Advanced Scene Generation

Mr. Robert "Bobby" Watson Doolittle Institute Technical Showcase

Munitions Directorate | September 21 2023

- One of nine Technology Directorates comprising the Air Force Research Laboratory
- **Location**: Northwest Florida - Eglin Air Force Base
- **Mission**: Discover, develop, integrate, demonstrate, and transition conventional air-launched weapons technologies, enabling the Department of the Air Force to dominate across all domains.

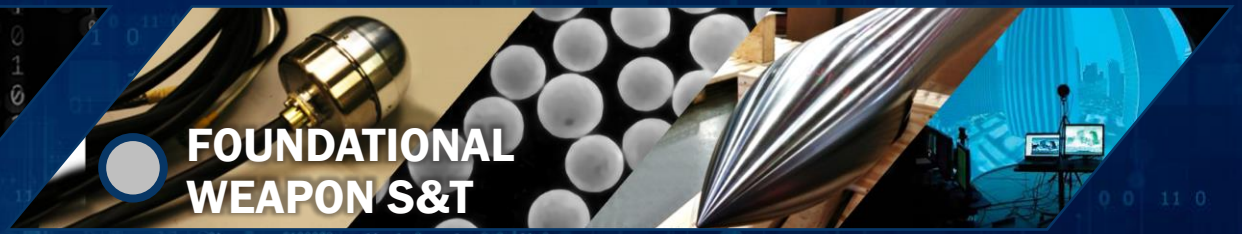
2023 Priority Areas for Munitions Directorate

RW 2.0 IMPLEMENTATION

COUNTERAIR

DIGITAL MATERIEL MANAGEMENT

FOUNDATIONAL WEAPON S&T



NETWORKED, COLLABORATIVE, AUTONOMOUS (NCA) WEAPONS

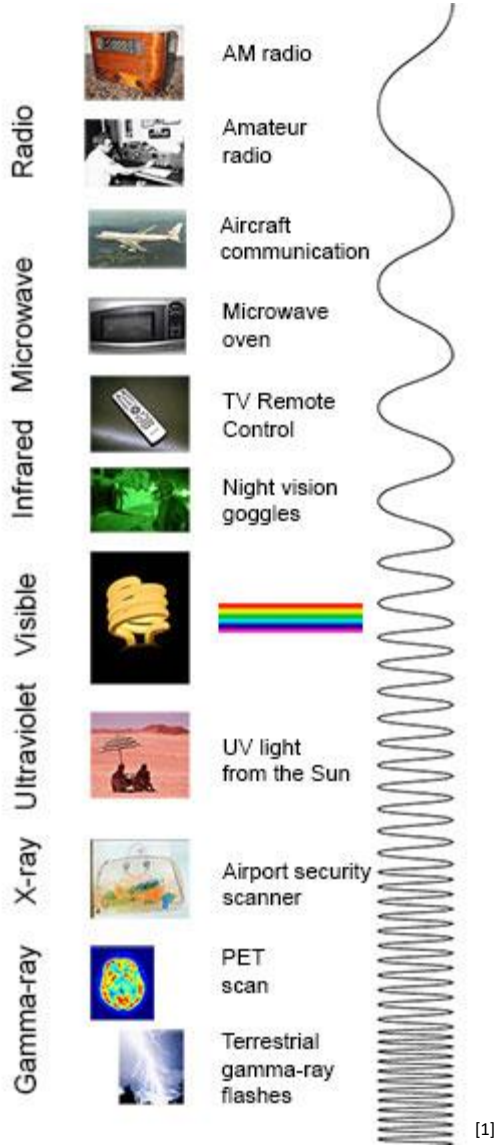
AIRBASE DEFENSE

COUNTERMARITIME

S&T ENABLERS FOR NDO, SOF, AND SPACE

What Is Scene Generation?

- Scene Generation is the process of using signatures of different real-world phenomenology to make a representative digital world based on physics
- Data is then taken of this digital world and input into real systems/algorithms for development and testing
  - Example: In Infrared, two-dimensional “photos” are taken (like a camera)
- Importantly energy conservative physics must be maintained to ensure the reality of the solution.
- RW’s Area of Interest is broad for advanced scene generation, encompassing:
  - Electro-Optical
    - Infrared (IR), Ultraviolet (UV), Visible
  - Radio Frequency (RF)
  - Magnetic



[1]

Visualization does not equal scene generation

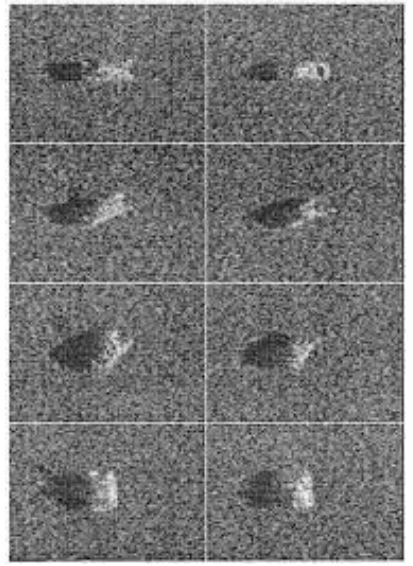
[1] NASA, March 2013, https://imagine.gsfc.nasa.gov/science/toolbox/emspectrum1.html#:~:text=The%20electromagnetic%20(EM)%20spectrum%20is,two%20types%20of%20electromagnetic%20radiation.

Common Challenges

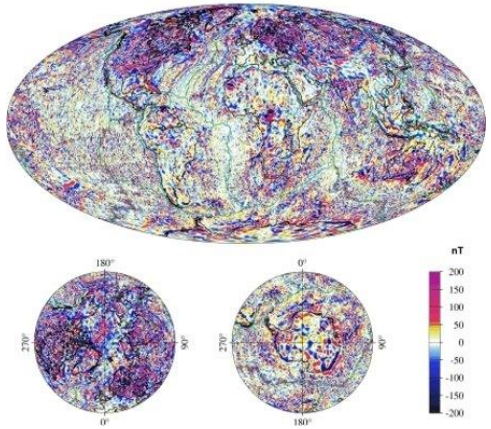
- Shifts in technology necessitate computational advancements:
  - More pixels
  - Increased framerates
  - Added scene content/phenomena
  - Faster computational speed -> real-time computations
- Availability of models
  - V&V of those models?
  - Material properties in bands of interest
- Scene Generation is not simple and requires a high level of expertise to be done correctly
  - Knowledge in Computer Science, physics, etc.

Electro-Optical

Radio Frequency



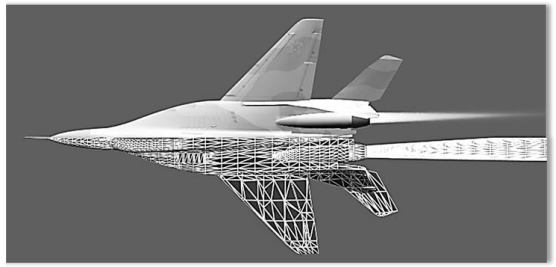
Magnetic Field



Effective analysis of R&D hardware requires a versatile and robust scene generation capability

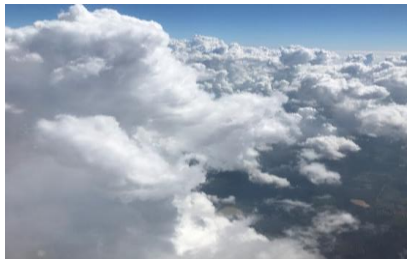
Fast Line-of-sight Imagery for Targets and Exhaust-plume Signature (FLITES)

Phenomenology



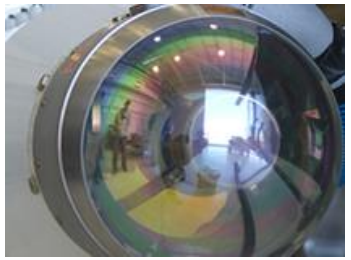
- Objects and Background
- Plumes/Exhaust
- Scene Dynamics
- Countermeasures

Environmental Effects



- Atmosphere and Solar
- Environmental Lighting
- Clouds

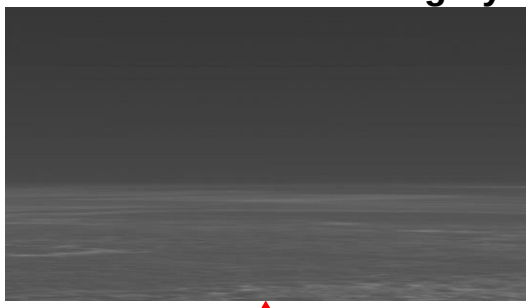
Optional Sensor Effects



- Jitter
- Sensor Noise
- Optical Blur

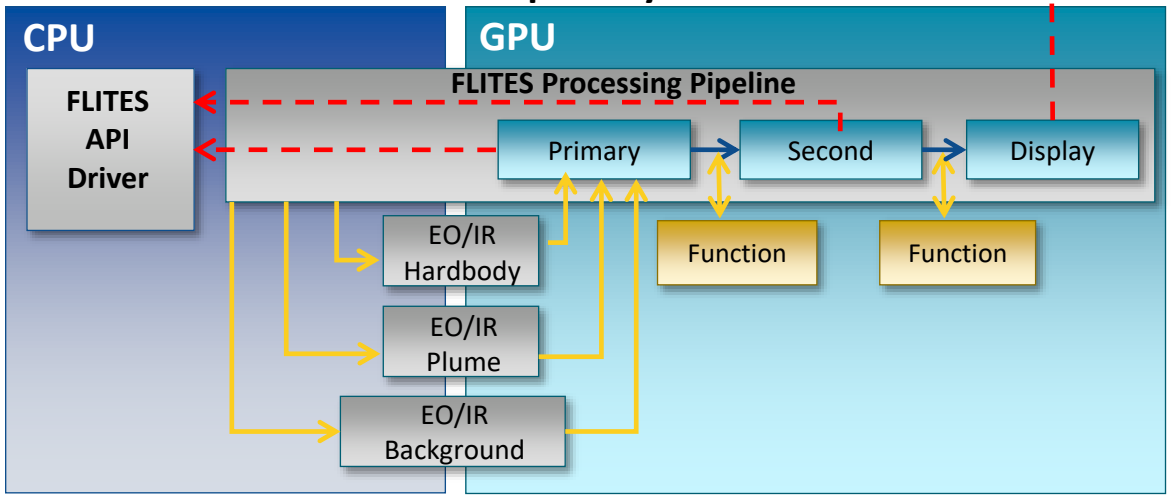
User defined functions

Generated Sensor Imagery



- Infrared, visible light, and ultraviolet spectra
- Includes all important phenomena that emit, absorb, or reflect electromagnetic energy
- Uses highly developed specialty codes
  - Integrates into a realistic representation
  - From a seeker/sensor perspective

Real Time Capability



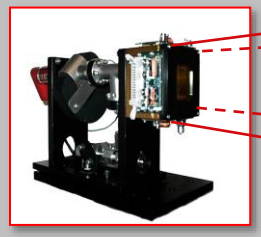
FLITES leverages highly specialized codes for real-time seeker test capabilities

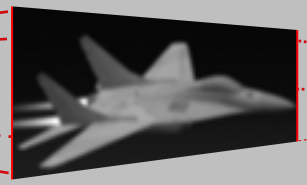
Why?

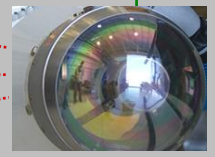
Desktop Phenomenology Analysis:

High Fidelity Digital Simulations:

Real-Time Synchronized Hardware-in-the-loop Testing Infrastructures:





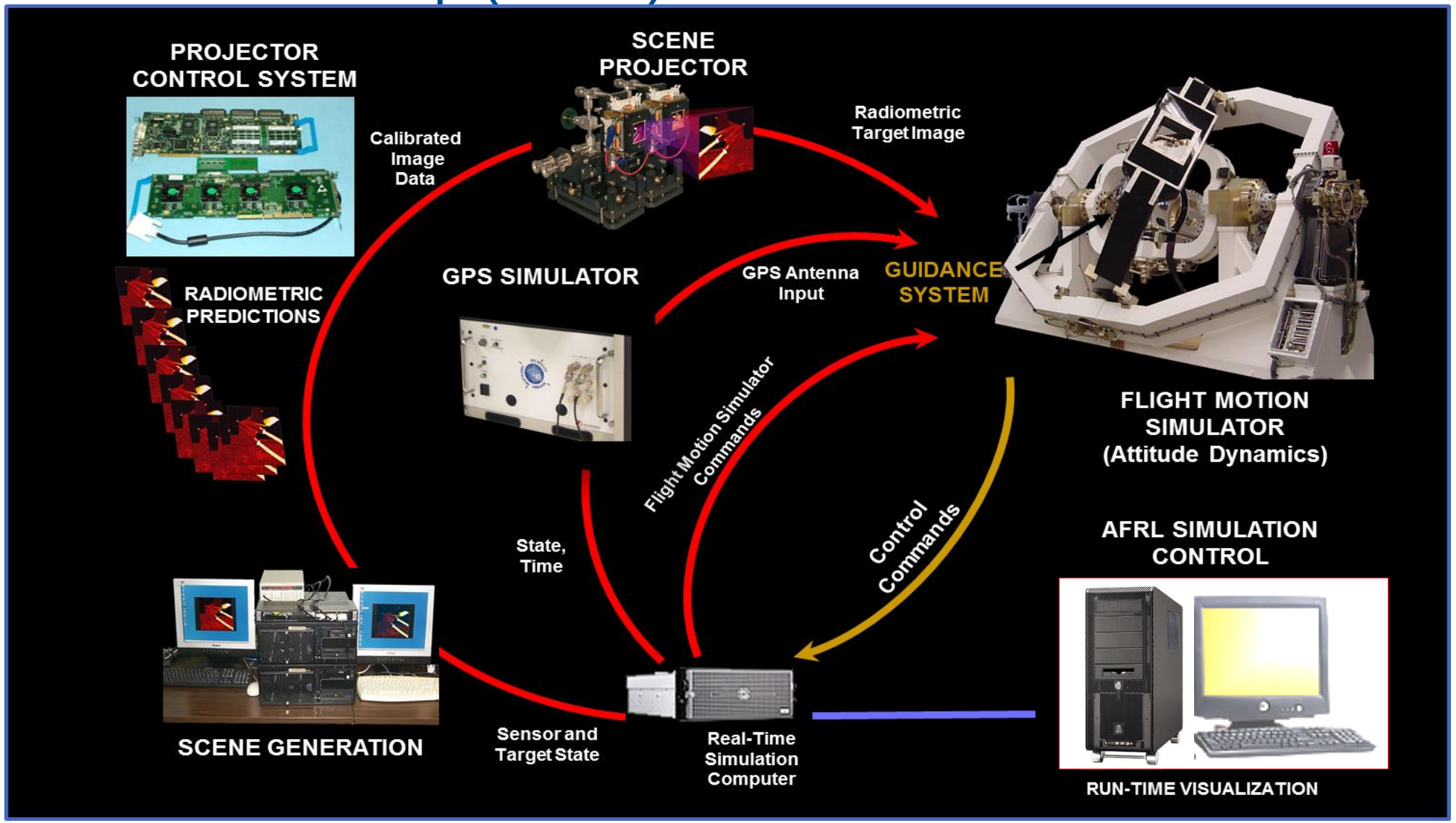


Example Uses

- Sensing Concept Development
- Software-in-the-loop
- Hardware-in-the-loop

Provides a common resource to support all phases of weapon testing

Hardware-in-the-loop (HWIL)



Kinetic Kill Hardware-in-the-Loop Simulator Facility

Mission

•Provide AFRL with a HWIL capability for non-destructive evaluation of integrated munition guidance, navigation and control concepts

Description

- 20,000+ square-foot simulation facility on 2 Floors
  - ✓ RF Chamber
  - ✓ Large computational resources (HPCs)
  - ✓ Real-time computers
  - ✓ Target Simulators (IR, RF, visible, laser)
  - ✓ Synthetic scene generation (FLITES, IRMA, RF Codes)
  - ✓ Advanced flight motion simulation (5 motion simulators)
  - ✓ World-class research and analysis staff (~70)
  - ✓ Distributed connectivity

Developing the next generation of test technologies.

Collaborators

- Chief, Capt. Ryan Trenter
- Mr. Robert Barton
- Mr. Cinque Ajose
- Mr. John Grimes

Questions?