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LIVE zone
Logistics Innovation and Vehicle Electrification Zone

LIVE Zone Operational Concept

Prepared For:

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List of Acronyms

Acronym/Abbreviation	Definition
ACL	Aircraft Cargo Loader
AFCT	Automated freight container transfer machine
AV	Autonomous or Automated Vehicle
AYJ	Autonomous Yard Jockey
BP	Business Partners
BSM	Basic Safety Message
CNG	Compressed Natural Gas
CV	Connected Vehicle
DMS	Dynamic Message Sign
Eastgate Regional COG	Eastgate Regional Council of Governments
EV	Electric Vehicle
FHWA	Federal Highway Administration
IoT	Internet of Things
LIVE Zone	Logistics Innovation and Vehicle Electrification Zone
LoRA	Long Range low power network protocol
MCS	Mission Control System
NS	Norfolk Southern
OBU	On-board Unit
PNCT	Pallet or Non-Conforming Form-Factor Transfer Machine
RSU	Roadside Unit
SPaT	Signal Phasing and Timing
TPIS	Truck Parking Information System
TRL	Technology Readiness Level
UC	Use Case
ULD	Unit load device (aircraft)
WRTA	Western Reserve Transit Authority
YWRA	Youngstown Warren Regional Airport

1 Project Overview

This conceptual operations plan serves as the initial, high-level summary of the Logistics Innovation and Vehicle Electrification (LIVE) Zone concept. The purpose is to document the Conceptual Operations of the proposed system including high level user needs, system components, and conceptual use cases. The overall system goals, user needs, and expectations are documented within this document.

1.1 Project Background

The LIVE Zone is a strategic infrastructure deployment and economic development initiative endorsed by the Eastgate Regional Council of Governments. LIVE Zone, and the surrounding area, located at the convergence of multiple transportation modes, poises it uniquely to serve as a premier regional warehousing, manufacturing, and distribution hub. The future vision in LIVE Zone, centered around existing manufacturing and distribution centers, optimizes existing transportation infrastructure, and strategically integrates innovative technologies and electrification into existing manufacturing and logistics activities to create the vision. Incorporating smart technologies and advanced automation solutions creates more sustainable options for utilizing the established infrastructure.

Moreover, advancing the LIVE Zone expands the evolving legacy of manufacturing and logistics, as well as building upon the successful Youngstown Smart2 Network, technology development, educational alliances, and industry partnerships. Investments in logistics technology such as an automated transfer yard, solar powered vehicle charging, and Smart Corridor solutions will allow the region to serve as the confluence of the major transportation modes it already contains and bolster supply chain resiliency.

1.2 Project Location

Located in Trumbull County, Lordstown is a rural village located northwest of Youngstown, Ohio. One primary feature of this community is immediate access to major transportation links such as CSX and Norfolk-Southern rail lines, I-80, and I-76. A vehicle manufacturing plant previously owned by General Motors in Lordstown was a generator of jobs for the surrounding areas. Since the plant's closure, ownership of the plant has changed hands multiple times and is currently owned by Foxconn, who will be contracting out to Lordstown Motors and other electric vehicle manufactures to create a new manufacturing opportunity in the region. The feasibility study limits also extend into Jackson Township, Mahoning County.

The Foxconn plant and adjacent Ultium lithium battery plant represents the core of the LIVE Zone and situated adjacent to a network of transportation facilities including two interstates and two Class 1 railroads, further maximizing goods movement exchange with multiple nearby distribution centers. The LIVE Zone is comprised of a "Smart Yard" with supporting "connected" infrastructure and autonomous vehicles. An innovative, technology-driven project such as the

LIVE Zone, requires well-designed, incremental implementation, defined through deployment phases, based on operational needs and the state of technology.

1.3 Project Scope

The LIVE Zone will deploy emerging technologies occurring across many industries that supports an advanced logistics management including:

- Automated technologies
- Internet of Things (IoT)/Connectivity
- Fleet Management System
- Electric Vehicle (EV) Charging Infrastructure
- Solar Farm/Storage and Microgrid
- Data and performance analytics

Overall design of the system will occur during later system engineering phases using this concept of operations for user needs and overall system components. Design details will be finalized with vendor input after procurement. Operations and maintenance of the system will require management personnel to oversee the system, address user needs, and coordinate with external partners; and maintenance personnel to troubleshoot, repair, and replace system components as needed.

Installation of system hardware and software will be done by either vendors or approved contractors to provide a complete and fully operational system. The contractor or vendor will supply the operations staff with documentation, user guides, warranty information, etc., as needed to operate, troubleshoot, repair, or replace system components.

To meet the workforce needs of a multi-faceted automated operating network, a labor strategy identifying specific labor functions and various training needs will be accomplished through a metaverse environment as well as hands-on technology interface.

Smart Mobility initiatives in Ohio have produced numerous potential collaborative partners, seeking to expand transportation and business capabilities through emerging technologies. LIVE Zone presents an opportunity to expand public-private partnerships as well as with educational institutions such as Youngstown State University.

2 Project Goals

Goals for a concept of operation generally define what the system is intended to do and the success of the system. That success is measured by comparing system output, results, or data against the relevant goal, providing a metric for system success. Goals may be qualitative or quantitative and specific or general. They are defined early to prevent scope creep or alteration of the general purpose of the system.

Goals are often accompanied by a vision statement for the project. The vision statement is a precursor for the system goals and outlines broadly the purpose and inspiration for a system. The vision of LIVE Zone is presented in the following.

LIVE ZONE VISION

The Live Zone will reimagine Voltage Valley in Eastern Ohio by creating a scalable and innovative ecosystem of smart and connected freight infrastructure that retains, expands, and attracts businesses while retraining the workforce to create a sustainable, equitable and resilient economy.

In support of this vision, the project team has developed goals with input from stakeholders and industry leaders. Goals are divided into three focus areas: Technology Planning and Deployment, Economic Development, and Collaboration. A summary of goals is presented in the following **Figure 1**.

Figure 1. LIVE Zone Goals

Technology Planning and Deployment

1. Make the Valley a national leader in smart logistics by developing a scalable proving ground that others can emulate.
2. Create opportunities for testing technologies and innovative concepts in a safe, low impact, real-world environment.
3. Enhance the safety of freight movement with automation and smart infrastructure.
4. Mitigate climate change and improve the electric grid's resilience through future-focused infrastructure, including vehicle electrification, alternative fuels and clean energy

Economic Development

1. Cultivate inclusive economic and workforce development through technology and infrastructure investment.
2. Support domestic manufacturing, agriculture and logistics by improving the reliability and efficiency of the regional supply chain.

Collaboration

1. Forge a dynamic and diverse community coalition that fosters innovative public-private partnerships that lay the groundwork for growth and incubation.
2. Assist, encourage, and promote cooperation and collaborative investment between the public and the private sector

3 Proposed System Overview

The LIVE Zone will deploy emerging technologies and automation to manage and perform logistics tasks. Automated systems, communications infrastructure, and a fleet management system will perform those logistics tasks, overseen by and/or assisted by management and operations personnel.

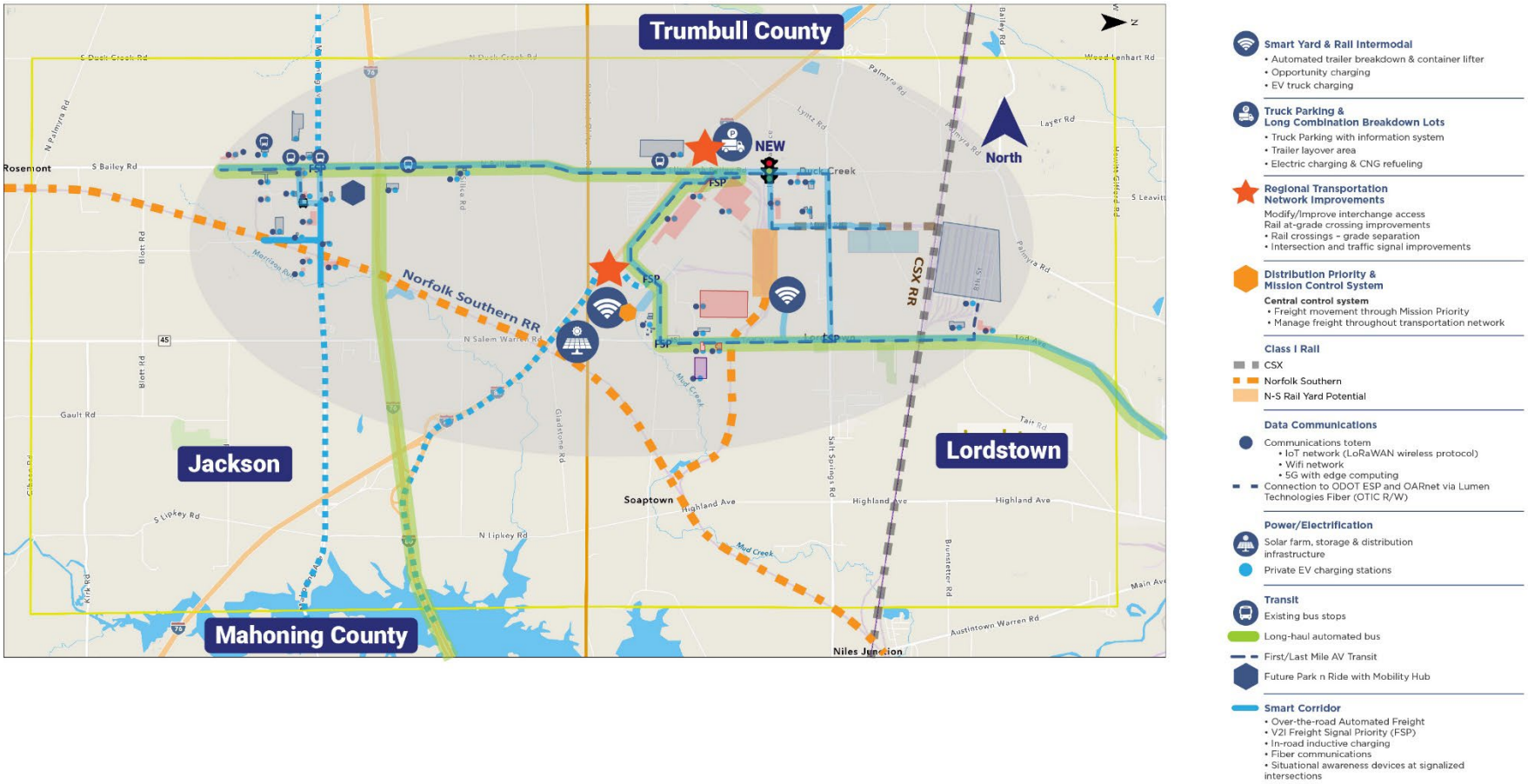
The overall system is comprised of several key features that will work in unison. Autonomous vehicles will transfer and move shipments from a Smart Yard located at the eastern interchanges along I-80 to and from other distribution and intermodal centers. Shipments will be moved accordingly to their destination between distribution centers, intermodals or manufacturing centers via a smart corridors.

Communications totems and fiber optics will facilitate that connectivity, located at strategic points along the corridors and within manufacturing and distribution facilities. To power this autonomous fleet, charging infrastructure will be deployed at strategic locations providing for optimal opportunity charging. Additionally, DC fast charging infrastructure will be deployed in the Smart Yards specifically for use by long-haul trucks.

The LIVE Zone autonomous freight movement vehicles, charging infrastructure, missions, and performance will be managed using a fleet management system. This management software will coordinate missions, optimize container staging, and provide performance analytics. Data can be extracted from this software or gathered by other means through coordination with research institutions such as nearby universities.

For continuous operation of the system, the workforce development required for labor resources can be done through metaverse and hands-on training to shift from traditional manufacturing to automated technologies. Strategic partnerships with private and public entities such as local universities, manufacturers, and distributors are established by opting into data systems, communications, and autonomous freight movement.

Figure 2. Proposed System Overview



4 High Level User Needs

User needs define what the users aim to accomplish with the system. System requirements will be developed from the user needs to describe what the system will do to meet those needs. Later, system validation will determine if the project has successfully met user needs.

Users will be anyone who interacts with the system to load and unload freight, receive and send shipments, use the charging stations for vehicles, or perform research. Autonomous vehicles will interface with the public on preplanned routes, however public use is not anticipated as this system is used for the movement and management of freight. Users of the LIVE Zone will include both private and public entities including DriveOhio, Eastgate Regional COG, local manufacturers and distributors, nearby universities, and trucking and rail companies.

4.1 Stakeholder Profiles

Many stakeholders will use, operate, or manage the LIVE Zone system. A user is defined as anyone who interacts with the system or may be affected by its use. Stakeholder classes are generalized by common activities, relation to system, and activities. **Table 4-1** shows the various stakeholders and their roles and responsibilities.

Table 4-1. Stakeholder Roles and Responsibilities

Stakeholders	Roles and Responsibilities
Infrastructure Owners and Operators	• Own and manage infrastructure, advise on public sector needs • Integrate automated systems into existing transportation networks and use technology to manage system efficiently • Expand capabilities according to changes in need or new partners • Training operators using virtual metaverse and on-hands
Distributors	• Oversee own logistics and use fleet management software • Use autonomous vehicles to break down triple trailers • Use autonomous transport vehicles to ferry freight between Smart Yards, warehouses, and rail lines • Charge electric trucks
Manufacturers	• Oversee own production and use fleet management software • Use autonomous vehicles to receive raw materials and export products
Business owners	• Export produce via rail • Develop areas of Lordstown and establish partnership with LIVE Zone
Universities	• Work with owners to conduct studies on automation • Extract data from fleet managements system and electric vehicle charging systems • Provide reports on study findings
Employees	• Operate, troubleshoot, repair, and replace system components • Manage the LIVE Zone system • Coordinate with users as needed • Report operations to owners

4.2 Conceptual User Needs

A series of interviews with stakeholders and meetings with Eastgate Regional COG and local official was conducted from between November and December 2021. The purpose of these interviews was to garner feedback and document needs for this system. The following **Table 4-2** details various stakeholders and their anticipated needs. It is noted that the needs identified were generated from limited stakeholder participation and an assessment of user needs based on the project area and the needs of the region that have been identified. The needs shown may be subject to change.

Table 4-2. User Needs

User	Needs
Eastgate Regional COG	• Ideal hub location, strong resources, business, and partners. Plenty of available land and interested buyers • Partnership with Lordstown Village and Jackson Township • Security against threats or risks for software/hardware
Distributors	• Charging infrastructure for trucks • Triple trailer transfer yard would allow for better rates • Container transfer from truck to rail and vice versa • Efficient system for moving goods, filling orders, and shipping • Management of warehouse inventory
Manufacturers	• Charging infrastructure for autonomous freight moving equipment • Receive raw materials and export products efficiently • Inventory management
Business owners	• Local farmers using rail and backhauling grain to China • Accommodations for business prospects looking to integrate into system
Universities	• Access to system data • Access to perform studies on system including site visits and other forms of data collection
Employees	• Hands-on and virtual training as needed • Manuals, guidebooks, and information on systems and how to troubleshoot, repair, and replace system components

5 System Components

The vision of the LIVE Zone system it to demonstrate how innovative technologies can be leveraged to meet logistics needs and bolster community economic development. The following sections detail a review of current and developing technology, individual system components, and a determination of chosen technologies deployment readiness.

5.1 National Scan

To determine the current state of emerging technology, best practices, and strategies, a national scan was conducted to research emerging technologies related to smart logistics. The national scan identified four key characteristics that exist regarding global logistics hubs:

1. They offer several options for transportation forms such as air/ocean freight, significant highway interchanges, and intermodal facilities.
2. They offer plenty of facilities capable of processing, storing, and distributing products.
3. They have access to international locations that operate with global logistics hubs.
4. Local economies and political environments are low-risk and exchange in the international trade of goods and service.

Smart logistics is a technology driven approach that implements smart devices and collects data to facilitate automation of logistics operations. Data analytics provides logistics managers the ability to make informed decisions on warehousing and distribution. As technology continues to emerge, so does solutions for issues around storage and distribution of goods. Today, logistics advances play a vital role in gaining competitive advantage in the e-commerce and retail industry. A host of business acquisitions is evidence of a shift in business.

Various nations around the world are advancing logistics with technology like Cainiao in Hainan City, China; Shanghai with massive scale automation; Los Angeles with Port Optimizer; and the Netherlands with Portbase. To support these initiatives, several companies offer logistics software and hardware specific to application. Cofano offers map navigation and route planning; Outrider provides autonomous electric yard trucks to move trailers, BNSF and CSX employ automated straddle carriers or gantry cranes; and ISEE provides autonomous capabilities for delivery and yard vehicles.

5.2 Conceptual System Components

5.2.1 Smart Yard

A Smart Yard located at the eastern interchange will offer staging and charging for trucks destined to or from the LIVE Zone. An automated trailer breakdown & container lifter will allow shipping containers to be removed from trucks and then transported to their destination. An automated container loader will load shipments into shipping containers. Opportunity charging will be available for autonomous yard jockeys and other autonomous freight movers and lifters via inductive plate to recharge as necessary. Electric trucks will also be able to be charged through direct hook-ups at specified charging stations. An intermodal rail yard adjacent to the existing Norfolk Southern yard will support transfer of freight between trucks and rail. The intermodal yard will provide raw materials and/or finished goods inbound and backhaul finished goods and/or locally grown and harvested agricultural products for export.

5.2.2 Truck Parking and Long Combination Breakdown Lot

The west interchange will be used as a rest area with truck parking managed by a truck parking information system (TPIS) and coupling/uncoupling combination trailers. Given the LIVE Zone's position near the Pennsylvania border, this allows combination trucks to add or remove trailers as necessary before continuing their journey. The lot will include electric truck charging stations as well as alternative fueling stations such as compressed natural gas (CNG) and potentially others in the future. The TPIS will manage parking and inform truckers looking for parking of available parking spots for overnight parking.

5.2.1 Smart Corridor

The Smart Corridor will connect manufacturing and distribution centers and intermodal facilities. Along the Smart Corridor will be communications totems and fiber optic communications to facilitate communications back to the central management system. Included will be over-the-road automated freight movements performed by autonomous yard jockeys to deliver shipping containers and truck trailers. The connected vehicle application freight signal priority will be deployed at signalized intersections along the corridor providing safe and efficient travel for both autonomous and operator driven trucks. Additionally, the intersection situational awareness application will be deployed for identifying the types of objects at an intersection and their speed and heading. An in-road dynamic inductive charging charges vehicles as they move and is also considered for this system component.

5.2.2 Power and Electrification

Electrification requires greater power generation and is anticipated for the LIVE Zone. Available space in in-field areas can be used to house solar arrays for clean power generation. To supplement those solar arrays, grid connections can provide additional power during surges and greater reliability. Workplace charging for private vehicles will be deployed in parking lots.

5.2.3 Distribution Prioritization and Mission Control System

Critical to the efficient operation of the system is a definition of prioritization protocols, or critical operating rules. A mission control system will oversee all system elements and coordinate critical missions or reservations to move freight within the LIVE Zone initially and as it expands regionally. The system would prioritize, schedule, and track missions and reassign after completion.

5.2.4 Data and Network Communications

The LIVE Zone will deploy various communication types throughout to meet demands for anticipated and unanticipated needs. Communications between autonomous freight vehicles, yard trucks, container lifters, automated transit, and the mission control system are required to fully operate the system. The communications will extend along the smart corridor and within warehouses/buildings as necessary to provide the coverage needed and interface for business partners to access the reservation system. Communications will be transmitted through fiber optic lines and communications totems that house protocol for IoT, LoRa, Wi-Fi, and 5G.

5.2.5 Transit

Transit is considered for its ability to move people to and from work efficiently and with less of a carbon footprint than individual vehicles and to address employment needs. Automated transit

can provide the first/last mile connections from home to place of employment. Long-haul automated buses are considered for their ability to transport regionally, however that technology is not readily available or approved for use. This system will also support the proposed Western Reserve Transit Authority (WRTA) Park n' Ride with communications and future kiosk to hail automated transit to service last mile ridership to employment centers.

5.2.6 Regional Transportation Network Improvements

Transportation network improvements include both traditional civil engineering improvements for interchange/roadway capacity and connected vehicle technology for traffic signals. Connected vehicle applications will be deployed at various intersections including freight signal priority, intersection situational awareness, signal phasing and timing (SPaT), intersection MAP, and basic safety messages (BSM). A roadside unit (RSU) at each signal will facilitate communications between connected vehicles and the infrastructure. RSUs may be augmented to existing signal controllers if compatible, however, if not compatible, the signal controller will be upgraded.

5.3 Technology Readiness Assessment

A formal evaluation of technologies readiness was conducted to determine which proposed technologies are readily deployable or required further research and development. It is not expected that the LIVE Zone will directly develop technology, however it can serve to incubate technologies to assist private companies research development.

Readiness is assessed through Technology Readiness Levels (TRL), as defined by the readiness assessment framework. The framework chosen for this application was that of the Federal Highway Administration (FHWA) given its relevance to transportation. Technologies were inventoried and researched to determine their maturity and list vendors or manufacturers that could supply this technology. A summary of TRLs is provided below with nine ranks of maturity from level 1 (basic research) to level 9 (implementation).

1. Basic principles and research
2. Application formulated
3. Proof of concept
4. Components validated in laboratory environment
5. Integrated components demonstrated in a laboratory environment
6. Prototype demonstrated in relevant environment
7. Prototype demonstrated in operational environment
8. Technology proven in operational environment
9. Technology refined and adopted

An assessment of each technology is provided on the next page in **Table 5-1**.

Table 5-1. Technology Readiness Assessment

Concept	Technology	Operational Description/Domain	TRL	Deploy	Readiness Notes
Smart Yard	Automated Trailer Breakdown and Container Lifter System	Freight container transfer from truck trailer to autonomous yard jockey trailer	8	Yes	Side loader machines mounted on trailer currently available and are remote controlled.
		Automated Container Loader	9	Yes	Automated Container Loaders in production and commercial use in relevant environments by companies like SmartTEH
		Automated trailer decoupling and positioning	8	Yes	Autonomous yard jockey or terminal trucks with management software currently available. Have proven to work within a defined ODD such as a yard.
		Pallet or other non-conforming form factor freight transfer from truck trailer to yard jockey trailer	9	Yes	There are autonomous solutions available for moving pallet loads or other loads using a forklift or pallet jack. These are typically operated by private companies to move material as needed. Autonomous solutions are available but used within the warehouse setting on smooth finished concrete.
	Opportunity Charging	Charging in between assignments	9	Yes	Several commercial scale manufacturers currently offering inductive charging equipment for industrial machines. Within a defined ODD, the opportunity charging is monitored and managed by the backend operating system.
	EV Truck Charging	Smart Yard electric truck charging stations	9	Yes	Long-haul trucking is not yet a strong market sector as there are limitations with battery technology and charging infrastructure to support long-haul operations of EV trucks. However, shorter, regional, and local operations can and do exist. Truck charging solutions commercially available but limited market penetration. First electric truck charging station being built now in Bakersfield Cal, however, charging infrastructure is similar to traditional passenger vehicle charging infrastructure.
	Rail Intermodal @ Norfolk Southern Goodman Yard	Intermodal yard with rail siding freight container transfer between train, truck, and autonomous yard jockeys	9	Yes	BNSF and CSX currently using automated gantry in normal operations at three different locations.
Truck Parking and Long Combination Breakdown Lot	EV Truck Charging	Truck Parking and Long Combination Breakdown Lot electric truck charging stations	9	Yes	See above Smart Yard - EV Truck Charging
	Alternative Fueling Stations	Truck Parking and Long Combination Breakdown Lot CNG fueling stations	9	Yes	CNG stations currently deployed across nation and some in Canada; LNG stations sparsely available; Propane stations widely available; Hydrogen stations limited to California; Biodiesel stations spread out across nation, though only three stations offer in Ohio
	Truck Parking w/ Truck Parking Information System	Third-party applications, broadcast to DMS, and MAASTO TPIMS	9	Yes	Applications currently available that offer truck parking information using various technologies to determine and disseminate available spaces.
Smart Corridor	Over-the-Road Automated Freight (autonomous yard jockey)	Dedicated travel lanes	8	Yes	Autonomous yard jockey or terminal trucks with management software currently available. Have proven to work within a defined ODD such as a yard and show potential viability of being able to replicate successful function in a modified environment such as dedicated lanes. A mixed traffic ODD likely would be more challenging at this point of technology maturity. Use or need for a driver as a failsafe will likely be dictated based on local and state requirements.
		Mixed traffic environment	6	No	
	Freight Signal Priority (V2X communication)	Traffic signals	9	Yes	Freight Signal Priority (FSP) utilizes signal request message set similar to transit signal priority within the connected vehicle SAE message set. The demonstration and implementation of FSP has been performed by outfitting demonstration vehicles with on-board equipment. Active deployment in Atlanta Transit Signal Priority Pilot: Midtown Atlanta with State Rail and Tollway Authority (SRTA) and Cisco/MARTA In Operation as of March 2021
	In-Road Dynamic Inductive Charging	Over-the-road dedicated or mixed traffic	7	No	The technology has been demonstrated in real-world environment with limited exposure. Tests have been conducted on short road segments in Israel, Sweden, and Germany. Bid for first dynamic road charging in US for Michigan to be operational in 2023.
	Intersection Situational Awareness	Traffic signals	8	No	Situational awareness devices have been deployed by third party solution providers and tech companies such as Honda, Bosch, Derq, Cisco, and Verizon. These devices have been deployed in limited pilot test locations within very specific operational environments.
Power and Electrification	Solar Field/Farm/Storage	Dedicated solar farm field with vanadium redox storage	9	Yes	Solar power generation and storage infrastructure widely available. Vanadium Redox storage systems currently in use in San Dirgo and Australia.
	Private (workplace) EV Charging	Private business partner property and parking lot.	9	Yes	EV charging infrastructure available for workplace charging
Distribution Prioritization and Mission Control System	Centralized Control System to Prioritize, Schedule and Track Critical Missions in the Transportation Network	Automated environment within the Zone	7	Yes	The fleet management systems require AI and critical operating rules to identify and optimize the distribution network priorities. Several companies offer AI in specific areas of logistical needs. UPS has ORION to determine fastest and most cost-effective route for vehicles dynamically in route. Lineage uses AI to manage warehouses and product storage.
		Non-automated modes within the larger distribution network (Warren, Youngstown, YNG)	9	Yes	To integrate external systems, a software "airgap" / integration point would be required between the systems with an enterprise service bus. This type of application would allow integration of an existing order management system from an airport, logistics hub, private sector partner, and transportation system to all be queued into one fleet manager and order system. There are several suitable options for this integration.
Data and Network Communications	Private Network Interface - IoT network (LoRa) - Wi-Fi - 5G with edge computing	Interior located and exterior totems that house a full spectrum of wireless communications	9	Yes	These technologies are all proven communication mediums that have been applied in various operating environments.
Transit	Automated Transit for First/Last mile to Employment	Dedicated travel lanes or mixed traffic	8	Yes	Deployments of low-speed automated transit vehicles increasing around world, though many still characterized as pilot deployments. Deployments in US includes Columbus, OH; University of Michigan; Dallas Fort Worth; Utah Transit Authority, Jacksonville Florida; Contra Costa County, CA; Arlington, Virginia. Most operate in a controlled ODD and are operating in limited mixed environments. Use or need for a driver as a failsafe will likely be dictated based on local and state requirements. Development of approved transit vehicles that comply with federal safety standards (operate over 25 mph) is evolving with the first deployments expected in 2022.
	Long-Haul Automated Bus	Open road/mixed traffic	6	No	An automated bus has been developed and constructed by New Flyer but not yet to demonstrated in an operational environment. SAE Level 4 transit vehicles are not yet available on the market. The timeframe estimated is to be 2024-25. Use or need for a driver as a failsafe will likely be dictated based on local and state requirements.
Regional Transportation Network Improvements	Traffic Signal Enhancements	n/a	9	Yes	Existing traffic signal technology for advanced systems - SPaT, MAP, BSM, as well as Transit and Freight priority are prevalent throughout the United States. Deployments of newer C-V2X technology is limited but known.

6 Operational Elements

6.1 Operational Description

The main operations of the LIVE Zone will occur in the zone. This is where the main data prioritization and mission control system will be housed with operators to oversee the system. That includes computers, connections, and software to run the control system. Beyond that, the zone will be connected to other systems components through fiber optics and communications totems located at strategic points between systems and roadside.

Users of the logistics management system will interface with the system at a workstation within their own buildings to make reservations. They will also house communications totems. Operators for private companies will require training on how to use the system to make reservations.

Electric truck charging and fueling stations are located at either the west or east interchange lots, which includes charging stations and electrical power connections. Fueling stations will require either underground storage tanks or above ground storage tanks. Personnel may be required to be present to accept payment for fueling. Solar arrays and storage will be located within interchange infield areas.

Autonomous yard jockeys are transient but will be staged at either interchange lots when not in use. Charging will occur at these lots as well via inductive plate. The automated container breakdown/lifter will be located at the Smart Yard eastern interchange. The automated container loader will also be located at the Smart Yard eastern interchange. No personnel are required to operate the machines but are required to service them.

Connected vehicle applications will be run through RSUs located at signalized intersections in the area. The applications will communicate with the signal and on-board units (OBUs) in private vehicles to relay messages to the driver. Signal controller upgrades may be required if the existing equipment is not compatible.

6.2 Conceptual Use Cases

This section provides a series of use case scenarios that describe how the LIVE Zone will operate. Each scenario is a workflow showing steps taken by users and how the system is expected to respond. While many scenarios are anticipated, the following provides an overview of the typical major operational uses. Standardized use cases, such as charging electric trucks, are not described.

The following is a summary of use cases (UC) detailed in the following sections:

- UC 1. Receive Freight
  - Scenario 1: Via Truck
  - Scenario 2: Via Rail
  - Scenario 3: Via Air Cargo
- UC 2. Ship Freight
  - Scenario 1: Via Truck
  - Scenario 2: Via Rail
  - Scenario 3: Via Air Cargo
- UC 3. Load Shipping Container
- UC 4. Truck Parking Availability
- UC 5. Vehicle-to-Infrastructure Freight Signal Priority
- UC 6. Automated Transit Connection to Employment

- UC 7. Situational Awareness at Signalized Intersections

6.2.1 Use Case 1. Receive Freight

Table 6-1. Use Case 1. Scenario 1: Receive Freight via Truck

Overview		
Scenario ID and Title	UC 1-S 1. Receiving freight via truck	
Objective	Business partners wanting to receive freight via truck using the reservation system to assign freight movement within the LIVE Zone and deliver the freight to the business partner.	
Actors and Interfaces	Actor	Role
	Business partner	Orders raw materials and/or wholesale product for further processing or other business activities
	Truck driver	Delivers freight to Smart Yard
	Autonomous yard jockey (AYJ)	Moves freight within LIVE Zone
	Automated freight container transfer machine (AFCT)	Transfers shipping container between truck trailer and yard jockey trailer
	Mission control system (MCS)	Oversees missions and system elements, assigns mission priority
Initial Status and Preconditions	Long-haul truck en route to Smart Yard to deliver freight No business partner reservation made	

Basic Flow of Events		
Step	Actor	Event
1	Truck driver	Truck arrives at Smart Yard, enters queue (if present) for container transfer
2	AFCT machine	Removes freight container from truck, places it onto AYJ trailer
3	AYJ	Moves trailer to intermediate staging area, decouples trailer and proceeds as needed with priority missions
4	Truck driver	Alerts business partner that container has been delivered to Smart Yard via mission control system. Then exits Smart Yard.
5	Business partner	Makes reservation to have freight delivered to business and designates location on property to receive freight
6	MCS	Creates mission and assigns mission priority as appropriate
7	AYJ	Receives mission details, locates and couples trailer with container, then moves freight to business
8	AYJ	Positions freight in loading dock or yard as designated by the business partner. Decouples trailer and continues to next mission
9	Business partner	Unloads freight then designates trailer for pickup in mission control system
10	AYJ	Returns to business, couples trailer, and returns trailer to Smart Yard. Informs mission control system that mission is complete
11	MCS	Designates mission completed and notifies business partner of completion

Post conditions
MCS closes out mission Business partner processes freight AYJ at rest in Smart Yard, charging at opportunity charging locations, or continues to next mission AFCT machine at rest, charging, or continues to next mission Truck driver enroute to next destination

Alternate flow (replaces above steps for same number)		
Step	Actor	Event
2a	Pallet or non-conforming form factor transfer machine (PNCT)	PNCT machine removes freight container from truck, places it onto AYJ flatbed trailer

Table 6-2. Use Case 1. Scenario 2: Receive Freight via Rail

Overview			
Scenario ID and Title	UC 1-S 2. Receiving freight via rail		
Objective	Business partners wanting to receive incoming freight via Norfolk Southern (NS) Goodman Yard rail using the reservation system to assign freight movement within the LIVE Zone and deliver the freight to the business partner.		
Actors and Interfaces	Actor	Role	
	Business partner	Orders raw materials and/or wholesale product for further processing or other business activities	
	Train/engineer	Delivers freight to NS Goodman Yard	
	Autonomous yard jockey (AYJ)	Moves freight within LIVE Zone	
	Automated freight container transfer machine (AFCT)	Transfers shipping container between rail car and yard jockey trailer	
	Mission control system (MCS)	Oversees missions and system elements, assigns mission priority	
Initial Status and Preconditions	Train en route to NS Goodman Yard to deliver freight No business partner reservation made		
Basic Flow of Events			
Step	Actor	Event	
1	Train engineer	Train arrives at NS Goodman Yard, enters staging line	
2	AFCT machine	Removes freight container from rail car, places it onto AYJ trailer	
3	AYJ	Moves trailer to intermediate staging area, decouples trailer and proceeds as needed with priority missions	
4	Train engineer	Alerts business partner that container has been delivered to NS Goodman Yard via mission control system.	
5	Business partner	Makes reservation to have freight delivered to business and designates location on property to receive freight	
6	MCS	Creates mission and assigns mission priority as appropriate	
7	AYJ	Receives mission details, locates and couples trailer with container, then moves freight to business	
8	AYJ	Positions freight in loading dock or yard as designated by the business partner. Decouples trailer and continues to next mission	
9	Business partner	Unloads freight then designates trailer for pickup in mission control system	
10	AYJ	Returns to business, couples trailer, and returns trailer to Smart Yard. Informs mission control system that mission is complete	
11	MCS	Designates mission completed and notifies business partner of completion	
Post conditions			
MCS closes out mission Business partner processes freight AYJ at rest in Smart Yard, charging at opportunity charging locations, or continues to next mission AFCT machine at rest, charging, or continues to next mission Train enroute to next destination			
Alternate flow (replaces above steps for same number)			
Step	Actor	Event	
2a	Pallet or non-conforming form factor transfer machine (PNCT)	PNCT machine removes freight container from rail car, places it onto AYJ flatbed trailer	

Table 6-3. Use Case 1. Scenario 3: Receive Freight via Air Cargo

Overview		
Scenario ID and Title	UC 1-S 3. Receiving freight via air cargo	
Objective	Business partners wanting to receive freight via air cargo using the reservation system to assign freight movement within the LIVE Zone, to the Youngstown Warren Regional Airport (YWRA), and deliver the freight to the business partner.	
Actors and Interfaces	Actor	Role
	Business partner	Orders raw materials and/or wholesale product for further processing or other business activities
	Aircraft/pilot	Delivers freight to YWRA
	Aircraft cargo loader (ACL)	Personnel and device that loads and unloads unit load devices (ULD) from aircraft
	Autonomous yard jockey (AYJ)	Moves freight within LIVE Zone
	Mission control system (MCS)	Oversees missions and system elements, assigns mission priority
Initial Status and Preconditions	Aircraft en route to YWRA to deliver freight No business partner reservation made	

Basic Flow of Events		
Step	Actor	Event
1	Pilot	Aircraft arrives at YWRA, enters staging area
2	ACL	Unloads freight from aircraft, transfers to storage shed, alerts business partner that container has been delivered to YWRA
3	Business partner	Makes reservation to have freight delivered to business and designates location on property to receive freight
4	MCS	Creates mission and assigns mission priority as appropriate
5	AYJ	Receives mission details, locates and couples trailer, then proceeds to YWRA
6	ACL	Loads freight onto AYJ, then designates loading AYJ complete in MCS
7	AYJ	Transports freight to business, positions freight in loading dock or yard as designated by the business partner. Decouples trailer and continues to next mission
8	Business partner	Unloads freight then designates trailer for pickup in mission control system
9	AYJ	Returns to business, couples trailer, and returns trailer to Smart Yard. Informs mission control system that mission is complete
10	MCS	Designates mission completed and notifies business partner of completion

Post conditions
MCS closes out mission Business partner processes freight AYJ at rest in Smart Yard, charging at opportunity charging locations, or continues to next mission ACL continues to next mission Aircraft en route to next destination

Alternate flow (replaces above steps for same number)		
Step	Actor	Event
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6.2.2 Use Case 2. Ship Freight

Table 6-4. Use Case 2. Scenario 1: Ship Freight via Truck

Overview		
Scenario ID and Title	UC 2-S 1. Shipping freight via truck	
Objective	Business partners wanting to ship freight via truck using the reservation system to assign freight movement within the LIVE Zone and ship the freight from the business partner.	
Actors and Interfaces	Actor	Role
	Business partner	Processes raw materials and/or wholesale product and package for transport
	Truck driver	Ships freight from Smart Yard to consignee
	Autonomous yard jockey (AYJ)	Moves freight within LIVE Zone
	Automated freight container transfer machine (AFCT)	Transfers shipping container between yard jockey trailer and truck trailer
	Mission control system (MCS)	Oversees missions and system elements, assigns mission priority
Initial Status and Preconditions	Freight packaged for transport No business partner reservation made Long-haul truck en route to Smart Yard to pick up freight	

Basic Flow of Events		
Step	Actor	Event
1	Business partner	Makes reservation to have freight picked up from business and designates location on property to pick up freight
2	MCS	Creates mission and assigns mission priority as appropriate
3	AYJ	Receives mission details, locates and couples empty trailer, delivers trailer to designated location at business, then continues as needed
4	Business partner	Loads cargo/freight into container then designates trailer for pick up
5	AYJ	Returns to business, couples trailer, then transports trailer to Smart Yard
6	AJY	Positions freight at intermediate staging area, decouples trailer and proceeds as needed with priority missions, designates freight as ready for loading in MCS
7	Truck driver	Arrives at Smart Yard, enters queue (if present) for container transfer
8	AYJ	Couples container trailer and positions for container exchange
9	AFCT machine	Transfers container from AYJ to truck
10	Truck driver	Confirms container is secure and designates freight received in MCS, then continues to destination/consignee
11	MCS	Designates mission completed and notifies business partner of completion

Post conditions
MCS closes out mission Business partner continues to next internal task AYJ at rest in Smart Yard, charging at opportunity charging locations, or continues to next mission AFCT machine at rest, charging, or continues to next mission Truck driver enroute to deliver freight

Alternate flow (replaces above steps for same number)		
Step	Actor	Event
9a	Pallet or non-conforming form factor transfer machine (PNCT)	PNCT machine removes freight container from AYJ flatbed trailer, then places it onto truck

Table 6-5. Use Case 2. Scenario 2: Ship Freight via Rail

Overview			
Scenario ID and Title	UC 2-S 2. Shipping freight via rail		
Objective	Business partners wanting to ship freight via Norfolk Southern (NS) Goodman Yard rail using the reservation system to assign freight movement within the LIVE Zone and ship the freight from the business partner.		
Actors and Interfaces	Actor	Role	
	Business partner	Processes raw materials and/or wholesale product and package for transport	
	Train/engineer	Ships freight from NS Goodman Yard	
	Autonomous yard jockey (AYJ)	Moves freight within LIVE Zone	
	Automated freight container transfer machine (AFCT)	Transfers shipping container between rail car jockey trailer	
	Mission control system (MCS)	Oversees missions and system elements, assigns mission priority	
Initial Status and Preconditions	Freight packaged for transport No business partner reservation made Train en route to NS Goodman Yard to pick up freight		
Basic Flow of Events			
Step	Actor	Event	
1	Business partner	Makes reservation to have freight picked up from business and designates location on property to pick up freight	
2	MCS	Creates mission and assigns mission priority as appropriate	
3	AYJ	Receives mission details, locates and couples empty trailer, delivers trailer to designated location at business, then continues as needed	
4	Business partner	Loads cargo/freight into container then designates trailer for pick up	
5	AYJ	Returns to business, couples trailer, then transports trailer to NS Goodman Yard	
6	AYJ	Positions freight at intermediate staging area, decouples trailer and proceeds as needed with priority missions, designates freight as ready for loading in MCS	
7	Train engineer	Train arrives at NS Goodman Yard, enters staging line	
8	AYJ	Couples container trailer and positions for container exchange	
9	AFCT machine	Transfers container from AYJ to train car	
10	Train engineer	Confirms container is secure and designates freight received in MCS, then continues to destination/consignee	
11	MCS	Designates mission completed and notifies business partner of completion	
Post conditions			
MCS closes out mission Business partner continues to next internal task AYJ at rest in Smart Yard, charging at opportunity charging locations, or continues to next mission AFCT machine at rest, charging, or continues to next mission Train enroute to deliver freight			
Alternate flow (replaces above steps for same number)			
Step	Actor	Event	
9a	Pallet or non-conforming form factor transfer machine (PNCT)	PNCT machine removes freight container from AYJ flatbed trailer, then places it onto train car	

Table 6-6. Use Case 2. Scenario 3: Receive Freight via Air Cargo

Overview		
Scenario ID and Title	UC 2-S 3. Ship freight via air cargo	
Objective	Business partners wanting to ship freight via air cargo using the reservation system to assign freight movement within the LIVE Zone, to the Youngstown Warren Regional Airport (YWRA), and deliver the freight to the business partner.	
Actors and Interfaces	Actor	Role
	Business partner	Processes raw materials and/or wholesale product and package for transport
	Aircraft/pilot	Ships freight from YWRA
	Aircraft cargo loader (ACL)	Personnel and device that loads and unloads unit load devices (ULD) from aircraft
	Autonomous yard jockey (AYJ)	Moves freight within LIVE Zone
	Mission control system (MCS)	Oversees missions and system elements, assigns mission priority
Initial Status and Preconditions	Freight packaged for transport No business partner reservation made Aircraft en route to pick up freight	

Basic Flow of Events		
Step	Actor	Event
1	Business partner	Makes reservation to have freight picked up from business and designates location on property to pick up freight, coordinates necessary clearances for air cargo transport
2	MCS	Creates mission and assigns mission priority as appropriate
3	AYJ	Receives mission details, locates and couples empty trailer, delivers trailer to designated location at business, then continues as needed
4	Business partner	Loads cargo/freight into container then designates trailer for pick up
5	AYJ	Returns to business, couples trailer, then transports trailer to YWRA
6	AYJ	Positions for freight exchange
7	ACL	Transfers freight from AYJ to storage shed, designates freight received in MCS
8	AYJ	Continues to next mission
9	Pilot	Aircraft arrives at YWRA, enters staging area
10	ACL	Transfers freight from storage shed to aircraft
11	MCS	Designates mission completed and notifies business partner of completion

Post conditions
MCS closes out mission Business partner continues to next internal task AYJ at rest in Smart Yard, charging at opportunity charging locations, or continues to next mission ACL continues to next mission Aircraft en route to next destination

Alternate flow (replaces above steps for same number)		
Step	Actor	Event
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6.2.1 Use Case 3. Load Shipping Container

Table 6-7. Use Case 3. Load Shipping Container

Overview			
Scenario ID and Title	UC 3-S 1. Load Shipping Container		
Objective	Business partners and external truck drivers wanting to load a shipping container with raw materials or finished goods		
Actors and Interfaces	Actor	Role	
	Truck/truck driver	Drops off, picks up, transfers trailers	
	Autonomous yard jockey (AYJ)	Moves freight within LIVE Zone	
	Mission control system (MCS)	Oversees missions and system elements, assigns mission priority	
	Automated container loader (ACL)	Transfers raw materials or finished goods from conveyor or platform into shipping container	
	Business partner	Loads automated container loader with raw materials or finished goods	
Initial Status and Preconditions	Truck en route to Smart Yard with empty trailer		
Basic Flow of Events			
Step	Actor	Event	
1	Truck driver	Truck arrives at Smart Yard, enters queue (if present) for container transfer	
2	AFCT machine	Removes freight container from truck, places it onto AYJ trailer	
3	AYJ	Moves trailer to intermediate staging area, decouples trailer and proceeds as needed with priority missions	
4	Truck driver	Alerts business partner that container has been delivered to Smart Yard via mission control system. Then exits Smart Yard.	
5	Business partner	Makes reservation to load the ACL	
6	MCS	Creates mission and assigns mission priority as appropriate	
7	Business partner	Receives mission details, proceeds to ACL and loads raw materials or finished goods onto ACL platform. Designates ACL is prepared to load in MCS	
8	AYJ	Receives details from MCS, moves shipping container to ACL loading dock, alerts ACL container is ready for loading	
9	ACL	Loads raw materials or finished goods into shipping container, alerts AYJ shipping container is ready for pick up	
10	AYJ	Receives details on container readiness, moves trailer to intermediate staging area, decouples trailer and proceeds as needed with priority missions	
11	MCS	Informs truck driver shipment is ready for departure	
12	Truck driver	Receives details, arrives at Smart Yard, enters queue (if present) for container transfer	
13	AYJ	Couples container trailer and positions for container exchange	
14	AFCT machine	Transfers container from AYJ to truck	
15	Truck driver	Confirms container is secure and designates freight received in MCS, then continues to destination/consignee	
16	MCS	Designates mission completed and notifies business partner of completion	
Post conditions			
MCS closes out mission AYJ at rest in Smart Yard, charging at opportunity charging locations, or continues to next mission Truck enroute to next destination			
Alternate flow (replaces above steps for same number)			
Step	Actor	Event	
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6.2.2 Use Case 4. Truck Parking Availability

Table 6-8. Use Case 4. Truck Parking Availability

Overview			
Scenario ID and Title	UC 4-S 1. Truck Parking Availability		
Objective	External truck drivers wanting to park trucks for driver to rest		
Actors and Interfaces	Actor	Role	
	Truck/truck driver	Uses TPS to locate parking spot for rest	
	Truck Parking Information System (TPIS)	Monitors and manages truck parking for LIVE Zone and connection to external third-party applications	
Initial Status and Preconditions	No parking reservations made TPIS broadcasting parking spot availability to DMS Truck en route to long combination trailer breakdown and transfer lot		
Basic Flow of Events			
Step	Actor	Event	
1	Truck driver	Accesses parking management system via third party application, places reservation if spot available	
2	TPIS	Reserves parking spot for truck driver	
3	Truck driver	Arrives at designated parking location, parks truck, rests	
4	Truck driver	Checks out of reservation, exits parking area, continues to next mission	
5	TPIS	Confirms truck has left parking spot, designates spot open for new reservation	
Post conditions			
Parking spot open for new reservation Truck en route to next destination			
Alternate flow (replaces above steps for same number)			
Step	Actor	Event	
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6.2.3 Use Case 5. Vehicle-to-Infrastructure Freight Signal Priority

Table 6-9. Use Case 5. Vehicle-to-Infrastructure Freight Signal Priority

Overview		
Scenario ID and Title	UC 5-S 1. Vehicle-to-Infrastructure Freight Signal Priority	
Objective	Provide safe and efficient freight vehicle movements through intersections. Allow freight vehicle platoons through an intersection.	
Actors and Interfaces	Actor	Role
	Truck/truck driver	Transporting freight
	Signal	Controls intersection traffic and interprets RSU communications for green extension
	Roadside unit (RSU)/Processor	Communicates with OBU, transmits data to processor
	On-board unit (OBU)	Communicates with RSU, notifies driver via user interface
Initial Status and Preconditions	Truck en route to signal OBU broadcasting standard messages RSU broadcasting standard messages	

Basic Flow of Events		
Step	Actor	Event
1	Truck driver	Approaches intersection
2	OBU	Determines if it will be forming a platoon with the preceding freight vehicle, and platoon characteristics.
3	OBU	Broadcasts a SRM containing data elements that indicate the requested approach.
4	RSU	Receives the SRM and processes it.
5	Processor	Determines if signal priority request can be accommodated.
6	RSU	Broadcasts SSM containing data elements that indicate if the request was accepted and the priority order.
7	OBU	Receives the SSM and processes it.
8	Signal	Green phase on approach is called early.
9	Truck driver	Proceeds through intersection.
10	Truck driver	Clears intersection.
11	Signal	Resumes normal intersection operations.

Post conditions
Truck driver experiences improved mobility at the intersection. Multiple freight vehicles can maintain platoon.

Alternate flow (replaces above steps for same number)		
Step	Actor	Event
8a	Signal	Green phase on approach is extended.

6.2.4 Use Case 6. Automated Transit Connection to Employment

Table 6-10. Use Case 6. Automated Transit Connection to Employment

Overview			
Scenario ID and Title		UC 6-S 1. Automated Transit Connection to Employment	
Objective		Provide safe and efficient transport of transit riders from WRTA Regional Transit Hub to employment centers.	
Actors and Interfaces		Actor	Role
		Automated transit vehicle	Transports riders
		Transit riders	Ride automated transit from WRTA transit hub to destination
		Mission control system (MCS)	Oversees missions and system elements, assigns mission priority
Initial Status and Preconditions		Rider at WRTA Regional Transit Hub Automated transit in normal operations	
Basic Flow of Events			
Step	Actor	Event	
1	Rider	Arrives at WRTA regional transit hub	
2	Rider	Makes reservation for automated transit in MCS, defines destination	
3	MCS	Creates mission and assigns mission priority as appropriate	
4	Automated transit	Proceeds to pick up rider	
5	Rider	Boards automated transit	
6	Automated transit	Proceeds to destination	
7	Rider	Exits automated transit, continues to destination	
8	Automated transit	Notifies MCS of completion of trip, continues to next mission	
9	MCS	Designates mission completed	
Post conditions			
Automated transit continues to next mission or returns to charging location. Rider enroute to destination.			
Alternate flow (replaces above steps for same number)			
Step	Actor	Event	
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6.2.1 Use Case 7. Situational Awareness at Signalized Intersections

Table 6-11. Use Case 7. Situational Awareness at Signalized Intersections

Overview		
Scenario ID and Title	UC 7-S 1. Situational Awareness at Signalized Intersections	
Objective	Provide safe and efficient vehicle movements through intersections. Alert driver of any impending conflicts and take corrective actions to avoid collision.	
Actors and Interfaces	Actor	Role
	Driver/operator/autonomous vehicle (AV)	Performs driving task
	Signal	Controls intersection traffic and communicates with RSU
	Roadside unit (RSU)/Processor	Communicates with OBU, transmits data to processor
	On-board unit (OBU)	Communicates with RSU, notifies driver via user interface
	Intersection situational awareness detectors/processor (ISA)	Uses object detection to monitor vehicle, pedestrian, and emergency vehicle trajectories. Communicates potential conflicts to OBU
	Mission control system	MCS
Initial Status and Preconditions	Vehicle en route to signal while signal is green RSU broadcasting standard messages (SPaT, MAP, etc.) OBU broadcasting standard messages (BSM, etc.) ISA monitoring object trajectories	

Basic Flow of Events		
Step	Actor	Event
1	ISA	Monitors object trajectories, maintains inventory of objects and cross-references trajectories to evaluate if conflict exists
2	Driver/operator/AV	Approaches intersection
3	ISA	Detects object approaching intersection, evaluates trajectory and identifies potential conflicts. Calculates decision point to notify driver of conflict with sufficient time to stop safely.
4	Driver/operator/AV	Vehicle approaches decision point
5	ISA	Broadcasts conflict to RSU
6	RSU	Broadcasts conflict to OBU
7	OBU	Notifies driver of conflicting pedestrian, red-light running vehicle, or emergency vehicle
8	Driver/operator/AV	Decelerates to stop, waits for conflict to clear, proceeds through intersection
9	ISA	Logs event data, transmits to RSU, resumes normal activities
10	RSU	Logs event data, transmits to signal controller, resumes normal activities
11	Signal	Transmits data to MCS, resumes normal activities
12	MCS	Logs event data, performs post processing, archives data for later use

Post conditions
Truck driver experiences improved mobility at the intersection. Multiple fright vehicles can maintain platoon.

Alternate flow (replaces above steps for same number)		
Step	Actor	Event
5a	ISA	If no conflict present, ISA does not broadcast and continues to monitor until vehicle has cleared the intersection.
6a	Driver/operator/AV	Clears intersection
7a	RSU/OBU/ISA/Signal	Resumes normal activities

6.3 Operational Constraints

Existing regulations may have implications for deployment of an in-vehicle user interface but are not expected to otherwise pose a constraint to connected vehicle (CV) deployments. Vehicle operators are expected to abide by regulations governing the operation of motor vehicles. The existing traffic control system is managed through traffic signals, static signage, dynamic message signs (DMS) (on certain roadways), and lane markings. Vehicle operators perform visual checks (e.g., determining traffic signal state, comprehending regulatory and warning signs, perceiving traffic conditions) and respond to audio cues (e.g., approaching emergency vehicle). U-turns are prohibited citywide unless designated by a traffic control device.

Constraints of the autonomous system elements include limited to no mixed traffic operations initially. The autonomous yard jockeys and automated transit vehicles will operate in dedicated lanes in the beginning of the deployment. They will then advance to mixed traffic after attaining the appropriate technology readiness level and along with the necessary governing regulatory environment and approval.

Limited market penetration of electric trucks results in little demand for electric truck charging. Several manufacturers are pursing electric trucks and single unit trucks are already available commercially for private owner-operators and electric truck fleets. While there is limited current commercial availability of long-haul single trailer or combination trailer electric trucks, that demand is anticipated to increase as electric consumer vehicles demand has over recent years with federal incentives to reduce carbon emissions.

A potential risk of deployment is generating enough power to sustain the electrical demands of this system and support electric vehicles and equipment through sustained and uninterrupted operation. To meet power demands, a solar farm is proposed, though limited in the initial deployment. To support this system, a grid tie-in could provide closure for any gaps in generation from the solar farm. Expanding the solar farm out during subsequent phases could lessen the demand for grid power. However, expansion of the LIVE Zone to regional industrial and logistics centers, along with greater prevalence of electric trucks would increase power demand on the LIVE Zone for charging.

In-road dynamic inductive charging offers greater flexibility in terms of vehicle efficiency by having to stop less. However, in-road dynamic charging currently is not anticipated to fully replace stationary charging of vehicles or equipment. Also, estimated costs for in-road charging equipment and installation is approximately $1.9M per mile, potentially cost prohibitive until economies of scale, adoption, and supporting infrastructure are in place. In-road inductive charging technology is cutting edge with only two planned deployments in the United States. Several other countries have tested this technology, but widespread adoption is potentially years out.

Business partner participation is critical to the success of the LIVE Zone. If demand is not sufficient, the LIVE Zone could experience operating at risk. A total of 20 potential private business partners have submitted letters of support for this project, along with several agencies such as the Ohio Farm Bureau, Youngstown Chamber of Commerce, Ohio Commerce Center, Mahoning Valley Manufacturers Coalition, etc., expressing support with connections to potential local and regional business partners.