Project 1
Team CLEAR
(Convoy Level Explosive Ammunition Removal)

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Researching warfighter needs with regard to the area clearing of improvised explosive devices (IEDs), we arrive at an identification of stakeholders and stakeholder requirements, top-level system requirements, and key performance parameters (KPPs) for the METAL-V system. Ranking the top-level system requirements allows us to help prioritize the systems engineering effort across the development of this project. Development of a capability needs statement focuses us and drives our collective understanding of the warfighter need and outcomes necessary to judge success or failure at the platform level. Lastly, we provide high-level contextual and system documentation.

1 Stakeholders and Stakeholder Requirements

1.1 Stakeholders

The following stakeholders were derived directly from the project documentation.

- Systems Engineering Experts, Inc. (SEE, Inc.)
- Testers-R-Us (responsible for testing the prototype against requirements)
- Contracting Companies (competing in advanced development prototype competition)
- Warfighter (the end user)
- Taxpayer (financial support)
- Congress (budget approval)
- PEO-IED (where our IPT works)
- Lego, Inc. (manufactures a critical component used to create METAL-V)

The following suggests an additional list of stakeholders not specifically referenced but who, nonetheless, should be considered.

- PEO C3T
- PM Mission Command
- Tank Automotive Research, Development and Engineering Center's (TARDEC)
- Project Manager Close Combat Systems (PM CCS)
- Product Manager Countermine and Explosive Ordnance Disposal (PdM CM&EOD)
- Product Manager IED Defeat/Protect Force (IEDD/PF)

1.2 Stakeholder Requirements

The following sections define requirements by stakeholder and are presented in no particular order.

- Systems Engineering Experts, Inc. (SEE, Inc)
  - SEE licensed software tools shall be utilized to analyze the product.
- Testers-R-Us
  - System shall be tested against Limited Objective Exercise (LOE) objectives.
  - System shall be tested demonstrating Technology Readiness Level (TRL).
- Contracting Companies
  - The assessment of alternatives shall be fairly weighted.
  - The system performance rating system shall be clearly defined.
- Warfighter
  - The system shall meet acceptable reliability level.
  - The system shall accurately detect explosives.
  - The system shall meet acceptable available levels.
  - The system shall meet acceptable ruggedized levels.
  - The system shall demonstrate fast search coverage.
  - The system shall be rapidly deployable by typical soldier/Marine.
  - The system shall be easy to transport.
- Taxpayer
  - The system shall be researched and developed in the most cost effective process possible.
- Congress
  - The system shall meet agreed upon budgetary constraints.
  - The system shall meet agreed upon schedule constraints.

- PEO-IED
  - METAL-V shall traverse designated area.
  - System shall detect simulated IED.
  - Simulated IED shall exhibit characteristics of IEDs found in theater.
- Lego, Inc.:
  - The system shall utilize the METAL-V to perform terrestrial locomotion

2 Capability Needs Statement

While the warfighter presently relies on efficient and effective route clearing of improvised Explosive devices (IEDs), continued sustainment of operations in theater as well as protection of civilian lives hinges on the development of safe and effective area clearing capabilities. The ability to detect IEDs within a defined area would result in a greater mission success rate by increasing the agility and flexibility of a mission over the current preferred alternative of IED detection, route clearance.

Currently IED area clearance is still an immature technology but the recent advances in the Micro Expeditionary Transforming Air Land-Vehicle (METAL-V) offers a mature product that can be enhanced into an IED area clearance system by adapting its software to detect IEDs that display known characteristics. Development of this technology for application in theater relies on the Army's ability to leverage commercially available hardware, industry expertise, and existing government intellectual property (IP) and developed capabilities. Utilizing a prototype system to prove the concept will ultimately shorted the time to fielding and increase Army acceptance.

3 Ranked Top Level System Requirements and KPPs

3.1 Key Performance Parameters

The table below summarized the key performance parameters for the METAL-V system.

Parameter	**Threshold**	**Goal**
Mission Reliability (DRM)	0.9	0.95
Operational Availability	0.8	0.9
Life-cycle Cost per Unit	\$50,000	\$25,000
Vehicle Weight	18 oz	14 oz
Refueling Time	60 sec.	30 sec.
DRM Elapsed Time	5 min.	3 min.
Deployed-to-Ready Time	10 min.	5 min.
SMETAL-V Storage Container	216 in^3	120 in^3
Operational Team Size	2 persons	1 person

3.2 Top-level System Requirements, Prioritized, of the METAL-V

The following is a list of top-level system requirements that have been ranked (prioritized) based on the operational stakeholder's (end user's) preference.

1. The system shall have a mission reliability of at least 0.90.
2. The system shall have an operational availability of at least 0.80.
3. The system shall never indicate a false negative.
4. The system shall indicate a false positive less that 2% of the time.
5. The system shall successfully detect and distinguish 95% of threats in a given area over a given time.
6. The system shall successfully alert the IED-clearance operator of a threat 98% of the time.
7. The system shall require an average training period not to exceed 4 hours.
8. The system's deployment-to-ready time shall not exceed 10 minutes.
9. The system shall have an average usability score of at least 8 based on end-user input.
10. The system shall require no more than 2 people to operate.
11. The system shall not require any specialized parts or training for routine maintenance or repair.[1]
12. The system vehicle's weight shall not exceed 18 ounces.
13. The systems SMETAL-V storage container shall have a volume not to exceed 216 cubic inches.
14. The system's DRM elapsed time shall not exceed 5 minutes.
15. The system vehicle shall have a drop height of at least 1 inch.
16. The refueling time of the system shall not exceed 60 seconds.
17. The system's life-cycle cost shall not exceed $50,000.

3.3 Explanation of Top-level System Requirement Prioritization

The top-level system requirements have been prioritized based on operational stakeholder (end user) preference. The top priority of any user is typically safety. In this case, the operational stakeholder is most interested in the system's ability to correctly perform its mission to detect IEDs and therefore preventing fatal injury to the operator and other friendly personnel.

Following the system's correct operation, the operational stakeholder is probably most interested in *how* the system will be operated. How much training is required? How long does the system take to deploy? How difficult is the system to use? These types of requirements are factors which directly impact the end user and play a role in user acceptance. Operational stakeholders must also consider the transport of the systems they use; therefore weight, volume, and drop height are areas of principal interest.

The system requirement having the lowest priority is life-cycle cost. As would be expected, the end user typically does not care how much a system costs as they are not directly responsible for payment. This requirement would have much higher priority, however, if viewed from a procurement office's point of view.

[1] We are treating the Lego Mindstorm Brick as a COTS product.

4 Diagrams

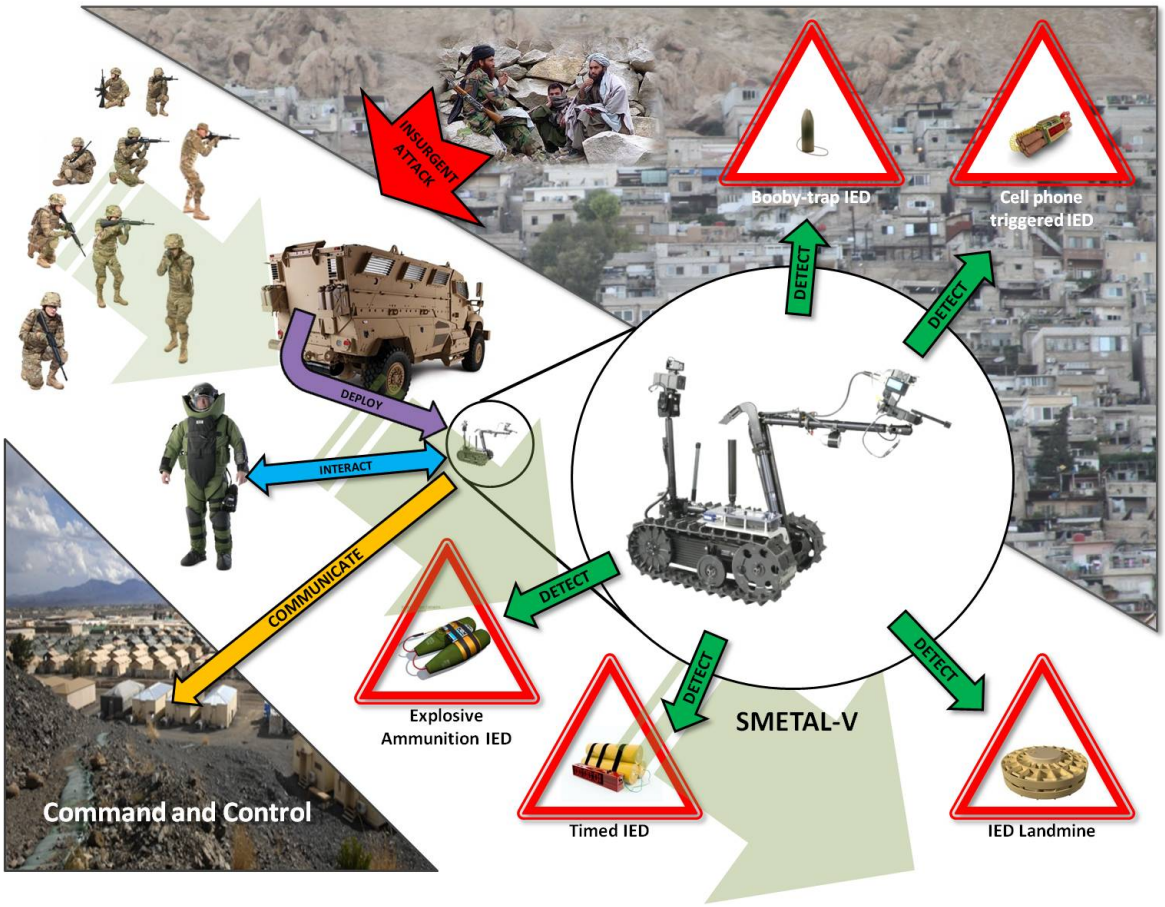

Figure 1: OV-1

The following figures lend insight into the system in several ways. They provide us with an increased understanding of logical encapsulation of data and functionality that informs software best practices, modular design, distributed development, and component re-use. Similarly, they help us to understand the physical encapsulation of functionality that informs modular design and manufacturing.

Since system timing and cohesiveness is critical to a well-functioning system and ultimately to a high mission success rate, it is important to note that the diagrams also inform our understanding of data flow needs including system timing requirements and lend an increased understanding of requirements for interoperability among component system parts.

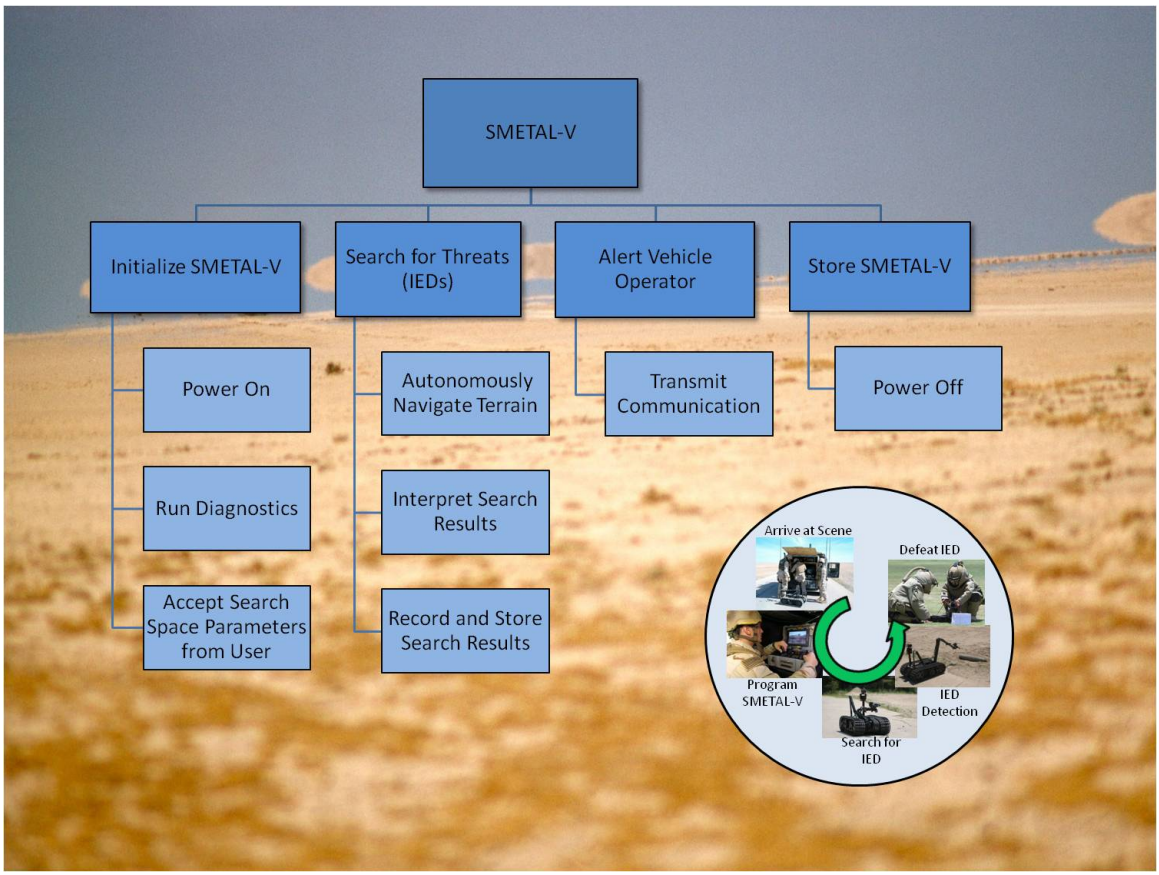

Figure 2: SV-4a

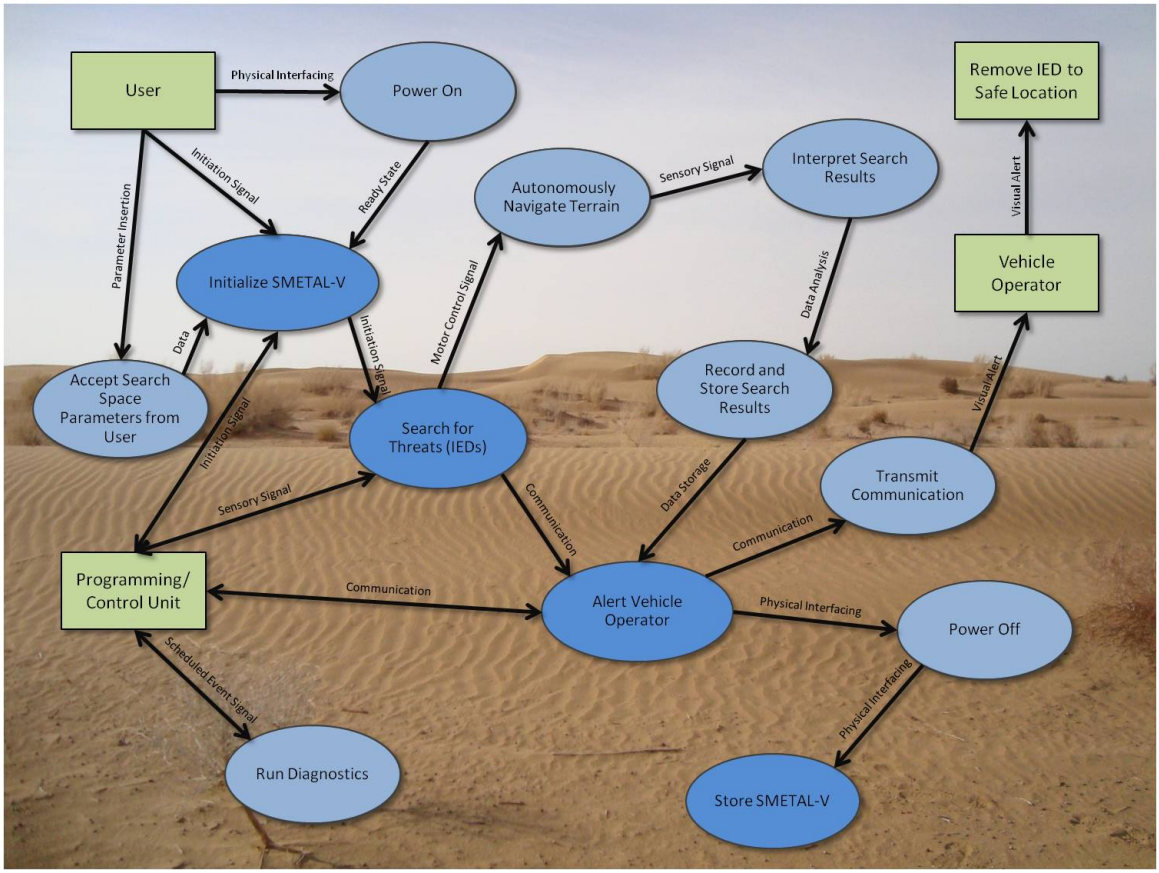

Figure 3: SV-4b