Memorandum

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Nick Palmer, Will County Board

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Subject: *DRAFT Emerging Technologies and Application for TMP*

This memorandum summarizes the current state of the practice for several technologies with potential relevance for the Transportation Master Plan study area. It builds upon the Will County Community Friendly Freight Mobility Plan (2017), which provided a high-level overview of emerging freight technologies at the time, including summaries of key technologies, their potential impacts on Will County, and implementation partners that would need to be engaged to implement each technology.

The following sections review five emerging technology strategies that are most relevant to this study: traffic signal control systems; traffic management centers; truck platooning and connected/autonomous trucks; at-grade railroad crossing systems; and vehicle electrification. National best practice examples are then provided, followed by planning considerations and conclusions that summarize policy recommendations for the planning area.

Review of Emerging Technology Strategies

Freight traffic poses unique concerns for transportation system operations and capital planning. Large trucks require wider turning radii and can have trouble navigating certain design features such as roundabouts. Trucks cannot accelerate or decelerate as fast as passenger vehicles, leading to potential signal timing issues, longer stopping and starting distances, and increased emissions in freight-intensive corridors where trucks make up a large share of the traffic stream. Safety issues in freight-heavy corridors are exacerbated due to the size and weight of the vehicles. Corridors with at-grade rail crossings may become congested and delayed when trains block crossings, and safety issues can arise at grade crossings.

Traffic Signal Control Systems

- **What is it?** Traffic signal control systems consist of approaches to managing traffic signal timing and coordination. It includes managing signal cycle length and intersection clearance times, coordination between multiple signals on a corridor, and adaptive signal control to deal with changing traffic conditions in real time. One freight-specific application is freight

signal priority, which reduces truck delays at intersections by enabling dynamically adjustable traffic signal phase timing that assigns priority to trucks when conditions allow. Freight signal priority makes the traffic signal system aware of trucks approaching properly equipped intersections. The system can then adjust signal phase timing as needed to assign priority to freight trucks, smoothing traffic flows for freight and reducing stop/start cycles, which in turn reduces emissions and pavement deterioration. The traffic control system can detect trucks in the traffic mix via several means including vehicle-to-infrastructure (V2I) communications, toll tags, or infrastructure designed to monitor such traffic, among others. Signal systems can also be configured to provide speed advisories to properly equipped trucks such that drivers will arrive when the light is green.

- **Where does it work best?** Traffic signal control approaches work best on urban freight arterials. Last-mile connections between freight generators, like intermodal yards and the Interstate highway network are natural candidates for freight signal priority.

- **Applicability to Study Area?** Freight traffic often has different time-of-day patterns than passenger traffic, so signal control strategies can be designed to better accommodate trucks at certain times (e.g. early morning pickups, afternoon departures) while reverting to passenger-focused timing during peak commuting hours. Potential applications in the Joliet/Elwood study area could include US 52, US 6, IL 53, Laraway Road, Arsenal Road, and Elwood International Port Road.

Traffic Management Centers

- **What is it?** A traffic management center (TMC) is a hub for regional traffic control, bringing together both human and technological inputs to manage the transportation network.[1] TMCs incorporate data from a variety of sensors and systems that could include vehicle sensors, cameras, flooding detection systems, weather stations, and data from first responders. All this information is assembled in a central location, allowing staff to manage devices and the network in real time. TMCs may focus on freeway operations, surface street management, transit, or some combination of the three. TMCs can be multijurisdictional with several counties or agencies combining into a larger regional TMC. TMCs are often linked to state or regional 511 traveler information systems to disseminate traveler information to the public via web sites, apps, highway advisory radio, and other means. In Will County, a TMC could link to dynamic message signs (DMS) to push information to the traveling public. It could also integrate with websites like the Lake Michigan Interstate Gateway Alliance. Any TMC plan should investigate opportunities for operational sharing among agencies and should be fully

[1] FHWA Office of Operations, *Traffic Control Systems Handbook*, retrieved from https://ops.fhwa.dot.gov/publications/fhwahop06006/chapter_8.htm#:~:text=One%20of%20the%20primary%20purposes,signal%20programs%20in%20real%20time. on December 12, 2020.

integrated with existing and planned TMCs within the region. Finally, TMCs can provide system usage and congestion data for planning needs.

- **Where does it work best?** TMCs work best wherever there are multiple systems that need to work together. They can be used in urban or rural areas. The greatest benefit is often achieved when multiple systems and agencies (e.g., city traffic managers, state DOTs, first responders, transit agencies) coordinate such that data from several systems can be collected, processed, fused with other data, and synthesized into actionable intelligence. From a freight standpoint, cameras, sensors, and DMS should be installed at critical locations chosen to benefit freight users. For example, freight-specific traveler information should be provided before major routing decision points to advise truck drivers on congestion ahead, travel times, safety messages, or the need to detour.

- **Applicability to Study Area?** As more and more systems get deployed, the need for a TMC will grow substantially. This could include systems as simple as a few detectors and DMS. Will County could install appropriate sensors at critical locations (e.g., before the Des Plaines River bridges) to advise freight traffic through DMS and traveler information about pavement conditions during inclement weather, construction/maintenance work, and other incidents, as well as in flood-prone areas (e.g., IL 53 south of I-80). These systems would be integrated in a potential new Will County TMC. This TMC would then share the information with existing regional TMCs, such as IDOT's Transportation Systems Center, the Illinois Tollway's Traffic and Incident Management System, and the DuPage County TMC,[2] to reach the greatest number of users. The cost to deploy a TMC will vary depending on many factors, including whether it's virtual or occupies a physical space, sensors and infrastructure that need to be installed, staffing requirements, and data sharing with other jurisdictions. Agencies can pool resources to minimize upfront costs associated with creating a new TMC, and also grow the coverage of their TMC gradually over time. DuPage has taken this approach with its TMC, beginning with a relatively low-cost "virtual" center, partnering with other agencies to leverage their telecommunications infrastructure, and deploying more sensors and other equipment in the field over time.

Connected and Autonomous Vehicles (CAV)

- **What is it?** Connected and autonomous vehicles cover a range of applications and abilities. Connected vehicles use on-board communications to share detailed and precise information concerning their status to vehicles and infrastructure nearby. Autonomous vehicles use a series of sensors and computers to essentially take over driving responsibilities. Both of these systems may include vehicle-to-everything (V2X) communications. CAV applications to the freight system include:

[2] List of Chicago-area TMCs from CMAP, *Highway Operations* ON TO 2050 Strategy Paper, retrieved from https://www.cmap.illinois.gov/documents/10180/517371/Highway+Operations+Strategy+Paper.pdf/26cff0fc-876a-4843-9fe5-c9aedbf73ddd?t=1487793545000 on December 16, 2020.

- Connected vehicle technologies allow cars, trucks, transit vehicles, and the infrastructure to share mobility and safety information so drivers are aware of dangerous situations such as congestion hotspots ahead of time. They also allow traffic managers to make better operational decisions. Freight signal priority using V2I is an example of a connected truck application.

- Truck platooning is a wireless technology that links two tractor-trailer trucks together such that the following truck mirrors the lead truck's braking, acceleration, and sometimes steering, allowing for shorter following distances and a reduction in fuel use and emissions. Truck platooning has been tested in multiple states including Michigan, Pennsylvania, and Ohio.[3]

- Autonomous vehicles partially or fully automate the driving task. Fully autonomous trucks are either under development or have been deployed by several private firms including TuSimple, Waymo, and Ike. Field deployments have been successful within well-defined use cases. These deployments have demonstrated potential long term and larger industry deployments and use.

- In addition, intermodal terminal operators increasingly use automated systems to maximize capacity within an existing facility's footprint. Examples include terminal gate automation, automated yard hostlers, and automated cranes for container storage, stacking, and loading. Advances in computing power, artificial intelligence, and machine learning will continue to fuel innovation in this sector as equipment manufacturers and technology startups test different use cases.

- **Where does it work best?** Truck platooning and fully autonomous trucks are typically focused on limited access highways, such as Interstate highways, where automation is simpler due to relatively stable speeds, long travel distances, and the absence of traffic signals, non-motorized users, and other variables encountered on surface streets. They can also work well on fixed routes, such as from a production site to a distribution center. Platooning works best on Interstate highway corridors with many trucks traveling between the same or at least similar origin-destination pairs. Pairing trucks may be easier if they come from the same fleet. Autonomous trucks can be deployed on any long-distance trade corridor within the operational design domain of autonomous systems available today.

- **Applicability to Study Area?** The best candidates for truck platooning and other connected/autonomous technologies in Will County are I-80 and I-55. Given the interregional nature of freight traffic on these corridors, test deployments would need to be led by IDOT and neighboring state DOTs in coordination with USDOT, local agencies, and industry partners. The Automated Driving Systems (ADS) project in Ohio is an example of such a

[3] https://aashtojournal.org/2020/10/30/multi-state-coalition-conducts-highway-testing-of-truck-platooning/

deployment project.[4] Terminal automation projects would be implemented by the Union Pacific and BNSF railroads but could have traffic impacts outside the terminal gates. For example, increased container throughput would lead to more truck traffic, more efficient pickups and drop-offs of containers could reduce truck dwell time at the intermodal yards, and innovations such as appointment systems could reduce the need for staging and redistribute truck volumes over the course of the day.

At-Grade Railroad Crossing Systems

- **What is it?** Grade crossings can contribute to safety and congestion issues on key freight corridors. Inadequate warning devices increase the risk of crashes between trains and motor vehicles or pedestrians, while busy crossings can block traffic while trains complete their maneuvers. At-grade railroad crossing systems improve safety and congestion by advising travelers of upcoming trains and how long they might block a crossing using non-intrusive systems such as video and lidar. Drivers could be alerted about trains occupying key crossings via DMS. Such signs need to be placed far enough ahead of key decision points so truckers can change their route. In addition, crossing gates could often be better coordinated with nearby traffic signals.

- **Where does it work best?** This technology is most applicable to busy grade crossings, including those located near major railyards where train speeds are lower and volumes are higher, with congested arterials. It also applies where geometry or design may introduce operational issues or concerns.

- **Applicability to Study Area?** According to CMAP, in 2011 vehicles were delayed more than 7,800 hours each weekday at the region's grade crossings, totaling more than 2 million hours of delay per year.[5] High delay/low reliability grade crossings in the study area that could be candidates for this technology include Laraway Road at UP Railroad and Gougar Road at CN/EJ&E Railroad, both of which are prioritized for improvement in CMAP's regional grade crossing scan (2019).[6] Costs and benefits of at-grade railroad crossing systems to other solutions like grade separation projects likely vary from location to location based on both rail and highway traffic profiles, as well as the availability of alternative travel routes for motorists. In some cases, grade crossing systems could be used as short-term mitigation strategies while more capital-intensive improvements are planned. For example, the Laraway Road crossing is currently under a Planning and Environmental Linkages (PEL) study for

[4] https://drive.ohio.gov/wps/portal/gov/driveohio/know-our-projects/projects/03.5-automated-driving-systems
[5] https://www.cmap.illinois.gov/updates/all/-/asset_publisher/UIMfSLnFfMB6/content/rail-crossing-delays-in-metropolitan-chicago
[6] https://www.cmap.illinois.gov/documents/10180/1013975/NE_IL_Priority_Grade_Crossings_June_2019.pdf/0e0899d0-6ed7-34cb-8564-1b02049829d4

various grade separation options,[7] and the Illinois Commerce Commission has programmed a queue cutter traffic signal at that location as a near-term safety improvement[8].

Vehicle Electrification

- **What is it?** This technology consists of electrification of the vehicle fleet, including trucks. Freight electrification includes trucks and intermodal terminal electrification. Electric trucks may also have some level of automation; Tesla's Semi, for instance, includes the company's Autopilot driver assistance feature.

- **Where does it work best?** Looking at truck electrification, adoption will depend on ownership costs compared to standard diesel trucks, as well as the availability of charging infrastructure. According to McKinsey & Company, in the U.S. electric vehicle uptake in the heavy-duty truck segment will probably lag market penetration in the passenger vehicle and light/medium duty truck fleet through 2030.[9] Even under optimistic assumptions, the firm forecasts less than 5 percent of the heavy duty truck market will be electrified in the United States by 2030. However, uncertain variables like the cost of diesel fuel and the regulatory environment may change this outlook. For example, a recent California Air Resources Board Advanced Clean Trucks regulation requires greater sales of zero-emissions trucks in the state beginning in 2024.[10] In addition, electrification of freight equipment for certain use cases, such as regional drayage and intermodal yard operations, may make economic sense in a shorter time frame.

- **Applicability to Study Area?** Electric truck market adoption will be driven by ownership costs and fitness for use in key applications. Diesel trucks continue to enjoy advantages for long-haul trucking, notably longer range between fueling. However, short-haul drayage (a common movement type in Will County) may be a feasible use case in the short- to medium-term. Railroads may also choose to electrify yard hostlers, cranes, and other yard equipment to reduce fuel expenses and emissions. Such projects may be eligible for federal emissions reduction grants.

National Best Practices

This section offers brief case studies that show how some of the technologies profiled above have been deployed to address congestion or safety issues related to freight activity. Three case studies are provided: Freight Signal Priority in Miami-Dade County; the Drayage Freight and Logistics Exchange (DrayFLEX) program in southern California; and Smart Columbus in Columbus, Ohio.

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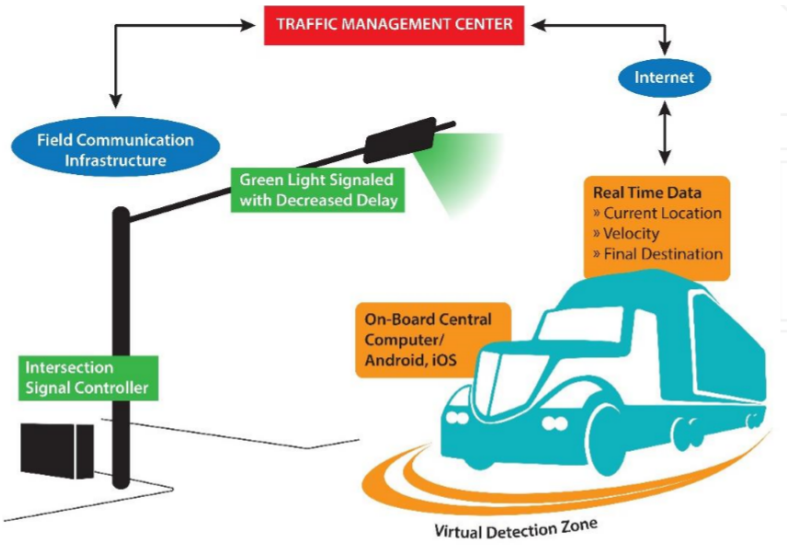
[7] https://www.cmap.illinois.gov/documents/10180/1265736/GradeCrossings_RTOC_20201119.pdf/c6fc955d-07bc-429e-6cc9-863bea7e69b9?t=1605815391424
[8] https://engage.cmap.illinois.gov/5189/widgets/20027/documents/16784
[9] https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/whats-sparking-electric-vehicle-adoption-in-the-truck-industry#
[10] https://ww2.arb.ca.gov/our-work/programs/advanced-clean-trucks

Freight Signal Priority

The Miami-Dade County Department of Transportation and Public Works (DTPW) began testing adaptive signal systems for transit in 2016. Recognizing the potential benefits for truck flows, DTPW is now leading deployment of freight signal priority along the Northwest 87th Avenue and Northwest 25th Street corridors, both of which serve freight-intensive land uses west of Miami International Airport. The first phase of deployment consisted of a smart freight mobility app, 18 upgraded traffic signals with Dedicated Short-Range Communications (DSRC) for V2X communications, and 500 DSRC radios that were deployed on fleet partner trucks. Phase 2 will deploy 60 upgraded traffic signals with dynamic signal priority that account for traffic on cross streets, and expanded fleet partner recruitment to test the smart freight mobility app.[11]

Signal controllers receive location, velocity, and destination information from trucks. Information is relayed through Traffic Management Center to the Field Communication Infrastructure, which enables the signals to provide green lights for freight. The features of this technology are shown in Figure 1.

Figure 1: ITS Communication for Freight Signal Priority



Source: Florida Department of Transportation (FDOT)

This deployment includes both dynamic/adaptive signal systems, which are programmed to adjust automatically to changing traffic conditions, and freight signal priority, which is a specific freight application that requires communication between trucks and the roadside. Based on experience with transit buses and modeling analysis conducted, freight signal priority will result in a 7-10

[11] http://www.miamidadetpo.org/library/presentations/Freight-Transportation-Advisory-Committee/fdot-advanced-freight-mobility-solutions-2018-09-18.pdf

percent decrease in delay and corridors with dynamic signals will experience a 14-20 percent decrease in delay. Fuel savings are expected to be 63,000 gallons of fuel with freight signal priority and 126,000 gallons with dynamic signals. (Field test results should be available by 2022.) Freight signal priority and dynamic signals combined are expected to generate an annual economic benefit of $2.5 million.

DrayFLEX

The Ports of Los Angeles and Long Beach form the biggest port complex in North America and handle two-thirds of the country's containerized imports via 13 container terminals. This amounted to nearly 8.6 million containers at the Port of Los Angeles[12] and 7.6 million containers at the Port of Long Beach in recent years.[13] This volume of traffic has led to increasing traffic congestion, emissions, and crashes around the two seaports.

The DrayFLEX program is deploying ITS technology in the region to address these issues. DrayFLEX is supported by FHWA's Freight Advanced Traveler Information System research program, which provides funds to pilot innovative technologies that benefit freight mobility[14]. The overall DrayFLEX program goals are to improve freight movement coordination and terminal efficiency, reduce traffic delays and truck queuing at terminal gates, and reduce fuel consumption and emissions. There are two deployment groups in the DrayFLEX program:

- **DrayFLEX Core** allocates trucks to appointments at the terminal and provides truck arrival times to terminals, which allows for better resource planning. The application integrates external public sector and private logistics firm systems to capture, process, and disseminate historical and real-time data that can be used to optimize port truck movements. This requires integration with trucking company and terminal operator management systems, which is resource-intensive but offers the potential to improve the full life cycle of port truck operations.

- **DrayFLEX Trip** provides in-cab truck traveler information and real-time routing. Truckers enter destination information in a mobile app, along with an appointment time at the terminal. The app then generates a recommended departure time and route. The app provides speed recommendations during the trip to avoid incidents, reduce travel time, and minimize pollution. The app also features Freight Queue Warning functionality, which can warn truckers about upcoming traffic slowdowns near congested port terminal gates and along congested freight corridors where sudden slowdowns contribute to rear-end crashes.

DrayFLEX also features performance dashboards to understand program impacts. Metrics can be tailored to different user groups like agencies and truck drivers (see Figure 2).

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[12] https://www.portoflosangeles.org/business/statistics/container-statistics/historical-teu-statistics-2020
[13] https://www.polb.com/business/port-statistics/#yearly-teus
[14] https://www.its.dot.gov/research_archives/dma/bundle/fratis_plan.htm

Figure 2: Example Performance Dashboard

Source: CDM Smith

Smart Columbus

Although not a freight-centric case study, the Smart Columbus program is a leading national example of applying advanced technology to meet a variety of surface transportation benefits, and offers potential lessons for freight movement in Will County.

In 2016, Columbus, OH won a $40 million USDOT grant through the Smart Cities Challenge. The program included a $10 million match from the Paul G. Allen Family Foundation. Grant funds are being used to deploy new transportation technologies in a holistic manner that improves mobility, equity, health, economic opportunity, and environmental outcomes. Further, Smart Columbus seeks to integrate this approach with other city services like public safety and energy. Key projects include:

- **Electric and automated vehicles –** Partnering with DriveOhio (a division of the Ohio Department of Transportation), Smart Columbus launched a self-driving shuttle service in December 2018 which provides free rides to destinations in downtown Columbus such as the National Veterans Memorial and Museum, Bicentennial Park, the Center of Science and Industry, and the Smart Columbus Experience Center. A planned second route will deploy 15-passenger automated shuttles in Linden, a disadvantaged neighborhood in Columbus. The route will connect Linden residents to community resources like public transit, affordable housing, recreation, and childcare.

- **Connected vehicles –** Columbus is deploying a Connected Vehicle Environment which will allow participating vehicles to communicate with each other and with traffic signals, enabling hazard alerts for drivers, favorable signal timing for buses and emergency vehicles,

and enhanced traffic management. The initial deployment includes intersections with the highest collision rates in the city. Alerts will include red light violation warnings, blind spot detection, and rear-end collision warnings. The Connected Vehicle Environment is considered an enabling technology since it leverages technology that can be used for multiple mobility and safety applications.

- **Smart Columbus Operating System –** This database (visualized in Figure 3) serves as the central repository for all data generated and used by the various deployments. The system is designed to ingest, scrub, aggregate, and publish data about the deployment projects and capture performance data for reporting to USDOT and the public. As such, it provides baseline and deployment data for measuring project benefits, developing lessons learned, and generating ideas for new deployments or research projects. Open datasets are available for search and download on the Smart Columbus web site.[15]

Figure 3: Smart Columbus Operating System Concept

Source: Smart Columbus

Partnerships with industry, nonprofits, and government agencies were a key reason Columbus won the Smart Cities Challenge. The City of Columbus partnered with One Columbus, an economic development organization for the 11-county region including government agencies, businesses, and

[15] https://www.smartcolumbusos.com/

non-profits.[16] This network of regional advocacy groups mobilized resources for the Smart Cities Challenge, including financial contributions that were a key factor in Columbus winning the award. These partnerships also ensured broad-based support for the program.

Planning Considerations – Regulations and Standards

From a public infrastructure planning perspective, a key uncertainty in planning for emerging technologies revolves around communications standards for connected vehicles. The Federal Communications Commission (FCC) recently approved a rule change that opens part of the 5.9 gigahertz radio spectrum previously reserved for V2X safety applications to unlicensed Wi-Fi use.[17] This portion of the spectrum is used by DSRC, on which most CAV applications to date have relied. While many industry players have embraced cellular technology – including the emerging 5G LTE standard – to enable future CAV applications, reassigning a portion of the spectrum could require additional research to ensure safety applications can be delivered via cellular communications rather than DSRC.

Conclusion

Given the degree of uncertainty surrounding many new transportation technologies, the following conclusions are provided as Will County plans for emerging technologies:

- Since there is no mandate for CAV equipment in production vehicles, planning for county-wide V2X deployment is likely premature for local agencies. Further, autonomous vehicles are being developed to operate within existing infrastructure constraints and without the need for communication with roadside equipment, offering limited scope for local government involvement. Nonetheless, routine maintenance of signs and pavement markings to consistent standards, along with installing ITS devices at spot locations or along individual corridors, may encourage adoption of emerging technology while benefiting all road users. Co-locating future CAV equipment with existing ITS infrastructure can also generate cost savings since the equipment can share the same power, cabinet, and communications infrastructure.

- Will County could explore technology demonstrations and pilot deployment projects, for instance to deploy signal system upgrades. Given the recent FCC rule change, there may be opportunities to sponsor pilot deployments to test cellular V2X applications. Will County could also coordinate with Midwest Gateway to identify additional truck traveler information, which could be published to Midwest Gateway's existing trucker page. In addition, competitive Congestion Mitigation and Air Quality (CMAQ) grants can be used to fund freight projects that reduce diesel emissions. This may present opportunities to fund intermodal terminal and/or fleet electrification projects in partnership with the private sector.

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[16] https://columbusregion.com/onecolumbus/
[17] https://www.caranddriver.com/news/a34963287/fcc-connected-cars-regulations-change-revealed/

It will be important to cultivate partnerships with technology providers, other agencies, and private firms as new transportation technologies continue to evolve. This can help Will County identify promising technologies, secure funds for technology planning and pilot tests, evaluate results, and generate lessons learned. For local or regional projects such as standing up a TMC or testing freight CAV technology in the study area, coordination with regional agencies like CMAP as well as fleet partners will be necessary. For multi-state corridor deployments like truck platooning, IDOT support will likely be required to leverage federal grant participation and technical expertise.