

POLIS

CITIES AND REGIONS FOR TRANSPORT INNOVATION

ANNUAL
CONFERENCE
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MultiCAV

The UK's first autonomous electric bus service

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Head of Policy – First Bus



The MultiCAV consortium



Listening Learning Leading



Part funded by:



Centre for Connected
& Autonomous Vehicles

Innovate UK



Why and Where?

Because we need to understand whether autonomous vehicles can be used to deliver mainstream public transport services

Trials at Milton Park – a business science and technology park near Didcot, Oxfordshire, UK





Project aims and requirements

- Mi-Link
 - Information on transport options, disruptions, tailored to Milton Park
 - – by website, mobile, what's app, messenger and sms
- Electric bikes for hire – building on existing local bike hire
- **Autonomous buses**
 - Buses – on public roads – in normal traffic – on normal service
 - Testing user acceptability, safety driver reaction and operational practicality



Regulatory requirements and processes

Internal

- Base vehicles are fully type approved and road registered
- Fusion modifications are VTP5 notifiable modifications
- Fusion's CAVStar system robustly tested and monitored
- Consists of cameras, radar, lidar, control unit, vehicle system actuators
- Level 4 autonomous, so any issues – vehicle stops in safe place (or safety driver takes over)
- Vehicles retested by DVSA – UK vehicle regulatory body
- Operational Design Domain (ODD) defined
- Full account taken of Department for Transport and British Standards Institute requirements
- Vehicle and Operational Safety Cases produced by Fusion and First Bus respectively
- Operational Safety Case independently reviewed by First "B" team
- Vehicle and Operational Safety Cases independently reviewed by Horiba MIRA
- Public Safety Case available



Regulatory requirements and processes

External

- Traffic Commissioner (industry regulator) fully involved in project
- Specific insurance for project
- Traffic signal detection
- Road markings checked and upgraded or modified where necessary (Milton Park crossings)
- Emergency communications plan; involvement of emergency services
- Final call on operations – project Safety Committee
 - before on-site driver training and each public operational phase.



In-service requirements

Drivers and Vehicles

- Operated by First Beeline Buses Ltd – Licensed bus operator
- Safety Driver on board at all times – required for UK operation of Level 4 autonomous vehicle as part of Safety Case
- Safety Drivers are fully qualified experienced bus drivers, hand picked
- Trained by Fusion and First – in classroom, on track, on road, at Milton Park; human factors research from Leeds ITS
- Two on board initially; moving to one Safety Driver and one Supervisor on site
- Besides Safety Case requirement, UK “Conduct Regulations” require human on board – and for passenger safety, security and wellbeing
- Vehicle maintenance by Fusion (CAVStar equipment), manufacturer, First Bus
- Depot on site at Milton Park for overnight electric charging, crew rest, minor maintenance
- Heavy maintenance or repair at closest First Bus operational depot



In-service requirements

Operational

- Additional safety checks on first use/handover and on 28 day inspection
- Route check before service each day
- Journey log record
 - conditions; vehicle behaviour; unexpected events/emergencies; need for driver handover
- Ongoing dialogue/reports First/Fusion - software or hardware upgrades
- Bus stops at every stop by default
- Passengers can view service on Mi-Link
- Passenger demand will influence route modifications for future Phases
- Cannot register route – no fares can be taken
 - ultimate flexibility for route or timetable change, suspension for maintenance/upgrade



Passenger, driver and third-party safety

- Fusion's CAVStar system robustly tested and monitored
- Any issues lead to driver handover or vehicle stopping in safe place
- Drivers fully trained in handover of control
- Vehicles fitted with seatbelts – this is an experimental operation not mainstream bus
- CCTV fitted internal and external (in addition to CAVStar)
- DriveGreen, Seeing Machines driver monitoring, two-way emergency comms fitted
- AVAS electric vehicle pedestrian warning system fitted
- Max 2 hour driving shifts within work pattern limited to UK drivers' hours regulations
- Clearly marked "autonomous vehicle"
- If it isn't safe, we don't operate!



Training and Testing

Vehicles – for each vehicle

- All certification completed
- On track testing – off road
- On route testing

Safety Drivers

- Classroom testing
- On track testing – vehicle familiarisation for each vehicle
- Safety committee approval
- On route testing for each phase
- Safety committee approval
- Passenger service commences

How is this funded?

The project has been part funded by the UK Department for Transport's Centre for Connected and Autonomous Vehicles, otherwise known as CCAV. All other funding has been provided by the commercial project partners.

None of this comes from local council tax, business rates or other local council expenditure.

What can we gain from autonomy?

The UK is at the forefront of autonomous technology and wishes to remain in that position. We are exploring the potential for the application of this technology to real world situations. Local bus services provide an equalitarian transport solution for everyone, irrespective of income, car ownership, ability to drive or personal mobility. However, running any type of vehicle is not cheap and this is equally true of buses. If we can find a way of reducing that operating cost, we will in future be able to extend the range of public transport to places where it is currently simply uneconomic and unaffordable to provide – either by commercial bus companies or funded by local authorities. But we have to learn about applying the technology first, from experience! And that includes your experience – as a passenger, a stakeholder, another road user, or just an observer.

How green is my journey?



The bus we are using is a state of the art fully electric vehicle powered by batteries which are recharged overnight. The vehicle's propulsion system produces no carbon and no airborne emission of oxides of nitrogen or sulphur. As part of the MultiCAV project, a fleet of Mi-Link electric bicycles is also available to hire from Didcot Parkway Station and other handy locations nearby – find out more by scanning this QR code.



The Centre for Transport & Society at the University of the West of England who are conducting the research including surveys and interviews. You can read about our research findings so far here: <https://www.mi-link.uk/projects>



Operators and managers of Milton Park, a business, science and technology park who have provided much of the infrastructure used by the autonomous vehicles, as well as the electric bicycles for hire.



The local planning authorities which have provided support to MultiCAV.



Creators of the Mi-Link journey planner and the QR codes and links that give easy access to the MultiCAV transport services and background transport provision.



The UK's leading developer of automated driving software and systems whose technology has enabled the operation of the autonomous buses.



NovaModus consultants who have provided technological and project management support.



Your Local Transport Authority responsible for highways and bus services in the County who have facilitated the operation of these services



The Centre for Connected and Autonomous Vehicles, part of the Department for Transport, has provided funding support for this project through Innovate UK's complement partners' contributions.



Leading the project and operator of the autonomous bus service. First Bus runs 4500 buses in and between major towns and cities in the UK and Ireland.

To contact any of the above please visit our website www.miltonpark.com/mi-link-autonomous-bus or email us at multicav@miltonpark.com. We hope you enjoy your experience on the UK's first autonomous bus service

MI-LINK

The UK's first autonomous bus service!



Phase 1 Launch: 23 Jan 2023 at Bee House, Milton Park

By Richard Holden, UK Parliamentary Under Secretary of State for Roads and Local Transport



Welcome

The Mi-Link bus service, electric bike and journey planning have been delivered by the MultiCAV project. This includes the first use of an electric autonomous bus to carry passengers in the UK.

The service is operating around Didcot in Oxfordshire, initially within the Milton Park business, science and technology park and later in the new year will provide links to Didcot Parkway station.

The bus is 100% electric and emissions free. The service is available for anyone to use and it's free to use. It is fully accessible to users of wheelchairs and other mobility aids.

If you're on the bus, welcome aboard and enjoy the trip! If not, why not give it a try – this leaflet will tell you all you need to know.



Milton Park Circular, Route 1

The service runs from 0700-1900 Monday to Saturday and a bus will operate every 15 minutes for most of the day.

Scan this barcode on your smartphone to view the timetable.



What is an autonomous bus?

An autonomous vehicle is one which is able to drive itself without human intervention. Some modern cars have autonomous features such as automatic lane keeping on motorways, or self-parking. Full autonomy extends this to the entire driving task, and that is what we have done with the Mi-Link bus. All steering, acceleration and braking is done automatically, and the vehicle will respond to other traffic and road conditions and external events.

What can I expect?

Just check the online timetable and wait for the bus at one of the specified stops. Each stop will provide details of the route and a QR code to scan for live, real-time updates for your journey using Messenger or WhatsApp. No fares are charged on the service. Take a seat (no standing is permitted), fasten your seat belt and we're off!

You are now part of a pioneering use of technology in the UK – the first time autonomous vehicles have been used to deliver a public service! Whilst on board, you may be asked to complete a small survey online, or be approached in person by one of the University of the West of England project team for your views. They will always have appropriate identification so that you know they are genuine. Many journeys will also have a member of the project team on hand to answer any questions. When you want to get off, just press the bell like you would on any other bus, and it will stop automatically at the next bus stop on the route.



Will I be safe?

Yes you will. Before starting operation, the project team has had to complete a rigorous safety assessment which has been independently reviewed. The vehicles we are using are standard electric buses, modified by Fusion Processing to operate autonomously with the modifications fully tested and approved for use on UK roads. The service is operated by First Bus, a fully licensed operator of bus and coach services throughout the UK and beyond. You will notice that there is always a "safety driver" on board – in case a cow jumps in front of the bus, frogs fall from the sky or a sink hole appears in the road – to take evasive action. The safety driver is always a fully qualified and experienced bus driver. We also have all the necessary legal consents and the emergency services have been briefed on our operations. If you feel nervous or worried, please tell the Safety Driver and you will be allowed to leave the bus at the next safe stopping point. If you're technically minded, we can provide you with a copy of the Public Safety Case.



MultiCAV Trials – Phase One

- Milton Park Circular 001 – operated for whole of March 2023
 - Shuttle connected Bee House, car parks, offices, food market and current bus services; providing internal site to site transport
 - Every 15 mins 0700-1830 mon-sat
 - Sought views on user convenience, acceptability of concept; reduced need for private transport



MI-LINK
Milton Park Circular bus times from this stop
Bee House
times are read downwards

scan for live updates

Mondays to Saturdays (except Public Holidays)	07:00	10:00	13:15	16:45	This service does not operate on Sundays.
	07:15	10:15	13:30	17:00	
	07:30	13:45	17:15		
	07:45	11:00	14:00	17:30	
	08:00	11:15	14:15	17:45	
	08:15	11:30	14:30	18:00	
	08:30	11:45	14:45	18:15	
	08:45	12:00	15:30		
	09:00	12:15	15:45		
	09:15	12:30	16:00		
09:30	12:45	16:15			
09:45	13:00	16:30			

Milton Park Circular bus route map showing key locations (Milton Feast, Milton Park Innovation Centre, Bee House) and bus stops. OXFJADJT

What did we learn from Phase One?

- Vehicle worked well in autonomous mode coping with hazards and conditions
- Drivers enthusiastic and keen to adopt technology – keen for future phases; very positive; no major or unresolved concerns with the training and driving experience...
- No accidents or near misses
- Ran autonomous most of the time, but some manual driving due to:
 - temporary roadworks
 - basic vehicle and mechanical issues
- Poor weather led to battery drain
- Information about service worked well
- Passenger reaction generally very positive – but need to show when operating autonomously; none of the participants felt unsafe during the trip



How is this funded?

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None of this comes from local council tax, business rates or other local council expenditure.

What can we gain from autonomy?

The UK is at the forefront of autonomous technology and wishes to remain in that position. We are exploring the potential for the application of this technology to real world situations. Local bus services provide an equalitarian transport solution for everyone, irrespective of income, car ownership, ability to drive or personal mobility. However, running any type of vehicle is not cheap and this is equally true of buses. If we can find a way of reducing that operating cost, we will in future be able to extend the range of public transport to places where it is currently simply uneconomic and unaffordable to provide – either by commercial bus companies or funded by local authorities. But we have to learn about applying the technology first, from experience! And that includes your experience – as a passenger, a stakeholder, another road user, or just an observer.

How green is my journey?



The bus we are using is a state of the art fully electric vehicle powered by batteries which are recharged overnight. The vehicle's propulsion system produces no carbon and no airborne emission of oxides of nitrogen or sulphur. As part of the MultiCAV project, a fleet of Mi-Link electric bicycles is also available to hire from Didcot Parkway Station and other handy locations nearby – find out more by scanning this QR code.



The Centre for Transport & Society at the University of the West of England who are conducting the research including surveys and interviews. You can read about our research findings so far here: <https://www.mi-link.uk/projects>



Operators and managers of Milton Park, a business, science and technology park who have provided much of the infrastructure used by the autonomous vehicles, as well as the electric bicycles for hire.



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The Centre for Connected and Autonomous Vehicles, part of the Department for Transport, has provided funding support for this project through Innovate UK to complement partners' contributions.



Leading the project and operator of the autonomous bus service, First Bus runs 4500 buses in and between major towns and cities in the UK and Ireland.

To contact any of the above please visit our website www.miltonpark.com/mi-link-autonomous-bus or email us at multicav@miltonpark.com. We hope you enjoy using Mi-Link, the first autonomous bus service in the UK.



Phase 2 start of service 12 June 2023

Press release but no formal launch – new PR campaign by Milton Park, additional signage at Didcot Parkway station



Welcome

The Mi-Link bus service, electric bike and journey planning have been delivered by the MultiCAV project. This includes the first use of an electric autonomous bus to carry passengers in the UK.

The service is operating around Didcot in Oxfordshire. Following the success of Phase 1 in March 2023, from 12 June services will link Milton Park business, science and technology park with Didcot Parkway station. Two separate routes will operate, Phase two being route 002 as described below, which will be followed in early July by Phase three (route 003). A different autonomous bus will operate each service

The buses are 100% electric and emissions free. The service is available for anyone to use and it's free to use. It is fully accessible to users of wheelchairs and other mobility aids.

If you're on the bus, welcome aboard and enjoy the trip! If not, why not give it a try – this leaflet will tell you all you need to know.



Milton Park to Didcot Parkway, route 002 from 12 June 2023

The service runs from 0700-1830 Monday to Saturday and a bus will operate every 40 minutes for most of the day.

Scan this barcode on your smartphone to view the timetable.

What is an autonomous bus?

An autonomous vehicle is one which is able to drive itself without human intervention. Some modern cars have driver assistance features such as automatic lane keeping on motorways, or self-parking. Full autonomy extends this to the entire driving task, and that is what we have done with the Mi-Link buses. All steering, acceleration and braking is done automatically, and the vehicle will respond to other traffic and road conditions and external events.

Will I be safe?

Yes you will. Before starting operation, the project team has had to complete a rigorous safety assessment which has been independently reviewed. The vehicles we are using are standard electric buses, modified by Fusion Processing to operate autonomously with the modifications fully tested and approved for use on UK roads. The service is operated by First Bus, a fully licensed operator of bus and coach services throughout the UK and beyond.

What can I expect?

Just check the online timetable and wait for the bus at one of the specified stops. Each stop will provide details of the route and a QR code to scan for live, real-time updates for your journey using Messenger or WhatsApp. No fares are charged on the service, but if you have a Milton Park travel pass please tap in and tap out on the ticket machine just as you would on any other local bus. Take a seat (no standing is permitted), fasten your seat belt and we're off!

You are now part of a pioneering use of technology in the UK – the first time electric autonomous vehicles have been used to deliver a public service! Whilst on board, you may be asked to complete a small survey online, or be approached in person by one of the University of the West of England project team for your views. They will always have appropriate identification so that you know they are genuine. Many journeys will also have a member of the project team on hand to answer any questions. When you want to get off, just press the bell like you would on any other bus, and it will stop automatically at the next bus stop on the route.

Why is there a driver behind the wheel?

You will notice that there is always a "safety driver" on board – in case a cow jumps in front of the bus, the Milton Park goslings decide to cross the road, or a sink hole appears in the road – to take evasive action. The safety driver is always a fully qualified and experienced bus driver. We also have all the necessary legal consents and the emergency services have been briefed on our operations. If you feel nervous or worried, please tell the Safety Driver and you will be allowed to leave the bus at the next safe stopping point. If you're technically minded, we can provide you with a copy of the Public Safety Case.



MultiCAV Trials – Phase Two

- Milton Park – Didcot Parkway 002 – operated for 7 weeks June-July 2023
 - Shuttle connected Bee House, car parks, offices, food market and current bus services; providing internal site to site transport and running to Didcot Parkway
 - every 40 mins 0700-1830 mon-sat
 - Provided unique convenient links to Milton Park sites off the “conventional” bus route



Milton Park Circular bus times from this stop Bee House

times are read downwards

Mondays to Saturdays (except Public Holidays)	07:15	16:35	This service does not operate on Sundays.
	07:55	17:15	
	08:35		
	09:15		
	09:55		
	11:15		
	11:55		
	12:35		
	13:15		
	13:55		
	15:15		
	15:55		



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Mi-Link service 002 Didcot Parkway – Milton Park
Departs from Bus Stop R4 turn left after you leave this building

Phase 2
starting 12 June 2023

What have we learned from Phase Two?

- Vehicle worked well in autonomous mode coping with hazards and conditions – including 40mph running
- No accidents or near misses
- Issues with vegetation have affected autonomous ability and required cutting – still growing!
- Not able to operate autonomously all the time – exit from Didcot Parkway Bus Station – but now able to negotiate Bee House – system “learns” from experience
- Passenger reaction generally very positive
- “Auto” indicator behind driver illuminates when autonomous
- Passengers tap on and tap off with Milton Park smart travelcard – trip data
- Drivers remain enthusiastic and keen to adopt technology – keen for future phases
- Single Safety Driver operation successfully trialled



MultiCAV Trials – Phase Three

- Milton Park – Didcot Parkway 003 – started September 2023
 - Full size bus connects Bee House, offices and food market to Didcot Parkway
 - every 30 mins 0700-1830 mon-sat



Route and stop location; Milton Park to Didcot Parkway





Further research

To be written up...

- Full monitoring data from Fusion for Phases 2, 3
- Journey logs from First for Phases 2, 3
- Additional safety driver, passenger and non user surveys for Phases 2, 3
- Third party survey data
 - schools visit, insurance services, Milton Park businesses



What happens now?

- Project team has learned valuable lessons and can apply these elsewhere
- Regulatory hurdles understood and can be tackled more efficiently
- Drivers trained, vehicles approved, principles of safety case proven
- Technology works – exceeds expectations
- Drivers accept technology – but need to retain safety driver – legal reasons
- Operation not commercial without support – costs more than conventional bus
- Local authority or third-party contracts; S106 developer contributions
- Revenue can be collected – if so desired
- Need depot site with charger – but no other constraints
- Need commitment to ensure vegetation kept in trim
- Visit www.mi-link.uk/research for detailed findings to date



Visit www.mi-link.uk

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Thank you for your attention!



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