SuperTruck

Development and Demonstration of a Fuel-Efficient Class 8 Highway Vehicle

Vehicle Systems

DOE Contract: DE-EE0004232

P.I.: Pascal Amar, Volvo Technology of America

2014 Annual Merit Review

Washington, DC

June 19, 2014

Project ID: VSS081

Project Overview

Timeline

Start: June 2011

End: June 2016

55% complete

Barriers

- Cost effective & timely evaluation of advanced components and configurations
- Operational effectiveness & end-user acceptance of advanced concepts

Budget

Total Cost: $38M

Cost share: $19M

Cost to date: $18.3M

Funds to date: $9.1M

Team

Lead: Volvo Technology of America

Partners: VOLVO, Grote, PENNSTATE IBSS, FREIGHT WING, RIDGE CORPORATION

Relevance

- **In support of DOE's mission**

"[…] more energy efficient and environmentally friendly highway transportation […]"

- **Project Objectives**

Objective 1	50% more ton-miles per gallon than a 'best in class' 2009 truck
Objective 1a	50% Brake Thermal Efficiency
Objective 2	55% Brake Thermal Efficiency Concept

- **Reporting Period Objectives**
  - Evaluate candidate technologies on concept vehicle
  - Complete technology selection (Phase I)
  - Start development & integration of technologies into demonstrator (Phase II)

Approach: Technology Selection & Integration

2011	2012	2013	2014	2015	2016

Phase I - Concept Selection

- Baseline Tests
- Techn. Development
- Concepts Evaluation
  - *engine bench*
  - *mule truck*
  - **Concept Truck**
- Model Development
- Validation
- Energy Management Dev.
- Virtual Optimization

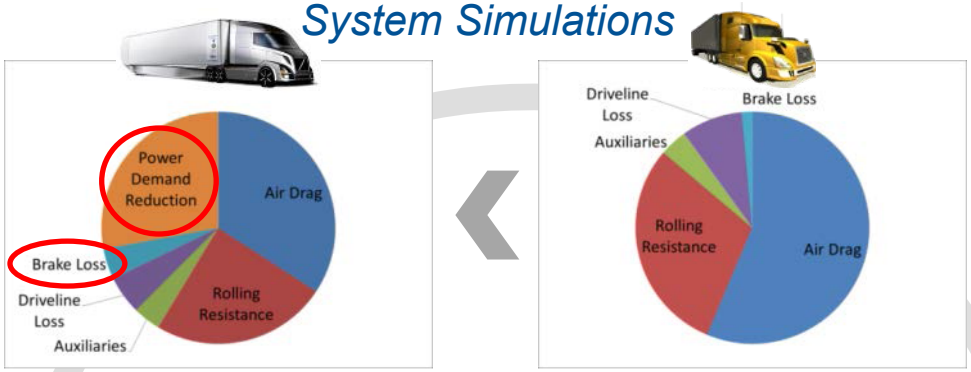
Identify, evaluate and select most promising technologies

Phase II - Development & Integration

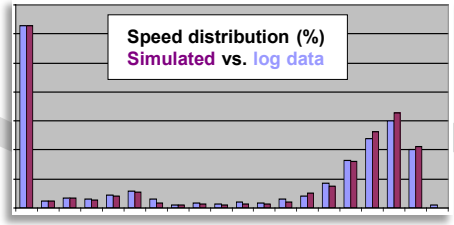
- Techn. Refinement
- Validation
- *engine bench*
- Integration
- *demonstrator chassis*
- Optimization
- **Demo Truck**

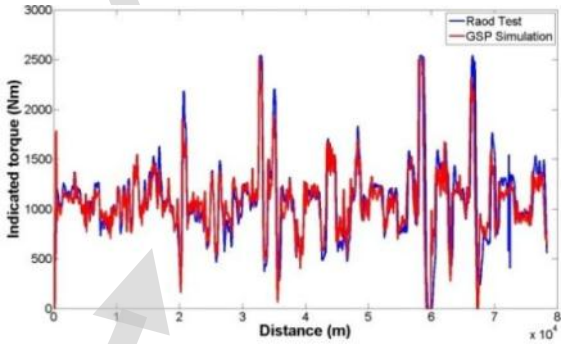
Designing for real operating conditions

System Simulations



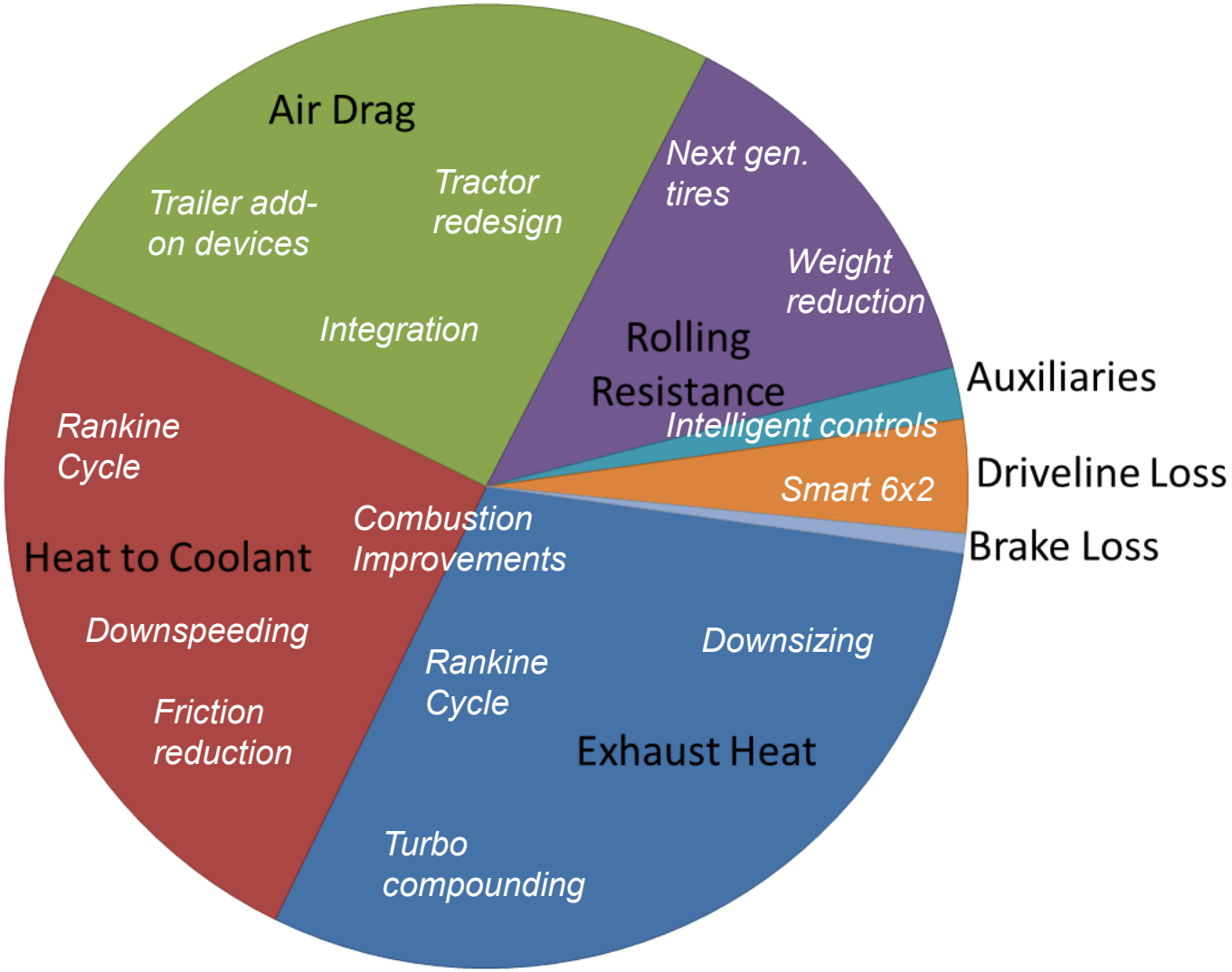
>1 billion miles of logged data



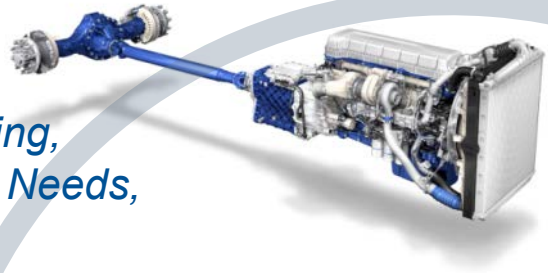


Customer Duty Cycles

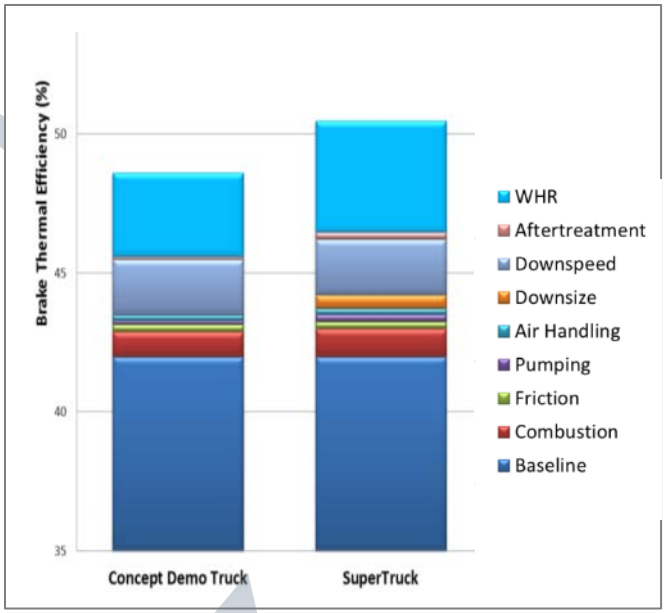
Typical Fuel Energy Analysis (Long-Haul)

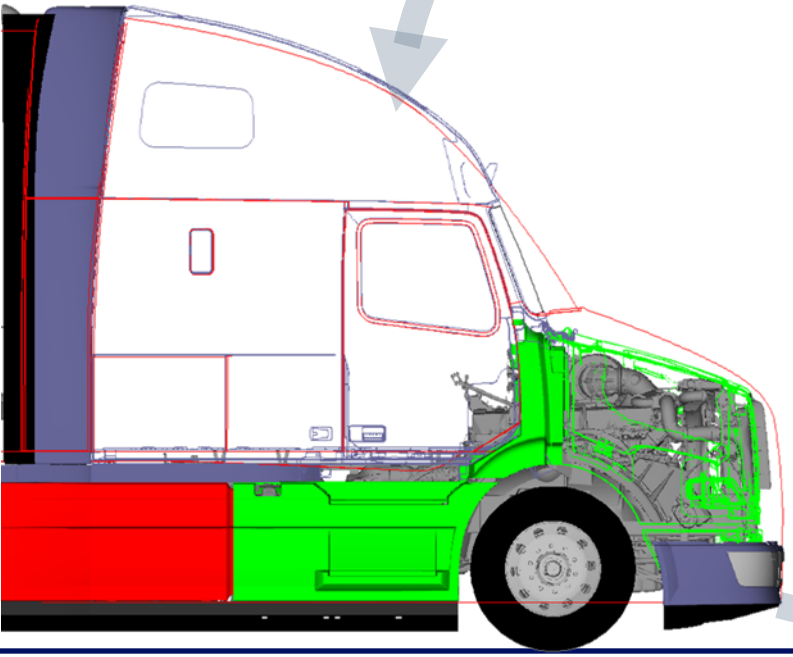


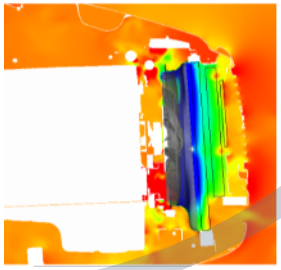
Importance of Integrated Design
Vehicle vs. Powertrain Improvements



Packaging,
Cooling Needs,
...

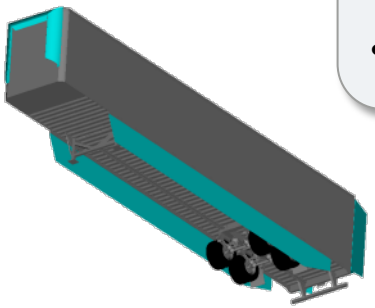


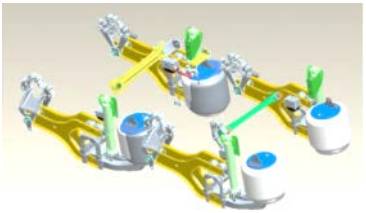




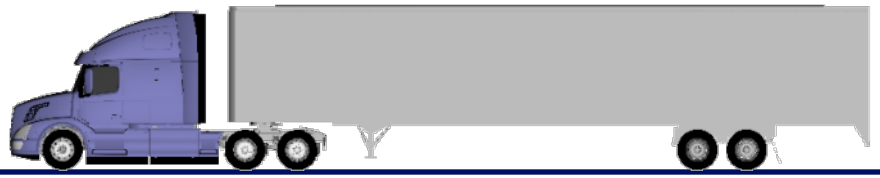
Road Load,
Heat Rejection,
...

Accomplishments: Phase I Testing Complete





- 16 configurations of Tractors & Trailer Modifications
- > 6,000 miles of on-road testing
- Correlated to chassis dynamometer & simulations



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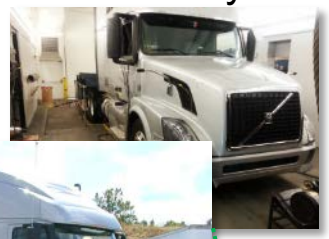
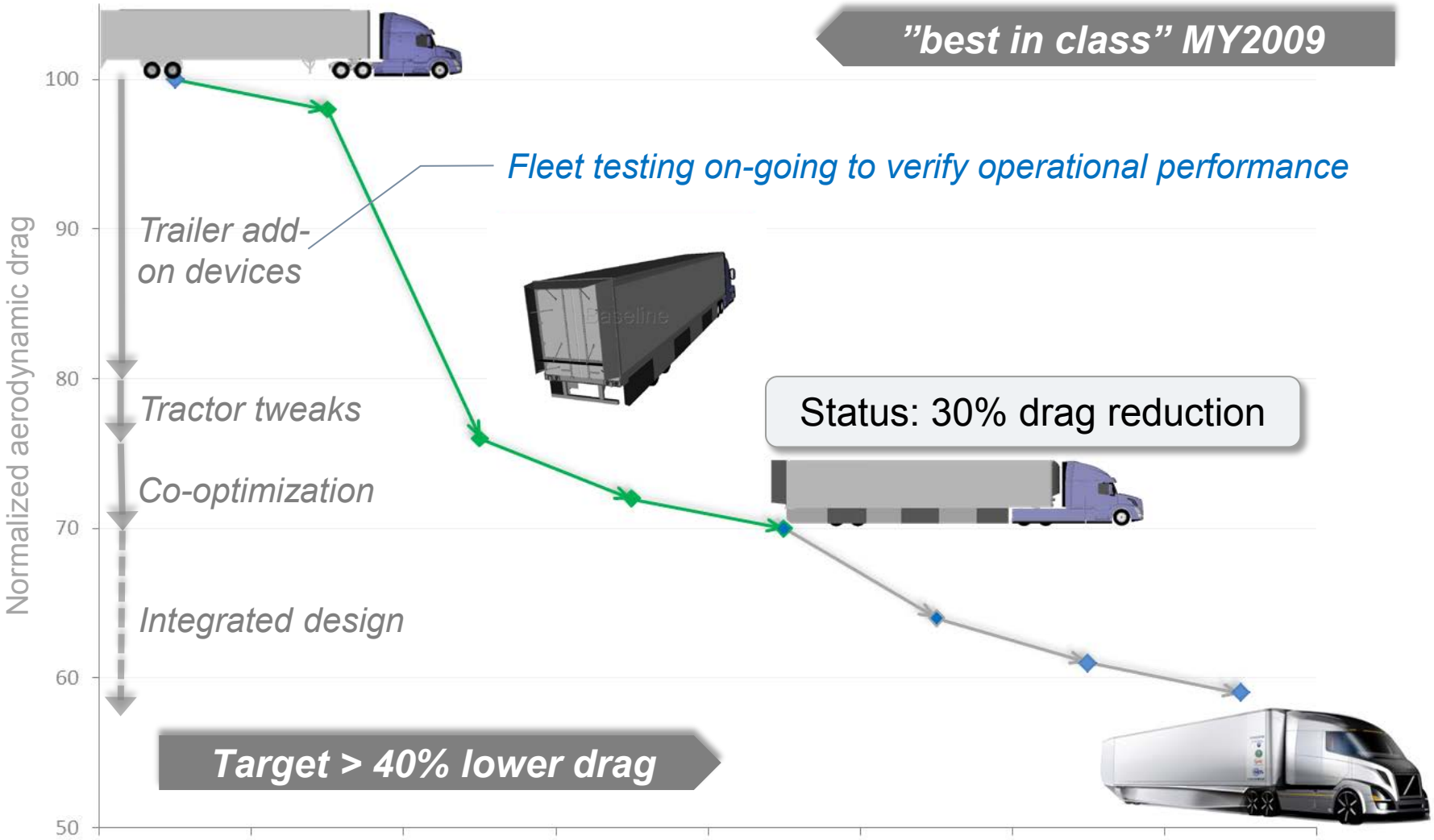
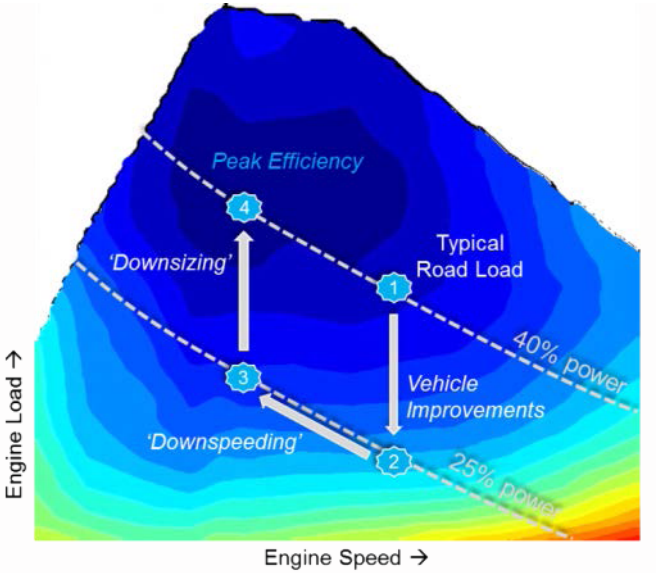
Phase I Results

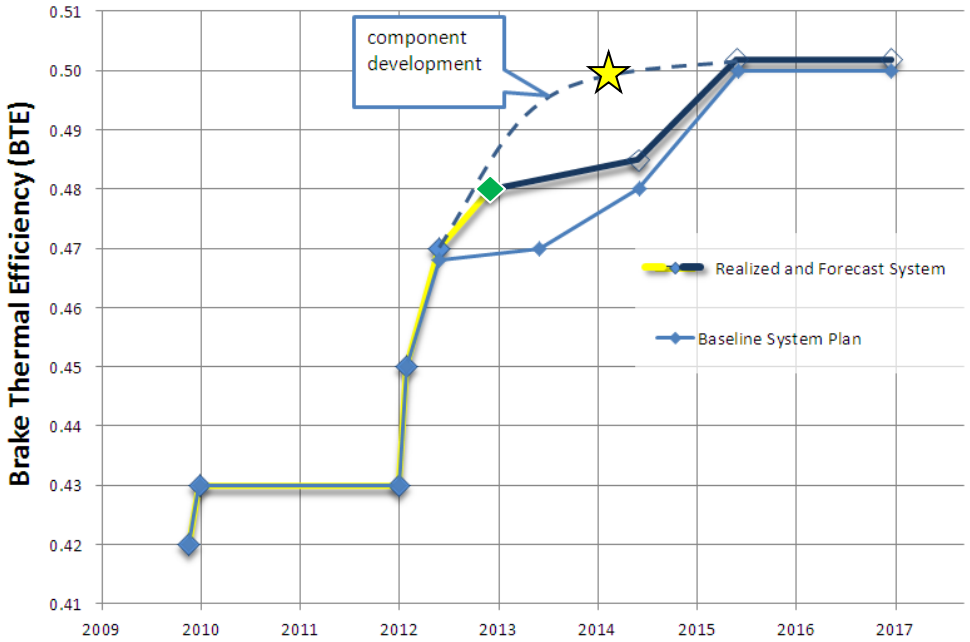


Complete Vehicle Aerodynamic Optimization



Accomplishments: Powertrain Improvements





- **Demonstrator engine running in test cell**
  - 11liter engine capable of same power as the 13liter
  - Targeting ~400lbs powertrain weight reduction
- **50% BTE technologies in test on component test rigs**

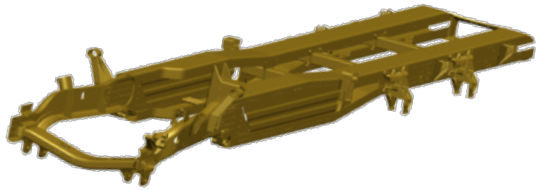
Accomplishments: Ultra Light Frame Assembly

Q3'2012

Evaluate Concepts

- *Bending*
- *Innovation*
- *Weight savings*
- *Manufacturing*
- *...*

Detailed Design & Stress Analysis



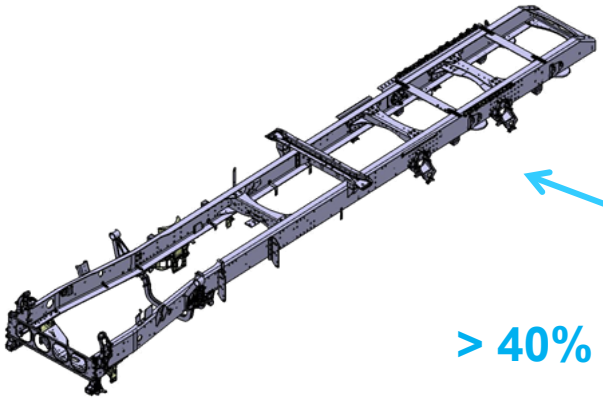
Q2'2013

- *FEA*
- *Virtual test track*
- *...*

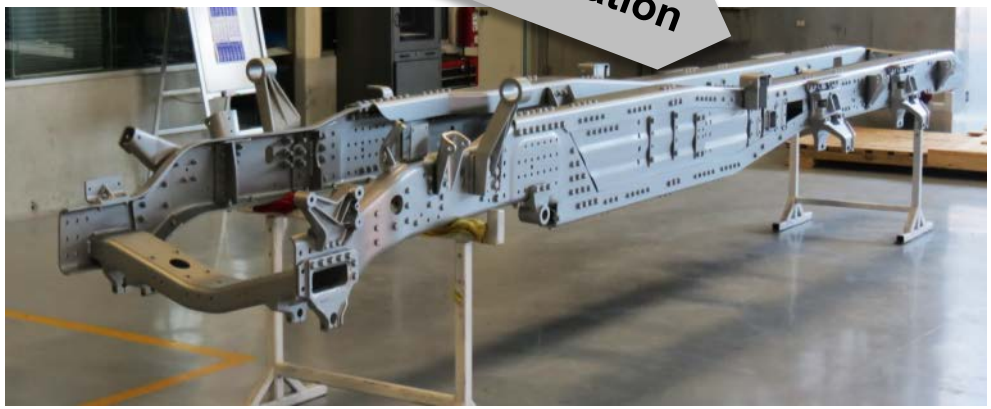
From idea to prototype in 18 months

Prototype Fabrication

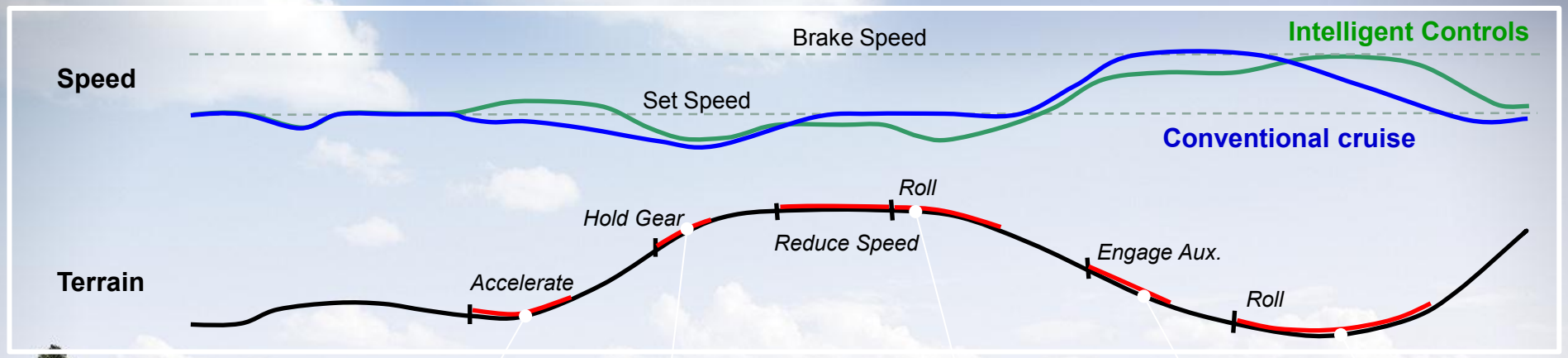
Q1'2014



> 40% lighter



New Opportunities for **Energy Management**



- **Intelligent Controls** leverage vehicle improvements to achieve further fuel efficiency gains
- - **Auxiliary Integration** maximizes use of free energy
- - **Powertrain Management** minimizes fuel use

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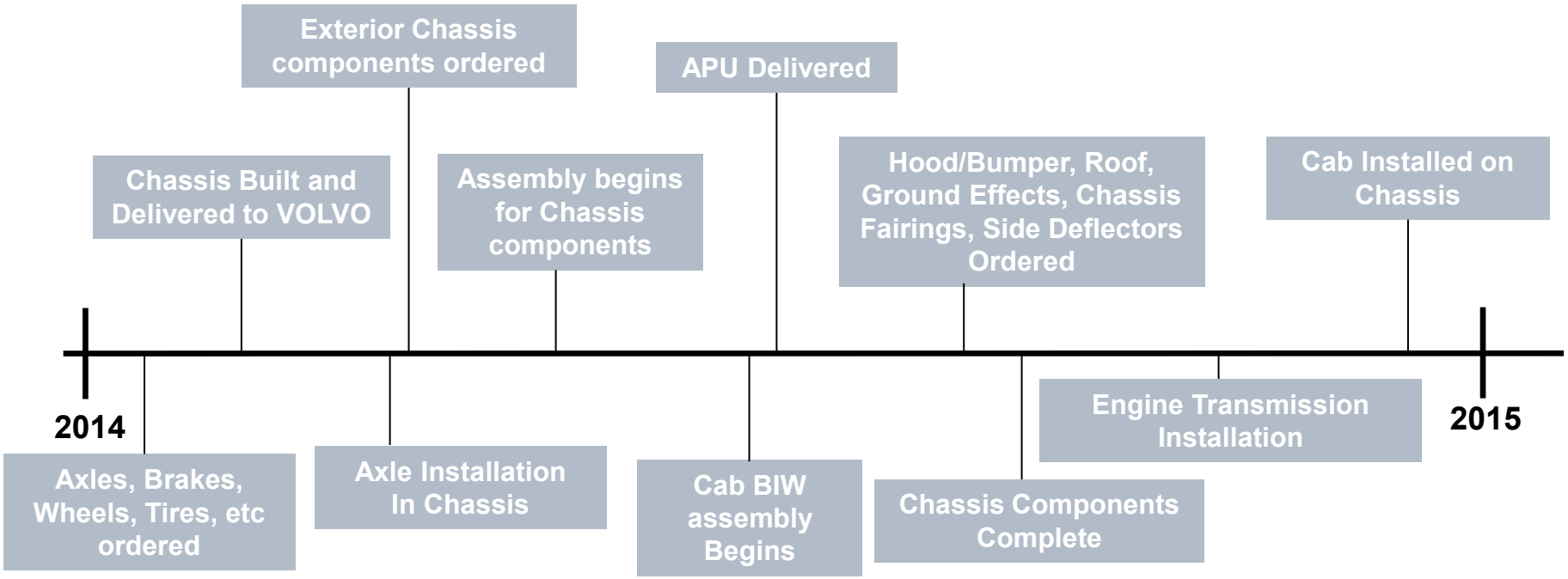
Future Work: Demonstrator Build Plan



Summary: Reporting Period Objectives

- **Accomplishments at 55% Project completion**
  - Candidate technologies evaluated on concept vehicle
    - Demonstrated 43% Freight Efficiency Improvements
    - Demonstrated 48% BTE powertrain in vehicle
  - Completed Concept selection (Phase I) on schedule
  - Started development & integration of technologies into demonstrator (Phase II)

- **Next Steps**
  - Integrate technologies in Demonstrator vehicle for initial tests by next AMR
  - Continue on-going operational testing of trailer aero improvements

Partners & key Collaborations

Organization	Key Contribution
Volvo Technology of America	Project lead & concept simulations
Volvo Group Truck Technology	Complete vehicle integration & vehicle testing
Volvo Group Powertrain Engineering	Efficient complete powertrain solutions
Ridge/Freight Wing	Advanced aerodynamic devices for trailers
Grote	Advanced lighting systems
Penn State University	Advanced combustion modeling & simulation
Hendrickson	Lightweight trailer axle & suspension components
ExxonMobil	Advanced fuels & lubricants
Alcoa Wheels	Lightweight wheels
Michelin	Advanced low-friction tires
Metalsa	Ultra-Light Frame Assembly

Relevant Research

This material is based upon work supported by

- DOE & NETL under Award Number DE-EE0004232
- DOE & NETL under Award Number DE-FC26-07NT43222
- DOE Project ID VSS006, Reduce Truck Aerodynamic Drag w/ LLNL
- DOE Project ID VSS022, CoolCab – Reduce Thermal Load w/ NREL