Army Ground Robotics Portfolio: NDIA Ground Robotics Capability Conference

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PM Force Projection
Agenda

- Portfolio Overview
- Active Robotics Programs
- Emerging Robotics Requirements
- Strategic Efforts
As the Army articulates RAS integration across multiple Warfighting Functions, this vision must also show *realistic objectives* in the **near-term**, *feasible objectives* in the **mid-term**, and *visionary objectives* for the **far-term**. Beginning with near-term objectives, each successive phase links its objectives to and builds from the achievements of the previous phase.

**Near-Term Objectives:**
- Leader-Follower Convoy Technology Employment
- Lighten the Soldier load
- Enhance stand-off from threats and improve situational awareness

**Mid-Term Objectives:**
- Technologies improve the *autonomy* of unmanned systems
- Technologies will enable unmanned cargo delivery
- Robots act as “teammates” rather than tools
- Micro autonomous air and ground systems will also enhance Platoon, Squad, and Soldier situational awareness

**Far-Term Objectives:**
Technologies will *enable manned and unmanned teaming in both air and ground maneuver* through investments in scalable sensors, scalable teaming, *Soldier-robot communication*, and shared understanding through advancements in machine learning.

Source for All Listed Objectives: TRADOC Pam 525-3-1, Army Operating Concept, Appendix C-2.
PEO CS&CSS Robotics Portfolio

- Man-Transportable Robotics System Mark I & II (EOD)
- M160 Light Flail
- Leader/Follower
- Semi-Autonomous Control Route Clearance & Interrogation System
- Robotic Enhancement Program
- Man-Transportable Robotics System Increment II
- Common Robotic System Individual
- Automated Convoy Operations
- Squad Multipurpose Equipment Transport
- Non-Standard Equipment
- Common Robotic System Heavy *
- EOD Robotics Payload *
- Husky Mounted Detection System

* Images are conceptual representations, not endorsements.
MTRS Inc II Program Overview / Update

• The Man Transportable Robotic System (MTRS) Inc II is a remotely operated, man-transportable, robotic system

• Provides a standoff capability to interrogate, detect, confirm and neutralize presence across War-fighting functions

• Capability to identify and disposition explosive hazards

• Army’s medium sized common platform allowing use of various platform payloads in support of current and future missions

* AAO includes EOD requirement of 587

✅ CPD: Approved, 15 MAY 2013
✅ RFP Released: 09 NOV 2016
• Contract Award: 4QFY17
• AAO: 1,210
• Users: Engineer, CBRN and EOD

Distribution A: Approved for Public Release
**System Description:** A man-packable (< 25lbs), miniature, highly mobile, unmanned robotic system with advanced sensors and mission modules for dismounted forces. Designed so that operators can quickly reconfigure for various missions by adding/removing modules and/or payloads.

**Common Robotic Platform Enabling Payloads to Address the Operational Capabilities Gaps:**
- Standoff short range Intelligence, Surveillance, & Reconnaissance (ISR)
- Remote Chemical, Biological, Radiological, and Nuclear (CBRN) detection
- Remote Explosive Obstacle Counter Measure (EOCM)
- Remote Explosive Ordnance Disposal (EOD) operations
- Remote clearance of danger areas

**Users:** INF, CBRN, ENG and EOD (EOD equals ENG payload; no unique requirement)

**Entire CRS(I) System required to fit into single Large MOLLE**

- **AAO:** 3,258 (Does not include Marines)
- **RFP Target Release:** APR 2017
- **Milestone B:** 4QFY17
- **EMD Contract Award:** 1QFY18
- **Milestone C:** 4QFY20
- **IOC:** 4QFY22
CRS(I) Proposed Materiel Solution

Entire CRS(I) System required to fit into single Large MOLLE

Standard Payload
- Tether*
- Lanyard*
- Optics*
- Manipulator*

Universal Controller
- Microphone/Speaker
- Radio
- Front & Rear Drive Optics
- Power source
- Additional UGV

Base Platform
IOP V1.0 Compliant

CBRN Payload
- Secondary Display*
- CBRN Sensor Adapter*

Engineer/EOD Payload
- Scraper/Hook*
- Secondary Display*

Projected CRS(I) Allocated Breakdown

*All diagrams are notional
**CRS(I) weight requirement does not include payloads or manipulator (included in standard payload)
CRS(UC) Demonstration at Ft Benning

**Purpose:**
Reduce overall program risk to meet CRS(I) Universal Controller(UC) KPPs while providing an cost-effective and viable government solution to meet current and future requirements.

**Objectives:**
- Confirm UAS H-GCS (aka TOGA) can operate both a UAS and UGV.
- Confirm MOCU4 Software can incorporate both UAS and UGV applications and enable hand-off between platforms within an operationally relevant environment.

MOCU – Multi-Robot Operator Controller  
TOGA – Tactical Open Government-Owned Architecture  
VIS – Vehicle Interface Specification  
UCS – Unmanned Control Segment  
JAUS – Joint Architecture for Unmanned Systems
Outcome:

- Controlled a UAS, Unattended Sensor, MTRS Inc II and CRS(I) surrogates
- Performed hand-off between multiple unmanned systems
- Demonstrated MOCU3&4 software interoperability on multiple controllers
- Confirmed MOCU software as a viable starting point (TRL6) for prospective CRS(I) offerors
Route Clearance & Interrogation System (RCIS) CPD consists of two capabilities that are unmanned, semi-autonomously controlled, highly mobile platforms to support Route Clearance Platoons and the BCTs.

- **RCIS Type I:**
  - Optionally manned or unmanned
  - High Mobility Engineering Excavator (HMEE) capable of enabling Soldiers to semi-autonomously interrogate, excavate, and classify deep buried explosive hazards, IEDs, and caches.
    - CPD: Approved, Dec 2012
    - RFP Release: MAR 17
    - Milestone B: 1QFY18
    - Contract Award: 1QFY18
    - AAO: 260

- **RCIS Type II** to follow, leveraging technology and architecture from the RCIS Type 1 program
Robotic Enhancement Program (REP)

• “Buy, try and inform” - evaluate state-of-the-art robotic systems and/or payloads that are Government-Off-The-Shelf (GOTS), Commercial-Off-The-Shelf (COTS) and Non-Developmental Items (NDI) to inform the requirement and acquisition process

• Status:
  - Experiment 16.1 – 17.1
    • Proposals submitted 109
    • Proposals Selected: 25
  - Experiment 17.2
    Proposals submitted 146 (62 New/ 84 Previous)
    Council of Colonels convened: 2 MAR 17

• REP Submission Site: http://www.peoccss.army.mil/rep.html
**SMET FORSCOM Excursion**

**Description:** Select ~4 Surrogates, totaling 60-80 systems issued to Soldiers in 2-3 Brigades for a 1 Year Excursion to develop TTPs and CONOPs

**Two Configurations:** Unmanned and Optionally Manned

**Required Capabilities:**
- Carry 1000 pounds
- Operate over 60 miles in 72 hrs
- Generate 3KW stationary and 1KW moving

**Stretch Goals:**
- Follow Me
- Battery Charging
- Reliability
- Silent Watch
- Universal controller compatibility
- Anti-Rollover
- Transportability at convoy speed
- Imbedded Video TM and Manuals
- Interoperability/Expandability

**Questions for Industry:**
- What is your production lead time and rate?
  - Robotic Rodeo (1-2 each)
  - Test (1-2 each)
  - Excursion Production (~5 unit sets)
- What is the earliest date you can have a system to Ft Benning for Rodeo assessment?
- How would you support Test, and Excursion?
- Is 5-10K sufficient to offset Rodeo costs?
- Would Rodeo assets be available to immediately support safety testing?

**RFI (+) coming soon**
Army SMET Goals

Army leadership desires automation & robotics sooner vs later.

Near Term (April to October 2017)

- OTA Request for Information/Proposal
- FY17 SMET Trials (late summer)
- Contract for Systems (~15-20 total)
  - 1-5 Test Assets
  - 10-15 Excursion Assets
- $100K per system target cost

Long Term (FY18-FY19)

- Excursion with 60-80 systems in 2-3 Brigades and at Test Sites
  - Demonstrate and insert increased capabilities
  - FSR Support for 15-20 systems at 4+ Government Sites/Installations
- CPD developed/informed by developing TTPs and CONOPs
- OTA continued leverage
- Informed Program Decisions Determine Future
Leader Follower Excursion

**Description:** Capitalize on Automated Ground Resupply S&T efforts to equip 3 Transportation Companies with Leader Follower capability for up to 2 year Excursion for TTP and CONOP development

**Required Capabilities:**

- Lane Following
- Day/Night Ops
- Obstacle Detection
- Line of Site Operation
- Primary/Secondary Roads
- Optionally Manned

**Stretch Goals:**

- Automated Reverse
- Sensor Range Improvement
- GPS Denied Ops
- Obstacle Avoidance
- Heavy Rain/Snow/Fog
- Unimproved Roads/Trails

**System Evaluation/ Measurement:** September 2017
Army LF Goals

Army leadership desires automation & robotics sooner vs later.

**Near Term** (Demonstrate in September 2017)

<table>
<thead>
<tr>
<th>Modes (Leader Follower, Teleop)</th>
<th>GPS Denied (LOS to Leader)</th>
<th>AO (Primary &amp; Secondary Roads)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assembly (Manual Line Up Vehicles)</td>
<td>Turnaround (Vehicle K Turn)</td>
<td>Operations (Day and Night Driving)</td>
</tr>
<tr>
<td>Formations (Column)</td>
<td>Obstacles (Static &amp; Large Dynamic)</td>
<td>Weather (Light Rain/Snow/Fog)</td>
</tr>
<tr>
<td>Reverse (Teleoperation and Manned)</td>
<td>Dynamic Rerouting (None)</td>
<td>Safe Harbor (Stop)</td>
</tr>
</tbody>
</table>

**Long Term** (FY18-20)

<table>
<thead>
<tr>
<th>Capitalize on S&amp;T Investments</th>
<th>10 Test Systems</th>
<th>CPD developed/informed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incremental approach and build</td>
<td>140 additional Excursion Systems</td>
<td>OTA continued leverage</td>
</tr>
<tr>
<td>2+ Year Excursion</td>
<td>Hardware Purchases</td>
<td>Informed Program Decisions</td>
</tr>
<tr>
<td>OTA Leveraged Activities</td>
<td></td>
<td>Determine Future</td>
</tr>
</tbody>
</table>
Autonomous Trucks Testing: “Long Tail” of Use-Cases

Use case variables include:

- **Operations:**
  - Wartime - High Intensity (7-day Surge)
  - Wartime - Low Intensity (30-day Period)
  - Peacetime - Low Intensity (240-day Period)

- **Hauling:**
  - Local Haul
  - Line Haul

- **Terrain:**
  - Primary Roads
    - High Quality Paved
    - Secondary Pavement
    - Rough Pavement Degraded
    - Rough Pavement Highly Degraded
  - Secondary Roads
    - Loose Surface
    - Washboard & Potholes
    - Belgian Block
  - Off-Road
    - Trails
    - Rough Trails

- **Speeds:**
  - 45 - 55 mph Primary Roads
  - 30 - 45 mph Secondary Roads
  - 10 - 30 mph Trails
  - 5 - 15 mph Rough Trails

- **Mobility:**
  - Dry (Sand)
  - Wet (Rain)
  - Snow

- **Cargo Loads:**
  - Full Load
  - Partial Load
  - No Load
  - Full Load w/trailer
  - Partial Load w/trailer
  - No Load w/trailer

- **Obstacles:**
  - Static
    - Trees larger than 4” diameter and 2ft. above ground level
    - Boulders larger than 18”L x 10”Wx18”H
    - Fire Hydrants
  - Dynamic
    - Oncoming Traffic
    - Blind-side Passing Traffic
    - Humans (minimum 36” tall)
    - Large Animals (e.g. camels/cows/horses/or larger)
    - Herds of small farm animals (sheep/goats/geese)

- **Serial Size (Follower Positions):**
  - 3 - 7 Follower Positions

Each point on the line represents a unique use-case.

Number of Times Use-Case Will Occur Over Lifecycle

“long tail” of use cases: cost driver for achieving reliability
For manned systems, testing organization (ATEC/OTC) trusts human driver’s decision making process to address these use-cases
Interoperability Profiles (IOPs) Status

- IOP V0 provided interfaces for capabilities already fielded
- IOP V1 provides interfaces for MTRS Inc II, CRS-I
- IOP V2 provides interfaces for RCIS & HMDS
- **IOP V3 priority** – Tactical Wheeled Vehicle Applique Kits, SMET & other emerging requirements
- IOP V4 priority – Additional TWV autonomy, Robotic Wingman w/ VICTORY, EOD Robotic Payloads

IOPs developed based on Navy AEODRS program

### Selected Examples

<table>
<thead>
<tr>
<th>IOP</th>
<th>Basic System Mgmt</th>
<th>Payload Mgmt &amp; Interfaces</th>
<th>Teleoperation</th>
<th>Basic Cameras</th>
<th>Basic Radios</th>
<th>JAUS Profiling Rules</th>
<th>Added Fidelity</th>
<th>Platform States &amp; Modes</th>
<th>Retrotraverse / Leader-Follower</th>
<th>Authentication &amp; Anti-Tamper</th>
<th>Comms Lost Management</th>
<th>Self Collision Avoidance</th>
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### IOP V1
- J1939 Profiling Rules
- JAUS Profiling Rules
- Autonomy Ground Resupply (AGR) Interfaces
- Driver Assist / Driver Warning
- Convoy Specification
- ROS to IOP Bridge
- Loading Specifications (CG for Trailer)
- Unmanned Systems Control Segment (UCS)
- Interface Description Document (IDD)

### IOP V2
- Platform Stability
- Platform & Payload Modeling
- Offboard Comms Interfacing
- Cost Map
- Basic World Modeling
- SW Version Reporting
- Debris Blowers

### IOP V3
- Dead Man Switch
- J1939 Profiling Rules
- JAUS Profiling Rules

IOP Documents Converted to XML

RAS-G IOPs enable modular open software & hardware interfaces

Distribution A: Approved for Public Release
Supplement existing commercial manuals with video instructions to mirror private sector sustainability for COTS and NDI equipment.

Path Forward (Pilot Program – MTRS Inc II & CRS-I)

- Decide on Pilot Program
- Obtain COTS Manual
- Video Production Cost Estimate
- Storyboard and Record Videos
- Video Storage Solutions
- Live Demo with Videos and Soldiers

Current Status: $10,000

Distribution A: Approved for Public Release
Discussion
Program Description

• Recapitalize 478 MTRS MKII to the Talon 5A configuration utilizing a return/retrofit/field strategy
  – Fielding starts APR 2017 for 5 years
• Qinetiq conversion kit includes:
  – Talon V Chassis Upgrade
  – Q-Tray- longer battery life per vehicle mission
  – Wave Relay 5 Radio, IOP compliant (same as NGB CBRNe)
  – Laptop Control Unit
**Vision:** Controller(s) which meets or exceeds CRS(I) threshold while leveraging Better Buying Power emphasis areas:

- Provide draft technical requirements to industry early and involve industry in funded concept definition
- Modular Open Systems Architecture
- Interoperability
- Organic engineering capabilities
- Extensibility & Commonality
- Cybersecurity
- Commercial Technology
- Supportability & Maintainability

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**Risk Mitigation:**

- Controller and Software demonstrations (Sept 16 and Jan 17) to mature MOCU4 software to handoff/operate on multiple controllers controlling multiple platforms
- Robotic Enhancement Program (REP) authorized purchase of Bokam, TRC-Lite controllers and UAS controller (TOGA H-GCS)
CRS(I) Weight Estimate

Shipping Container

CRS(I) System

CBRN Payload Interface: Mounting Bracket

ENG/EOD Payload: Scraper/Hook

Standard Payload: Camera/Illuminator
Lanyard
Subterranean NLOS (tether)
Manipulator Arm/Gripper
(full functionality of arm to pick up object)

CRS (I) Mobility Base Platform (MBP)

MBP Cameras
Cables and accessories
Processor
Power Source
Radio
Speaker
Microphone
Stair Climbing

OCU
Processor
Memory
Power Source
Radio & Environmental Case
Hand Controller
Dexterous Controls
Built-in Display
Speaker/Microphone
Secondary Display
(Not part of 25 lb weight; packaged with EOD/Engineer Payload)

Does Not Include: MOLLE Pack, CBRN Sensors
*The items listed are meant to provide information regarding the allocation of the weight requirements as listed in the CRS(I) performance specification and is not an all inclusive list.