Smart Mobility Corridors

Exploring Freight Automation for Brown County, WI

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Executive Summary

What applications do emerging automation technologies have for the future of freight and shipping in Brown County?

The two-person University of Oregon team of Joshua Skov and Rachel Cohen assessed possible technology and vendor options for a "smart mobility" corridor for freight coming into and leaving from the Port of Green Bay.

To explore this possibility, the team conducted market research to determine the key technologies in question, including vendors and business models, and the extent to which they require surrounding 5G infrastructure, conducting interviews with industry thought leaders in automation and freight logistics to gain insight on technology applications, implementation, and best practices.

Based on this research and outside examples of AV testing and pilots, the team developed three potential deployment models for Brown County and assessed their feasibility. While there are indeed exciting opportunities for automation to disrupt freight and logistics, the team found that there is a lack of technology or business ecosystem maturity at this moment to recommend a particular public-sector investment or pilot project in Brown County at this time.

First, fully-autonomous vehicle technology is nascent; many have pushed back the notion of level 4 or 5 autonomous trucks reaching scale for a decade or more. Second, partial and conditional autonomy including driver assist features and platooning are sweeping the logistics industry, but do not require any special regulatory approval, since the State of Wisconsin recently approved the use of platooning.

However, the team lays out several next steps that Brown County can take to keep up with the pace of innovation in smart mobility. These include taking part in statewide strategy conversations, engaging with local industry, and investing in conventional infrastructure improvements, which will make the region an enticing opportunity for future deployments.

State of Freight Automation

Freight

The Economic Case for Automation

"Looking at the economics, [autonomous driving] makes more sense in the trucking space."

- *Richard Zhang, Full Truck Alliance*[1]

A convergence of several trends in long-haul trucking has encouraged industry leaders to take a closer look at automation in 2020. In recent years, e-commerce has increased demand for fast and reliable goods transport, while big box retailers compete for customer loyalty with low-cost shipping. Margin constraints for logistics are further squeezed by limits on hours that drivers are allowed to operate and a growing shortage of new commercially-licensed drivers.[2] The American Trucking Association projects that shortage could triple between 2018 and 2026.[3]

2020 brings a new set of hardships for trucking. During the COVID-19 pandemic, e-commerce has shifted from a matter of convenience to one of safety, while major supply chain disruptions have occurred from household goods, to meat, to medical equipment.[4] Meanwhile, massive unemployment and declining GDP provide a bleak economic outlook.

With these factors in mind, it is unsurprising that major firms in both the AV and logistics industries are considering automation as a solution for freight.

"The first application of Level 4 technology is going to be in that long distance, on-ramp to off-ramp type or hub-to-hub type scenario. And we think that the technology is going to interact and work with drivers. The technology initially is not going to be able to replace the driver. The driver is going to have to perhaps handle the loads for the initial and final-mile delivery."

- *Stephan Olsen, General Manager, Paccar Innovation Center*

Industry leaders say that autonomous freight does not necessarily spell the end of trucking jobs. Some proposals suggest that logistics could operate like commercial flights, where a driver navigates city streets during departure and arriving at the destination, while turning on "autopilot" for long stretches of interstate.

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[1] The Information, (2019). Autonomous Vehicle Software Better for Trucking Than Ride-Hailing, Executives Say

[2] Washington Post, (2018). Analysis | America has a massive truck driver shortage. Here's why few want an $80,000 job.

[3] McKinsey, (2018). Autonomous trucks disrupt US logistics

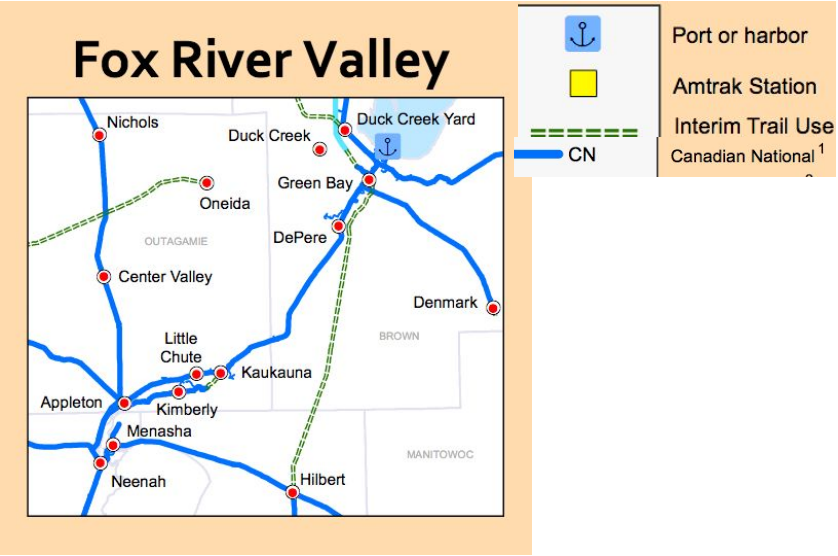
[4] McKinsey, (2020). US food supply chain: Disruptions and implications from COVID-19

Automated trucks may also have the potential to extend hours of service by giving drivers a break while platooning, allow drivers to remotely operate one or more vehicles at a time, or kick in to aid the driver under difficult and dangerous conditions.

Freight in Brown County, Wisconsin

To make up for the unit economic constraints described above, many logistics companies rely on intermodal hubs, which combine the flexibility of trucking with less expensive rail transport. While existing Canadian National rails run along the Port of Green Bay and the Fox River (Figure 1), no intermodal facility currently exists in Brown County. In fact, Wisconsin has just 2 remaining intermodal facilities in the state since Canada Pacific closed a Milwaukee terminal in 2012.[5] A hub in Arcadia exclusively serves Ashley Furniture, while the remaining terminal in Chippewa Falls is located 180 miles from Green Bay.

Figure 1 -- Existing Rail Lines in Brown County[6]



Brown County and the Port of Green Bay currently rely on trucking to and from out-of-state hubs like Joliet and Chicago, IL, 200+ miles away. However, Wisconsin DOT finds that transfers to intermodal hubs in Illinois are not economical. "Competition for drayage drivers willing to travel to and from Wisconsin (and the costs of such drayage, especially for shippers north of Milwaukee) minimizes or negates any cost advantages of rail quotes from the Chicago yards."[7]

Brown County has proposed plans for port improvements, including a potential intermodal facility at the decommissioned coal plant at the mouth of the Fox River. While changes are uncertain at this point, this assessment will explore the possibility to pair port improvements with automation projects in a way that addresses current logistics challenges and promotes economic development in the region.

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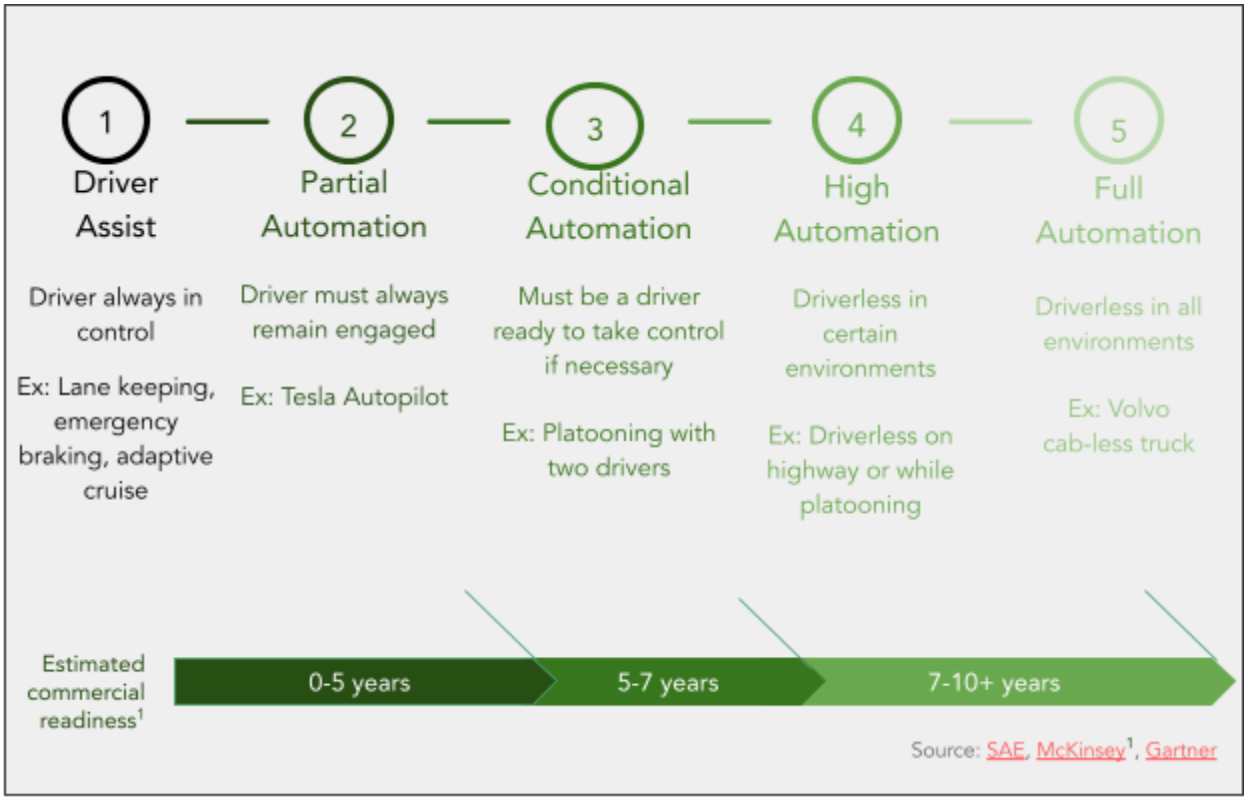
[5] Wisconsin Intermodal Terminals
[6] Wisconsin Railroads and Harbors Map 2020
[7] Overview of Intermodal Freight in Wisconsin - Executive Summary

Automation

Since autonomous vehicles arrived on the scene, the industry has used SAE's automation levels as a model for AV development (Figure 2). Now, after a decade of high-profile testing and a cutthroat race to the autonomous passenger car between players like Waymo, Tesla, Uber, and automakers, the industry has largely changed its tune.

Figure 2: SAE Automation Levels (Source: NHTSA, McKinsey[8], Gartner[9])



Level 4 and 5 automation, which can operate in some or all environments without a driver, have lagged relative to expectations, while low-level automation has outpaced projected timelines. Some players are taking the bet on the long view, perfecting level 4 and 5 technology in simulations, closed-track testing, and in private facilities like warehouses. Meanwhile, Level 1 and 2 automated features like lane keeping, adaptive cruise control, and self-park are available from every major automaker in new passenger models for 2020 and 2021.[10]

[8] McKinsey, (2018). Autonomous trucks disrupt US logistics
[9] Gartner, (2019). Hype Cycle for Emerging Technologies, 2019
[10] NHTSA, Automated Vehicles for Safety

In response to overhyped expectations for autonomous passenger mobility,[11] the industry has diverged into a multitude of vehicle types, business models, and service models. One of the beneficiaries of this fracturing has been increased interest in trucking.[12]

"Now everybody's saying self-driving cars will never happen, and I'm pounding on the table again saying it's going to happen, but it's going to happen in stages, in steps."

- *Çetin Meriçli, CEO, Locomation*

One of the companies diversifying its bets for automation is Daimler North America. While Daimler is conducting simulations and early testing of level 4 and 5 trucks, it is rapidly deploying partial automation features in new Freightliner models. This staged approach allows its customers to gain some of the efficiencies of freight automation without facing regulatory gridlock, assuming risk for unproven technologies, or being limited by cost.

In mapping business models of the AV trucking world, the team arrived at three categories:

1. Firms that create a combination of hardware, software, and management platforms. These companies hope to partner with automakers to "plug in" their technology to vehicles pre-production. Many of these companies are backed by Silicon Valley, such as Alphabet-owned Waymo and Aurora, whose largest investor is Amazon.

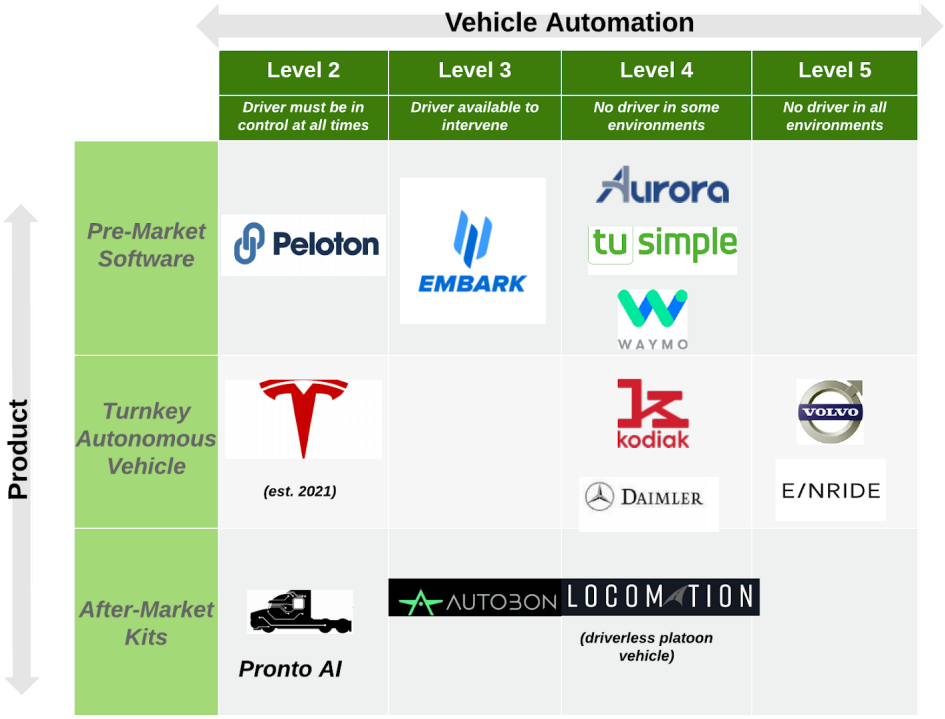
2. "Turnkey" autonomous vehicles are specially-built with automation in mind. Most in this category are automakers, with the exception of Kodiak. Kodiak plans to not only build its autonomous truck from the ground up, but act as the owner-operator, cutting out logistics companies from deliveries.

3. So-called "after-market" kits, which retrofit an existing vehicle with software and sensors that perform autonomous functions. These tend to be much more cost-effective solutions, but offer a lower degree of automation. For example, Locomation's kit allows two trucks to platoon by equipping one vehicle with level 2 functionality and the other with level 4, meaning that while they are synced, only the lead driver must be engaged.

[11] 5 Trends Appear on the Gartner Hype Cycle for Emerging Technologies, 2019

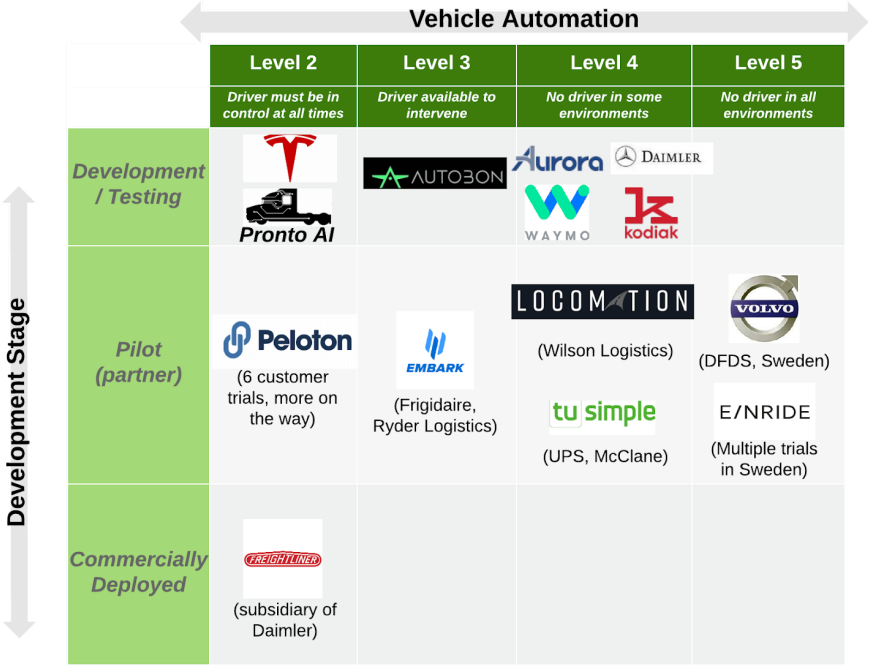
[12] While Self-Driving Car Hype Decelerates, Automated Trucks Grab Attention at CES

Figure 3: Mapping the Autonomous Truck Market



Below, the same companies are mapped according to the extent to which they have been deployed. We found that very few in the AV trucking world have achieved commercial viability, meaning that the product is widely available to a broad array of customers in the market.

Figure 4: Autonomous Truck Deployments



Instead, most companies remain in testing, or in pilot deployment projects with a small group of partners, often between the company and a single logistics partner in a particular region. For example, TuSimple's pilot with UPS runs 20 trips per week between Arizona and Texas.[13]

"We're not at the point where one company can build a widget and the world will change. We need a very complicated regulatory and infrastructure investment before we get to the next stage and that is going to be a far more complicated journey than any of us expected."

- *Orin Hoffman, partner, Engine*

Industry leaders specifically cite lagging federal policy as a major inhibitor to AV deployment. A lack of strategy and clarity, especially between federal agencies, has prevented successfully-piloted technologies from becoming commercially available products.

One particular sticking point has been the NHTSA waivers that AVs have to apply for. Brad Basten of the Wisconsin DOT told the team that as requests for NHTSA waivers (which allow AVs to operate on the road without regulatory approval) increase each year, they are expected to run out quickly. A consensus on federal policy is not expected in the near future.[14]

Connectivity

Industry leaders say the promises of autonomous vehicles require a reliable network connection. which both enables computers inside the vehicle to process information about its surroundings and allows vehicles to communicate with other vehicles and 'smart city' features in their surroundings. For governments, this allows them to collect information

But what kind of communication technology is needed, and what role must governments play in deploying it? This section is an overview of connected vehicle technologies and network requirements according to several industry sources.

V2X

"Vehicle to everything," or, the communication between a connected (or connected-autonomous) vehicle and its surroundings, including ITS infrastructure, other vehicles, and even pedestrians and cyclists.

DSRC

Digital short range communications (DSRC) is a dedicated frequency band on the 5.9 gHz spectrum which allows for short-range communications without cellular networks. Since 2001 it has historically been reserved for very specific transportation safety use cases, which is why it is

[13] TuSimple Expands Autonomous Trucking Program With UPS
[14] Federal autonomous vehicle legislative push stuck in neutral

sometimes referred to as "the safety band." [15] However, DSRC has not been deployed on a broad scale. The only deployment of DSRC roadside units in Wisconsin is in Madison.[16] [17]

In recent years, NHTSA and several industry groups have called for the FCC to widen limits on DSRC use cases to include a broader spectrum of V2X applications. [18] [19] [20] For example, crash footage taken on transit buses might be compared to ITS movement data to identify problem areas and recommend specific corridor improvements.

However, the FCC has moved in the opposite direction, pushing for "spectrum-sharing" for unlicensed wifi and other use cases. FCC spokespeople say that DSRC has not yet been widely deployed in its 20 year history to justify the frequency restrictions. All 50 state DOTs, including Wisconsin, co-sponsored a 2019 AASHTO memo to the FCC denouncing this decision, citing V2X safety concerns if traffic on the spectrum increases.

5G

5G is the fifth generation global wireless technology standard. At 50 times faster than 4G networks, 5G massively increases network capacity, availability, and reliability and reduces latency -- network upload and download speeds -- to just one millisecond.[21]

In addition to expanding rural broadband and personal mobile technology, the emerging network is attractive for smart cities use cases, which rely on IoT ('internet of things') technology, including intelligent transportation systems (ITS). 5G supports cellular V2X (C-V2X), which allows communication over a network rather than local short-range communications.

However, the speed of 5G deployment is up for debate. "Research firm Strategy Analytics projects that by 2023, only 6.5% of global wireless subscriptions will be 5G, while 70% will be 4G." Asked if 5G was necessary to AV rollout, all experts said no. "Our communications need a standard to work with, but it doesn't have to be 5G." "We need the industry and the regulators to decide."

[15] US DOT, (2019). V2X Communications for Transportation: An Overview
[16] US DOT US DOT - The Safety Band
[17] TrafficCast (2019). TrafficCast and DENSO Sign Joint Development Agreement
[18] 5G Automotive Association, (2018). Update on V2X Communications Deployment in North America
[19] NHSTA, (2020). Keynote Address at ITS America
[20] ITS America, (2019). FCC Proposal Will Significantly Reduce Safety, Deter Future Innovation
[21] What is 5G | Everything You Need to Know About 5G | 5G FAQ

Analysis: Is Freight Automation Feasible in Brown County?

A convergence of industry challenges -- growing e-commerce demand and shrinking labor supply, for example -- make freight automation appealing, but thought leaders say we should not expect to see driverless, Level 4 and 5 trucks at scale for at least a decade.

The team found that the fragmented nature of the logistics industry and turbulence in the CAV technology landscape makes it impossible, at this time, to predict the specific form of a single, clear partnership model for full deployment of autonomous trucks on public roadways in Brown County.

However, a series of incremental shifts such as driver assistance and platooning can and are improving freight efficiency and productivity. These, for the most part, do not require policy or investments beyond a regulatory green light, which is already the case in Wisconsin.

Additionally, while the public right of way may not be ready for broad-scale level 4 AV deployment, one opportunity for automation in Brown County might be in closed-system facilities, such as airports, ports, distribution centers, and logistics hubs. Sites around the world are leveraging automation to increase productivity and reduce congestion. This type of deployment can limit the number of necessary partners and limit community concern.

What is the industry specifically asking of the public sector? The team heard over and over again that C-AV firms' first priority is regulatory clarity.[22] Clearly-defined strategy and policy are urgently needed at the federal level before pilots can scale to broad-based deployment. Rules and guidelines must be consistent between the FCC, which governs communications and broadband, and the US DOT, which establishes vehicle standards. Unfortunately, policy debates are not expected to be resolved in the near term.[23]

At the state and local level, companies want to educate government officials about the potential benefits of automation in order to encourage collaboration for testing and deployment. Though it has approved platooning, the State of Wisconsin is behind in setting statewide policy for AVs.[24] However, Wisconsin DOT is gathering an official committee which will begin meeting this fall.[25]

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[22] FT, (2019). FedEx Freight calls for US self-driving truck regulations

[23] Automotive News, (2020). Federal autonomous vehicle legislative push stuck in neutral.

[24] SB 695 (2018): This bill defines a "platoon" as a group of individual motor vehicles traveling in a unified manner at electronically coordinated speeds. This bill creates an exception for platoons to the traffic law requiring the operator of a motor truck with a gross weight of more than 10,000 pounds to maintain a distance of not less than 500 feet behind the vehicle immediately preceding.

[25] NCSL, Autonomous Vehicles State Bill Tracking Database.

Brown County should take a leadership role in these discussions as its leaders have already begun the work to educate themselves and the public. Inviting researchers and industry leaders into these conversations and encouraging AV testing in Wisconsin can not only establish the state as a leader, but help to move the industry past some important obstacles. Most testing has happened in the Sun Belt, in states like Arizona and Texas, meaning that algorithms have not learned to drive in inclement weather.[26] Waymo began testing in Michigan in 2017.[27]

Ensuring that local roadway infrastructure is updated and in a state of good repair will also be important for CAV deployment. While some recommendations are high-tech, many needs for autonomous vehicles are the same as for human drivers. A report from Australia and New Zealand identifies the following key factors for assessing readiness for autonomous vehicles:[28]

- Physical infrastructure: Ensuring that signage, signals, pavement, and markings are consistent and in a state of good repair for the purposes of digital mapping and wayfinding. Consider increasing weight limits to accommodate platooning vehicles.

- Digital infrastructure: Install ITS features to communicate traffic safety information, such as weather conditions, roadway hazards, detours, etc. However, roadside communications units should be installed contingent upon establishing a clear national standard.

- Road Operations: Assess network performance and roadway conditions regularly. Collect and analyze data internally, and establish policies for data management, privacy, and data-sharing agreements. Perform regular maintenance, and establish traffic control and demand management policies.

Investments in dedicated infrastructure, such as AV-only lanes, are beyond what the industry is ready to ask for. With deployment use cases still in flux and differing opinions across individual players. However, maintaining roadways in a state of good repair is a must for future AV deployments.

According to McKinsey, "Deteriorating roads aren't only a nuisance for human drivers: they are major impediments for AVs. To promote higher levels of autonomy, mapping software must be highly accurate—for difficult intersections, for instance, it will need to record dimensions down to the inch. If roads are deteriorating and road markers are fading, the physical structure of the intersection will constantly change."

On connectivity standards, not much can be done at the local level until industry, states, and federal regulatory bodies standardize policy and regulations. Making a large-scale investment for V2X purposes, such as DSRC roadside units or C-V2X 5G capabilities, requires Brown

[26] GovTech (2018). For AVs, Snow Is a Formidable Opponent.

[27] Waymo Starts Testing Self-Driving Cars in Michigan, Seeking Bad Weather

[28] Assessment of Key Road Operator Actions to Support Automated Vehicles

County to choose between technologies which are still under fierce debate, and with no clear end in sight.[29]

However, deployment of intelligent transportation systems (ITS) for local roadway operations and data gathering may make Brown County an attractive candidate for future deployments. While these may not yet be ready to communicate with connected vehicles, they will gather needed data and have systems that can "plug in" to future fleet needs.

Additionally, industry insiders told the team that electric vehicle infrastructure will be of high importance to C-AV rollouts, as the vast majority of autonomous vehicles will be electric. Ensuring that adequate charging infrastructure can be scaled will be an important factor for future developments. Engagement at the utility level is key.

Potential Deployments

Following the market research analysis, the team developed three potential autonomous freight deployment scenarios. Considerations include which technologies and vehicle types are ready for deployment, where they can feasibly be deployed, and what service models are ideal for partnership.

Option 1: Automated Testing Corridor

One option would be to allow autonomous trucks to operate in the right of way along a particular corridor. A major example is being carried out via the Virginia Tech Transportation Institute. VTTI won a $7.5 million grant from the U.S. DOT to test level 4 autonomous trucks along the I-95 corridor in order to produce a policy playbook for how to integrate autonomous and conventional trucks on public roadways.[30]

The project is a huge undertaking which required Virginia Tech to partner with six state DOTs, three technology companies, two logistics providers, and more.[31] We suggest that Brown County reach out to Virginia Tech for additional details about this study and its progress.

If Brown County were to pursue such a project, the 25 mile section of the I-41 corridor, which runs along the Fox River between the Port of Green Bay and Appleton would have the greatest impact for the region from a freight perspective. However, the team anticipates difficulty gaining enthusiasm from logistics providers in the region, unless the effort could extend beyond the Brown County jurisdiction and allow for complete routes, for example, to Milwaukee or hubs in Joliet, Illinois.

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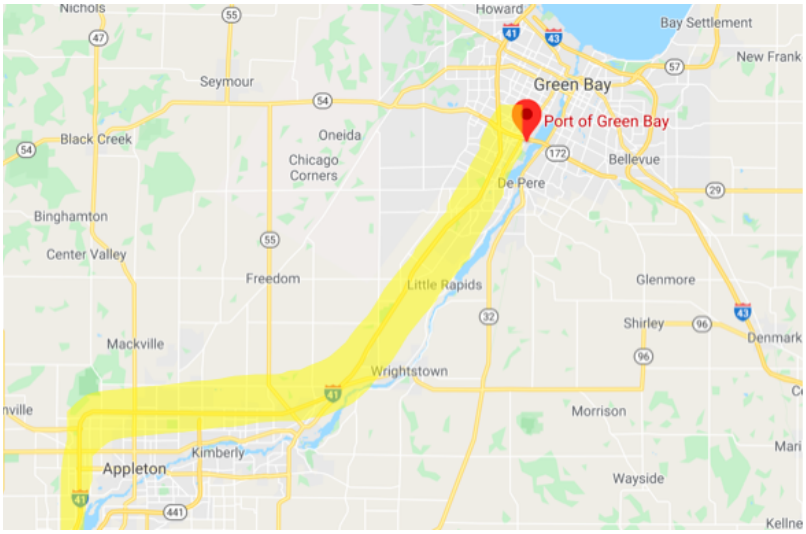
[29] McKinsey, (2019). A new look at autonomous-vehicle infrastructure.
[30] US DOT, (2019). Safely Operating ADS in Challenging Dynamic Scenarios: An Optimized Automated Driving Corridor Demonstration.
[31] Virginia Tech, (2019). $7.5 million study to develop operational plan for mixed truck fleets

As with the Virginia Tech study, academic research partnerships may be desirable for this type of project, as research purposes might . Other necessary partnerships would include



Option 2: On-Site Freight Automation

While level 4 deployment on public roadways will be slow to take off, there is some indication that on-site automation at logistics hubs, airports, and other industrial areas is promising.[32] Automation has come in many forms, including automated cranes in addition to road vehicles.[33]

One such example has emerged in Sweden, where Einride has deployed driverless trucks in two DB Schenker logistics hubs.[34] The vehicles operate within the two facilities and on a few kilometers on public roadway between them.

These types of projects can be implemented with a clear set of partners -- the operator(s) of the facility, local officials, and one or a few technology/vehicle providers -- with a distinct set of benefits for each partner. There is limited (if any) need to support AVs on public roadways, and there are a greater variety of vehicle options depending on partner needs.

In Brown County, planned port improvements forge an opportunity to capitalize on such projects. However, the success of such a program is contingent upon the proposed site development's successful launch -- such as an intermodal facility or port expansion at the decommissioned Pulliam Plant.

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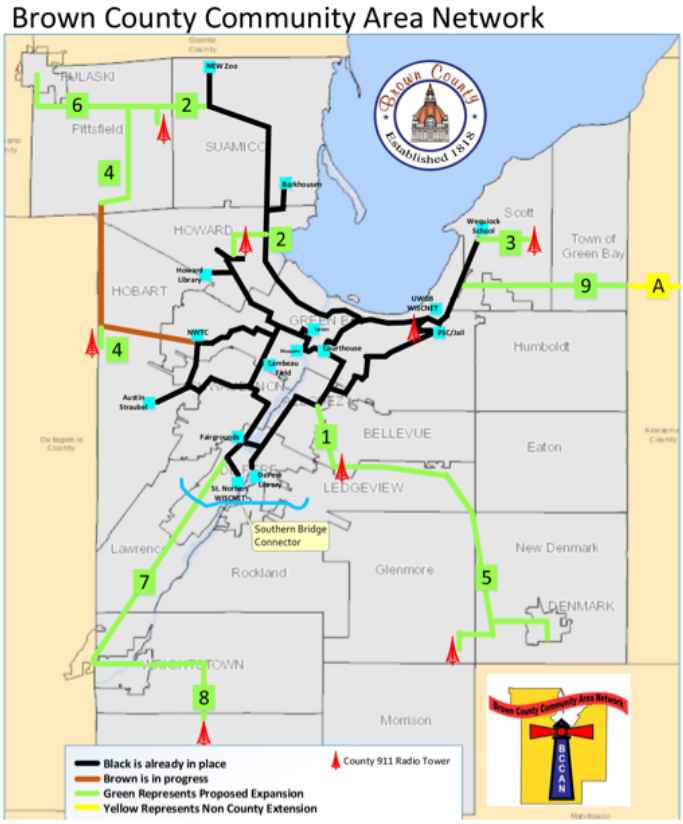
[32] Supply Chain Dive, (2018). AVs are put to the test in airports and ports
[33] Automated Ports Help Carriers Get in and Out of Facilities Faster
[34] Sweden: Autonomous electric truck in operation (2019)

Option 3: Connectivity Pilot

While the team has concluded that connectivity is not a necessary pairing with autonomous vehicle deployments and that such deployments may not be feasible for several years, there is momentum (and grant opportunities) for broadband improvement efforts in Brown County, seen below.



To explore how these projects may have transportation applications, we illustrate with an example along a three-mile stretch of the 805 corridor in San Diego County. This is a partnership between Caltrans (the California DOT), the regional MPO, and the City of Chula Vista, and C-V2X chipmaker Qualcomm to research and demonstrate the capabilities of the technology. [35]

However, because interest in C-V2X testing has been concentrated in technology companies and telecoms (which are still developing their chips and service models), the team does not feel that there might not be an immediate benefit to freight or logistics companies.

[35] Qualcomm, (2020). San Diego Regional Proving Ground Joins Efforts with Qualcomm to Launch C-V2X Program in San Diego

Conclusion

After conducting extensive market research, speaking with industry experts, and outlining potential models, the team concludes that there is not currently a feasible option for Brown County to deploy autonomous freight solutions at this point in time.

However, several considerations and recommendations to take part in conversations and stay educated on potential future opportunities follow.

Next Steps

1. Engage Stakeholders and take part in C-AV thought leadership
   Engaging with the local business community can give Brown County an idea about local concerns and what options might be ideal to pursue in the future based on how autonomous vehicle technology evolves over time.

   Additionally, engagement at the state level will be critical. Wisconsin DOT is gathering a group of transportation professionals and industry representatives. The committee will first and foremost aim to set statewide priorities and goals and develop a clear strategy to proceed that supports these goals.

2. Roadway and Port Improvements
   In the meantime, a robust local infrastructure can make future projects in Brown County more enticing for industry.

3. Formulate Partnerships
   After thorough engagement with stakeholders, neighboring jurisdictions, major industry players, and local businesses, this process may reveal opportunities for future partnerships with Brown County.

4. Design a Model and Identify Funding
   After understanding local needs and conditions, the industry will have time to mature to a place where proven technologies and business models exist.