The Implications of Automated Vehicles for the Public Transit Industry

June 22, 2016 Presentation to I-95 Corridor Coalition

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Transit and Autonomous Vehicle Technology

- **Impact of Self-Driving Cars on Transit**
- **Opportunities for Autonomous Driving Technology in Transit**

Impact of Level 2 Technology - Cars

- Jam assist
- Adaptive Cruise Control
- Lane-keeping

- Fewer crashes
- Lower Stress
- Some increase in auto commuting trips

Impact of Level 3 Technology - Cars

- **Automatic Valet Parking**
- **Limited Self-driving – freeways, pre-mapped or programmed routes, good weather**

- **Significant reduction in center city parking time and cost**
- **Drivers safely can do some non-driving activities**
- **Increases in longer auto commuting trips**

Impact of Level 4 Technology - Cars

- **Unrestricted self-driving**
- **Empty vehicle movements permitted**

- **Growth in shared automated taxi services**
- **Non-drivers can make low-cost individual trips**
- **Time spent in motion no longer wasted – in-vehicle experience is transformed**
- **Vehicle trips may exceed person trips**

The Market for Transit

Transit riders generally fall into two categories, captive and choice

- **Captive riders – cannot drive or do not have access to a car**

- **Choice riders - generally do own cars, but choose transit when it can offer a faster, cheaper or more convenient trip. Choice riders can avoid congestion, use time on transit to read, work or sleep, and can avoid parking costs and hassles at their destinations.**

Impact of Self-Driving Cars on Transit

- **Self-driving cars will offer mobility to those transit captives who cannot drive, and, in conjunction with car-sharing, can offer mobility to those who do not have ready access to a car. (30.9 million in US, includes 24.8 million age 10-15 and 6.1 million visually impaired adults)**

- **For choice riders, self-driving cars can offer amenities similar to those of transit in terms of how one can use time while traveling, to read, sleep or work.**

- **According to studies, automated cars could double highway capacity. Couple that with the ability to self-park, and the transit advantage could melt away.**

- **So the impact on many transit systems could be huge.**

Opportunities for Autonomous Driving Technology in Transit - Recommendations

- **Technological Response**

- **Institutional Response**

Potential Impact for Transit – Level 3 Automation

- Co-operative Adaptive Cruise Control
- Lane keeping
- Precision docking

- Increased capacity in high volume bus corridors

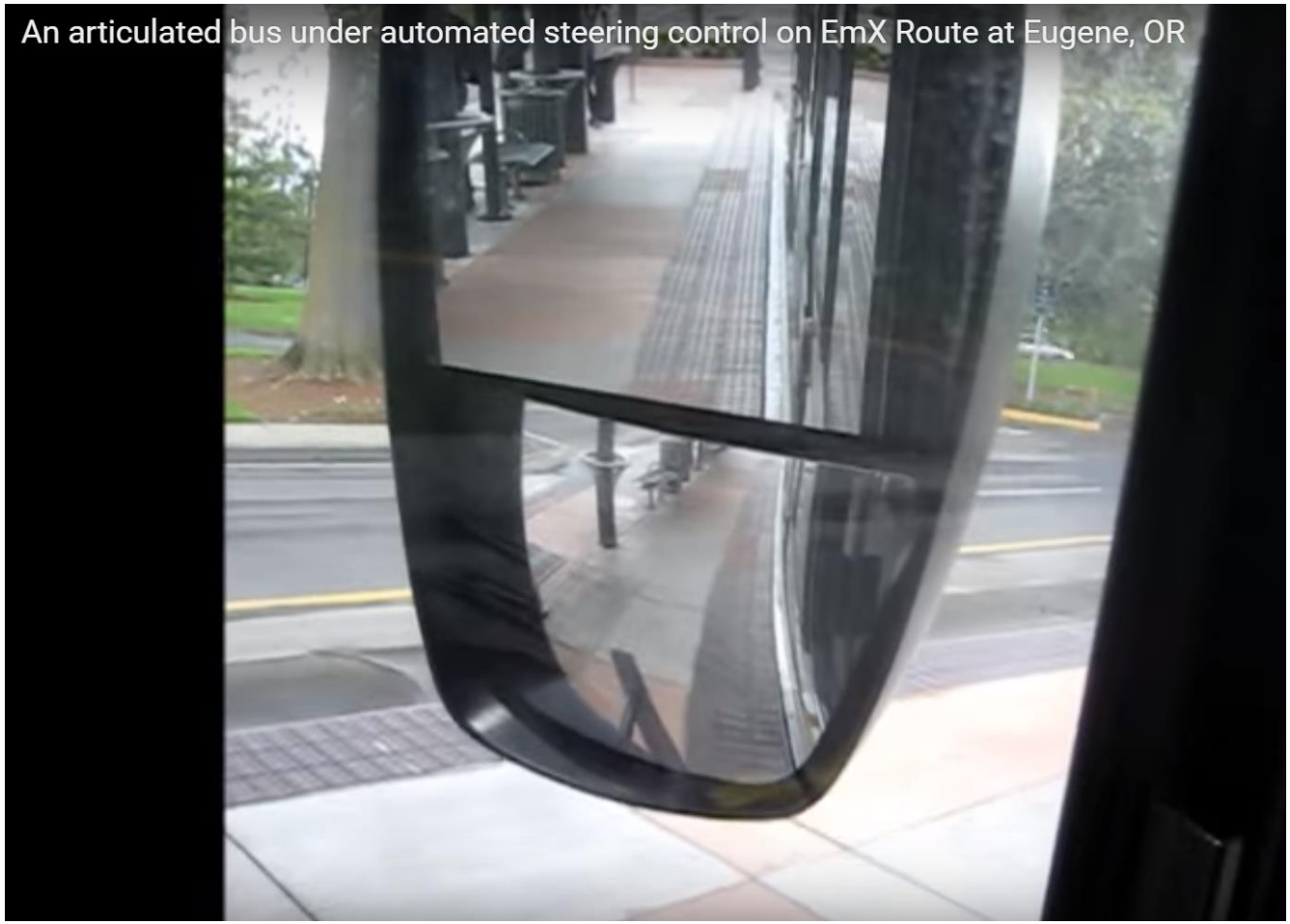
Bus Rapid Transit Technologies: Assisting Drivers Operating Buses on Road Shoulders - Minneapolis

Bus Rapid Transit Technologies:

VAA Test (Oregon): Lane Transit District

Precision Docking + Lane Guidance

Bus Rapid Transit Technologies: Automated Docking Eugene OR



Collisions, Fatalities, Injuries, Casualty and Liability Expenses for Bus and Rail Modes

Source: Federal Transit Administration (FTA) National Transit Database (NTD)

Mode	Reporting Period 2002-2014			Reporting Period 2002-2013
	Collisions	Fatalities	Injuries	Total Casualty and Liability Expenses by Mode
Total Bus, Demand Responsive and Van Pool	85,391	1,340	201,382	$5,753,790,938
Total Rail	6,118	1,303	89,806	$3,174,067,800

Notes: Bus includes Commuter Bus (CB), Demand Responsive (DR), Demand Responsive Taxi (DT), Motor Bus (MB), Bus Rapid Transit (RB), Trolley Bus (TB), and Van Pool (VP). Rail includes Automated Guideway (AG), Cable Car (CC), Heavy Rail (HR), Light Rail (LR), Monorail/Guideway (MG), Monorail (MO), Streetcar Rail (SR), Hybrid Rail (YR). Casualty and liability expenses are included for Commuter Rail (CR); Collisions, fatalities, and injuries are not reported for Commuter Rail (CR).

Washington State Transit Insurance Pool Active Safety Collision Warning Pilot Project

- **$100,000 IDEA grant awarded by TRB**
- **Additional funding from Munich RE America, Government Entities Mutual (GEM), and Alliant Insurance Services**
- **38 transit buses at seven WSTIP member agencies and KC Metro equipped with CAS**
- **Includes comprehensive examination of the total costs of the most severe and costly types of collisions**
- **Evaluate potential for CAS to reduce the frequency and severity of these types of collisions, and reduce the associated casualty and liability expenses**

ROSCO-Mobileye Shield+ System

CENTER DISPLAY & EYEWATCH

OFF

- Center Display
- Contains the Pedestrian Display and EyeWatch.
- The EyeWatch readouts and explanations can be found below on this document.

DETECTION

- Yellow illumination with no sound
- Indicates a pedestrian or cyclist is in front of the moving bus or coming towards the moving bus.
- Operator should exercise additional caution until verifying that the danger of collision has passed.

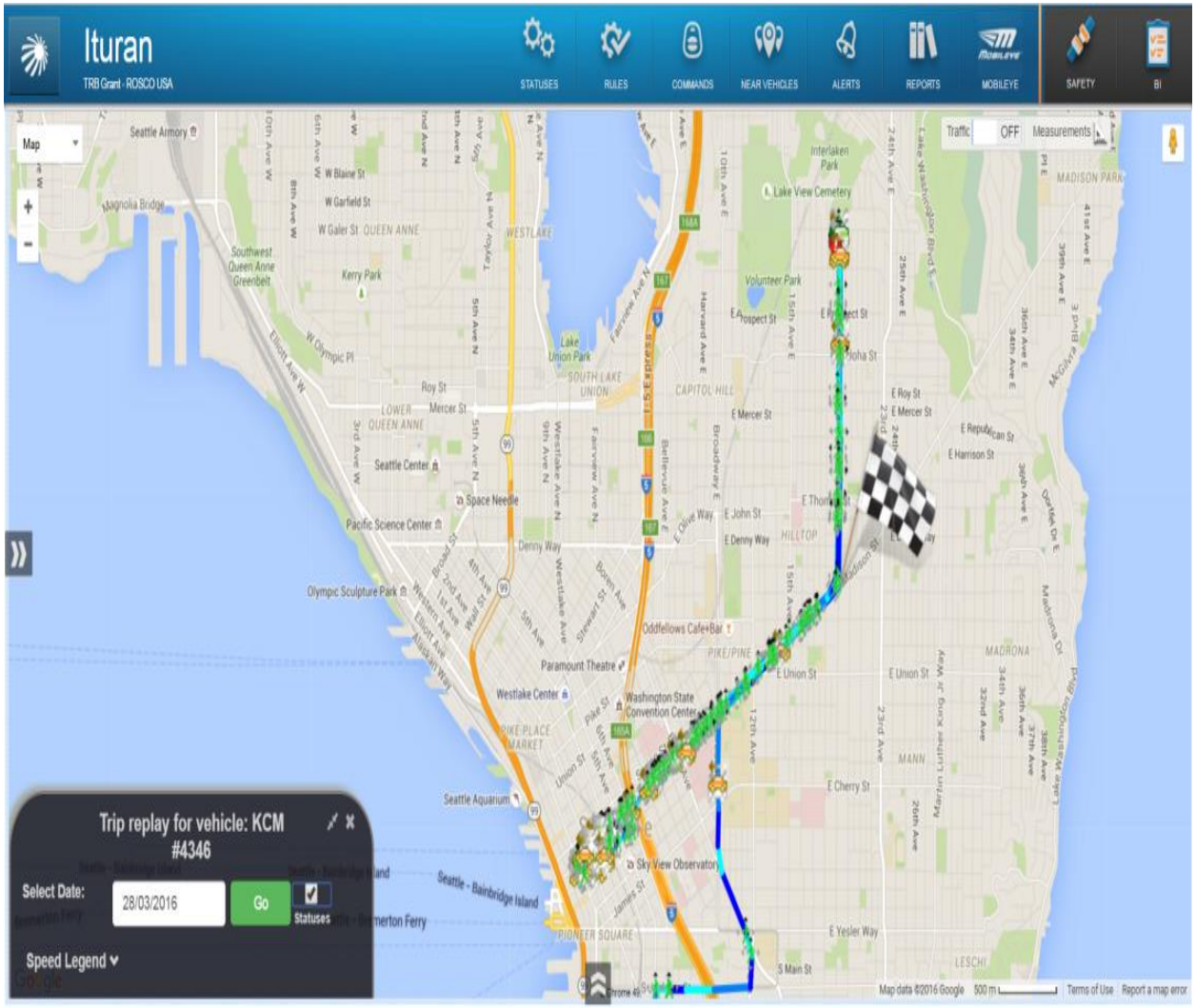
ALERT

- Red flashing with beeping sound
- Indicates a pedestrian or cyclist is in front of the moving bus or coming towards the moving bus and collision is imminent.
- Operator should take action to carefully stop bus to avoid collision.

Telematics and Video

Loc Time	Vehicle name	Heading	Miles	Address	Speed	Status Name	Rule name
6/10/2015 6:24:26 PM	Pierce Bus #516	-	1632.05	900-910 Tacoma Avenue South, Tacoma, WA 98402, USA	-	PCW-LF	ME 4 - PCW - Left Front

Hot Spot Mapping



The Potential Exists for the Cost of Equipping an Entire Bus Fleet with Collision Avoidance Technology (CAS+AEB) to be Recovered by Preventing One Pedestrian or Bicycle Collision

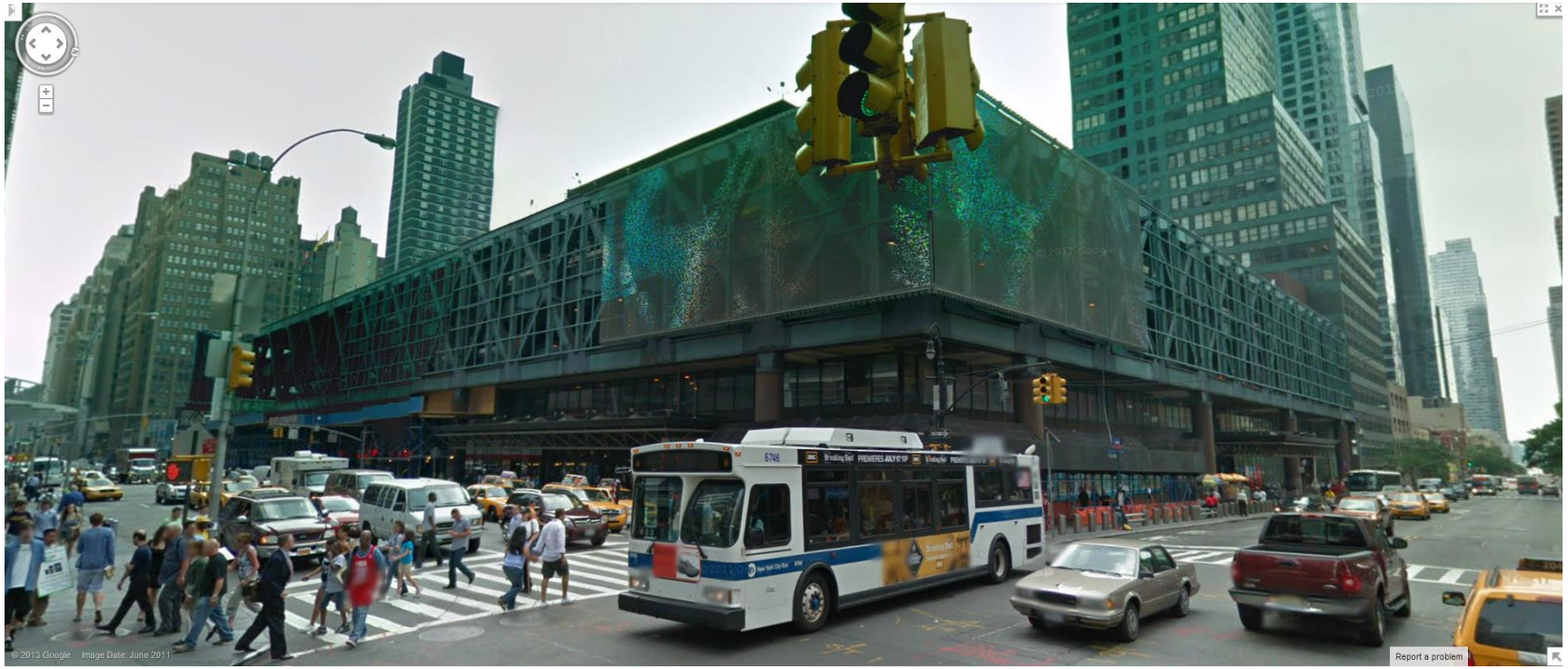
A Capacity Bonus for NJ TRANSIT

Exclusive Bus Lane (XBL) to New York City

Source: Port Authority of New York and New Jersey

Port Authority Bus Terminal (PABT)
New York City

Source: Google Maps 2013



Potential Increased Capacity of Exclusive Bus Lane (XBL) Using Cooperative Adaptive Cruise Control (CACC)

(Assumes 45 foot (13.7 m) buses @ with 57 seats)

Average Interval Between Buses (seconds)	Average Spacing Between Buses (ft)	Average Spacing Between Buses (m)	Buses Per Hour	Additional Buses per Hour	Seated Passengers Per Hour	Increase in Seated Passengers per Hour
1	6	2	3,600	2,880	205,200	164,160
2	47	14	1,800	1,080	102,600	61,560
3	109	33	1,200	480	68,400	27,360
4	150	46	900	180	51,300	10,260
5 (Base)	212	64	720	-	41,040	-

Light Rail is great, but can be $$ expensive

Bus Rapid Transit is much less expensive to build but has less capacity

Potential Impact for Transit – Level 4 Automation – First Mile/Last Mile

- CityMobil2 - European Union project to pilot test automated road transit
- Pilot testing driverless shuttle vehicles across Europe
- Funded at €15 million
- Two sets of six vehicles supplied by two vendors
- Vehicles are battery powered
- Operating speed is typically 8-15 km/hr
- Seating for six with four standees
- Guidance uses GPS and LIDAR


DRIVERLESS VEHICLE
CityMobil2
EZ10
BIOT
LIGIER
robosoft

Citymobil2 Demonstration Trikala Greece

https://www.youtube.com/watch?v=pLsmsTj393o

Recommendation - Transit Institutional Response

- **Exit markets where transit load factors are too low to justify operating a transit vehicle**

- **Concentrate transit resources in corridors where more traffic and parking will be too costly and too congested, and where transit can increase the people carrying capacity of a lane beyond that of a general traffic lane**

- **Promote shared-use autonomous cars as a replacement for transit on many bus routes and for service to persons with disabilities**

Recommendation - Transit Institutional Response

- Promoting development of level 4 automated vehicles to serve the disabled community
- Current ADA paratransit service is TERRIBLE!
  - Reserve 24 hours ahead
  - ADA schedule window +/- one hour
  - Unreliable
- Average operating cost per transit trip - 2014
  - US = $3.68, farebox recovery = 39%
  - NJT=$7.33, farebox recovery = 45%
- Average operating cost per paratransit trip - 2014
  - US = $34.43, farebox recovery = 8%
  - NJT=$63.19, farebox recovery = 3%

Recommendation - Transit Institutional Response- Continued

- **Focus attention on land use – work with partners to create Transit-Oriented Development that limits the need for driving and where trip-end density will provide enough riders**
  - **Create compact activity centers**
  - **Allow higher density**
  - **Promote mixed use development**
  - **Make streets pedestrian and bike friendly**
  - **Manage parking ratios and configuration**

Grandpa, what's a Drivers License?

That's something we needed in the old days before cars drove themselves.

Thank You

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