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**WARGAMING AND ADVANCED RESEARCH  
SIMULATION LAB  
A Virtual Range**

**G. Darl Lewis**

**17 April 2023**

**Tech Note**

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Public Affairs release approval #AFRL-2023-1824.**



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## REPORT DOCUMENTATION PAGE

<b>1. REPORT DATE</b> 17 April 2023		<b>2. REPORT TYPE</b> Technical Note		<b>3. DATES COVERED</b>	
				<b>START DATE</b>	<b>END DATE</b>
<b>4. TITLE AND SUBTITLE</b> Wargaming and Advanced Research Simulation Lab A Virtual Range					
<b>5a. CONTRACT NUMBER</b>		<b>5b. GRANT NUMBER</b>		<b>5c. PROGRAM ELEMENT NUMBER</b>	
<b>5d. PROJECT NUMBER</b>		<b>5e. TASK NUMBER</b>		<b>5f. WORK UNIT NUMBER</b> No associated work unit number	
<b>6. AUTHOR(S)</b> G. Darl Lewis					
<b>7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)</b> Air Force Research Laboratory 3550 Aberdeen Ave SE Kirtland AFB, NM 87117-5776				<b>8. PERFORMING ORGANIZATION REPORT NUMBER</b>  AFRL-RD-PS-TN-2024-0008	
<b>9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)</b>			<b>10. SPONSOR/MONITOR'S ACRONYM(S)</b>  AFRL/RDMW		<b>11. SPONSOR/MONITOR'S REPORT NUMBER(S)</b>
<b>12. DISTRIBUTION/AVAILABILITY STATEMENT</b>  Approved for public release; distribution is unlimited. Public Affairs release approval # AFRL-2023-1824					
<b>13. SUPPLEMENTARY NOTES</b>					
<b>14. ABSTRACT</b>  Drive collaboration across all warfighting domains and allow integrated analysis through model-based systems engineering to simultaneously improve system capabilities and performance while reducing both cost and schedule.					
<b>15. SUBJECT TERMS</b>  Wargames, Directed Energy, HITL					
<b>16. SECURITY CLASSIFICATION OF:</b>			<b>17. LIMITATION OF ABSTRACT</b>		<b>18. NUMBER OF PAGES</b>
<b>a. REPORT</b> Unclassified	<b>b. ABSTRACT</b> Unclassified	<b>c. THIS PAGE</b> Unclassified	SAR		13
<b>19a. NAME OF RESPONSIBLE PERSON</b> G. Darl Lewis				<b>19b. PHONE NUMBER (Include area code)</b> 505-853-1633	



# AFRL

## Wargaming and Advanced Research Simulation Lab *A Virtual Range*

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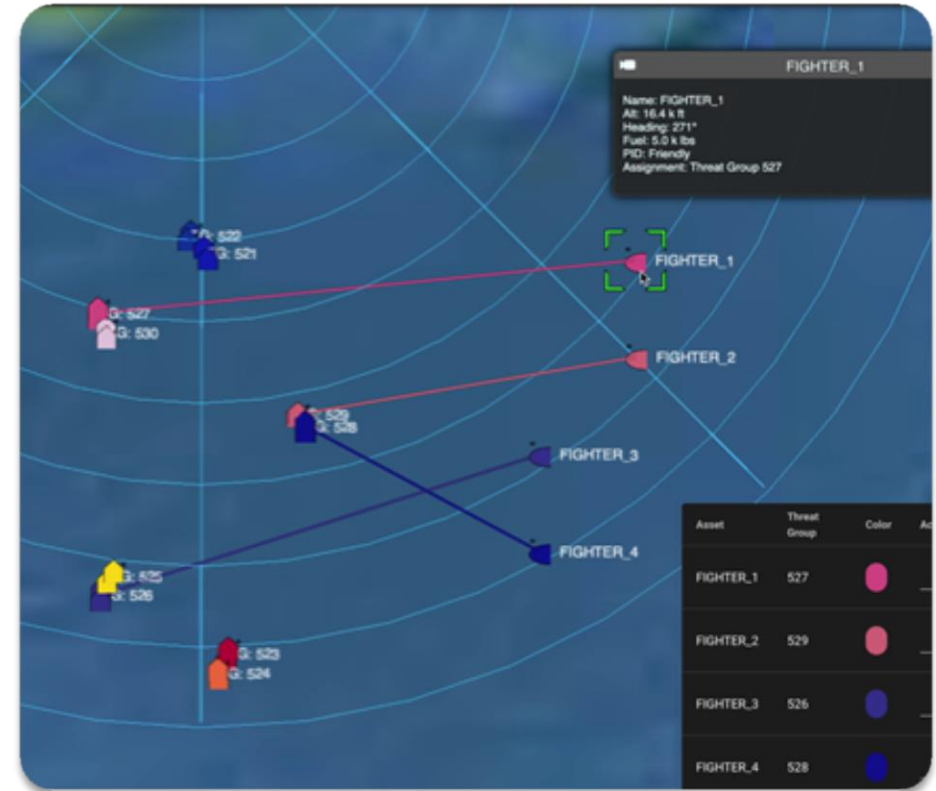
# Wargaming and Advanced Research Simulation Laboratory

- 10,685 square foot laboratory dedicated to wargaming, modeling, simulation, and analysis
  - Joint effort between AFRL Directed Energy and Space Vehicles Directorates
  - Explore more concepts faster, without waiting for the “real thing” hardware
  - Exploit digital engineering to save time and money
- Address three strategies to deter conflict—innovation, speed, and partnerships (ISP)
  - Focus on competition with our adversaries across all domains of warfighting
  - Drive collaboration across all warfighting domains and allow integrated analysis through model-based systems engineering (MBSE) to simultaneously improve system capabilities and performance while reducing both cost and schedule
  - Further transformational weapons systems and promote ISP across AFRL and the DoD
- Improve Human-in-the-Loop (HITL) analysis in support of constructive M&S to advance next-generation warfighting capability



# Foundational Modeling and Simulation (M&S)

- Incredible value to next-generation systems:
  - Low-cost
  - Inform requirements early
  - Basis of initial CONOPs, CONEMPS
  - Demonstrate and educate on capability
- Limitations:
  - Complex scripted behavior
  - Limited warfighter input
  - Inflexible Tactics, Techniques, and Procedures (TTPs)
  - Uncertain external validity
- Solutions:
  - Live wargames are expensive
  - Tabletops are slow, rely on subjective expertise



**Virtual wargames balance fidelity of M&S with flexibility and external validation of Human-in-the-Loop (HITL) wargames prior to costly prototyping**

# What is a DEUCE wargame?



- Low-cost mission-level wargame hosted at AFRL/RD designed to study the military utility of next-generation Directed Energy (DE) concepts
- Combine virtual and constructive analyses to assess concept performance incorporating high-fidelity modeling data alongside human operators and artificial intelligence
- Warfighter feedback throughout planning and execution ensures proper representation of current and future capabilities as well as needs in the combatant community

# Add warfighter credibility to constructive analysis

- Combat Air Force (CAF), Training and Test Communities in the loop
  - **CAF:** Familiarity with threats; inputs on battle management, HEL pod employment, and interface designs
  - **Training Community:** Inputs from highly experienced fighter pilots with significant CAF experience
  - **Test Community:** Flexibility in employing new concepts
- Participation by Weapons School graduates – determine how units employ weapons
- Cross-service participation by USA and USN provides broadened insight to joint missions
- Senior warfighters bring extensive operational experience; junior personnel bring new eyes and the possibility of receiving fielded systems



## What are the outcomes?

- Promote maturity of DE concepts
- Provide a distributed virtual environment to analyze mission-level DE concepts and advanced technologies
- Solicit warfighter feedback into development of DE technology
- **DEUCE Capability Payoff:**
  - Military utility assessment, increased awareness, advocacy, and demonstration of DE capabilities to Joint Warfighter
  - Low cost/low risk look at new concepts of employment (CONEMPs) and tactics, techniques, and procedures (TTPs) for DE technologies used with existing conventional systems
  - Focus technology investments to address capability gaps





# Challenges of warfighter integration

## COCOM & MAJCOM buy-in

Warfighter availability  
Reference materials  
Advocacy

## DE Training

DE effects  
TTPs, CONOPs, CONEMPS  
Communication

## M&S Tools

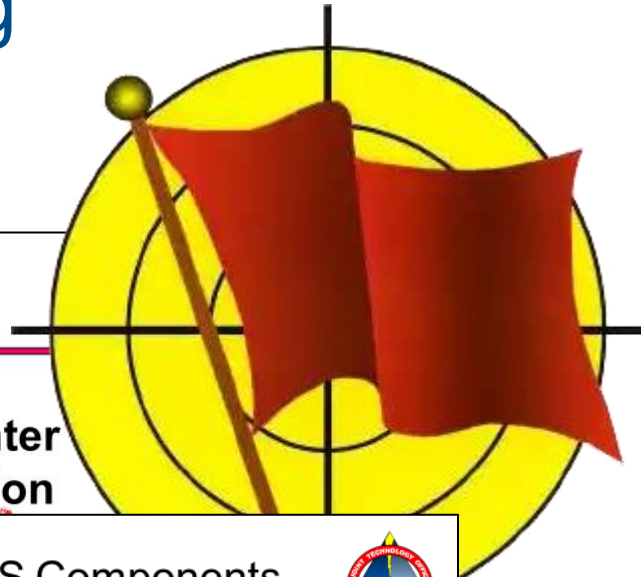
Network configuration  
User Interface  
Design of experiments

# COCOM and MAJCOM buy-in


- Ops, training, and test communities are **very busy**
  - Prepare and provide materials well ahead of capstone events to minimize down-time on-site
  - Be ready for last minute substitutions
- Operator insights are key to integrate next-gen technology with current CONOPs
  - The most robust insights come when warfighters can tie their own training into our S&T
  - Let them know early what you are hoping to get
- Accept criticism—and improve next time
  - Operators want to see the next generation of capability & help it live up to expectations—their lives may depend on it
  - Recognize the value of the operator experience—even if it comes with reduced M&S fidelity
  - Make their presence useful
- Participants take any feedback to their units—positive or negative




# DE training




- **Training is a two-way street**
  - Tech push vs. requirement pull
  - Warfighter language vs lab language
  - Early and often throughout development
- S&T community teaches Space and DE
  - How do these tools affect targets?
  - What needs to be done to make this happen?
  - What 'needs' are flexible?
- Warfighting community teaches Ops
  - How to get to the right place at the right time?
  - What is the actual capability need?
  - What other missions will support? Interfere?
- Meet in the middle—but where?



## HEL Warfighter Familiarization



### HEL WS Components



- HEL
  - Wavelength
  - Power
  - Efficiency (size, weight)
  - Beam quality
  - Weapon availability (magazine, duty cycle)
- Platform (fixed or mobile)
  - Thermal management
  - Environmental factors
  - Jitter (vibration)
  - Aero-optic effects
  - HEL WS power source
    - Determines magazine depth
- Battle Manager
  - Targeting information
  - Laser enable
- Fire Control
  - Schedules Beam Control
  - Controls HEL fire (dwell time)
    - Damage/kill assessment

**Battle Manager**

**Fire Control**

**Beam Control**

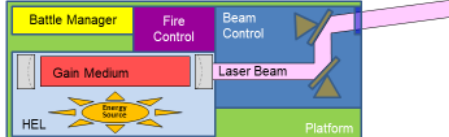
**Gain Medium**

**Laser Beam**



**Energy Source**

**HEL**

**Platform**



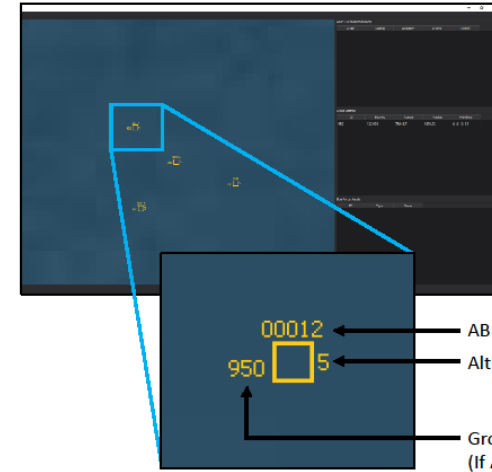
- Beam Control
  - Large aperture important (limits diffraction)
  - Target tracking
    - Through other lasers (lower power)
    - Through main beam optics
  - Atmospheric, jitter, target interaction compensation
    - Target-in-loop
    - Could include adaptive optics

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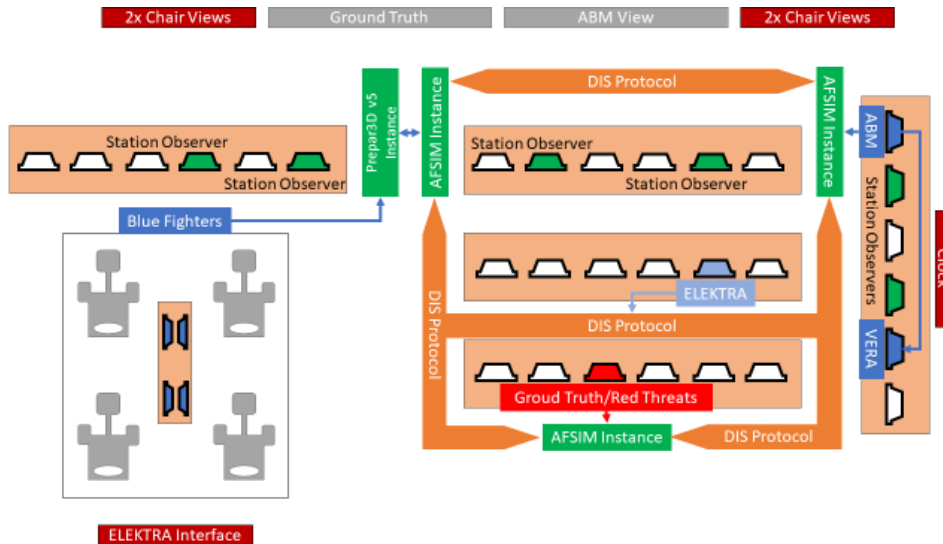
# M&S Tools

- What hardware is required?
- What software is required?
- Do computers need to talk to each other?
- What needs to be modeled to accomplish the goal? What is extra? What is harmful?
- **Test, stress test, and test again**



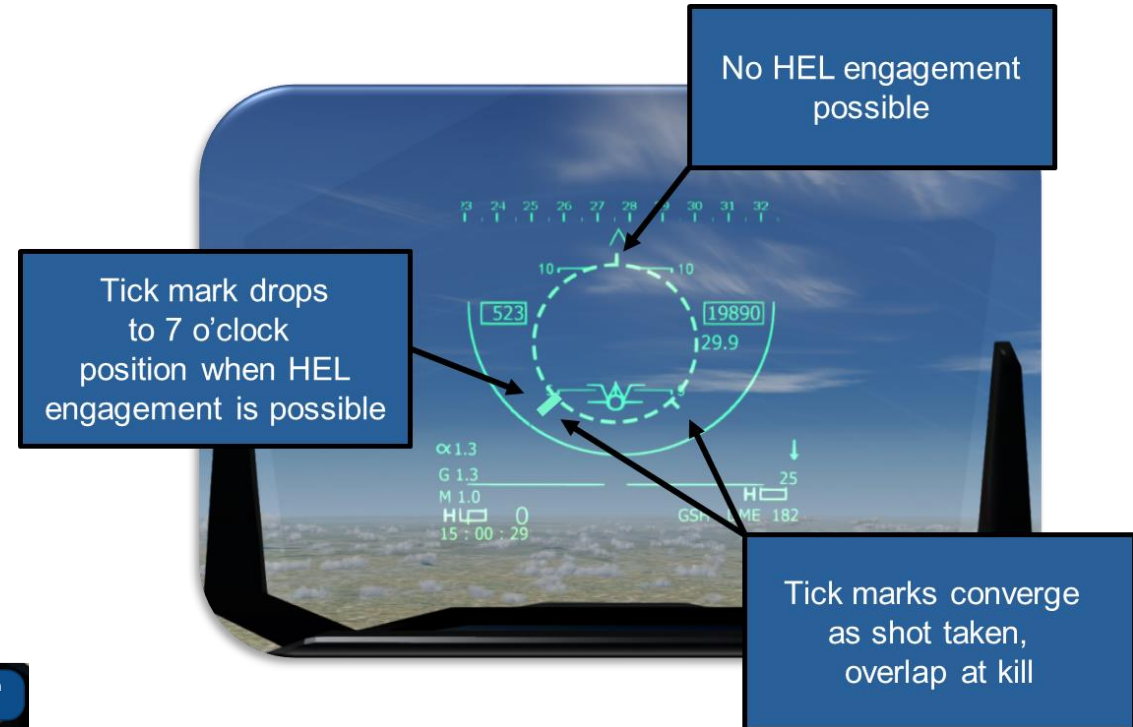
### Track Icon

- Tracks will be shown FRIENDLY (green), HOSTILE (red), UNKNOWN (yellow)
- Altitude of track is kilofeet by default
  - Can be changed based on user preference (in development)



# User Interfaces

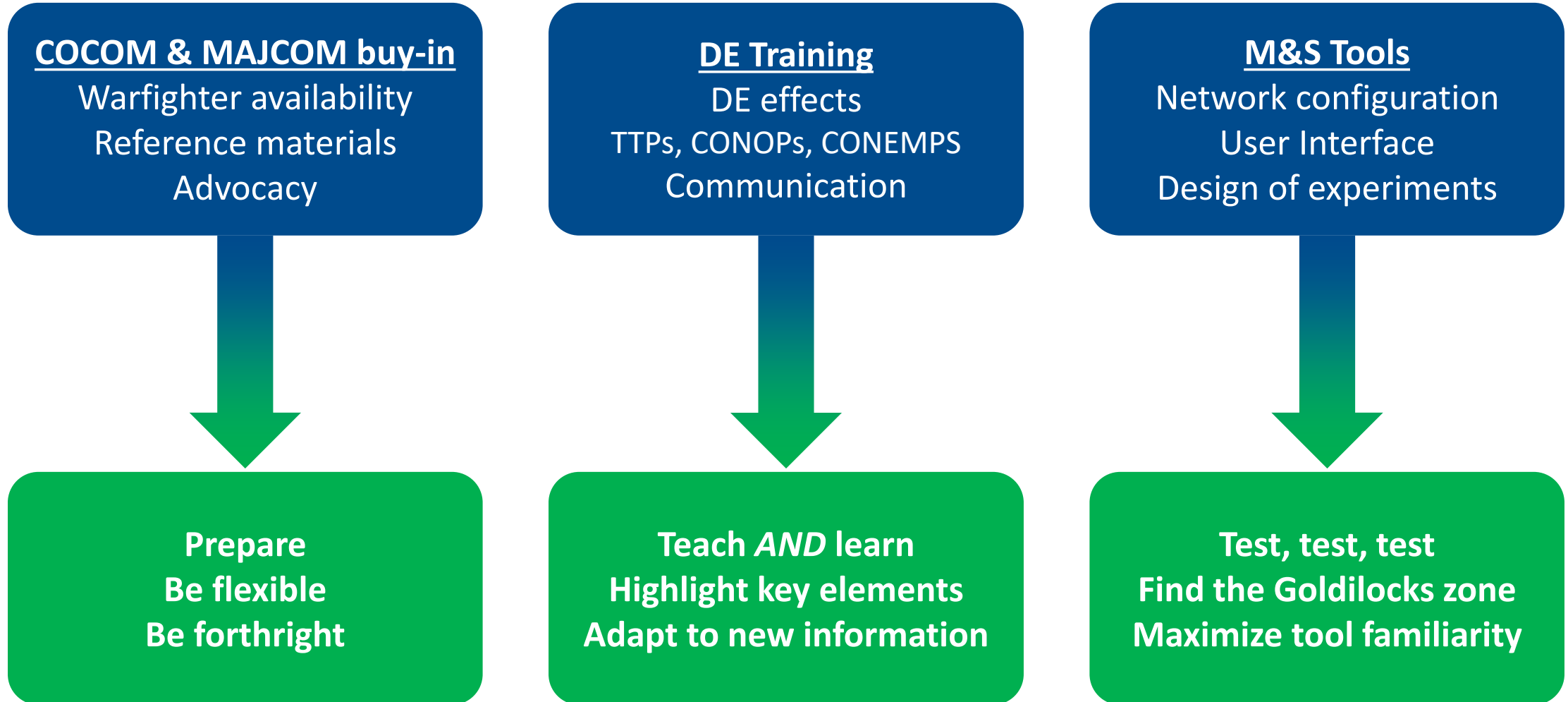
- Extensive and ongoing work with the operational community to inform interfaces
  - For the simulator
  - For the future system
- Inform data requirements for developing systems
- Identify simulator limitations and requirements to generate realistic operational environments



- Generate novel interfaces for next-gen tech
  - Balance familiarity with unique requirements
  - New challenges for engagement & BDA
  - Flatten the DE learning curve
- Generate interfaces to incorporate AI
  - Present the right information at the right time
  - Filter unnecessary data
  - Provide accurate, and timely information



# Solutions for warfighter integration





# Questions?