Only National Laboratory Dedicated Solely to Energy Efficiency and Renewable Energy
• Leading clean-energy innovation for over 35 years

• 1800 employees with world-class facilities

• Campus is a living model of sustainable energy

• Owned by the Department of Energy

• Operated by the Alliance for Sustainable Energy

• Energy Systems Integration Facility – newest national “users facility on NREL campus”
What is Platooning?

- Electronically linked commercial truck driving to take advantage of shared aerodynamic load

- Enabling technologies for platooning
  - Forward object detection
    - Radar
    - Lidar
    - Stereo cameras
  - Vehicle-to-vehicle communications (V2V)
    - Dedication short-range communication (DSRC)
    - 5G
  - Vehicle-to-infrastructure communications (V2I)
    - Cloud
    - Direct road way communication
  - Vehicle braking and torque control interface
  - Driver displays & communication interface
NREL Platooning Research

2014-2018

- Lead or been involved in 3 truck platooning track testing campaigns
- 2 National Impact of platooning Big Data studies
- Correlation of LLNL wind tunnel platooning studies to track studies
- Reanalyzed Volpe “naturalistic” truck driving behavior as relevant to background platooning
- https://www.nrel.gov/transpor tation/fleetest-platooning.html
- ARPA-E NEXTCAR advanced platooning team
- DOE Fuel Efficient Platooning FOA teams

NATIONAL RENEWABLE ENERGY LABORATORY
2017 Truck Platooning Track Test Campaign with LBNL & NRC

- 2017 Truck Platooning Track Test Campaign with LBNL & NRC
  - 26 two & three truck platooning scenarios investigated
    - Aerodynamic sleeper cabs, side skirts and trailer tails were tested
    - SAE J1321 gravimetric fuel measurement procedures
    - J1939 data collection
    - Additional wind/temperature/torque sensing on all trucks
    - Paper presented at SAE World Congress Experience April 2018 with LBNL & NRC
  - Findings match remarkably well to previous NREL & Auburn U. track testing and LLNL wind tunnel findings
  - **Confirms question on true “baseline” of trucks in traffic today**
    - 2% individual truck savings following compact SUV
    - 5-9% trailing truck savings at over 140’ behind tractor trailer
Two and three Vehicle Platooning results.

- Lead vehicles experience the same savings pattern.
- Trailing vehicles experience the same savings pattern, including reduced savings at close following, but 3 vehicle system has larger savings for trailing vehicle.
- Middle vehicle matches trailing vehicle of 2 vehicle platoon beyond 18m, but closer than 18m it has the pattern of the lead vehicle, but at higher savings.
- Maximum Team Savings
  - 7% savings for 2 truck platoon team
  - 13% savings for 3 truck platoon team
“Potentials for Platooning in U.S. Highway Freight Transport”
• Presented at SAE World Congress Experience April 2017
  • SAE Journal Publication
  • Over 3 million miles of high resolution data
  • Over 200 class 8 tractors
  • Vehicle Speed and time duration analysis
• 65.6% of vehicle miles in this dataset can be considered to be platoonable.
• 76.6% of vehicle miles from “early adopter” subset considered platoonable.

“Opportunities for Truck Platooning based on Telematics Data”
• Presented to SAE World Congress Experience April 2018 with Volvo Truck
  • Over 210 million miles telematics data provided by Volvo Truck
  • Over 57,000 class 8 Volvo tractors included
• Average Driving Speed Analysis Results
  • 63% platoonable miles at 50 mph; matches well with previous analysis
  • Top 32% of trucks would account for 54% of the total platoonable miles
• Geospatial Partner Single Day Analysis Results
  • 55.7% of all classifiable miles driven being platoonable (38% unknown)
  • Usually several partners are available if one is
Spatial distribution of platoonable observations with partner considerations

- highest regions of platoonability occur across major shipping corridors and interstate highways
- significant opportunity on Canadian shipping corridors
- 55.7% of all classifiable miles driven being platoonable

<table>
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<th></th>
<th>Platoonable</th>
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<td>34.0%</td>
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<td>55.7%</td>
<td>44.3%</td>
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Volvo platooning partners:

- Usually more than 1
- Peak around 3 partners
- Mean of 10 partners
- Opportunity for 3 and 4 truck platoons needs to be investigated
- Even some level of fleet/technology incompatibility minimal impact on partner availability
So where are we now?

- European Truck Platooning Challenge
- Demonstrations in Michigan I-96, Washington DC, Colorado...
- Most truck OEMs have CAV truck demos
- Semi autonomous “driver assist” platooning is close to market ready
- Level 4/5 driverless systems are a long way off
So where are we now?

• 2018
  o Lots of platooning papers at SAE & TRB conferences
  
o DOE Platooning FOA awards 3d: Fuel Efficient Platooning - - $2.5 million
    – Cummins
      ▪ Advancing platooning with advanced driver assisted systems control integration and assessment
    – American Center for Mobility
      ▪ Fuel-efficient platooning in mixed traffic highway environments
  
o DOT FHWA
    – BAA- Truck Platooning Early Deployment Evaluation, Phase 1 - - $500K
    – Proposals currently being evaluated
Obstacles / Needs

• Technical
  o Sensor & controls refinement stage
  o System interoperability standards
  o Fleet/user cooperation savings sharing

• Regulatory
  o Where can I platoon & when?
  o Who decides?
  o What happens at state lines?
  o Law enforcement knowledge?
Obstacles / Needs

• Liability/Insurance
  o What happens if there is an accident?

• Driver acceptance
  o Sure it saves fuel – but do I know/trust the guy in the lead?

• Public acceptance
  o My mom would panic if she saw 3 trucks driving 20’ apart
  o Other drivers would cut right in between
Opportunity

• Maximum Team Fuel Savings
  • 7% savings for 2 truck platoon team ** about 5.5% to begin with
  • 13% savings for 3 truck platoon team

• Big Data Truck Average Driving Speed Analysis Results
  • 63% platoonable miles above 50 mph; matches well with previous analysis
  • Top 32% of trucks would account for 54% of the total platoonable miles

• Geospatial Partner Single Day Analysis Results
  • 55.7% of all classifiable miles driven being platoonable (38% unknown)
  • Usually several partners are available if one is
  • ****Data set limitations; some fleets could be much higher****

• Safety increase from connectivity & synchronized braking
Opportunity

Truck speed distribution over time

2018 Telematics Big Data Paper Average Driven Speed Results
Opportunity

Truck speed distribution over time

2018 Telematics Big Data Paper Average Driven Speed Results