



AFRL

Wargaming and Advanced Research Simulation Lab *A Virtual Range*

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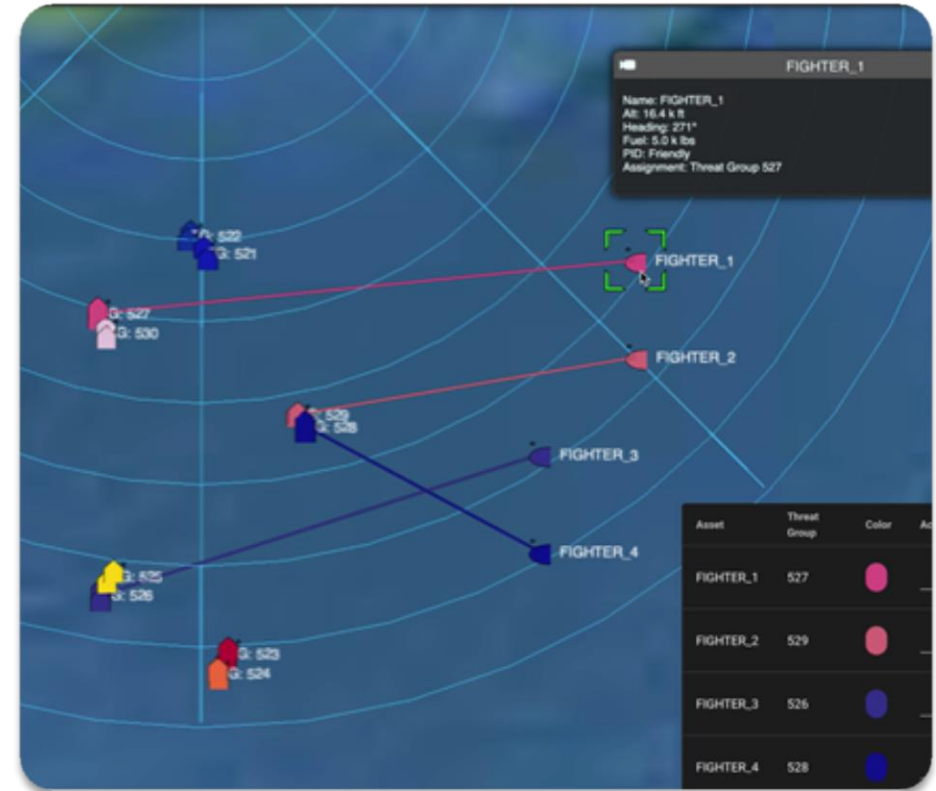
Wargaming and Advanced Research Simulation Laboratory

- 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

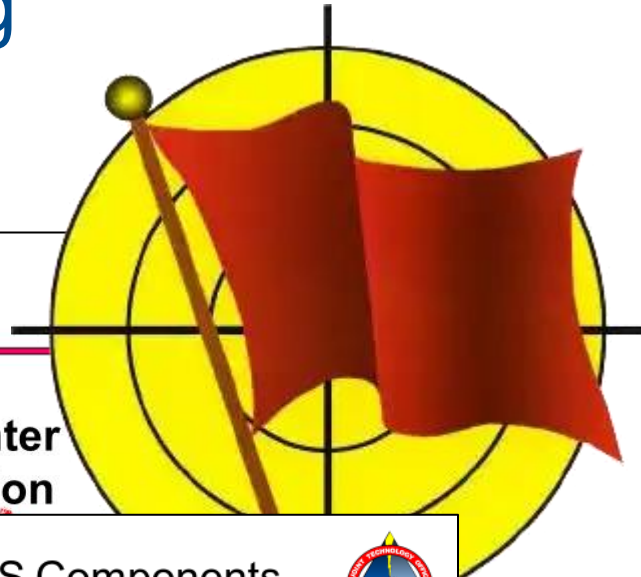
Network configuration
User Interface
Design of experiments

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?



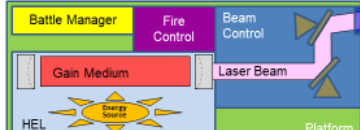
HEL Warfighter Familiarization



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



The diagram shows the flow of information and energy in a HEL system. It includes components like Battle Manager, Fire Control, Beam Control, Gain Medium, Laser Beam, Energy Source, and Platform.

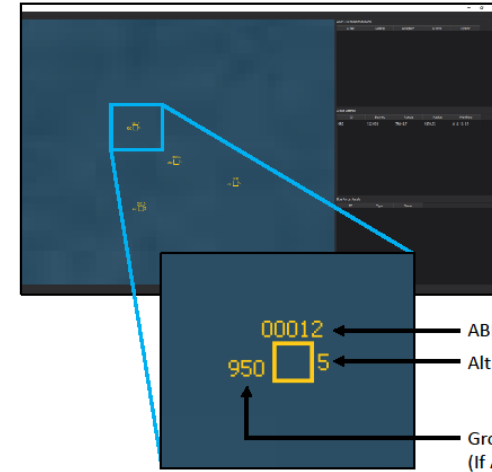
- Beam Control
 - Large aperture important (limits diffraction)
 - Target tracking
 - Through other lasers (lower power)
 - Through main beam optics
 - Atmospheric, jitter, target interaction compensation
 - Target-in-loop
 - Could include adaptive optics

38

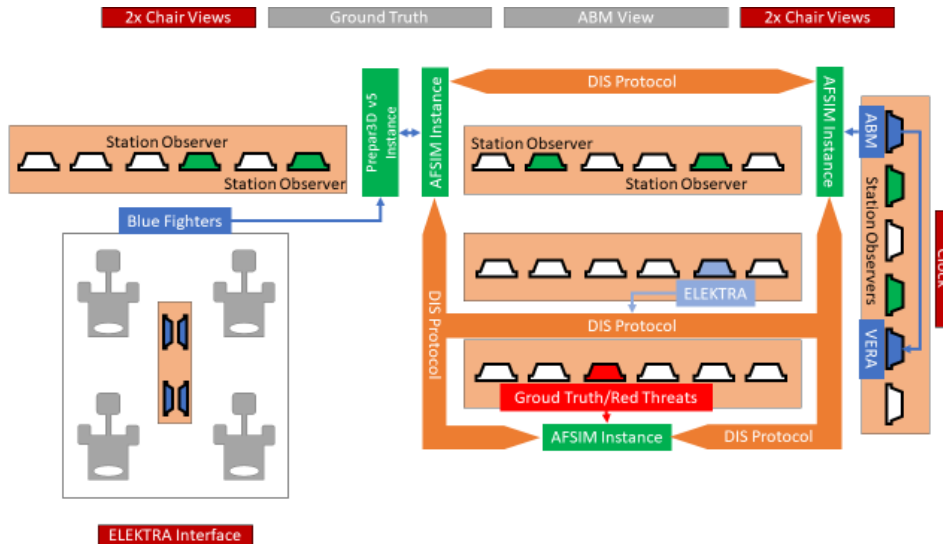
M&S Tools

- 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**



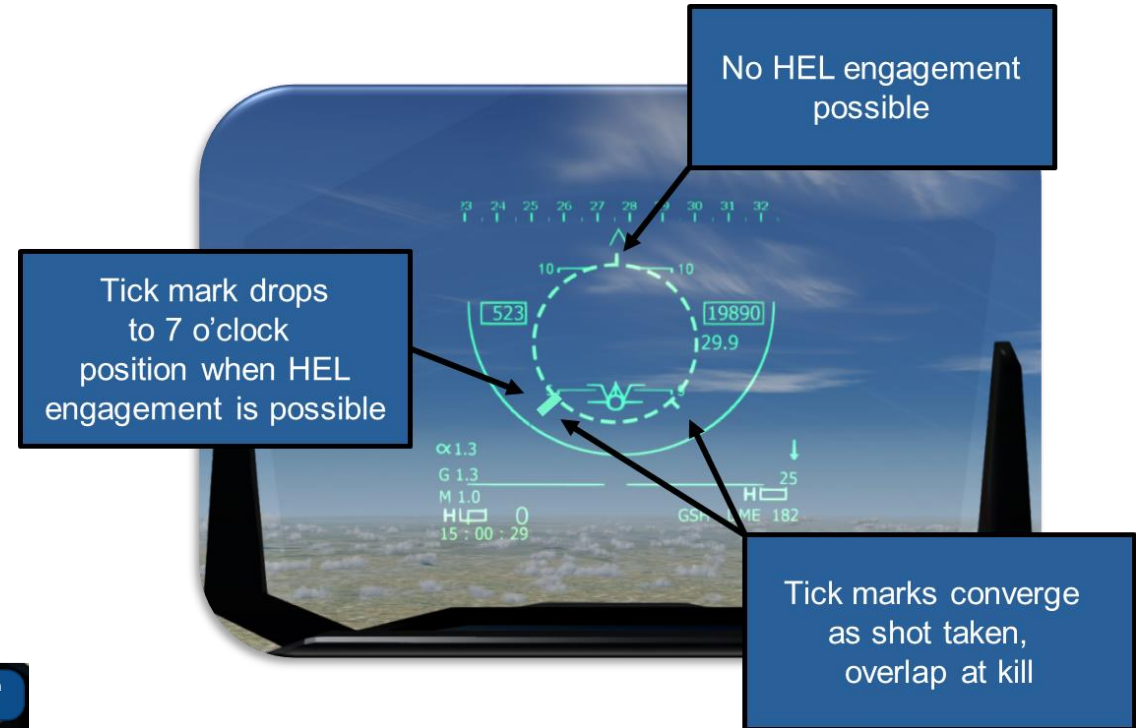
Track Icon

- 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

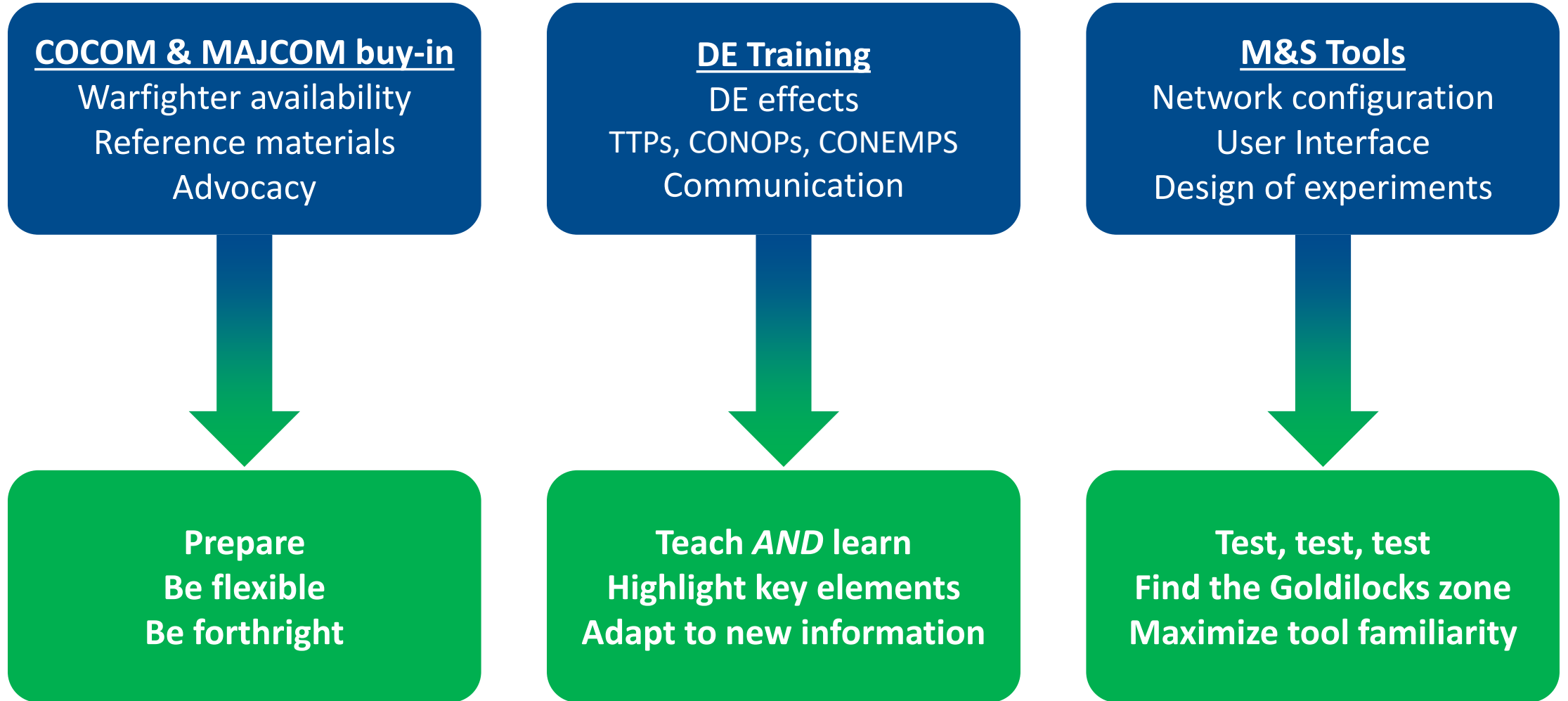
- Extensive and ongoing work with the operational community to inform interfaces
 - For the simulator
 - For the future system
- Inform data requirements for developing systems
- Identify simulator limitations and requirements to generate realistic operational environments



- 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?