur, who joined the co-design panel through a forum for young people said of the experience:

“

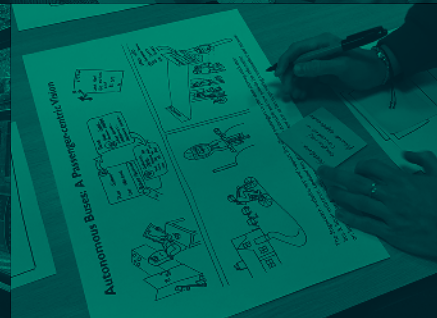
It was quiet exciting, the thought of getting on for the first time, I wasn't worried at all about it – you wouldn't know the difference between this and a normal bus from the driving.

And reflected on the project:

This is something I never thought I would be involved with. I've really enjoyed having the opportunity to share my opinions and bring my thoughts forward – and it's brilliant to see it come through and become this actual thing from a few drawings!

”





“ There’s a way to do it better.
Find it.
Thomas Edison ”



Acknowledgments

The CAVForth project partners would like to thank our funders, CCAV, our many research participants and our lovely Co-design Panel, without whom launching the AB1 service would not have been possible. We are grateful for your support, commitment and energy.

A pre-emptive thank you goes to all the innovators and early adopters who will try out the AB1 service during the trial – we hope you have a lovely journey and go on to tell future generations how you were one of the UK's first to ride on an Autonomous Bus.

Get in Touch

For more information and to keep up-to-date as the trial progresses, visit our website:

www.stagecoachbus.com/autonomousbus
www.CAVForth.com

Twitter: @StagecoachEScot

Facebook: @StagecoachEastScotland
#StagecoachAB1

If you have any questions or feedback, please get in touch anytime:

autonomous@stagecoachbus.com

