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Optimizing Future Soldier Systems through the Incorporation of Human Aspects into the Soldier as a System Domain using the Systems Modeling Language

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SOLDIER AS A SYSTEM

Problem: The U.S. Army has historically focused on the development and optimization of Soldier **equipment**, leading to integration challenges between Soldiers and their equipment.

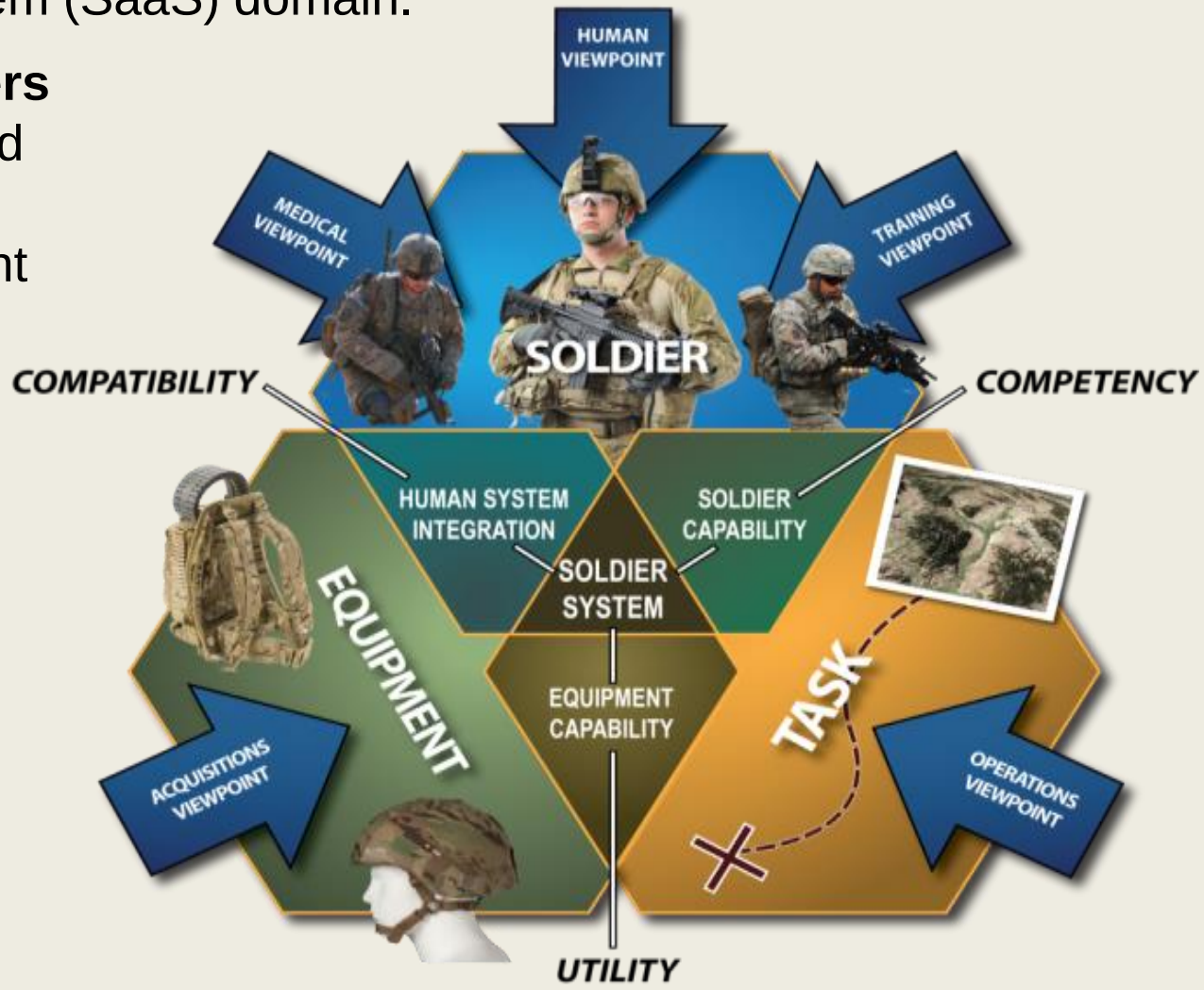
Best:
- Unmanned aerial vehicles
- Operational rations
- Organization/leadership
- Quality of life standards, etc.

It's not just about Soldier equipment. We must also understand and predict the performance of the ***full system***, inclusive of the Soldier, his/her equipment, and the tasks he/she must perform.

SOLDIER SYSTEM ENGINEERING ARCHITECTURE

Objectives: Create a principle-based Soldier architecture and framework to enable a **system level tradeoff analysis** of the Soldier as a System (SaaS) domain.

- Create the **foundation for design parameters** for the next generation of Soldier systems and subsystems, which considers the complete **Soldier as a System** with the full complement of equipment, the human performance capabilities, and the mission tasks.

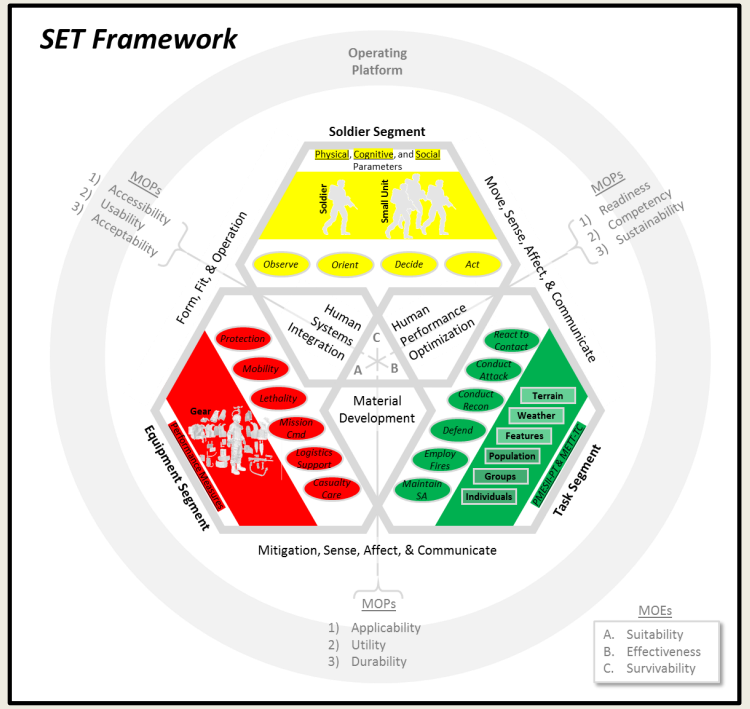


Anticipated Outcomes:

- Increased efficiencies and optimized performance of the Soldier as a System.
- Enterprise approach across Soldier-Small Unit Science and Technology (S&T) efforts, combat developers, and acquisition communities.

SOLDIER SYSTEM ENGINEERING ARCHITECTURE

Purpose: Utilize Systems Engineering tools and processes to allow stakeholders across the Soldier Enterprise to manage the overwhelming complexity of the Soldier as a System domain.



Soldier System Engineering Architecture (SSEA) is integrating these tools and processes for the Soldier Enterprise.

SOLDIER SYSTEM ENGINEERING ARCHITECTURE

Soldier as a System (SaaS) Reference Model:

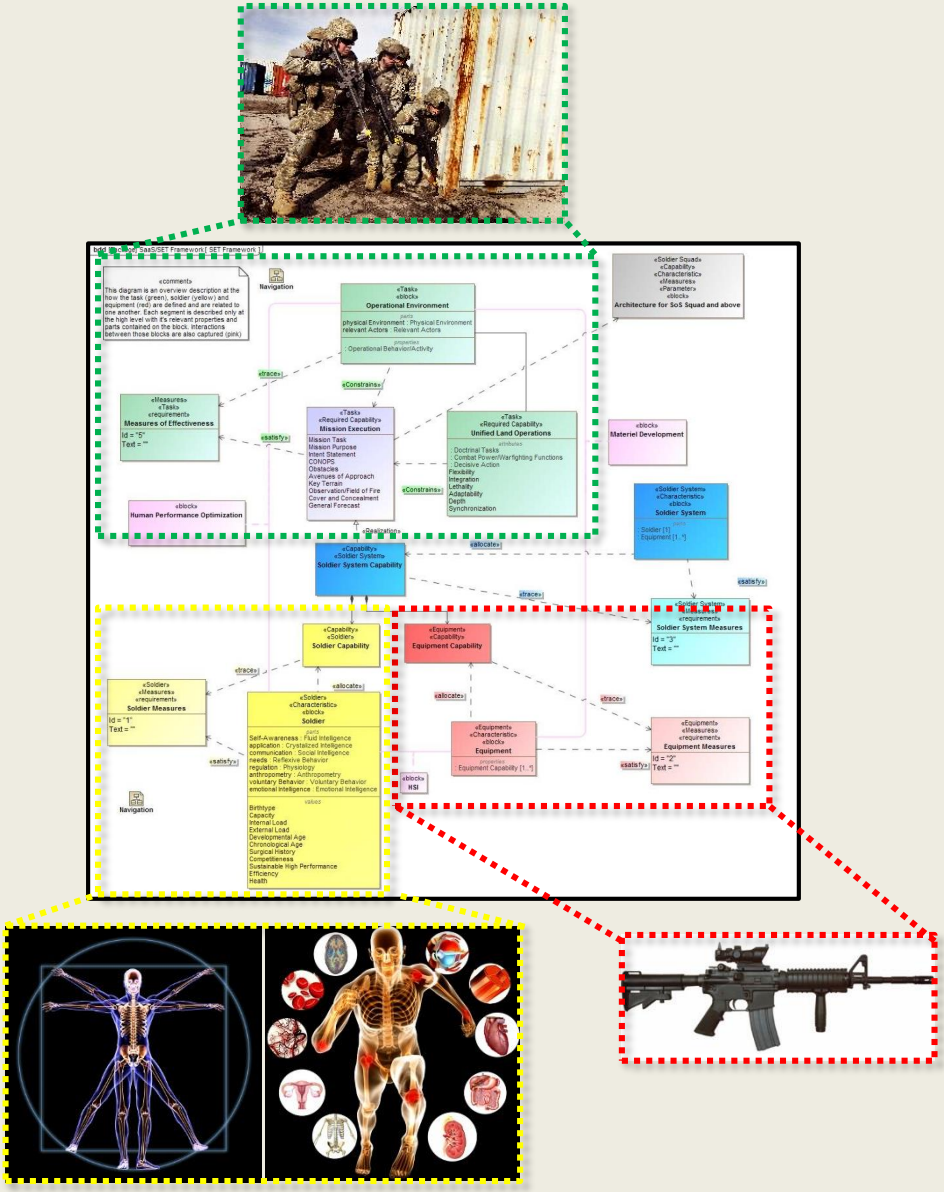
- **Characterizes** the Soldier as a System **domain** in terms of the human dimension, the materiel solutions, and the operational environment (i.e., the Soldier, Equipment, Task [SET] framework).
- Formalizes the **definition** of the **SaaS** domain.

  → Elements of the Soldier, Equipment, and Task, along with their interactions and interrelationships.

System Modeling Language (SysML):

- **Captures the system model** and **defines the boundaries** of the system space.

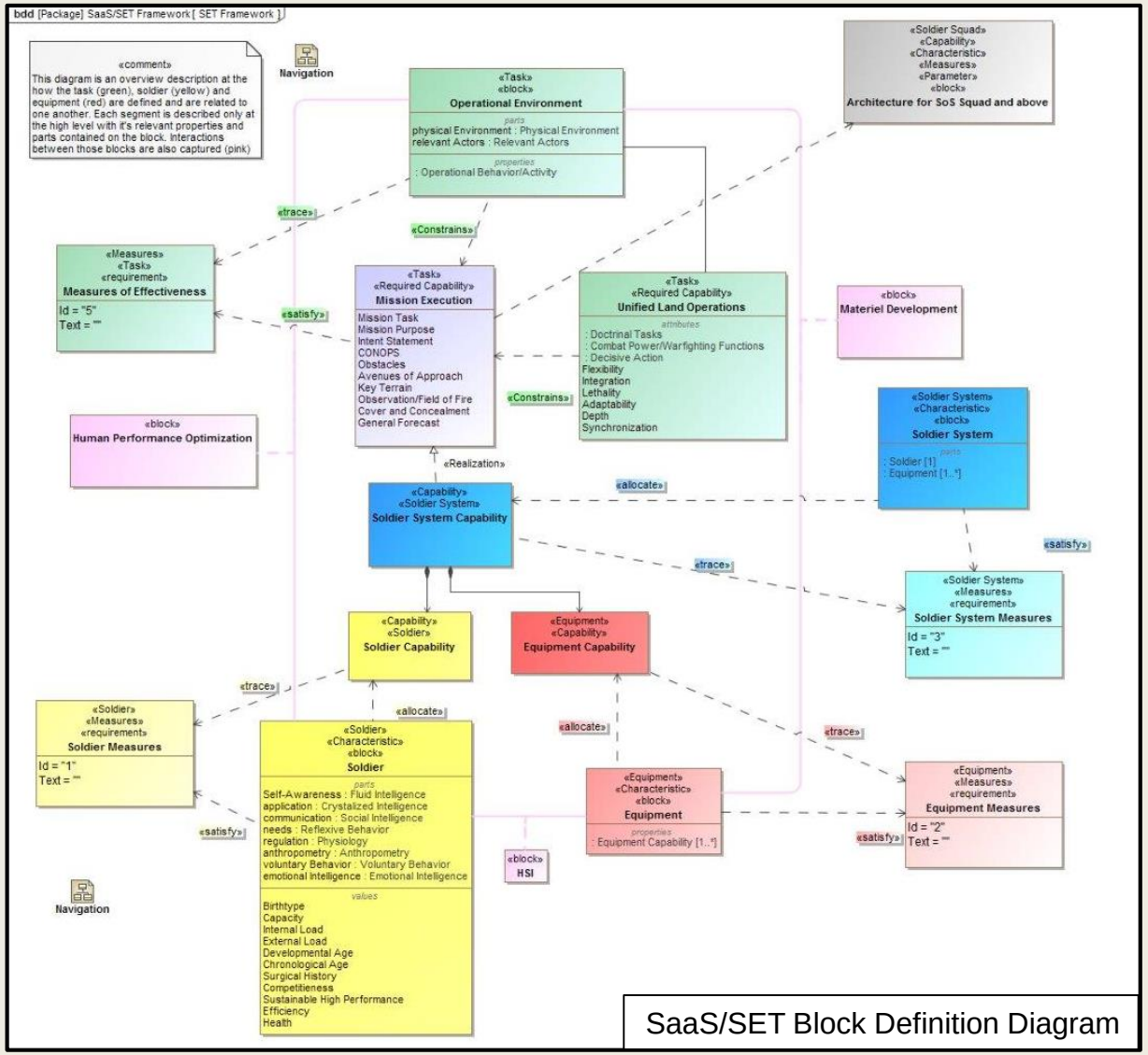
  → Enables decomposition of the SaaS domain and establishes a common vocabulary.
- Provides a **common underpinning for SSEA**, allowing **stakeholders** to further **understand** their piece of the SaaS domain and its impact points over the full system space.



SaaS Model Structure

Purpose of the Model Structure:

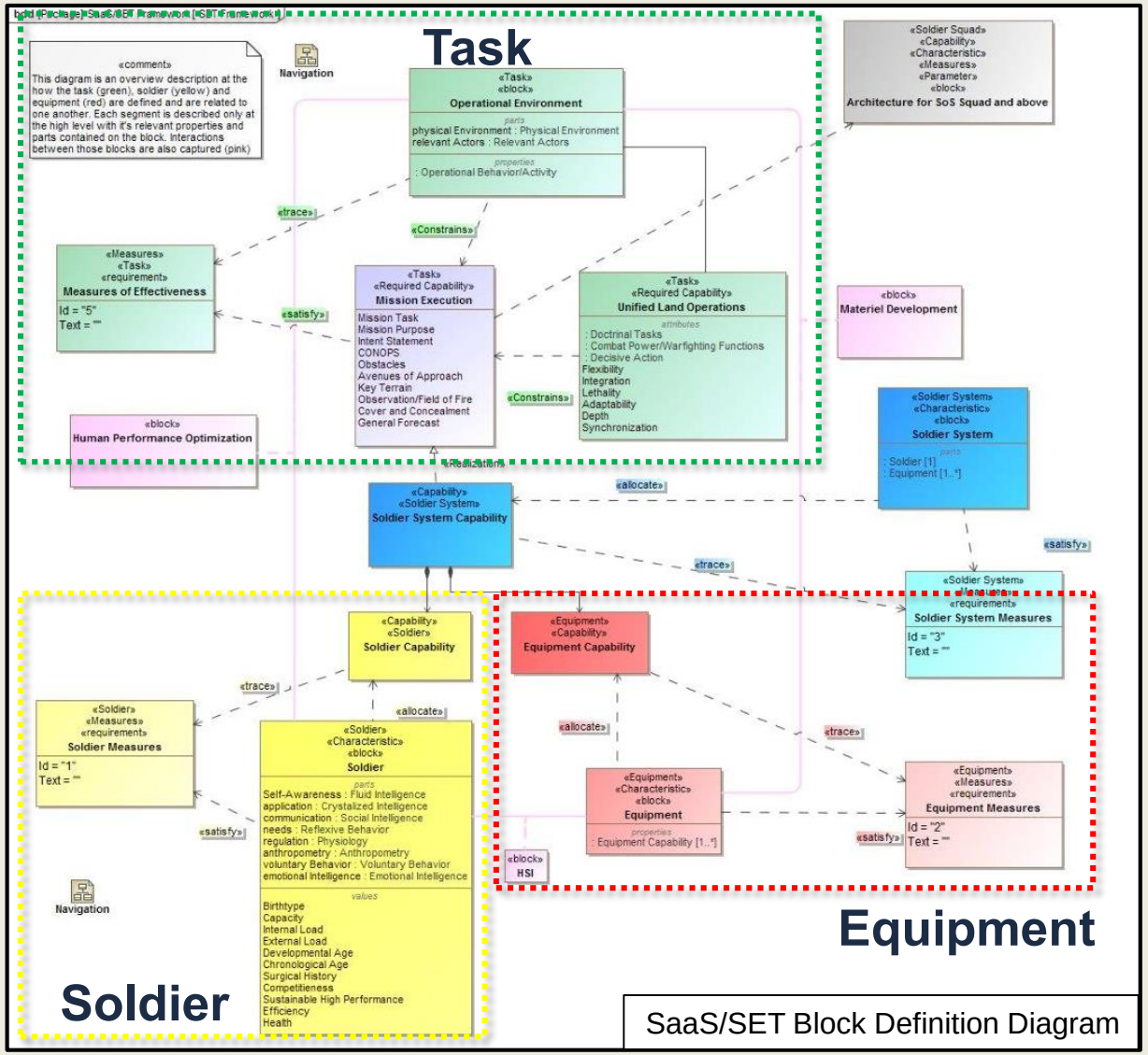
- Define the domain/system space (SaaS) and boundaries.
- Serve as a central hub for the defined SaaS components and relationships.
  - Comprised of the Soldier system within an operational context.
  - Displays any interrelationships between the primary model components.



SaaS/SET Block Definition Diagram

SaaS Model Structure

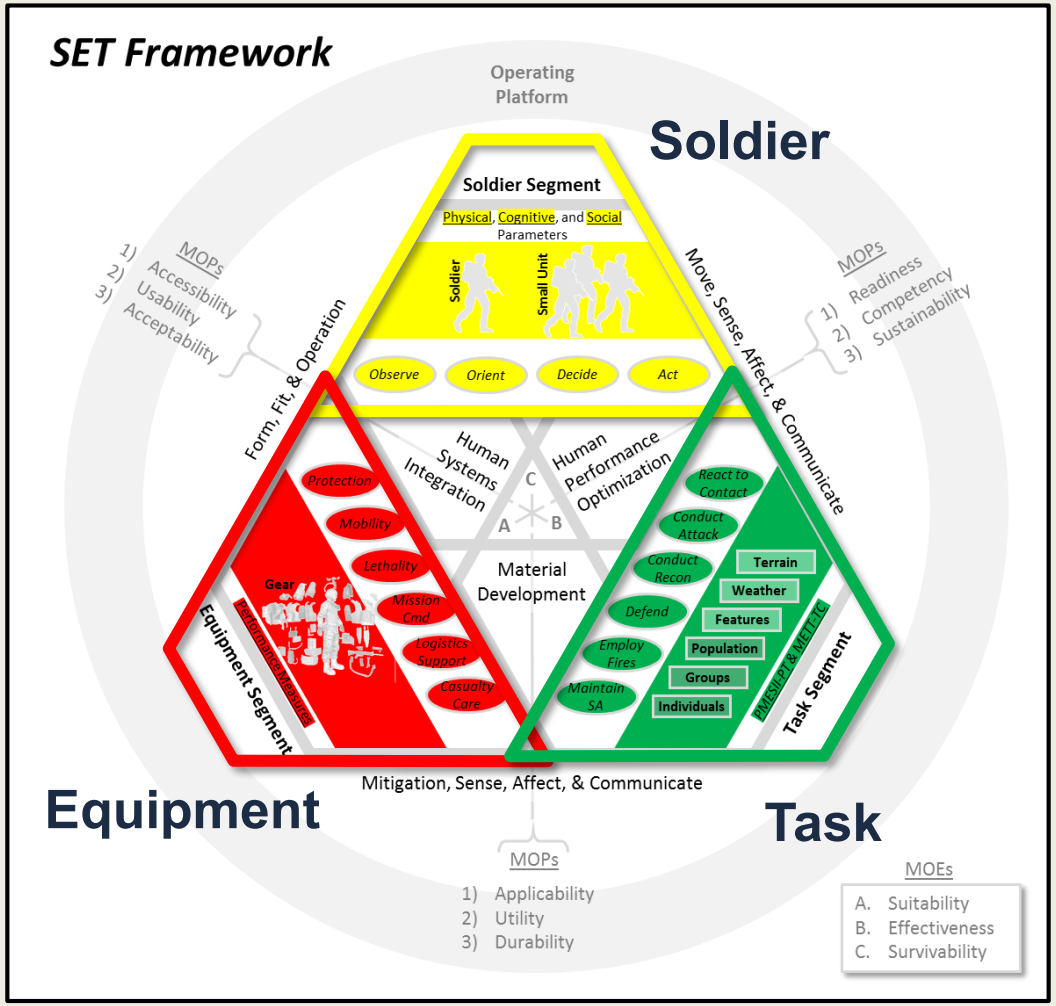
Scenario: Soldier engaging an enemy target.



SaaS/SET Block Definition Diagram

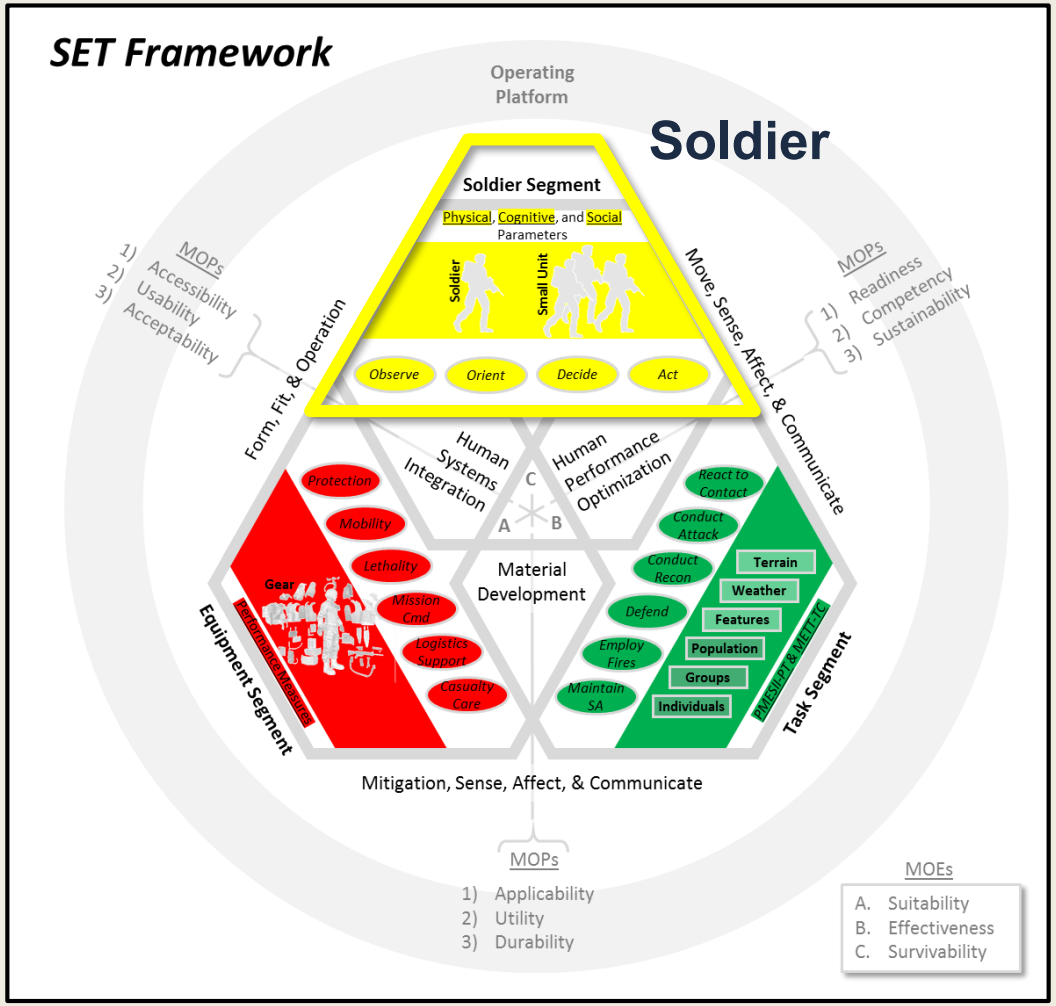
SOLDIER, EQUIPMENT, AND TASK SEGMENTS

Purpose: Define the elements and relationships contained within Soldier, Equipment, and Task (SET) segments of the Soldier as a System (SaaS) model.

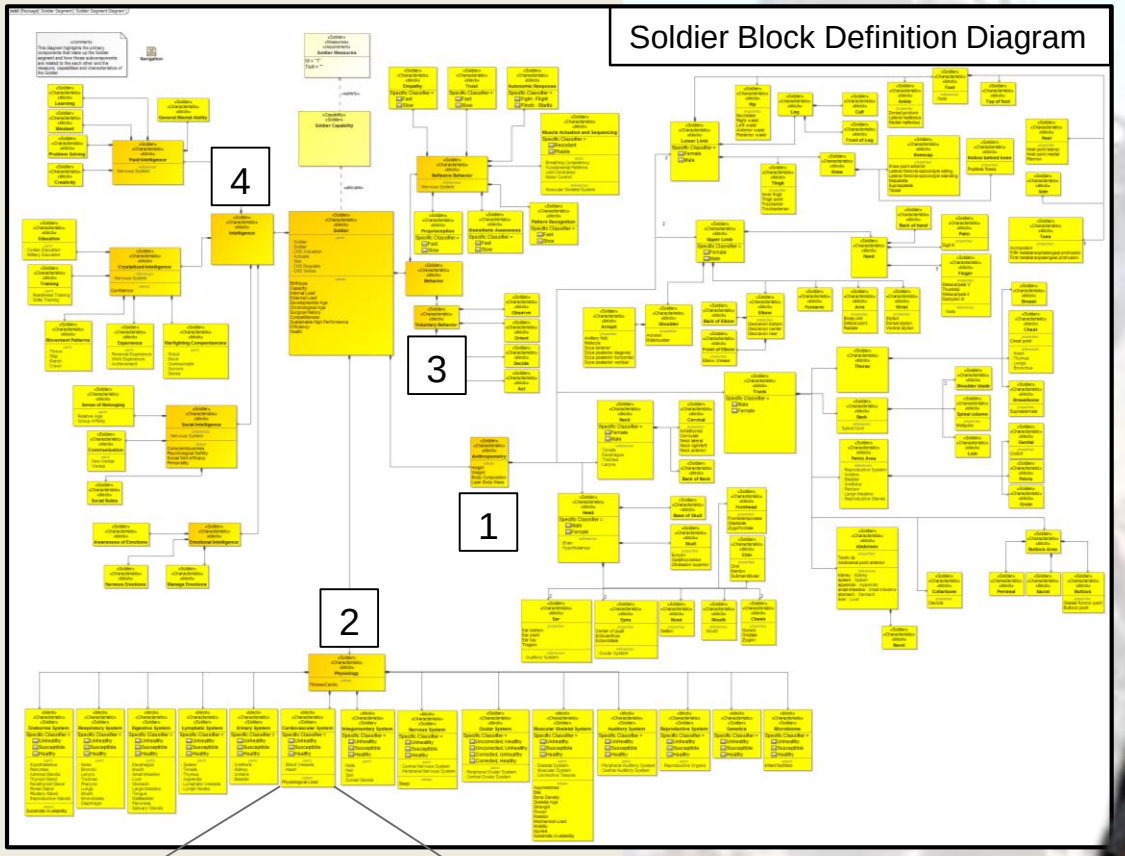


SOLDIER SEGMENT OF THE MODEL

Purpose: Define the elements and relationships within the human dimension, which includes cognitive, physical, social, and emotional parameters to further characterize the Soldier.



SOLDIER AS A SYSTEM: SOLDIER SEGMENT OF THE MODEL



Four Main Components:

1. *Anthropometry – Physical structures of the human*
2. *Physiology – Internal regulatory systems of the human*
3. *Behavior – Voluntary (i.e., cognitively founded) and reflexive (i.e., "hard-wired") behaviors*
4. *Intelligence – Fluid (i.e., creativity and learning), crystalized (i.e., prior skills and knowledge), social, and emotional intelligence*

Component Classifiers:

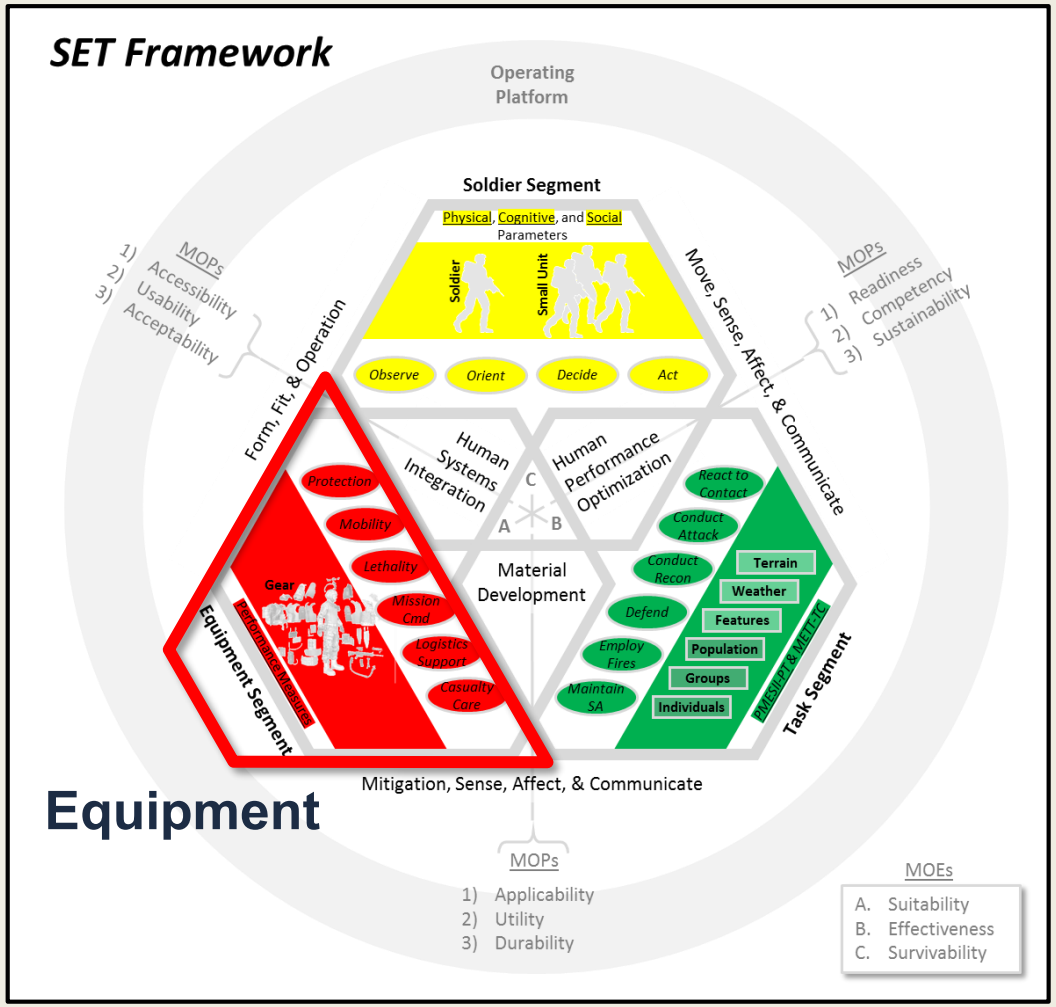
- *Size and shape*
- *Health state*
- *Response*
- *Creativity and learning*
- *Education and experiences*
- *Communication style*
- *Emotions*

Ports / Interactions (examples):

- *Shoulder / Support, Stabilize*
- *Hand / Support, Secure*
- *Finger / Control Magnitude, Actuate*
- *Eye / Signal Sense*
- *Body / Support, Secure, Attach*

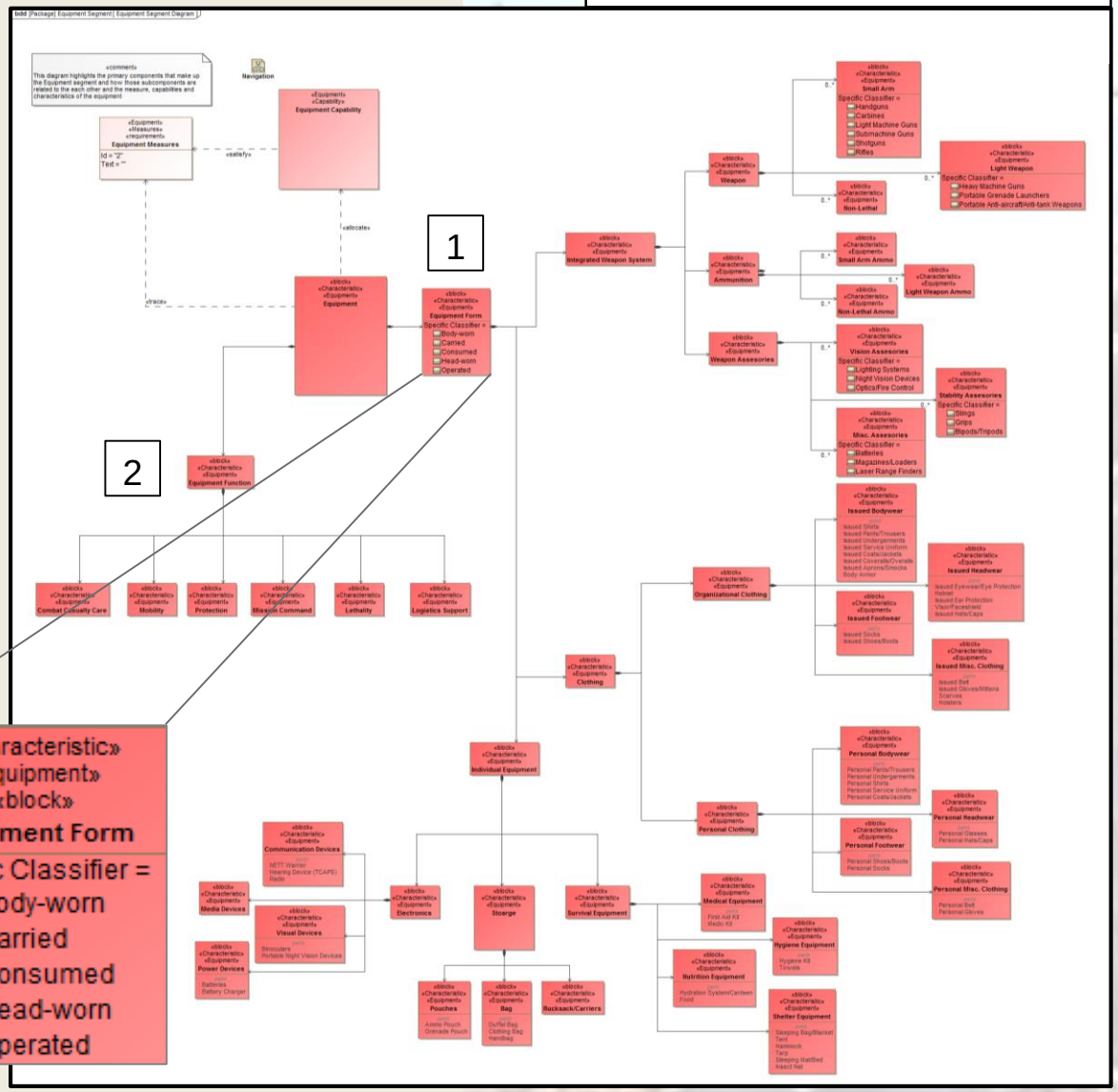
EQUIPMENT SEGMENT OF THE MODEL

Purpose: Define the elements and relationships within the material development dimension, including the type, form, and function of the equipment and how it relates back to its requirements.



SOLDIER AS A SYSTEM: EQUIPMENT SEGMENT OF THE MODEL

Equipment Block Definition Diagram



Two Components:

- *Equipment Form – Integrated weapon system, clothing, and individual equipment*
- *Equipment Function – Combat casualty care, mobility, protection, mission command, lethality, logistics support*

Component Classifiers:

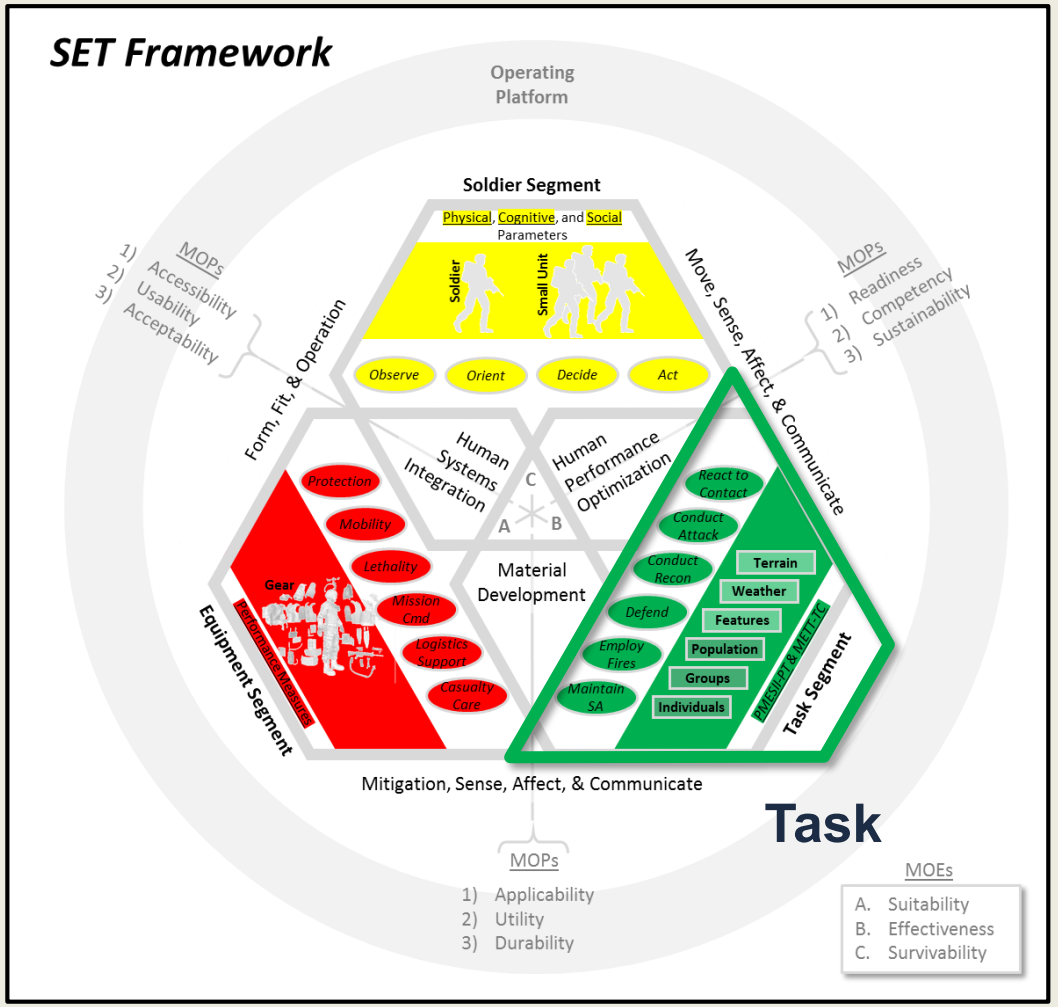
- *Forms of Equipment*
  - *Body-worn*
  - *Carried*
  - *Consumed*
  - *Head-worn*
  - *Operated*

Ports / Interactions (examples):

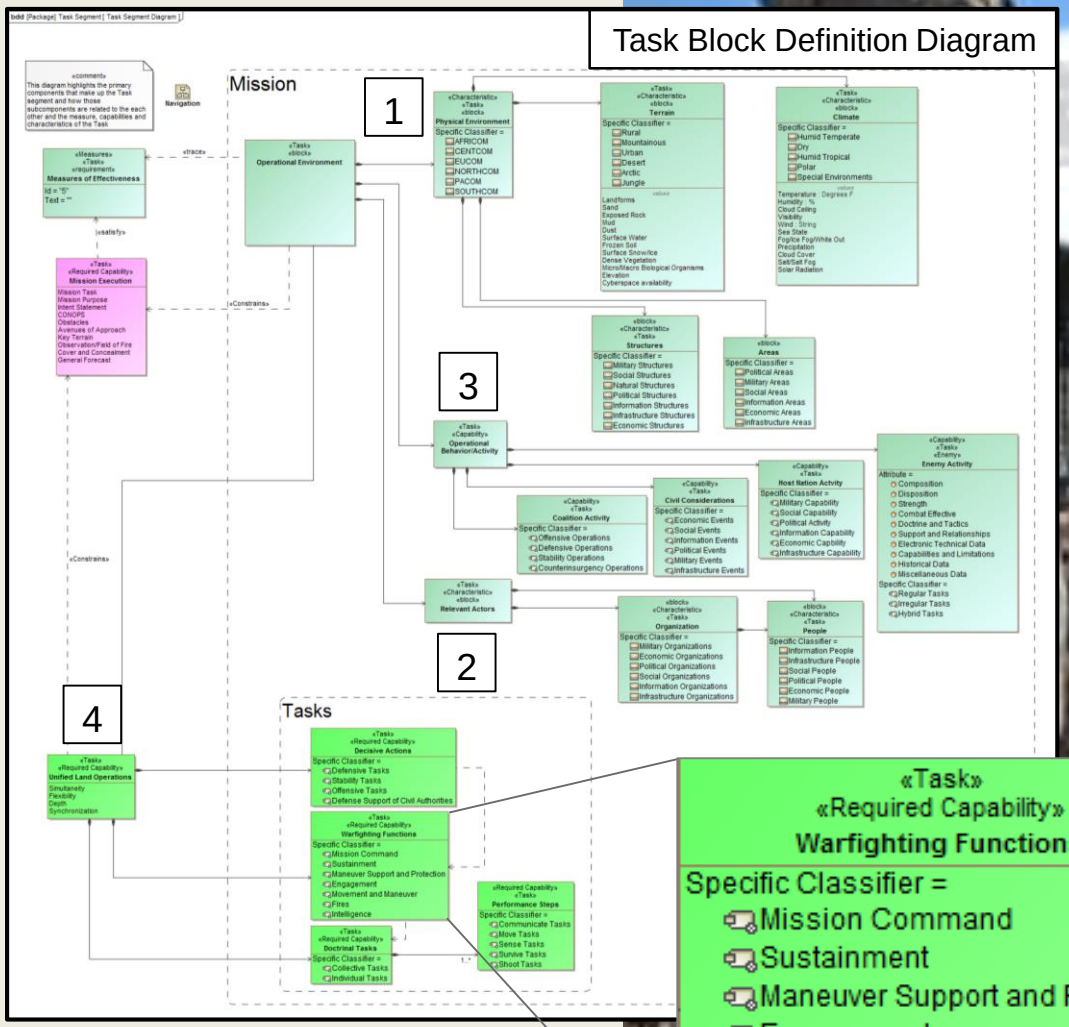
- *Buttstock / Support, Secure*
- *Improved Outer Tactical Vest / Support, Stop, Protect*
- *Rucksack / Provision, Store, Hold*
- *Close Combat Optic / Channel, Import, Allow*
- *Eye Protection / Control Magnitude, Regulate*

TASK SEGMENT OF THE MODEL

Purpose: Define the elements and relationships that the Soldier will encounter within a specific operational environment. This focuses primarily on doctrinal mission elements and parameters.



SOLDIER AS A SYSTEM: TASK SEGMENT OF THE MODEL



«Task»
«Required Capability»
Warfighting Functions

Specific Classifier =
- Mission Command
- Sustainment
- Maneuver Support and Protection
- Engagement
- Movement and Maneuver
- Fires
- Intelligence

Four Components:

1. *Physical Environment – Terrain, climate, structures (man-made or natural), and regional areas*
2. *Relevant Actors – Organizations and people*
3. *Operational Behavior and Activity – Coalition, host nation, and enemy activities, along with civil considerations*
4. *Unified Land Operations – Characterizes decisive actions, warfighting functions, and doctrinal tasks*

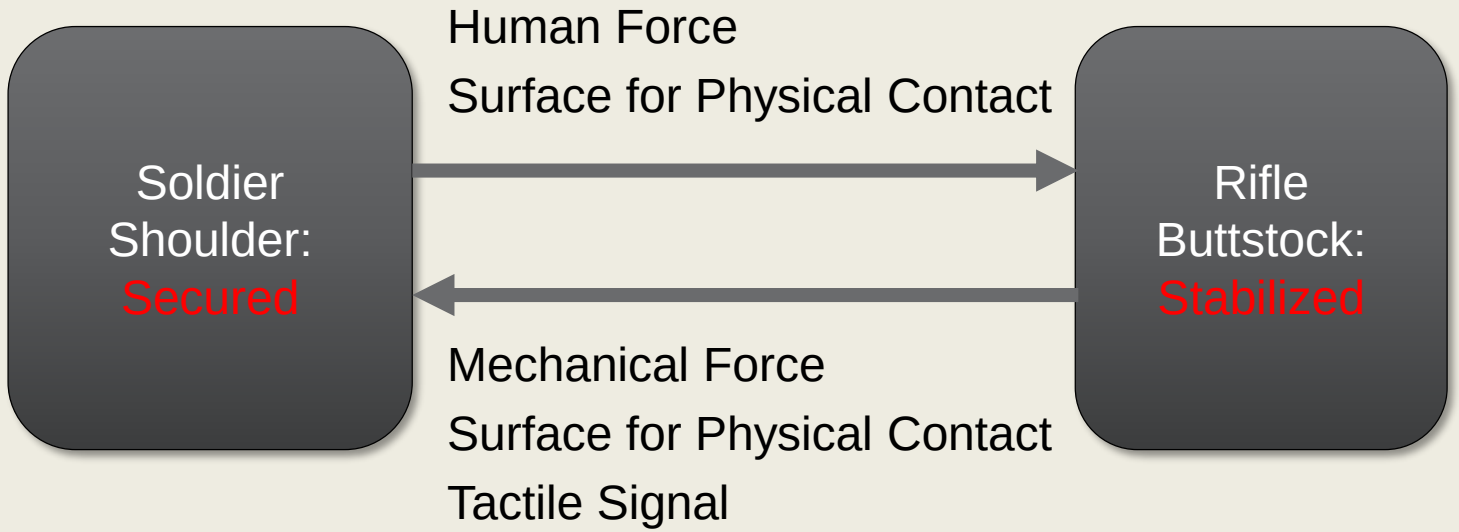
Component Classifiers:

- *Types of:*
  - *Terrain and climate*
  - *Physical structures and areas*
  - *Groups and personnel*
  - *Operational variables (HAMO)*
  - *Operational activities*
  - *Threats and actions*
  - *Tasks and functions*

SOLDIER SYSTEM INTERACTION APPROACH

Purpose: Standardize methods and elements to depict the relationships between the Soldier, Equipment, and Task segments of the SaaS model.

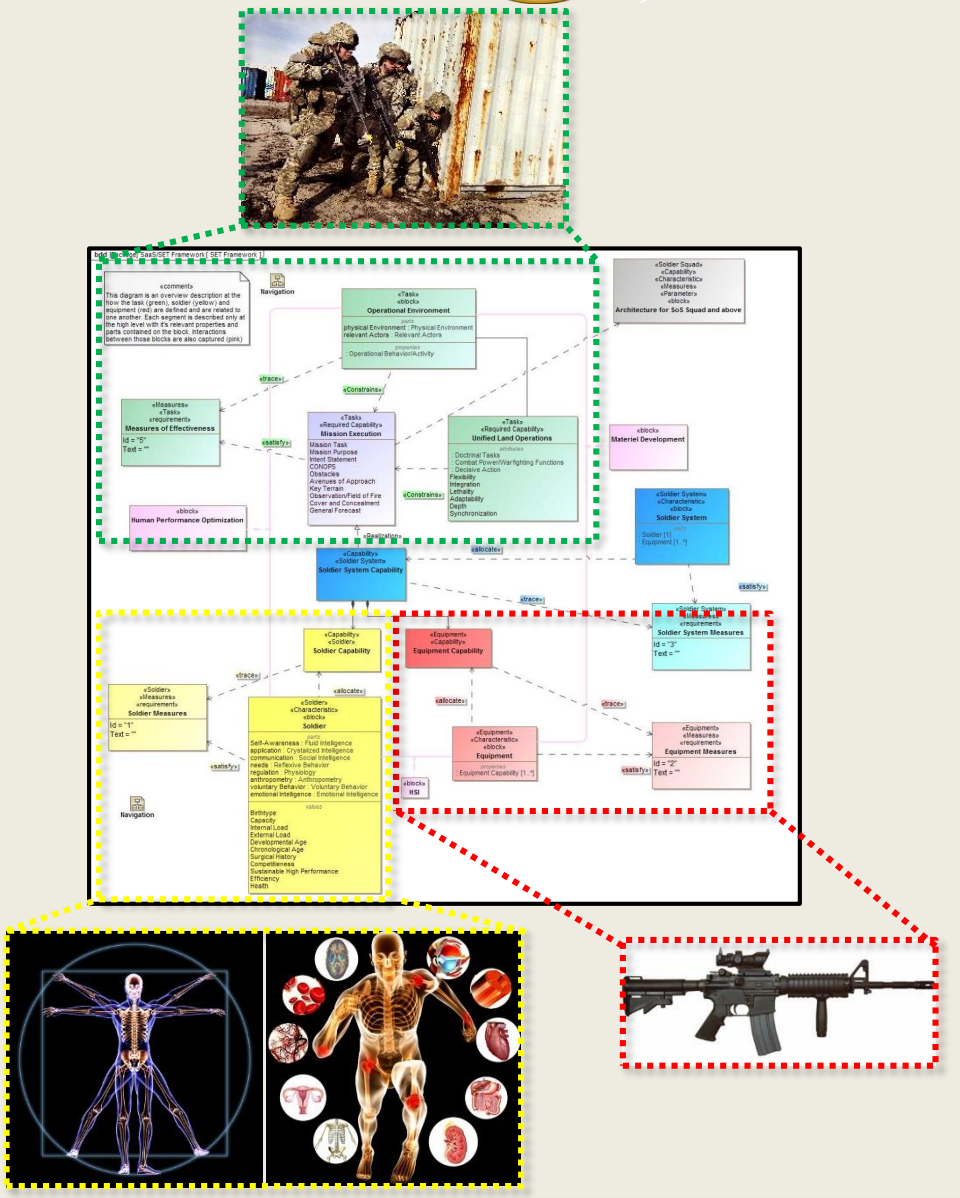
Interaction: Soldier Shoulder to Rifle Buttstock in an active “engagement” position.



Otto K and Wood K. Product Design: Techniques in Reverse Engineering and New Product Development, 1st Ed. 2000.

CONCLUSIONS

- SysML SaaS model captures a system of interest, which include elements related to the Soldier, equipment, and task capabilities.
- Human systems integration aspects are captured to further depict the relationships between the Soldier and their equipment in an operational context.
- SSEA SysML models can be used as a tool to improve decision making through a better understanding of Soldier-equipment interactions, leading to the optimization of future Soldier systems.



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