

Lessons Learned

Autonomous Vehicle Demonstration



S huttling
W lth
A utonomous
N avigation



First Things First



LYNX AV Services Study

Concept of Operations Report

FINAL
April 2021

LYNX, the City of Orlando, and MetroPlan Orlando completed the Concept of Operations for AV Services in 2021

- 🐾 Autonomous vehicles need to provide the same or better service as existing before they are ready for deployment
- 🐾 LYMMO Orange was identified best option for pilot
- 🐾 Pilot option was to operate with a focus on off-peak periods to offset smaller vehicle size

Continued development of autonomous vehicle technology in a “living lab” to:

- ④ Allow familiarization with the technology to a broad spectrum of ages and technical levels
- ④ Gain feedback on meeting the needs of passengers with an autonomous vehicle
- ④ Operate in an urban setting including complex multiple lane intersections, an overhead highway, and adjacent pedestrian activity and streetscape

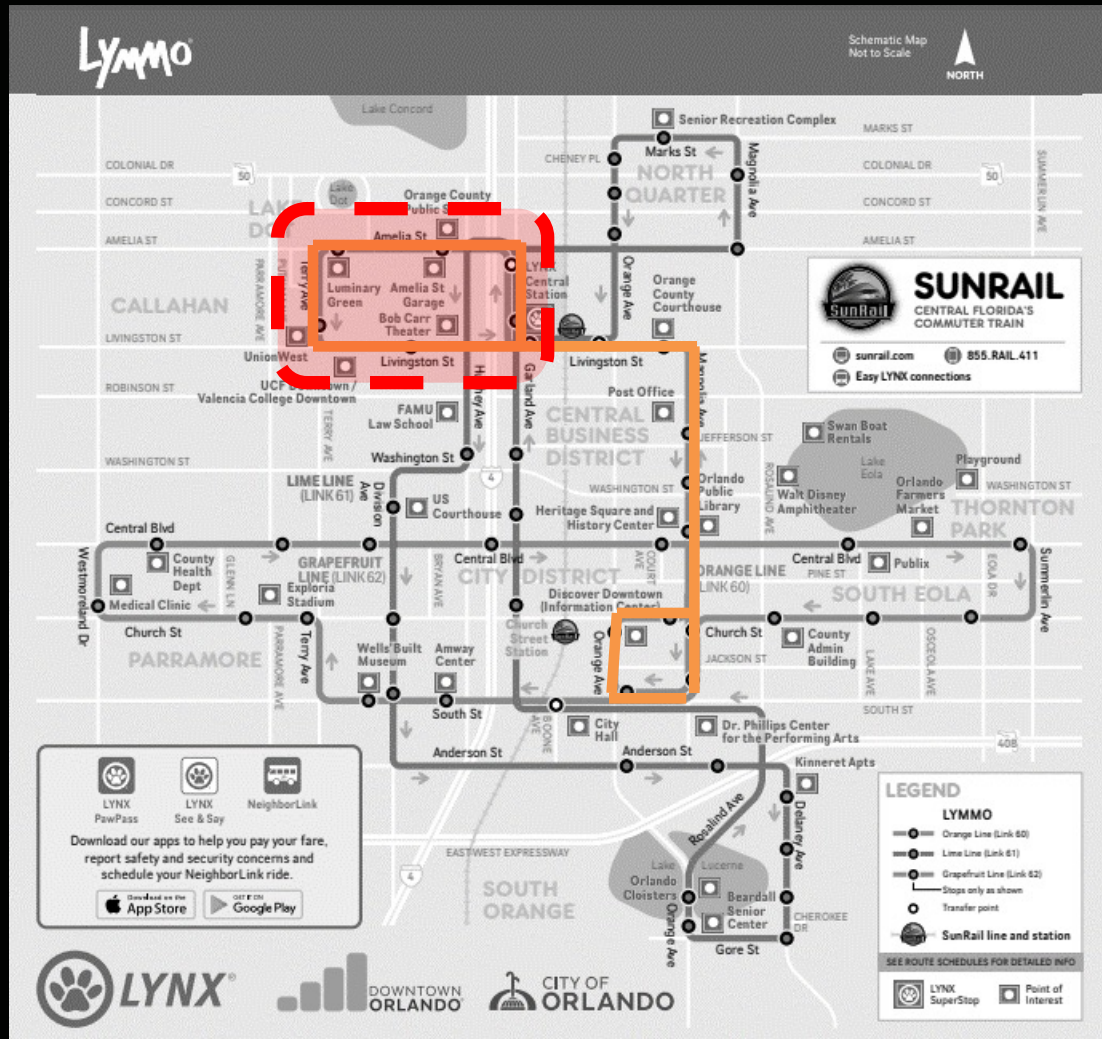
The National Highway Traffic Safety Administration (NHTSA) established the Federal Motor Vehicle Safety Standard (FMVSS) specifying 73 standards that must be on vehicles sold in the United States.

- 🐾 FMVSS uses human-centric federally-mandated standards (examples include steering wheels, brake pedals, driver's seat, mirrors)
- 🐾 Vehicles that do not meet FMVSS require a petition for a temporary exemption from NHTSA to be permitted on public roads
- 🐾 NHTSA requires operators of autonomous vehicles to report crashes to the agency

First Things First – The Location



First Things First – The Location



- Six-month demonstration
- Existing transit service
- Off-peak hours (two 4-hour shifts per day)
- 8-minute headways during business hours



First Things First – Why Here?



Pilot location serves:

- Callahan and Parramore Neighborhoods, Salvation Army Orlando Citadel/William Booth /Catherine Booth Towers (Justice40)
- Orange County Public School Academic Center for Excellence (K-8 school)
- Orlando Technical College, Valencia College, University of Central Florida, and Florida A&M (higher education)
- EA Orlando (technology)
- Bob Carr Theater, Marriott, Crown Plaza Orlando Downtown (visitors)
- LYNX Central Station (bus and rail transit hub)



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What We Learned – Weather

What We Learned - Precipitation



Weather affects operations

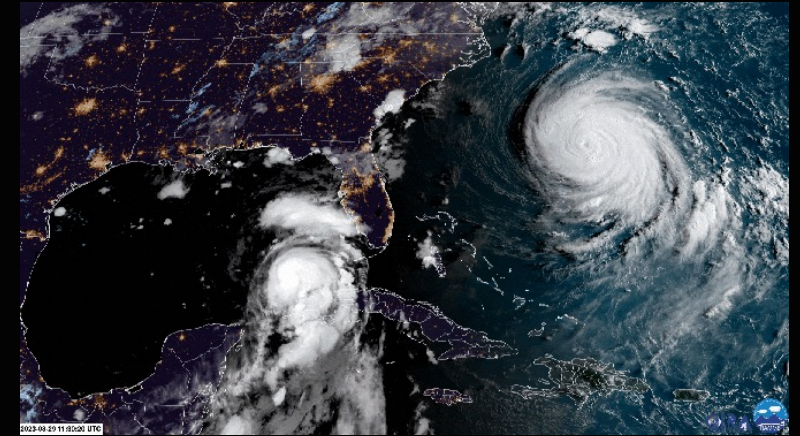
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What We Learned - Precipitation

Weather affects operations

- 🐾 Sensors see rain as a wall (launched September 20, 2023)
- 🐾 Hurricanes Franklin and Idalia (September 30, 2023)



What We Learned – Heat and Cold



Weather affects operations

- 🐾 Sensors see rain as a wall (launched September 20, 2023)
- 🐾 Hurricanes Franklin and Idalia (September 30, 2023)

🐾 Heat (and humidity) affect battery range



September						
Mon	Tue	Wed	Thu	Fri	Sat	Sun
				1 ☁️ +88° night +79°	2 ☁️ +86° night +77°	3 ☁️ +88° night +77°
4 ☀️ +90° night +75°	5 ☁️ +90° night +75°	6 ☀️ +91° night +77°	7 ☀️ +93° night +79°	8 ☁️ +86° night +81°	9 ☀️ +88° night +73°	10 ☀️ +90° night +77°
11 ☀️ +90° night +79°	12 ☁️ +90° night +77°	13 ☁️ +88° night +81°	14 ☁️ +88° night +79°	15 ☁️ +88° night +79°	16 ☁️ +86° night +77°	17 ☁️ +88° night +79°
18 ☁️ +88° night +81°	19 ☁️ +86° night +75°	20 ☁️ +88° night +77°	21 ☁️ +86° night +75°	22 ☀️ +84° night +75°	23 ☀️ +86° night +72°	24 ☁️ +88° night +72°
25 ☁️ +88° night +75°	26 ☁️ +86° night +77°	27 ☁️ +84° night +75°	28 ☁️ +84° night +75°	29 ☁️ +86° night +75°	30 ☁️ +84° night +75°	

Yahoo Finance



What We Learned – Roadway

What We Learned – Use of Lanes



Pauli Exclusion Principle: two objects cannot occupy the same space at the same time

What We Learned - Roadway

Pauli Exclusion Principle: two objects cannot occupy the same space at the same time

- 🐾 Either buses or shuttles operate in the lane, not both



A solid white line marks the edge of the roadway or separates lanes of traffic moving in the same direction. You may travel in the same direction on both sides of this line, but you should not cross the line unless you must do so to avoid a hazard.

What We Learned - Construction

Pauli Exclusion Principle: two objects cannot occupy the same space at the same time

- 🐾 Either buses or shuttles operate in the lane, not both
- 🐾 Construction vehicles like to park in bus lanes

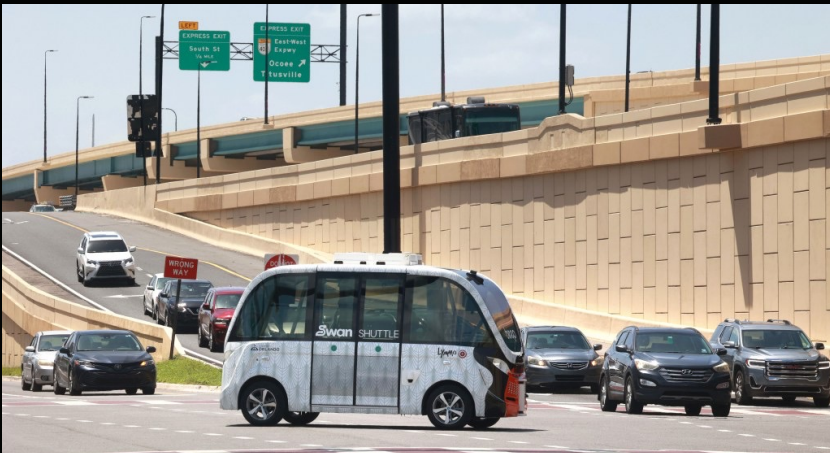


What We Learned – Traffic Signals



Pauli Exclusion Principle: two objects cannot occupy the same space at the same time

- 🐾 Either buses or shuttles operate in the lane, not both
- 🐾 Construction vehicles like to park in bus lanes
- 🐾 Some vehicles don't follow the rules



What We Learned – The Riders

What We Learned – Rider Focus



Autonomous shuttle vehicles are different than buses

- 🐾 Vendor attendants are not transit employees



What We Learned – “Coolness” Delays



Autonomous shuttle vehicles are different than buses

- 🐾 Vendor attendants are not transit employees
- 🐾 People stop the shuttle to ask questions (headways)



What We Learned – Design for Riders



Autonomous shuttle vehicles are different than buses

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- 🐾 Snuggle up (11 passengers?)



What We Learned – Design for Riders



Autonomous shuttle vehicles are different than buses

- 🐾 Vendor attendants are not transit employees
- 🐾 People stop the shuttle to ask questions (headways)
- 🐾 Snuggle up (11 passengers?)
- 🐾 Buckle up



What We Learned – Slow Speed

Autonomous shuttle vehicles are different than buses

- 🐾 Vendor attendants are not transit employees
- 🐾 People stop the shuttle to ask questions (headways)
- 🐾 Snuggle up (11 passengers?)
- 🐾 Buckle up
- 🐾 Zero to 60 mph in ?



What We Learned – Accidents

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Operators of vehicles equipped with Level 2 to Level 5 autonomous driving capability must report any accidents to the National Highway and Traffic Safety Administration (NHTSA) within 24 hours.

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September 23, 2023 – Bus merges into shuttle vehicle, back in service the next morning

November 11, 2023 – Shuttle (manual) advances through stop signal and hits bus

What We Learned – Accidents

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Lesson 1: A crash with an autonomous vehicle can make national and international news, even if vehicle only has scratches

Lesson 2: A crash with an autonomous vehicle can result in a review of the waiver to conduct the deployment (still have to provide service)



What We Learned – The Results

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Out 1,916 scheduled hours, we have experienced:

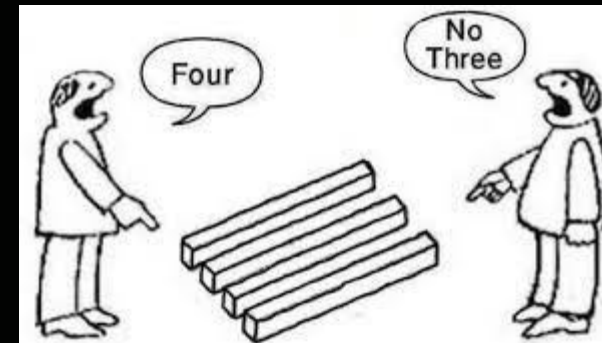
- 🐾 5% affected by weather events (48 events for 88h 49m)
- 🐾 4% affected by insufficient battery (103 events for 74h 38m)
- 🐾 2% affected by lane blockages (24 events for 40h 3m)
- 🐾 11% affected by construction (59 events for 217h 3m)
- 🐾 3% affected by traffic signal issues (25 events for 57 h 38m)
- 🐾 1% affected by loss of GNSS signal (12 events for 7h 45m)
- 🐾 1% affected by accidents (4 events for 15h 0m, not suspension)
- 🐾 3% affected by other issues (33 events for 63h 58m)

What We Learned – The Results



Out 1,916 scheduled hours, lost 196 hours and 14 minutes (8%)

- 5% affected by weather events (48 events for 88h 49m)
- 4% affected by insufficient battery (103 events for 74h 38m)
- 2% affected by lane blockages (24 events for 40h 3m)
- 11% affected by construction (59 events for 217h 3m)
- 3% affected by traffic signal issues (25 events for 57 h 38m)
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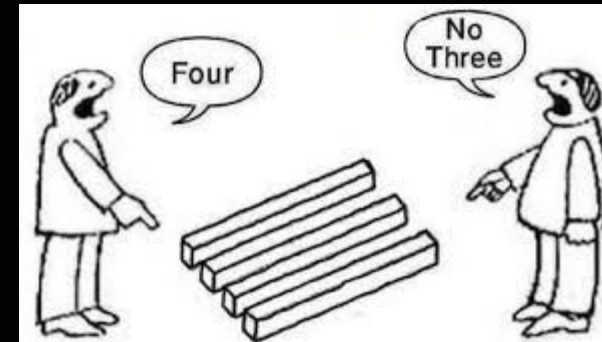
Technology
Perspective

What We Learned – The Results



Out 1,916 scheduled hours, lost 592 hours and 56 minutes (31%)

- 5% affected by weather events (48 events for 88h 49m)
- 4% affected by insufficient battery (103 events for 74h 38m)
- 2% affected by lane blockages (24 events for 40h 3m)
- 11% affected by construction (59 events for 217h 3m)
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- 1% affected by loss of GNSS signal (12 events for 7h 45m)
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Transit
Perspective

What We Learned – The Results



Sensor technology that operates reliably in rain, snow, and fog

“Fuel” that lasts for at least the same shift as a bus operator (at least 10 hours in service)

Ability to maneuver around lane blockages on complex streets

Acceleration and speed comparable to adjacent traffic

Vehicles that can operate on detours without advanced notice

Cabins that reflect personal comfort and space rather than maximize capacity

Thank You



Doug Jamison
Program Administrator - Innovation

