

# VPRO and Cloud Connected Delivery Vehicle Project: Challenges Facing Predictive Powertrain Technologies

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# UMN Connected Vehicle Research

## Vehicle Routing and Powertrain co-Optimization (VPRO)

- Merge physics models with spatial data analytics
- Historical vehicle data and exogenous parameters
- Used to guide powertrain decisions about energy flow strategy



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# Project: Cloud Connected Delivery Vehicles



**WORKHORSE**

**Aim:** Improve the fuel economy of range extender (REx)-equipped electric delivery vehicles through real-time powertrain optimization using two-way vehicle-to-cloud (V2C) connectivity

**Goal:** Greater than 20% energy efficiency improvement of a baseline 2016 E-GEN delivery vehicle integrating routing, V2C and physics-aware data analytics

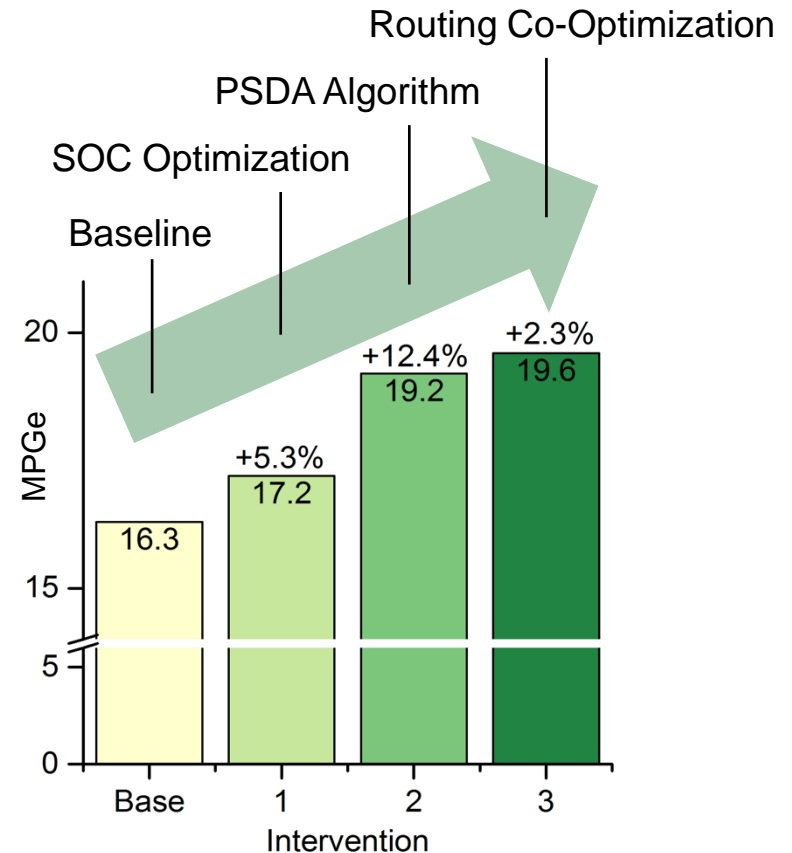


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# Connected Delivery Fuel Economy Improvement

## Three Interventions:

1. Battery state of charge (SOC) optimization REx engine on/off
2. Physics-aware spatiotemporal data analytics (PSDA) for optimal engine operation
3. PSDA plus routing co-optimization to improve powertrain efficiency



# Predictive Powertrain Logistical Challenges

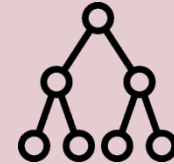
1) Communication Integrity



2) Data Security



3) Deployment Infrastructure



4) Regulatory Requirements



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# VPRO Key Challenge

## Predict future vehicle trajectory (velocity vs. time) given a known route

- Optimization strategies and vehicle models have been developed
- Real drive cycle unknown
- Algorithms require:
  - Historical data
  - Exogenous parameters
  - Physics models
- Confounded by:
  - Traffic patterns
  - Driver behavior

WLTC Cycle (source: DieselNet)

