INRIX Automated Freight Corridor Assessment

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EXECUTIVE SUMMARY

Highly Automated Vehicles (HAVs) are poised to dramatically alter the long-haul trucking sector. However, significant uncertainty persists concerning the best-suited locations for their initial, successful commercial and safety focused deployment. In response to this uncertainty, INRIX Research sought to identify corridors in the United States, United Kingdom and Germany that are best suited for near-term autonomous trucking deployment. Commercial and safety viability indexes were developed for each country by drawing on INRIX data and proprietary products.

Each country of study holds significant potential for HAV technology deployment in commercial trucking based in part on critical labor shortages, which are only expected to worsen in the future. Faced with increasing labor costs, the ability of freight operators to recoup the higher capital costs of HAV technology will improve over time, particularly as the price of the technology also declines as it scales and component prices decrease.

The environmental benefits of HAV technology are more ambiguous than the operational benefits. Declining costs may increase demand, resulting in an increase of overall vehicle miles traveled. That said, HAV technology is being developed predominately on alternative drivetrains (battery, compressed natural gas, hybrids) so increased efficiencies may outweigh potential demand increases.

This report provides valuable insights concerning the early adoption of HAV technology on specific corridors. By identifying the priority corridors in each country, decision makers can make educated decisions as to where autonomous freight technology should first be deployed. Deployment will likely begin in the near-term and progress rapidly as the technology reaches maturity. To guarantee its success, operators must identify and prove its feasibility on existing corridors. This report applies a systematic, data-driven approach to identify where autonomous trucks are best suited to first take the road.

INTRODUCTION

Globally, the commercial freight sector faces increasing costs driven predominately by labor, emissions, and rising fuel efficiency.1 Highly Automated Vehicle (HAV) technology can decrease the costs of emission regulations and fuel efficiency standards. Furthermore, HAV technology holds significant potential to decrease truck-related incidents. The returns on investment for safety features will likely be high due to the disproportionate role trucks play in roadway incidents.

Freight sector adoption of HAV technology can improve safety and decrease operational costs if deployed effectively. This report offers insights into the applicability of HAV adoption in the near term. Answering the following for the United States, United Kingdom and Germany:

1. Which corridors are most commercially viable for early autonomous freight adoption?
2. Where can HAV technology maximize safety benefits?

What is a truck?

In this report we use the term truck, lorry and freight vehicle interchangeably. In the U.S. these terms refer to a ‘heavy duty’ truck with a gross vehicle weight rating of at least 26,000 pounds (12,000 kg) and which require a commercial driver’s license to operate. In the U.K. and Germany, this study focused on heavy goods vehicles (HGV), also known as large goods vehicles (LGV) which is the term for any truck with a gross vehicle weight rating of over 7,716 lbs (3,500 kg).

METHODOLOGY

High-impact commercial corridors are roadways of 100 miles or more with congestion rates of approximately five-percent or lower. Overall length and freight volumes for the identified corridors were then calculated.2 Congestion, length, and volumes respectively were scaled from zero to one. One being the best, zero the worst. By normalizing these values, comparisons between non-related variables is possible. From their averaging, a commercial suitability index was derived. Corridors with low congestion and great length were identified to be the most viable for early adoption of HAV technology due to the operational simplicity and potential to reduce operating costs.

The least safe corridors were identified by examining 100-mile segments with the highest number of incidents per mile (i.e. crashes, slowdowns, construction). Unlike in the commercial procedure, the distance was not included in the scaling or average score since it was held fixed. Freight volumes and incidents were scaled for each identified corridor. The average of these two values created a safety suitability index. Severe slowdowns provide the best insights since it incorporates environmental hazards. HAV technology could improve safety on these corridors to a high degree since these systems will have the ability prepare for and react more quickly than human drivers to dangerous conditions.
INRIX DRIVERLESS TRUCK SUITABILITY INDEX

To determine the best roads for autonomous truck deployment, INRIX Research used three key variables: freight volume, congestion levels and incident rates. A corridor length of 100 miles (161 kilometers) or more was the threshold for analysis. INRIX products used to access this data were:

- **INRIX Trips**: Driver trip data was utilized to identify critical corridors for study. The tool provided a proxy to measure freight volumes (freight traffic volume adjusted for length of road) on corridors across every road in the U.S., U.K. and Germany. The period of observation extended from June 6 to August 8, 2018. The start point, end point and waypoints of every freight vehicle in the extracted data were used to estimate the relative freight density on the roads in each country (i.e., the busiest freight corridors).

- **INRIX Roadway Analytics**: For each of the freight corridors identified from INRIX Trips, congestion was estimated using INRIX Roadway Analytics and an algorithm in which the average speed was divided by the designed speed of a given facility.

- **INRIX Incident Platform**: The platform was used to find corridors with the highest per mile incident rates, by averaging scaled freight volumes and distance with scaled congestion and incident data, top ten list were created for commercial and safety viability.

LABOR AND PRODUCTIVITY

The primary economic impetus behind HAV adoption is decreasing labor inputs based on the premise that truck operators will not be required for all operations.

The second economic incentive is HAV technology will potentially enable the operation of larger trailers or truck trains. Additionally, there could be savings from reduced parking fees as the need for truck stoppage decreases. Finally, even if deployed on current diesel drivetrains, autonomous technology could provide fuel savings by optimizing vehicle operations.

Decreasing labor and fuel costs could have significant implications for the growth of the freight industry. Lower prices would enable trucking to compete with rail at greater distances than at present, increasing truck market share. Furthermore, lower costs will make it feasible to serve a larger geographic area as the ‘break even’ point will decrease. Both improved competitiveness and greater scope would promote sectoral growth.

However, HAV efficiency improvements may not outweigh sectoral employment trends. Labor shortages permeate the trucking industry and HAV deployment will be critical to combating future deficiencies. The forecast of higher market share and serviceable areas depends upon the cost savings from autonomous and new drivetrain technology outpacing increased labor costs. Similar to trucking, rail will experience increased operating efficiencies from technological advances. However, rail’s existing low labor and fuel cost per unit of freight gives it less potential for technology-driven savings than trucking.

SAFETY AND ENVIRONMENT

HAV deployment on dangerous corridors is forecast to improve overall safety performance. INRIX Research foresees this trend continuing and the scope of HAV applicability increasing with time. The reduction in incidents will enhance corridor performance and decrease congestion. Insurance premiums will likely decrease proportionately with incident reduction. Additionally, the public sector may see a decrease in corridor operational costs due to declining incident responses.

The positive impacts of HAVs on congestion and emissions, independent of incident prevention, are less certain. Near-term (0-5 years) improvements will be marginal due to low HAV penetration rates. Ideally, HAV technology will decrease congestion in the medium (5-20 years) and long-term (20-50 years). Hypothetically, HAVs will enable the operation of larger equipment and multiple trailers, decreasing gross trips.

Uncertainty persists concerning decreased congestion as a product of automation. Given the price sensitivity of freight consumption (price elasticity), a decrease in costs will cause a commensurate increase in demand, increasing aggregate vehicle miles traveled (VMT). In the near-term, the adoption of larger vehicular size and multiple trailers is unclear in many markets due to the need for regulatory approval. Improved roadway throughput is improbable as HAV saturation will not reach the levels necessary to achieve revolutionary improvements in facility performance. In the mid- to long-term, reducing congestion caused by trucking, via HAV technology, may not drive permanent improvements. Passenger vehicles may consume any ‘slack’ produced by decreasing truck trips, a phenomenon known as induced demand.

HAVs are unlikely to eliminate all choke points even at high levels of market penetration in both freight and passenger sectors. Corridors will still be subject to capacity constraints, albeit much higher than the present. Average speeds may increase, but increased capacity, coupled with persistent levels of congestion, may lead to an increase in society’s aggregate time spent in congestion. Within the context of freight, the costs associated with congestion will decrease, increasing roadway usage during peak hours.

With the deployment of HAVs, vehicle-level emissions will decrease, while the aggregate impact of declining costs may increase VMT. Accordingly, this could lead to an overall increase in emissions, depending on the magnitude of each change. This concept of increased pollution as a product of increased efficiencies is an economic phenomenon known as Jevon’s Paradox. Optimistically, HAV technology will directly reduce emissions via improved operations.

The efficiencies derived from autonomous technology could drive the adoption of newer, low-emission vehicles. HAV technology on conventional engines will also result in smoother acceleration and deceleration profiles. Reducing the incidence of acceleration could significantly reduce the emission of pollutants characteristic of this action.\(^5\)
COUNTRY-LEVEL ANALYSIS

Ten corridors, prioritizing for commercial and safety respectively, were identified for each country. Country-specific economic and regulatory factors receive analysis relative to the deployment of HAV technology. From the aforementioned, feasibility and forecasting for the countries of study are developed.

The goal of this study was to identify corridors for businesses and policymakers where deployment of autonomous trucks are best suited to provide immediate returns, assuming the greater technological costs of HAVs. The corridor rankings between countries were not directly comparable in this study since corridor scaling occurred within nations. The scope of this analysis was limited to articulated Heavy Goods Vehicles (HGVs) since they complete the vast majority of long-haul freight movements. Any references to freight, trucks, lorries or vehicles should be assumed to be HGVs unless otherwise noted.

UNITED STATES

The United States exhibits strong potential for HAV deployment due to increasing freight demand coupled with a shrinking labor pool. The U.S. Department of Transportation projects gross tonnage will increase by 44 percent from 2015-2045. Meeting this demand with a smaller labor force will require productivity increases.

LABOR AND PRODUCTIVITY

The trucking industry exhibits extreme labor shortages, approximately 60,000 at present. Industry observers expect the shortfall to double in the near-term. Luckily, America’s developed highway network and the preponderance of long-duration and low-congestion corridors suits it for the deployment of HAV technology. The high proportion of drivers devoted to long-haul trucking means their displacement by HAV technology will provide higher returns than its deployment in the UK and Germany. The prevalence of ‘long-haul’ routes in the United States offers an ideal context for HAV implementation.

REGULATORY AND ENVIRONMENTAL

The US is developing guidance and regulations at the federal level for the development and deployment of HAV technology. The Consolidated Appropriations Act, 2018 (2018 Omnibus Bill) directs the Department of Transportation to conduct research into HAV technology and develop a general framework for the management of HAV deployment. At present, the Department of Transportation is engaging stakeholders and defining goals and objectives of HAV regulations. Developing a Federal framework is critical for HAV deployment since it will enable their operation across state lines. The first iteration of the Comprehensive Management Plan for Autonomous Vehicle Initiatives is scheduled to be completed in 2019. Further refining will occur on an iterative basis.

Unlike the U.K. and Germany where progressively more stringent standards for emissions and fuel economy are certain, the current administration has taken steps to roll-back emission regulations. The rescinding of these standards could slow the adoption of alternative drivetrains in the United States since impending regulations may reduce fleet ‘churn.’ However, the deployment of HAV technology, even on more expensive alternative drivetrains, may be justifiable due to the gross labor cost savings.
The U.S. has a very high number of routes that are strong candidates for HAV deployment due to the prevalence of high volume, low congestion corridors. This will likely lead to a more diffuse pattern of HAV adoption than in other countries where a few select routes stand out above all others.

I-95 from Jacksonville to Miami scored as the best corridor for autonomous truck deployment due to its noticeably low congestion rates and relatively high freight volumes. I-5 from the Canadian border to northern California scored second due to its exceptionally high freight volumes and long distances under low congestion. The large number of roadway options in itself could prove an impediment to adoption at scale as the industry is less likely to reach consensus around a limited number of corridors for early deployment, potentially leading to a fragmented approach.

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TOP 10 CORRIDORS FOR SAFETY IMPROVEMENTS

There is little overlap between the commercial and safety indexes for the U.S. Thus, it would likely not see the same level of performance improvements from automated trucks as one of the top 10 corridors in the U.K. and Germany. However, the sheer difference in scale between the U.S., U.K., and Germany makes direct comparisons very difficult. Corridors that do not fall within the top 100 in the U.S. by volume would still fall within the top 10 for the U.K. and Germany. When considering the top U.S. routes, the lack of overlap is a product of the high number of corridors that meet the criteria for HAV deployment.

In the United States alone, nearly 4,000 people died in truck-related crashes, representing approximately 1 in 10 of all highway deaths. The added safety features in automated trucks will likely have a disproportionate impact due to their outsized role in roadway incidents. The I-75 from Chattanooga to Atlanta scored highest in terms of safety efficiency gains. Its high freight volume coupled with high incident rate differentiated it from other corridors that exhibited higher incidents per mile or overall volumes. It is followed by I-45 (Houston to Dallas) based on the route’s incident rate which exceeds all other American corridors studied by at least 10 percent.

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### CONCLUSION

Based on the high number of long-distance routes, decreasing labor costs and progress towards a unified regulatory framework, the United States holds exceptional promise for the deployment of automated freight. The vast marketplace will facilitate savings via economic scaling. Some uncertainty does persist concerning vehicle-level emissions standards, which corresponds with the incentive to adopt alternative drivetrains. Due to the likelihood of AV technology emerging first on more expensive alternative drivetrains, this may produce a headwind to their adoption. However, the benefits supplied by labor cost savings will likely exceed the capital costs associated with alternative drivetrains.

When averaging normalized congestion, volume, length and incident rates, the following chart indicates the top five corridors in the U.S. Of these routes, I-5 from the Canadian border to Northern California is the strongest corridor for initial autonomous truck deployment due to its low congestion rates, high freight volumes and length. I-95, despite its comparatively short length, placed second due to its very high freight volumes and low congestion.

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UNITED KINGDOM

Although the U.K. has high levels of uncertainty in terms of Brexit, labor, regulatory and environmental considerations, the economic rationale for HAV deployment is strong. According to the Department for Transport, employment in the commercial freight sector increased by 15 percent and economic value by 4 percent from 2015 to 2016. Despite increases in employment, driver shortages persist. HAV adoption can alleviate forecasted labor shortages.

LABOR AND PRODUCTIVITY

The United Kingdom faces a critical shortage of qualified HGV lorry operators, as of Q2 2017 there is a shortage of 52,000 drivers, with European Union (E.U.) nationals providing significant relief from a declining domestic labor pool. (14 percent of drivers are E.U. nationals in Q2 of 2017 compared to 10 percent in Q2 of 2016). Due to Brexit, the U.K. may not have the same levels of access to E.U. labor. Declining driver numbers, coupled with increased demand, will place upward pressure on wages. Thus, HAV technology has high potential in the U.K. to mitigate increased labor costs.

REGULATORY AND ENVIRONMENTAL

If the U.K. adopts pending E.U. HGV emission standards, lorries produced in 2019 will be required to emit 15 percent less carbon dioxide by 2025. Increasing environmental standards could promote higher levels of fleet churn while incentivizing the adoption of alternative drivetrains. Given HAV technology is presently being developed predominately on compressed natural gas and battery vehicles, this regulatory regime could facilitate the earlier wide-scale adoption of HAV technology.

Similar to emission regulations, the U.K. may adopt E.U. guidance regarding the operation of HAVs. At present, the E.U. is taking a holistic approach and developing a robust framework for HAV development and deployment amongst its member states. Critically, the E.U. is confronting the issues of liability and insurance with the adoption of HAV’s, while reviewing existing statutes for their applicability to HAV operation. Regulatory certainty across the European Economic Zone will reduce uncertainty concerning the adoption of HAVs.
The M25 circling London recorded significantly higher levels of dangerous slowdown incidents per mile than any other corridor. Its high-risk profile coupled with its freight volume means it could benefit most from the adoption of HAV safety technology. The M6 from approximately Coventry to Manchester places second due to its freight volume nearly matching the M25 and an incident rate more than 20 percent higher than the next closest. Given eight corridors appear on both lists, deployment of HAV technology could deliver significant returns regarding both safety and cost with relatively low adoption rates.

**TOP 10 CORRIDORS FOR SAFETY IMPROVEMENTS**

**CONCLUSION**

The U.K. has multiple corridors that are appropriate for the deployment of HAV technology in the near term. While freedom of movement and access to the European labor market may be maintained, hedging against a potential labor shock does have intrinsic value. These labor shortages (domestic retirements and uncertainty with surrounding Brexit) mean investments in HAV technology could provide valuable savings.

Given U.K. lorries will likely have to adhere to E.U. guidelines when undertaking transnational movement, it makes little sense for operators in the U.K. to purchase noncompliant vehicles. Standardization will likely decrease capital costs of HAV technology while increasing the scope of their potential operations. There is a high potential for HAV adoption in the U.K. due to rising labor pressures, future emission regulations, and regulatory reform at the E.U. level.

According to INRIX data, the A1 and M5 are the two best corridors for initial autonomous lorry deployment due to their relative length and relatively low congestion rates. Each of those in the top 5 for combined appear in the safety and commercial top 10 tables, indicating little variation in corridor suitability among those identified.
GERMANY

Germany faces a looming driver shortage coupled with a projected 16.8 percent increase in gross road freight tonnage from 2010-2030. However, Germany stands to benefit uniquely from HAV safety improvements. The worst German safety corridor exhibited incident rates of more than 50 percent higher than any U.K. or U.S. corridor. Due to exceptionally high levels of incidents, Germany could see greater returns on HAV adoption when compared to the U.S. and U.K.

LABOR AND PRODUCTIVITY

Germany, similar to the U.K., faces driver shortages due to an aging workforce and labor force growth not keeping pace with retirements. According to projections, 40 percent of German drivers will retire over the next 10-15 years, creating a shortage of approximately 150,000 drivers. Demographics, similar to the U.S. and U.K., is the primary factor contributing to the labor shortage. Germany has two potential sources of available labor; proximity to Eastern European drivers and a large, relatively low skilled, migrant community. Expansion of the E.U. in 2003 coincided with a massive influx of Eastern European drivers to fill more appealing jobs in Western Europe. However, these two labor pools will be unable to meet future demand fully. Due to labor shortages, and corresponding labor cost increases, Germany is an attractive country for the deployment of HAV trucks.

REGULATORY AND ENVIRONMENTAL

As a member of the E.U., Germany will be required to adopt its emissions and HAV regulations. As discussed in the U.K. section, the E.U. is creating a robust regulatory framework for the deployment of HAVs, which will reduce uncertainty surrounding their implementation. Furthermore, increasingly stringent environmental regulations will promote fleet churn, leading to the adoption of new technologies in the trucking sector.

TOP 10 CORRIDORS FOR COMMERCIAL RETURNS

The most viable corridor in Germany follows the A3 from the Austrian border to Wurzburg, a length of approximately 225 miles (360 km). The motorway extends into Austria with low congestion. It is the only corridor identified across the countries of study that is ranked first in freight volume, congestion, and length. The remaining nine motorways 4-9 exhibit small differences in profile and are virtually interchangeable regarding commercial viability.

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INRIX RESEARCH | INTELLIGENCE THAT MOVES THE WORLD

INRIX AUTOMATED FREIGHT CORRIDOR ASSESSMENT

RANK CORRIDOR ROUTE FREIGHT INCIDENTS
1 A3 Wurzburg-Passau 1 1
2 A5 Mannheim-Basel 2 2
3 A2 Dusseldorf-Hanover 3 5
4 A9 Munich-Leipzig 5 4
5 A7 Kassel-Hamburg 7 3
6 A81 Wurzburg-Konstanz 4 7
7 A10 Berlin Ring 9 6
8 A8 Mannheim-Bad Hersfeld 8 8
9 A4 Gera-Gotha 10 9
10 A61 Heidelberg-Bonn 6 10

TOP 10 CORRIDORS FOR SAFETY IMPROVEMENTS

The A3, and German motorways more generally, exhibited significantly higher numbers of dangerous slowdowns. Incidences on the A3 occurred approximately 50 percent more frequently than on the worst performing U.K. corridor. The higher number of incidents likely comes from German roadways posting negative congestion rates, meaning vehicles travel above recommended speeds.

CONCLUSION

Germany’s labor retirement crisis in the freight sector will provide a powerful incentive for the adoption of HAV technology. External regulatory frameworks, established by the E.U., will decrease risk and uncertainty associated with the deployment of HAV technology. Furthermore, the high concentration of heavy vehicle manufacturers in Germany will further catalyze deployment within Germany. Each list shares eight of the same corridors. The A3 and A5 are the two best segments for early HAV adoption. Similar to the U.K., limited investments in HAV technology could deliver outsized benefits if deployed strategically.
SUMMARY

While HAV technology is increasingly being tested on public roads, the ultimate near-term impact remains unclear. For initial deployments, not all roads are created equal and understanding the fit of the technology to individual corridors will be key to maximizing benefits. What benefits stand to be maximized (commercial versus safety) vary based on the corridors selected for initial operation, and access to accurate volume, congestion, and safety profiles are essential to this evaluation process.

Leveraging INRIX data, commercial truck operators considering the adoption of HAV technology can identify corridors that provide the greatest returns on investment. Similarly, departments of transportation and road authorities can leverage existing data to identify where deployment of autonomous trucks are likely to have the greatest impact for public good. INRIX Research has shown that, particularly in the U.K. and Germany, there is overlap between the best fit corridors when considering both potential commercial and safety benefits. As the public and private sector works together to select initial testbeds for HAV technology in commercial trucks, these corridors present immediate opportunity for both parties to realize early benefits of the technology and increase the likelihood of successful deployments that both deliver commercial gains and increase road safety.

2. Scaled value = (X-Xmin)/(Xmax-Xmin)
5. U.S. Department of Transportation, Bureau of Transportation Statistics and Federal Highway Administration, Freight Analysis Framework, version 4.1, 2018
7. Ibid.
9. Ibid.
16. Ibid.

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