# Heavy-Duty Powertrain Development
## Current Status and Future Opportunities

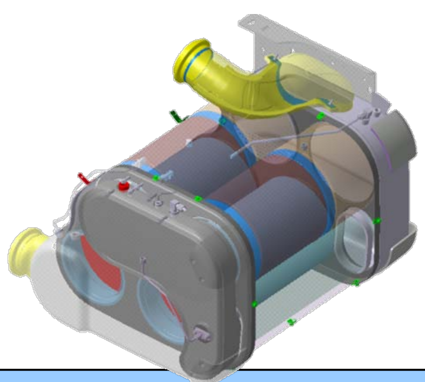
Detroit, Sep.29th 2010

Rakesh Aneja

# Daimler Trucks is globally positioned w/ truck and components plants

# Global Heavy Duty Engine Platform
## Clean Sheet Design

| Attribute | DD13 | DD15 | DD16 |
|---|---|---|---|
| Target Market | LTL, Reg. Dist., Vocational | Truck Load | Specialized Hauling, O/O, Vocational |
| Displacement (l) | 12.8 | 14.8 | 15.6 |
| HP Range (hp) | 350 – 500 | 455 – 560 | 475 – 600 |
| Torque Range (ft-lb) | 1250 – 1650 | 1550 – 1850 | 1750 – 2050 |

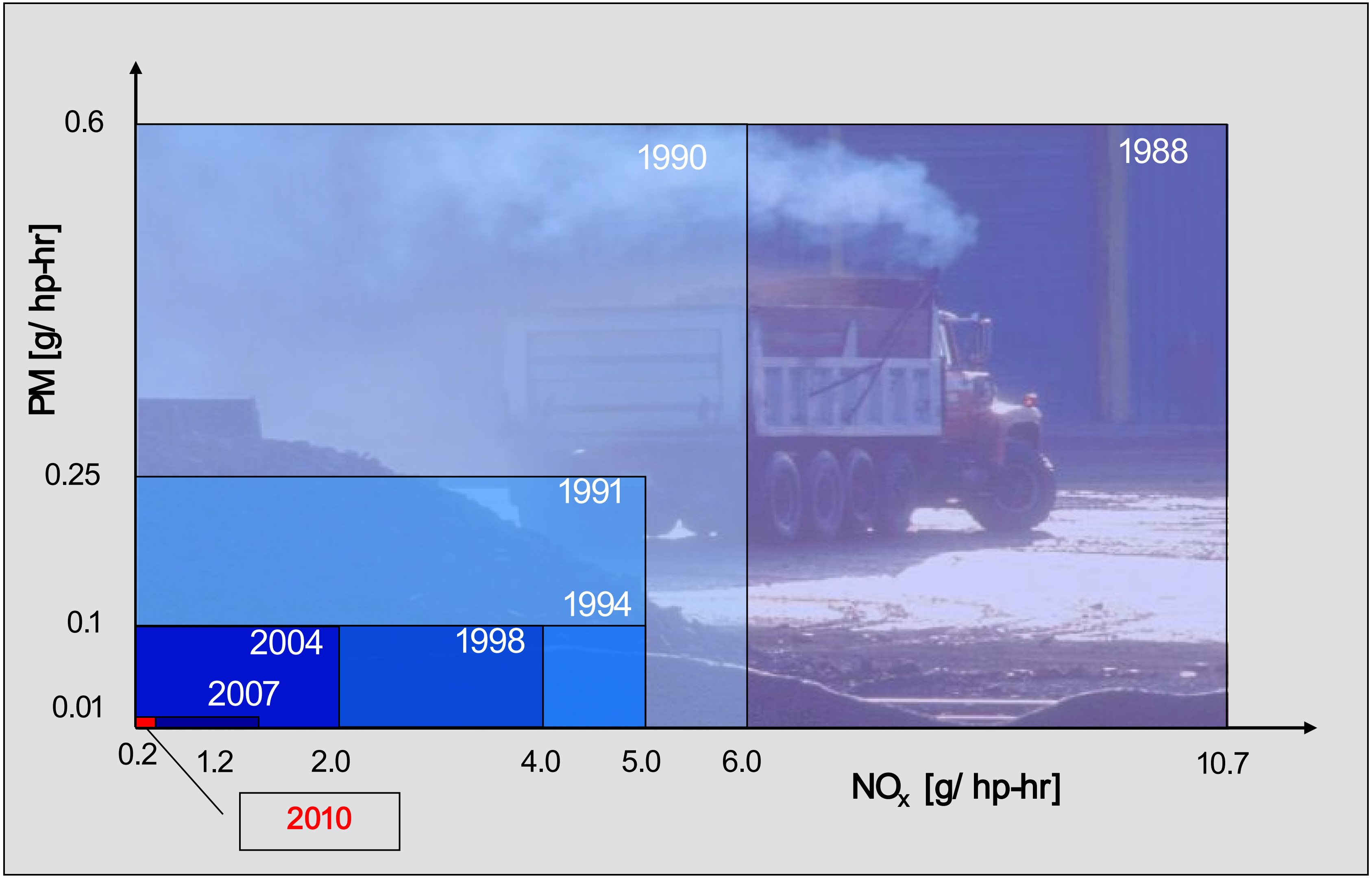




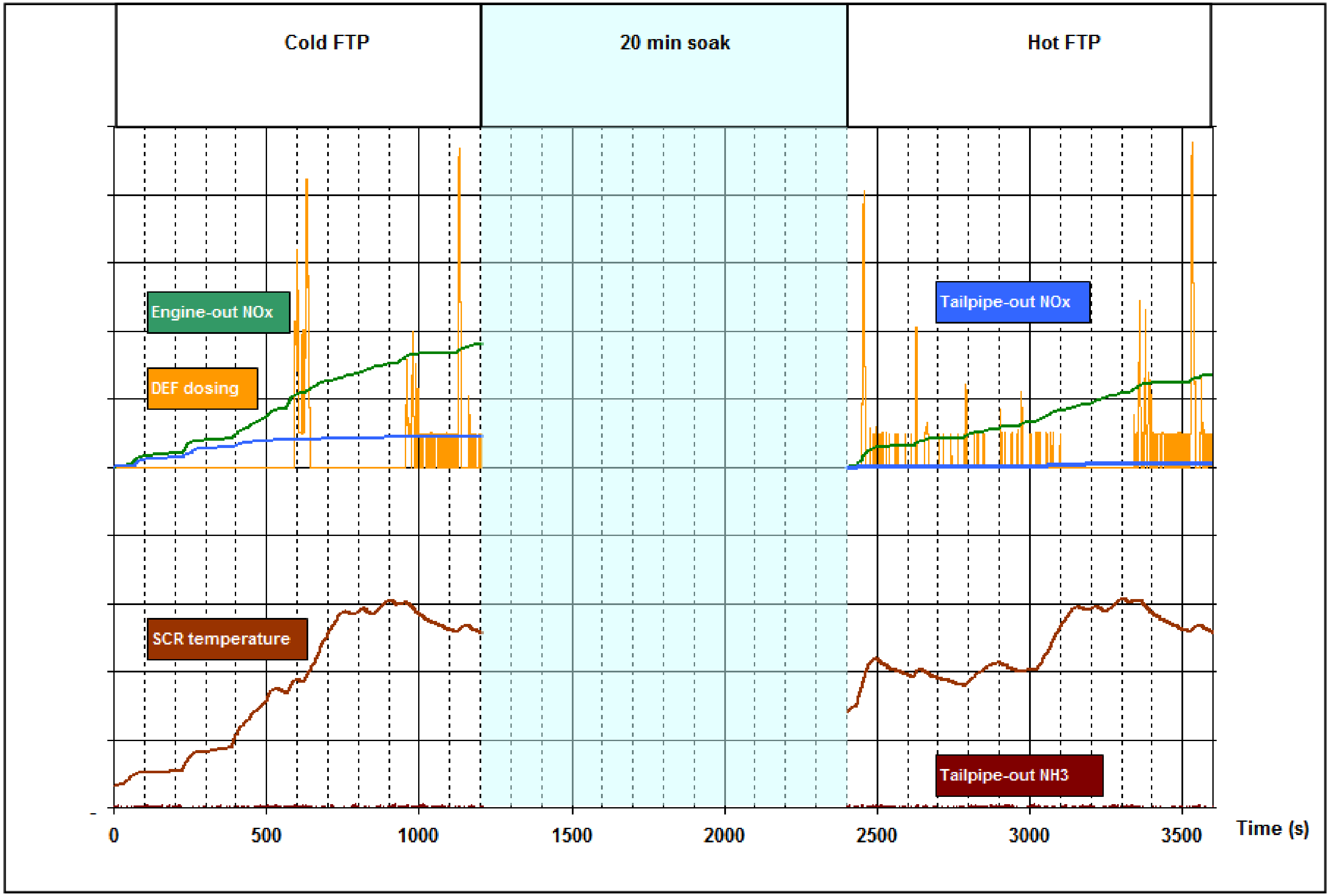

BLUETEC
EMISSIONS TECHNOLOGY

- DD13,15,16 worldwide HD engine platform (NAFTA + EU + Japan)
- Amplified Common-Rail Fuel System
- Turbo-Compounding
- DOHC w/ integral engine brake

# The Age of Criteria Pollutant Emissions Reduction



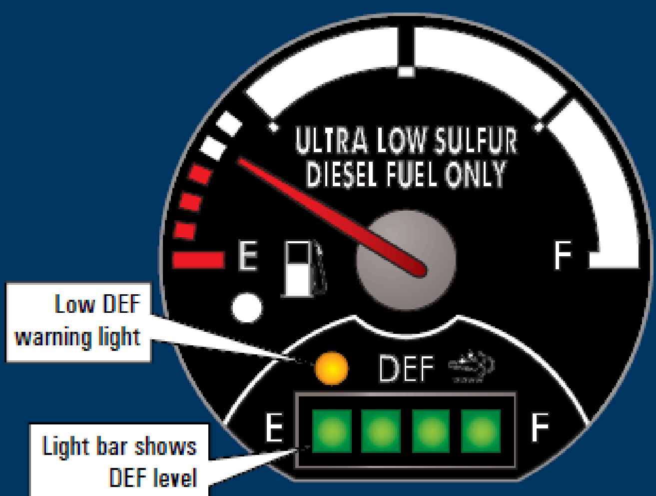
# Near-Zero Emissions Today
## DD1x Series Equipped with BlueTec Emissions Control



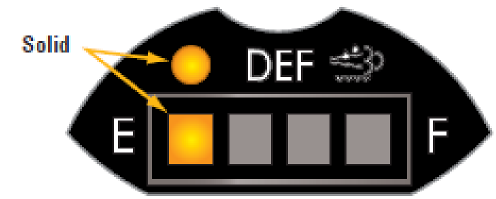
DETROIT DIESEL
DEMAND PERFORMANCE™

# DIESEL EXHAUST FLUID (DEF) INDICATOR LAMPS

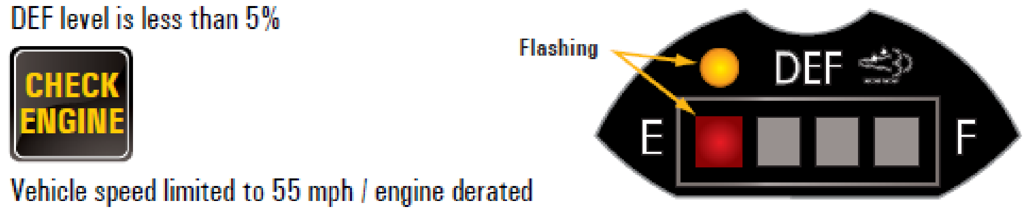
- The light bar indicates the level of fluid in the DEF tank.
- Low DEF levels will trigger a decrease in engine performance.
- The use of improper fluid will trigger a decrease in engine performance.
- In the empty and ignored state, if the diesel tank is refilled without filling the DEF tank, vehicle speed will be limited to 5 mph until DEF is detected in the tank.




DEF level is less than 10%

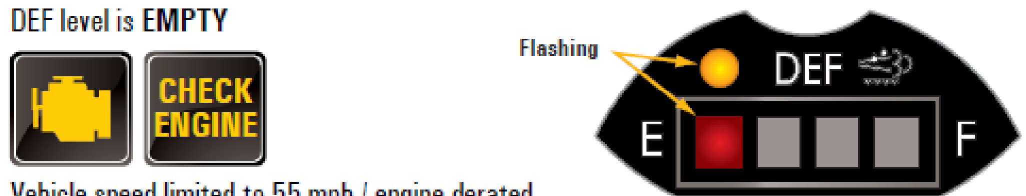



DEF level is less than 5%



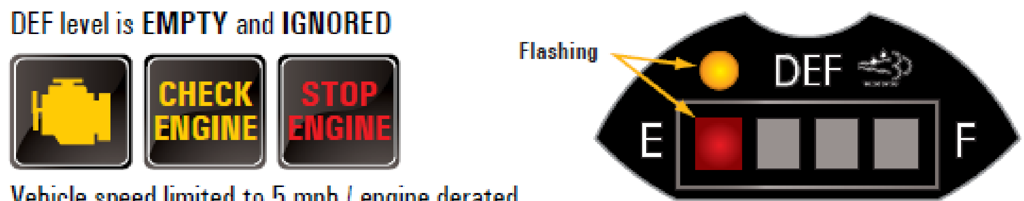

Vehicle speed limited to 55 mph / engine derated

DEF level is **EMPTY**




Vehicle speed limited to 55 mph / engine derated

DEF level is **EMPTY** and **IGNORED**

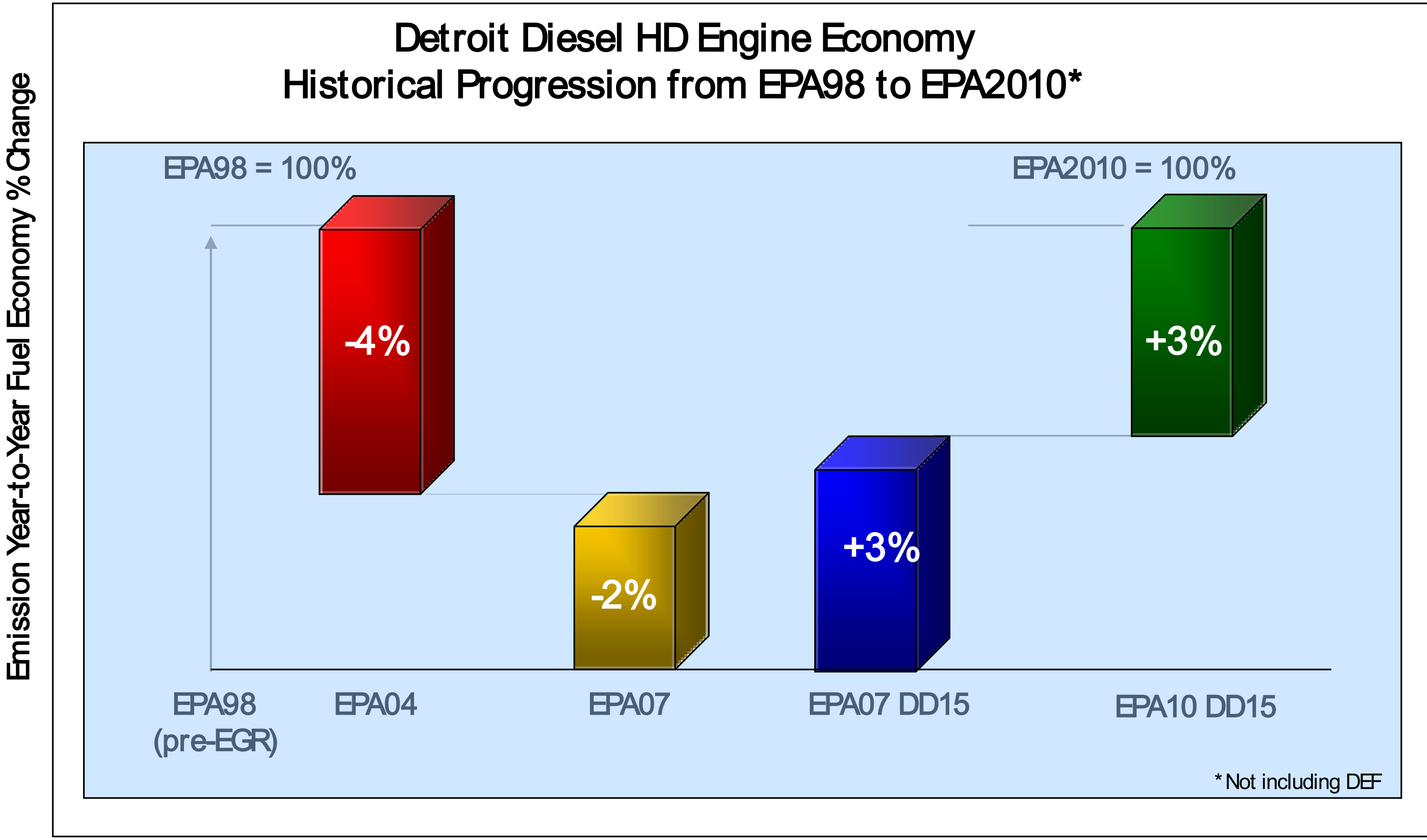



Vehicle speed limited to 5 mph / engine derated

BLUETEC EMISSIONS TECHNOLOGY

Detroit Diesel

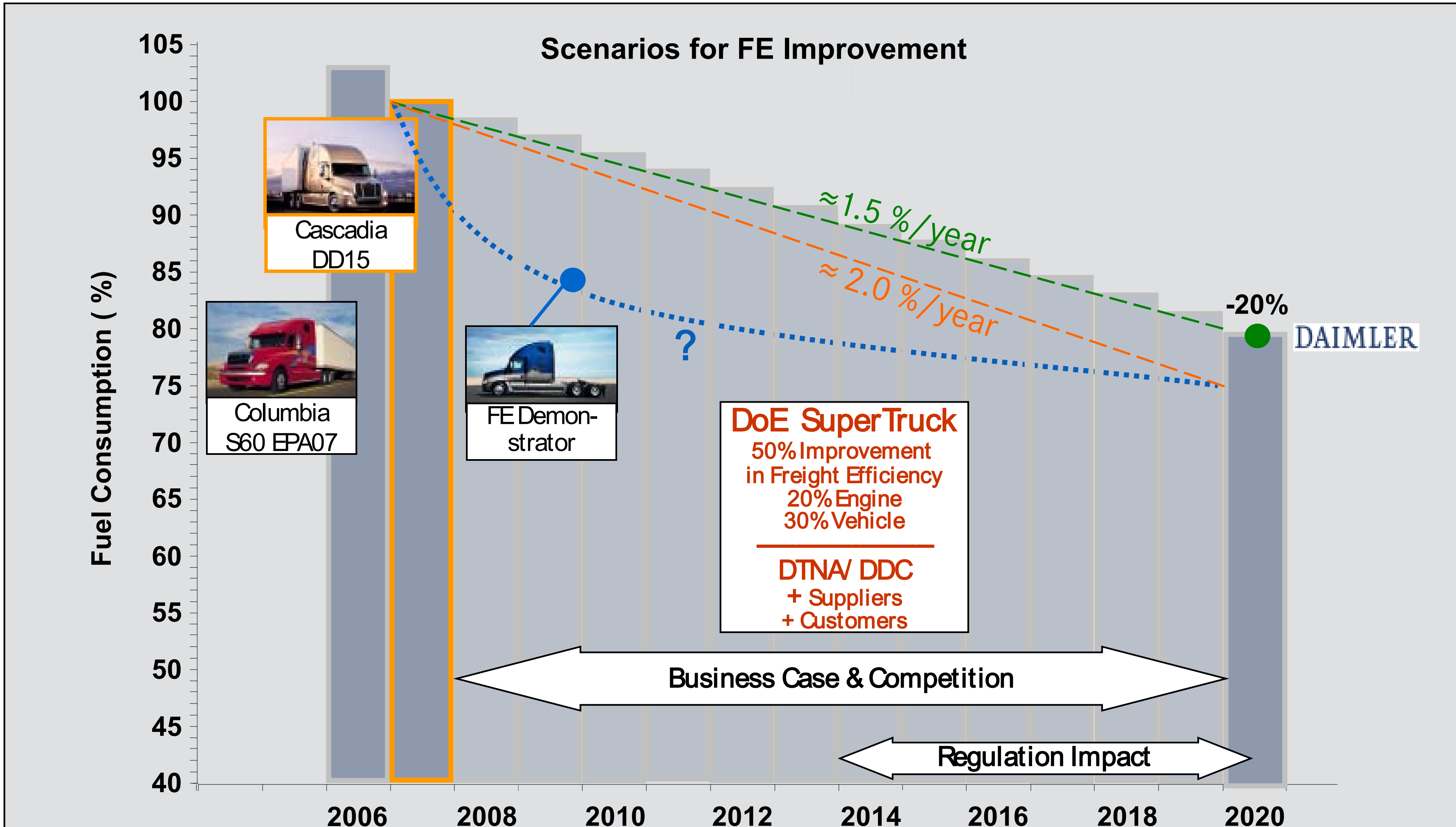
# Fuel Economy Progression




"…[BlueTec fuel economy] slightly better than our pre-EGR trucks…"
*– Steve Duley, VP Purchasing – Schneider National*

# The Age of $CO_2$ - Fuel Economy Improvement Scenarios

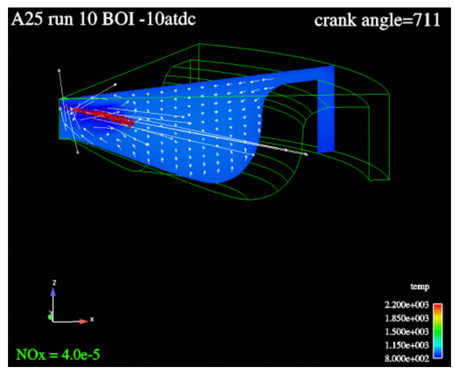
- Fuel economy improvements will be introduced very quickly
- Life Cycle Costs will continue to drive efficiency improvement, but legislation begins to play a role
- DoE Super Truck project with a 50% improvement target [in ton-miles/ gallon] will help accelerate introduction of innovative technologies



# DDC/ DTNA DoE SuperTruck Technologies

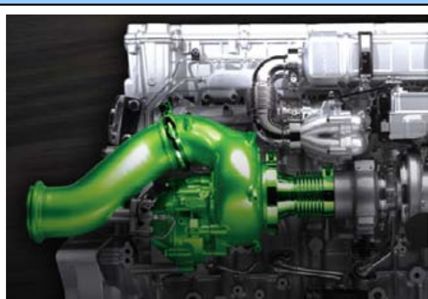
## ENGINE & POWERTRAIN

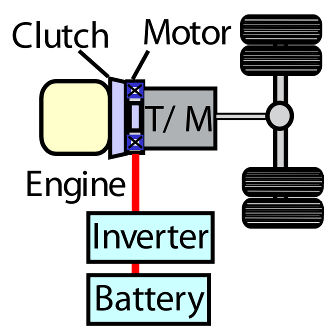
- Combustion
- Fuel Injection
- Air/ EGR
- Controls
- Waste heat recovery
- Auxiliary components
- Powertrain: Engine downsizing, hybridization, transmission optimization

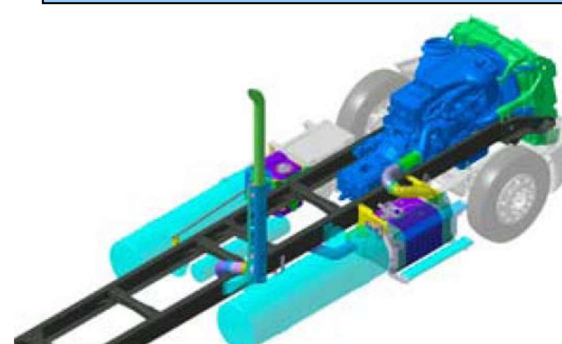



## VEHICLE

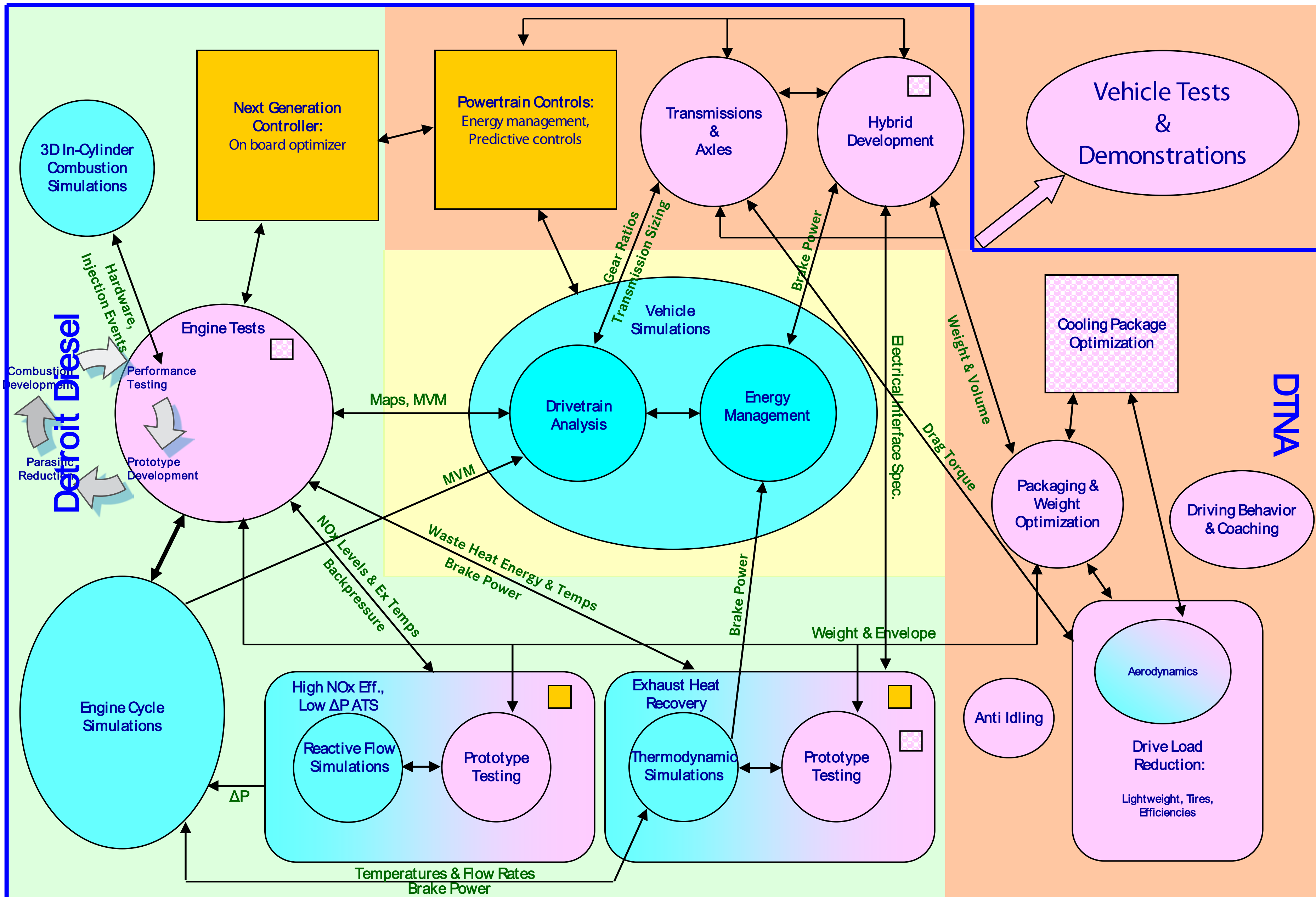
- Aerodynamics
- Driveline optimization
- Predictive power management
- Weight reduction
- Idle reduction
- Driver feedback
- More freight efficient vehicle concepts (*e.g.*, 60 ton vehicles)
- Navigation and route planning





# SuperTruck Technical Road-Map/ Interaction Matrix

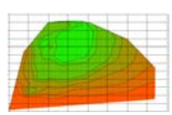


# *Analytical Model Requirements for HD Vehicle Fuel Efficiency*

VEHICLE SIMULATION SOFTWARE

Fuel consumption optimization

**Engine Fuel Map**



**Component Characteristics (lookup table)**

- Gear and axle ratios
- Transmission efficiency (per gear)
- Axle efficiency
- Inertias
- Mass
- Tire rolling resistance
- others

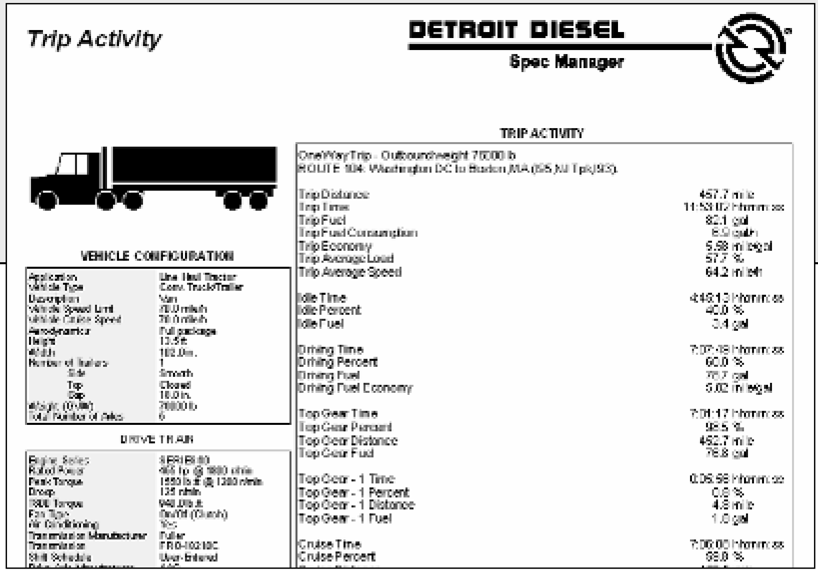
**Vehicle Characteristics: $C_dA$**

Drag ($c_d$*A) from
- lookup table or
- measurements
- analysis (CFD)

**EcoFeatures: system characteristics**

**Route profile**

- Real routes with driver model



*Trip Activity*

DETROIT DIESEL Spec Manager

VEHICLE CONFIGURATION

| | |
|---|---|
| Application | Line Haul Tractor |
| Vehicle Type | Conv. Truck/Trailer |
| Description | Van |
| Vehicle Speed Limit | 70.0 mi/h |
| Vehicle Cruise Speed | 70.0 mi/h |
| Aerodynamics | Full package |
| Height | 13.5 ft |
| Width | 102.0 in. |
| Number of Trailers | 1 |
| Side | Smooth |
| Top | Closed |
| Gap | 18.0 in. |
| Weight (GVW) | [illegible] |
| Total Number of Axles | 6 |

DRIVE TRAIN

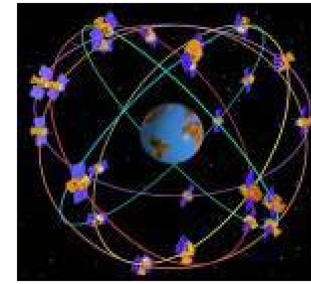
| | |
|---|---|
| Engine Series | SERIES 60 |
| Rated Power | [illegible] hp @ 1800 r/min |
| Peak Torque | 1550 lb ft @ 1200 r/min |
| Droop | 125 r/min |
| [illegible] Torque | [illegible] lb ft |
| Fan Type | On/Off (Clutch) |
| Air Conditioning | Yes |
| Transmission Manufacturer | Fuller |
| Transmission | [illegible] |
| Shift Schedule | User-Entered |

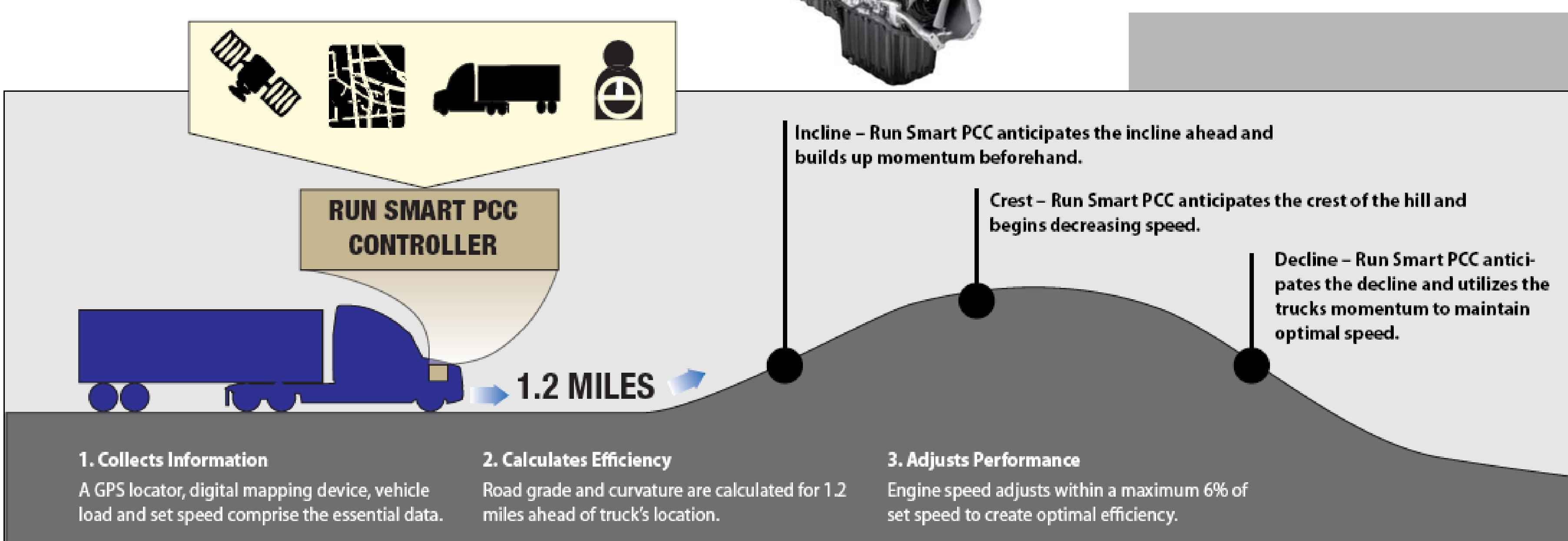
TRIP ACTIVITY

OneWayTrip - Outboundweight 75000 lb
ROUTE 104: Washington DC to Boston MA (95 NJ Tpk/95)

| | |
|---|---|
| Trip Distance | 457.7 mile |
| Trip Time | 11:53:02 hh:mm:ss |
| Trip Fuel | 82.1 gal |
| Trip Fuel Consumption | 6.9 gal/h |
| Trip Economy | 5.58 mile/gal |
| Trip Average Load | 57.7 % |
| Trip Average Speed | 64.2 mile/h |
| Idle Time | 4:45:13 hh:mm:ss |
| Idle Percent | 40.0 % |
| Idle Fuel | 3.4 gal |
| Driving Time | 7:07:49 hh:mm:ss |
| Driving Percent | 60.0 % |
| Driving Fuel | 78.7 gal |
| Driving Fuel Economy | 5.82 mile/gal |
| Top Gear Time | 7:01:17 hh:mm:ss |
| Top Gear Percent | 98.5 % |
| Top Gear Distance | 452.7 mile |
| Top Gear Fuel | 76.8 gal |
| Top Gear - 1 Time | 0:06:56 hh:mm:ss |
| Top Gear - 1 Percent | 0.8 % |
| Top Gear - 1 Distance | 4.8 mile |
| Top Gear - 1 Fuel | 1.0 gal |
| Cruise Time | 7:06:00 hh:mm:ss |
| Cruise Percent | 98.0 % |

# RunSmart Predictive Cruise™ – Freightliner Cascadia with DD15



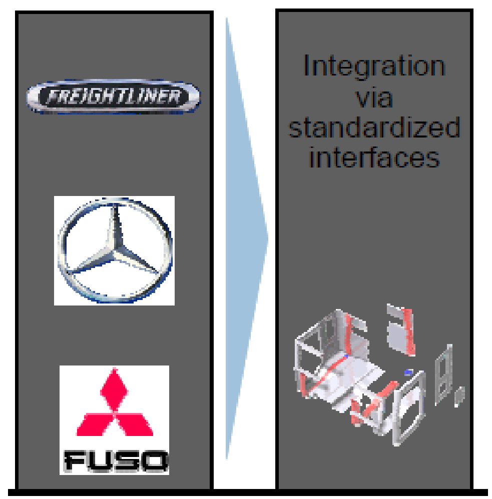


# Changes in Technologies and Regulations Drive changes in Development Processes

## Yesterday

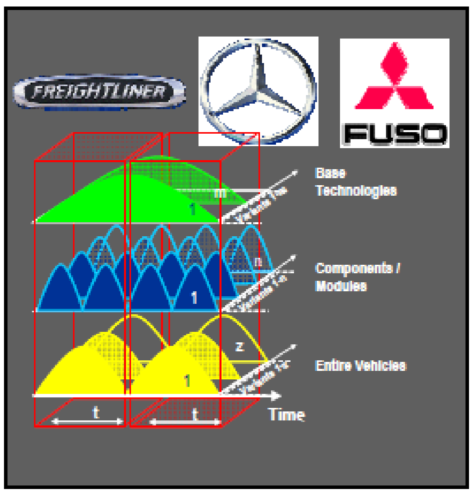

Stand alone development

## Today




Definition of modules and platform architectures

## Tomorrow




Engineering Cycle Management in entire vehicle platforms

# Summary

- DDC's new global Heavy Duty Engine Platform includes the latest technology for fuel efficiency and emissions control and is well-positioned for future regulatory and customer demands
- In the next decade commercial vehicle development focus changes from criteria pollutant reduction to CO2 reduction in terms of freight efficiency
- Freight efficiency improvements require not only engine advancements but also powertrain and vehicle improvements and optimized system integration
  - Vehicle modeling tools are key to understand technology trade-offs and to maximize improvements
- Global application of engines requires further technology development (e.g. to manage fuel variation)


Freight Efficiency - Which Solution?

# Thank You