Autonomous Shuttle for LA Olympic 2028

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1. Background & Case Study

1.1 Literature Review

As Los Angeles looks forward to hosting the 2028 Olympics, automated bus shuttles offer an innovative solution to handle the transport needs of such a significant event. These shuttles promise economic and environmental benefits that align well with the city's vision for sustainable growth.

From an economic standpoint, autonomous bus shuttles reduce operating costs by eliminating the need for drivers, which is one of the largest expenses in public transit[1][3]. Additionally, these shuttles can optimize traffic flow and improve fuel efficiency[2], which leads to lower maintenance costs and more efficient operations. Successful showcases like the Tokyo 2020 Olympics demonstrate how introducing such technology can attract investments and foster local economic development[1][2].

On the environmental side, using autonomous shuttles powered by electric or hydrogen fuel cells can significantly cut greenhouse gas (GHG) emissions compared to traditional diesel buses[2]. Their advanced driving technology ensures smoother, more efficient acceleration and braking, which conserves energy and reduces emissions. For instance, eco-driving strategies enabled by autonomous vehicles can reduce emissions by 10–20% in congested traffic conditions[2]. This could play a key role in helping Los Angeles meet its sustainability goals and contribute to broader climate commitments like those of the Paris Agreement[2][3].

However, deploying automated shuttles isn't without its challenges. Regulatory approvals, infrastructure needs, and seamless integration with existing systems require attention[3]. There's also a risk that increased convenience could lead to more vehicle miles traveled (VMT), potentially offsetting emission reductions if not carefully managed[2][3].

In conclusion, automated bus shuttles for the 2028 Olympics present an opportunity to enhance urban transit, cut costs, and support sustainability. With thorough planning, investment, and regulatory support, Los Angeles can use this moment to showcase itself as a leader in innovative, eco-friendly transportation[1][2].

1.2 Case Study

Autonomous shuttles are an emerging technology that can provide efficient, sustainable transportation for short distances within limited geographic areas. Common applications include university campuses, business parks, airports, and urban centers.

Here are several examples of autonomous shuttles:

Case Study	Key Features	Outcomes/Learnings	SAE Level	ITS Features[1]
Tokyo 2020 Olympics	- Toyota e-Palette vehicles - Customized for athlete accessibility - Low-speed operation (1-2 km/h) - Onboard safety operators	- Temporary suspension after incident - Enhanced safety measures implemented - Highlighted the need for flexible protocols	Level 4	- V2I communication - Real-time monitoring - Remote intervention capability
Paris 2024 Olympics (Planned)	- EasyMile EZ10 shuttles - Fully autonomous - 1.5 km route - Remote monitoring	- Aims to validate economic/operational model - Showcase for scaling up autonomous services	Level 4	- Advanced V2X communication - Cloud-based fleet management - Real-time data analytics
Mcity Driverless Shuttle	- Two NAVYA shuttles - Max speed 12 mph - Extensive data collection	- Emphasized the importance of safety protocols - Value of phased testing approach - Insights on user behavior and acceptance	Level 4	- Comprehensive sensor suite - Data acquisition system - V2I integration with campus infrastructure
Las Vegas CES	- Various manufacturers - Operated on designated routes - High-traffic urban environment	- Demonstrated challenges in complex environments - Insights on public perception in tech-focused setting	Level 4	- Integration with traffic signals - Real-time traffic information - Passenger information systems
Santiago, Chile	- First in Latin America - 3-month pilot - Connected park to Metro	- Carried over 2,500 users - Insights into developing country context	Level 4	- Integration with existing public transit - Real-time passenger information - Traffic signal priority
Contra Costa County	- First public service in Bay Area - Free electric shuttles - Mixed traffic on public roads	- Part of broader mobility initiative - Focus on long-term deployment and integration	Level 4	- On-demand service model - AI-powered real-time learning - Integration with other transit modes

Table 1 Autonomous Shuttle Case Study

Summarized from the table, the existing autonomous shuttles typically have a capacity of 12-15 passengers and operate at speeds of 8-20 mph on pre-defined routes. Level 4 technology, which enables full self-driving with no human operator needed, is applied in all case studies with electric propulsion. The shuttles are equipped with sensors, cameras, GPS, and other technologies for navigation.

Inspired by the ITS features of the existing case studies, the direction of the innovation proposal is to optimize route planning and integrate with existing transportation facilities in order to showcase LA's leadership in innovative transportation solutions.

Objective: To create a groundbreaking autonomous bus route that connects the USC Memorial Coliseum, DTLA Crypto Arena, and Union Station, offering a modern, efficient, and eco-friendly transportation option to transfer athletes and staff, and ticket holders swiftly between venues and Metro Stations in DTLA.

Goal:

- **Sustainable Transportation**

[1] SAE refers to Society of Automotive Engineers, they defines 6 levels of driving automation ranging from 0 (fully manual) to 5 (fully autonomous). These levels have been adopted by the U.S. Department of Transportation.

Reduce carbon emissions by introducing an eco-friendly and electric autonomous shuttle system, contributing to a greener Olympics.

- **Create a Positive Visitor Experience**
  Make getting to and from Olympic events effortless and enjoyable, giving visitors a positive and stress-free travel experience.
- **Innovation and Legacy**
  Set a Global Benchmark Make Los Angeles a global leader in smart transportation by successfully rolling out autonomous shuttles for one of the biggest international events.

2. Methodology

2.1 Proposed Workflow

The shuttle plan would select the optimal route that is the most time-saving among all the existing routes and maximize the utilization of existing bus lanes and bus stops. The criteria of bus stops are guided by two key principles: **"Connect 'Last Mile' to Public Transit"** and **"Encourage Shared Bike Usage"**. The bus stops would prioritize their connection to public transit stations and then proximate to the gathering bike racks. we will analyze the bus stop accessibility to multi-modal transportation, such as Metro bike-share racks and existing public transit stations and design an operation proposal combined with ITS and different data sources based on the historical data and ridership assumption.

The shuttle operation involves existing routes comparison to select time-saving bus lanes for autonomous shuttles. Ridership is estimated based on historical data and venue capacities, enabling optimized operational design with appropriate headways with assumptions such as mode split and route scenarios. Additionally, advanced technologies like V2X and ATM systems are integrated to enhance safety, efficiency, and passenger experience. Collaboration with traffic and transportation agencies provides real-time data for reliable operations, while continuous monitoring and real-time updates allow dynamic adjustments to bus deployment, routes, and speeds for optimal performance.

2.2 Key Data Source

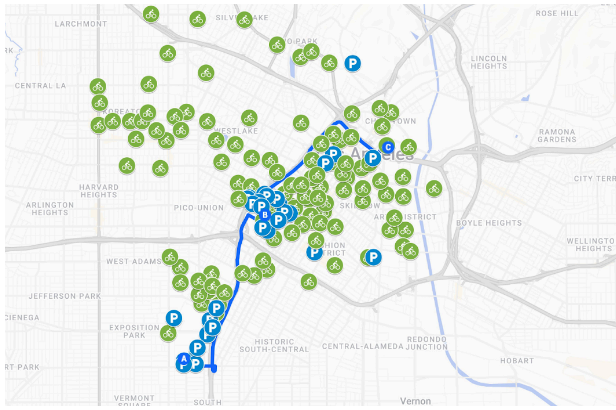
- Google Map
- Metro Bike Share
- Navigate LA

3. Key Infrastructure Assessment

3.1 Locations of existing electric bike/scooter stations

Based on the analysis of the bike share data for the area around the potential 2028 Olympic venues in Downtown Los Angeles (DTLA), the total number of trips relevant to this area is: **122,539** trips
This number represents bike share trips that either started or ended at stations within the specified geographical boundaries of DTLA, which are likely to be near Olympic venues. The boundaries used for this analysis were:

- Latitude: 34.039 to 34.059
- Longitude: -118.265 to -118.235



Fig(1): Map of Bike stations, Parking facilities near to the venue and autonomous shuttle route between the venues.

https://www.google.com/maps/d/u/0/edit?mid=1REZ4GF0ecuvrfk-3J7Y29kMJL1Fg8i8&usp=sharing

3.2 Bus Stop Accessibility and Quality Analysis

The proposed bus lane plan leverages existing bus infrastructure, which avoids additional construction costs. The selection criteria for bus stops are detailed in the accompanying table. This strategic approach allows for the identification of three primary bus stops proximal to the selected venues. They're within 1 mile of walking distance to the metro station, which could provide optimal interchange and avoid traffic congestion outside the venue. Near the USC Memorial Coliseum and Crypto Arena, the selected stops are located at ***Figueroa/39th Street*** and ***Olympic Blvd and Flower***, respectively. Due to the scarcity of bus facilities around Union Station, a new stop has been strategically placed on the west side of the station along Alameda Street.

Furthermore, one to two alternative stops will be designated along the route to enhance connectivity with key Metro interchanges. The ***Figueroa/Venice*** station, approximately one mile from Pico Station, which serves both the E-line and A-line, is also in close proximity to five bike-share facilities. This strategic placement effectively addresses the last-mile connection challenge and enhances the efficiency of multi-modal transfers.

Location (Bus Bench)	Venue/ Metro	Proximity to Public Transit Station (Bus/Metro) (mile)	Walking Distance (min)	Number of Bike Share Facility within 0.5 miles
Figueroa/39th Street	USC Station	0.6m	10	3
Figueroa/Flower	USC Station	0.2m	6	7
Figueroa/Jefferson	USC Station	0.15m	Adjacent	4
Figueroa/Adams	LATTC/Ortho	0.7m	11	12
Figueroa/23rd Street	LATTC/Ortho	0.5m	6	4
Figueroa/Washington	/GrandLATTC Station	0.3m	4	3
Figueroa/Venice	Pico Station	1.0m	14	5
Olympic Blvd and Flower	Crypto Arena	0.4m	6	4
NB Figueroa FS	7thST/metro center station	Adjacent	2	3
WB 7th St NS Francisco	7thSt	0.2m	4	7

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Figueroa/23rd Street	LATTC/Ortho	0.5m	6	4
WB olympic blvd	Pico Station	0.5m	8	2
Patsaouras Transit Plaza	Union Station	0.1m	2	5
Alameda street	West side of Union Station	0.2m	4	0

Table 2 Bus Stop Selection Criteria

3.3 Destinations of Metro Station

Along the bus route, there are metro stations connected to A line, B line, E line, L Line, which led to destinations such as Hollywood Walk of Fame, Griffith Observatory and LACMA, etc.

Attraction	Metro Line	Station Name	DASH/Metro Bus Route	Walking Distance from Metro station (miles)	Link
Hollywood Walk of Fame	B Line	Hollywood/Vine	DASH Hollywood, Metro 210, 212	0.1	https://walkoffame.com/
Griffith Observatory	B Line	Vermont/Sunset	DASH Observatory, Metro 180, 181	0.5	https://griffithobservatory.org/
Santa Monica Pier	E Line	Downtown Santa Monica	Big Blue Bus 1, 2, 3	0.25	https://santamonicapier.org/
Venice Beach Boardwalk	E Line	Downtown Santa Monica	Big Blue Bus 1	1.0	https://www.venicebeach.com/
Universal Studios Hollywood	B Line	Universal City/Studio City	Metro 150, 240	0.6	https://www.universalstudioshollywood.com/
The Getty Center	E Line	Sepulveda	Metro 734, 788	0.5	https://www.getty.edu/visit/center/
LACMA	D Line	Wilshire/Western	DASH Fairfax, Metro 20, 720	0.3	https://www.lacma.org/
California Science Center	E Line	Expo Park/USC	DASH Exposition Park, Metro 81	0.2	https://californiasciencecenter.org/

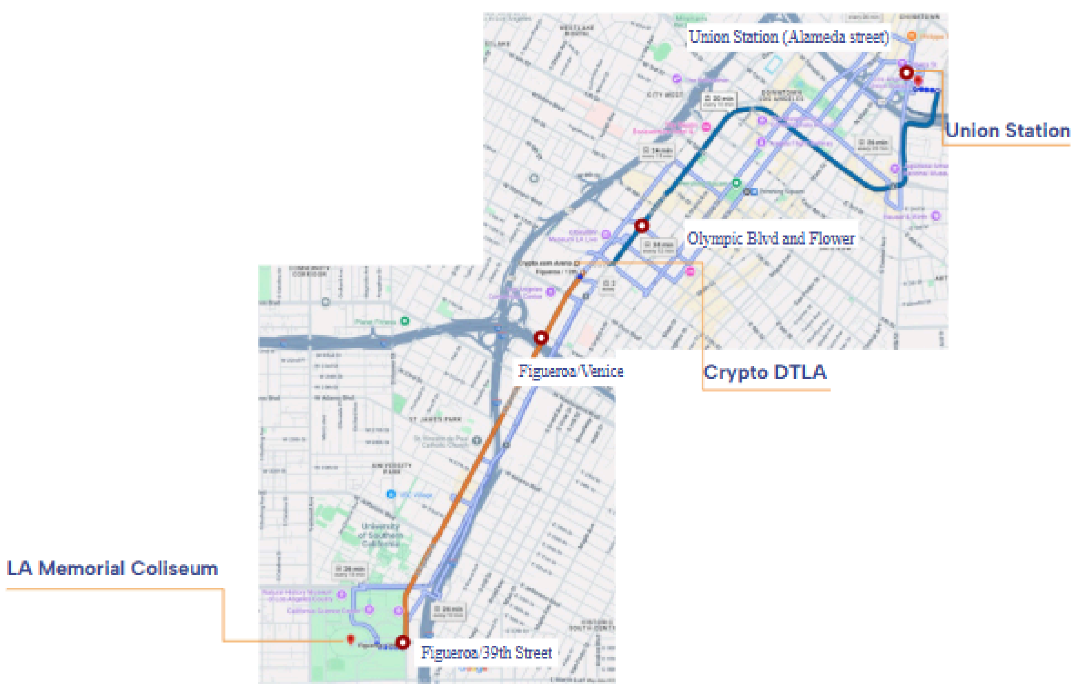
The Broad	B, D Lines	Civic Center/Grand Park	DASH D, Metro 28, 30, 33	0.2	https://www.thebroad.org/
Chinatown	L Line	Chinatown	DASH B, Metro 45, 76	0.1	https://www.chinatownla.com/
Grand Central Market	B, D Lines	Pershing Square	Metro 28, 30, 33, 40	0.2	https://grandcentralmarket.com/
La Brea Tar Pits	D Line	Wilshire/La Brea	Metro 20, 720	0.2	https://tarpits.org/
Rodeo Drive	D Line	Wilshire/Rodeo	Metro 20, 720	0.5	https://rodeodrive-bh.com/
Walt Disney Concert Hall	B, D Lines	Civic Center/Grand Park	Metro 28, 30, 33	0.1	https://www.laphil.com/about/our-venues/walt-disney-concert-hall/
TCL Chinese Theatre	B Line	Hollywood/Highland	Metro 212, 217, 222	0.2	https://www.tclchinesetheatres.com/

Table 3 Overlapped Metro Line Destination

4. Operation Proposal

4.1 Route Selection

Comparing the existing bus routes of different agencies, the chosen route prioritizes time efficiency while avoiding freeways due to safety concerns for Level-4 autonomous vehicles. The selected paths between USC Memorial Coliseum and Crypto Arena, as well as between Crypto Arena and LA Union Station, are designed to maximize time savings and operate on urban roads. The total length is **6.5 miles**.



Fig(2) Map of Bus Route （Google Map, 2024）

4.2 Speed Limits and Time Design

To be as competitive as traditional buses in the speed limit, the driving speed of the bus would be similar, between **25-35 miles/ h**. Referred to LAX People Mover, the capacity is expected to maximum of 60 sitting and standing people with 3 double-side doors. There are 60 people getting off and 60 getting up through two doors of the bus at the final destination.

Boarding/alighting time per passenger drops to 1.5 seconds: $60 \times 1.5 \times 2 / 2 = 90$ seconds (1.5 min)

Average Time spends on Road: $6.5 / 35 \times 60 = 11$ min

The average time for a one way trip is around 12.5 min include the dwell time.

4.3 Ridership Forecast

The route is used to support athletes (coaches, team managers, etc.), game ticket holders and volunteers to switch smoothly from venue to venue and venue to Metro Station and Union Station, as the important intercity interchange. The capacity of the stadiums and the assumption of athletes and staff are based on historical data about Olympic events and information given by the stadium. For example, based on 1984 Olympic Open Ceremony data, the attendants is larger than the real capacity, which means there's potentially higher ridership demand during the game. The attendance rate and mode split varies on the game type and duration. Overall, the expected ridership for each game is 30,330 and 5,793 for LA MEMORIAL COLISEUM and ARENA DTLA respectively.

	LA MEMORIAL COLISEUM	**ARENA, DOWNTOWN LOS ANGELES**
Capacity	77,500 - 92,516 (1984 Open Ceremony)	20,000 - 24,000 (Pluc volunteers and Staffs)
Athletes + Staffs	150 Athletes (Plus Team Staffs) 350 Volunteers 150 management staff	100 Athletes (Plus Team Staffs) 150 Volunteers 60 management staff
Sports	Track and Field competitions; the Opening Ceremony	Artistic Gymnastics; Rhythmic Gymnastics; Trampoline Gymnastics
Normal Duration	10 days	11 days
Assumed Attendance Rate	~97%	~95%
Assumed Mode Split	40%	30%
Expected Ridership Per Game	30,330	5,793

Table 4 Ridership Forecast

4.4 Headway Design

To evaluate the bus number needed and design headway for peak and off-peak periods, we assumed a maximum capacity of 60 passengers per bus. The time for a round-trip completion is 25 minutes so that every bus can finish 3.5 round trips within 90 min.

Based on the assumption of different destinations, the demand is separated into three routes.

	LA MEMORIAL COLISEUM	**ARENA, DOWNTOWN LOS ANGELES**
Venue - Venue	10% (3,033)	15% (869)
Venue - Union Station	60% (18,198)	65% (3,766)
Venue - Metro Station	30% (9,099)	20% (1,159)

Table 5 Route Ridership Forecast

Based on the ridership and the input data, there are three scenarios to consider:

A. **Scenario 1: Two Games from Different Stadiums Ends (Begins) at the Same Time**

All attendees (spectators, athletes, volunteers, and staff) leave the venues simultaneously. 60% of attendees are transported to Union Station and the remaining 40% go to various Metro Stations.
Total Ridership =30,330 + 5,793 = 36,123 riders
Union Station: 36,123×0.60= 21,674 riders
Metro Stations: 36,123×0.40=14,449 riders
Total Shuttle Trips: 362 + 241 = 603
Buses Required: 603 / 3.5 ≈ 172 buses
Headway: 90 / 172 ≈ 0.5 minutes

B. Scenario 2: Riders come only from the LA Memorial Coliseum
Total Ridership = 30,330 riders.
Union Station: 30,330 × 0.60 = 18,198 riders.
Metro Stations: 30,330 × 0.40 = 12,132 riders.
Total Shuttle Trips: 303 + 202 = 505
Buses Required: 505 / 3.5 ≈ 144 buses
Headway = 90 / 144 ≈ 0.6 minutes (40s)

C. Scenario 3: Riders come only from the Crypto Arena
Total Ridership (DTLA)=5,793
Total Shuttle Trips: 63+34=97
Buses Required: 97 / 3.5 ≈ 28
Headway = 90 / 28 ≈ 3 minutes

The difference between the number of buses needed for these three scenarios could lead to a waste of resources, canceling stops at Metro Station during Peak hours ensures people to transfer between the stadium and Union Station in time. If we prioritize the ridership between Union Station and to stadium in the first scenario, the total ridership demand would decrease from 36,123 to 21,674, and the bus required reduced by 72 buses to around 100 buses with around 1 minute headway.

After Intervention	Total Ridership	Total Shuttle Trips	Buses Needed	Headway (minutes)
Both Games End Simultaneously	21,674	362	100	1
Only Memorial Coliseum Game Ends	18,198	304	82	1
Only Downtown LA Arena Game Ends	5,793	97	28	3

Table 6 Bus Number and Headway Design after Interventions

4.5 Vehicle to Everything (V2X)

Equip shuttles with V2X capabilities to enable communication between the shuttle and traffic management systems including traffic signals, other vehicle information and road situations, and connected infrastructure such as Metro schedule and available shared bike location.

Utilize data from sources such as SCAG and Caltrans GIS datasets to assess traffic flow, congestion points, and optimal routes.

The App to connect with vehicle information would be helpful to support the tourism experience. Passengers are notified of the next game's start time, public transit arrival time, and the best routes to reach different Olympic venues with nearby landmarks, cultural sites, and restaurants along the route, which helps them to develop daily travel plans with their preferred Language system. The system includes announcements and wayfinding for passengers with disabilities, such as visual and auditory prompts synchronized with shuttle locations.

The ITS system extends beyond passenger convenience to prioritize safety and traffic management during the Olympics. Autonomous shuttles leverage ATM (Active Traffic Management) strategies, such as Hard Shoulder Running (HSR) and Variable Speed Limits (VSL), for efficient operations and quick responses in emergencies.

- During critical situations, such as accidents, medical emergencies, or unexpected delays, shuttles are equipped to receive high-priority clearance signals from traffic management centers.
- During periods of high congestion near venues, VSL can reduce shuttle speeds to minimize potential collisions and maintain flow consistency.

4.6 Operational Partners:

The project cooperates with the Automated Traffic Surveillance and Control (ATSAC) Center and the Los Angeles Regional Transportation Management Center(LARTMC), which provides real-time traffic management to ensure reliable travel and route planning to avoid incidents and congestion.

Additionally, this project is going to cooperate with LA Metro to fill the shortage of buses. Leverage real-time traffic data to design efficient shuttle paths that minimize travel time and enhance reliability. Conduct thorough evaluations of existing road conditions, potential bottlenecks, and areas needing infrastructure upgrades to support autonomous operation. Develop primary and backup routes that consider various scenarios, such as event-specific congestion and emergency detours. Focus on routes that connect major Olympic venues, ensuring accessibility and minimal disruption.

5. Smart Transportation Hub for LA Olympics 2028 (website)

5.1 Key Features

Interactive Map

The platform includes an interactive map displaying:

- Bike stations
- Parking structures
- Air taxi zones
- Olympic venues

This feature allows users to visualize transportation options and venue locations, facilitating easier navigation and planning.

Booking Services

The hub provides integrated booking options for:

- Air taxis
- Hotels
- Cabs

This centralized system simplifies travel and accommodation arrangements for visitors.

Travel Guide

The travel guide offers:

- Local transportation information
- Navigation tips

It helps attendees understand LA's transit systems and plan their journeys efficiently.

Olympic Information

Users can access:

- Venue details

- Events calendar

This ensures attendees stay informed about Olympic events and locations.

5.2 Benefits

All-in-One Solution

The platform consolidates all transportation needs into a single, user-friendly interface, eliminating the need for multiple apps or tools.

Seamless Integration of Transport Modes

It integrates various transportation options, including air taxis, public transit, and bike-sharing, offering flexibility and convenience.

Real-Time Updates

The hub provides real-time updates on:

- Availability of transportation modes
- Schedules and delays

This ensures users can make timely adjustments to their plans.

User-Friendly Design

The intuitive interface makes it easy for users to navigate, book services, and access information.

5.3 Alignment with LA's Vision

Transit-First Approach

The platform supports LA's goal of a "transit-first" Olympics by promoting sustainable transportation options like public transit and bike-sharing.

Car-Free Experience

By offering diverse transport solutions, the hub aims to reduce reliance on personal vehicles during the Games.

Showcase of Innovation

Incorporating cutting-edge technologies such as air taxis highlights LA's commitment to innovative urban mobility solutions.

5.4 Sustainability and Urban Mobility Goals

Environmental Impact

The platform encourages the use of eco-friendly transport modes, contributing to reduced carbon emissions during the Olympics.

Supporting Infrastructure

It integrates with existing infrastructure like metro stations, bike-sharing facilities, and parking zones to maximize efficiency without requiring extensive new construction..

5.5 Conclusion

The Smart Transportation Hub is a transformative solution for the 2028 Los Angeles Olympics, aligning with the city's goals of sustainability, innovation, and efficiency. By centralizing information, offering real-time updates, and integrating multiple transport modes in a user-friendly platform, it ensures a seamless experience for visitors while showcasing LA's leadership in smart urban mobility solutions.

The Smart Transportation Hub for the 2028 LA Olympics can be explored at the [Smart Transportation Hub Website].

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