The Evolution of Transportation in TX through Connectivity and Automation
Agenda

TTI Overview
TX Freight Overview
TX Initiatives
TTI Research
GM Futurama – 1939 Worlds Fair
Legacy
Established 1950
State Agency
Early Focus: roadside safety, pavements, bridges
Current Research Emphases

Technology
CAV
Mobility
Human Behavior
TTI Facts

- Professional Researchers: 400+
- Public and Private Sponsors: 200+
- Students: 200+
- Annual Projects: 700+
- Annual Research Expenditures: $62.5M+
Locations

**Headquarters**
College Station
Bryan

**Urban Offices**
Arlington
Austin
Dallas
El Paso
Galveston
Houston
San Antonio
Waco
Washington, D.C.

**International**
Mexico City, Mexico
Doha, Qatar
2,000 Acres
TTI Facilities
Workforce Development
Industry Collaboration
TTI Move to RELLIS

Spring 2019
Texas Freight Situation

- **Annual projected changes between 2014 and 2040 in TX:**
  - Freight tonnage moved will increase by 46%, from 2.6 billion to nearly 3.8 billion
  - Freight tonnage moved by trucks will double, from over 1 billion to over 2.2 billion
    - Translates to 89% increase in VMT
  - Truck trips increase from 589,000 to over 1 million

- In 2013, Texas had over $1 billion in congestion cost to the trucking industry, ranking only behind California.
  - Dallas ranked 4th with over $406 million
  - Houston ranked 6th with over $373 million

- I-35 through Austin experienced over 116,000 hours of trucking delays in 2013
  - #1 in TX
Texas AV Proving Ground Partnership

www.texasprovinggrounds.org
TX AV Proving Ground Expertise

**TTI**
- Infrastructure, connected automation, operations, human factors, freight, UAVs, deployments

**UT/CTR**
- Travel behavior, GPS and wireless sensing, cybersecurity, policy and regulation

**SwRI**
- Localization, perception, cybersecurity, connected automation, UAVs
TX AV Proving Ground
Urban and Freight Test Bed Locations

- Austin Area — Austin- Bergstrom International Airport and Riverside Drive corridor
- Houston Area — Texas Medical Center, Houston METRO HOV lanes and Port of Houston.
- Dallas/Fort Worth/Arlington Area — UTA campus, Arlington streets, I-30 freeway and managed lanes.
- San Antonio Area — Fredericksburg Road/Medical Drive corridor and bus rapid transit system.
- El Paso Area — Tornillo/Guadalupe Port of Entry.
Texas Connected Freight Corridors  
2017 USDOT ATCMTD Program Award

- **Vision**: to create a sustainable CV environment covering the 865-mile Texas Triangle (including extension to Laredo) to support V2V and V2I safety and mobility applications.

- **On-going success** and support will be achieved by:
  - *Promoting economic efficiency and safety*
  - *Creating Day One benefits*
  - *Minimizing infrastructure costs* to state and local agencies.

Courtesy of TX Dept. of Transportation
Texas Connected Freight Corridors Project

- Proposal: Equip “Texas Triangle” with connected infrastructure technology (IH10, IH30, IH35 & IH45)
  - Equip 1,000 trucks and TxDOT fleet vehicles with on-board technology
- HEB is the flagship partner, approaching others for participation
- Provide freight operators and drivers with info and warnings to improve safety and mobility:
  - Warnings for traffic queues, work zones, low bridge heights, weather (heavy rain, ice, fog), wrong-way drivers
  - Equipped truck will get braking warnings from other equipped trucks
  - Traveler info on traffic conditions, route guidance, border wait times

Courtesy of TX Dept. of Transportation
Public Sector Stakeholders

Project provides opportunities for expansion of public sector stakeholders

Courtesy of TX Dept. of Transportation
Environmental and Emissions Research Facility
Connected Work Zone
Independent Evaluator

Columbus, OH, Smart Cities Deployment

CV Pilots: New York City DOT, Tampa, FL, and Wyoming DOT
Campus Transportation Technology Initiative

- 7.5 million annual transit riders
- 120,000 people on football game days (4th largest downtown in Texas)

smartcampus.tti.tamu.edu
Wrong Way Driving Mitigation
Truck Platooning
What is Truck Level 2 Platooning?

- Extension of cooperative adaptive cruise control
- **Automated and precise lateral and longitudinal vehicle control (L2 automation)**
  - Maintain tight formation
    - Safely follow at short distances
- Lead truck: manually driven
- Following truck(s): driver engaged and monitoring environment and driving task
- Leverages ACC and collision mitigation system
  - Bendix® Wingman® Fusion™
Why Truck Platooning?

- Fuels savings
- Emission reductions
- Safety benefits
- Traffic network benefits
- Driver benefits
- Other
Project Focus

- **Collaboration**: Bring together major partners who have committed resources in terms of in-kind matching of equipment, engineering services, and intellectual property.
- **Feasibility Assessment**: Assess feasibility of deploying 2-vehicle truck platoons on specific corridors in Texas in 5 to 10 years.
- **Implementation**: Performing systems engineering to develop the system, an implementation plan, and deployment guidance necessary for Phase III deployment.
- Outreach, training and knowledge transfer
# Project Structure and Timing

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<thead>
<tr>
<th>Phase-1: Concept Feasibility (Apr 2015 – Aug 2016)</th>
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<td>Feasibility Studies</td>
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- **Phase-2 Decision Gate**
  - August 2016

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<th>Phase-2: Preparation for Implementation (Nov 2016 – Apr 2019)</th>
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<td>Systems Engineering</td>
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- **Phase 3 Decision Gate**
  - April 2019

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<th>Phase-3: Implementation (TBD)</th>
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<td>Field deployment</td>
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Phase 2 research
Functional Safety for Commercial Truck Platooning

• A Highly Complex Cyber-Physical-System

• Safety achieved through:
  – Adoption of “Industry Best” development methodologies (Model Based Systems Engineering)
    • Requirements and Tests Driven, Architecture and Model Based Development, ISO 26262
  – Extensive testing for verification / some validation
    • Extensive verification (especially corner cases) using Virtual Simulations
    • Limited verification through controlled vehicle tests
    • Cautious and objective transition to naturalistic testing
MBSE Process for Commercial Truck Platooning

Desktop: Model In the Loop (MIL) Simulations: Control Algorithm Verification

In-vehicle Testing: Control Algorithm Validation

Desktop: Software In the Loop (SIL) Simulations: Control Algorithm Verification

Lab Testing: Hardware In the Loop (HIL) Simulations: Control Algorithm Verification

Real Time Vehicle Simulator

Rapid Prototyping Controller
Implementation Planning

- Developed initial simulation-based traffic operations guidance
- Work with stakeholders to identify and address “roadblocks” that might limit Commercial Truck Platooning in Texas
  - Governance
  - Regulatory
  - Enforcement
  - Operations
  - Legal
  - Education
  - Outreach
- Impact of Recent AV Legislation
Examples of Truck Trailer Combinations not Included in Platooning Research to Date

- Double Trailer Combinations
- Tankers
- Construction Vehicles
- Truck with Lowboy Trailer
- Commercial Truck and Stringer-Steered Semi-Trailer Combination Transporting Automobiles (or Boats)
- Traditional Boat or Automobile Transporter Combination
- Truck and Pole Combination
- Saddlemount Truck Combination
TTI Freight Shuttle Video
Freight Shuttle System Facts

- Moves over 8,600 shipments per guideway per day
- At full capacity, moves more than 300,000 tons of goods per day in each direction
- Reduces energy consumption by $\frac{2}{3}$ compared to heavy-duty diesel trucks at one-sixth of the cost
- Moves truck trailers and domestic intermodal containers up to 53 feet in length
- Utilizes elevated guideways on existing ROW for distances up to 500 miles
Connected Transportation is Our Future