The driverless road ahead for logistics:

Realising the Connected Autonomous Logistics (CAL) opportunity

Newcastle University

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Foreword

The road freight sector is an essential component of the UK economy, providing a crucial service to a wide range of industries and contributing £13.6bn to GDP each year.

However, as the demand for road freight increases, so too does the need for the sector to evolve and adapt if it is to be fit for purpose and sustainable into the second half of the 21st century.

First, there are significant workforce challenges in the freight sector, including shortages of skilled drivers and an ageing workforce. HGV drivers are also rightly restricted by the number of hours they can drive each day and week, and there are a range of safety considerations that need to be taken into account for drivers.

Secondly, HGVs have a high carbon footprint and are among the worst polluting road transport vehicles in the UK. To meet the UK's ambitious Net Zero target, it's important that all sectors play their part in reducing carbon emissions, so there is a challenge for the road freight sector in becoming more sustainable.

Connected Autonomous Logistics (CAL) technology presents a unique opportunity to address these challenges and drive innovation in the sector. By leveraging advancements in technology, we can improve the efficiency, safety, and sustainability of the road freight sector, while also creating new and better job opportunities for workers.

At the heart of this research and innovation is the North East of England and the work that my Newcastle University team are leading with industry partners and other key stakeholders. With the right support, the region has the potential to be a centre of innovation for the UK.

This report provides valuable insights into the potential of CAL and the steps we must take to fully realise its benefits including a consideration of the establishment of a National Innovation Centre for Connected and Autonomous Logistics (NICCAL).

I encourage all policymakers and industry partners to read this report and consider its recommendations carefully. By working together, we can build a stronger, more sustainable, and more inclusive road freight sector for the future.

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Executive Summary

Overview

The road freight sector is worth a massive £13.6bn to the UK economy each year. It underpins a wide range of industries, acting as an enabler for everything from manufacturing and heavy industry to retail and hospitality.

Road freight will be at the heart of powering the UK's future economy, but there are big challenges we must first tackle. As demand for road freight increases – with the volume of goods moved by road up 23% in the decade to 2019 – the UK is facing a major workforce shortage in the sector.

According to the Road Haulage Association (RHA), the country has an estimated shortage of 100,000 HGV drivers, something that it describes as being at "crisis point", while critical supply chains are failing[1]. As the age of drivers in the sector rises too, road freight is facing a further workforce crisis further down the line, as workers reach retirement age and exit the labour market – leaving a large workforce gap in their wake.

Meanwhile, there is an ongoing public conversation in the aftermath of the Covid-19 pandemic about the future of work. As office workers benefit from increasing flexibility to work remotely and flexibly,

we must consider how the logistics sector can leverage advancements in technology to improve the quality of jobs and appeal to a more diverse workforce.

Advancements in Connected Autonomous Logistics (CAL), pioneered in the North East, present a real opportunity to innovate and future proof the logistics sector – improving efficiency, lowering costs, and creating safer and more flexible jobs for thousands of workers in the sector.

The opportunity at hand is huge — with a potential 60% uplift in the economic contribution of the UK's road freight sector in the future from fully autonomous logistics vehicles, as well as a range of social benefits from the implementation of CAL, such as a more flexible and inclusive future of work for remote operators.

To realise this, we need the Government to support research and development, by investing in the North East, and helping to enhance the region's position as a centre for innovation in the UK.

1. Road Haulage Association (RHA), 2021, A report on the Driver Shortage

Summary of recommendations

1.

The UK's Vehicle Certification Agency should work with stakeholders and industry to define a fast-track pathway towards type approval for CAL vehicles.

2.

The Government should enhance public investment in public 5G and 6G telecommunications infrastructure to ensure CAL vehicles can access resilient, high-quality and low latency communications.

3.

The Government should continue to expand the UK's cyber-security capabilities, to ensure that CAL vehicles can operate safely in light of emerging threats such as the development of quantum computing.

4.

The Government should commit to further R&D investment in the North East to help drive further innovation in the region to create end-to-end integrated business models and systems, and support levelling-up objectives.

5.

The Government should support further and higher education providers, as well as vocational training providers to develop new qualifications and adapt existing courses to equip students with the skills to develop and/or operate CAL technology in the future, including in cyber-security software engineering, and tele-operation of CAL vehicles.

6.

The Government should support the creation of a globally unique National Innovation Centre for Connected Autonomous Logistics (NICCAL) in the North East of England, which builds upon the UK CAV ecosystem, contributing to the region's ambitions to be the regional demonstrator for Connected and Autonomous Mobility (CAM).

7.

The Government should explore how investment in technology such as CAL could help to expand access to the labour market in the long-term.

8.

The Government should improve access to education and training in technical areas which would be required to scale the development and deployment of CAL technology.

The logistics challenge

Value of the road freight sector

The road freight industry contributed £13.6 billion to the UK economy in 2019 – a 9% rise on 2018[2]. In 2019, 1.44 billion tonnes of goods were moved by road freight in the UK, across a total distance of 19 billion kilometres[3].

The sector has grown significantly in recent years, with 23% more goods moved by road in 2019 compared with a decade ago[4]. Couriers and hauliers account for most of the recent growth in the UK's overall transport and storage sector[5]. Between 2011 and 2021, the number of businesses classified as "freight transport by road" increased by 114%[6].

Every major sector of the UK economy is supported by road freight. Retail businesses rely on road haulage to deliver goods, whilst construction and manufacturing businesses rely on the sector for materials, health and social care for medicines and equipment, and the food industry for ingredients. In practice, this means that the road freight sector contributes significant indirect value to the UK economy, acting as a vital enabler for other industries and driving economic growth.

Workforce pressures

The sector is currently facing a significant workforce shortage, placing pressure on its ability to meet rising demand.

An estimated 268,000 people were employed as HGV drivers between July 2020 and June 2021[7]. This is 39,000 fewer than the year ending June 2019.

Whilst the pandemic saw a significant decrease in the number of HGV drivers in the UK, this decline is part of a longer-term trend that has seen a 53,000 drop in the number of drivers since a 2017 peak of 321,000.

The RHA estimates that based on the declining number of HGV drivers and the increase in demand, there was a shortage of more than 100,000 HGV drivers in 2021, while critical supply chains are also failing[8].

Part of this decline has been driven by a sharp fall in European Union (EU) nationals working as HGV drivers in the UK. There were 28,000 EU nationals working as HGV drivers in the year ending June 2021, which is 12,000 (30%) fewer than the year ending June 2017[9].

Meanwhile, gender diversity in the sector is extremely low – with women making up just 1% of the workforce. There is limited data to explain why the number of women working at HGV drivers in the UK is so low, but the Transport Select Committee heard evidence in 2022 that working conditions including unpredictable hours, the physical nature of the job, and poor access to facilities often deterred women from the sector[10].

The HGV driver workforce is older than the average across the total employed population. Between July 2020 and June 2021, 29% of HGV drivers were over ages 56 years or older, compared with 19% for the overall employed population. The sector has seen a 7% decline in the number of younger drivers aged up to 35 since 2017. In practice, this means that as drivers reach retirement age and exit the labour market, there are fewer younger drivers to replace them, which will add further pressure to an already strained sector.

2. Department for Transport (DfT), 2020, Domestic Road Freight Statistics United Kingdom 2020
3. Department for Transport (DfT), 2020, Domestic Road Freight Statistics United Kingdom 2019
4. Ibid
5. ONS, 2022, Data for number of UK business premises used for transport and storage, by sub-industry
6. Ibid

7. ONS, 2021, Fall in HGV drivers largest among middle-aged workers
8. Road Haulage Association (RHA), 2021, A report on the Driver Shortage
9. Ibid
10. Transport Select Committee, 2022, Road freight supply chain

Future of work in the road freight sector

As businesses across the economy explore opportunities to transform work and workplaces in light of new technology and a changing society, the wider logistics industry has already undergone significant transformation.

In key parts of the industry such as warehousing, large scale automation and digitalisation have already taken hold, with more workers now working in tandem with robots and using digital communication, sensors and other technology to work more efficiently.

Road freight still relies entirely on human labour, requiring workers to spend long periods of time away from home without the flexibility increasingly available to workers in other sectors of the economy.

In a change largely driven by the Covid-19 pandemic, remote and hybrid working has exploded in recent years. In April 2020, nearly half (46.6%) of people in employment did some of their work from home[11]. In February 2022, 84% of workers who had to work from home because of the coronavirus pandemic said they planned to carry out a mix of working at home and in their place of work in the future[12]. The total proportion of workers hybrid working in May 2022 stood at 24%[13].

Data shows that younger workers and those with young children are more likely to favour remote and hybrid working options. A 2021 study by McKinsey & Company found that 48% of 18-29 year-olds said they preferred remote working, whilst only 8% of employees with young children said they preferred fully on-site models of work[14].

There are good reasons for this change in employee attitude. ONS data shows that more than three-quarters (78%) of those who worked from home in some capacity felt that being able to work from home had given them an improved work life balance[15].

As road freight grapples with the challenge of a declining workforce, embracing the opportunities of tele-operation as demonstrated in trials of CAL in the North East, and wider automation in the sector will be a vital means of appealing to a new demographic of workers, and building a more appealing future of work for those working in the sector.

11. ONS, 2020, Coronavirus and homeworking in the UK: April 2020
12. ONS, 2022, Opinions and Lifestyle Survey
13. Ibid.
14. McKinsey & Company, 2021, What employees are saying about the future of remote work
15. ONS, 2022, Opinions and Lifestyle Survey

What is connected autonomous logistics?

Connected Autonomous Logistics (CAL) is a new concept for embedding autonomous technology in the road freight sector. Using the latest developments in autonomous vehicle technology, a new generation of heavy goods vehicles (HGVs) capable of autonomous operation over long distances is currently in development and testing.

Whilst there are various ways CAL technology could be deployed, we are currently developing a solution that would allow CAL vehicles to be remotely operated in addition to autonomous operation – as a transition on the journey to full automation. Using communications networks including 5G, 6G, and other technologies in the future, a network of tele-operators would be able to connect to vehicles and operate them remotely in real-time.

Future technology in the logistics sector

CAL would represent a vital advance in the logistics sector, as technology advancements change the way goods move through supply chains. Recent years have already seen significant developments in automated loading and unloading systems, along with enhanced digitalisation to enable connected supply chains with greater end-to-end visibility.

CAL would take these technologies to another level, increasing efficiency and unlocking further benefits from combining wider advancements to deliver safer and more economically viable outcomes.

The rollout of CAL vehicles would also reduce friction involved in intermodal transfer – the transfer of freight from one form of transportation to another – such as from sea and rail to road, by combining the power of autonomous vehicle operation with technologies such as automated loading and unloading. This would have the additional benefit of reducing capital and operational costs in the movement of freight, which would provide an additional boost to the UK economy.

The technology underpinning CAL could also be applied to smaller logistics vehicles, to improve efficiency in 'last mile logistics' in addition to benefits for long haul freight movement.

Collectively, these technological advancements in the logistics industry – supercharged by the development of CAL – would enable a smoother flow of goods from port to production line and from farm to fork, and help to create a more integrated transport network in the future.

How it works

1.

HGV tractors would be manufactured as purpose-build CAL vehicles. Each vehicle would be delivered with in-built communications and autonomous driving technology.

2.

Existing HGV tractors could also be retrofitted to function as CAL vehicles, helping to speed the adoption of CAL across the industry, and reducing the investment required by individual logistics firms.

3.

CAL vehicles would connect to a UK-wide network of 5G and 6G communications infrastructure, enabling constant communications with highly trained remote tele-operators.

4.

The vehicles would operate autonomously – initially on private roads, such as within large ports through 5G CAL.

In complex traffic situations, CAL vehicles would be able to stop safely and handover to tele-operators who would be on hand to step in if needed. This would ensure there is always a failsafe for the purpose of safety.

The potential of connected autonomous logistics

The development and rollout of CAL would represent a massive step change in how the road freight sector operates.

Best estimates show that fully autonomous logistics vehicles could boost the road freight sector's annual contribution to the UK economy by up to 60%, from around £13 billion in GVA each year to more than £21 billion. This estimate is based on an expected reduction in logistics operating costs by 47%, driven by reducing labour costs and increasing efficiency of vehicle operations[16].

Looking at the impact of manufacturing and sales of new semi and fully autonomous HGVs, the global market is expected to reach more than £60 billion by 2027, at a growth rate of more than 10% each year[17]. With the UK playing a leading role in the development of CAL vehicles, the country would be well placed to export vehicles, helping to drive additional growth in the UK economy.

Workforce considerations

As well as tackling the current shortage of drivers in the sector, CAL would reimagine the roles of vehicle operators, creating new jobs fit for the future of work. The rollout of CAL would remove the need for vehicles operators to be physically present in vehicles, enabling them to work remotely from anywhere in the UK. This would be particularly beneficial as a means of bringing remote jobs to areas of the country with high rates of unemployment.

Operators would also be empowered to work more flexibility — bringing the sector into greater parity with other areas of the economy such as office work. Long routes could be split into segments, controlled by multiple tele-operators enabling short shift patterns which could fit more easily around caring and childcare responsibilities and leisure time.

CAL would also bring inherent safety benefits to the sector. In 2019, more than 1,300 HGV drivers were killed or seriously injured in collisions on the UK's road network, despite high safety standards in the sector[18]. Collisions involving vehicles also take place in warehouses, freight yards, and other similar settings each year, causing injury to vehicle operatives and other logistics workers.

Removing operators from vehicles would remove their risk of injury in the event of collision, and moving to autonomous operation would also reduce the overall risk of collisions, enhancing safety for other logistics workers.

Today, drivers in the logistics sector are rightly bound by carefully considered restrictions on the number of hours they can drive before taking a break, and the total number of hours they can work each week. These regulations are essential for the safety of drivers and other road users, but CAL has the potential to render some restrictions redundant.

If remote CAL operators reach their maximum hours for safe operation, another remote operator would easily be able to take over, preventing the need for numerous stops over long journeys.

In practice, this would allow for increased speed and efficiency in road freight, helping to reduce the number of vehicles required to deliver goods – thus reducing traffic congestion in urban areas and on major arterial roads.

16. PwC, 2018, The era of digitized trucking
17. Acumen Research and Consulting, 2020, Semi & Fully Autonomous Truck Market
18. Department for Transport (DfT), 2022, Reported road accidents, vehicles and casualties tables for Great Britain

The green agenda

The rollout of CAL vehicles would drive a major step forward in the sustainability of road freight. At present, Department for Transport statistics show that they account for 18% of greenhouse gas emissions and 13% of nitrogen oxide (NOx) emissions for road transport in the UK[19].

However, typical CAL vehicle journeys would be more efficient than traditional HGV journeys because vehicles operating autonomously drive more consistently and are capable of factoring in a more complex range of data into their calculations to help optimize their performance. Moreover, it is expected that many CAL vehicles will have an electric or hydrogen fuelled drivetrain as with the 5GCAL and V-CAL projects currently demonstrating CAL in the North East.

In addition, enhanced connectivity of CAL vehicles could deliver further benefits, such as through integration with Green Light Optimised Speed Advisory systems (GLOSA) connecting CAL vehicles to traffic systems to help determine how fast the vehicle should drive to ensure it can pass through traffic lights without having to brake or accelerate. This would deliver significant fuel savings as well as reducing tyre and brake particulate reduction.

CAL technology could also enable new logistics practices such as 'platooning' where a convoy of HGVs is controlled by a lead vehicle to help reduce drag and improve fuel efficiency. Research shows this practice could produce 2-15% of fuel savings[20,21].

Whilst CAL technology would initially be retrofitted to existing fossil fuel powered HGVs in many cases, future CAL vehicles could also be designed to be fully electric or hydrogen powered, enabling the logistics sector to further reduce its emissions footprint.

These benefits would help the UK move closer to its overall Net Zero targets, whilst also supporting the UK's regions, cities and towns to decarbonise at a local level.

19. Department for Transport (DfT), Transport and environment statistics: Autumn 2021
20. U.S. Department of Transportation, 2018, Emerging Freight Truck Technologies: Effects on Relative Freight Costs
21. McKinsey and Company, 2018, Distraction or disruption? Autonomous trucks gain ground in US logistics

The North East as a centre of innovation

Logistics is widely recognised as a key enabling sector for the North East, and contributed £662 million in Gross Value Added (GVA) to the region in 2020[22]. Further investment in the region's capability to drive innovation in this sector would help to create jobs and unlock huge economic potential, supporting the UK's levelling up objectives.

The North East is already leading the way when it comes to developing CAL technology. Since 2020, Newcastle University has led a research consortium together with the North East Automotive Alliance (NEAA), the Connected Places Catapult, Coventry University, Sunderland City Council, and leading businesses including Vantec Europe Limited, StreetDrone Limited, and Perform Green Limited.

The research project received £2.4 million from the UK Government's 5G Create competition, to develop a globally unique centre of excellence and operational test facility for CAL. In May, the consortium led trials of the UK's first zero emission automated logistics HGV, testing last mile delivery for autonomous HGVs weighing up to 40 tonnes on a private road[23].

Two further CAM projects were announced as part of the 'Commercialising Connected and Automated Mobility: Deployments' competition in February 2023 the SAMS (Sunderland Automated Mobility Shuttle) and the VCAL (successor to the 5GCAL project), again demonstrating the increasing role the NE is playing in this field.

The North East is ideally placed to continue development of CAL technology, with access to vital technical knowledge and resources to drive further research and development.

The region already has an emerging CAL supply chain, with leading businesses such as Nissan, Terberg, and StreetDrone located in the region. In total, more than a thousand transport and logistics companies are currently based in the North East, employing more than 15,000 people. The region has a high density of industrial sites and a mature supply chain, meaning that as CAL technology continues to advance, vehicles can be piloted in distributing parts and assemblies at sites such as the Nissan Sunderland plant, linking to many local SMEs in the supply chain.

Across the wider region, a wealth of additional expertise also exists, including in the communications networks that would underpin CAL, as well as cyber security requirements to ensure CAL can be rolled out safely.

The North East is also an important transport hub, and the development and deployment of CAL vehicles in the region would likely have a major impact on the local economy. The region already has two international airports and four major seaports, providing the ideal conditions to realise the full benefits of CAL technology, without the need for major infrastructure investment by the Government.

We are currently developing detailed plans for to establish a new globally unique National Innovation Centre for Connected Autonomous Logistics (NICCAL) in the North East of England, which builds upon the UK CAV ecosystem, contributing to the region's ambitions to be the regional demonstrator for Connected and Autonomous Mobility (CAM). This recommendation is a result of our partnership work with the NEAA, funded by the North East Local Enterprise Partnership.

Sunderland has successfully trialled a 5G CAL vehicle at Nissan/Hitachi demonstrating safe tele-operation of a tractor-trailer system

Sunderland established itself as a 'smart city', with a 20-year plan to turn the city into a world-leading digital centre

Sedgefield is home to the North East Satellite Applications Centre of Excellence

The North East has the world's largest automotive cluster with a high concentration of over 30 Tier 1 suppliers and many SMEs

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22. ONS, 2022, GVA by Detailed Industry Sector in North East LEP
23. Citti Magazine, 2022, UK's first zero-emission autonomous HGV trial underway

Connected Autonomous Logistics is part of a wider innovation hotbed

Key

- Airport
- Seaport
- Academic
- Industry

Northumberland

Green Superport, Blyth

Newcastle International Airport

Newcastle University

Port of Tyne

NICCAL

Nissan, Vantec and IAMP

Port of Sunderland

Tyne and Wear

Durham University

Port of Hartlepool

Teesport

County Durham

Teesside International Airport

Getting ahead of the logistics challenge

The North East is ideally placed to support the development and delivery of Connected Autonomous Logistics. We've already made exciting progress, but we need support from Government to scale our work and deliver benefits across the region and the UK more widely.

Between May and July 2022, Newcastle University hosted a series of workshops with attendees from across the region, representing academia, industry, and local government. During these workshops, we explored the technical, economic and social challenges that need to be overcome in order to fully realise the CAL opportunity and get ahead of the numerous challenges currently facing the logistics sector.

Drawing on this analysis, we have provided an overview of key barriers to development and rollout of CAL technology below, along with a number of recommendations for the UK Government.

Technical advancements

CAL vehicles constitute a new type of road vehicle, and therefore must receive Type Approval by the UK's Vehicle Certification Agency before they can be driven on public roads. Introducing type approval will also support manufacturers, by establishing a consistent set of standards for the design of CAL vehicles.

As CAL vehicles are further developed, greater consideration will be needed to explore the role of new tele-operators, and how robust safety and operation standards can be ensured through effective regulation.

Finally, robust communications infrastructure and cyber-security systems will need to be developed to ensure the safety of CAL vehicles. Whilst road freight operators using CAL vehicles may need to invest in private 5G and 6G technology in some areas, investment in the UK's public telecommunications network must be expanded to ensure semi and fully autonomous vehicles such as CAL HGVs can rely on access to resilient and high-quality communications.

The UK Government should also continue to invest in additional cyber-security measures, to meet emerging threats that could impact of the ability of CAL vehicles to operate, such as quantum computing technology.

Recommendation 1
The UK's Vehicle Certification Agency should work with stakeholders and industry to define a fast-track pathway towards type approval for CAL vehicles.

Recommendation 2
The Government should enhance public investment in public 5G and 6G telecommunications infrastructure to ensure CAL vehicles can access resilient, high-quality, and low latency communications.

Recommendation 3
The Government should continue to expand the UK's cyber-security capabilities, to ensure that CAL vehicles can operate safely in light of emerging threats such as the development of quantum computing.

Economic and skills opportunities

The North East already has a strong research and development ecosystem, but the region needs support to turbocharge innovation in key sectors including logistics.

Newcastle University has played a leading role in strengthening the link between industry and academia, working with a range of key businesses across the region to understand industry needs and drive regional and national economic growth.

As the UK Government seeks to level up the country, investment in the North East to drive innovation, meet skills shortages, and address access to employment will all be vital enablers of delivering a more cohesive and balanced UK economy.

In the logistics sector, businesses are currently hampered by worsening driver and skills shortages, limiting their ability to grow within the region.

As we have highlighted elsewhere, future demands on the road freight sector are likely to increase, as public consumption habits change, and technological advancements mean that news skills will be required in the logistics workforce.

Further investment in the research and development CAL technology would unlock significant benefits for industry within the region and across the UK, enabling logistics firms to rollout new business models with long-term financial savings and more efficient operation. Additionally, the technology would help to stabilize wages in the road freight sector, which increased by 12% in 2021[24], as well as helping the UK become a world leader in the provision of zero-emission automated logistics vehicles with a massive export value to a global logistics market worth $4.92 Trillion in 2021[25].

24. Logistics UK, 2022, Skills and Employment Update 2022
25. Business Wire, 2022, Logistics Market: Global Industry Trends, Share, Size, Growth, Opportunity and Forecast 2022-2027

Recommendation 4

The Government should commit to further R&D investment in the North East to help drive further innovation in the region to create end-to-end integrated business models and systems, and support levelling-up objectives.

Recommendation 5

The Government should support further and higher education providers, as well as vocational training providers to develop new qualifications and adapt existing courses to equip students with the skills to develop and/or operate CAL technology in the future, including in cyber-security software engineering, and tele-operation of CAL vehicles.

Recommendation 6

The Government should support the creation of a globally unique National Innovation Centre for Connected Autonomous Logistics (NICCAL) in the North East of England, which builds upon the UK CAV ecosystem, contributing to the region's ambitions to be the regional demonstrator for Connected and Autonomous Mobility (CAM).

Social considerations

The roll-out of CAL vehicles would require significant steps to communicate the value and safety of autonomous driving technology to the general public. Whilst industry can play an important role in educating communities about the benefits of new technology, the UK Government should commission research to understand public perceptions of CAL technology and potential interventions for improving acceptance.

Meanwhile, as public attitudes about the nature and shape of work continue to change over time, the UK Government should take further steps to explore how investment in technology such as CAL could help to expand access to the labour market in the long-term, and how a transition to CAL could be managed effectively. As part of this, the Government must improve access to education and training in technical areas, such as software development, which would be required by the widespread implementation of CAL vehicles.

Recommendation 7

The Government should explore how investment in technology such as CAL could help to expand access to the labour market in the long-term.

Recommendation 8

The Government should improve access to education and training in technical areas which would be required to scale the development and deployment of CAL technology.

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