PRECISION WEAPONS TESTING CHALLENGES—How do we find efficiencies to test weapons including Ranges, Costs, M&S & Training?

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State of Weapons testing

- Precision Weapons today are more complex and demanding of our ranges than ever before -
  - Longer range
  - Self-navigating
  - Precise seekers
  - Network-enabled
  - New vulnerabilities
- Current inventory weapon TTP experimentation
  - Multi-hit (MH) weapon attacks – tunnels/bunkers
  - Follow-on slope / cave / tunnel attack / portal closure
  - Defeat of penetration protective features

Direct Attack Weapons

- JDAM Family (GBU-31/32/38/54)
- Legacy Warhead Improvement Programs (LWIP)
  - GBU-28 (BLU-113) survivability/function tests
  - BLU-109C/B design improvement validation
- Advanced 2,000/5,000lb (A2K/A5K) Penetrator Development
- Hard Target Munition (USAF AoA)
- GBU-57 Massive Ordnance Penetrator
- B61 Mod 12 (JDAM-esque)

Standoff Weapons

- **USAF**
  - GBU-39 Small Diameter Bomb Inc 1
  - GBU-53 Small Diameter Bomb Inc 2
  - AGM-158 Joint Air-to-Surface Standoff Missile-Extended Range
  - Long-Range Standoff missile
- **Navy/Marine Corps**
  - GBU-53 Small Diameter Bomb Inc 2
  - AGM-88E Advanced Anti-Radiation Guided Missile
  - AGM-154C-1 Joint Standoff Weapon (Block III)
  - AGM-158C Long Range Anti-Surface Missile Inc 1

Ranges

- **Ranges that support weapons testing are designed for either test or training, but not both**
  - **Test ranges have excellent data collection, electronic warfare and custom built targets**
    - White Sands Missile Range (WSMR), NM
    - Gulf Test Range, Eglin AFB, FL
    - R-2508, NAWS China Lake, CA & Edwards AFB, CA
    - Sea Range, NAS Pt. Mugu, CA
  - **Training ranges have excellent airspace, but limited data collection and generic targets**
    - Nevada Test and Training Range (NTTR), Nellis AFB, NV
    - Utah Test and Training Range (UTTR), Hill AFB, UT
    - Pacific-Alaska Range Complex (PARC), Eielson AFB, AK
    - Fallon Range Training Complex (FRTC) , NAS Fallon, NV

Targets

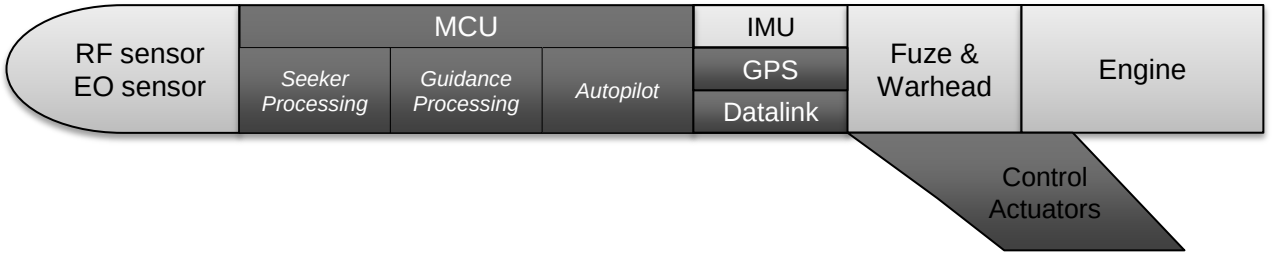
- White Sands Missile Range (WSMR), NM
  - Hard and Deeply Buried Target testing requires special built targets
  - Limited number on WSMR and being used up quickly with improved weapons testing
- Cost and time are the two biggest challenges to continue to provide adequate test environment
  - $100M (approx) to maintain current target complex
  - 1+ years for construction for each target
- Sea Range
  - Mobile Ship Target (MST)

Testing Methods

- **End to End system simulation**
  - Mission planning through target impact, was an integral component of the JASSM development program. Lockheed-Martin used an high fidelity, six-degree of freedom (6-DOF) ETE simulation to verify weapon accuracy and target impact parameters.
- **Hardware in the Loop (HIL)**
  - HIL simulation testing is used for ETE simulation validation. HIL testing demonstrates missile functional performance while executing simulated flight scenarios using integrated flight representative hardware and software. Timeline and subsystem operation are demonstrated.
- **Seeker testing**
  - Captive flight test
    - SDB II seeker on UH-1 at WSMR and Eglin AFB
    - JSOW C-1 captive testing on F/A-18F

LRASM example

Hardware in the loop



Captive Carry

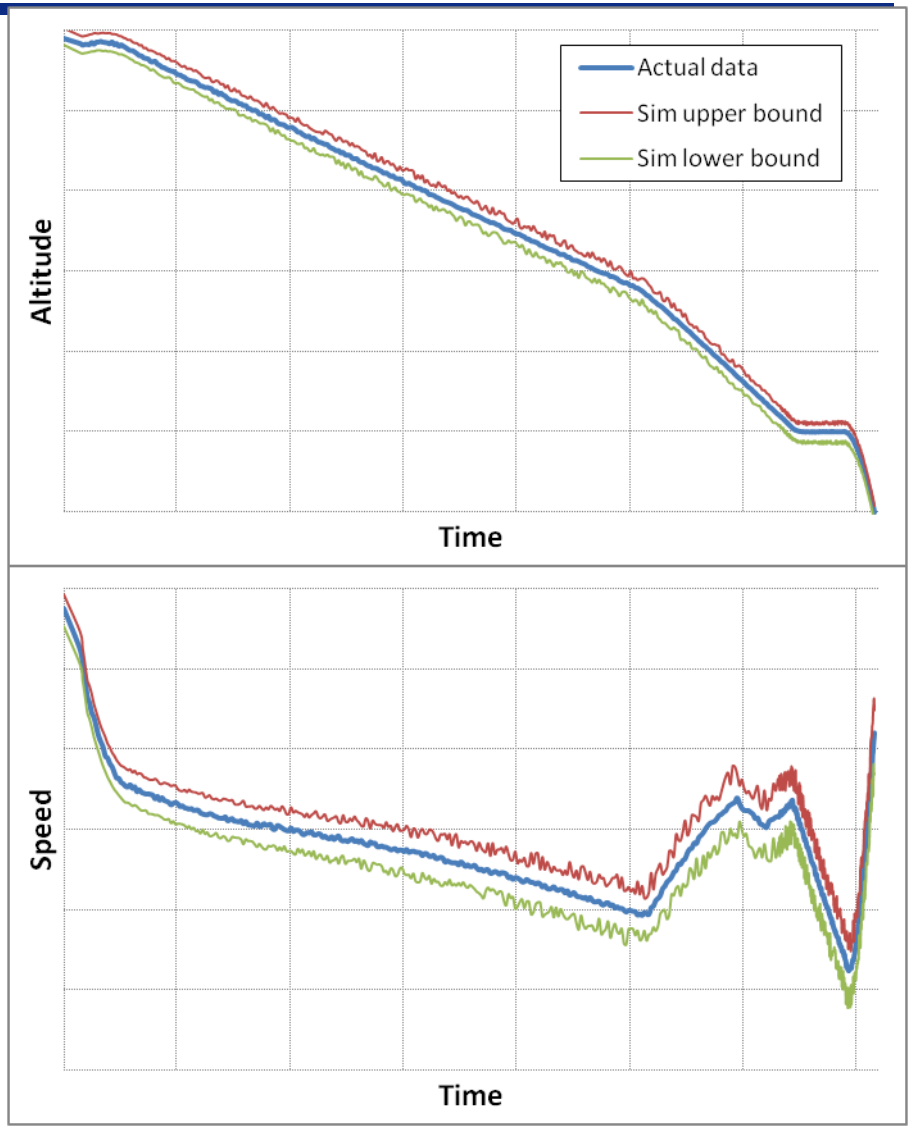
Flight Test

Actual Hardware | Simulated

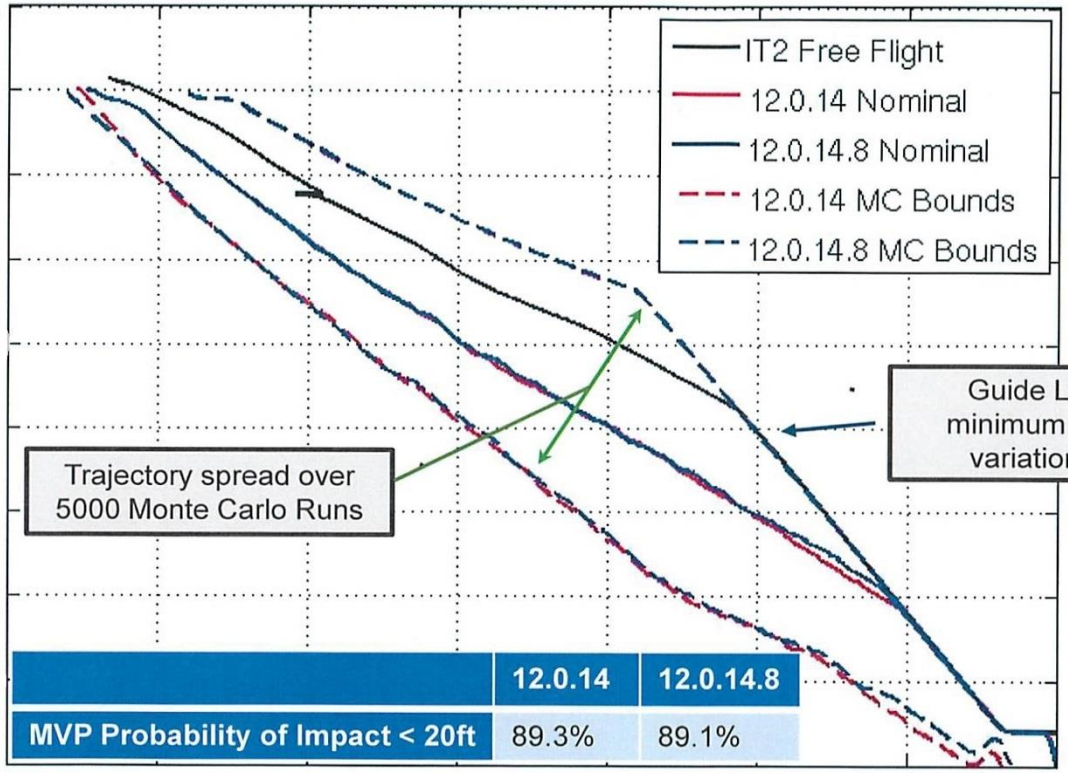
Use of Flight Test Data for Digital Simulation Validation

IFS simulations to be validated using *measured flight test telemetry data*

- Simulation run many times using ***"Monte-Carlo" combinations of input conditions*** to see sensitivity of results
- Data from single flight should fall ***within bounds of results*** from simulation run set to ***build confidence*** in predictions



JSOW C-1: IT2 Performance Analysis (example)



	12.0.14	12.0.14.8
MVP Probability of Impact < 20ft	89.3%	89.1%

Differences between Projected Simulated Performance and actual Free-flight Performance are Statistically Insignificant

Training implications

- **Training Opportunities limited at home station**
  - USAFE/ACC/PACAF/CVW - limited access to ranges for training with modern weapons (GPS/Datalink/active seekers)
  - Combat Hammer is unique in offering training/testing
- **Historical experiences with lack of training**
  - Operation IRAQI FREEDOM - AGM-130
  - Operation ENDURING FREEDOM – AFGHANISTAN - SDB I
- **More and more weapon engagements are simulated**
  - Air-to-air combat training model
  - 6DOF models are needed
  - OFPs need to be updated concurrent with weapon OFPs (UAI)

Conclusions

- Full Scale weapon test requirements continue to exist
- "Full-scale" test beds aging
  - Tunnels: 11 – 53 years old
  - Bunkers: 20+ years old
- Test beds expensive long-lead items; cost likely difficult for typical weapons programs to bear
- Training opportunities limited for Ops crews – need to take output from extensive investment in M&S and import it into aircraft OFPs
- *Improve the migration of test data/models to training for ops squadrons*

QUESTIONS?