US ARMY RDECOM

An Emerging Methodology for Mapping Between a System's Components and Capabilities: *The System Capabilities Analytic Process (SCAP)*

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

William Landis
Richard Moyers
Kevin Agan
Army Research Laboratory
Survivability/Lethality Analysis Directorate
Aberdeen Proving Ground, MD

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Outline

- Issues
- Objective and results
- Overview of SCAP
- Sources of dysfunction
- The Functional Skeleton
- What about personnel?
- Meaningful results
- Application of the Functional Skeleton
- Examples
- Next steps and conclusion

What are the issues?

- "Do I still have the capability to complete the mission following a damaging event?"
  - Key to Army's Mission-Based Test and Evaluation (MBT&E)
  - Cannot be answered easily using traditional methods or metrics
  - Not necessarily a single answer

- The issue with using the traditional methods or metrics in MBT&E:
  - Traditional analysis results are **qualitative** values called loss of function (LoF).
  - MBT&E requires a **quantitative** understanding of a system's remaining capability to define an effect on a mission.
  - The correlation to a specific mission context is not possible.

Objective and results

Objective:

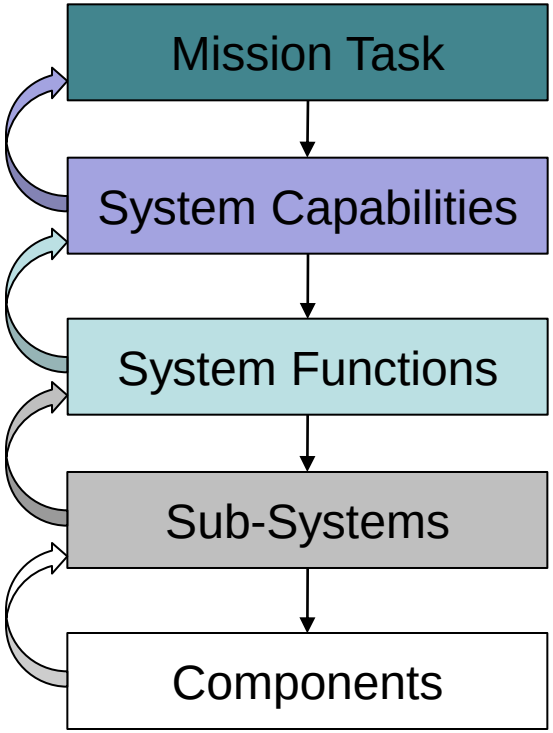
Create a methodology that will quantitatively map between a system's capabilities and a system's components.

Results:

- We have developed the System Capabilities Analytic Process (SCAP).
- SCAP produces a map between the system's capabilities and the system's components. These maps are known as the Functional Skeleton (FS).
- The FS provides the information required to determine the remaining capabilities, and therefore the course of action, following a damaging event.

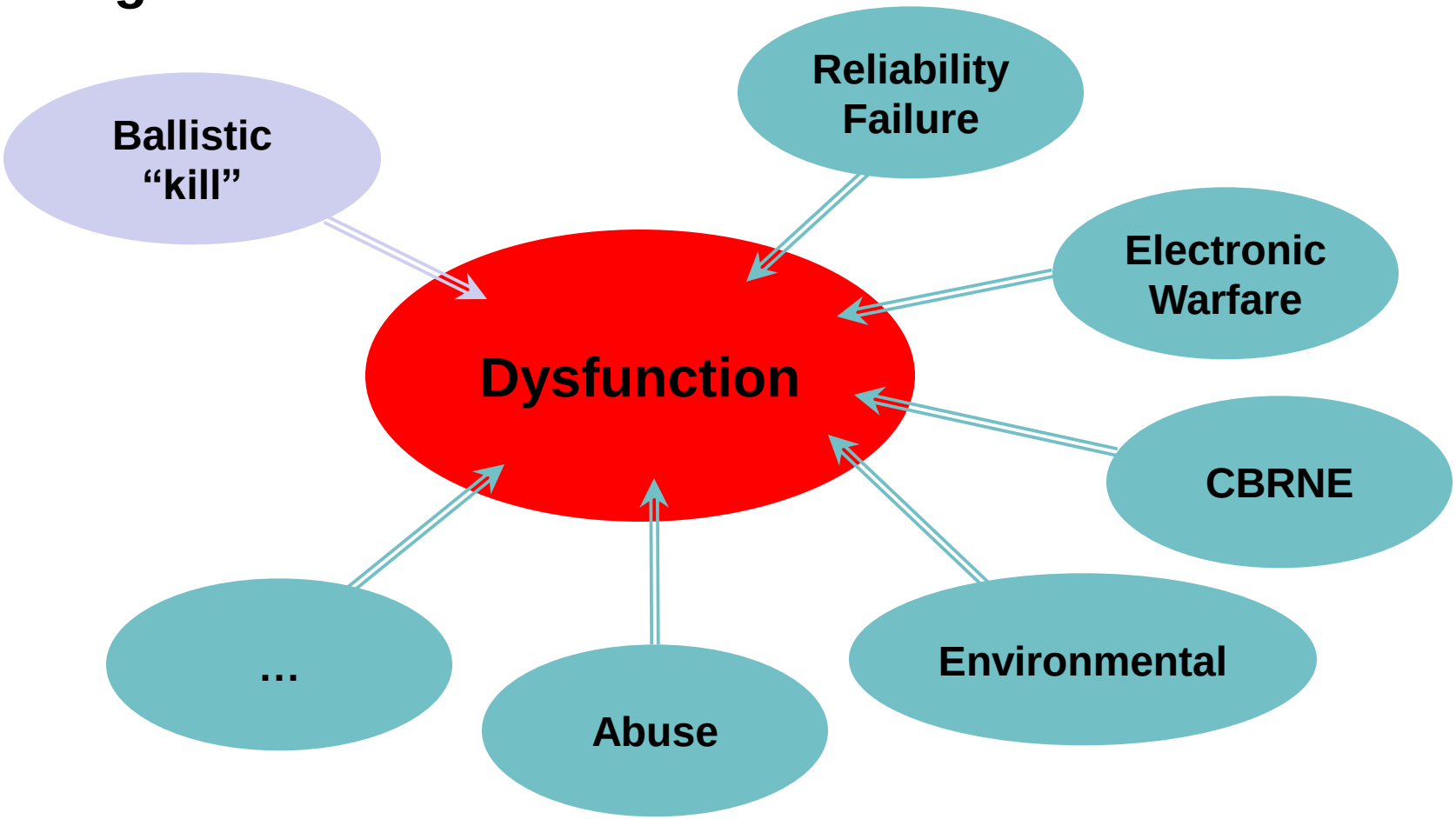
A preview of SCAP

- Components that are grouped into sub-systems perform functions that provide the capabilities to complete the mission task.
- SCAP is very similar to processes used in the consumer-product industry.
- The process reports metrics expressed in the language of the military user.
- The focus of SCAP is a system's remaining capability.

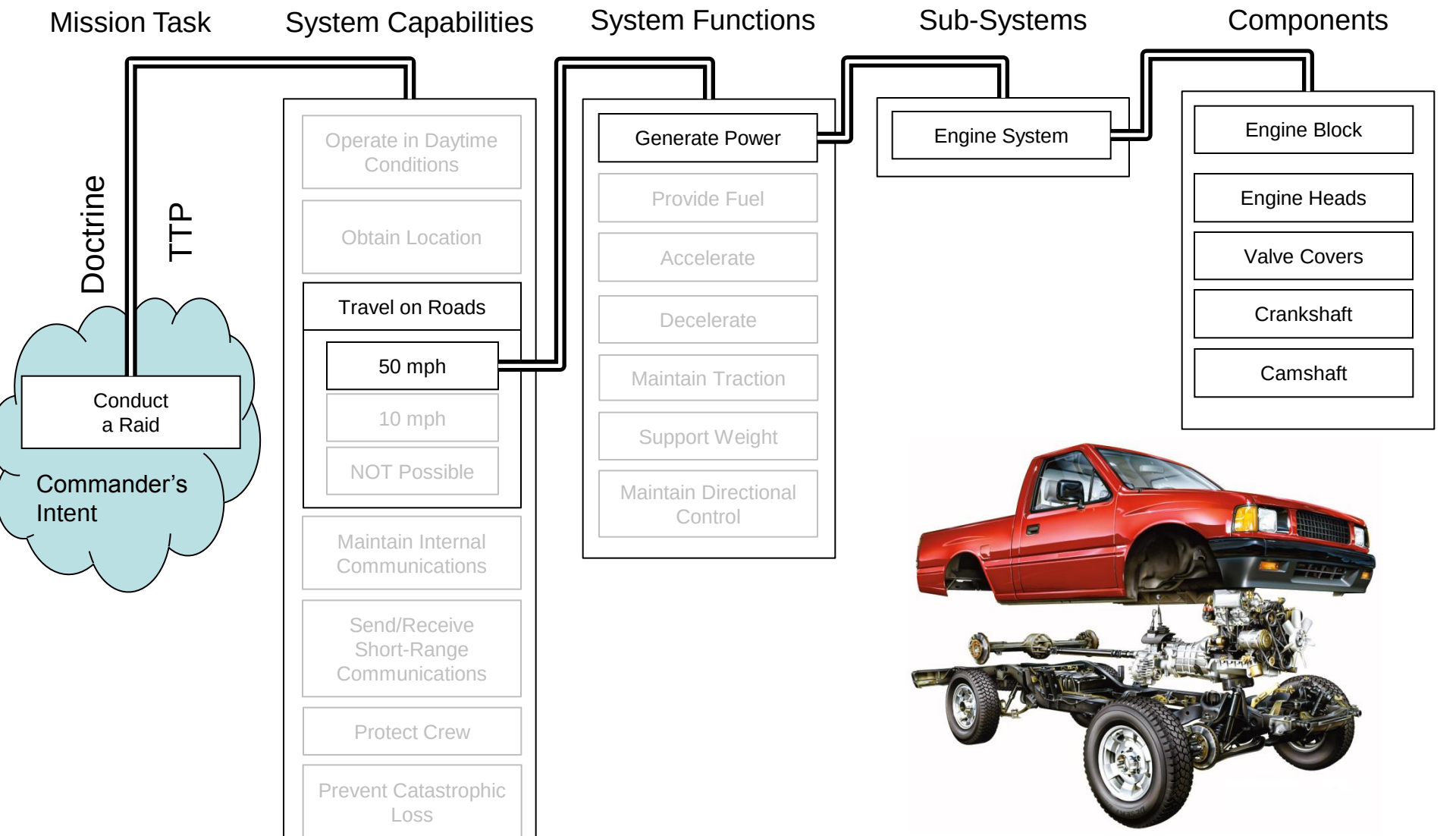


Sources of dysfunction

Dysfunction is defined as a component that is not functioning as it is intended.



The Functional Skeleton: A map between component and capability



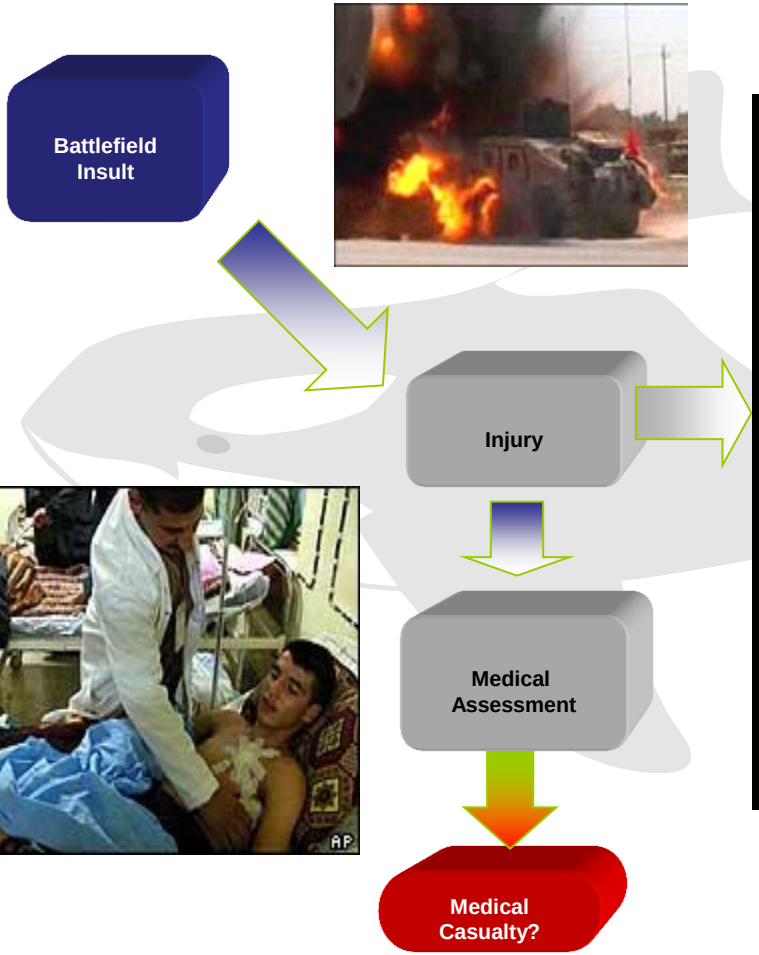
How are personnel assessed?

- First, begin with the “battlefield insult.” This is the actual mechanism that causes the injury / wounding.

- The injury is characterized both:
  - in a method to understand the medical severity, and
  - as a detailed mapping to the ability to perform certain functions post-wounding.

What toolset assesses the crew?

Operational Requirement-based Capability Assessment (ORCA)



Begin with the battlefield insult.

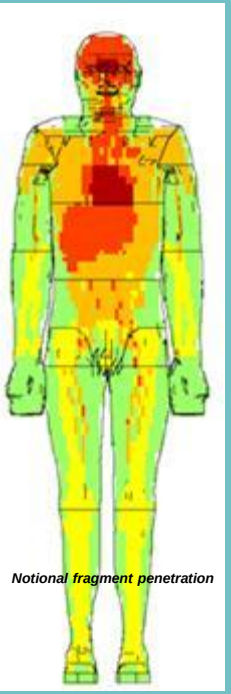
Medical Casualty

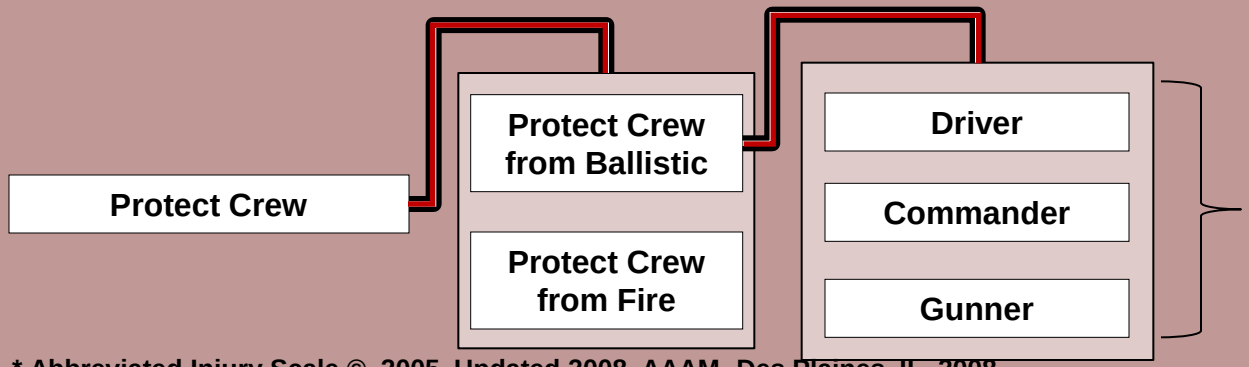
System Capabilities | System Functions | Sub-Systems

A high-resolution 'shotline' is drawn through the affected tissues to determine risk to life. This is communicated in terms of the Abbreviated Injury Scale© (AIS).*

None	Minor	Moderate	Serious	Severe	Critical	Maximal
0	1	2	3	4	5	6

The threshold of '3' (serious) or greater is scored as a medical casualty.





Medical Casualty

Warfighter has experienced an injury requiring evacuation from unit so that medical treatment can be administered.

* Abbreviated Injury Scale ©, 2005, Updated 2008, AAAM, Des Plaines, IL, 2008.

Linking injuries to functionality

Operational Requirement-based Capability Assessment (ORCA)

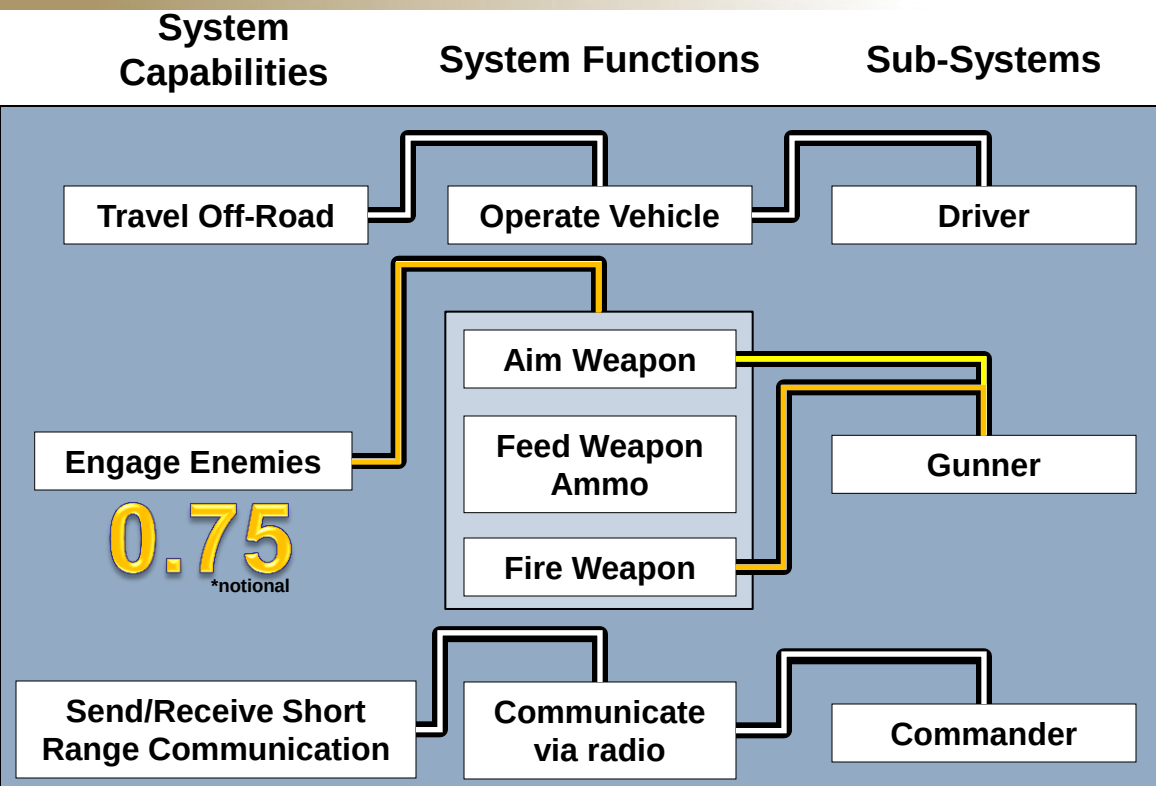
Battlefield Insult

Injury

Medical Assessment

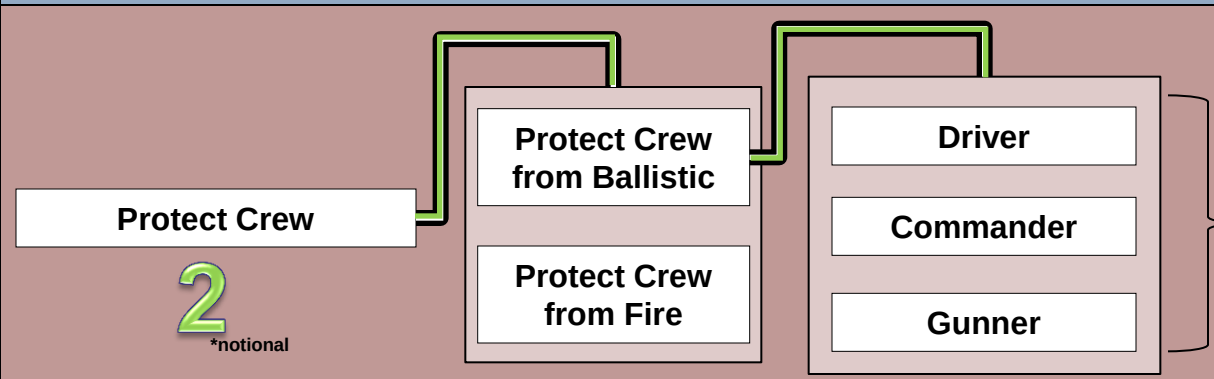
Medical Casualty?

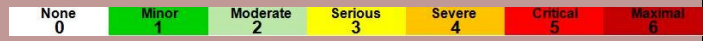
Operational Casualty



Incapacitation

Operational casualty is defined as a warfighter being unable to perform a required task or function.





Medical Casualty

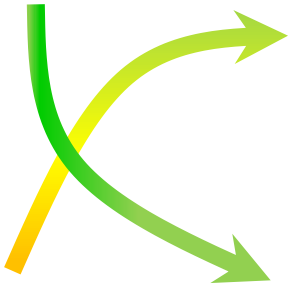
Warfighter has experienced an injury requiring evacuation from unit so that medical treatment can be administered.

A paradigm shift: action-reaction-new assessment

In the preceding example, the gunner was the only one injured. After some time, the Commander & Gunner trade places*.

Initial Incident (time=0)

- Driver:
  - AIS: 0
  - Incapacitation: 0
- Commander:
  - AIS: 0
  - Incapacitation: 0
- Gunner:
  - AIS: 2
  - Incapacitation :0.75



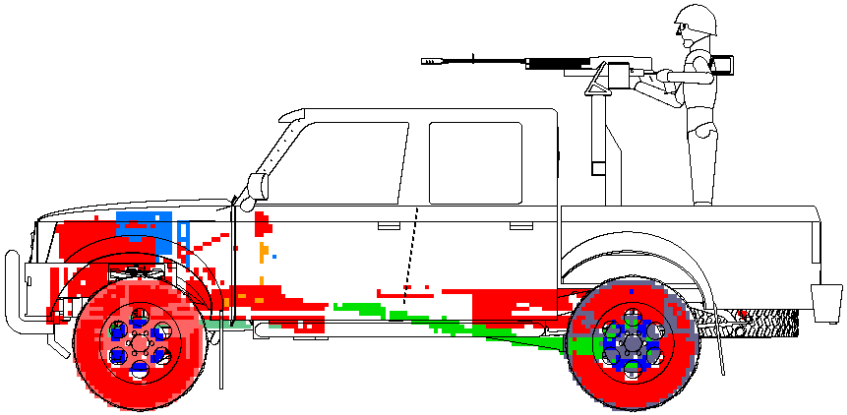
After Crew Drill(s)

- Driver:
  - AIS: 0
  - Incapacitation: 0
- Commander:
  - AIS: 2
  - Incapacitation: 0.1
- Gunner:
  - AIS: 0
  - Incapacitation: 0.1

*assumptions include no deleterious effects & some loss of performance for weapon familiarity / zeroing.

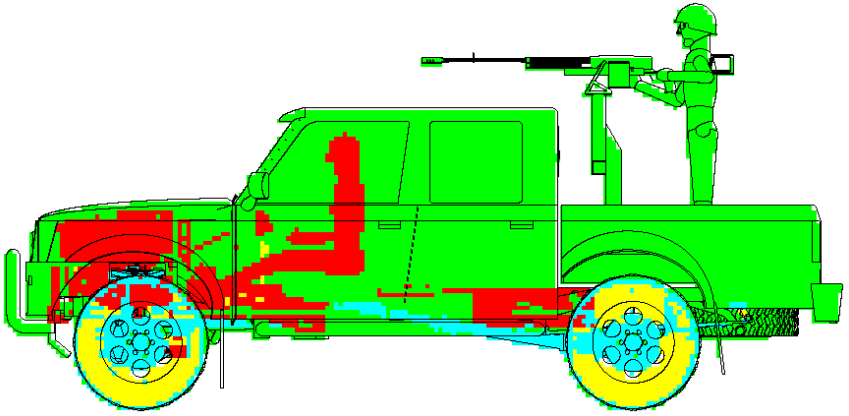
Transition to meaningful results

Traditional: mobility kill



loss of function

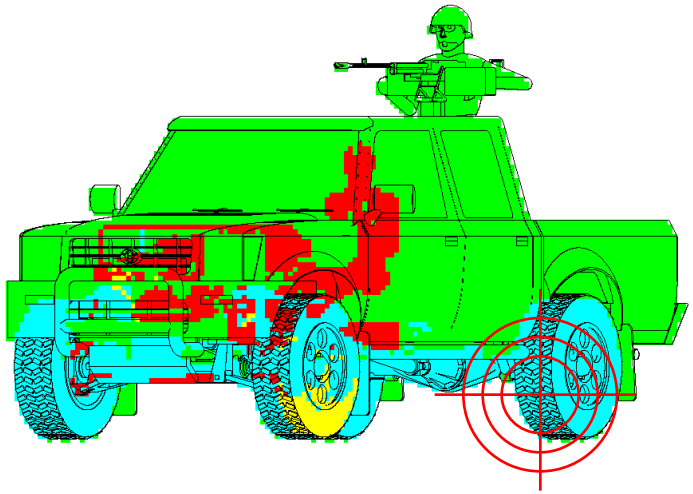
One possible SCAP metric: travel on roads

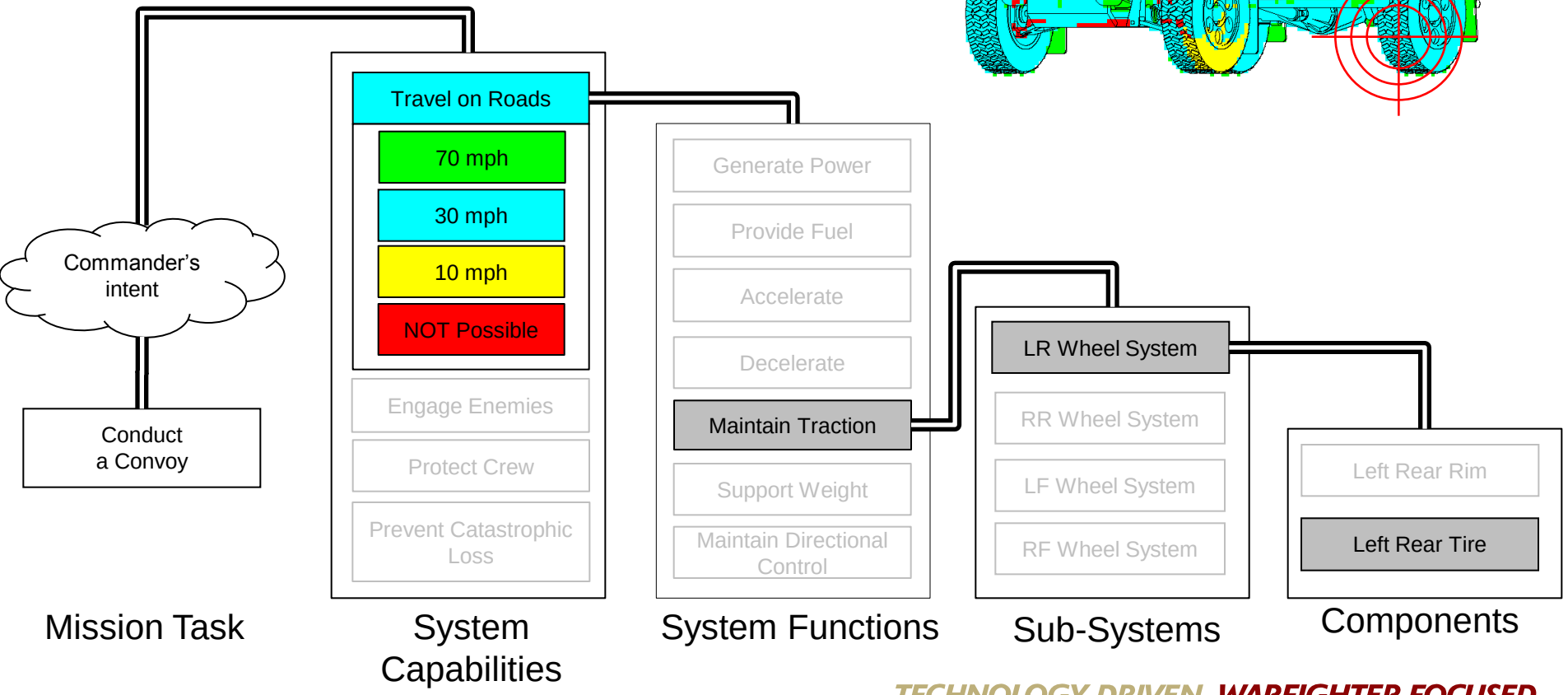


- can go max speed
- can go up to 30 mph
- can go up to 10 mph
- no-go

Truck functional skeleton

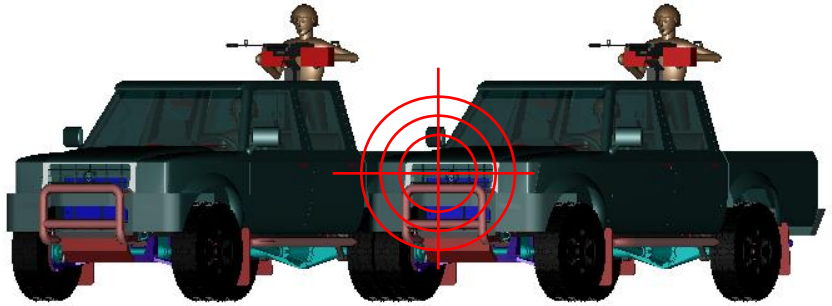
Because the truck was damaged, it's capability to travel on roads is reduced.

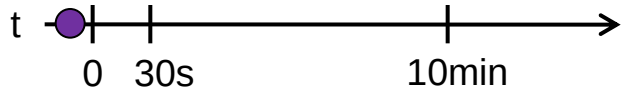


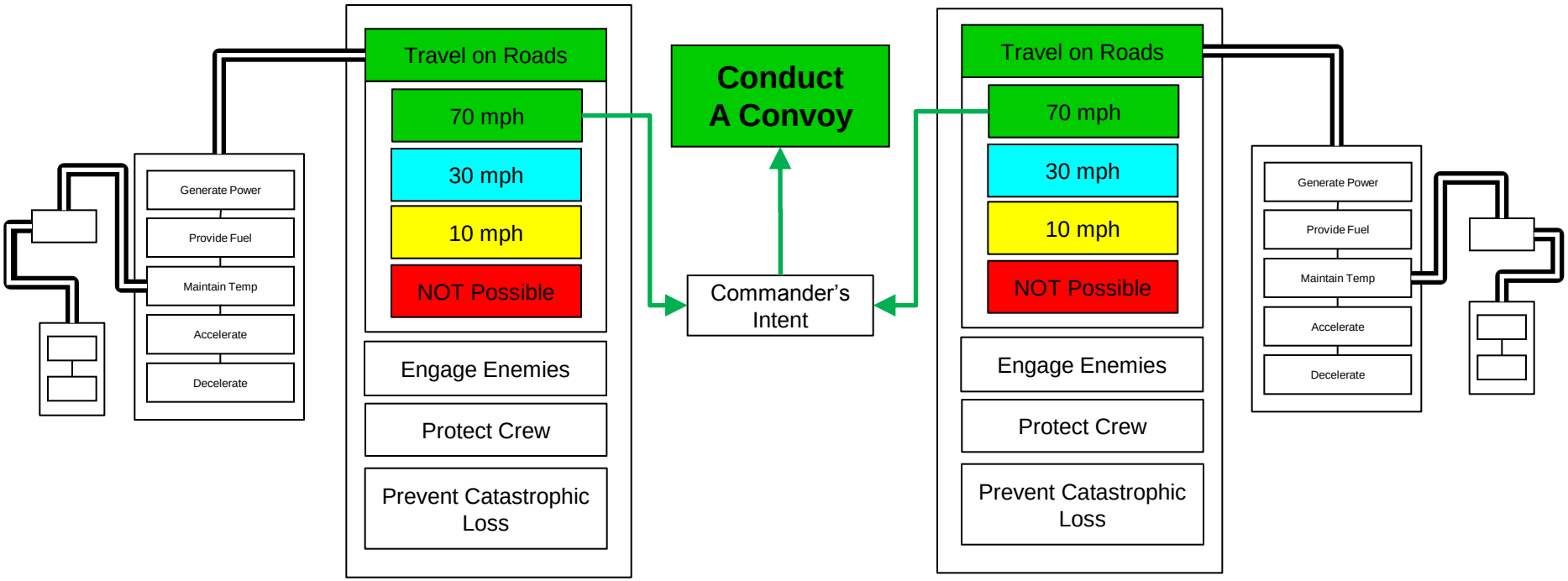


System-of-systems mission

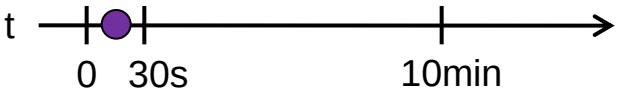
Two trucks are operating in a convoy mission. By the commander's intent, the speed of the convoy is limited to the speed of the slowest vehicle.

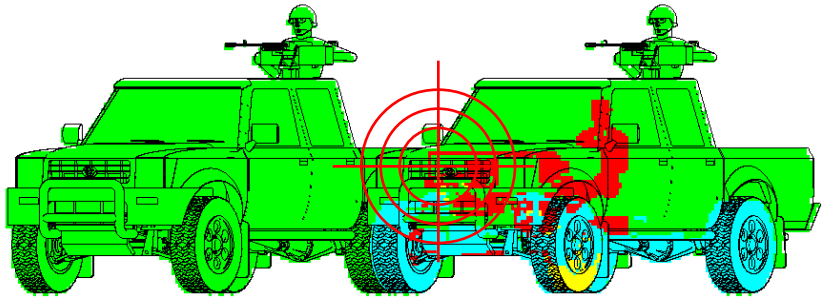




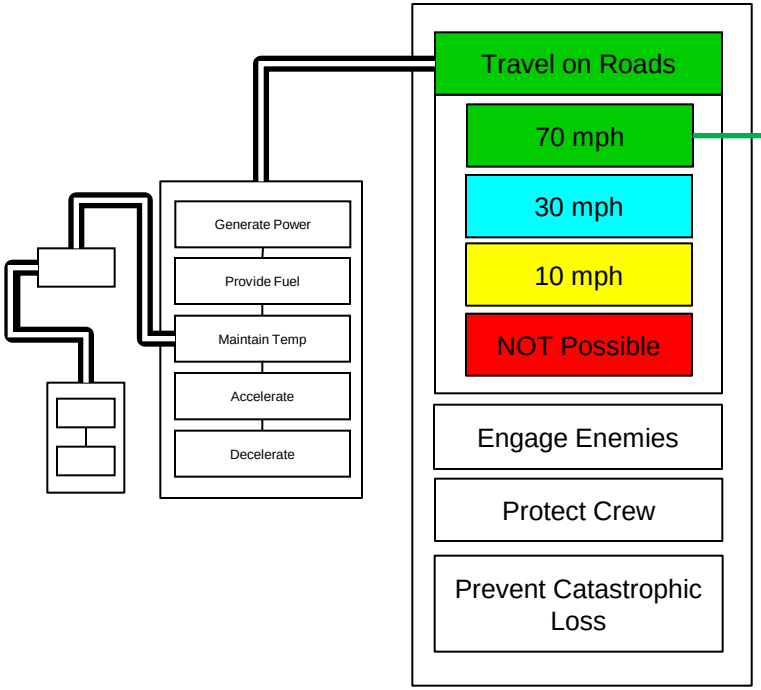


System-of-systems mission





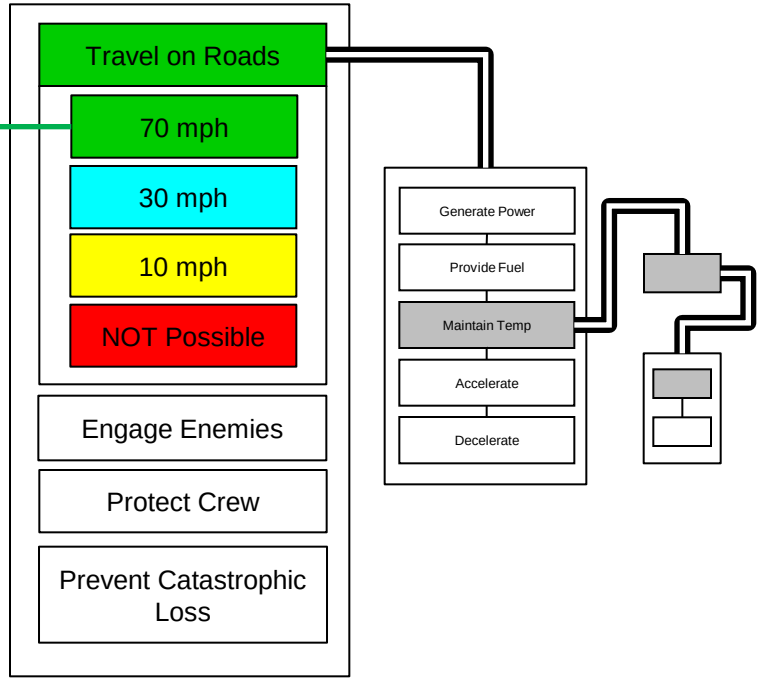
Vehicle not damaged



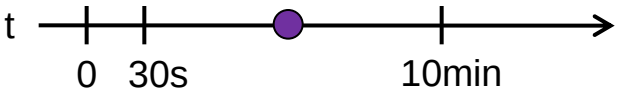
Conduct A Convoy

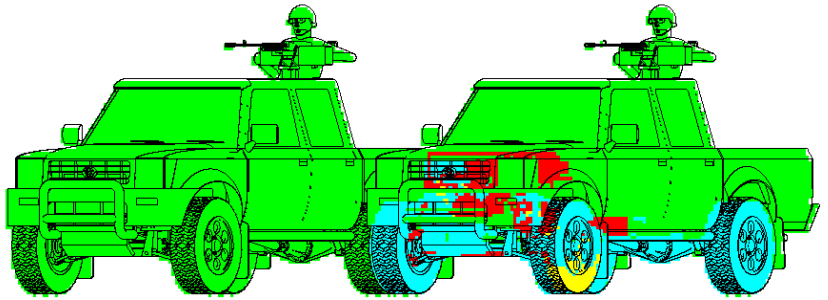
Commander's Intent

Vehicle damaged



System-of-systems mission





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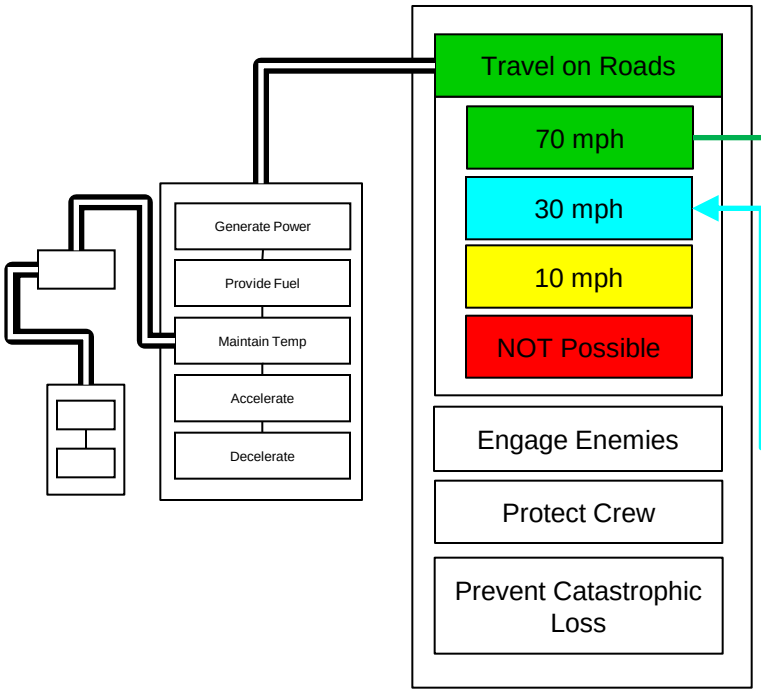

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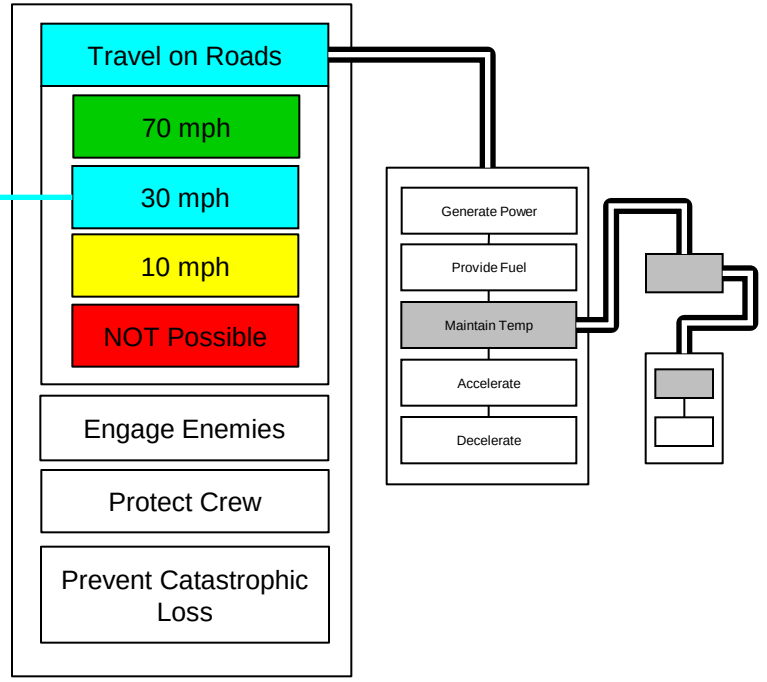

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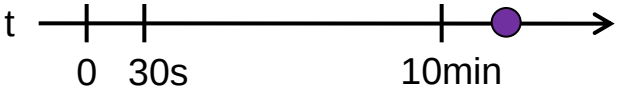

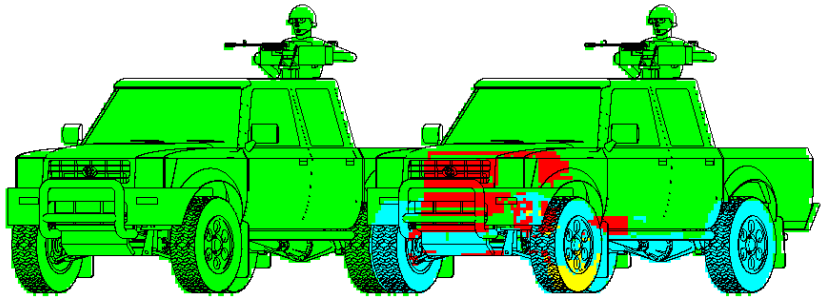

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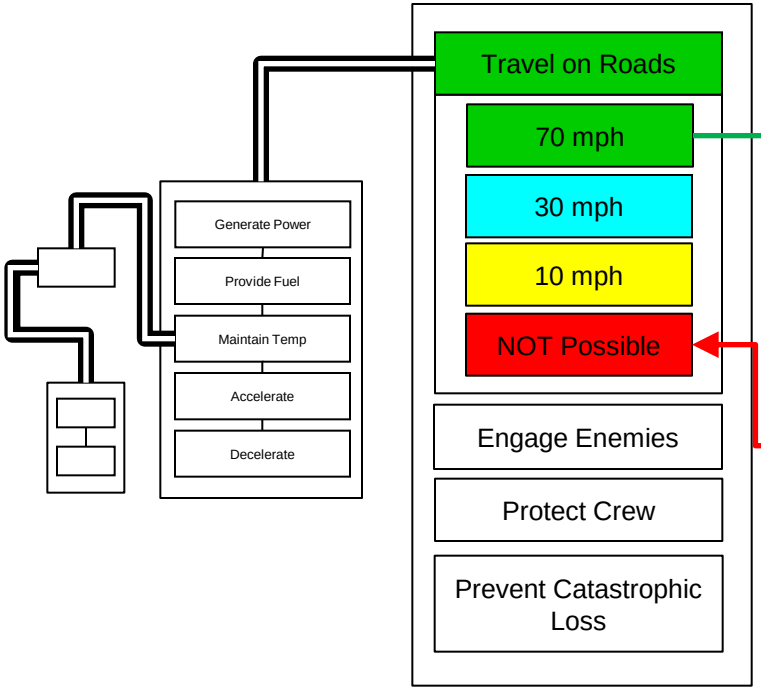

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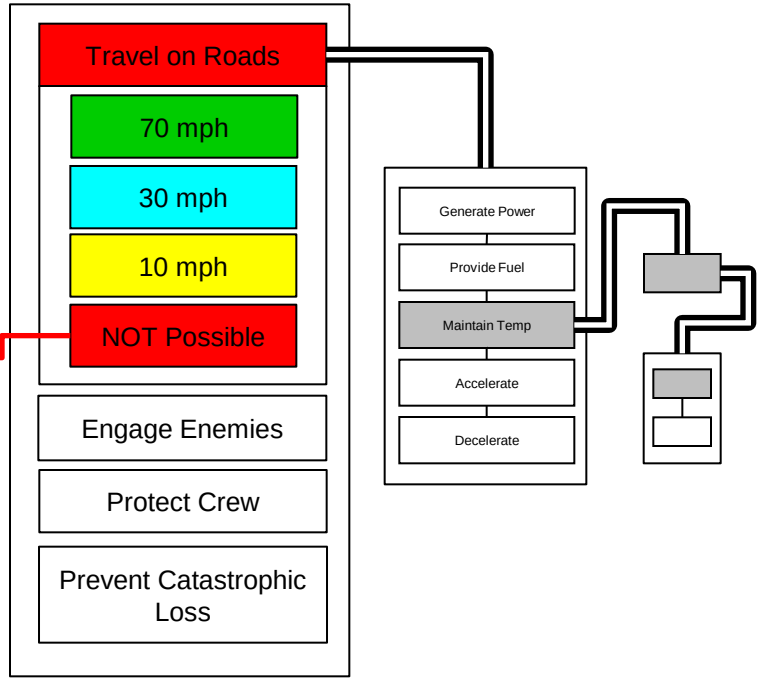
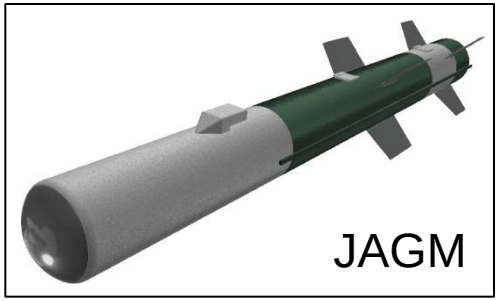


ARL's next steps

- Further explore and integrate crew metrics and time-dependent degradation
- Conduct SCAP-based analyses for the MBT&E pilots (JLTV, PIM, JAGM)



- Apply the Functional Skeleton in the System-of-Systems Survivability Simulation (S4)
- Explore the utility of the Functional Skeleton across the Army enterprise

Summary and conclusions

- ARL/SLAD has developed SCAP to quantitatively map between a system's capabilities and a system's components.
- ARL/SLAD can use SCAP to generate quantitative data that defines a system's remaining capability after a component is no longer functioning.
- Based on AEC feedback, the metrics developed from SCAP meet the requirements of MBT&E.
- SCAP has potential application across the Army enterprise.

Existing Impact

- Briefed at:
  - 2010 March NDIA T&E Conference
  - 2010 October AORS
  - 2010 August JLTV LF IPT

- Program acceptance:
  - Accepted by AEC as **the** engineering-level methodology for MBT&E
  - Written in the JLTV and PIM Live-Fire Strategy
  - Development of Human Availability Technique (HAT)*

- Publications:
  - Jan 2010 MBT&E workshop first review of SCAP (ARL-SR-0218)
  - March 2010 NDIA T&E Conference presentation of SCAP (ARL-SR-0217)
  - Applying SCAP to the MBT&E of the JLTV (ARL-SR-206)
  - An Emerging Methodology: SCAP (ARL-TR-5415)

* Collaboration with HRED

Contact Information

William Landis

Mechanical Engineer

ARL/SLAD

(410)278-2675

william.landis1@us.army.mil

Richard Moyers

Systems Engineer

ARL/SLAD

(410)278-4761

richard.moyers@us.army.mil

Kevin Agan

Mechanical Engineer

ARL/SLAD

(410)278-4458

kevin.agan@us.army.mil