Texas A&M Transportation Institute

The Effects of Automation on the Public Transportation Workforce

Industry Data Collection Webinar

June 18th, 2020

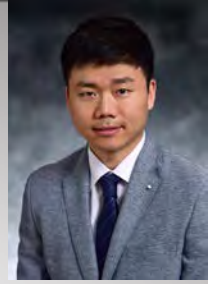
TCRP Project J-11 / Task 34

Introductions

Michael J. Walk

- Research Scientist at Texas A&M Transportation Institute (TTI)
- Manager of TTI's Transit Mobility research program
- Expertise and Interests
  - Transit Performance and Financial Management
  - Process Management and Improvement
  - Bus Planning, Scheduling, Operations, and Maintenance
  - Applying Innovation and Technology to Address Transit Challenges and Improve Customer Service

Jinuk Hwang, Ph.D.



- Assistant Transportation Researcher at Texas A&M Transportation Institute (TTI)
- Expertise and Interests
  - Urban and Transportation Planning
  - Advanced Technology to Support Transportation Disadvantaged Populations
  - Sustainable Transportation Systems

Agenda

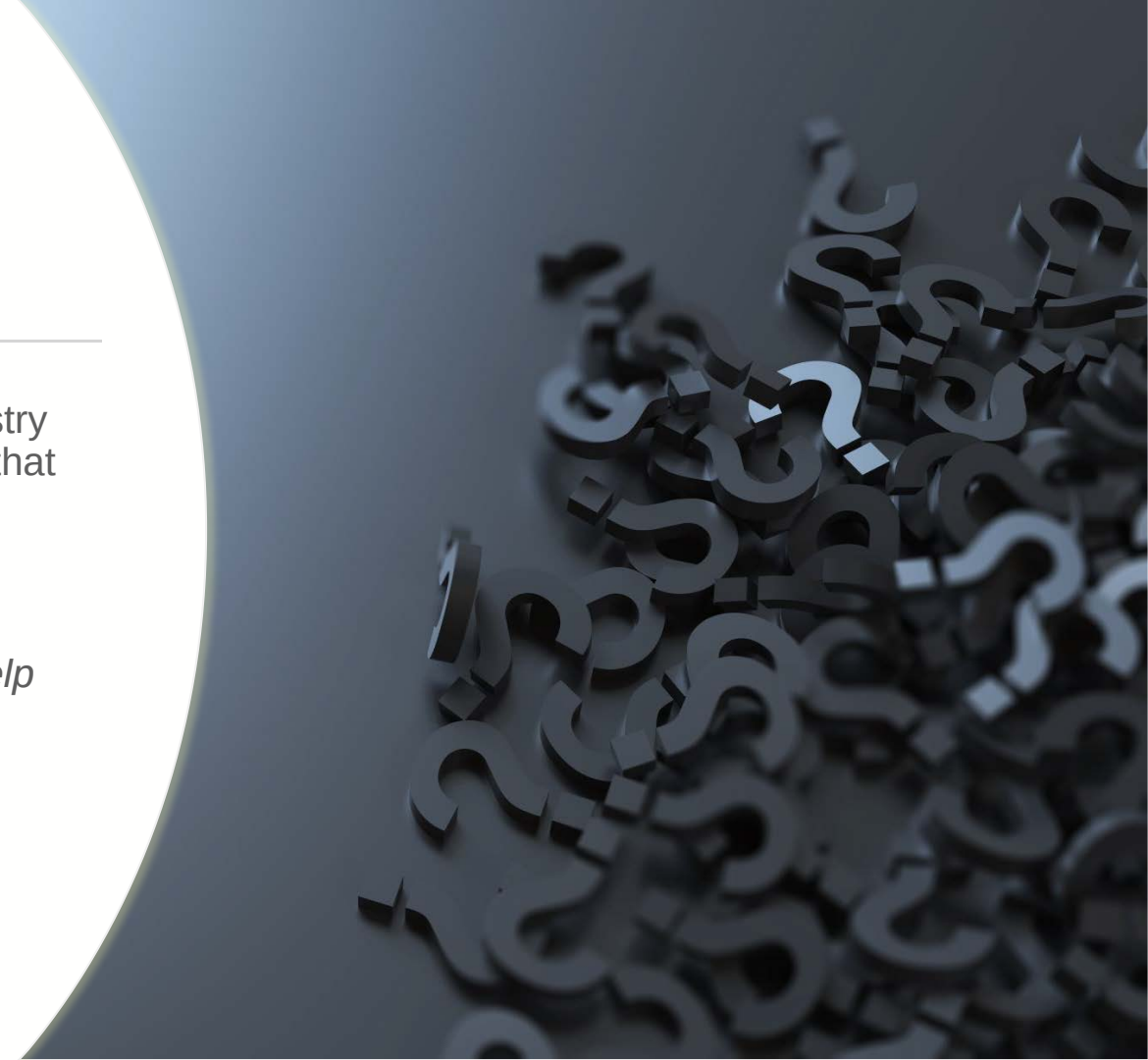
What are we doing today?

Start	End	Duration	Session Title
2:00 PM	2:10 PM	0:10	Introductions
2:10 PM	2:20 PM	0:10	Discussion of Foundational Assumptions
2:20 PM	2:25 PM	0:05	Live Polling – Intro and Training
2:25 PM	3:15 PM	0:10 each	Use Cases 1 – 5 Overview and Decision Making
3:15 PM	3:30 PM	0:15	Q&A and Discussion

Workshop Purpose

Obtain feedback from the transit industry on key planning and policy decisions that will have implications on workforce impacts of transit vehicle automation.

You will *provide data today that will help guide the rest of the study!!!*



Why the Study?

- Vehicle automation: It’s coming…
- Transit workforce impacts not well-documented or understood
  - Type
  - Magnitude
- Knowledge empowers preparation

Automation's Workforce Impacts Will Vary

- Transit agency type and size
- Public employees vs. private employees
- Positions / jobs / tasks

Impacted Transit Jobs

Directly-Impacted Operations Jobs

- Bus operators
- Bus mechanics / maintenance technicians
- Bus service persons / fuelers / cleaners
- Dispatchers / controllers
- Road or street supervisors / traffic controllers

Automation impact will be **quantified**

Indirectly-Impacted Key Jobs

- Bus garage superintendent
- Bus operations trainer
- Maintenance trainer
- Parts clerk
- Operations and maintenance facilities maintainer
- Short-range transit planner / schedule maker
- Transit police officer

Automation impact will be **discussed**

New Jobs / New Organizational Structures?

- Vehicle Automation Technician?
- Office of Vehicle Automation?
- Chief Automation Officer?

Research Approach

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Foundational Assumptions

Key Study Assumptions

Transit vehicle automation will come: use cases assumed to be fully safe, mature, deployable

Transit agency acceptance: transit agencies will accept and deploy use cases as appropriate in their local context

Public acceptance: the public will accept and ride each use case

Labor protection: workforce impacts will be felt even with federal labor protections

Key Study Assumptions (cont'd)

Automation Levels

- Level 0: No Automation
- Level 1: Driver Assistance
- Level 2: Partial Automation
- Level 3: Conditional Automation
- Level 4: High Automation
- Level 5: Full Automation

Automation ≠ electrification: we are not modeling the impacts of electrification or assuming all automated vehicles will be electric

Human operator / attendant:

- Fully autonomous use cases (Level 5) will not *require* an operator
- Remaining use cases (Level 4) will *require* an operator / attendant

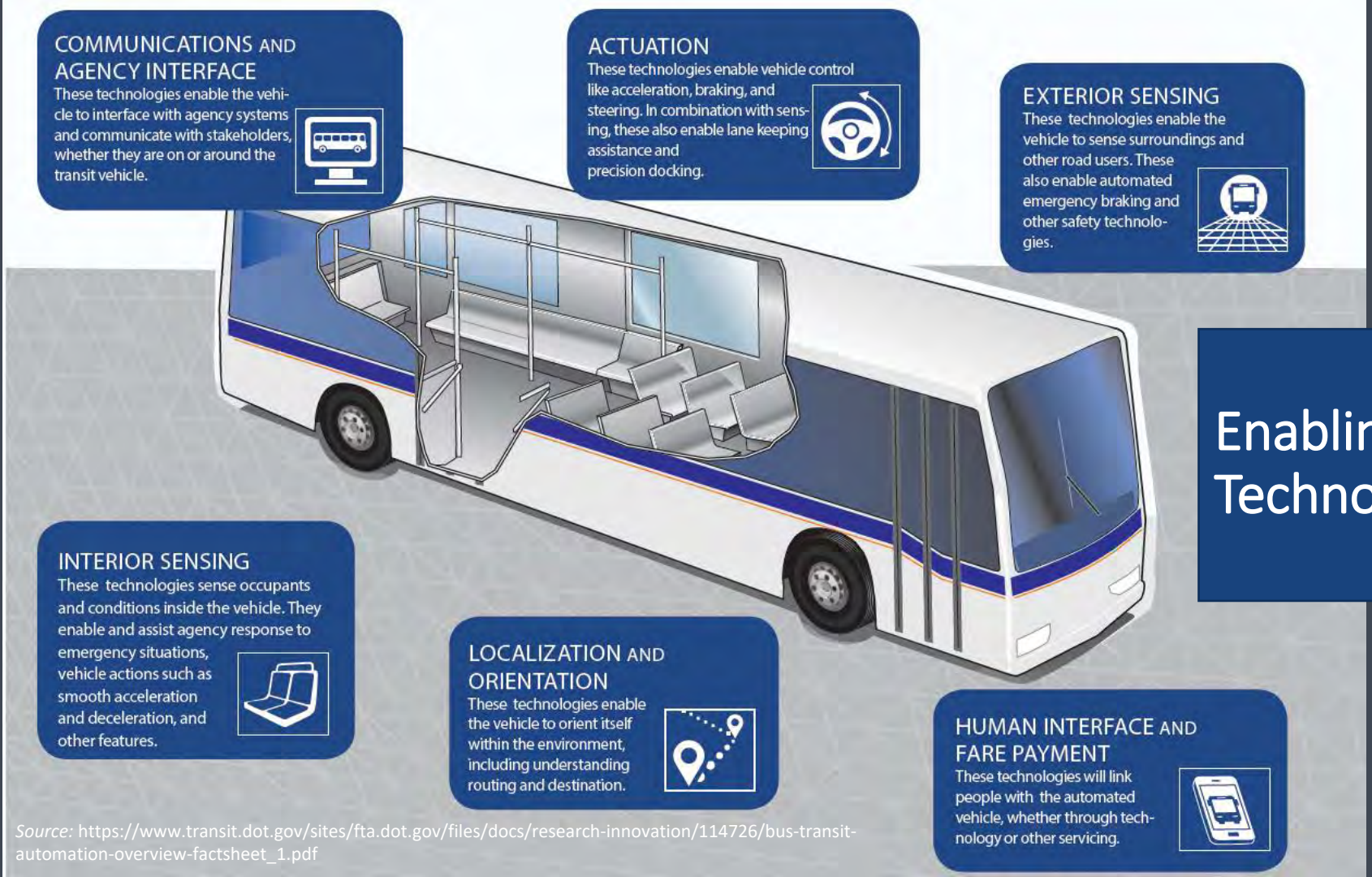
Transit agency types matter: Use case deployment and impacts will vary across rural/tribal, small urban, and large urban transit agencies

Use Case Enabling Technologies

In common: On-board technologies to support automated operations L4 or L5

Differences: some specific technologies / systems might be needed for certain use cases

Enabling Technologies



Source: https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/research-innovation/114726/bus-transit-automation-overview-factsheet_1.pdf

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Preview of Live Polling

How to provide data that will be used in this study

How to join

Web

1. Go to **PollEv.com**
2. Enter **MICHAELWALK897**
3. Respond to activity

Text

1. Text **MICHAELWALK897** to **37607**
2. Text in your message

Messaging and/or data rates may apply

Have you ever ridden in an autonomous shuttle?

Yes **A**

No **B**

No and never plan to **C**

What type of agency or organization best describes where you currently work (or most recently worked)?

Public transit agency or department

City or county government

Local or regional planning entity (e.g., MPO or COG)

State government or DOT

Labor union

Human services agency or similar non-profit

Private contracted transit provider

Transit software or hardware company

Other

What type of transit agency will you be answering for today?

Rural / tribal	**A**
Small urban (may also include rural)	**B**
Large urban (may also include small urban and rural)	**C**
I cannot respond for any type of transit agency	**D**

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Use Cases and Decision Making

5 Transit Vehicle Automation Use Cases

Use Case List

Use Case #1

Bus Automation for Maintenance and Yard Operations

Use Case #2

Low-Speed Automated Shuttles

Use Case #3

Automated Bus Rapid Transit

Use Case #4

Automated Mobility on Demand (MOD)*

Use Case #5

Automated Local Bus Transit

* MOD: demand-responsive approach to mobility

Cautions and Disclaimers

Bus Automation for Maintenance and Yard Operations

Description / Examples	Operational Impacts
• Automation of bus movements in transit agencies' operations and maintenance (O&M) facilities. • From/To maintenance bays, vehicle storage, parking, washing, and fueling areas.	• Increase efficiency of the O&M facilities. • Improve safety within the yard. • Enhance on-time service performance by simplifying yard movement procedures. • *Not seen by the riders.*

Bus Automation for Maintenance and Yard Operations

Additional Supporting Technology	Demos, Pilots, and Potential Timeline
• The O&M facilities and parking areas may need to be equipped with supportive devices for interactions with vehicles (Vehicle-to-Infrastructure [V2I] communication). • Intensive mapping of the facilities.	• 2017: Karlsruhe Institute of Technology (Germany) autonomous bus depot system. • 2018: RATP Group, CEA, and Iveco Bus (France) fully autonomous bus garage. • 2021: Demonstration of automation for maintenance and yard operations (FTA's Strategic Transit Automation Research [STAR] Plan).

Bus Automation for Maintenance and Yard Operations

Assumptions of Workforce Impacts	Directly-Impacted Transit Jobs
• Reduction in labor hours related to yard movements. • Increase in labor hours related to inspection, maintenance, repair, and cleaning of automation-enabling vehicle systems and O&M facilities.	• Bus operator. • Bus mechanic/maintenance technician. • Bus service person/fueler/cleaner.

USE CASE 1 POLL QUESTIONS

When answering these questions:

- Think of the transit agencies in the type you're answering for (don't limit your answer to just what *your* agency would do)
- Assume that funding is not a limitation
- Assume the technology is fully mature and safe
- If the use case could apply to your agency type, assume it is actually deployed

Use Case #1: Q1

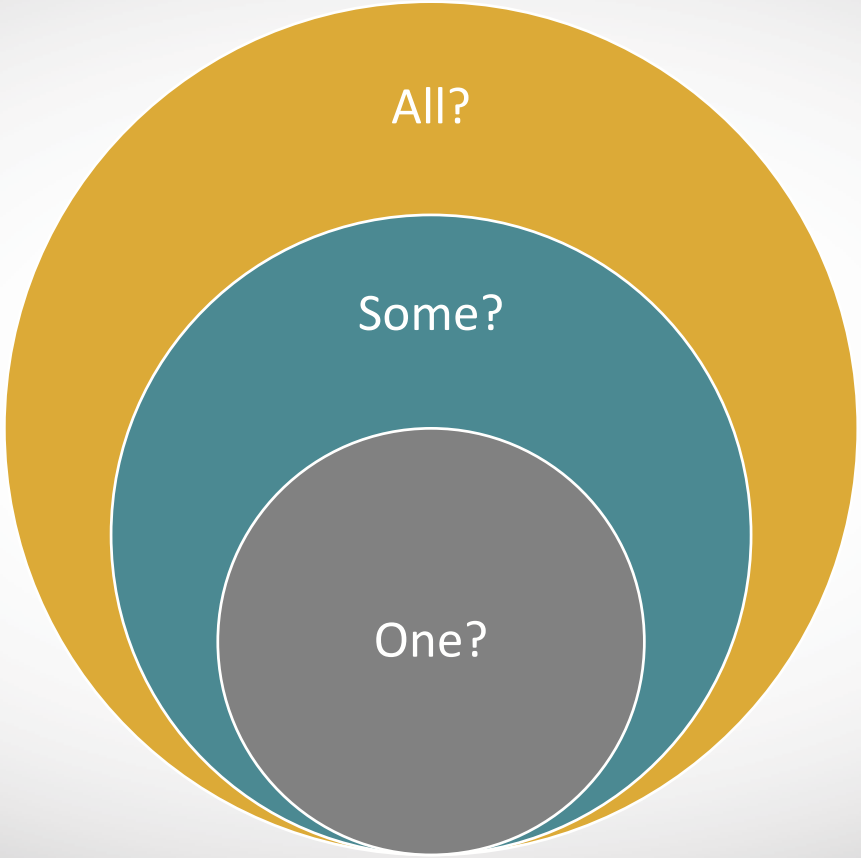
How likely is it that automated yard operations would be used at your transit agency type?

Very likely

Very unlikely

Not sure

Q2 & Q3: Yard deployment



Use Case #1: Q2

Transit agencies with multiple bus yards will deploy this use case to:

All yards

Only at select yards

Does not apply to my agency type

Use Case #1: Q3

Within a single bus yard equipped for automated yard movements, transit agencies will:

Have a MIX of buses--some capable of autonomous yard movements and others not

Have ONLY buses capable of autonomous yard movements

Q4: Operator Time Savings

Operator arrives & calls bus

Bus autonomously moves to inspection zone

Operator conducts pre-trip

Operator returns to yard; conducts post-trip

Operator releases bus for storage

Bus self-vaults(?) & self-parks

Use Case #1: Q4

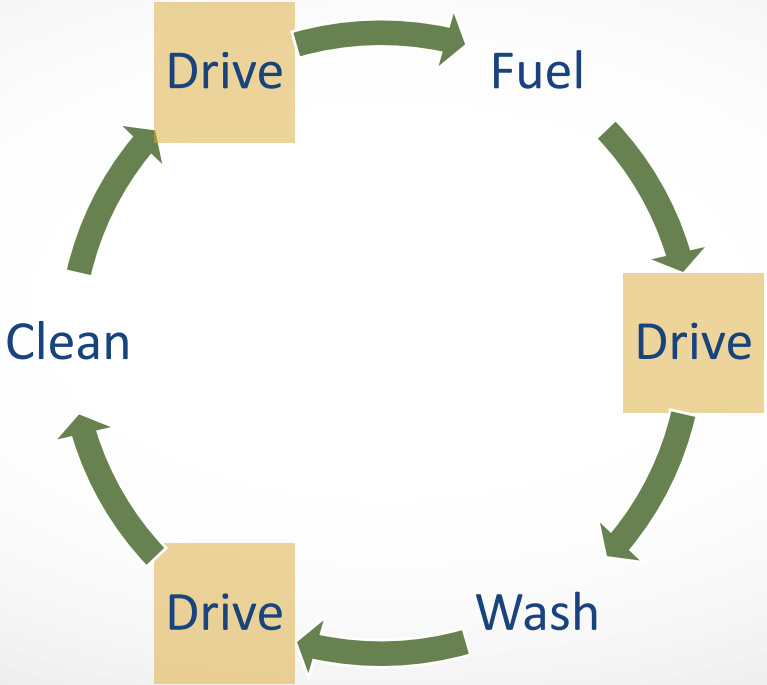
Bus operators' time saved on bus retrieval, vaulting, and parking will be:

Cut from operators' runs

Added back into revenue service

Kept as is, giving operators more time to conduct their bus inspections

Q5: Bus Service Person Time Savings



Use Case #1: Q5

The time saved on bus yard maneuvers between bus-readying tasks will:

Reduce the labor hours associated with bus-readying tasks

Allow service people more time to perform their tasks or do additional tasks

Q6: Yard Space

Current Configuration

Possible Automated Yard Configuration

Source:
Peirce et al. (2019). *Assessing the Transit Agency Business Case for Partial and Full Automation of Bus Services*. TRR vol 2673(5), p. 117

Use Case #1: Q6

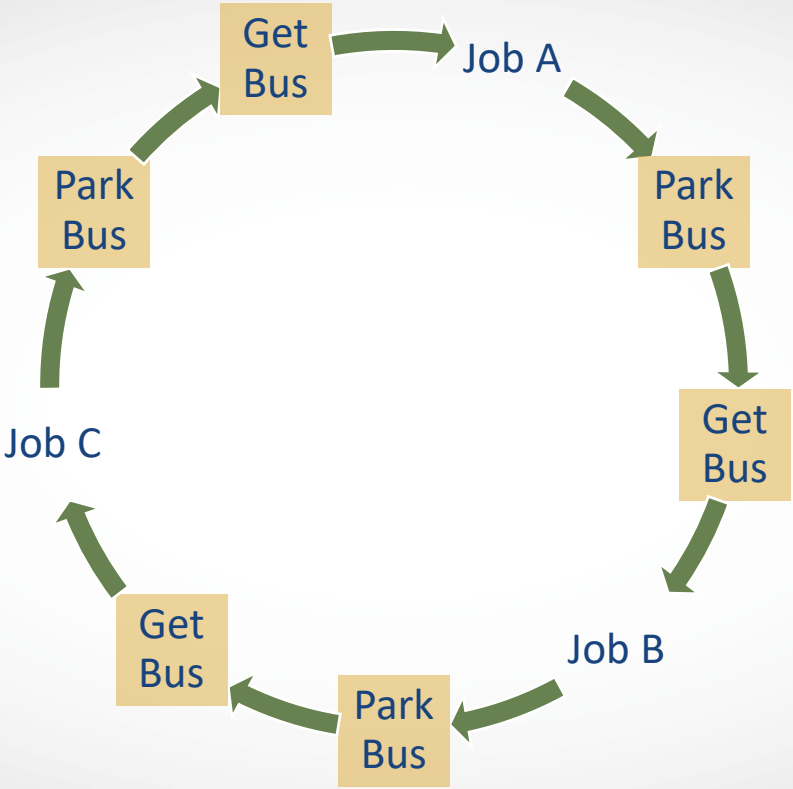
The potential yard space saved will be used for:

Increasing bus yard capacity

Doing nothing--agencies would rather not change their yards

Some other way (e.g., adding buildings or selling/re-purposing excess land)

Q7: Bus Mechanic Time Savings



Use Case #1: Q7

The time saved on maintenance yard movements will:

Reduce the labor hours associated with bus maintenance tasks

Allow bus mechanics more time to perform their tasks or do additional tasks

Low-Speed Automated Shuttles

Description / Examples	Operational Impacts

• Vehicles are intended for use without a driver or operator on board.
• Restricted operational design domain (L4):
  • Operation is intended for protected and less-complicated environments.
  • Service is generally limited to 25 mph (or lower), with cruising speeds around 10–15 mph.
• Shared-ride service.
• Shared right of way.
	• Potentially reduce labor costs.
	• Reduce capital and operational costs associated with smaller, lower-capacity vehicles.
	• Expand service coverage in new or currently underserved areas.
	• Replace fixed-route bus services that are currently not cost effective.

Low-Speed Automated Shuttles

Additional Supporting Technology	Demos, Pilots, and Potential Timeline
• Signal Phasing and Timing (SPaT) information through Dedicated Short-Range Communication (DSRC) (optional).	• CityMobil and CityMobil2 projects in Europe. • As of August 2018, more than 260 demonstrations and pilots (with some planned, some ongoing, and some completed) worldwide. • Many low-speed automated shuttle pilots are currently operating in the U.S. • Low-speed automated shuttles will likely have the shortest implementation timeline.

Low-Speed Automated Shuttles

Assumptions of Workforce Impacts	Directly-Impacted Transit Jobs
• Presence or absence of a human safety driver or operator. • Reduction in labor hours spent on maintenance.	• Bus operator (fixed-route only). • Bus mechanic/maintenance technician. • Bus service person/fueler/cleaner.

USE CASE 2 POLL QUESTIONS

When answering these questions:

- Think of the transit agencies in the type you're answering for (don't limit your answer to just what *your* agency would do)
- Assume that funding is not a limitation
- Assume the technology is fully mature and safe
- If the use case could apply to your agency type, assume it is actually deployed

Use Case #2: Q8

How likely is it that low-speed automated shuttles would be used at your transit agency?

Very likely

Very unlikely

Not sure

Q9: Replace vs. Create

+	−
Create new service	Replace current service

Use Case #2: Q9

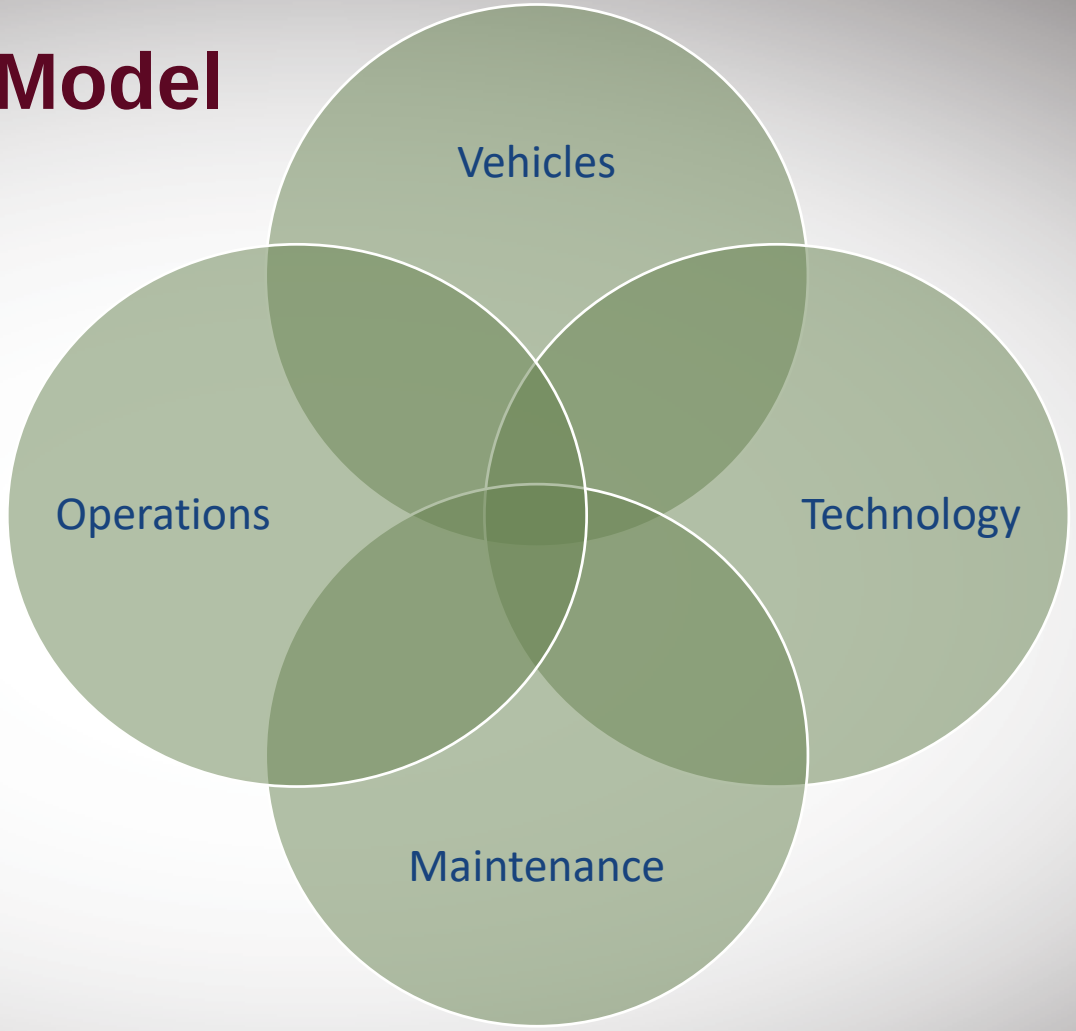
Transit agencies will mainly use automated shuttles to:

Replace current feeder or circulator routes

Create new services, causing minimal impact on current transit routes

BOTH replace current services and create new services

Q10: Delivery Model



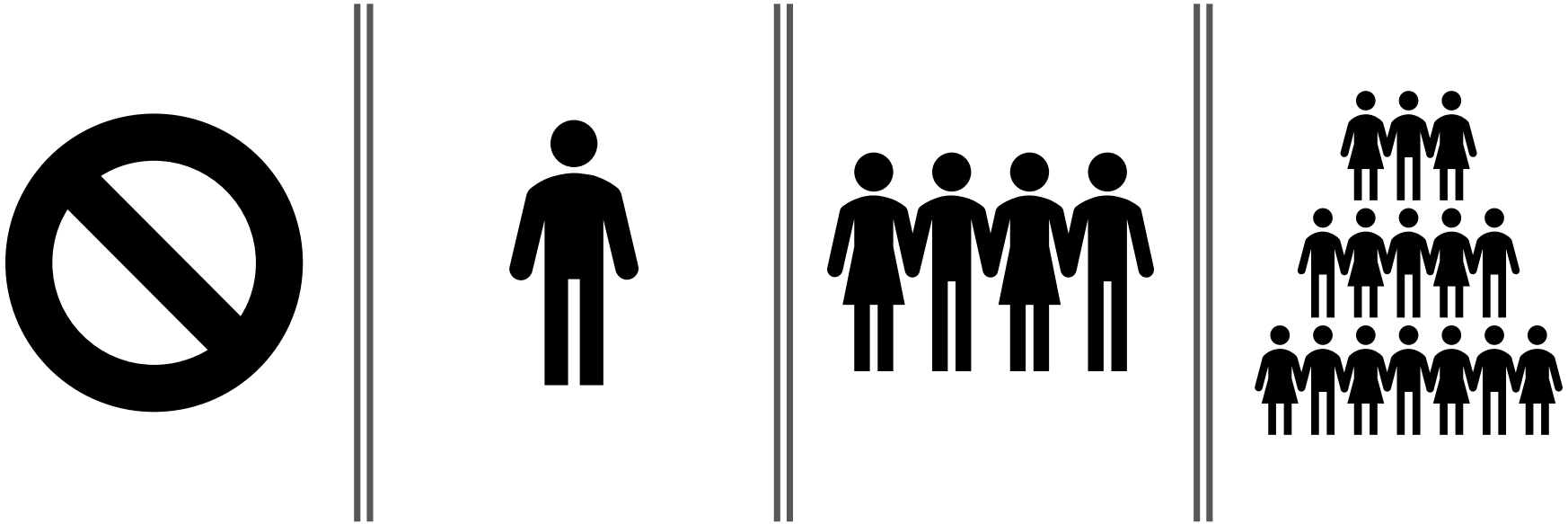
Use Case #2: Q10

Automated shuttle services will be:

Turnkey: private firms provide transit agencies with shuttles, technology, maintenance, and operations staff

Robots-as-a-service: private firms provide shuttles, technology, and maintenance; transit agencies provide operations staff

Traditional: transit agencies buy/lease shuttles from vendors/OEMs and provide maintenance and operations staff



Q11: Dedicated Human Positions

Use Case #2: Q11

Will dedicated positions for human operators/attendants be needed, and, if so at what position-to-vehicle ratio?

Yes--onboard every vehicle	**A**
Yes--but at a reduced ratio (using tele- or stand-by operators)	**B**
No--dedicated positions will not be needed (other staff / tech will handle tasks)	**C**

Q12: In-House Shuttle Maintenance

Use Case #2: Q12

In-house shuttle maintenance will be performed by:

A new classification of bus mechanics mostly or only working on shuttles

Current bus mechanics (after receiving training)

Automated Bus Rapid Transit

Description / Examples	Operational Impacts
• Bus Rapid Transit (BRT) using autonomous vehicles. • BRT is generally considered to be a potential early L4 application and use case due to the designated rights of way. • Could include platooning, in which multiple automated buses are together with a single human driver.	• Reduce labor costs associated with not employing a driver or other onboard attendant. • Increase safety and service availability associated with the additional functions such as lane centering in narrow lanes, precision docking at boarding platforms, and bus platooning. • Require increased maintenance and technician qualifications.

Automated Bus Rapid Transit

Additional Supporting Technology	Demos, Pilots, and Potential Timeline

• Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) connectivity for platooning and for traffic signal prioritization.	• Automated BRT will be an early testing and pilot use case for bus transit automation because of the control that can be exercised over the application.
	  • 2014: CityPilot project based on the Mercedes-Benz Actros Truck with Highway Pilot (Netherland)
	  • 2019: East Japan Railway Company's BRT Lines (Japan)
	  • 2020: Port Authority of New York and New Jersey's demonstration of bus platooning on the Exclusive Bus Lane
	• FTA STAR Plan indicates an intent to demonstrate automated BRT in FY 2021-2022.

Automated Bus Rapid Transit

Assumptions of Workforce Impacts	Directly-Impacted Transit Jobs
• Presence or absence of a human safety driver, operator, or vehicle attendant. • Increase in labor hours related to inspection, maintenance, repair, and cleaning of automation-enabling vehicle systems. • Changes in dispatcher/controller duties. • Changes in road/street supervisor duties.	• Bus operator (BRT operators only). • Bus mechanic/maintenance technician. • Bus service person/fueler/cleaner. • Dispatcher/controller (BRT staff only). • Road/street supervisor or traffic controller (BRT staff only).

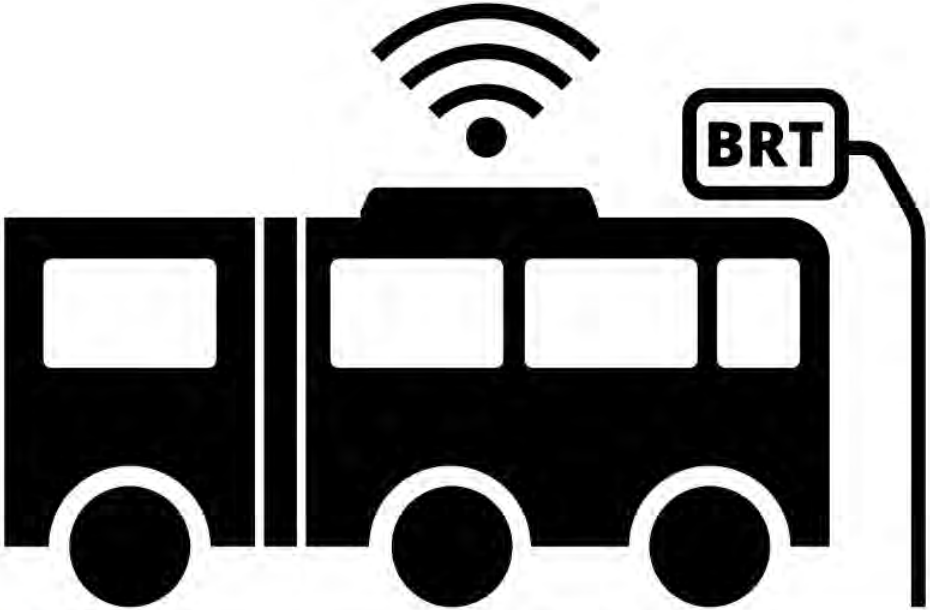
USE CASE 3 POLL QUESTIONS

When answering these questions:

- Think of the transit agencies in the type you're answering for (don't limit your answer to just what *your* agency would do)
- Assume that funding is not a limitation
- Assume the technology is fully mature and safe
- If the use case could apply to your agency type, assume it is actually deployed

Use Case #3: Q13

How likely is it that automated BRT would be used at your transit agency type?

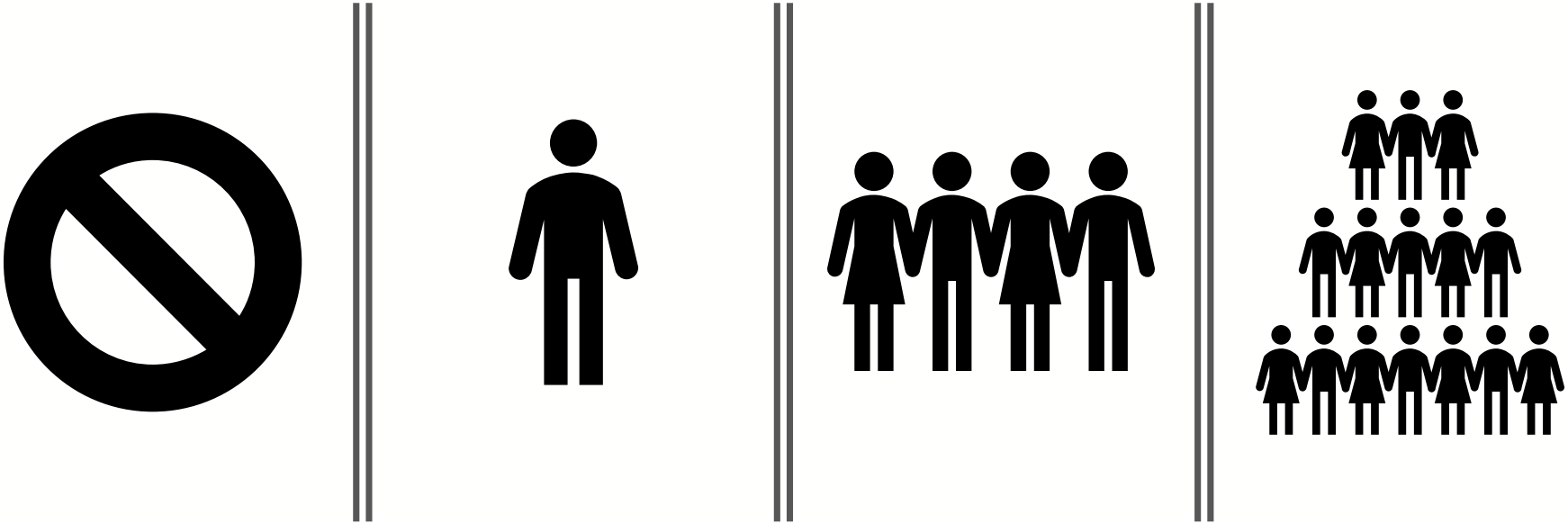


Very likely

Very unlikely

Unsure

My agency type does not / will not have BRT service



Q14: Dedicated Human Positions

Use Case #3: Q14

Will dedicated positions for human operators/attendants be needed and, if so, at what position-to-vehicle ratio?

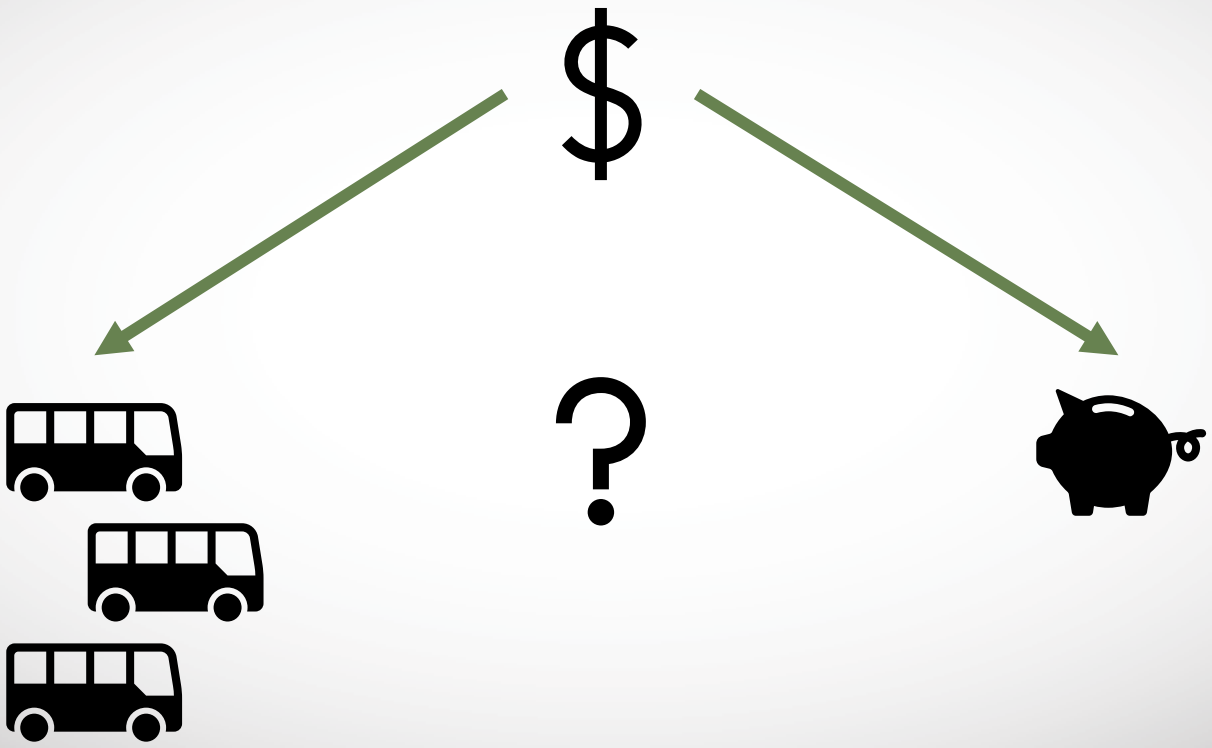
Yes--onboard every vehicle

Yes--but at a reduced ratio (using tele- or stand-by operators)

No--dedicated positions will not be needed (other staff / tech will handle tasks)

My agency type does not / will not have BRT service

Q15: Potential Cost Savings



Use Case #3: Q15

Transit agencies will use the potential operating cost savings to:

Reinvest in service--increasing service capacity (e.g., more buses on a route)

Make other improvements (e.g., improved amenities or customer services)

Reduce reliance on subsidy—the savings will not be reinvested

My agency type does not / will not have BRT service

Q16: Non-Typical BRT Applications

Use Case #3: Q16

Will transit agencies likely use automated BRT in lower-density areas or for non-traditional service models?

Yes

No--automated BRT will be used in traditional service areas/corridors

My agency type does not / will not have BRT service

Q17: Replace vs. Create

+	−
Create new service	Replace current service

Use Case #3: Q17

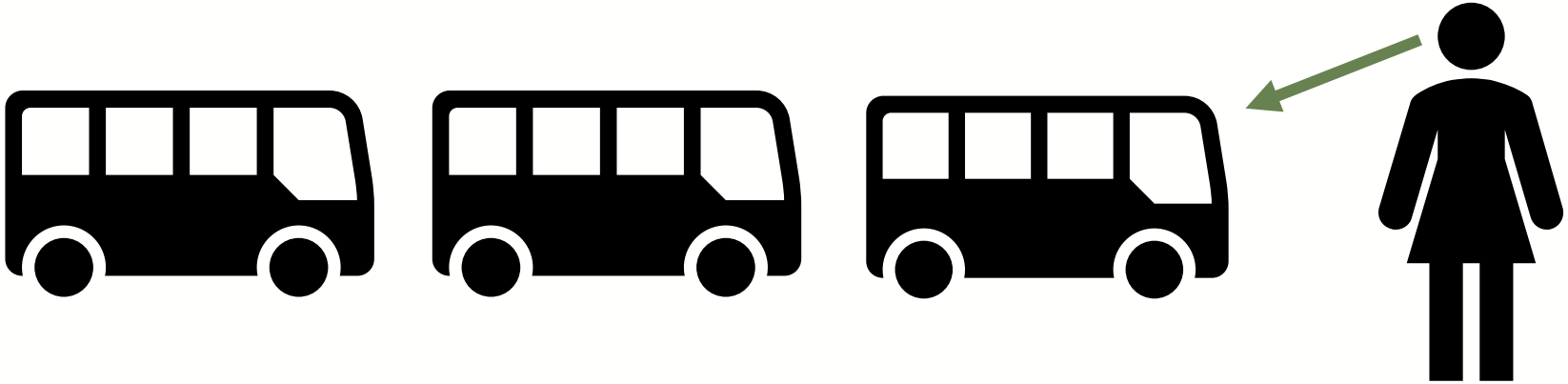
Transit agencies will use automated BRT systems to:

Replace current BRT routes with automated operations

Create new BRT routes, causing minimal impact on current BRT routes

BOTH replace current BRT routes and create new BRT routes

My agency type does not / will not have BRT service



Q18: Platooning

Use Case #3: Q18

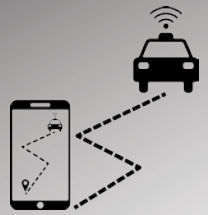
How likely is it that platooning in an automated BRT application would be used at your transit agency type?

Very likely

Very unlikely

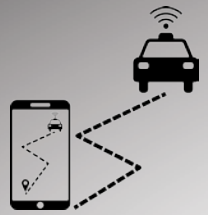
Unsure

My agency type does not / will not have BRT service



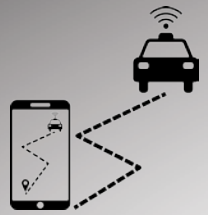
Automated Mobility on Demand (MOD) (Operated by Transit Agency)

Description / Examples	Operational Impacts
• Automated MOD service requires L5 automation to operate on-demand service. • Automated MOD services will provide on-demand service between any two locations within a defined service area. • Key applications for automated MOD service: 1) Automated alternatives to ADA paratransit; 2) Automated first/last mile; and 3) On-demand shared ride.	• The most likely operational model for public transit agencies will be through contracts with private automated MOD providers. • Not significant impacts on vehicle maintenance requirements and tasks. • Automated alternatives to ADA paratransit perhaps require operators or on-board attendants.



Automated Mobility on Demand (Operated by Transit Agency)

Additional Supporting Technology	Demos, Pilots, and Potential Timeline
• Internet of Things (IoT) technology, which helps communications between vehicles and users, automated dispatching, traveler communication, route optimization, pooling, and energy/maintenance management. • Trip management platforms and/or call centers to help customers request trips and to provide customers with real-time information.	• A potential strategy would be for transit agencies to engage in the variety of potential partnerships with private-sector firms. • 2018: Waymo and Valley Metro in Phoenix initiated first/last-mile travel to the Valley Metro's light rail system. • FTA STAR Plan indicates that automated MOD for ADA paratransit service will be finalized by FY 2022.



Automated Mobility on Demand (Operated by Transit Agency)

Assumptions of Workforce Impacts	Directly-Impacted Transit Jobs
• Presence or absence of a human safety driver, operator, or vehicle attendant. • Service replacement vs. service expansion. • Changes in dispatcher/controller duties. • Changes in road/street supervisor duties.	• Bus operator (demand response only). • Dispatcher/controller (demand response staff only). • Road/street supervisor (demand response staff only).

USE CASE 4 POLL QUESTIONS

When answering these questions:

- Think of the transit agencies in the type you're answering for (don't limit your answer to just what *your* agency would do)
- Assume that funding is not a limitation
- Assume the technology is fully mature and safe
- If the use case could apply to your agency type, assume it is actually deployed

Use Case #4: Q19

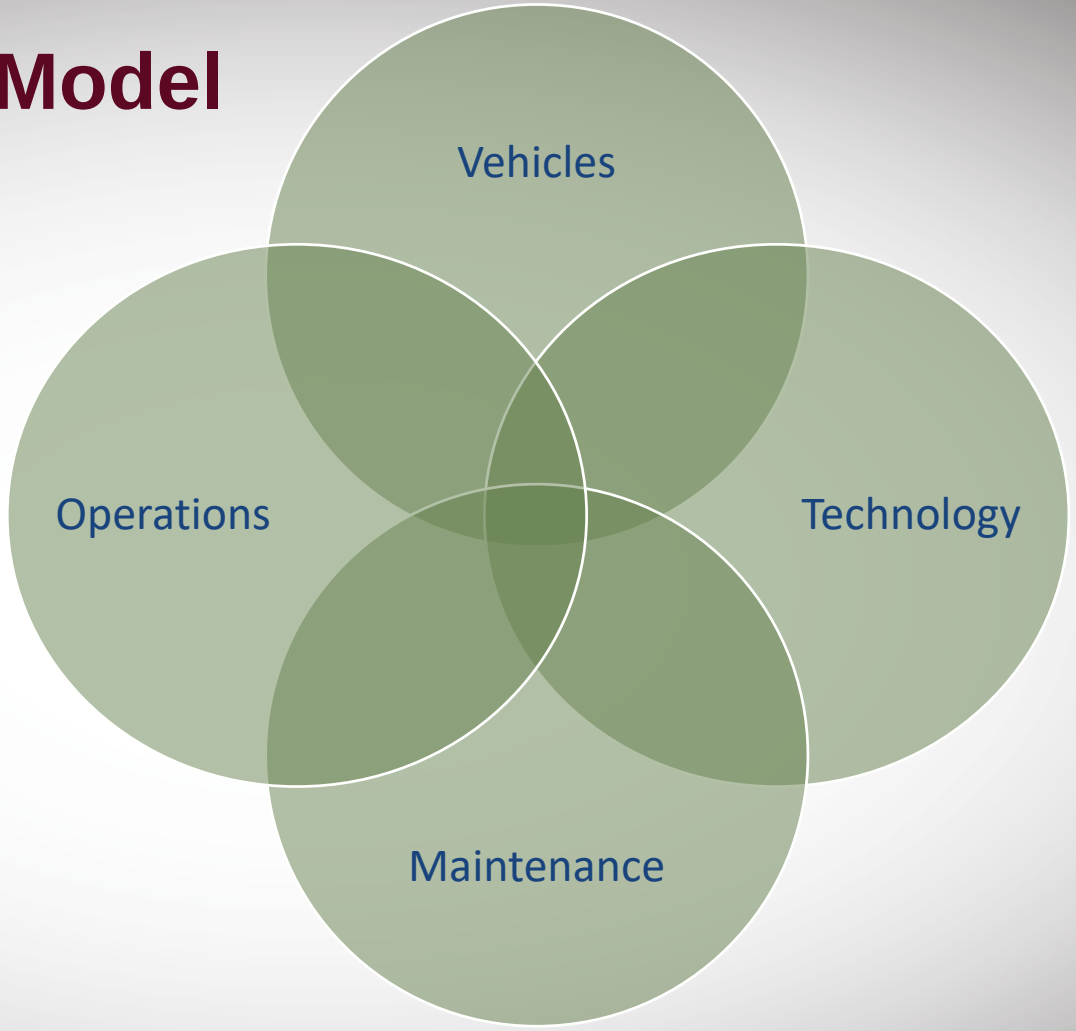
How likely is it that automated MOD would be used at your transit agency type?

Very likely

Very unlikely

Not sure

Q20: Delivery Model



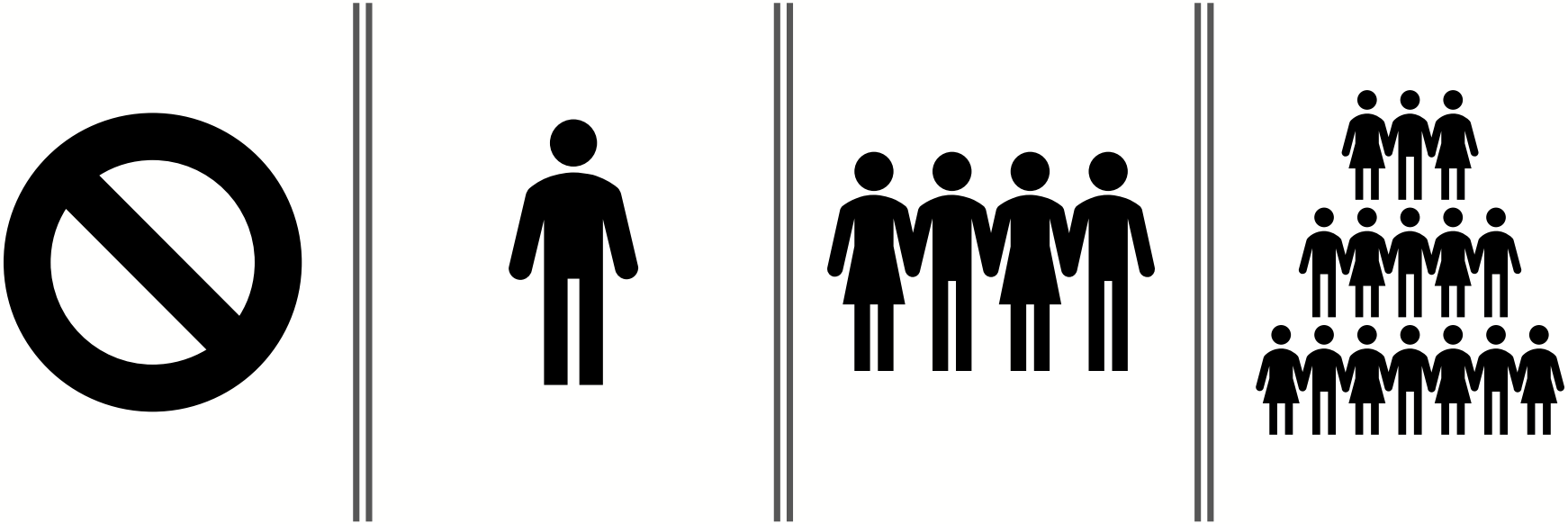
Use Case #4: Q20

Automated MOD services will be:

Turnkey: private firms provide transit agencies with vehicles, technology, maintenance, and operations staff

Robots-as-a-service: private firms provide vehicles, technology, and maintenance; transit agencies provide operations staff

Traditional: transit agencies buy/lease vehicles from vendors/OEMs and provide maintenance and operations staff



Q21: Dedicated Human Positions

Use Case #4: Q21

Will dedicated positions for human attendants be needed and, if so, at what position-to-vehicle ratio?

Yes—onboard every vehicle

Yes—but at a reduced ratio (using tele- or stand-by attendants)

No—dedicated positions will not be needed (other staff / tech will handle tasks)

Q22: Dispatcher / Controller Time Savings

Use Case #4: Q22

The time saved on the management of demand response scheduling will:

Be cut from dispatchers' / controllers' work

Give them more time to perform tasks or handle increased demand

Automated Local Bus Service

Description / Examples	Operational Impacts
• The regular operation of transit buses along a route, stopping at fixed bus stops according to a published timetable.	• Reduce operating costs and crash risks. • Improve headways and time point adherence. • May reduce labor expenses if a human operator is not required.

Automated Local Bus Service

Additional Supporting Technology	Demos, Pilots, and Potential Timeline
• Systems with predefined fixed points, either physically embedded in the infrastructure (e.g., magnets or radio-frequency identification tags) or marked digitally with GPS and geospatial maps. • Interior sensing and communication systems.	• Timeline for the full implementation of the L5 use case is more long term than near term. • Automated Bus Consortium http://www.automatedbusconsortium.com

Automated Local Bus Service

Assumptions of Workforce Impacts	Directly-Impacted Transit Jobs
• Presence or absence of a human safety driver, operator, or vehicle attendant. • Increase in labor hours related to inspection, maintenance, repair, and cleaning of automation-enabling vehicle systems. • Changes in dispatcher / controller duties. • Changes in road / street supervisor duties.	• Bus operator. • Bus mechanic / technician. • Bus service person / fueler / cleaner. • Dispatcher / controller. • Road or street supervisor / traffic controller.

USE CASE 5 POLL QUESTIONS

When answering these questions:

- Think of the transit agencies in the type you're answering for (don't limit your answer to just what *your* agency would do)
- Assume that funding is not a limitation
- Assume the technology is fully mature and safe
- If the use case could apply to your agency type, assume it is actually deployed

Use Case #5: Q23

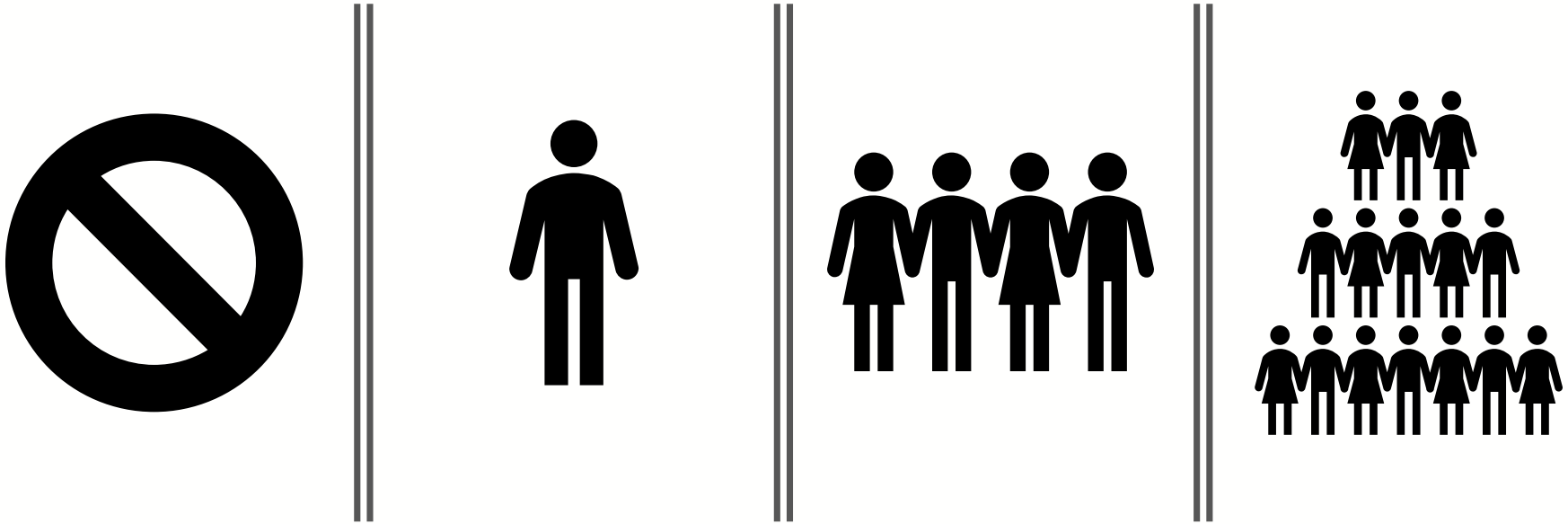
How likely is it that automated local bus transit would be used at your transit agency type?

Very likely

Very unlikely

Unsure

My agency type does not / will not have fixed-route bus service



Q24: Dedicated Human Positions

Use Case #5: Q24

Will dedicated positions for human attendants be needed and, if so, at what position-to-vehicle ratio?

Yes—onboard every vehicle

Yes—but at a reduced ratio (using tele- or stand-by attendants)

No—dedicated positions will not be needed (other staff / tech will handle tasks)

My agency type does not / will not have fixed-route bus service

Q25: Replace vs. Create

+	−
Create new service	Replace current service

Use Case #5: Q25

Transit agencies will mainly use automated local bus systems to:

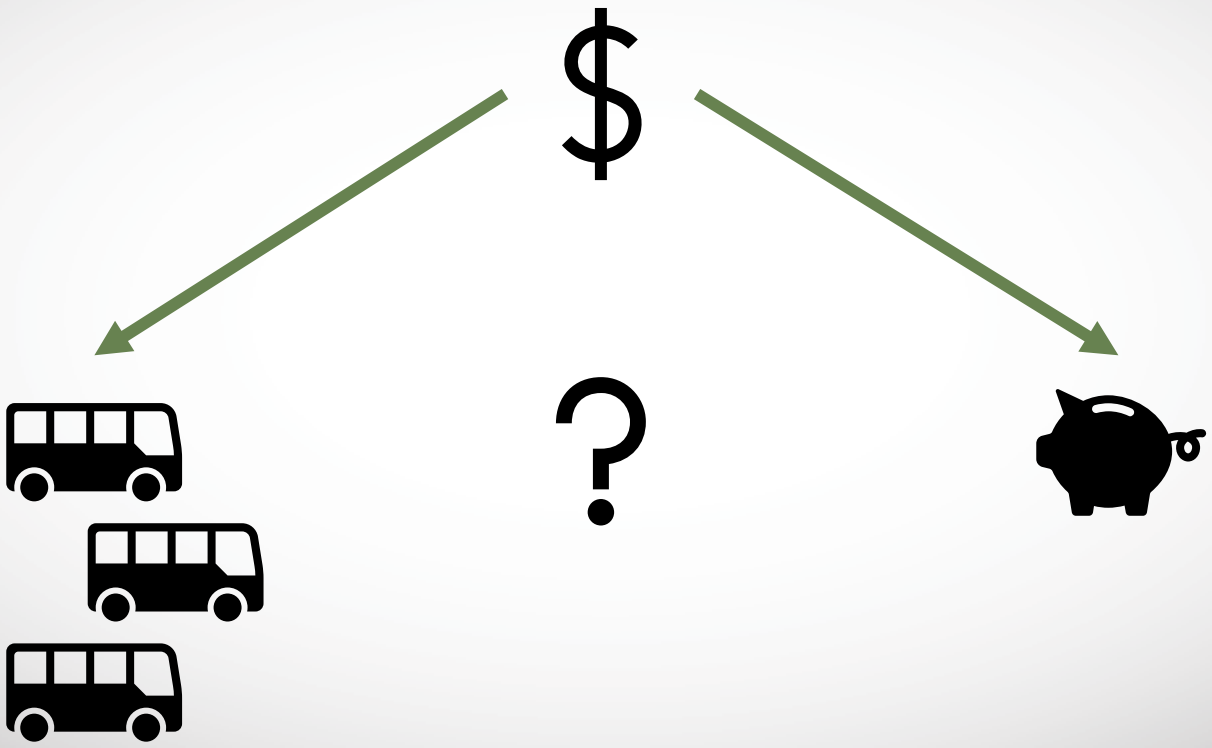
Replace current bus routes with automated operations

Create new bus routes, causing minimal impact on current bus routes

BOTH replace current routes and create new routes

My agency type does not / will not have fixed-route bus service

Q26: Potential Cost Savings



Use Case #5: Q26

Transit agencies will use the potential operating cost savings to:

Reinvest in service--increasing service capacity (e.g., more buses on a route)

Make other improvements (e.g., improved amenities or customer services)

Reduce reliance on subsidy—the savings will not be reinvested

My agency type does not / will not have fixed-route bus service

When poll is active, respond at **PollEv.com/michaelwalk897**

Text **MICHAELWALK897** to **37607** once to join

Which key questions didn't we ask but should have?

Questions & Discuss

Staying Involved

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