

*High Performance Computing is key to addressing the DoD's most significant challenges*

Computational Research for Engineering and Science  
Ground Vehicle (CRES-GV)



***Computational Research for Engineering and Science Ground Vehicles***

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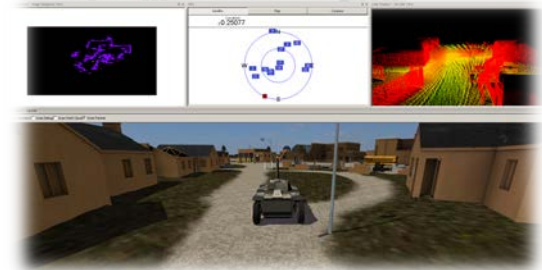
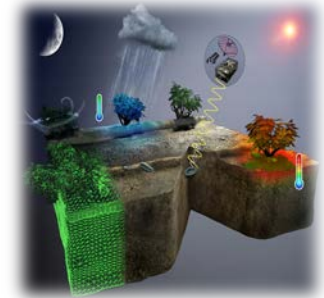
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# Agenda

- HPC is the Key
- Acquisition driving needs
- Preliminary product ideas
- Discussion items

# High Performance Computing (HPC) is key to addressing the DoD's most significant challenges:

- In *research*, HPC enables exploration and evaluation of new theories well beyond what is financially possible using experiments alone.
- In *acquisition*, HPC facilitates the use of comprehensive multi-scale, physics-based, validated applications for requirements, specifications, acquisition, and testing of complex systems.
- In *operations*, HPC allows for real-time calculations to produce just-in-time information for decision makers on the battlefield.



***HPC is transforming and revolutionizing DoD's ability to accomplish its present and future mission.***

***Computational Research for Engineering and Science Ground Vehicles***

# Computational Research for Engineering and Science - Ground Vehicle (CRES-GV)

- Develop an HPC software suite to perform physics-based systems integration of ground systems.
  - Supported, commercial quality
  - Government owned
- Acquisition program focus
  - Positively impact cost, schedule, performance and reduce risk
- Goal: OEM and government use

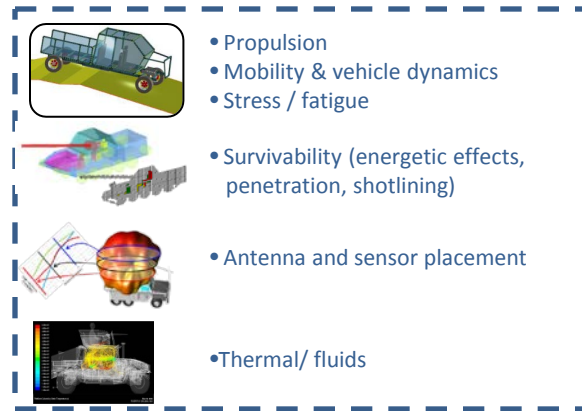


## HPC Solutions for;

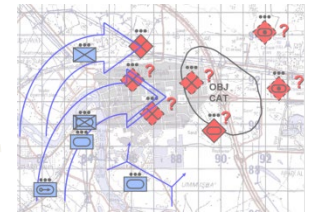
- Mixed-fidelity multidisciplinary physics solver
- Optimization tool focusing on robustness
- Supply of data to high level trade-space tools
- Improved Soldier–in-the-Loop using virtual systems
- Enhanced collaboration for design and analysis

# How CRES-GV Solver Will Integrate

## CRES Multiphysics Quick Turnaround HPC-Enabled Solver Suite



### Feeds Existing Operational Models



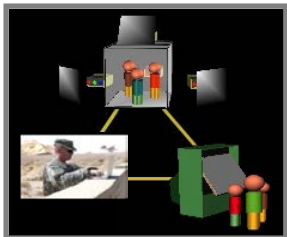
- Better vehicle data = better results
- Improved vehicle requirements

### Enhanced Soldier-In-The-Loop



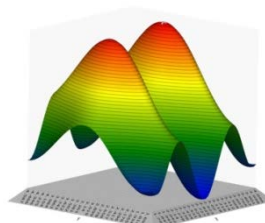
- Enables soldier-centric design
- Accurate geo-environments
- Duty cycle characterization

### Immersive Collaboration Environment



- 3-d Immersive Collaboration
- Pre/post processing
- Better user feedback

### Thorough Designspace Exploration



- Robustness optimization

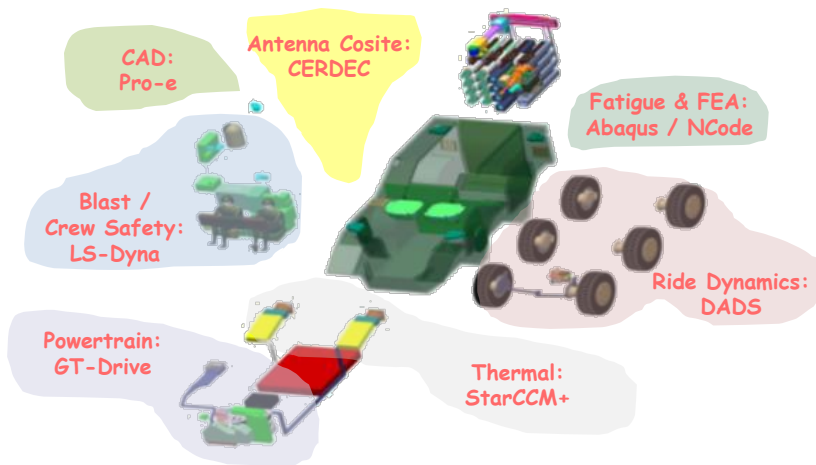


- Allow interactive exploration of the requirements space

# Why Should We Care? Systems Integration

## Current Practice = Performance Risk

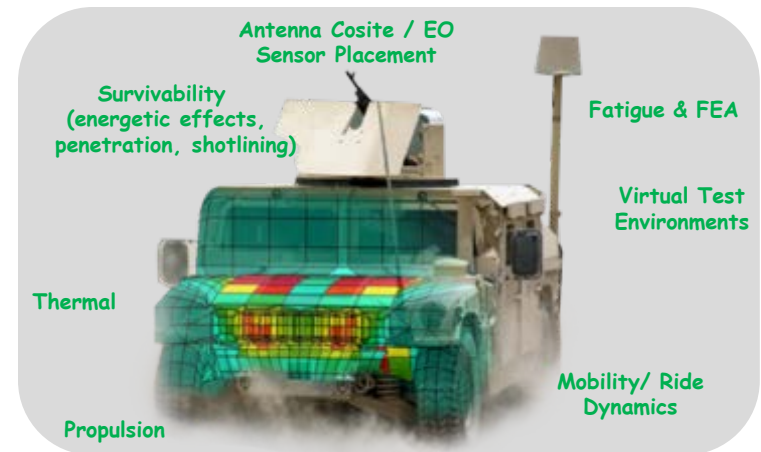
- “Stovepiped” analysis performed by separate SMEs in each physics domain = **RISK**



## CRES-GV Approach = Reduced Risk

- Integrated analysis performed for all physics domains = **REDUCED RISK**
- Captures secondary effects

### Virtual Systems Integration

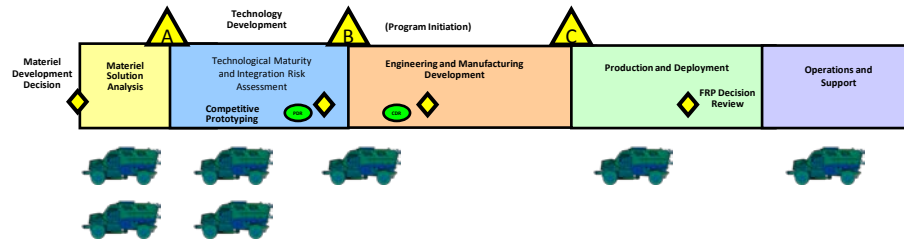




# Why Should We Care? Cycle Time

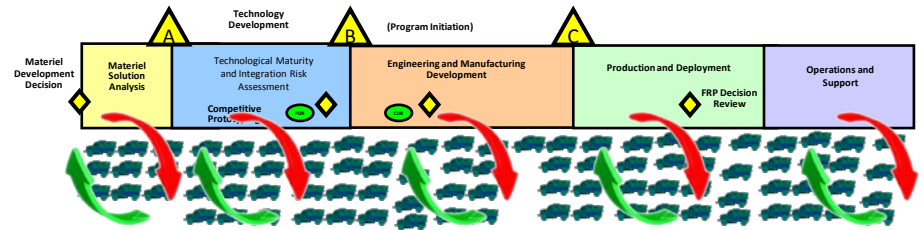
## Current Practice = Schedule and Performance Risk

- 2-3 month turn around on CAE = Non optimized system and limited flexibility



## CRES-GV Approach = Improved Schedule & Reduced Performance Risk

- 72 hour turn around on CAE = Maximum design flexibility and optimization
- More iterations better designspace explorations



# Why Should We Care? Soldier Centric Design

**Current Practice =  
Performance risk,  
Schedule and cost risk**

- Soldier only able to “kick tires” of physical prototype

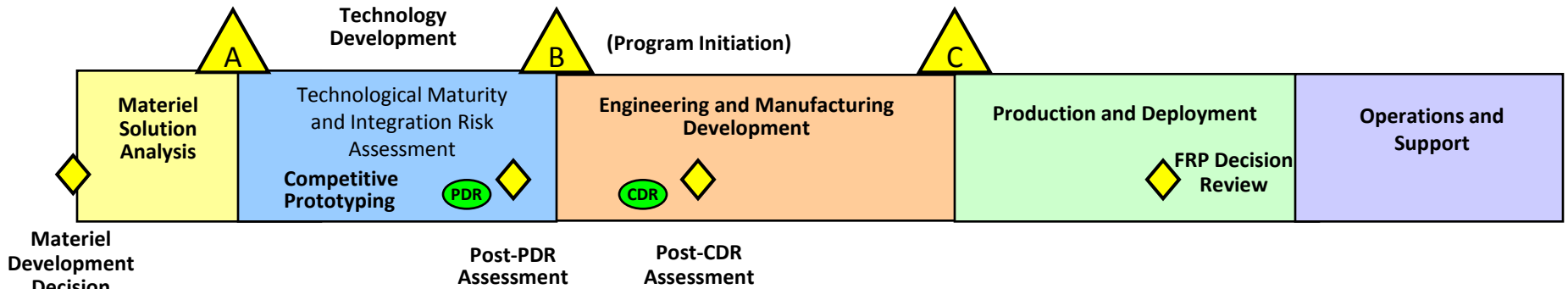


**CRES-GV Approach =  
Improved Performance  
Eliminates rework cost and  
schedule impacts**

- Soldier able to try out virtual vehicle before metal is cut
- Ride quality / 360 degree awareness issues
- Layout of gauges and crew station
- Evaluate duty cycles



# HPC Impact on Design and Acquisition

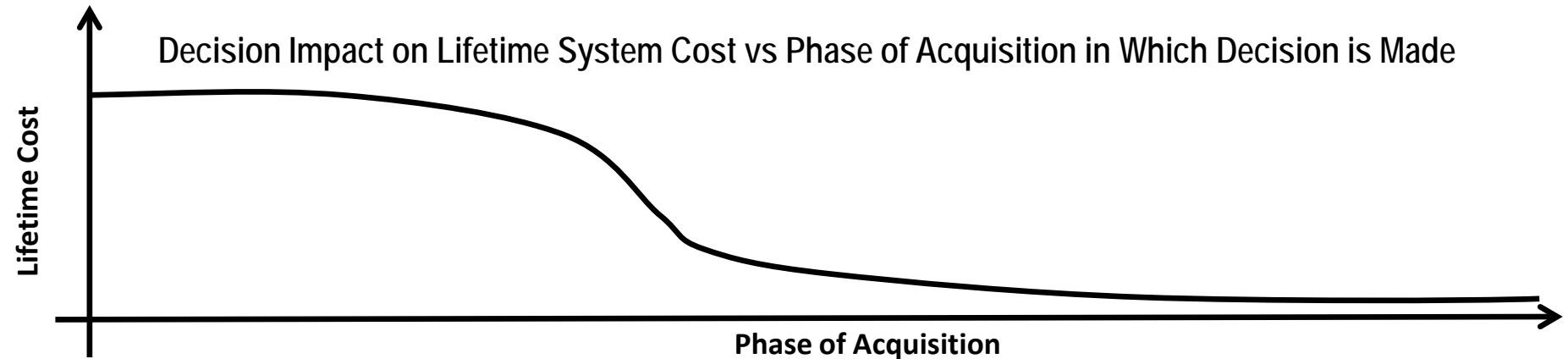


Government M&S

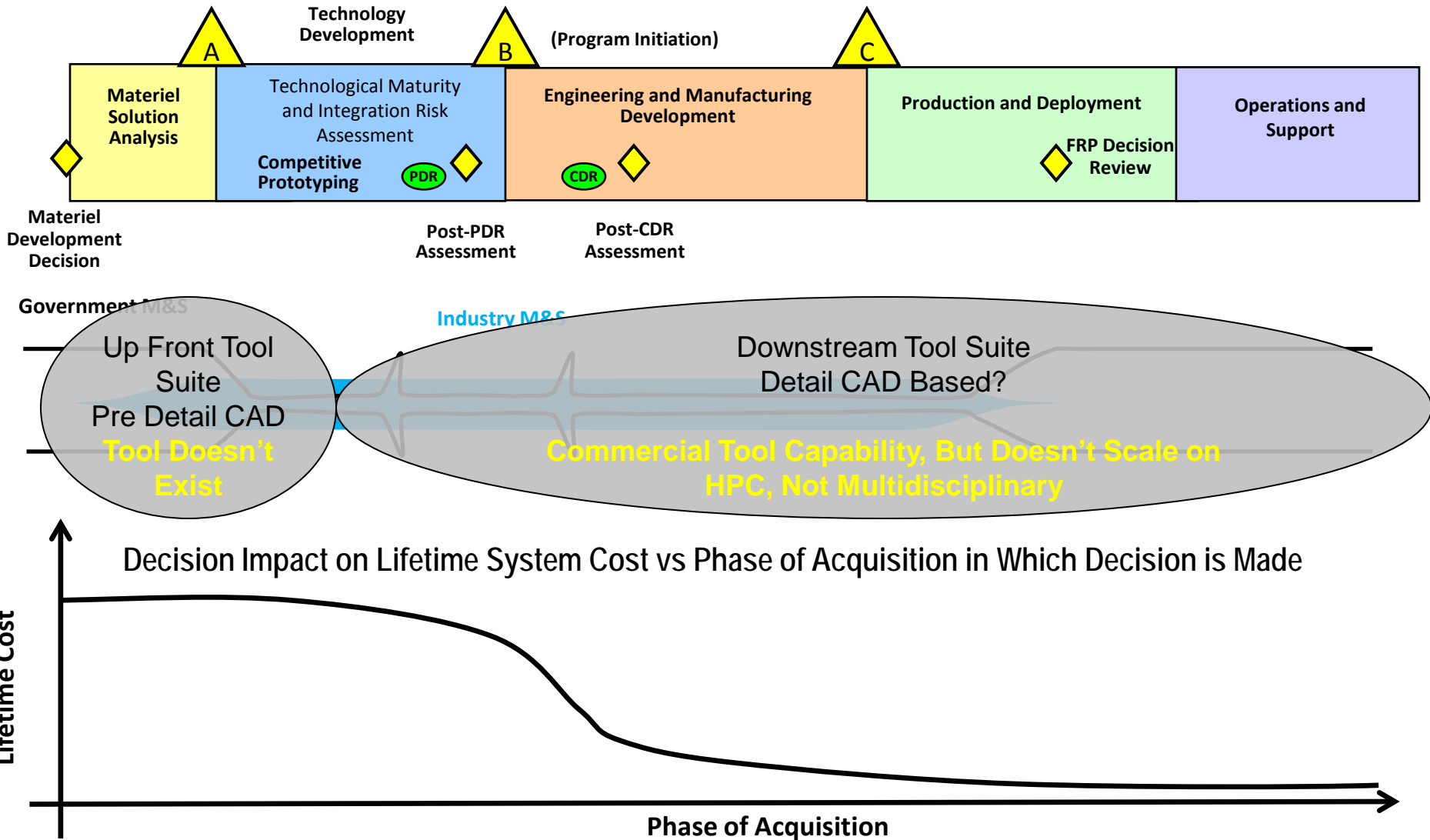
Industry M&S



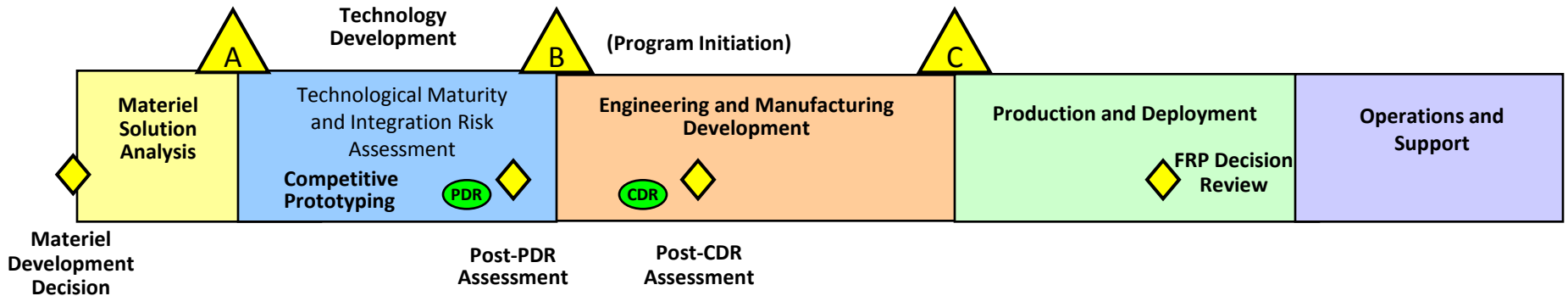
Decision Impact on Lifetime System Cost vs Phase of Acquisition in Which Decision is Made



# HPC Impact on Design and Acquisition

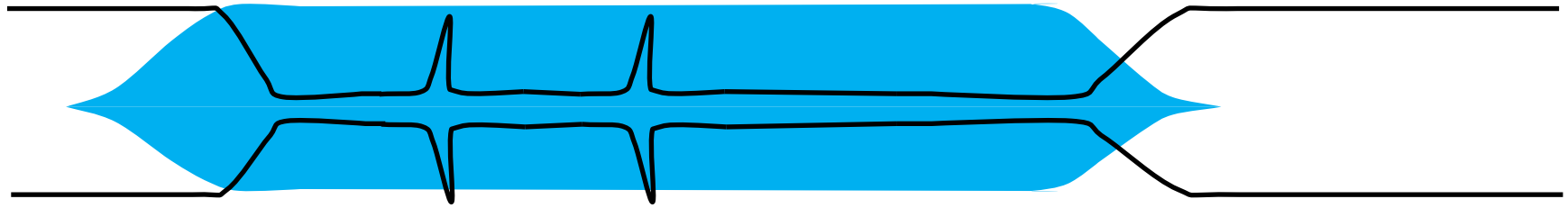


# HPC Impact on Design and Acquisition

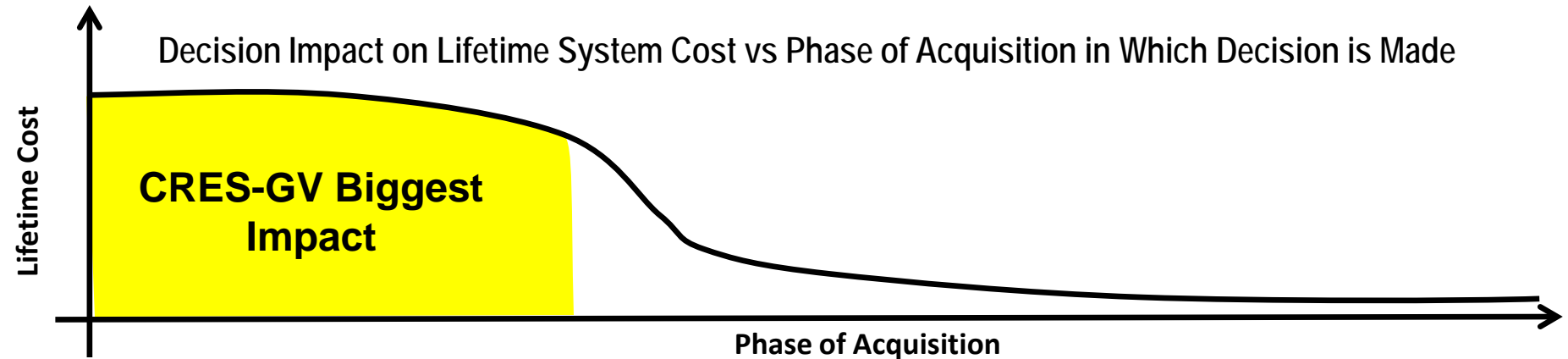


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Decision Impact on Lifetime System Cost vs Phase of Acquisition in Which Decision is Made



# Computational Research for Engineering and Science - Ground Vehicle

## **Conclusions**

- Develop an HPC software suite to perform physics-based systems integration of ground systems
  - Knowledge up-front and early
  - Supported, commercial quality
  - Government owned
- Acquisition program focus
  - Positively impact cost, schedule, performance and risk
- OEM and government use will enhance designs directly and not just requirements

# BACKUP

# Computational Research for Engineering and Science – Ground Vehicle (CRES-GV)

## Objectives and Capability Payoff

### Objective

- The objective is to develop validated physics-based modeling and simulation methods to assist in the design and development phase of ground vehicles. Modeling and simulation methods are critical in assessing the performance requirements of competing designs, and in conducting trade-off studies and sensitivity analyses or “what-if” scenarios to help in the development of a robust vehicle design which meets and/or exceeds all functional and performance requirements. The capability being developed can also be used to understand the performance of current vehicles in operational environments.

### Capability payoff:

- HPC hardware capabilities, coupled with a focused development of physics-based software tools and the ease of use of these tools from the designers desktop will revolutionize the Ground Vehicle design and development acquisition process and the system life cycle costs.
- Program Executive Offices (PEOs) and Project/Product Managers (PMs) will be able to make informed decisions of new concepts for initial design or for modifications of existing systems based on sound fundamental science and engineering principals.

## Funding, Schedule and Performers

- Year 1:** Finalize working group, apply the methodologies for integration and full leveraging of the HPCMP CREATE project, requirements gathering from the analytical and end-user communities, identify existing and relevant computational tools, develop and strengthen partner relationships by identifying existing and potential commercial and industry partners, create a board of directors, and obtain endorsements from the acquisition community.
- Year 2-3:** Execute program

ORG	FY-12 (\$K)	FY-13 (\$K)	TOTAL (\$K)
ERDC	180	-	-
TARDEC	320	-	-
TOTAL	500	5000	5500

## Technical challenge & approach

### Technical Challenges:

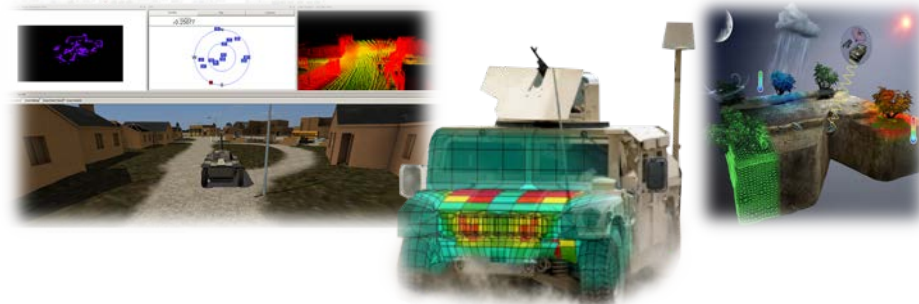
- Software tools that enable computational designs to use comprehensive multi-scale analysis methods.
- Integration of computational tools which include both the geo-environment and vehicle for assessing ground vehicle design and performance.

### Technology / Approach:

- Multi-scale, physics-based modeling for ground vehicle designs based on physical characteristics and composition which would allow the computation of the projected performance for the alternative designs.
- “System of systems” approach for ground vehicle design, requiring a multi-disciplinary optimization process incorporating aspects of mobility, vehicle dynamics, energetic effects, propulsion, thermal, acoustic, and fluid effects.

## Accomplishments & Transition (potential)

- HPC hardware capabilities, coupled with a focused development of physics-based software tools and the ease of use of these tools from the designers desktop, will revolutionize the Ground Vehicle design and development acquisition process, significantly reduce system life cycle costs, and shorten acquisition schedules. PEOs and PMs will be able to make informed decisions of new concepts for initial design or for modifications of existing systems based on sound fundamental science and engineering principals, enhanced by CRES-GV.





# Technology Focus for HPC Multi-Scale, Physics-Based Modeling

- Propulsion
- Survivability (blast, penetration, shotlining)
- Thermal
- Antenna and sensor placement
- Duty cycles
- Mobility & vehicle dynamics
- Stress / fatigue