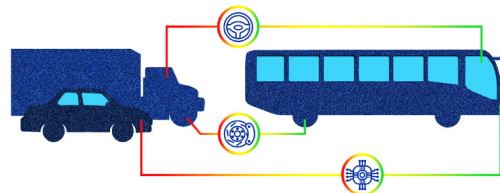




U.S. Department of Transportation  
Federal Transit Administration



# Transit Bus Automation Project: Transferability of Automation Technologies

## Background

This report seeks to answer the question of whether transit buses benefit from the massive research and development investments being made in the passenger and commercial vehicle sectors. It examines the state of the industry and the feasibility of implementing automated systems in transit buses. It explores commercially-available automation systems in light-duty vehicles and commercial trucks, technical and safety challenges of transferring those systems to transit buses, and ways to overcome some of the identified barriers to implementation.

## Objectives

The scope of the report is limited to SAE Level 2 and lower automation systems currently in production for light-duty vehicles and commercial trucks with potential applicability to 40-foot diesel transit buses. This report identifies and characterizes 13 relevant automation systems, then assesses their potential transferability to transit vehicles, and assigns each system a grade (green, yellow, or red) based on an analysis of the extent of modifications required and the severity of safety concerns.

## Findings and Conclusions

*Transferring existing automation systems from other vehicles to buses requires modification, replacement, or redesign of components and systems on the bus; to enable automation systems, the transit bus industry will need to implement foundational and interfacing systems that can support electronic actuation.*

Object Detection and Collision Avoidance (ODCA) systems are most ready for transfer and were graded as Green. It should be noted that ODCA systems can be component inputs to automation systems that were graded as Yellow or Red. Applications using only automated steering were graded as Yellow due to the modification required. Automation of current transit bus brake systems, particularly electronic actuation of braking, is more challenging. Consequently, applications using automated braking or a combination of automated braking paired with automated steering were graded as Red. Relevant automation systems and their grades are included in the table below.

### Relevant Automation Systems and Modification Classifications

Green – Minor Modifications	Yellow – Major Modifications	Red – New Technology Required
<ul style="list-style-type: none"> <li>Object Detection and Collision Avoidance</li> </ul>	<ul style="list-style-type: none"> <li>Lane Keeping/Lane Centering</li> <li>Steering Assist</li> <li>Docking</li> <li>Park Assist</li> <li>Park Out</li> <li>Yard Park</li> </ul>	<ul style="list-style-type: none"> <li>Automatic Emergency Braking</li> <li>Reverse Brake Assist</li> <li>Full Park Assist</li> <li>Valet Parking (Bus Yard)</li> <li>Adaptive Cruise Control with/without Stop-and-Go</li> <li>Traffic Jam Assist with Lane Keeping/Lane Centering</li> </ul>

Transferring existing automation systems from other vehicles to buses requires modification, replacement, or redesign of components and systems on the bus. To enable automation systems, the transit bus industry will need to implement foundational and interfacing systems that can support electronic actuation. Key findings for foundational and interfacing systems include:

- Modifications to **powertrain systems** in support of automation should be more easily made than modifications to other foundational systems (i.e., steering and braking).
- Bus **steering systems** may require more modification, but heavy-duty vehicle steering solutions exist to enable automation and may not require extensive changes.
- Implementation of electronic control of a transit bus **brake system** appears to be a major challenge, as pneumatic brakes found in buses are less conducive to automation and more extensive design changes may be needed.
- Automated applications may require a new **communication system** architecture with bandwidth to carry numerous complex signals reliably.
- Buses will require new **human-machine interfaces** to control automation systems, though these should be relatively easy to design and implement.
- **Sensors** are relatively mature and should be able to be adapted to buses without modification.

## Benefits

A significant part of the FTA research mission is to fund demonstration of transit technologies, with the goal of improving system performance throughout the industry. When considering research and demonstration priorities, FTA may wish to consider not only the relative transferability of an application but also the objectives that federally-supported research and demonstration can serve.

There are other factors to consider beyond the ease and safety of transferring a technology. Transit agencies have particular issues that are conducive to automation solutions (e.g., eliminating gaps at boarding platforms or keeping buses centered in narrow lanes or road shoulders). FTA should consider the importance and value of the problem to be addressed when prioritizing research and demonstration projects. Similarly, some technologies may help reduce operational or other costs (e.g., maintenance and repair or insurance liability) more than others and hence may be more valuable to transit agencies than applications that may be more readily transferable.

## Project Information

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