

Special Operations Medical Symposium - 2018




 **Medical Robotic & Autonomous Systems (MED-RAS)**
New Army S&T Task Area

Capability Area Manager:
Dr. Gary Gilbert, TATRC
16 May 2018

Medical Robotic and Autonomous Systems




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Presentation Outline



1. **Medical challenges of Army's Multi-Domain Battle concept.**
2. **Summary of Medical Robotic & Autonomous Systems S&T Task area; research challenges, strategies, and funded projects.**
3. **Autonomous Medical Evacuation.**
4. **Extramural Research funding opportunities based on the new MED-RAS S&T task area.**

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Multi-Domain Battle Concept





GEN David G. Perkins, CG, TRADOC
 2016 LANPAC Symposium and Exposition
 (Credit: Army Staff Sgt. Christopher McCullough)

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4

Multi-Domain Battle Concepts Constraints on Medical Resources

Limited freedom of movement for conventional vehicle platforms (both air and ground) to provide emergency medical resupply and casualty evacuation

- Wide Dispersion of Maneuver Units
- Area denial (e.g. CBNRE)
- Air Superiority not assured.
- 6-Dimensional threats (air, land, subterranean, maritime, space, and cyber).

Limited Medical Resources

- High risk Environments for manned assets
- Delayed Evacuation / Prolonged Field Care
- Risk of loss of irreplaceable human resources.


Robotics & UMS as Force Multipliers (PLAN B)

- When conventional manned assets are denied access
- When air superiority is not assumed
- When medical resources are severely constrained
- As UMS replace manned “vehicles of opportunity”

Advantages:

- Performance – Speed, Maneuverability, Endurance
- Smaller Landing Zones (LZs)
- Cost & Capacity***





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Medical Simulation & Information Sciences New Army Science &Technology (S&T) Task Areas

To support medical care delivery in dispersed and complex environments through futuristic technologies.

AUTONOMOUS AND
UNMANNED
MEDICAL CAPABILITY



VIRTUAL HEALTH

Threats


- Dispersed Operations
- Contested Air Space
- Limited Casualty Evacuation
- Delayed Definitive Patient Care
- Lo/No Comm Environments

MEDICAL ASPECTS OF
MAN-MACHINE TEAMING:
MEDICAL ROBOTICS




Multi-Year Army S&T POM: 2019 -2024

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Secretary of the Army Priorities - Lethality




- Army Secretary Mark Esper: “As I return to duty, I want you to know that my **first priority is readiness**.... with an immediate focus on preparing for a high-end fight against a near-peer adversary”
 - ✓ Modernization and reform rounded out his top three, which go hand in hand with the **new Army Futures Command**.
 - ✓ Focus is on six areas crucial to combat; Long-Range Precision Fires, the next-generation combat vehicle, Future Vertical Lift, the network, air and missile defense, and **soldier lethality** *
(from “New in 2018: Army secretary lays out his priorities”, Army Times 27 Dec 2017)

- LTG Edward Cardon* visit to MRMC 17 Apr 2018: “**How does this contribute to Lethality?**”
 * charged with standing up new Army Modernization Command




“The more things change.....” ➔ **TWO Primary Weapons Systems off Line!**

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Medical Robotic & Autonomous Systems (RAS)



- Gaps Assessment -

Required Capabilities *	
1. Army Units lack fully adequate medical evacuation capability and capacity in select environmental and operational conditions due to shortfalls in platform availability, mobility, protection, all-weather/visibility, and responsiveness across the operational area. <i>Relevant Extremely/High Risk CNA Gaps:</i> 501244, 461752, 203567, 550200, 202506	2. Army Units with medical capability (point of injury and Role 1/2) possess limited capability to provide prolonged field care and enroute care (resuscitative and stabilizing medical or surgical treatment). <i>Relevant Extremely/High Risk CNA Gaps:</i> 501244, 501281, 461752, 203225, 203554, 502277
Potential RAS Solutions *	
<ul style="list-style-type: none"> • RAS Patient Extraction & Evacuation in Complex Environments <ul style="list-style-type: none"> • Cargo/utility RAS transport pressed into service in CASEVAC, additive to manned MEDEVAC force structure to add capacity • RAS CASEVAC for reduced risk operations in CBRN and DVE • RAS Wing-men (escort, scout) to support MEDEVAC • RAS delivery of CLVIII and blood products 	<ul style="list-style-type: none"> • Robotic & Autonomous Critical Care System <ul style="list-style-type: none"> • Enroute care during prolonged field care & RAS evacuation • Closed-loop respiratory, fluid, pharmacology management • Tele-surgical Robotic Operative Network <ul style="list-style-type: none"> • Telerobotic & semi-autonomous surgery • Robotic Assistant For Medical Treatment Facilities <ul style="list-style-type: none"> • Patient monitoring & mentoring (cognitive offload)
Collaborative Partnerships (Past, Present & Future)	
<ul style="list-style-type: none"> • US SOCOM and Service SOCs • Office Naval Research – Airforce Research Lab-Marine Corps Warfighting Lab • DARPA/OUUSD(AT&L) / NAVAIR • RDECOM -ARL/AMRDEC/TARDEC/CERDEC/CWL • Other Army MRMC Labs and Acquisition Programs 	<h3 style="margin: 0;">ESSENTIALLY ANYBODY & EVERYBODY!!!</h3>

*From Army Medical Command HRCoE CDID Medical Evacuation Proponency (MEPD) RAS Gaps Assessment and/or from ARCIC Unified Quest 18 RAS Workshop

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Research Strategies

1. **Integration of Medical Systems with general purpose UMS to include Communications & Virtual Health**
2. **Soft Robotics. Bio-inspired lightweight robotic manipulators based software and flexible materials**
3. **Multi-robot Teams and Swarms. Robot/robot teaming (eye-in-sky and rescue robot). Self assembly of small robots to perform specific missions like casualty extraction and CASEVAC**
4. **Unique Mobility Platforms for challenging environments. Navigate the MDB space of complex threats. Novel approaches to locomotion; rapid transformation (shape-shifters ala transformers).**
5. **Mission based intelligent navigation & flight controllers to implement constraints and adapt behaviors when patients are on board.**

Fisher & Gilbert, *Small Wars Journal*, 22 July 2017.
<http://smallwarsjournal.com/jrnl/art/medical-robotic-and-autonomous-system-technology-enablers-for-the-multi-domain-battle-2030>

SMALL WARS JOURNAL

HOME NEWS JOURNAL SWJ BLOG FORUM EL CENTRO MAD SCIENCE

Medical Robotic and Autonomous System Technology Enablers for the Multi-Domain Battle 2030-2050

by Nathan L. Fisher and Gary R. Gilbert

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Programmed Army S&T Research Project List

Medical Robotic & Autonomous Systems:

1. **Artificial Intelligence Assist for Combat Medic (FY18-24)**
 - Enhancing TCCC for PFC Via Knowledge-Based Technology
2. **Semi- Autonomous and Autonomous Casualty Management System**
 -Trauma Care in a Rucksack: TRACIR (FY19-22)
 - Autonomous Robotic Delivery of Trauma Care in the Field)
3. **Robotic Casualty Perception & Extraction in Complex Environments (FY19-21)**
4. **Tele-surgical Robotic Operative Network (FY19-22)**
5. **Autonomous Enroute Care & Patient Safety in Unmanned Air Systems (UAS) - DP-14**
 - “Flying Research Lab” (FY20-23)
6. **Medical Missions Module for Evacuation on Unmanned Systems**
 - Autonomous Reconfigurable Embedded System (ARES) CASEVAC Pod

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RDT&E Challenges for Evacuation on Autonomous & Unmanned Systems



MEDICAL


- Safe Ride Standards for UMS Transport (2012 NATO Task Group HFM-184 Study)
- Interoperability – Integration with Medical-specific equipment/capabilities – “carry on”
- En Route Care – Medic Attending vs. Remote Patient Management vs. Autonomy
- AI-based Closed Loop Critical Care Capability
- Testing, Verification and Validation

MEDICAL/NON MEDICAL


- Efficient and Safe Man-Machine/Human-UMS Interaction

NON MEDICAL

- Bandwidth & communications availability
- Cyber threat
- Autonomous/Unmanned Platform Availability
 - Need appropriately-sized multipurpose platform:
 - Air –Vertical Takeoff & Landing (VTOL)
 - Ground – multi-terrain with shock absorption



Safe Ride Standards for Casualty Evacuation Using Unmanned Aerial Vehicles
 (NATO Task Group HFM-184 Study)
 (NATO Task Group HFM-184 Study)
 (NATO Task Group HFM-184 Study)




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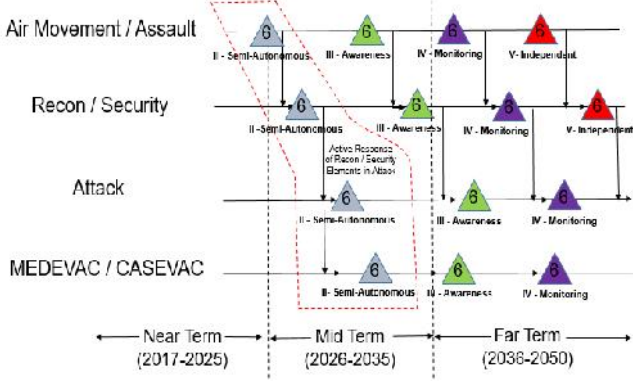
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AMRDEC Initiative



- **AMRDEC Levels of Autonomy Working Group**
 - FY 2017-18. Report out 3rd Qtr FY18
 - **OBJECTIVE:** Development of Army Aviation RDT&E Roadmap

DRAFT Tech Demo Objectives (TRL 6)



Levels of Autonomy

- **Level 1: Automatic**
Operator initiates specific function; e.g. auto-land
- **Level 2: Semi-Autonomous**
Operator confirms autonomous actions
- **Level 3: Awareness**
Direct oversight of system(s) by operator
- **Level 4: Monitoring**
Monitoring of multiple systems at mission control
- **Level 5: Independent**
No datalink required

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TATRC Research with Unmanned Aircraft

Piasecki Aircraft/CMU "Combat Medic UAV"
TATRC SBIR 2010

ARES Medical Mission Module:
Defense Health Program JPC-1 FY17
Army POM FY20-25

TATRC SBIR w/ Research Labc
DP-14 UAS "F" Research L

"UAS HCI and C2 for Medical Missions"
TATRC SBIR 2017
Leveraging ONR's AACUS Program

"UAS/UGV HCI and C2 for Medical Missions"
TATRC SBIR with NAVAIR, PjM MEDEVAC
Mission Equipment

ARES UAS Common Flight Module
[DARPA, AMRDEC, MCWL]

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ARMY SBIR Research Opportunity

A18-123 Emergency "just-in-time" Delivery and Recovery of Whole Blood via Unmanned Aerial Systems (UAS)

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Home > for Small Business > Current Announcements > DoD 2018.2 SBIR Announcement

for Small Business

Program Descriptions

Getting Started on Phase I

Eligibility

BAA Schedule

Current Announcements

Topic Q&A (5/15)

DoD 2018.2 SBIR Announcement

This UAA is in PHL/RL/LLASL.

IMPORTANT NOTE: In addition to following the DoD-wide instructions in the DoD Program Announcement, proposers must also follow the Component-specific instructions for the Component to which they are applying - see table below.

BAA Documents	Last Modified	
DoD Instructions: 2018.2 SBIR	April 20, 2018	+L
Army	April 20, 2018	+CS

IMPORTANT DATES

April 20, 2018
BAA opens pre-abstract

May 22, 2018
BAA opens and DoD begins accepting proposals

June 6, 2018
SFTIS Q&A System closes to new questions

June 20, 2018
BAA closes to receipt of proposals at 0:00 PM ET—*please* ahead and submit early.

<https://www.acq.osd.mil/osbp/sbir/solicitations/sbir20182/index.shtml>

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  **Extramural Research Funding Opportunity** 


USAMRAA
U.S. Army Medical Research Acquisition Activity

Broad Agency Announcement




United States Army Medical Research and Materiel Command Broad Agency Announcement | USAMRMC BAA

BAA # W81XWH18SBAA1


Oct 1, 2017 thru Sept 30, 2002


<https://www.grants.gov/web/grants/view-opportunity.html?opId=297726>

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  **Questions / Discussion** 

“The enterprise that does not innovate ages and declines. And in a period of rapid change such as the present, the decline will be fast” - Peter Drucker


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ARCIC/RDECOM Initiative



- **ARCIC/RDECOM “Unified Quest 2018” Robotic Autonomous Systems (RAS)Applications Workshops**
 - 11-15 Dec 2017, Carlisle Barrack, PA (Echelons Above Brigade & Brigade & Below)
 - 5-9 March 2018, Fort Eustis, VA (Brigade Combat Team)
 - OBJECTIVE: Operationalizing the Future of RAS in Support of Multi Domain Battle

System #	Organization	System Name	System #	Organization	System Name	System #	Organization	System Name
1	Armored BCT Infantry BCT	Man Transportable Robot: System Enhancement (I)	11	Armored BCT Infantry BCT	Soldier Name Server (SNS)	21	Armored BCT Infantry BCT	Screening Observation Module - Remotely Operated Signature Management System-Occurance (SOM) (ROSS)CIC
2	Armored BCT Infantry BCT	Soldier Autonomous Sensor	12	Armored BCT Infantry BCT	Automated Convoy Operator (ACQ)	22	Engineer BDE	ICV Counter Explosive Hazard (Next Generation Explosive In-vehicle (NGEIV) (ie. Mine Clearing Line Charge Replacement))
3	Engineer BDE	Ruck Mounted Detection System	13	Armored BCT	Enhanced Unmanned Aerial System (UAS)	23	Armored BCT Infantry BCT	Large Area Multi Spectral Smoke System
4	Engineer BDE	Road Clearance Interrogation System	14	Armored BCT	Robotic Combat Vehicle - Direct Fire	24	Armored BCT Infantry BCT	Obscure Occlusion Device
5	Engineer BDE	Robotic Beach Vehicle	15	Armored BCT	Robotic Combat Vehicle - Indirect Fire			
6	Engineer BDE	Common Robotic System - Individual (CRS (I))	16	Armored BCT Infantry BCT	Robotic Combat Vehicle- Indirect Fire (Mortar/How)			
7	Engineer BDE	Common Robotic System - Heavy (CRS (H))	17	Armored BCT Infantry BCT	Robotic Combat Vehicle- Non Lethal			
8	Engineer BDE	Signal Multi-Function Equipment Transport (SME-T)	18	ABCT, SBCT, MBCT, RAS BCT	ICV Indirect Fire (Robotic Line Mines from Engagement) (BLADE)			
9	Armored BCT Infantry BCT	Joint Tactical Autonomous - Aircraft Resupply System (JTARS)	19	MED BDE (SPT) (Medical Company Area Support) also applies directly to organic medical units at Echelons Above Brigade	Robotic Patient Extraction in Complex Environments			
10	Armored BCT Infantry BCT	Mini UGV / UHweight Reconnaissance Robot	20	MED BDE (SPT) (also applies to organic medical units at echelons above brigade)	Robotic Autonomous Critical Care Systems			

Robotic Patient Extraction in Complex Environments

Robotic Autonomous Critical Care Systems

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Joint & NATO Initiatives



- **ASBREM Sponsored Joint “State of Science” Workshop in Autonomous Medical Evacuation (AME).**
 - Arlington, VA, 10-12 July 2018
 - OBJECTIVES:
 1. Provide visibility of medical needs to enable autonomous evacuation.
 2. Develop a common understanding of current capabilities and research objectives.
 3. Discuss the trajectory of enabling technologies and identify key technical challenges and gaps.
 4. Identify opportunities for coordination and novel partnerships across Communities of Interest (COI).
- **NATO Human Factors in Medicine Development of Autonomous Medical Systems for Tactical Evacuation. HFM-ET-167 Jan 2018-Jan 2019.**
 - USA leads with France, Great Britain, Canada
 - OBJECTIVES
 1. Establish common NATO concepts for leveraging emerging general purpose unmanned systems (UMS) platforms for medical missions.
 2. Establish a common NATO research and development roadmap for robotic, autonomous, and unmanned capabilities in support of combat casualty care
 3. Develop methods and approaches for implementing safe ride standards
 4. Survey and select interoperability standards.
 5. Define mission planning capabilities to coordinate patient transport




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