



# Step change in Fuel Efficiency: Eaton's perspective

October 2012

# Many parts of the value chain... ...fuel efficiency is the *central* challenge!

**Government**

**Fleets**

*Safety*

*CO2 emissions*

*Freight efficiency*

*Regulations*

*Fuel cost*

*Drivers*

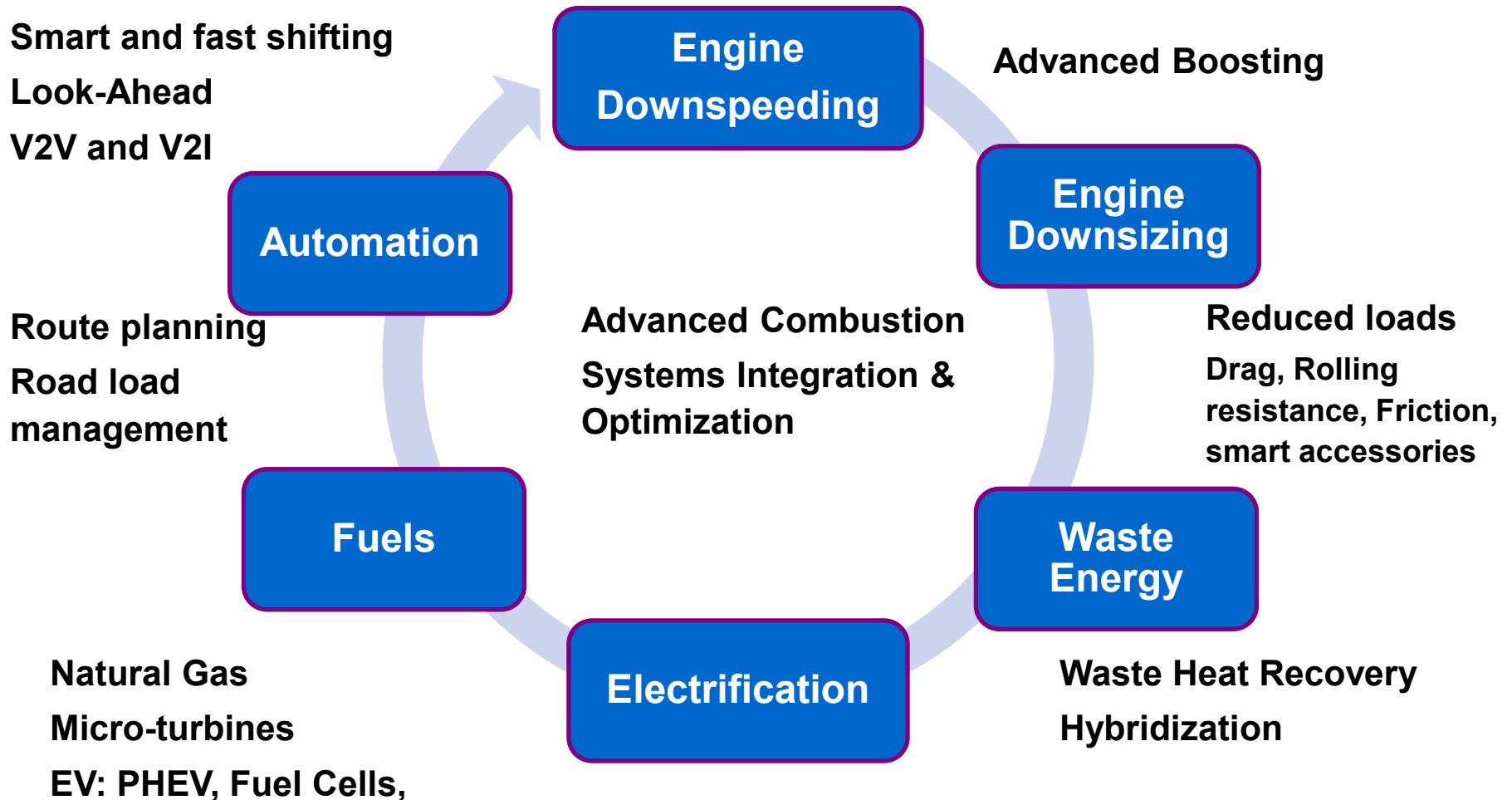
*Differentiation*

*Technology  
Costs*

**Manufacturers**

**Suppliers**

# Technology: no silver bullet... future is in smart systems and deep integration



# Diesels, Trucks and Trends...

## Downspeeding 101






- Lower Friction
- Lower Pumping
- Combustion Optimization

**1.5-3% Fuel Economy / 100 rpm**

## CO2 regulations 101

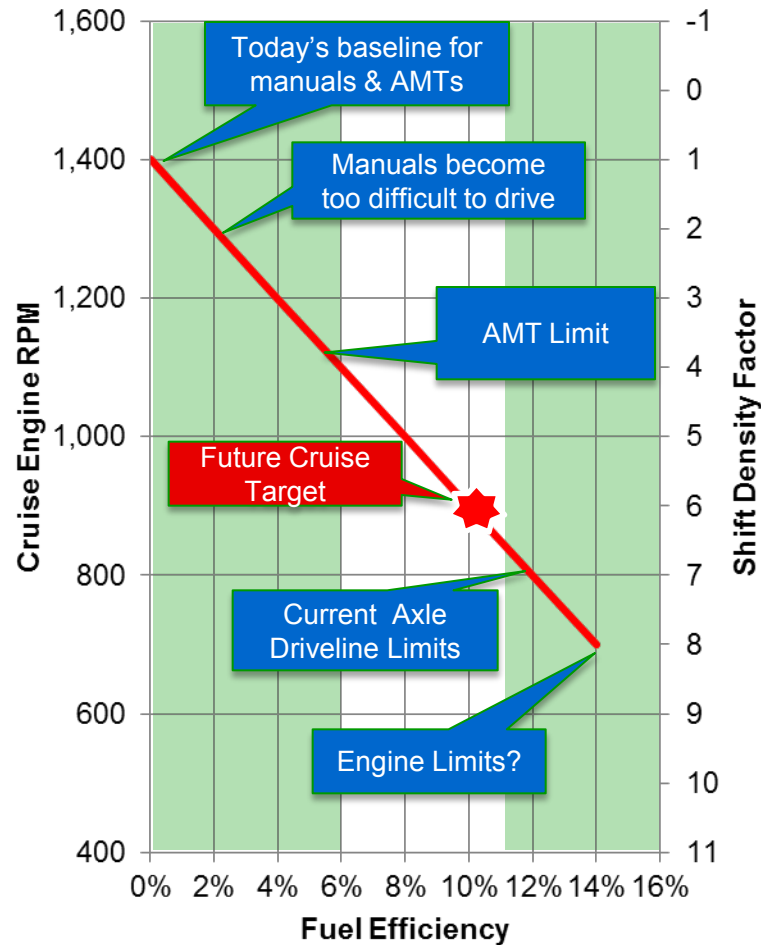
- Phase 1 (2014/17)
  - 6-23% reduction in Fuel Consumption
  - Special incentives for Advanced Technologies
- Phase 2 (2018+)
  - TBD Reduction
  - Technology-Forcing

## Trends

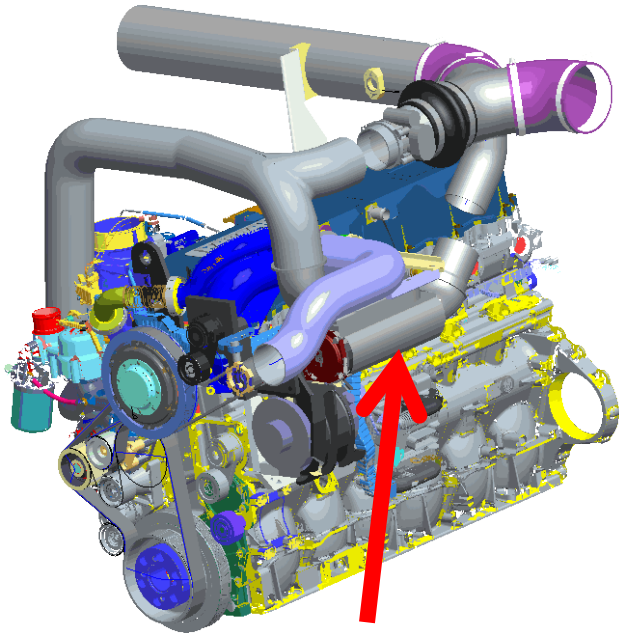
Vehicle Speed		+Fuel -Productivity	More Trucks!
Engine Speed		+Fuel -Driveability	High-Performance Automation
Engine Displacement		+Fuel -Driveability	Supercharging VVA

Implications

# Downspeeding saves fuel but increases shift density



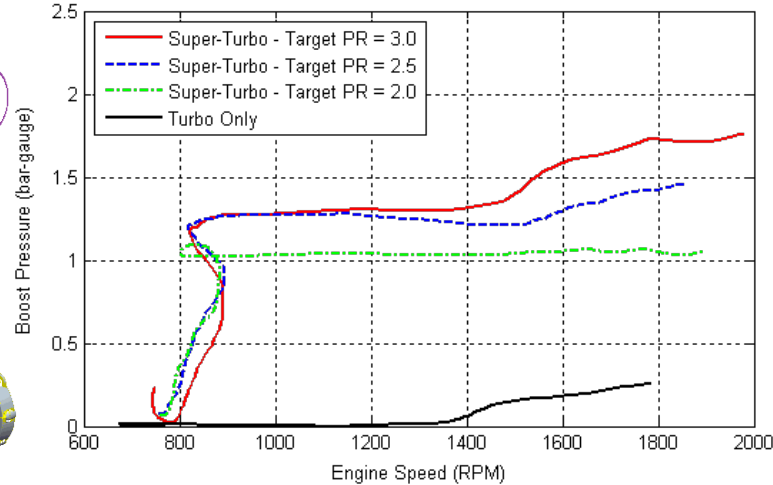
# Advanced boosting



## HD Diesel Supercharger

- Instant boost
- Eliminates turbo lag
- Turbo optimized for steady conditions

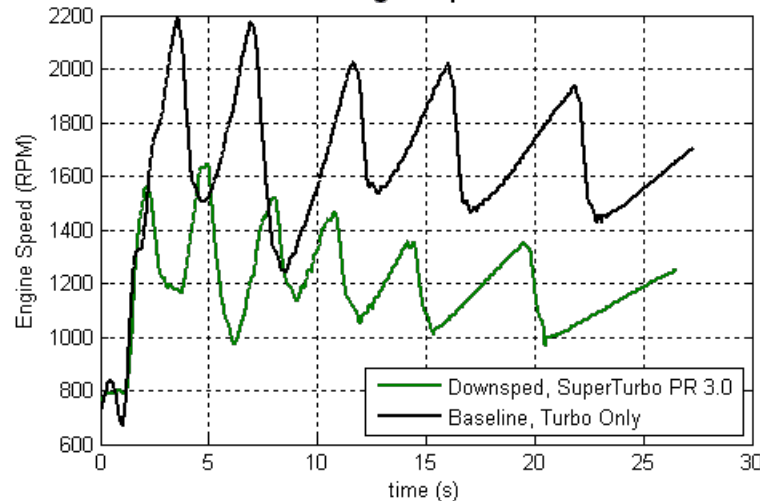
Boost Pressure Comparison - 2nd Gear Acceleration



## Turbo lag elimination



Engine Speed

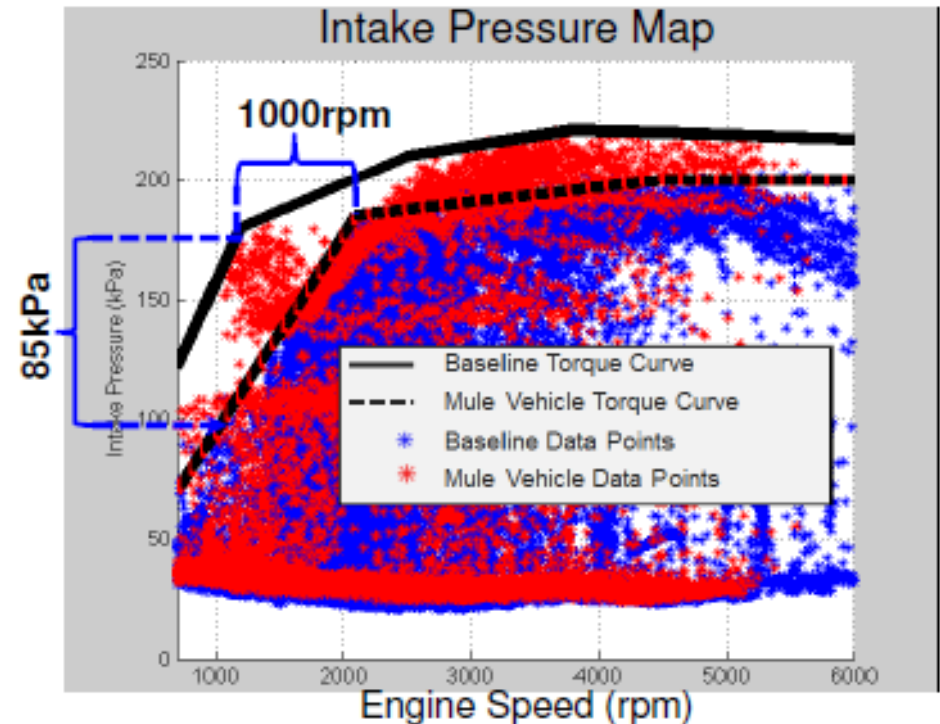


## Fuel economy with matched performance

- 22% 0-35 mph accel
- 2.3% line haul
- 5.4% HHDDT
- 16.7% FTP 72

# What about Class 2b – 3?

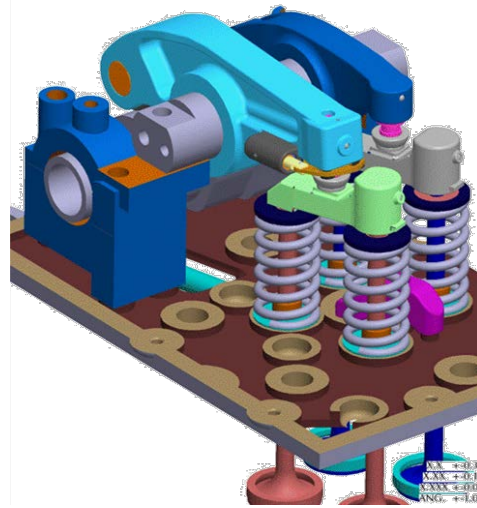
- Significant fuel consumption improvement
- Electrical boosting
- Start-Stop
- Up to 50% engine downsizing



# Efficient Variable Valve Actuation

## Downspeeding

- Loss of engine brake capacity



## Downsizing

- Cylinder deactivation

## Multi-stroke cycles

- Added/Lost motion
- Cam-less
- Active timing control



# Energy Recovery

## Affordable Hybrids



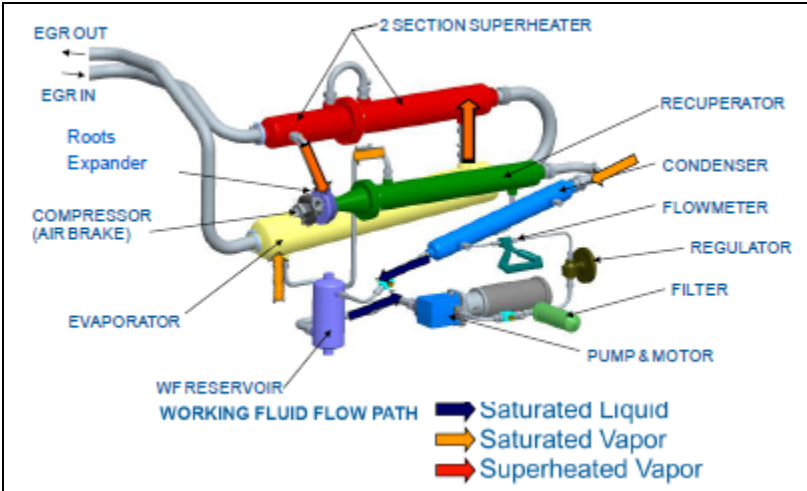
**Challenge: Get to 3 year payback from saved fuel**

- State of art transmissions
- Small e-machines run in efficiency sweetspot
- Novel architecture



Powering Business Worldwide

## Waste Heat Recovery



**Challenge: compact, simple, cost effective systems?**

- Large heat exchangers vs. aerodynamics
- **Expander** efficiency vs. high speed machine complexity

# MD and Bus: Ripe for Innovation!



## Electrification

- Efficient EV drivetrains
- Rapid charging
- Fuel cells and micro turbines
- High Voltage Distribution



## Hybrids

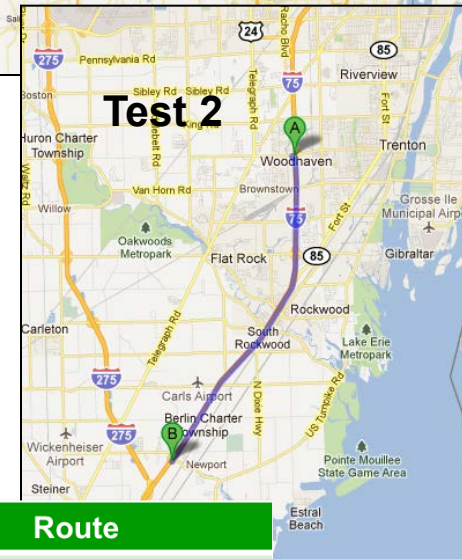
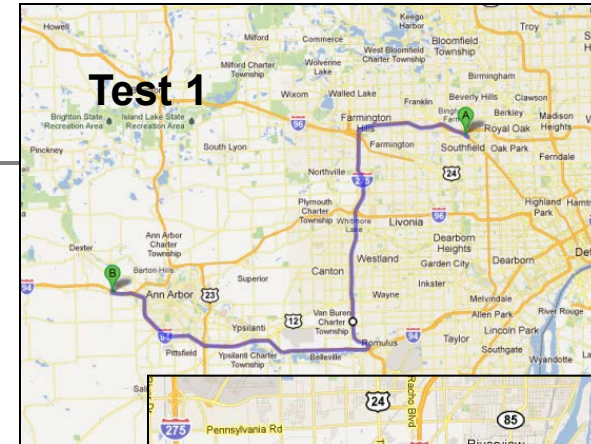
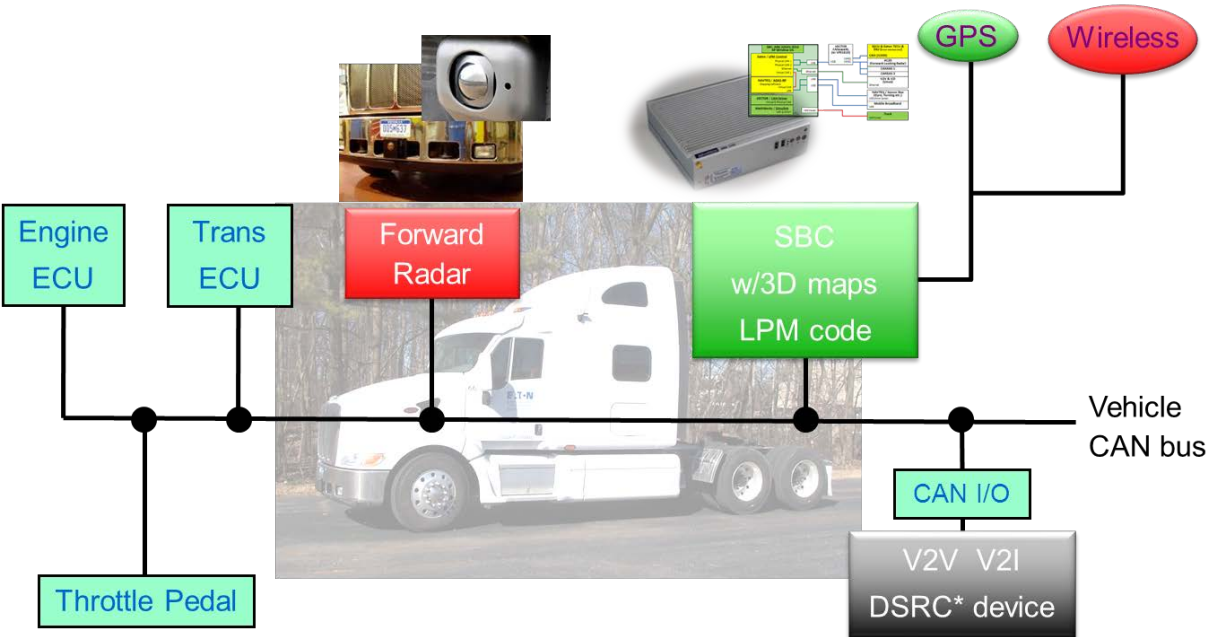
- Affordable solutions
- Scalability is key
- Advanced controls to reduce battery needs



## Drivelines

- Efficient
- Automated

# Advanced automation makes every driver a best driver



		Baseline	LPM On	Delta (%)	Compensated	Route
<b>Test 1</b>	MPG	6.06	6.28	+3.5	+5.3%	Southfield – Ann Arbor 45,000 lbs
	Avg Speed	52.42	51.40	-2.0		
<b>Test 2</b>	MPG	6.59	6.66	+1.0	+2.5%	Detroit – Toledo (10 miles) 75,000 lbs
	Avg Speed	59.55	61.24	+2.8		

**Expected average >4% mpg improvement across the fleet**

# Winning team: Government and Industry partnerships



**EATON**

*Powering Business Worldwide*