U.S. ARMY COMBAT CAPABILITIES DEVELOPMENT COMMAND

Robotics S&T: Enhancing Ground Combat Capabilities Through Manned/Unmanned Teaming w/ Robotics Systems

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Army Futures Command - Combat Capabilities Development Command
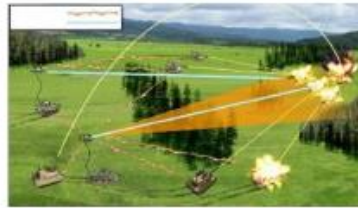
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VIDEO

(AKA ROBERT'S RULES ~~OF ORDER~~ FOR ROBOTS)

Let the Robot Die First
- Dull, Dirty, Dangerous on Steroids
  - New Tradespace: Survivability, Lethality, Mobility, Cost
  - Robots can be tougher than humans – not just sleep
    - 6 Watt Ride (Shock/Vibe), Overpressure Limits, Acceleration Limits
- *Robots Don't Flinch Under Fire (Well at least not yet)*

From a Tool to a Teammate
- It's not just manned-unmanned teaming… also about AI agents
  - Reducing cognitive load (Health Usage Monitoring just one example)
  - What about COA analysis, Real time mission assessment
- Beyond *Siri for Robots* to a two way conversation
  - Negotiation
  - Scalable, Shared World Model w/Contextual understanding
  - Hand and Arm Gestures
- Ability to give a backbrief and eventually an AAR

Whom do you Trust? – Safe Learning Enabled Components DARPA
- Explainable AI / Assured Autonomy
- Training Validation followed by Runtime Safety, Behavior, and Mission Assurance over a Dynamic mission profile
- Can adaptable systems remain within safe operating region?
- Continuous recertification? CTT/Table VI for AI…

Baked in Cyber: Assured HW/SW architecture
- Leverage best practices from aviation community
- Cyber/red teaming part of the development process
- Tools to validate Open Source Software
- *On platform AI agents for IDS*
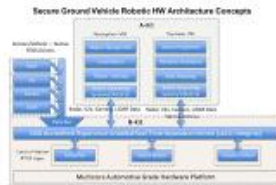
Need More M & Ms: Getting from Movement to Combined Arms Maneuver
- Multi-Domain, Combined Arms, METT-TC informed
- Vehicle paired UxS that can provide a SALUTE report, Scan IV Lines, keyhole shots, etc.

Cross country maneuver at operationally relevant speeds

Get Soldier's Hands Dirty
- Early-On and Often Afterwards
- Practice, Refine, Repeat as necessary

Don't Bite Off More than You can Chew
- Incremental delivery rather than gold-plated requirements upfront
  - **Minimally Viable Product** is somewhat different in a military context
  - Design for Growth
- User based Prioritization
- Spiral/Sprint/Scrum out Capability
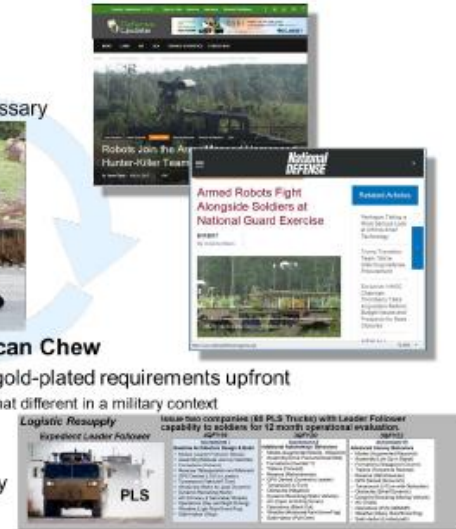
It Takes a Village: Academia, Industry, Innovators, Gov't Labs
- Requires solutions from many sources

Let's Play Together: Autonomy App Store ::ROS-M
- Common architecture, Development environment
- Not your normal app store - Building a marketplace
- Enables non-traditional partners / innovation community to play

Don't Go It Alone: We fight as a joint, combined coalition team
- Leverage partners
- ANVEL for Allies
  - RAS Sim environment
  - Includes Soil Interactions

TORVICE

(AKA ROBERT'S RULES ~~OF ORDER~~ A FOR ROBOTS)

How Much (Testing) is Enough?
- Solving the TEV&V Risk Riddle
- Can simulation solve the trillion-mile challenge
- Will we experiment with higher safety risk systems
- *Can we use AI to "drive" M&S to reduce physical test?*

No longer in the Driver's Seat: Adapting COTS to MOTS
- DoD no longer sets the pace for microelectronics
- Modified Automotive grade may be good enough
- Design architectures that accept new components

FAR, FAR Away – Use an OTA or Other Transactional Agreements (as appropriate…)
- Modular Open Systems Architecture coupled with Rapid prototyping
- Little appetite for typical acquisition EMD timelines

"Are We Really that Smart?" – Will AI save the world (or doom it)?
- AI/ML vs. Artificial General Intelligence
- Challenged by sparse, biased data sets: dirty, dinky, deceptive… ,
- Transfer learning
- Are you a tool? …. This morning: Comb/Brush, Toothbrush, Fork/Spoon
- *Think about soldier adaptation, improvisation, curiosity, and initiative …*

"Are We there Yet ? - Challenging the Status Quo
- Untapped potential as RAS becomes integrated in Army formations
- Room Breach
- Robotic Arms in the Wild (Dexterous/Safe Industrial Arms)
  - Transforming Sustainment (Enhance Optempo)
  - Automating R3P point for minimal footprint/maximal throughput

NEW

Bend Virtual Metal First: Role of M&S and Gaming

- Virtual Prototypes / Behavior Development
- TTP and CONOP Development
- Not a substitute for prototyping

Putting future vehicle concepts into the hands of today's Soldiers

Accelerate Innovation & Increase Warfighter Involvement

BLUF: Enhanced Robotic Modularity – Sustainable RAS (MOSA w/Code Re-Use)

- Modularity in Software: Messaging/Middleware and the Autonomy App Store
- Modularity in Hardware: Interoperability Profiles and Modular Mission Payloads
- Commonality in Controller Interfaces: Multi-domain, UCS convergence

PROBLEM STATEMENT

Bridge 6.1-6.4 "Valleys of Death" by leveraging a common developmental framework, scalable approach, and experimental playground with robotic stables

SPEAK THE SAME LANGUAGE

SUCCEED/FAIL SMALL & CHEAP

REDUCE BARRIERS TO ENTRY & ENABLE NICHE PLAYERS

VISION: Create a Focused Development **Pipeline** to **Accelerate Soldier Informed Capability Transition** from our Partners thru **Experimentation** that gets capabilities in **Formations Faster**.

Leverage <u>ongoing efforts</u> using Modular "Open Source" Software Approach, Adaptable Robotic Capability, and a Secure Repository to build the *Army Autonomy App Store*

ROS-M

FBGA – Oct 2018

Wingman JCTD

JWA 2019

Warrior Machine Interf

Year 1 – Baseline User Assessment

Year 2 – Interim User Assessment

Armed Robots Fight Alongside Soldiers at National Guard Exercise

Project Origin FY19-20

Robotic Combat Vehicle Family

BENDING VIRTUAL METAL: SOLDIER ENGAGEMENT THRU SOLDIER INNOVATION WORKSHOIPS AND VIRTUAL EXPERIMENTS

✓ **NGCV-VE #1 (DEC 2018 @ GVSC):** *1st Armored Division, Ft. Bliss*
   Explore TTPs and gather Soldier input for two distinctly different RC

✓ **NGCV-VE #2 (MAR 2019 @ GVSC):** *1st Cavalry Division, Ft. Hood*
   Explore TTPs and gather Soldier input for OMFV-RCV control ratios/handoffs
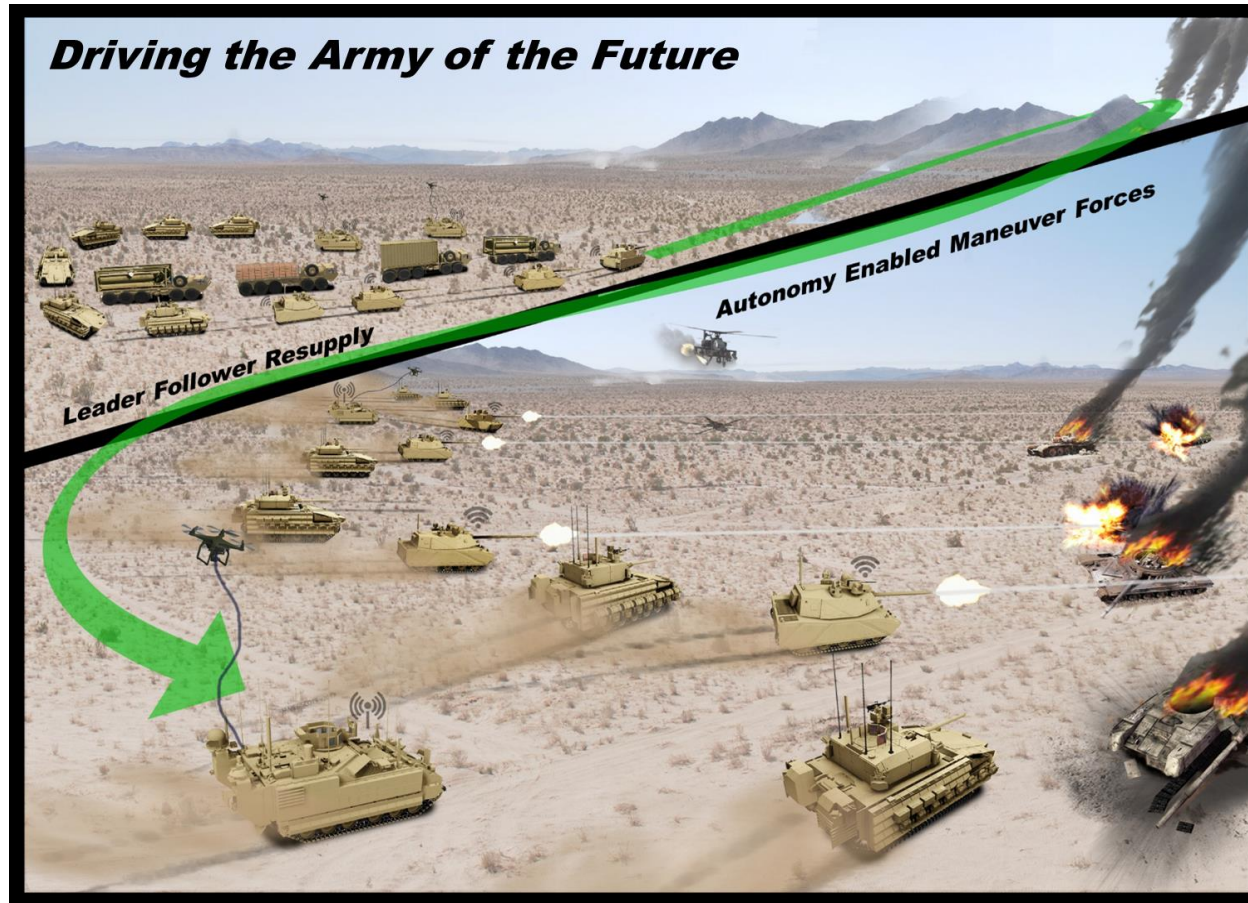
NGCV-VE #3 (4QFY19): *32 Soldiers*
   Experiment objectives, missions, and tech based on lessons learned from VE #1 / #2

NGCV-VE's FY20: *Scale to 100+ participants, to allow execution of Company level*

AUTONOMOUS MOBILITY THRU INTELLIGENT COLLABORATION (AMIC)

Develop/integrate Artificial Intelligence and Machine Learning (AI/ML) technologies to increase autonomy and mobility to perform teamed operations with manned and unmanned air and ground vehicles in a military relevant environment through data collection on relevant Soldier training exercises.

AMIC FOCUS AREAS

AMIC is focused on the mobility portion of the Manned-Unmanned Teaming. From an operational perspective, it adds the required pieces for further unmanned operational missions like lethality, RSTA, and others.
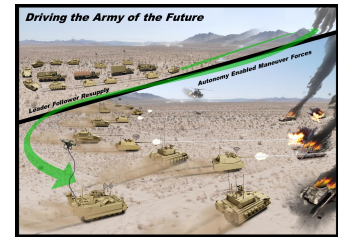
Data Collection

Data collection will involve both simulation and live collection events. Simulation will provide a base to correctly collecting, cleaning, and analyzing data that meets the need for developing algorithms for both Formation Control and UAV Map Input for UGV Mobility. Live data will start with Surrogate platforms in local areas. This will allow proper collection techniques, tools, and data to maximize embedded autonomy using Machine Learning and other Artificial Intelligent methods before utilizing live training events for data collection.

Formation Control

Use AI/ML techniques to develop/integrate intelligent formation control to be used on maintained roads and in complex terrain without the need for GPS. Data will be collected from mounted platforms utilizing special internal and external sensors to develop algorithms for exact positioning, undistributed formation control, and increased speeds of unmanned platforms.

UAV map input for UGV mobility

Use AI/ML techniques to develop intelligent autonomous ground platform planning through the use of UAV mapped areas. Data collected from air vehicle will be converted to maneuverable information for unmanned ground platform with the identification of enemy positions, go/no-go areas, terrain classification, and optimal suggested paths.
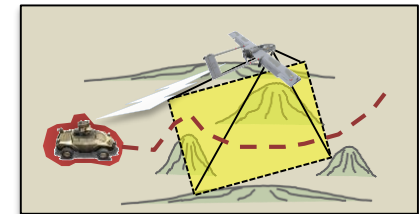
DATA COLLECTION

Crawl

- Simulate single vehicle
  - Use CCTT or other simulation
  - Sync voice and location

- Use multiple vehicle simulator like SEGA or other
  - Sync voices with positon of vehicles

This data will help sync global movements with voice to create tools for cleaning and analyzing data as well as to help understand live data to collect.
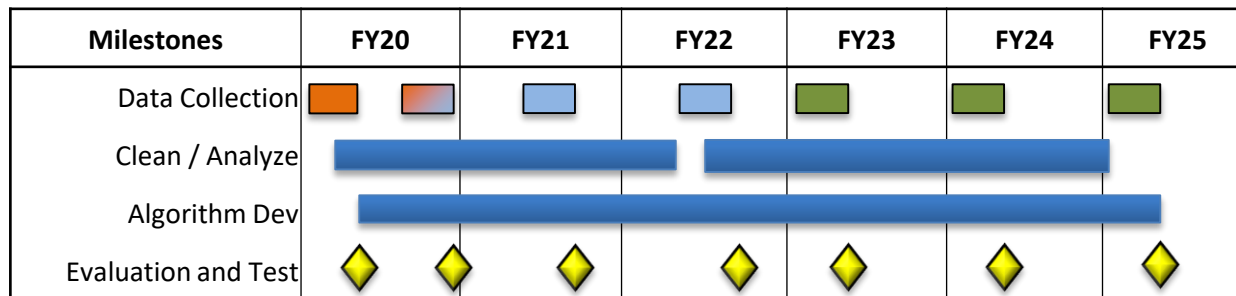
Walk

- Live data collection using surrogate vehicles
  - Sync voice, position, and BFT data along with low level data (vehicle vibrations, SBT, and terrain data)
- Clean and analyze data. Build algorithms for formation control.
- Update SEGA and CCTT/other simulations with live data

This will help update and validate simulations, understand proper data to collect from training exercises, and develop collection, analysis, and validation tools.

Run

- Live data collection at NTC during training exercises.
  - Capture, clean, analyze, and develop algorithms

- Develop transition algorithms between environments and between vehicles.

Data will continue to be collected and updated from the change in environment and vehicles. Transition functions will help extend the data past the trained environments.

Milestones	FY20	FY21	FY22	FY23	FY24	FY25
Data Collection	▮ ▮	▮	▮	▮	▮	▮
Clean / Analyze						
Algorithm Dev						
Evaluation and Test	◆ ◆	◆	◆	◆	◆	◆

▮ - Simulation Data ▮ - Surrogate Vehicle Data ▮ - NTC Data

Mobility Data
- Unclassified
- GVSC/ARL lead

Shoot Data – *Not AMIC*
- Mostly classified
- ARDEC/CERDEC/ARL lead

CCTT – Close Combat Tactical Trainer BFT – Blue Force Tracker SEGA –Soldier Experimental Gaming Analysis SBT – Steering, Brake, Throttle NTC – National Training Center

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SUMMARY / QUESTIONS

"Little David"
Circa 1950s

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