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How Opportunistic is it for Prognostics Products to Transition?

AMRDEC
STRENGTH THROUGH TECHNOLOGY

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

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Condition Based Maintenance (CBM)

PREVENTIVE	INDICATORS	DIAGNOSTICS	PROGNOSTICS	ON-CONDITION
• Reactive Maintenance • Time Based Inspection/Overhaul		• Digital Source Collector Installation • Knowledge Development • Fault Diagnosis • Remaining Useful Life Calculation • Inspection Targeting	• Proactive Maintenance • 'On Condition' Inspection/Overhaul	

CBM Program Objectives:

- Decrease Maintenance Burden on the Soldier
- Increase Platform Availability and Readiness
- Enhance Safety
- Reduce Operations & Support (O&S) Costs

Key CBM Enablers
- Digital Source Collectors
- Flight Line Diagnostics
- Data Fusion/Analysis

The Purpose of Army Maintenance is to Generate Combat Power.
AR 750-1

Currently Monitored by Vibration

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Systems Need to Work ...

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Photos Courtesy of U.S. Army

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They have to Work …

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Because these guys need them

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How do WE make sure our systems will work?

- We talk Systems Engineering
  - Build a better system
    - More reliable
    - Less hardware (maybe)
  - Build in Redundancy
    - How much redundancy?
  - Build smarter systems
    - Self aware/ prognostic enabled (?)
  - Buy more systems

- Which one is best?
  - Better system is always good, but at what cost
  - Redundancy was good reliability offset
  - Smarter follows thread of better
    - Knowledge vs. Wisdom
    - Knowledge is of the past, wisdom is of the future. Vernon Cooper
  - Unless its really cheap, more is not better

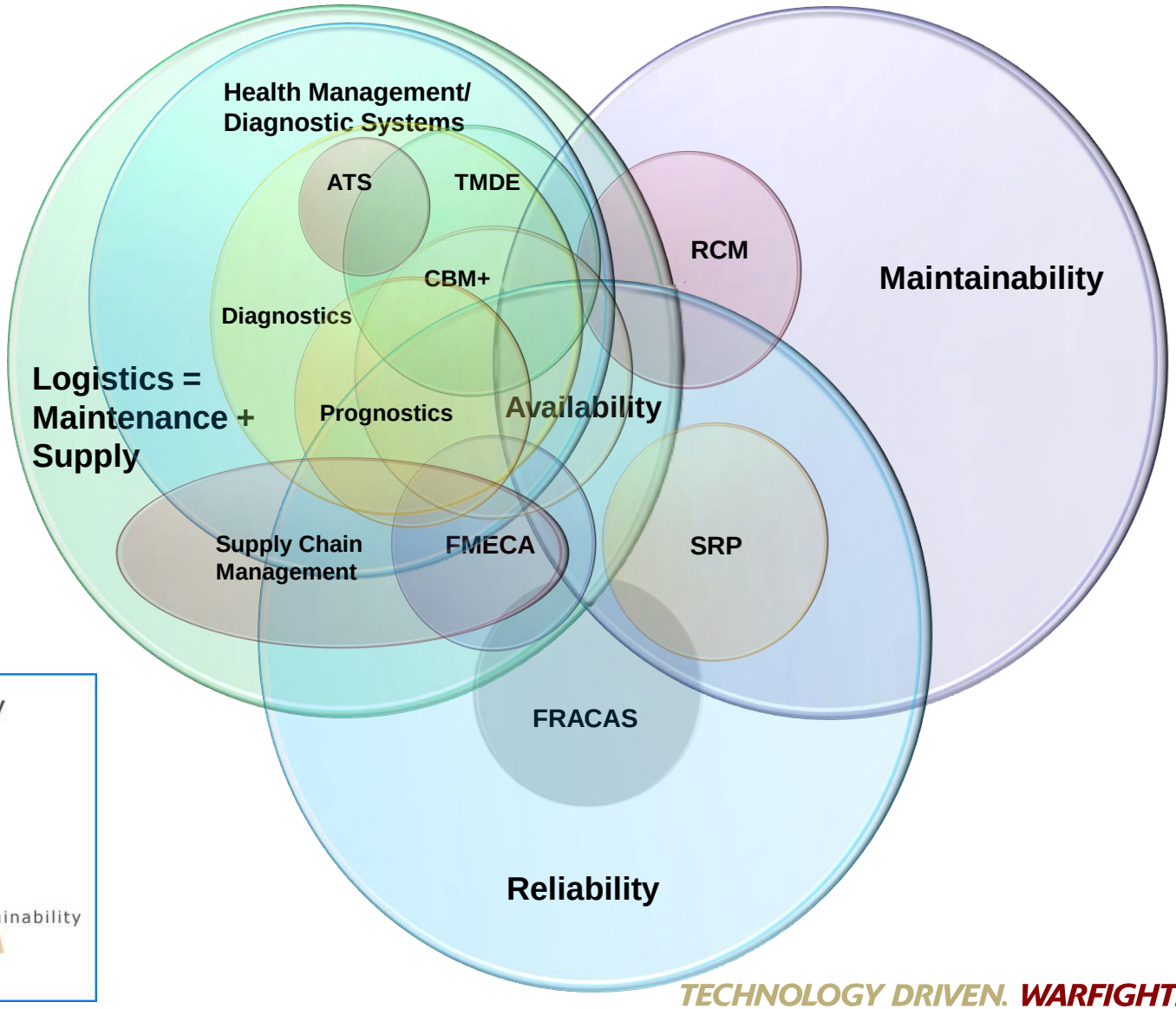
Prognostics a Path to Wisdom?

- The Department of Defense has performed system health management in many forms.
- Maintaining the systems and equipment that protect our troops has never seen more visibility and support, but not necessarily the budget to effectively deliver.
- The latest form of system health management is an augmentation that employs prognostic measures to increase probability of a successful mission.

- Chicken & Egg
  - Diagnostics/Prognostics
  - Probabilistic vs. Measurement Based
  - Integrated Diagnostics vs. Condition Based Maintenance (CBM+)
  - EHM, IVHM, SHM, ISHM, PHM, …
- All have two letters in common – HM
  - Health Management

Goal is increased READINESS through AVAILABILITY

Availability Building Readiness



PHMTech

Major goals of this event were to identify and share the methods to overcome PHM Technology validation and maturity issues and expedite PHM Technology transition to our defense and commercial systems. The focus was in four areas:

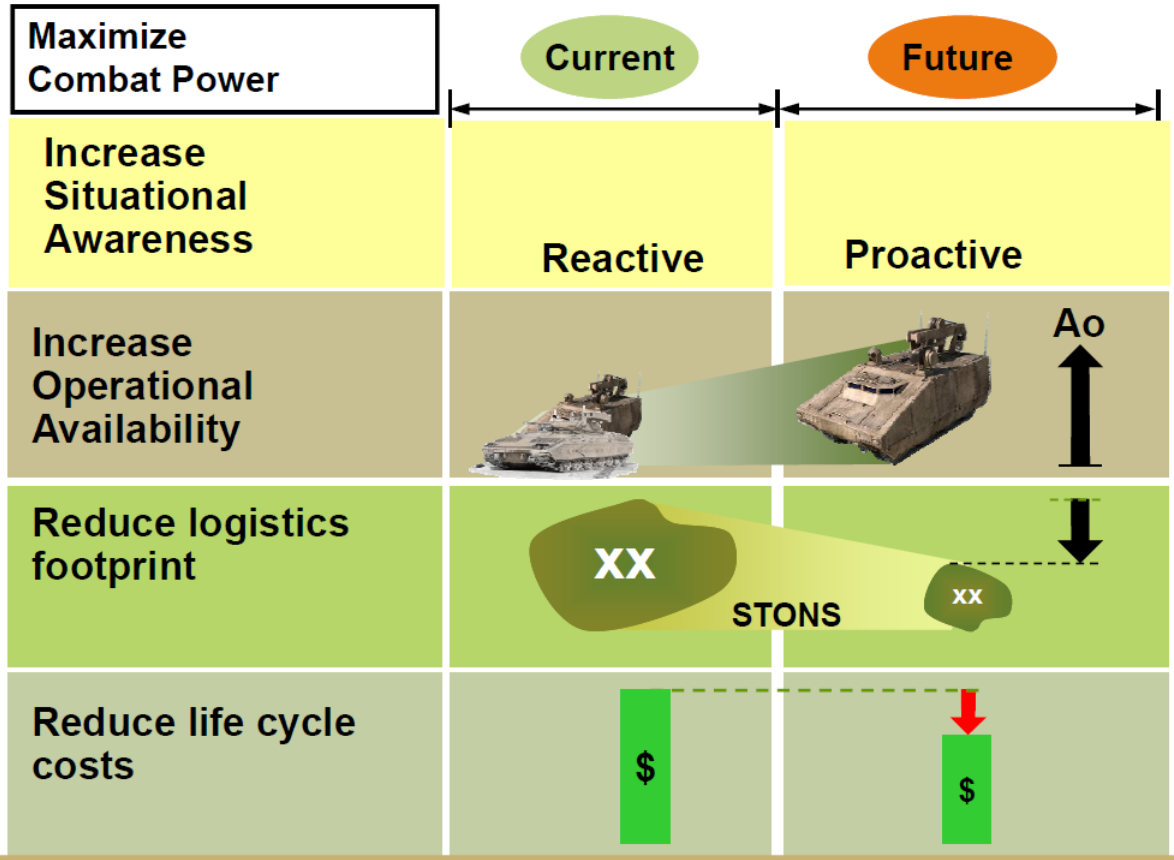
1. **How do we define PHM Technology needs?**
2. **How do we develop the basic and applied technologies needed to assure PHM for our systems?**
3. **How do we mature these technologies in today's environment?**
4. **How do we assure transition to our systems?**

Defining Prognostic Technology Needs

- DOD "Needs/Requirements" generated by the "User" Representative
- Summary from COL(R) Steve Bourgeois
  Deputy Director,
  Sustainment Battle Lab

- How we fight and the operational environment have dramatically changed
- Prognostic/Diagnostic requirements are challenging and absolutely essential to Operational mission success
- These requirements pose challenges that cannot be met using past practices

Our Objectives...The Solution



Equip platforms and designs with self-reporting, real-time, embedded prognostic and diagnostics systems.

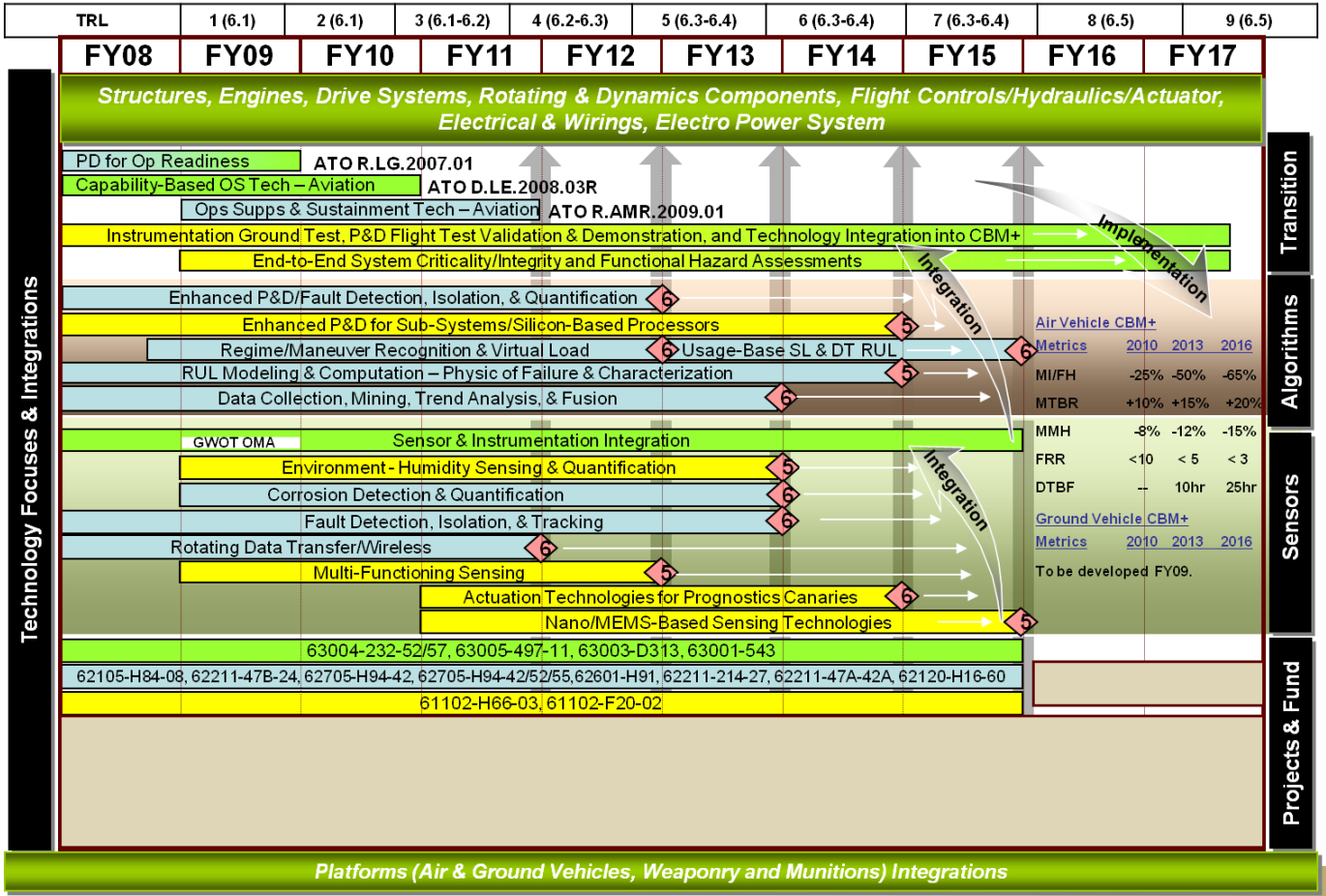
Develop the Basic and Applied Technologies

- **DOD Basic and Applied Research and Development Technologies developed by the R&D Laboratories and through Academia and Industry Programs**
- **"There are numerous activities ongoing throughout the Government and industry—*we must leverage these efforts." Treven Baker, AMRDEC AATD Operations Support & Sustainment Technologies (OSST)-Aviation ATO Manager***
- **PHM Technologies: From Fundamentals to Applications, George Vachtsevanos Georgia Tech and Impact Technologies**
  - **The challenge: A paradigm shift; cultural and technical issues; show me! Transitioning on-platform.**
- ***Effective Electronic Prognostics for Critical Systems – Tech Transition,* Doug Goodman Ridgetop Group, Inc.**
  - ***SBIR companies and Prime Contractors work from opposite ends of the TRL scale***
- ***NASA Prognostics Center of Excellence, Kai Goebel***
  - ***Implementation will be slow and painful, often one small step at a time***
  - ***Overcome bottlenecks in academia, government, industry***
    - ***Vision: coordination of programs, technology development, education***

Maturing Prognostic Technologies in Today's Environment

- *Maturing PHM Technologies, Serdar Uckun, M.D., Ph.D., Palo Alto Research Center*
  - *Lesson #1: technology "push" is not an ideal method for infusing advanced technologies in mission-critical applications.*
  - *Lesson #2: In order to fly, new technologies need to reduce overall project risk, not increase it.*
  - *Lesson #5: In order to be accepted into practice, PHM technologies need to address key customer requirements.*

US Army RDECOM Mobility – Logistics Technology Focus Team Prognostics & Diagnostics Roadmap
Dy D. Le, Army Research Lab



Assuring Transition

- *Core Barriers/Challenges to Transition, Tim Wilmering, Boeing Research & Technology*
  - Lack of Validated Benefits, Confidence in HM Payoff
  - Lack of Data Sets to Support HM Development: Plenty of Algorithms, Not Enough Data
  - Lack of a Coordinated Systems Approach in Upgrading Legacy Vehicles. Example: MFOQA and IVHM
  - Lack of Coupling between HM Requirements Flow Down and System Design
  - Lack of Focus on HM Integration Requirements: Technologies and Approaches to Integrate IVHM into legacy or new Avionic Systems.
- NDIA Enterprise Health Management (EHM)
  - EHM/CBM+ S&T roadmaps are not integrated across the Services, Agencies and domain IPTs : duplicate core efforts, stakeholder resources are not aligned to achieve vision

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Opportunity Knocks

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- WE as a community, NEED to work together to make transition of prognostic technology happen
- WE as a community, NEED to develop standards that convey understanding of prognostic needs and define prognostics in common terms to Program Managers and their Staffs
- Prognostic Horizons need to be defined in terms related to operational environments
  - Operational Prognostic Horizon (may be minutes/hours)
  - Strategic Prognostic Horizon (may be days/weeks)
- Prognostic technology transition is not singular event
  - Not necessarily an engineering transition
  - Need to speak Logistics – Maintenance and Supply
  - Impacts the entire enterprise support architecture

The Opportunity to transition Prognostic Technology is OURS to …

Thank-you