Autonomous Vehicle Technology and Transit

Jerome Lutin, Ph.D., P.E.

Consultant, APTA Standards Program & Principal, Jerome M. Lutin, PhD, LLC, Monmouth Junction, NJ

Former Senior Director, Statewide & Regional Planning, NJ TRANSIT (retired)
Federal Transit Administration
National Transit Database for 2013

- Commuter Bus (CB), Motor Bus (MB), Bus Rapid Transit (RB), Demand Responsive (DR)
- 119 Fatalities
- 15,351 Injuries
- Casualty & Liability expenses paid =
- $499,872,628
- Average of $6,187 per bus
In the next five days the bus transit industry will spend $6.8 million in casualty and liability expenses
US Bus and Paratransit Data  2003-2013
Injuries/Million Passenger Miles
Source: Federal Transit Administration
US Bus and Paratransit Data 2003-2013
Injuries per Reporting Year
Source: Federal Transit Administration

- 2003
- 2004
- 2005
- 2006
- 2007
- 2008
- 2009
- 2010
- 2011
- 2012
- 2013
Casualty & Liability Expense in $ millions

US Bus and Paratransit Data  2003-2013
Casualty & Liability Expense
Source: Federal Transit Administration
Casualty and Liability Claims are a Huge Drain on the Industry

• For the 10 year period 2004-2013, more than $4.8 Billion was spent on casualty and liability claims
• For many self-insured transit agencies these expenses are direct “out-of-pocket”
• Large reserves for claims must be budgeted
• Claims experience is reflected in insurance premiums
• There are gaps in data reporting
Costs of Bus Crashes – Industry Wide

Tangible – reported as casualty and liability expense

- Physical damage insurance premiums
- Recovery of physical damage losses for public liability and property damage insurance premiums
- Insured and uninsured public liability and property damage settlement pay outs and recoveries
- Other corporate insurance premiums (e.g., fidelity bonds, business records insurance)
Costs of Bus Crashes – Industry Wide

Tangible -likely not reported as casualty and liability expense

- Accident investigation
- Drug and alcohol testing
- Emergency services response
- Hearings and discipline
- In-house legal services
- In-house vehicle repair
- Lost fare revenue
- Overtime
- Passenger and service delays
- Sick time
- Spare vehicles and replacements
- Vehicle recovery
Costs of Bus Crashes – Industry Wide

Intangible

• Human loss and suffering
• Media attention
• Good will
This sounds serious, but why are we hearing this in a technology session? Shouldn’t you be presenting this in a safety or insurance session?
There is proven technology that can significantly reduce the number of collisions, injuries, fatalities and claims.

My goal is to make this technology available to the transit bus industry.
Automation - Potential Impact for Transit Collision and Claims Reduction

• Adaptive Cruise Control
• Autonomous emergency braking
• Blind spot monitoring (for vehicles and pedestrians)
• Driver fatigue and attentiveness monitoring
• Lane keeping assistance
• Obstacle detection and avoidance
• Rear collision warning and mitigation
This radar-based function is now enhanced by the addition of Steering Assist, which helps drivers to stay centered in their lane by generating the appropriate steering torque when travelling on a straight road and even in gentle bends.
BAS PLUS® with Cross-Traffic Assist

- Brake Assist BAS PLUS is capable of more than just helping the driver to avoid collisions with vehicles ahead or lessen their consequences in a purely longitudinal direction: the new Cross-Traffic Assist function can also come to the driver's aid when there is a risk of a collision with cross traffic at junctions.
PRE-SAFE® Brake

with pedestrian detection and urban braking function

- Visual and acoustic warning
- BAS PLUS: boosts inadequate braking by the driver as appropriate to the given situation
- PRE-SAFE® Brake: autonomous braking when the driver fails to respond

Detection of pedestrians in the area in front of the vehicle
PRE-SAFE® PLUS: Rear-end Collision Protection

- Using a radar sensor in the rear bumper to monitor the traffic behind the vehicle, PRE-SAFE PLUS provides occupant protection for rear passengers by engaging measures and increasing the brake pressure in order to keep the vehicle firmly braked during a possible rear-end collision.
History and Development of DISTRONIC:
Price reduction, intelligent packaging and availability cross-carline

- **MY 2000**
  - Introduce DISTRONIC
  - Adaptive Cruise Control
  - In package for +$3,700
  - Only available on S/CL

- **MY 2006 - Current**
  - DISTRONIC PLUS
    - Autonomous Braking Intervention
    - In “Driver Assistance Package” with Blind Spot Assist/Lane Keeping Assist $2,950
    - Available Cross-Carline on almost every model

- **MY 2014 - Future**
  - Enhancements to Driver Asst. Package
    - • Steering Assist
    - • BAS with Cross-Traffic Assist
    - • PRE-SAFE Brake with Pedestrian Detection
    - • PRE-SAFE PLUS – protection during rear collisions

    In “Driver Assistance Package” with Blind Spot Assist/Lane Keeping Assist +$2,800
    Only available on S/E
These Systems are Reducing Claims

“Compared to other midsize luxury SUVs, it is estimated that the XC60 bodily injury liability claims frequency was reduced by 33 percent with City Safety.” (IIHS, 2015)

Vehicles rated “Superior” in front crash avoidance by the Insurance Institute for Highway Safety

• Cadillac ATS sedan and SRX crossover-utility vehicle
• Mercedes-Benz C-Class sedan
• Subaru Legacy sedan and Outback wagon
• Volvo S60 sedan and XC60 crossover
Can’t we already buy this stuff?

• Some technology is available for buses:
  – Audible warnings for pedestrians
  – Advance driver warnings of imminent collisions
• Warnings have limited effectiveness
• We need autonomous responses to assist drivers
• What works in autos could be dangerous in buses, especially with standing passengers
• We do not have specifications to easily procure this stuff
Why do we need automated systems?

• An operator typically needs two to three seconds to respond to an imminent collision and apply the brakes.

• In two to three seconds, at 30 mph, the bus will travel between 90 and 135 feet, about two to three bus lengths, before the brakes are applied.

• Autonomous systems can cut that time to near zero.
Business Case for Collision Avoidance Technology Based on 2013 average of $6,187 in casualty & liability expenses per bus

<table>
<thead>
<tr>
<th>Example Equipment Price Point</th>
<th>Percent Claims Reduction Achieved</th>
<th></th>
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<tr>
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Recommendations
Prepare for Technological Evolution and Obsolescence

- Buses last from 12 to 18 years or more
- Computer technology becomes obsolete in 18 months to two years
- Expect to replace components and systems several times during the life of a bus
- Do not expect replacement parts to still be available
- Sometimes stuff does not work as expected
Need Open Architectures and Standards

• Avoid problems of legacy systems and sole source procurements
• Modular systems and components
• Standard interfaces between systems and components
• Multiple sources and innovation from vendors
• “Plug and play”
Collision Avoidance Logic

Timing and Calibration

Alert/Warning Messages

Vehicle Controls Braking/Steering/Throttle

Vehicle Systems Status Brake Pressure/Front Wheel Angle/Wheel Slip/Engine RPM

Data Logger

On-Board Collision Pending Sensors

Vehicle Position & Dynamic Status Sensors Accelerometers/Gyros/GPS

Connected Vehicle Communications

Bus Collision Avoidance Reference Architecture
Proposal Title:
Application of Autonomous Collision Avoidance Technology to Transit Buses to Reduce Claims, Injuries and Fatalities

Submitted by
Princeton University
In association with:
American Public Transportation Association
Greater Cleveland Regional Transit Authority
Washington State Transit Insurance Pool
Jerome M. Lutin, PhD, LLC
Project Goals and Objectives

• Expedite the introduction of autonomous bus collision avoidance technology to the transit bus industry
  – Create industry coalition and expert working groups
  – Provide tools for transit agencies to account for the full costs of collisions
  – Develop the unique requirements and specifications that will enable procurement of this technology for buses
  – Develop testing and certification procedures and systems
1. Create a broad, inclusive stakeholder group of transit agencies and other members of the transit industry, and achieve a comprehensive view of the problem and potential solutions from all sides

- representatives of transit agencies
- risk management and insurance providers
- consultants
- vehicle manufacturers
- systems developers
- standards organizations
- vendors
- motor vehicle regulators
- USDOT officials
Expert Technical Working Groups (ETWG’s)

- Claims analysis and data collection
- Human factors/operations/safety
- Bus interfaces/systems/maintainability
- Autonomous systems and controls
- Testing and certification
2. Conduct a research assessment of why casualty and liability claims are increasing and determine the potential for automated collision avoidance systems to reduce fatalities, injuries and claims

- historical trends
- reasons that the costs of collisions are increasing
- relationship between costs and types of accidents
- link individual claims and other expenses with individual incidents
- assemble an accurate record of the total agency cost of each collision
- identify cost-effective autonomous collision avoidance technologies
3. ETWG’s develop functional requirements and standards to allow installation of autonomous collision avoidance technology (ACAT) and driver assist technology on new transit buses and retrofit of existing buses

• define the capabilities and performance requirements for autonomous collision avoidance technology for buses

• allow autonomous collision avoidance technologies to be retrofitted to buses, using competitive procurements and “plug and play” interfaces

• balloted set of standards for autonomous collision avoidance technology and for the electromechanical and data on-board interfaces needed to host the technology
4. Develop a prototype test bed that would allow developers of innovative collision avoidance and driver assist technologies to work with transit agencies and researchers to expedite development and deployment

- on-board test-bed network using electromechanical and data interface standards developed in Phase 3, to accommodate the installation and testing of prototype autonomous collision avoidance technologies

- collision avoidance system simulator that can be installed on a new or retrofitted bus to test the bus’s ability to host, and autonomously respond to inputs from, a collision avoidance system

- data logger and analyzer that will monitor multiple performance parameters of both the bus and the autonomous collision avoidance technology and produce reports that can be used to certify compliance with the performance requirements and standards

- extensive field operational test of all three elements
ENDORLING/SUPPORTING ENTITIES

Washington State Transit Insurance Pool On Behalf of 25 Member Agencies

California Transit Indemnity Pool On Behalf of 33 Member Agencies

Ohio Transit Risk Pool On Behalf of 10 Member Agencies

Virginia Transit Liability Pool On Behalf of 7 Member Agencies

Munich Re America, Inc.
Where do we go next?

- Is this worth pursuing?
- Are we communicating effectively?
- How do we get support from the transit industry?
- How do we get the message to the decision-makers?
- Should FTA give this project funding priority?
Thank You

Jerry Lutin

Jerome.Lutin@Verizon.net