Field Operational Tests of Vehicle Assist and Automation Technologies

California-Oregon VAA Team

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FTA and RITA JPO Vehicle Assist and Automation Demonstration Program

- ✓ Addresses deployment issues
- ✓ Assesses benefits and costs through revenue-service operations

California-Oregon

- BRT and HOV applications
- Lane guidance and precision docking
- Magnetic and GPS technologies

Minnesota

- Bus on highway shoulder application
- Steering assist
- DGPS technology

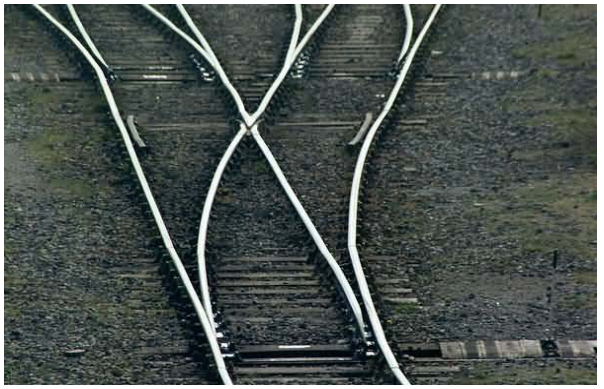
San Diego

- Bus on highway medians
- Lane guidance and collision warning

Vision technology

Why VAA for BRT?

- **Problems and Challenges**
  - Right-of-way purchase costs are high and increasing
  - Transit agencies seek safe and cost-effective transit systems
  - Transit customers demand high-quality transit service
- **Potential Benefits**
  - Reduced right-of-way requirements and infrastructure costs (potential go-no-go decision)
  - Reduced accidents
  - Reduced operating and maintenance costs
  - Smoother ride and level boarding for faster travel and reduced dwell time
  - "Rail-like" status
    - More attractive to choice riders
    - Encourage transit oriented development



Review of Previous Work

- **R&D on AHS**
- **Lane Assist Systems for Bus Rapid Transit: Needs and Requirements**
- **Lane Assist Systems for Bus Rapid Transit: Technical Scan Tour to Europe**
- **Lane Assist Systems for Bus Rapid Transit: Interface Requirements**

Review of Previous Work (Con'd)

- **Automated Bus demonstration in 2003**

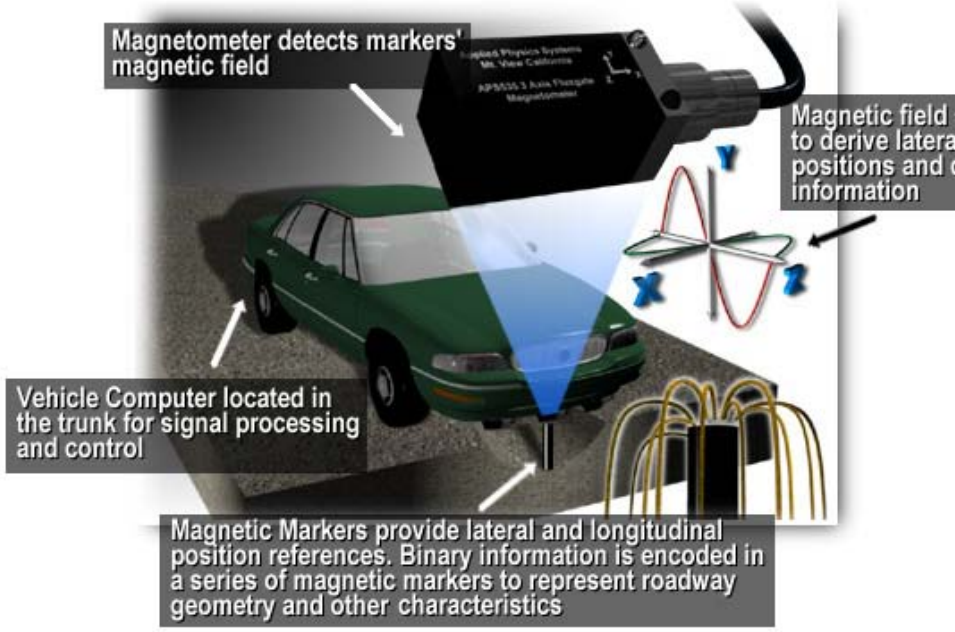
  -- To capture imagination of stakeholders and the public at large, and to energize public and private decision makers toward VAA

  -- Three-bus platoon with fully automated functions

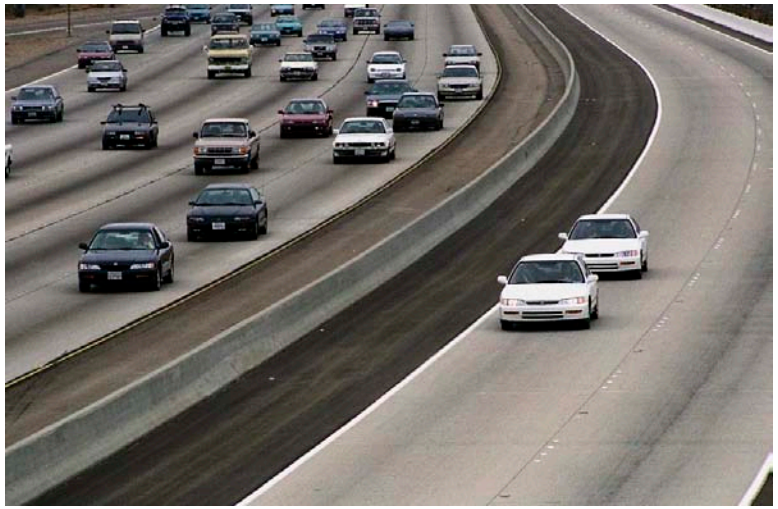
- **Demonstration of Lane Assist and Precision Docking Systems at ITS World Congress 2005 in San Francisco**

Magnetic Marker System

- Subject to interference
  - Missing magnets (detectable)
  - Unwanted magnets (detectable)
- Not compatible with crashed asphalt
- Require infrastructure installation with $10-25k per lane mile
- No maintenance



PATH Development:
Vision-based Guidance Technology



PATH DGPS/INS/Magnet System

Technology Selection

- **Criteria**
  - **Operating conditions**
    - **Weather**
    - **road surface conditions**
  - **Safety and reliability requirements**
    - **Reliability**
    - **Fail-Safe (sensing) vs. Fail-Soft (system)**
  - **Performance requirements**
    - **Tracking and docking accuracy**
    - **Robustness**
  - **Maintenance requirements**
  - **Life cycle costs**
- **Selection:**
  - **Magnetic marker reference/sensing as primary sensing technology (for both AC Transit and LTD applications)**
  - **Combined with GPS to demonstrate fused sensing technologies (AC Transit application)**

VAA Project Background

- Participants
  - FTA, Caltrans, Transit operators (AC Transit & Lane Transit District), UCB/PATH, Industrial subcontractors
- Two guidance technologies:
  - Magnetic sensing
  - DGPS based

Revenue Service (Deployment) →→

- Product Development (Robustness/Reliability)
- Safety: Redundancy Operations (HW/SW)
- Safety: Fault Detection/Operations–All aspects
- Customer Satisfaction (agencies, operators, passengers, contracts, …)
- Re-design for deployment in almost every aspect
- Very little margin for mistakes

- Project goals
  - Demonstrate the technical merits and feasibility of VAA technology applications
  - Access benefits and costs
- Project durations
  - Component development, system integration and refinement primarily in the first two and half years
  - Revenue operation starts 2012

VAA Project Scope

- **LTD, Eugene Oregon**
  - 2.5 miles of single/double dedicated ROW
  - One 60ft New Flyer BRT bus
  - Functions to be tested:
    - Lane guidance for on dedicated BRT lane
    - Precision docking
- **AC Transit**
  - A 3 mile section of HOV lane, on the California Highway 92 freeway from Hesperian Blvd. to the San Mateo Bridge toll plaza
  - Two MCI (50ft) coaches
  - Functions to be tested:
    - Lane guidance on HOV lane
    - Guidance through toll bridge
- **Full range of VAA applications for BRT**
  - Highway and urban BRT applications
  - Precision docking and guidance
  - Very low to highway speed (65 mph)
  - Degrees of driver assist

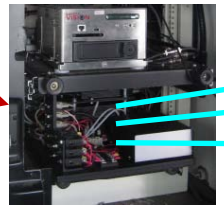
VAA FOT in Revenue Service -- Design & Development for Deployment

- Revenue service elevates design requirements of automated control
  - Apply product development methodologies (reliability + maintainability)
    - Prefer to use embedded controllers and sensors
  - Emphasize on safety design (redundancy + fault detection/management)
    - Fail-safe and fail-soft
- Deployment requires professional installation
  - Installation not to degrade bus normal operations
  - Normal maintenance to be straightforward (visual inspection, fault reporting, data collection)
  - Most repairs could be conducted by transit personnel (spare part replacement)
- Deployment requires the handling of all operational modes
  - Work in all possible operational conditions and scenarios (different drivers, speeds, weather, traffic conditions, transition methods, …)
  - Detect and manage all (known) faults
- Revenue service demands addressing any (new) issues
  - Work through operational and other issues (e.g., policy, legal, institutional) with transit agencies

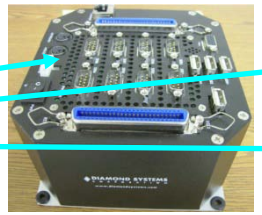
VAA Test (Oregon): Lane Transit District
Precision Docking + Lane Guidance

LTD Automated Bus (New Flyer, 60')
VAA System Installation/Configuration

J1939 connection



Instrument Cabinet



Control computer (2)

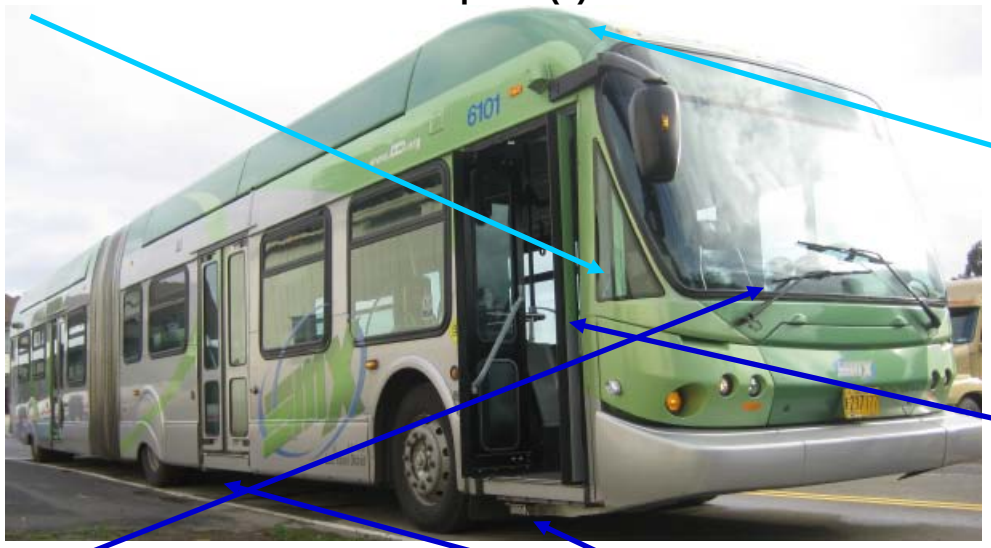
Actuator controller

HMI controller (2)

Buzzer (2)

Indicators (2 sets)

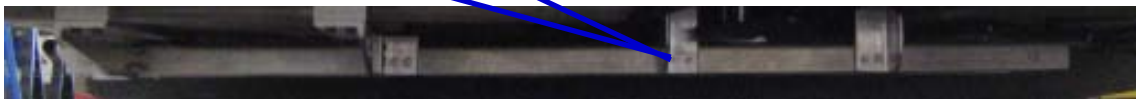
Switch & button



GPS

Steering actuator

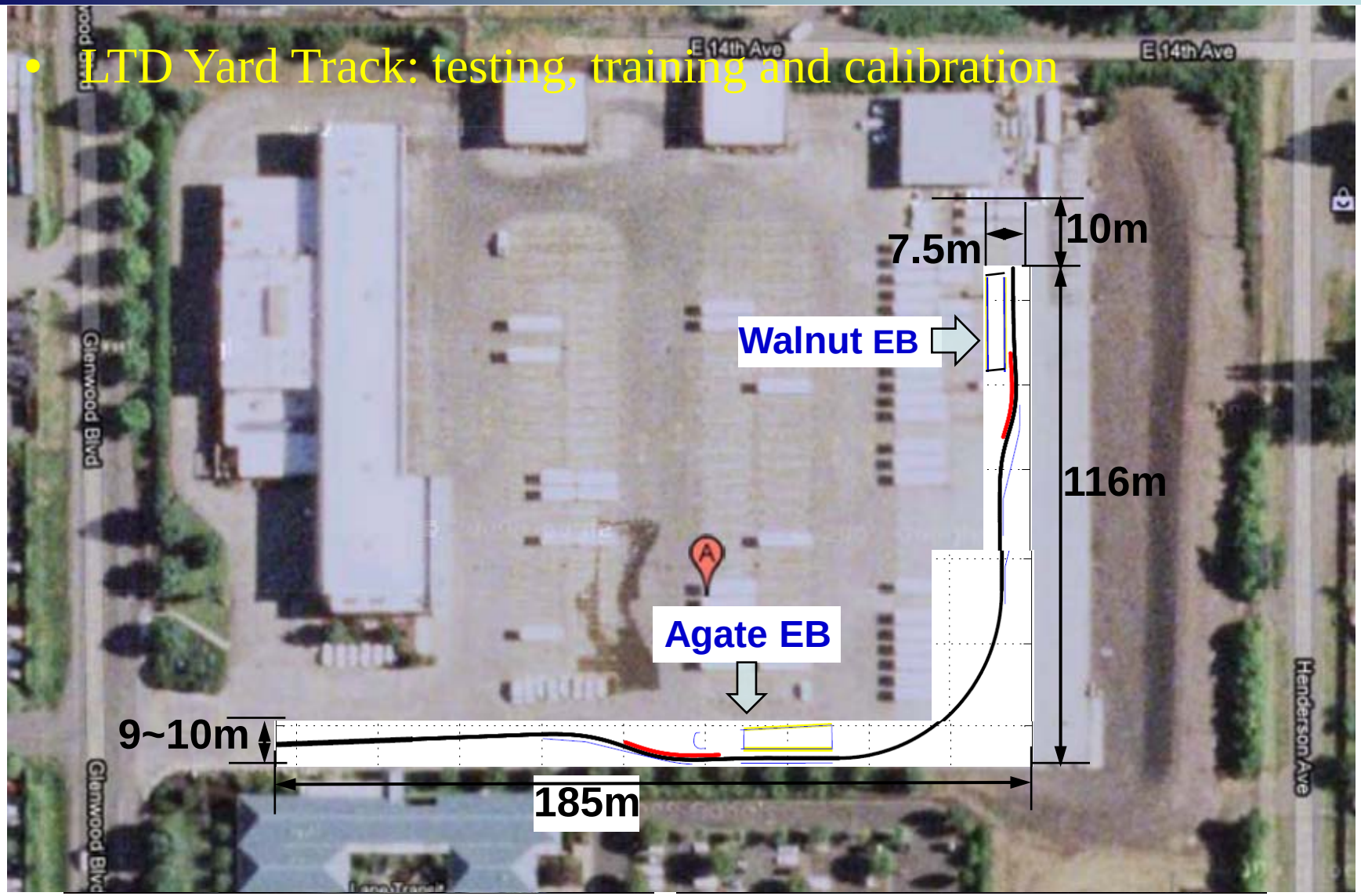
Yaw rate gyro



Front & rear magnetometer sensor bars (2)

LTD Automated Bus Yard Track Results:
LTD First Test Drives

- LTD Yard Track: testing, training and calibration



LTD Automated Bus Preliminary Results:
Docking Performance on Replicated Stations

Testing on BRT Corridor

Summary

- The VAA FOT addresses deployment issues and benefits/costs through revenue-service operation
- California-Oregon team selected magnetic guidance as the primary guidance technology based on thorough evaluation and technical merits
- Full range of VAA applications for BRT is to be field tested
  - **Highway and urban BRT application**
  - **Precision docking and guidance**
  - **Very low to highway speeds (65 mph)**
- FOT will begin in the fall/winter of 2012

Questions

- Please contact Wei-Bin Zhang

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