The Effects of Automation on the Public Transportation Workforce

Industry Data Collection Webinar
June 18th, 2020
TCRP Project J-11 / Task 34
Introductions
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• 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
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• 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
<table>
<thead>
<tr>
<th>Start</th>
<th>End</th>
<th>Duration</th>
<th>Session Title</th>
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<tbody>
<tr>
<td>2:00 PM</td>
<td>2:10 PM</td>
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<td>Introductions</td>
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<td>2:10 PM</td>
<td>2:20 PM</td>
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<td>Discussion of Foundational Assumptions</td>
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<td>2:20 PM</td>
<td>2:25 PM</td>
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<td>Live Polling – Intro and Training</td>
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<td>2:25 PM</td>
<td>3:15 PM</td>
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<td>Use Cases 1 – 5 Overview and Decision Making</td>
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<td>3:15 PM</td>
<td>3:30 PM</td>
<td>0:15</td>
<td>Q&amp;A and Discussion</td>
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**Agenda**

What are we doing today?
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
<table>
<thead>
<tr>
<th>Directly-Impacted Operations Jobs</th>
<th>Indirectly-Impacted Key Jobs</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Bus operators</td>
<td>• Bus garage superintendent</td>
</tr>
<tr>
<td>• Bus mechanics / maintenance technicians</td>
<td>• Bus operations trainer</td>
</tr>
<tr>
<td>• Bus service persons / fuelers / cleaners</td>
<td>• Maintenance trainer</td>
</tr>
<tr>
<td>• Dispatchers / controllers</td>
<td>• Parts clerk</td>
</tr>
<tr>
<td>• Road or street supervisors / traffic controllers</td>
<td>• Operations and maintenance facilities maintainer</td>
</tr>
<tr>
<td></td>
<td>• Short-range transit planner / schedule maker</td>
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<td></td>
<td>• Transit police officer</td>
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</table>

Automation impact will be quantified

Automation impact will be discussed
New Jobs / New Organizational Structures?

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

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
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
COMMUNICATIONS AND AGENCY INTERFACE
These technologies enable the vehicle to interface with agency systems and communicate with stakeholders, whether they are on or around the transit vehicle.

ACTUATION
These technologies enable vehicle control like acceleration, braking, and steering. In combination with sensing, these also enable lane keeping assistance and precision docking.

EXTERIOR SENSING
These technologies enable the vehicle to sense surroundings and other road users. These also enable automated emergency braking and other safety technologies.

INTERIOR SENSING
These technologies sense occupants and conditions inside the vehicle. They enable and assist agency response to emergency situations, vehicle actions such as smooth acceleration and deceleration, and other features.

LOCALIZATION AND ORIENTATION
These technologies enable the vehicle to orient itself within the environment, including understanding routing and destination.

HUMAN INTERFACE AND FARE PAYMENT
These technologies will link people with the automated vehicle, whether through technology or other servicing.

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?

A. Yes
B. No
C. No and never plan to
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?

<table>
<thead>
<tr>
<th>Rural / tribal</th>
<th>A</th>
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<tbody>
<tr>
<td>Small urban (may also include rural)</td>
<td>B</td>
</tr>
<tr>
<td>Large urban (may also include small urban and rural)</td>
<td>C</td>
</tr>
<tr>
<td>I cannot respond for any type of transit agency</td>
<td>D</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Description / Examples</th>
<th>Operational Impacts</th>
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<tbody>
<tr>
<td>• Automation of bus movements in transit agencies’ operations and maintenance (O&amp;M) facilities.</td>
<td>• Increase efficiency of the O&amp;M facilities.</td>
</tr>
<tr>
<td>• From/To maintenance bays, vehicle storage, parking, washing, and fueling areas.</td>
<td>• Improve safety within the yard.</td>
</tr>
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<td></td>
<td>• Enhance on-time service performance by simplifying yard movement procedures.</td>
</tr>
<tr>
<td></td>
<td>• <em>Not seen by the riders.</em></td>
</tr>
</tbody>
</table>
### Bus Automation for Maintenance and Yard Operations

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

- 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.

### Directly-Impacted Transit Jobs

- 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

- All?
- Some?
- One?
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
- Bus self-vaults (?) & self-parks
- Operator releases bus for storage
- Operator returns to yard; conducts post-trip
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

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

Job A
Get Bus
Park Bus
Get Bus

Job B
Park Bus
Get Bus

Job C
Get Bus
Park Bus
Get Bus
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
### Description / Examples

- 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.

### Operational Impacts

- 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

<table>
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<tr>
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</thead>
<tbody>
<tr>
<td>• Signal Phasing and Timing (SPaT) information through Dedicated Short-Range Communication (DSRC) (optional).</td>
<td>• CityMobil and CityMobil2 projects in Europe.</td>
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<td>• As of August 2018, more than 260 demonstrations and pilots (with some planned, some ongoing, and some completed) worldwide.</td>
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<td>• Many low-speed automated shuttle pilots are currently operating in the U.S.</td>
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<td>• Low-speed automated shuttles will likely have the shortest implementation timeline.</td>
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Low-Speed Automated Shuttles

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

- Vehicles
- Technology
- Operations
- Maintenance
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?

A
Yes--onboard every vehicle

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

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

<table>
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<tr>
<th>Description / Examples</th>
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<tr>
<td>• Bus Rapid Transit (BRT) using autonomous vehicles.</td>
<td>• Reduce labor costs associated with not employing a driver or other onboard attendant.</td>
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<tr>
<td>• BRT is generally considered to be a potential early L4 application and use case due to the designated rights of way.</td>
<td>• 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.</td>
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<tr>
<td>• Could include platooning, in which multiple automated buses are together with a single human driver.</td>
<td>• Require increased maintenance and technician qualifications.</td>
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**Automated Bus Rapid Transit**

<table>
<thead>
<tr>
<th>Additional Supporting Technology</th>
<th>Demos, Pilots, and Potential Timeline</th>
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<tbody>
<tr>
<td>• Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) connectivity for platooning and for traffic signal prioritization.</td>
<td>• 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.</td>
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<td>• 2014: CityPilot project based on the Mercedes-Benz Actros Truck with Highway Pilot (Netherland)</td>
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<td>• 2019: East Japan Railway Company’s BRT Lines (Japan)</td>
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<td>• 2020: Port Authority of New York and New Jersey’s demonstration of bus platooning on the Exclusive Bus Lane</td>
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<td>• FTA STAR Plan indicates an intent to demonstrate automated BRT in FY 2021-2022.</td>
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## Assumptions of Workforce Impacts

- 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.

## Directly-Impacted Transit Jobs

- 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)

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

### Additional Supporting Technology

- 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.

### Demos, Pilots, and Potential Timeline

- 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)

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<td>Presence or absence of a human safety driver, operator, or vehicle attendant.</td>
<td>Bus operator (demand response only).</td>
</tr>
<tr>
<td>Service replacement vs. service expansion.</td>
<td>Dispatcher/controller (demand response staff only).</td>
</tr>
<tr>
<td>Changes in dispatcher/controller duties.</td>
<td>Road/street supervisor (demand response staff only).</td>
</tr>
<tr>
<td>Changes in road/street supervisor duties.</td>
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</table>
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

- Vehicles
- Operations
- Technology
- Maintenance
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

- Handle call
- Book trip
- Book trip
- Handle call
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

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<tr>
<td>• The regular operation of transit buses along a route, stopping at fixed bus stops</td>
<td>• Reduce operating costs and crash risks.</td>
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<tr>
<td>according to a published timetable.</td>
<td>• Improve headways and time point adherence.</td>
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<tr>
<td></td>
<td>• May reduce labor expenses if a human operator is not required.</td>
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</table>
## Automated Local Bus Service

### Additional Supporting Technology

- 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.

### Demos, Pilots, and Potential Timeline

- Timeline for the full implementation of the L5 use case is more long term than near term.
- Automated Bus Consortium
  
  [http://www.automatedbusconsortium.com](http://www.automatedbusconsortium.com)
Automated Local Bus Service

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<td>• Bus operator.</td>
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<tr>
<td>• Increase in labor hours related to inspection, maintenance, repair, and cleaning of automation-enabling vehicle systems.</td>
<td>• Bus mechanic / technician.</td>
</tr>
<tr>
<td>• Changes in dispatcher / controller duties.</td>
<td>• Bus service person / fueler / cleaner.</td>
</tr>
<tr>
<td>• Changes in road / street supervisor duties.</td>
<td>• Dispatcher / controller.</td>
</tr>
<tr>
<td></td>
<td>• Road or street supervisor / traffic controller.</td>
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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
Which key questions didn't we ask but should have?
Questions & Discuss
Staying Involved

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