### Armor Considerations for Ground Platforms

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Goal:

To develop advanced armor technologies that provide ground combat and tactical wheeled vehicles capability to provide enhanced protection (multiple threats), weight reduction, and adaptability to threat evolution.
Motivation

DRIVERS

• Lightweight/Mobile
• Threat
• Designable/Repairability
• Armor: Multifunctional Ballistic/Structural

The 3 Ps!

NEED TO BALANCE

PERFORMANCE

PROTECTION

PAYLOAD

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Armor Design

- Optimal use of mechanics and materials
  - Understand/use mechanics to obtain desired effect
  - Use materials that will amplify the performance of the mechanics
  - Demand “ultimate” performance from materials

Numerical simulations are an integral portion, providing understanding and direction
Vehicle Armor Damage Concerns

• Fabrication issues ("Was that supposed to go in there?")

• Logistical issues ("Did you drop that?")

• Non-combat impact ("Where did that [tree, ditch, wall, (fill in your own)] come from?")

• Combat impacts (penetrating AND non-penetrating ballistic events, blast)
Materials for Ground Platforms

- Ideal situation: materials readily available and fully developed.
  - RHA
  - High hard steel
  - Aluminum
- Reality: Research projects are ongoing to further develop advanced lightweight armors.
  - Composites
  - Ceramics
  - Titanium
  - Magnesium
  - Composite and metal matrix
  - ?????????
- Silicon Carbide Armor Tile Comparison at Equivalent Ballistic Protection

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<th>Cost</th>
<th>Density</th>
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*Production cost

- Titanium & Aluminum/Lithium Alloy Raw Material Cost

\[\sim$12/lb \text{ vs. } \sim$4/lb \text{ for Conventional Aluminum}\]
Transportability Assessment

DOD - Rail

C17

GIC - Rail

-2.5” B1 + 18” RA

The graphic displays RA outline minus the 2.5” B1 armor.

Note: the ICV has storage on the outside of the side armor.
Combat Vehicles

Current

- Thick, heavy armor
- Structure as by-product of armor
- Inherently damage tolerant
- Arrive on ships
- Well understood materials and manufacturing practices
- Designed for force-on-force engagement
- Cumbersome logistics tail
- Basic situational awareness

Future

- Lightweight armor
- Structure plus armor (A + B)
- Relatively damage intolerant
- Air transportable (C-130)
- Advanced ceramic armors, use of polymer composites and associated mfg. practices
- Designed for noncontiguous, non-linear, reorganizing battlefield
- Common components, reduction of logistics footprint
- Network centric, highly interdependent
Tactical Vehicles

Current
- Tired and aging fleet
- Corrosion prone
- Cabs typically unarmored. Armoring via add-on-armor kits
- Reduced vehicle payload, maneuverability, reliability, safety, maintainability, and life expectancy
  - Increased wear and tear on vehicle components, fuel consumption, and life cycle costs
- Multiple original equipment manufacturers, little commonality
  - Designed for traditional role of logistics support

Future
- Recapitalization with appliqué armor (A-kit/B-kit)
- Be more survivable in mine blast events
- Component commonality (hardware, transparent armor, B-kit panels
- Gun turret and advanced countermeasures
- Crew installable B-kit, with minimal tools
- Enhanced crew survivability to meet threat
- Increased system reliability
- Taking on more of an assault role

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SUMMARY

- Significant challenges remain in areas of material development and mechanisms
- Modeling and simulation is a critical enabler