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2026 FIFA WORLD CUP METLIFE STADIUM TRANSPORTATION PLANNING

TRANSPORTATION TECHNOLOGY TOURNAMENT 2025

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1. Overview

1.1. Problem statement description

In 2026, MetLife Stadium in East Rutherford, New Jersey, will host eight matches of the FIFA World Cup, drawing hundreds of thousands of spectators from around the world. These matches represent one of the largest and most logistically demanding planned special events (PSEs) in the region's history. **Table 1** summarizes the eight scheduled matches at MetLife Stadium, half of which fall on weekends (FIFA, 2024). Match times are yet to be determined.

Table 1. 2026 FIFA World Cup schedule for MetLife Stadium

No.	Date (Day)	Match	No.	Date (Day)	Match
1	June 13, 2026 (Sat)	Group Stage	5	June 27, 2026 (Sat)	Group Stage
2	June 16, 2026 (Tue)	Group Stage	6	June 30, 2026 (Tue)	Round of 32
3	June 22, 2026 (Mon)	Group Stage	7	July 5, 2026 (Sun)	Round of 16
4	June 25, 2026 (Thu)	Group Stage	8	July 19, 2026 (Sun)	Final

The surrounding transportation network, especially New Jersey State Route 3 (NJ 3), is expected to experience severe strain due to a surge in travel demand on match days. NJ 3—connecting the New Jersey Turnpike and the Lincoln Tunnel to MetLife Stadium—is already congested during peak hours, and World Cup traffic from private vehicles, rideshare services, charter buses, and transit could overwhelm existing capacity.

Each match is expected to attract approximately 80,000 fans, in addition to over 16,000 FIFA staff, volunteers, and contractors (Meadowlands Chamber of Commerce, 2025). This surge in visitors and personnel highlights the urgent need for proactive and comprehensive transportation planning.

Adding to the challenge, MetLife Stadium is expected to offer little to no on-site parking during the tournament due to heightened security. Instead, a regional park-and-ride system will be deployed, allowing spectators to park at designated lots and take shuttle buses to the venue. This shift will increase reliance on transit and shuttle services, placing additional pressure on regional infrastructure.

1.2. Study Area

The study area centers around NJ 3 in northern New Jersey, specifically the corridor between the New Jersey Turnpike (I-95) and New Jersey State Route 120 (NJ 120) near the Meadowlands Sports Complex, where MetLife Stadium is located (**Figure 1**). This segment of NJ 3 serves as the main artery for eastbound and westbound travel between New York City, Newark, and the stadium, intersecting with major routes including New Jersey State Routes 17 and 21 (NJ 17 and NJ 21) and the Garden State Parkway.

The area features key transportation assets such as the Secaucus Junction rail station, NJ TRANSIT bus lines, and multiple park-and-ride facilities. The New Jersey Department of Transportation (NJDOT) and NJ TRANSIT also operate ITS infrastructure, including dynamic message signs (DMS), traffic surveillance cameras, and transit signal priority (TSP). Despite these assets, real-time coordination, dynamic reconfiguration of lanes, and proactive transit and parking guidance are limited, especially during major events.

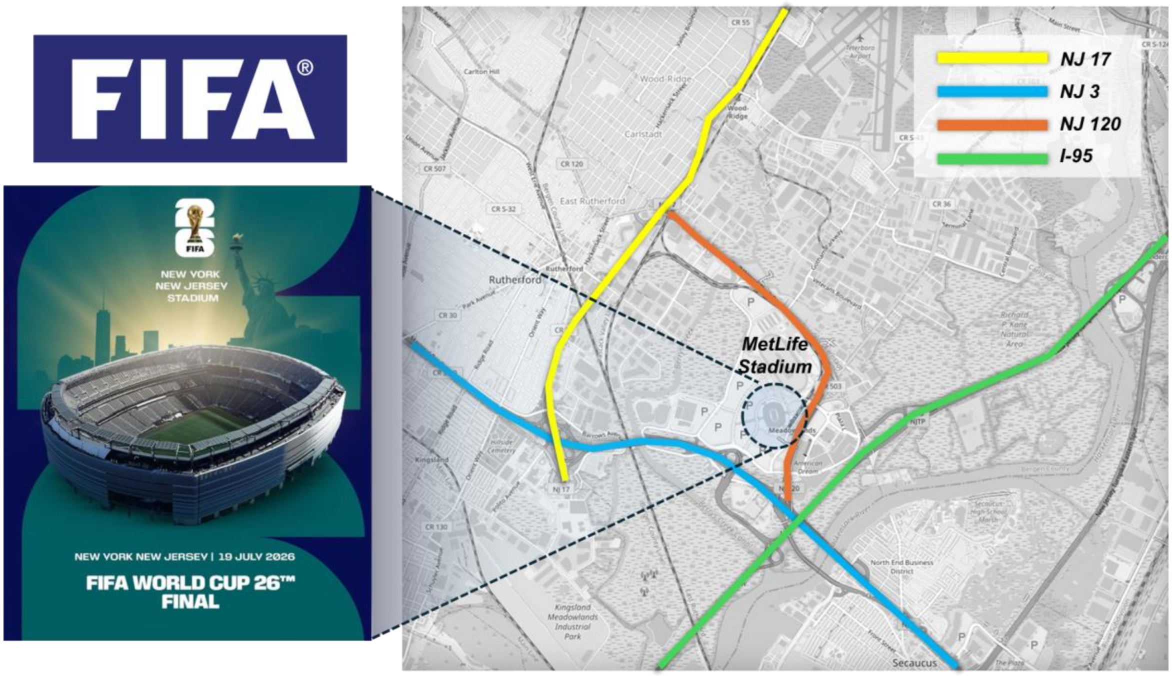

Figure 1. Study Area

1.3. Study Area Challenges

NJ 3 has long been a congestion hotspot, with high traffic volumes and limited flexibility to accommodate surges. During previous large events at MetLife Stadium—such as the Super Bowl and major concerts—multi-mile backups, local road spillovers, and significant bus delays have occurred.

The primary challenges include:

- Fixed lane usage that does not adapt to fluctuating demand patterns.
- Limited information dissemination to drivers and transit users during live events.
- High reliance on private vehicles due to insufficient real-time park-and-ride and transit integration.

- Inadequate enforcement tools to support dynamic lane policies or HOV/bus prioritization during surges.

Without intervention, these challenges will cause significant delays, increase emissions, and degrade the spectator experience, potentially impacting regional mobility and public perception of the event.

2. Solution statement

To manage the expected congestion on NJ 3 during the eight 2026 FIFA World Cup matches at MetLife Stadium, we propose a refined strategy that integrates Smart Park and Ride (PM02), Dynamic Transit Operations (PT03), and Intermittent Bus Lanes (PT10), supported by travel demand forecasting and passenger demand prediction models. The system begins with PM02, which monitors real-time availability at Park-and-Ride locations and communicates this information to travelers via apps and signage. The output from PM02, combined with passenger demand predictions, is then fed into PT03. PT03 uses this data to manage shuttle dispatching, routing, and real-time vehicle tracking, adjusting operations dynamically based on actual Park-and-Ride usage and forecasted passenger demand.

The output from PT03—specifically real-time shuttle loads and routing decisions—feeds into PT10, which uses this information along with broader travel demand forecasts to dynamically manage traffic conditions on NJ 3. PT10 responds by opening shoulder lanes or converting general-purpose lanes to bus-only use during peak demand and reverting them when conditions improve. Overhead signage and lane control signals are used to inform and guide drivers, accordingly, ensuring efficient lane usage and transit vehicle prioritization during the event. **Figure 2** presents our solution framework.

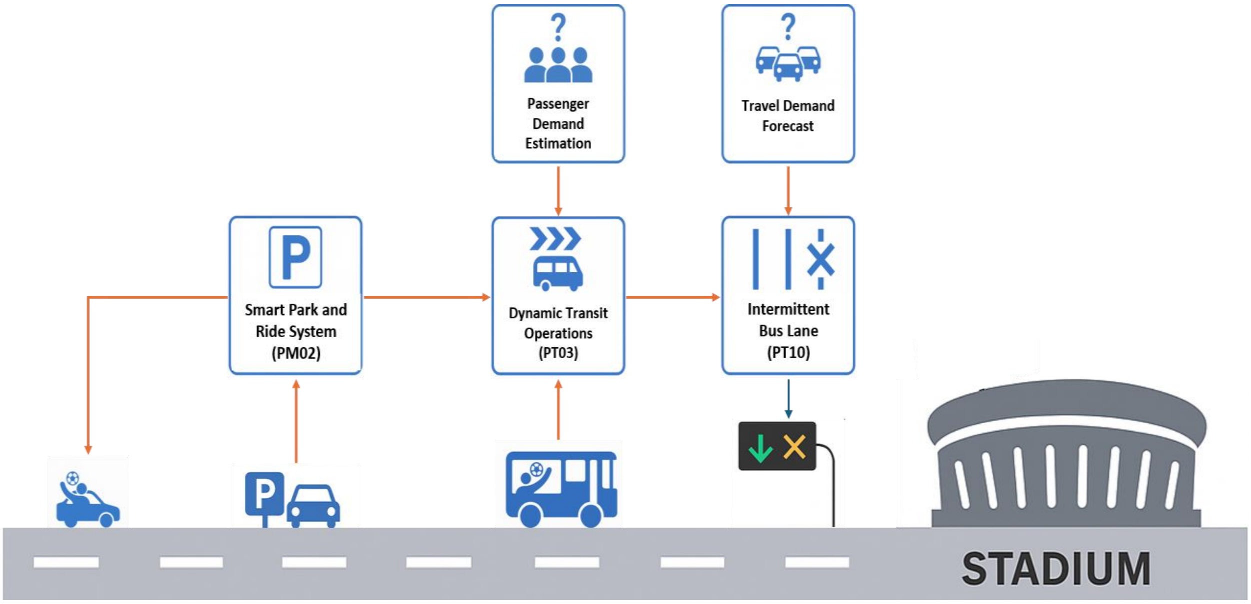

Figure 2. Solution Framework

2.1. Traffic Demand Forecasting

Preparing for the 2025 FIFA World Cup at MetLife Stadium would require understanding of existing conditions and strategies to mitigate the temporary surge in travel demand. We can utilize LBS (Location Based Services) data platforms to investigate the travel demand for both macro and micro level analysis using Replica and StreetLight. Also, we can utilize NJDOT's Straight Line Diagrams (SLD) to obtain the number of lanes and the width of shoulders. The Replica data platform can be used to obtain trip making characteristics such as the number of daily trips, the hourly volume, travel purpose, travel mode, average distance traveled, and average duration of trips to a destination block group. On the other hand, the StreetLight data platform can be used to query traffic volume and speed of specific dates and locations. For Replica, the weekday trips are represented by the average second quarter of 2024 ("Replica HQ's 2024 Q2 Thursday") and the weekend trips are represented by the same time period but of the weekends ("Replica HQ's 2024 Q2 Saturday").

Figure 3 shows the geography of the block group that encompasses the MetLife stadium. The Census block group 340030120013, highlighted in red, has residential areas to the north and marsh lands to the middle and south, and the MetLife stadium, highlighted in yellow, and the American Dream shopping mall, highlighted in purple, to the east. Also, there are four major highways, highlighted in green, that are adjacent to the stadium, namely NJ 3, 17, 120, and New Jersey Turnpike (NJTP). However, since NJTP is not part of the NJDOT jurisdiction, it is excluded from this analysis. To the south of MetLife Stadium is NJ 3, which carries traffic from NYC via Lincoln tunnel and vice versa. To the west is NJ 17 that carries New Jersey residents into Bergen county and vice versa. To the north and the east is NJ 120 that connects NJ 3, 17, and NJTP. Also, there is the second largest mall in the United States, which is the American Dream mall that has more than 450 stores and 3 million square feet of retail space.

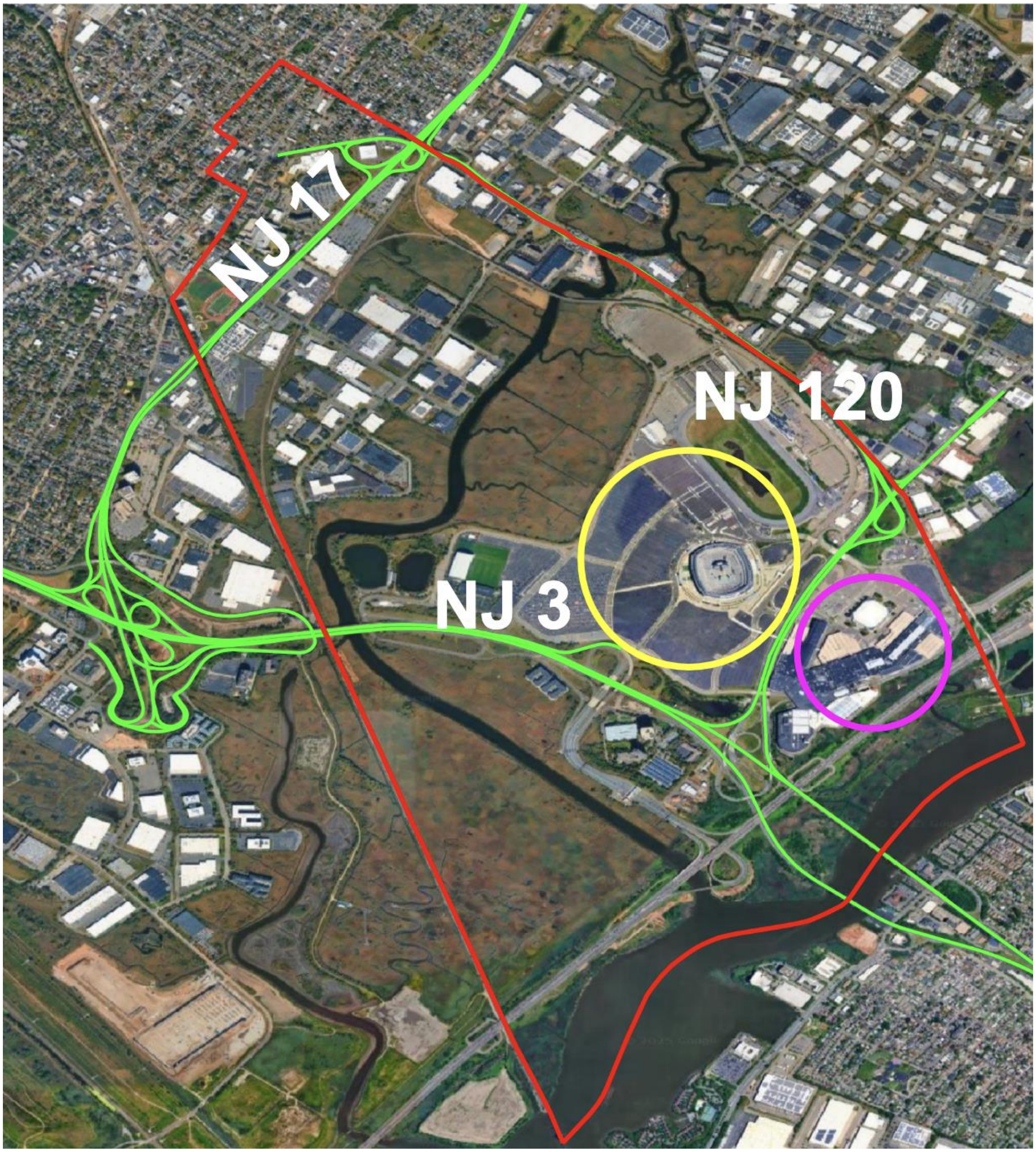

Figure 3. Census Block Group of MetLife Stadium

The queried results from Replica, visualized as plots in **Figure 4**, shows that the major proportions of the travel purpose to the Census block group is shopping. Therefore, it is crucial to install ATMS that will seamlessly transport the World Cup spectators from nearby parking spaces to the stadium while disturbing the existing traffic minimally.

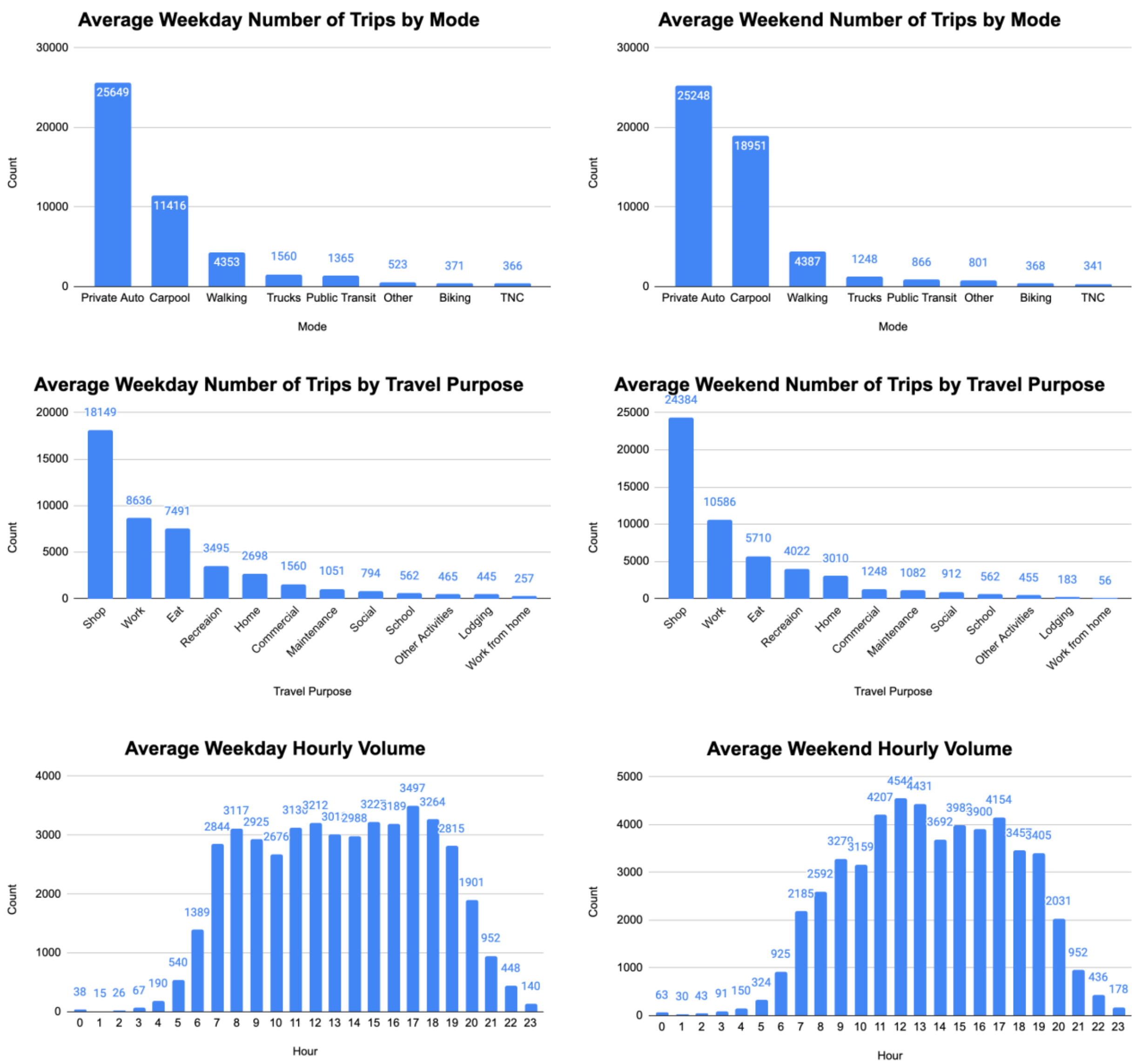

Figure 4. Trip Making Characteristics to the MetLife Stadium Block Group from Replica

Based on the Replica's 2024 Q2 Thursday and Saturday dataset, while there was a total of 45603 trips on a Thursday, there were 52210 on a Saturday. The average distance traveled was 11.46 and 13.48 miles and average travel time was 20.95 and 21.08 minutes on Thursday and Saturday respectively. From Thursday to Saturday, there was a 14.4% increase in the number of trips that ended at the Metlife Stadium block group, 17.6% increase in travel distance, and .6% increase in travel time. Another noteworthy observation is the time when the peak volume is observed during different days. On a Thursday, the peak volume was at 5 PM while the same was at 12 PM on Saturday.

On the other hand, StreetLight can be used to obtain route specific volumes and speed by different time periods. To forecast the transportation demand on NJ 3, 17, and 120 during the

World Cup at the MetLife stadium, a similar significant event was queried for reference. Taylor Swift's concert was held at MetLife Stadium from May 26th to 28th (Friday to Sunday), 2023 and the gates opened at 4:30 PM and it started at 6:30 PM.

Table 2 shows the aggregated average peak AM and PM volume and speed of NJ 3, 17, and 120 during the three days of the Taylor Swift concert. StreetLight provides data at a segment level (routes divided into small portions), the average value of the segments in the same routes were considered to obtain the "Route Level" volume. Data is provided by four time periods and of the four are "Peak AM" and "Peak PM," which indicate 6 AM to 10 AM and 3 PM to 7 PM respectively.

Table 2. The average volume and speed of the segments of NJ 3, 17, and 120.

Route Name	Peak AM Volume	Peak PM Volume	Peak AM Speed (mph)	Peak PM Speed (mph)
NJ 3	9550	19679	61.4	55.5
NJ 17	3858	7246	45.4	43.1
NJ 120	2845	9612	49.8	34.8

During the three days analysis, about 1.5 times to more than 3 times volume increase from AM peak to PM peak can be observed. While there was no park and ride during the Taylor Swift concert, it is crucial to take the existing traffic into consideration.

To place various ITS equipment where appropriate, network characteristics, such as number of lanes and shoulder width, was obtained from the NJDOT SLD. Table 3 is an example of NJ 3 eastbound network characteristics.

Table 3. NJ 3 Eastbound Network Characteristics

Route	Direction	MP_Start	MP_End	#_of_lanes	shoulder_width(ft)	note
3	EB	0	0.2	2	12	
3	EB	0.2	0.45	3	0	
3	EB	0.45	3.91	3	12	
3	EB	3.91	4.45	4	12	
3	EB	4.45	5.1	3	12	
3	EB	5.1	5.4	4	12	
3	EB	5.4	5.6	5	3	
3	EB	5.6	6.3	4	12	
3	EB	6.3	6.5	3	12	
3	EB	6.5	7.1	4	12	

3	EB	7.1	7.7	3	12	
3	EB	7.7	7.9	4	0	
3	EB	7.9	9.1	4	12	Local Express Split
3	EB	9.1	10.85	2	12	Local
3	EB	9.1	10.25	3	15	Express
3	EB	10.25	10.4	2	0	Express lane ends

2.2. Active Traffic Management (ATM)

2.2.1. Smart Park and Ride System (PM02)

During the event period, a large number of spectators from various regions are expected to gather. As parking at MetLife Stadium will be prohibited, it is necessary to implement a Park and Ride policy. Park and Ride is a system where individuals park their cars at designated locations and use public transportation (such as buses or trains) to reach their final destination.

The proposed **Smart Park and Ride service** in this section is a module that provides real-time information on the availability and capacity of Park and Ride locations. It supports users in making informed decisions by recommending the optimal parking location and public transit options based on real-time data.

The first step in implementing this service is to determine the locations of the Smart Park-and-Ride facilities. By applying various optimization methodologies and GIS-based spatial analysis techniques, we can identify the optimal locations for parking lots and transfer centers (Cavadas and Antunes, 2019; Palaguachi et al., 2024). Based on these results, we can provide real-time information to users heading to these parking facilities as well as to the Dynamic Transit Operations (PT03) system. This will help shift car traffic to public transit and disperse traffic over a wider area, thereby reducing congestion.

An example of the location selection and information provision process for Smart Park-and-Ride facilities is illustrated in the following figure (**Figure 5**).

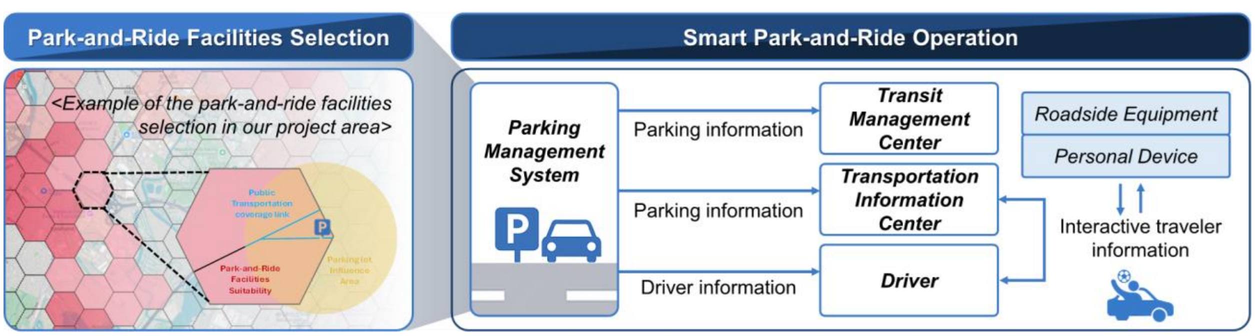

Figure 5. Example of the Smart Park-and-Ride System Operation

2.2.2. Dynamic Transit Operations (PT03)

Dynamic Transit Operations (PT03) is a system that manages public transit services using real-time data and passenger demand forecasts. It uses input from the Parking Management system (PM02) and demand prediction models to control shuttle dispatching, route planning, and vehicle tracking. This allows the system to adjust operations based on actual Park-and-Ride usage and expected demand.

Dynamic Transit Operations allows users to request trips and receive travel itineraries using personal devices such as smartphones, tablets, or computers. The system supports multiple modes of transportation, including public transit, shared mobility services, walking, and biking. During the FIFA World Cup, a large number of travelers are expected to use NJ Transit. In this context, our focus will be on integrating and managing public transportation options such as buses and the light rail system to handle increased demand efficiently and ensure smooth travel for event attendees.

The system is based on technologies such as Computer-Aided Dispatch (CAD), Automated Vehicle Location (AVL), and automated scheduling software. It supports coordination between transit providers and enables real-time scheduling, dispatching, and rerouting of in-service vehicles. They can group similar trip requests and assign them to the same vehicle when possible.

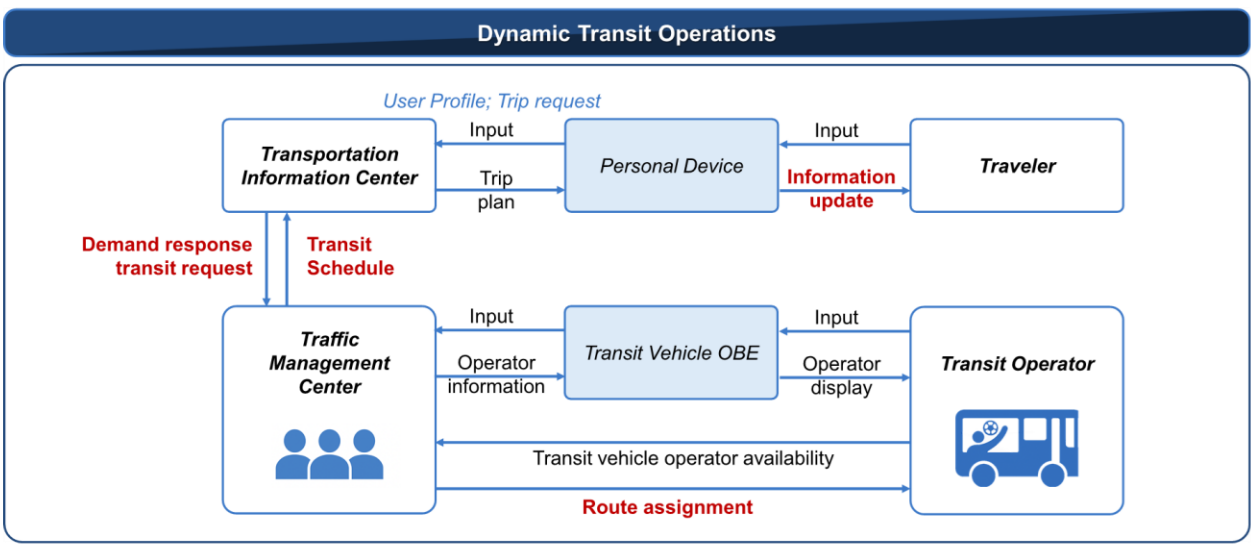

Figure 6. Example of the Dynamic Transit Operations

2.2.3. Intermittent Bus Lane (PT10)

The Intermittent Bus Lane (PT10) is a vital component of the integrated strategy to manage the anticipated surge in travel demand during the 2026 FIFA World Cup at MetLife Stadium. Unlike fixed bus-only lanes, PT10 allows for the dynamic allocation of existing general-purpose lanes or shoulders exclusively for buses during peak periods, particularly before and after matches. This flexible approach optimizes roadway use by prioritizing high-capacity shuttle buses without permanently removing lanes from general traffic. PT10 operates based on real-time data from Dynamic Transit Operations (PT03) and regional travel demand forecasts to determine when and where bus priority is most beneficial. This enables the timely activation of dedicated bus lanes, reducing shuttle delays and improving transit reliability for thousands of park-and-ride users.

From an operational standpoint, PT10 is supported by overhead lane control signals, dynamic message signs, and intelligent transportation systems (ITS) to notify and guide drivers during lane reassignments. The intermittent use of these lanes ensures that buses receive priority access only when necessary, while allowing normal traffic flow to resume during off-peak periods. This efficient reuse of existing infrastructure increases person throughput along NJ 3 and mitigates congestion without requiring costly construction or permanent lane dedication. By enabling rapid and reliable transit movement, PT10 serves as a cost-effective, scalable solution for managing large-scale event traffic while maintaining regional mobility.

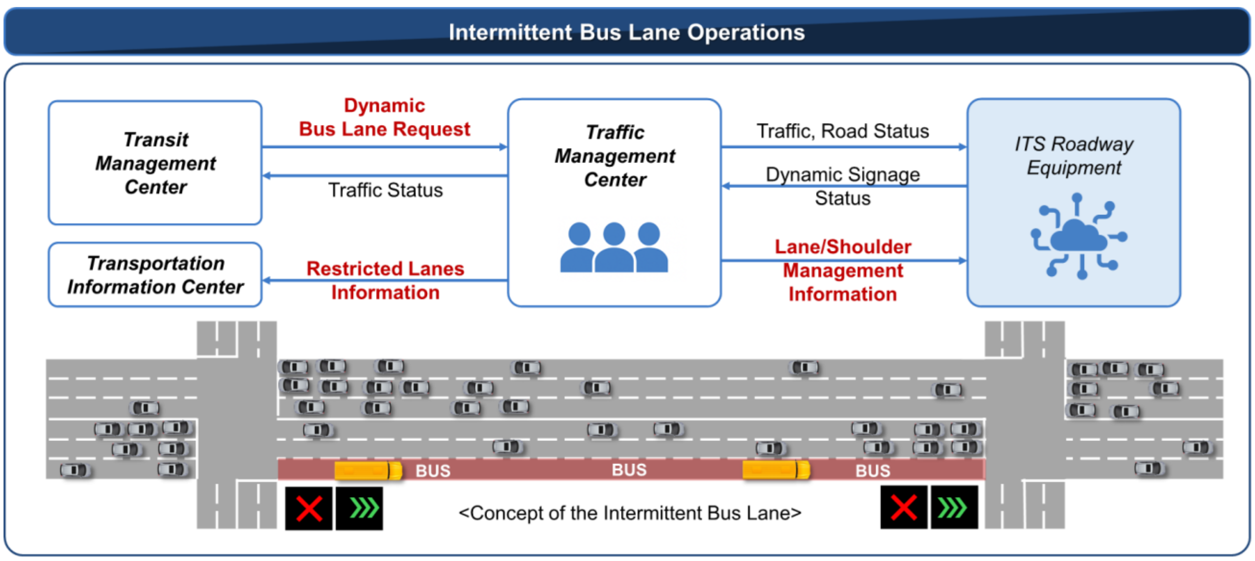

Figure 7. Example of the Intermittent Bus Lane Operations

3. Solution analysis

3.1. Concept of Operations Analysis

We devise a concept of operations (Con-Ops) with three ITS service packages, PM02, PT03, and PT10.

3.1.1. Physical Architecture

The physical architecture describes the transportation systems that support ITS and the exchange of information between them. In this proposal, we refer to three ITS service packages, PM02, PT03, and PT10, to design an integrated module aimed a+t mitigating traffic congestion. Physical Architecture of the proposed system is illustrated in **Figure 8**.

The physical architecture of the proposed solution in the Intelligent Transportation Systems (ITS) environment consists of four operational centers, one field equipment unit, two vehicle equipment units, and one personal device.

First, the **Parking Management Center** provides parking information to both the **Transportation Information Center** and the **Transit Management Center** to support decision-making for transit operations and to prepare for a transit park-and-ride system. The **Transit Management Center**, after receiving this information, combines it with data such as transit schedules and operator availability obtained through communication with the transit vehicle OBE and transit operators. Based on this, it assigns transit routes and sends a dynamic bus lane request to the **Traffic Management Center**.

The **Traffic Management Center**, using this information along with traffic data and dynamic strategy statuses gathered from the ITS Roadway Equipment, plans the operation of intermittent bus lanes. This plan is then shared with both the ITS Roadway Equipment and the Transit Management Center.

Through the exchange of information among these centers and equipment, the system ultimately provides relevant trip information and responds to traveler requests via personal information devices. This enables drivers to make informed travel plans and move efficiently.

This comprehensive module facilitates the shift of vehicle demand to public transit, enhances the usability of public transportation, and helps mitigate traffic congestion in the project area surrounding the stadium.

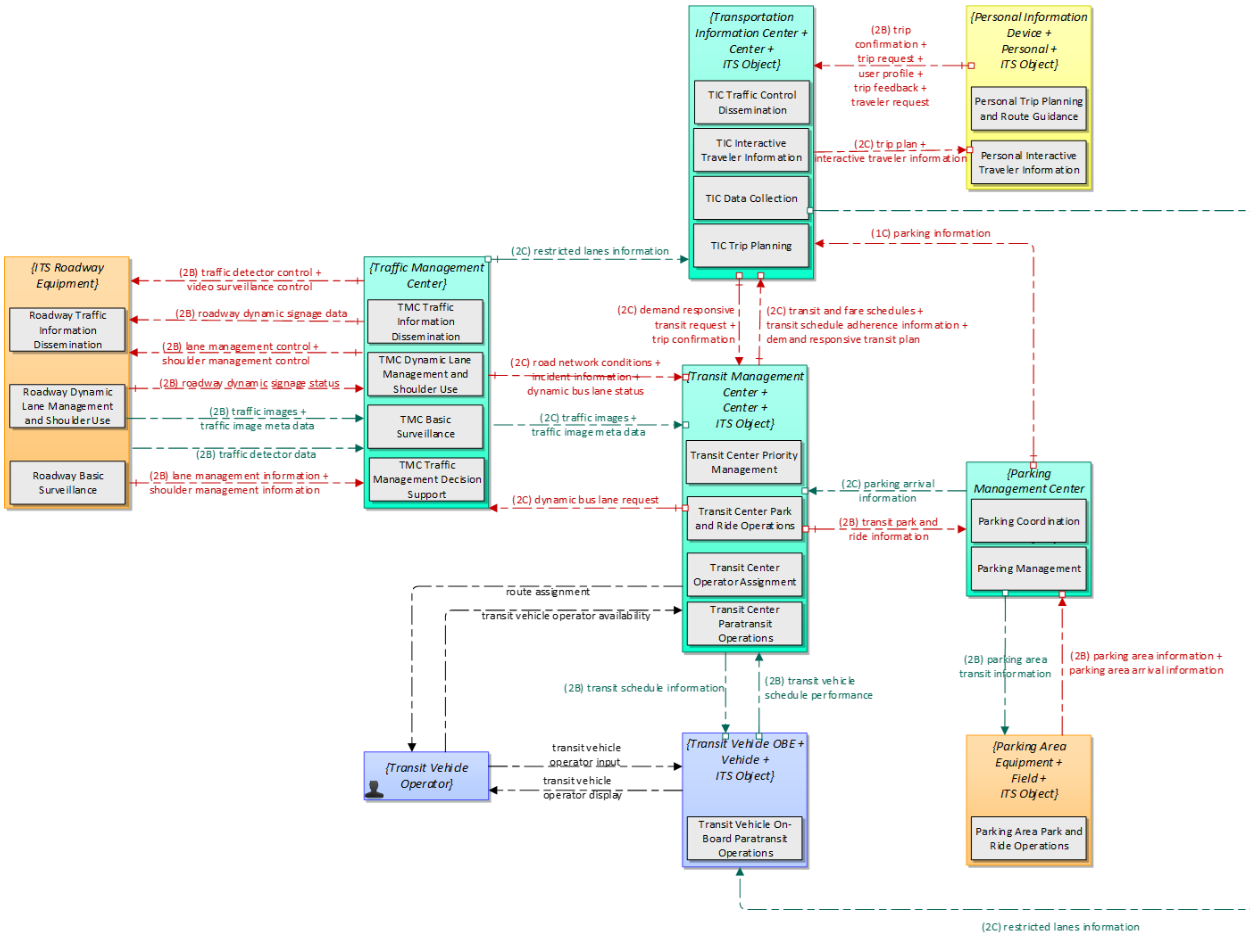

Figure 8. Physical Architecture (The Physical Architecture of Individual Modules, Information Flows Descriptions, and the Diagram Legend are provided in Appendix 1-3.)

3.1.2. Functional Architecture

The objective of the proposed system is to improve traffic flow on surrounding roads and provide timely information to travelers in preparation for the planned special event at MetLife Stadium. To achieve this, functions of key entities such as the Traffic Management Center, Traffic Information Center, and Public Transit Operators are essential. Our functional architecture is provided in **Table 4**.

Table 4. Functional Architecture

Physical Object	Functional Object	Description
Traffic Management Center	TMC Traffic Information Dissemination	Disseminates traffic and road conditions, closure and detour information, and other traffic-related data to other centers and driver information systems.
	TMC Dynamic Lane Management and Shoulder Use	Monitors and controls the system that is used to dynamically manage travel lanes, including temporary use of shoulders as travel lanes.

	TMC Basic Surveillance	Monitors and controls traffic sensor systems and surveillance (e.g., CCTV) equipment, and collects, processes and stores the collected traffic data.
	TMC Traffic Management Decision Support	Recommends courses of action to the traffic operator based on current and forecast road and traffic conditions.
Transportation Information Center	TIC Traffic Control Dissemination	Disseminates intersection status, lane control information, special vehicle alerts, and other traffic control related information.
	TIC Interactive Traveler Information	Tailored information, including traffic conditions, transit information, and etc., is provided based on the traveler's request in this interactive service.
	TIC Data Collection	Collects transportation-related data, performs data quality checks and then consolidates, verifies, and refines the data and makes it available in a consistent format to applications.
	TIC Trip Planning	Provides pre-trip and en route trip planning services for travelers.
Parking Management Center	Parking Coordination	Supports communication and coordination between equipped parking facilities and also supports regional coordination between parking facilities and traffic management systems.
	Parking Management	Monitors parking area operations, current operational status including current parking occupancy and rates supporting back office operations.
Transit Management Center	Transit Center Priority Management	Monitors transit schedule performance and generates requests for transit priority on routes and at certain intersections.
	Transit Center Park and Ride Operations	Monitors park and ride customer arrivals in the parking facility and manages the transit services for those park and ride customers.
	Transit Center Operator Assignment	Automates and supports the assignment of transit vehicle operators to runs.
	Transit Center Paratransit Operations	Managing demand responsive transit services, including paratransit services.
Personal Information Device	Personal Trip Planning and Route Guidance	Provides a personalized trip plan to the traveler.
	Personal Interactive Traveler Information	Provides traffic information, road conditions, transit information, special event information, and other traveler information.
ITS Roadway Equipment	Roadway Traffic Information Dissemination	It includes field elements that provide information to drivers, including dynamic message signs and highway advisory radios.
	Roadway Dynamic Lane Management and Shoulder Use	It includes the field equipment, physical overhead lane signs and associated control electronics that are used to manage and control specific lanes.
	Roadway Basic Surveillance	Roadway Basic Surveillance' monitors traffic conditions using fixed equipment such as loop detectors and CCTV cameras.

Transit Vehicle OBE	Transit Vehicle On-Board Paratransit Operations	It forwards paratransit and flexible-route dispatch requests to the operator and forwards acknowledgements to the center.
Parking Area Equipment	Parking Area Park and Ride Operations	It manages parking lots specifically to support park and ride operations.

3.1.3. Enterprise Architecture

The enterprise architecture is structured into four main layers: business, data, application, and technology. The business architecture focuses on identifying the stakeholders and understanding how they will be impacted by the implementation of the proposed system. The data architecture addresses key data elements, such as time, location, and validation, that are generated after the algorithm processes the input. The application architecture refers to the algorithm itself, which performs the core processing functions. Lastly, the technology architecture represents the ITS implementation, where the algorithm is executed to generate alerts, confirm system outputs, and manage the appropriate responses. The enterprise architecture is illustrated in **Figure 9**.

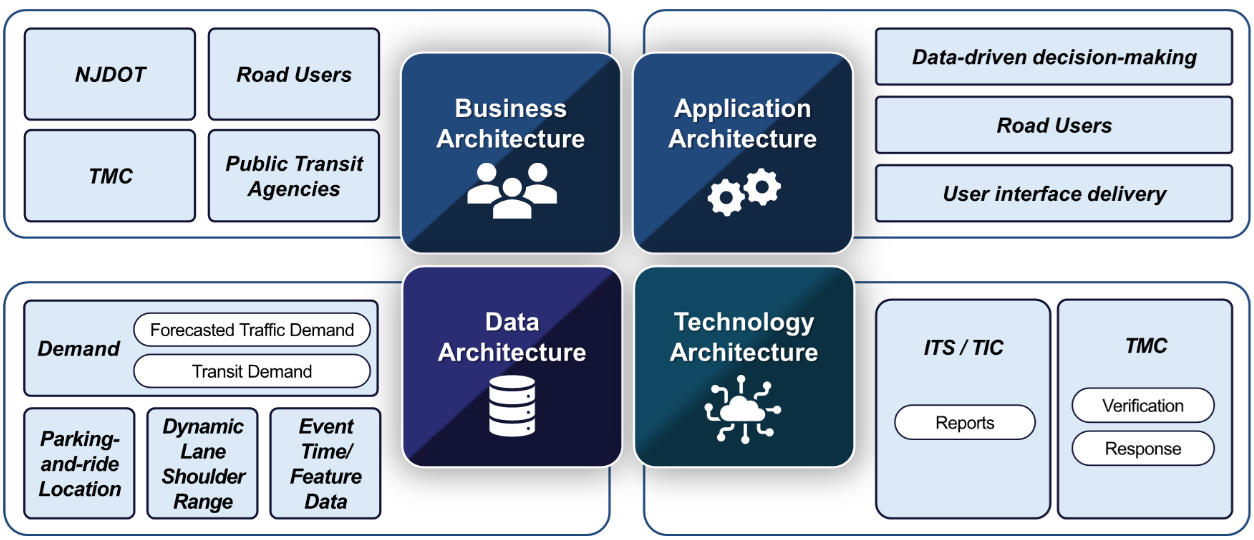

Figure 9. Enterprise Architecture

3.2. Estimated Installation Time and Budget

The total estimated cost and timeline for the initial implementation of the system, including multiple phases, have been developed based on the authors' knowledge and experience. These estimates are summarized in **Table 5** and **Table 6**.

Table 5. Estimated Timeline of Implementing the Proposed System

Phase	Description	Estimated Timeline
1. Traffic Demand Forecast	Analyze traffic data and generate demand forecasts	4–6 weeks
2. Planning and Design	Define requirements and finalize system specifications	2 weeks
3. Procurement and Contracting	Select vendors and procure required equipment	2–4 weeks
4. Equipment Delivery and Inspection	Receive and test equipment for compliance	2 weeks
5. Installation and Construction	Install Dynamic Message Signs (DMS), surveillance, and network infrastructure	4–6 weeks
6. System Development and Integration	Configure systems and integrate ITS components	3–4 weeks
7. Pilot Operation and Final Inspection	Conduct trial operations and finalize system handover	2 weeks
Total		7 to 8 months

Table 6. Cost Breakdown

Category	Description	Quantity	Estimated Cost
Equipment	Information facility for Park-and-Ride (Dynamic Message Sign)	5 × $15,000	$75,000
	Information facility for Dynamic Lane and Shoulder (Dynamic Message Sign)	5 × $15,000	$75,000
	Surveillance Equipment	2 × $100,000	$200,000
System	Real-time traffic platform	1 × $100,000	$100,000
	Parking monitoring system	1 × $100,000	$100,000
	Integration	1 × $100,000	$100,000
Total			$650,000

4. Anticipated outcome

- **Operational benefit**: The program realizes cross-system and cross-agency real-time data sharing and decision-making linkage through the establishment of a collaborative platform between NJDOT, NJ TRANSIT and local governments. The dynamic bus operation system (PT03) is based on the real-time data provided by the intelligent park-and-ride system (PM02) to achieve flexible scheduling and path optimization of feeder buses, avoiding the waste of resources caused by the traditional static timetable. In addition, relying on ITS infrastructure (e.g., dynamic message signs and traffic monitoring systems) reduces the need for manual intervention and lowers operational and labor costs during events. Traffic demand forecasting with Replica and StreetLight data also helps to optimize the deployment before the event and reduce the number of emergencies.

- **Safety Benefits**: This system improves the overall safety level of spectators, drivers and pedestrians through information technology. PM02 system diverts traffic to remote parking spots, reducing traffic density around the stadium and decreasing the probability of traffic accidents from the source. PT10 system dynamically opens up the shoulder of the road or adjusts the dedicated lanes during peak hours, effectively reducing high-risk behaviors such as forced merging of vehicles and illegal parking. Combined with the automatic on-board information dissemination system (e.g. on-board signs) and road video surveillance, it improves the perception ability and emergency response speed of traffic participants.

- **Mobility Benefits**: This solution can significantly improve the efficiency of NJ 3 and its connecting corridors (e.g. NJ 17, NJ 120 and the New Jersey Turnpike).PT10's dynamic lane management function can flexibly adjust the roadway capacity according to the changes in traffic flow, and ease the bottleneck of east-west traffic flow before and after the game to improve the overall capacity.PT03 system arranges the frequency of shuttle buses based on real-time interchange demand and The PT03 system arranges the frequency of shuttle bus departures and traveling paths based on real-time interchange demand, reducing passenger waiting time and vehicle congregation. Passengers can also obtain personalized transfer plans through mobile terminals, realizing a multi-modal, integrated and predictable access experience.

- **Environmental Benefits**: By encouraging the use of interchange systems and increasing the proportion of public transit trips, this program is expected to significantly reduce carbon emissions per viewer. Optimized parking guidelines and real-time route recommendations can effectively reduce idling emissions caused by vehicle idling, detours and congestion. In addition, the use of cleaner modes of travel, such as transit and shared mobility, will help alleviate air quality pressures during the event, enhance the environmental experience for both neighborhood residents and participants, and is consistent with New Jersey's sustainability strategies at both the state and national levels.

- **Economic Benefits**: In the short term, improved accessibility will reduce the economic loss of travelers due to delays, and reduce fuel consumption and transportation costs. In the long term, the business districts around MetLife Stadium and the American Dream mega-mall will benefit from improved accessibility, helping to boost local consumption, employment and tourism. At the same time, the program can be used as a successful example of smart city construction, laying a good foundation for attracting large-scale events, investment and infrastructure upgrading projects in the future, and enhancing the regional brand image and development confidence.

5. Conclusion

The ability to handle the previously unprecedented challenges and travel demands while ensuring effective, secure, and sustainable transportation operations is essential to the 2026 FIFA World Cup's successful hosting at MetLife Stadium. This Concept of Operations (ConOps) offers a strong and cohesive strategy designed to handle the major mobility issues that are expected to arise during this major international event.

The suggested approach is intended to adjust dynamically to changing passenger and traffic conditions by utilizing a combination of Smart Park and Ride Systems (PM02), Dynamic Transit Operations (PT03), and Intermittent Bus Lanes (PT10), strengthened by detailed traffic demand forecasting and real-time operational data. This robust ITS-based framework improves overall system efficiency, user satisfaction, and safety, in addition to reducing congestion on important corridors like NJ 3, NJ 17, and NJ 120.

Cross-agency cooperation, less reliance on manual traffic control, efficient infrastructure usage, and responsive mobility services are some of the operational advantages of the suggested system. Redistributing traffic patterns and disseminating information in real time greatly improve safety, and lowering emissions and increasing the share of transit modes benefits the environment. By facilitating easier access to important commercial hubs and raising the area's attractiveness for upcoming major events, this project promotes regional economic development.

Furthermore, this solution's scalability makes it possible to replicate it at other significant venues across the country. In addition to ensuring a successful World Cup, the strategies put out here offer a progressive framework for smart city transportation planning that fits New Jersey's long-term objectives for economic development, sustainability, and mobility.

This ConOps serves as a foundation for system improvement, stakeholder alignment, and coordinated implementation. Agencies and stakeholders can guarantee that the 2026 FIFA World Cup is not only a top-tier athletic event but also a demonstration of New Jersey's leadership in innovative event management and intelligent transportation systems by using ideas and tactics presented here.

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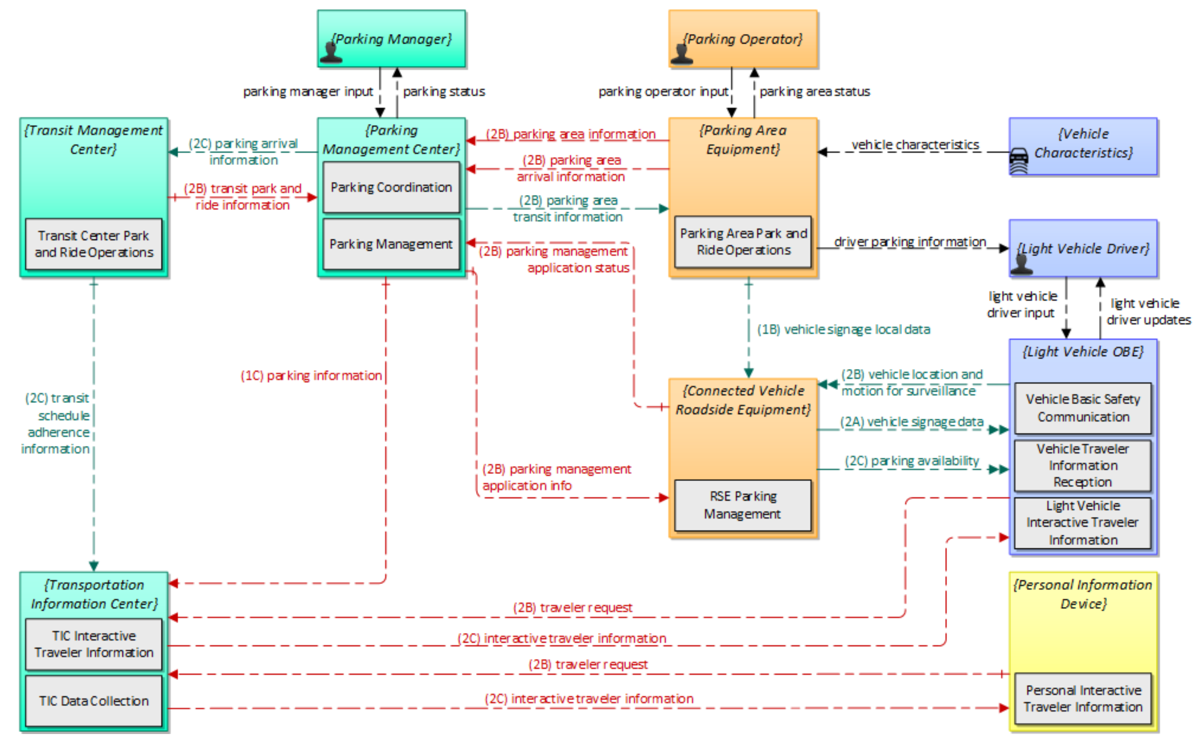
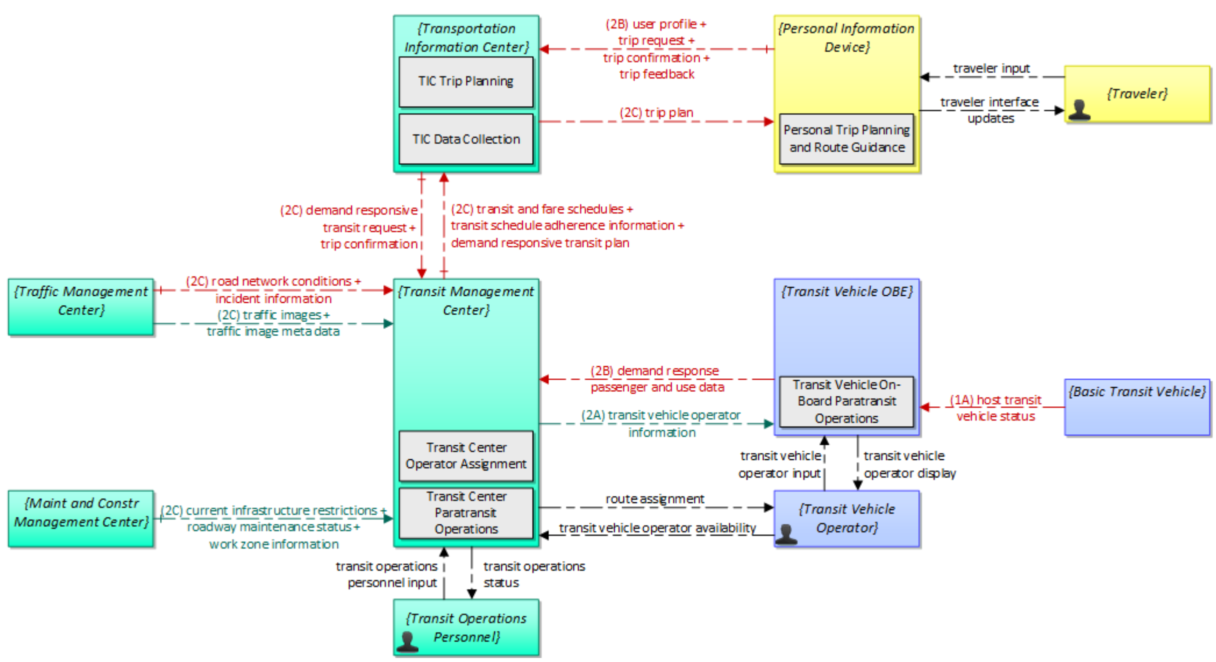
Appendix 1. Physical Architecture of Individual Modules

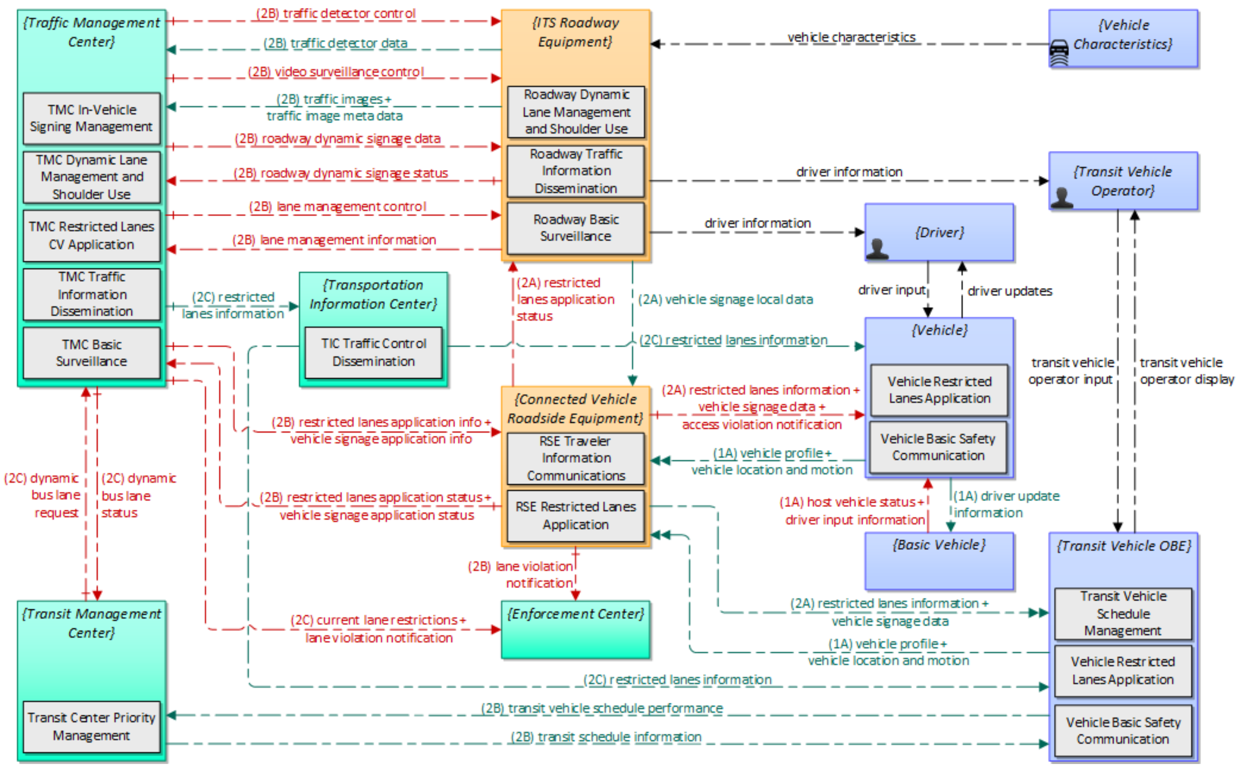
[PM02] Smart Park and Ride System



[PT03] Dynamic Transit Operations



[PT10] Intermittent Bus Lanes



{Traffic Management Center}
TMC In-Vehicle Signing Management
TMC Dynamic Lane Management and Shoulder Use
TMC Restricted Lanes CV Application
TMC Traffic Information Dissemination
TMC Basic Surveillance
{ITS Roadway Equipment}
Roadway Dynamic Lane Management and Shoulder Use
Roadway Traffic Information Dissemination
Roadway Basic Surveillance
{Vehicle Characteristics}
{Transit Vehicle Operator}
{Driver}
{Vehicle}
Vehicle Restricted Lanes Application
Vehicle Basic Safety Communication
{Transportation Information Center}
TIC Traffic Control Dissemination
{Connected Vehicle Roadside Equipment}
RSE Traveler Information Communications
RSE Restricted Lanes Application
{Basic Vehicle}
{Transit Vehicle OBE}
Transit Vehicle Schedule Management
Vehicle Restricted Lanes Application
Vehicle Basic Safety Communication
{Transit Management Center}
Transit Center Priority Management
{Enforcement Center}
(2B) traffic detector control
(2B) traffic detector data
(2B) video surveillance control
(2B) traffic images + traffic image meta data
(2B) roadway dynamic signage data
(2B) roadway dynamic signage status
(2B) lane management control
(2B) lane management information
vehicle characteristics
driver information
driver information
driver input
driver updates
(2C) restricted lanes information
(2A) restricted lanes application status
(2A) vehicle signage local data
(2C) restricted lanes information
transit vehicle operator input
transit vehicle operator display
(2A) restricted lanes information + vehicle signage data + access violation notification
(2B) restricted lanes application info + vehicle signage application info
(1A) vehicle profile + vehicle location and motion
(2C) dynamic bus lane request
(2C) dynamic bus lane status
(2B) restricted lanes application status + vehicle signage application status
(1A) host vehicle status + driver input information
(1A) driver update information
(2B) lane violation notification
(2A) restricted lanes information + vehicle signage data
(2C) current lane restrictions + lane violation notification
(1A) vehicle profile + vehicle location and motion
(2C) restricted lanes information
(2B) transit vehicle schedule performance
(2B) transit schedule information

Appendix 2. Information Flows Descriptions

Flow Name	Description
demand responsive transit plan	Plan regarding overall demand responsive transit schedules and deployment.
demand responsive transit request	Request for paratransit support.
dynamic bus lane request	Request for a restricted bus lane. May also describe affected services and include schedules with specific vehicle arrival times.
dynamic bus lane status	Status of dynamic lane request, identifying if the request can be met, specific location, and time period where priority is to be granted.
incident information	Notification of existence of incident and expected severity, location, time and nature of incident.
interactive traveler information	Traveler information provided in response to a traveler request.
lane management control	Information used to configure and control dynamic lane management systems.
lane management information	System status of managed lanes including current operational state, violations, and logged information.
parking area arrival information	Detailed arrival information within a parking area and area entrances available for transit use.
parking area information	Current status for the parking area. This includes information on general parking area status.
parking area transit information	Predicted and actual arrival times at the parking area and services offered by arriving transit vehicles.
parking arrival information	Detailed parking information to support park and ride operations.
parking information	General parking information and status, including current parking availability, parking pricing, and parking space availability information.
restricted lanes information	This flow defines the location, duration, and operating parameters for lanes that are reserved for the exclusive use.
road network conditions	Current and forecasted traffic information, road and weather conditions, and other road network status.
roadway dynamic signage data	Information used to initialize, configure, and control dynamic message signs.

Flow Name	Description
roadway dynamic signage status	Current operating status of dynamic message signs.
route assignment	Route assignment information for transit vehicle operator.
shoulder management control	Information used to configure and control systems that allow use of a shoulder as a lane for vehicular traffic.
shoulder management information	System status including current operational state, violations and logged information.
traffic detector control	Information used to configure and control traffic detector systems such as inductive loop detectors and machine vision sensors.
traffic detector data	Raw and/or processed traffic detector data which allows derivation of traffic flow variables and associated information.
traffic image meta data	Meta data that describes traffic images. Traffic images (video) are in another flow.
traffic images	High fidelity, real-time traffic images suitable for surveillance monitoring by the operator or for use in machine vision applications.
transit and fare schedules	Transit service information including routes, schedules, and fare information. This also includes on-demand service information.
transit park and ride information	Detailed transit information to support parking and ride operations.
transit schedule adherence information	Dynamic transit schedule adherence and transit vehicle location information.
transit schedule information	Current and projected transit schedule information used to initialize the transit vehicle with a vehicle assignment.
transit vehicle operator availability	Transit vehicle operator availability data that can be used to develop vehicle operator assignments and detailed operations schedules.
transit vehicle operator display	Visual, audible, and tactile outputs to the transit vehicle operator including vehicle surveillance information, alarm information, etc.
transit vehicle operator input	Transit vehicle operator inputs to on-board ITS equipment, including tactile and verbal inputs.
transit vehicle schedule performance	Estimated times of arrival and anticipated schedule deviations reported by a transit vehicle.
traveler request	A request for traveler information including traffic, transit, toll, parking, road weather conditions, event, and passenger rail information.

Flow Name	Description
trip confirmation	Acknowledgement by the driver/traveler of acceptance of a trip plan with associated personal and payment information required to confirm reservations. Conversely, this flow may also reject the proposed trip plan. Confirmations include the selected route and subsequent trip confirmation messages will be issued for route changes.
trip feedback	Information provided during or at the conclusion of a trip that supports performance monitoring and system optimization.
trip plan	A travel itinerary covering single or multimodal travel.
trip request	Request for trip planning services that identifies the trip origin, destination(s), timing, preferences, and constraints.
user profile	Information provided to register for a travel service and create a user account.
video surveillance control	Information used to configure and control video surveillance systems.

Appendix 3. Diagram Legend

The Physical View Service Package Diagrams show the subset of the ARC-IT Physical View that supports each service package. These diagrams identify the physical objects, functional objects, and information flows that support each service package.	
Vehicle On-Board Equipment	Physical objects are shown as colored rectangles. They represent the operational centers, field equipment, vehicle on-board equipment, personal devices, and support systems in the Intelligent Transportation Systems environment. They are color coded to identify which of these classes they belong to. Since they correspond closely with the physical transportation system, the interfaces between physical objects tend to be prime candidates for standardization. Center / Field / Vehicle / Personal / Support / ITS
Driver	People also have an operational role in ITS. People are shown in the physical view as colored rectangles that include a human silhouette that distinguishes them from the other physical objects that represent man-made parts of the Connected Vehicle environment. Like the other physical objects, they are color coded to represent the environment where they primarily operate.
Roadway Environment	ITS must work within an operational environment that includes things like the road surface and striping, vulnerable road users and other objects to be detected and avoided, and unequipped vehicles that must be sensed to be avoided. This operational environment is depicted in ARC-IT with physical objects that represent the environment; these objects represent what field and vehicle-based sensors sense. All of these objects have three 'sensor' curves in the lower left corner. They may be colored as Field, Vehicle, or Personal depending on the portion of the environment they represent.
Communications	Some of the physical objects defined in ARC-IT primarily provide a communications capability that enables other physical objects to share information. These communications objects are not shown on every interface where they apply to keep the service package diagrams manageable, but when they are included, they are shown as physical objects with the support class color and rounded corners to distinguish them from other physical objects.
Vehicle Intersection Warning	Functional objects are shown as smaller white rectangles that are contained within a physical object. Functional objects define the functionality that is required for each physical object to support one or more service packages. The functional objects serve as service-oriented containers for the functionality defined in the Functional View. Not all physical objects include functional objects since functionality that is peripheral to a particular service may not be shown on the service package diagram. Physical objects that are peripheral to ITS (e.g., a Financial Center or Weather Service Center) may not include functional objects in any of the service packages. The interfaces to these physical objects are important to ITS, but ITS will not add functionality to these broader systems.
intersection status + vehicle signage data →	Information flows between physical objects are shown as solid lines that include arrowheads to indicate the direction the information is flowing. The flow is labeled with one or more flow names that identify the information that is transferred. The source physical object, destination physical object, and information flow together identify a "triple". The relationship between functional objects and information flows are not shown on the diagram. Consult the website or the database to view the specific functional objects that are associated with each information flow.
Flow Time Context 1 - Now 3 - Historical 2 - Recent 4 - Static	Flow Time Context is represented as a number to the left of the flow name. This indicates the time sensitivity of the data contained within the information flow. The values are "Now", "Recent", "Historical", or "Static" for data that never or rarely ever changes.
Flow Spatial Context A - Adjacent D - National B - Local E - Continental C - Regional	Flow Spatial Context is represented by a letter to the left of the flow name. This indicates the spatial relevance of the data contained within the information flow. The values are "Adjacent", "Local", "Regional", "National", or "Continental".
Flow Cardinality Unicast Multicast Broadcast	Flow Cardinality shows whether a flow is unicast (sent to one destination), multicast (sent to multiple addressees), or broadcast (sent to anyone with the right equipment). It is represented by the arrowhead – single, closed; single, open; or double, closed.
Flow Control Receipt acknowledged Transaction initiated by left-hand party	A crossing line at the flow source indicates whether an information flow is acknowledged. Flows that are part of a transaction initiated by one side or the other are shown with a white box on the side that initiates the transaction. *(Note: the initiator boxes are only available in PNG format, the SVG drawings do not show the initiator boxes.)*
Flow Security Clear text, No Authent. Encrypted, No Authent. Clear text, Authenticated Encrypted, Authenticated	Flow Security is used to indicate what mechanisms should be in place in order for the information to get to its destination securely and in support of the overall security and privacy requirements for the system and its users. Black indicates 'clear' or no security specified; Blue indicates it should be encrypted but the sender does not have to be authenticated as the source of the message; Green indicates the information can be sent without encryption but the sender should be authenticated; Red indicates flows that require both encryption of the information and authentication of the source. These characteristics are based on a FIPS-199 analysis that evaluates confidentiality, integrity, and availability requirements for each triple.