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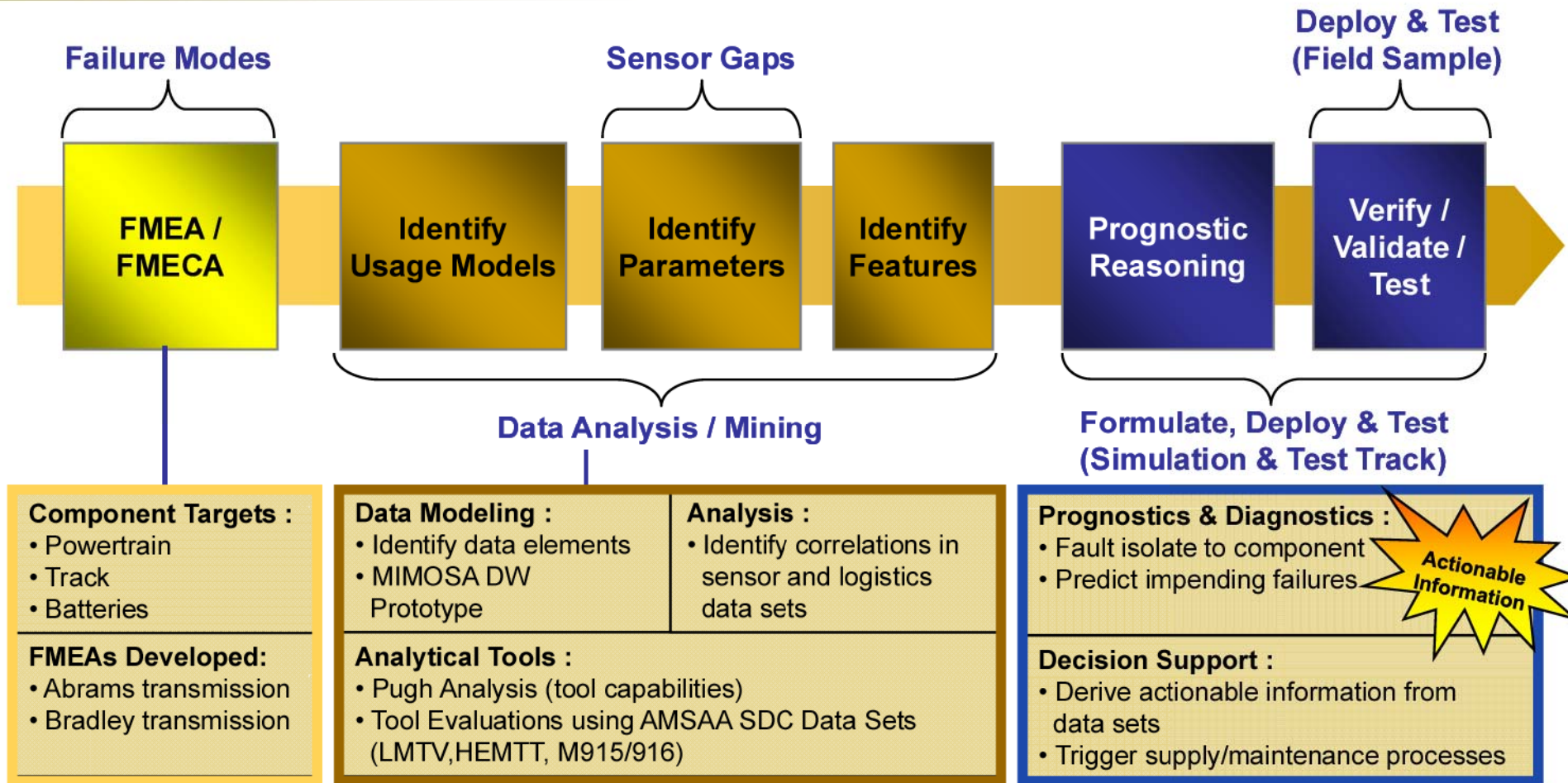
Technology Transition Brief

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Report Documentation Page				Form Approved OMB No. 0704-0188	
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1. REPORT DATE 15 MAY 2009		2. REPORT TYPE N/A		3. DATES COVERED -	
4. TITLE AND SUBTITLE Technology Transition Brief				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) Jeff Kozierowski				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) US Army RDECOM-TARDEC 6501 E 11 Mile Rd Warren, MI 48397-5000				8. PERFORMING ORGANIZATION REPORT NUMBER 19851RC	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S) TACOM/TARDEC	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S) 19851RC	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution unlimited					
13. SUPPLEMENTARY NOTES Presented at NDIAs Ground Vehicle Systems Engineering and Technology Symposium (GVSETS), 17 22 August 2009, Troy, Michigan, USA, The original document contains color images.					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT SAR	18. NUMBER OF PAGES 7	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			



Prognostics & Diagnostics Value Chain



TACOM ILSC, RDECOM (TARDEC/AMSAA/ARL), LOGSA, and LCMC PMs

Turning raw sensor data and logistic data into actionable information...

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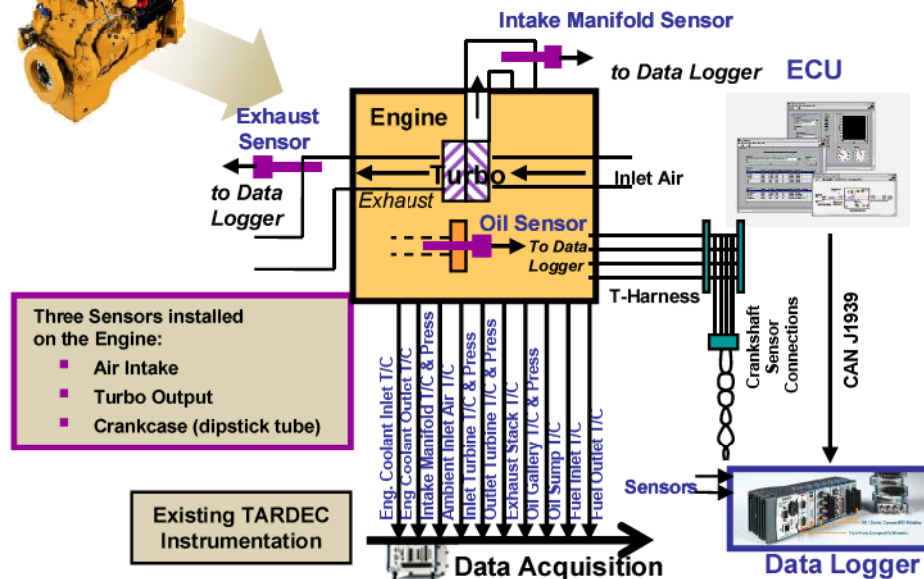
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Advanced Diagnostics for Diesel Engines



Diesel Engine Characterization



Schedule & Cost

Milestones	FY08 2-4Q	FY09 1-2Q	FY09 3-4Q	FY10 1Q
Analysis of AMSAA SDC Data				
Engine Baseline Characterization				
Algorithm Development				
Seeded Fault Testing				
Algorithm Val/Ver				
TOTAL \$ 1,190K				

Purpose:

This effort will focus on the Diesel Engine used by the LMTV and Stryker and involves:

- Development of health assessment models and algorithms for ground vehicle diesel engines through seeded fault and durability analysis at the component level
- Identification of sensor strategies that could be implemented in a ground vehicle application to allow for accurate diagnosis of impending faults

Products:

- Algorithm approach through sensor and data analysis
- Self-learning Neural Network approach to Condition Based Maintenance that can be expanded to other engines, sub-systems and vehicles
- Library of model signatures based on seeded fault testing

Payoffs:

- Provide critical insight into sensors required for diagnosis of diesel engine health and prediction of Remaining Useful Life (RUL)
- Demonstrate how CAN data and neural software can be used to create virtual sensors that can be used for health monitoring
- Demonstrate fault prediction by inducing failures into engine on TARDEC's dynamometer test cell
- Provide Government owned knowledge that can be applied across a variety of vehicle platforms

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Transmission Health Assessment



Schedule & Cost

Milestones	FY10 1Q	FY10 2Q	FY10 3Q	FY10 4Q
FMEA and Failure Mode Selection				
Component Testing & Data Analysis				
Model & Algorithm Development				
Vehicle Testing & Algorithm Refinement				
TOTAL \$ 500K FY10 Funding Plan				

Purpose:

This internal TARDEC effort will focus on the Bradley, commercial bus and future truck transmissions and involves:

- Development of health assessment models and algorithms for ground vehicle transmissions through seeded fault and durability analysis at the component level
- Identification of sensor strategies that could be implemented in a ground vehicle application to allow for accurate diagnosis of impending faults
- Evaluation of the potential Return on Investment (ROI) for implementing this technology in a vehicle
- Collaboration with AMSAA to evaluate the developed algorithms in a vehicle environment

Products:

- Prognostic and Diagnostic algorithms for selected failure modes
- Sensor strategy for vehicle implementation
- CBA / ROI Analysis

Payoffs:

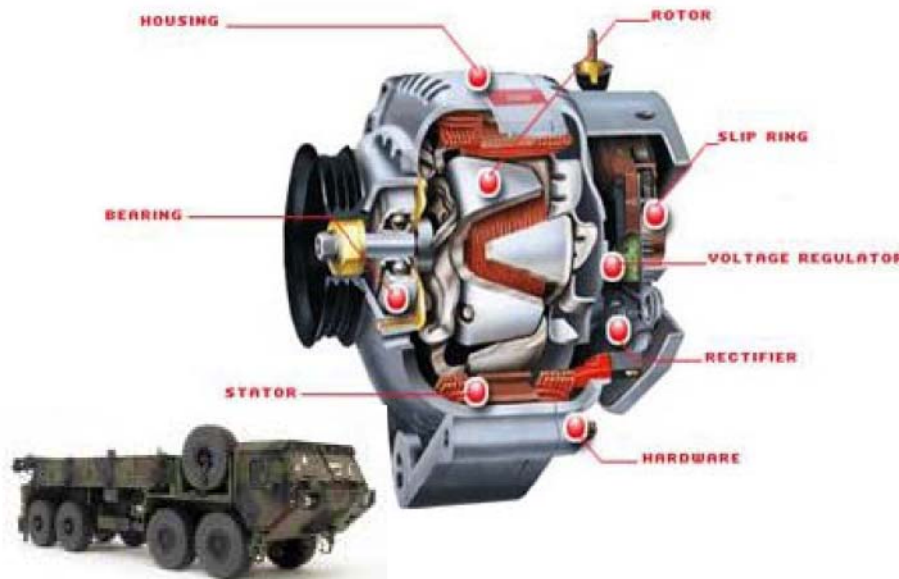
- Provide critical insight into sensors required for diagnosis of transmission health and prediction of Remaining Useful Life (RUL)
- Allow for replacement of the transmission component prior to a failure that could potentially damage batteries or dead-line a vehicle
- Provide Government owned knowledge that can be applied across a variety of vehicle platforms

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Alternator Health Assessment



Purpose:

This internal TARDEC effort involves:

- Development of health assessment models and algorithms for ground vehicle alternators through seeded fault and durability analysis at the component level
- Identification of sensor strategies that could be implemented in a ground vehicle application to allow for accurate diagnosis of impending faults
- Evaluation of the potential Return on Investment (ROI) for implementing this technology in a vehicle
- Collaboration with AMSAA to evaluate the developed algorithms in a vehicle environment

Products:

- Prognostic and Diagnostic algorithms for selected failure modes
- Sensor strategy for vehicle implementation
- CBA / ROI Analysis

Payoffs:

- Provide critical insight into sensors required for diagnosis of alternator health and prediction of Remaining Useful Life (RUL)
- Allow for replacement of the alternator component prior to a failure that could potentially damage batteries or dead-line a vehicle
- Provide Government owned knowledge that can be applied across a variety of vehicle platforms

Schedule & Cost

Milestones	FY09 4Q	FY10 1-2Q	FY10 3-4Q	FY11 1-2Q
FMEA and Failure Mode Selection	■			
Component Testing & Data Analysis		■	■	
Model & Algorithm Development		■	■	
Vehicle Testing & Algorithm Refinement				■
TOTAL \$ 200K FY09 – FY10 Funding Plan				

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Battery Aging Study



Li-ion



PbA



Schedule & Cost

Milestones	FY08 4Q	FY09 1-2Q	FY09 3-4Q	FY10 1-3Q
Define Relevant Duty Cycles				
Battery Aging Cycle Test				
Model Development				
Algorithm Development				
TOTAL \$ 400K				

Purpose:

Development of cumulative aging models for both current fleet and hybrid batteries through durability testing under military duty cycles. These will allow for the prognosis of battery aging, and an accurate prediction of the Remaining Useful Life (RUL) of batteries. Identification of sensor strategies that could be implemented in a ground vehicle application. Development of on-board diagnostic tests to determine the instantaneous battery health.

Products:

- Aging models for both Li-ion and PbA batteries based on military duty cycles.
- State of Charge (SoC) and State of health (SoH) algorithms for batteries based on the developed models.

Payoffs:

- Provide calendar or mileage based (RUL) estimation for batteries based on military specific duty cycles.
- Leverages experience in battery aging processes developed through work with industry.
- Leverages NAC Investment

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Tactical Wheeled Vehicle CBM SIL



Schedule & Cost

Milestones	FY08 4Q	FY09 1-2Q	FY09 3-4Q	FY10 1-3Q
Diagnostic Software Evaluation				
Data Bus Evaluation				
ECU Diagnostic Comms. SW Model				
Sensor Integration and HWEvaluation				
Lab Demonstration				
TOTAL \$ 450K				

Purpose:

To develop a Tactical Wheeled Vehicle System Integration Lab (SIL) that will be utilized to asses, test, and evaluate various COTS/GOTS software & hardware and vehicle electrical data buses. The SIL will also be used for sensor integration and ECU model development.

Products:

- Advantages/disadvantages of various vehicle electrical data bus designs
- Advantages/disadvantages of various diagnostic software suites
- Vehicle CAN bus simulator
- Powertrain ECU models\
- Sensor integration network

Payoffs:

- Risk reduction facility where software & hardware can be integrated, validated, and tested prior to being fielded
- Evaluation of both stand-alone functionality and interoperability prior to being fielded
- Honest broker assessments of technologies and systems
- Provides an opportunity to familiarize ourselves with current PD TMDE software and hardware
- Ability to simulate CAN bus messages for multiple platforms without the need of a vehicle..

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