

Production Hardware-in-the-Loop Missile Testing: Past, Present, and Future

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Agenda

- Traditional QALVT Approach
- Longbow HELLFIRE STAF
- Process Improvements
- AMSTAR Production Facility





Traditional QALVT Approach

- QALVT – Quality Assurance Lot Verification Testing
 - Sampling-based test program to determine if production lots of munitions meet quality standards (“Fly-to-buy”)
 - Both non-destructive and destructive testing can be very expensive
- More complex missiles led to two problems:
 - Increased cost – more expensive missiles to buy and destroy
 - Increased risk/Decreased confidence – a missile with multiple modes of operation can only be fired in one of those modes





Alternate QALVT Approach

- Leveraging Simulation-based Hardware-in-the-Loop (HWIL) techniques could reduce risk and volume of flight tests
 - Provides a system-level test without energetics
 - Missiles are developed using HWIL simulations – utilize the development testability features for acceptance testing
 - Can never completely replace live fire testing
- First facility to explore this QALVT approach was the Longbow HELLFIRE Simulation Test Acceptance Facility (STAF) at Redstone Arsenal





Longbow STAF

Simulation, Test & Acceptance Facility

First All-Up-Round Missile Hardware-in-the-Loop Production Acceptance Facility

– Tactically Configured Missile with Energetics (Warheads and Motor)

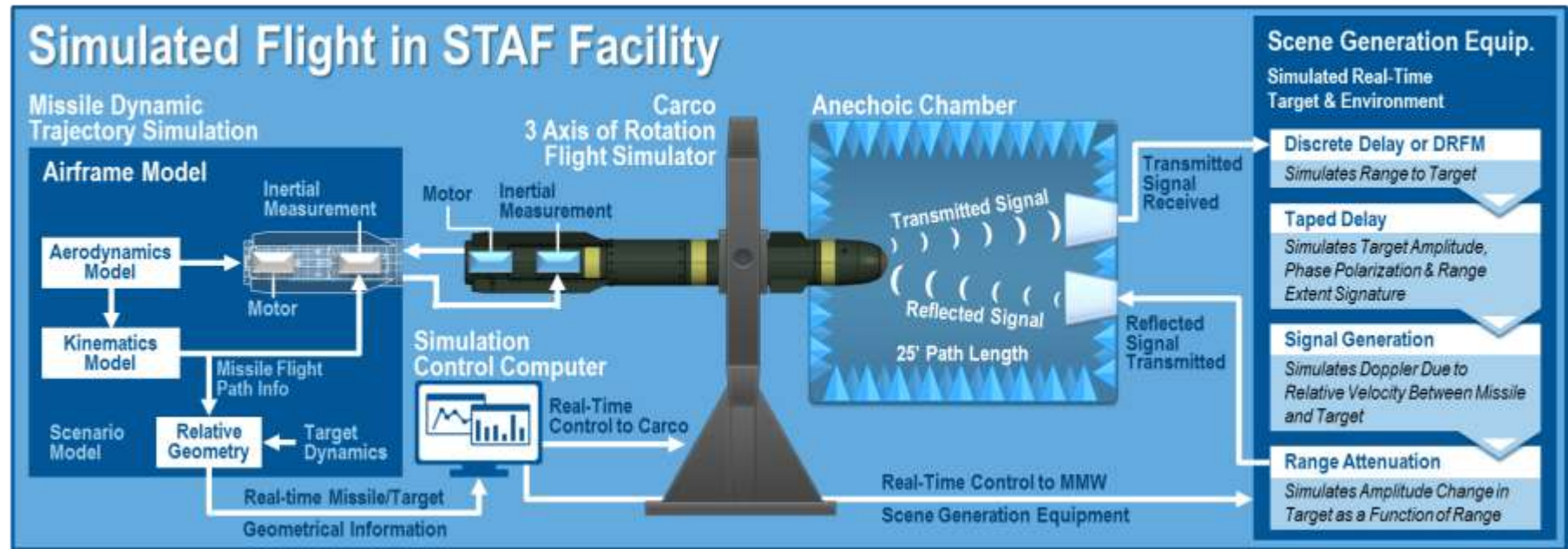
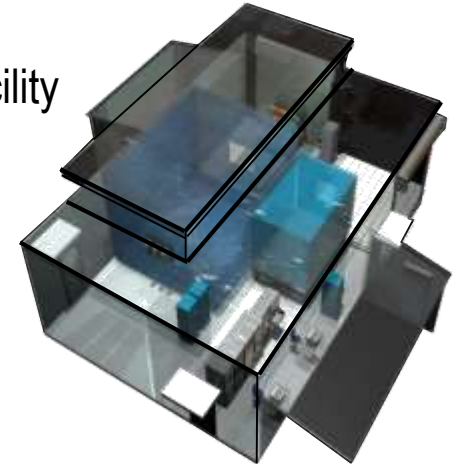
Simulated MMW (Ka band) Scene & 3-Axis Missile Motion

QALVT (1997-2006)

– QALVT Tested 746 Rounds Total

– Performed all Lot Acceptance Testing on Longbow Missile (6 Missiles / Month)

– Saved U.S. Army Approximately \$8M / Year over Traditional Fly-to-Buy Acceptance





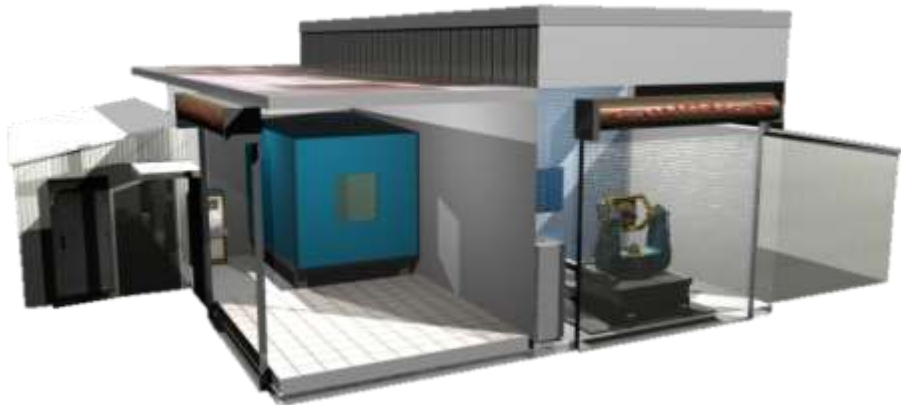
Longbow STAF

Simulation, Test & Acceptance Facility

SRP (2006 – Present)

- Stockpile Reliability Testing of over 1800 Missiles Since 2006
- Throughput Steadily Increasing – Many Lessons Learned for Doing Large Quantity HWIL with Explosive Items
- Tested over 500 Rounds in FY15
- Can Test at Temperature Extremes

Longbow Seeker at -45°F



Jointly Developed and Operated by





Process Improvements

Challenges:

- Stockpile Reliability Program (SRP) Plan specified a 350 round/year workload to recertify Longbow to extend shelflife
 - Substantially more than 6/month for QALVT testing
- Had been sufficient to only test 3 rounds at a time during QALVT
- All missile handling including instrumentation handled outside of STAF
- Too many steps in process





Process Improvements

Solutions:

- STAF requires that an instrumentation board be installed in missile prior to test
 - Upgraded instrumentation design away from obsolete design and mass produced so that more than 3 rounds could be modified at a time
 - Increased spares, reduced coupling between steps in the logistics chain
- Consolidated all missile movement operations to a single group – removed process steps
- Later started doing all instrumentation installs and removal at STAF
 - Retests with new instrumentation no longer required movement.





The AMSTAR Project

- Army Test and Evaluation Command (ATEC) invests in the Advanced Multispectral Test Acceptance Resource (AMSTAR) Major Instrumentation Project
 - 2002-2009
 - Based on the success with STAF
 - Partnership between AMRDEC and RTC
 - Three AMSTAR test bays are built and outfitted for upcoming multi-mode missile testing
 - Performance Bay in the RF3 facility in building 5400
 - Cutting edge performance bay to feed test technology into the configuration controlled production bays.
 - 2 Production Bays inside Redstone Arsenal Test Area 10





AMSTAR

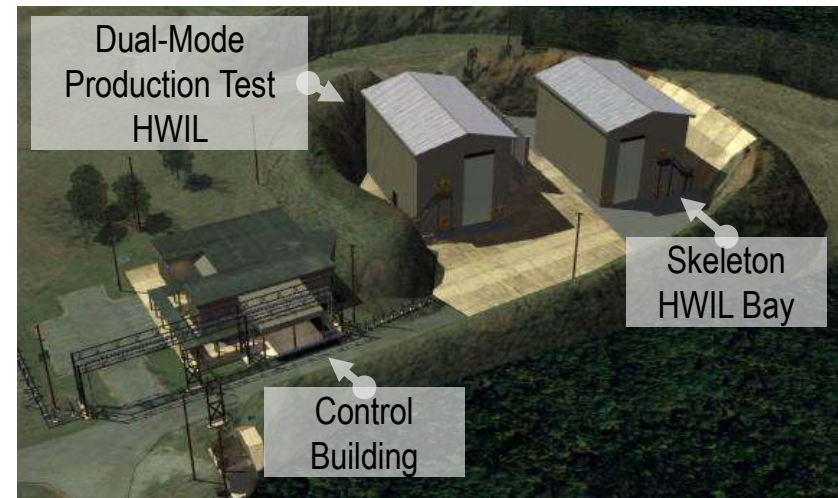
AMSTAR is 3 Separate HWIL Facilities

- Tri-Mode Performance Bay in 5400
 - Millimeter Wave Radar (MMW)
 - Semi-Active Laser (SAL)
 - Passive Infrared – Midwave (MWIR) or Longwave (LWIR)
- Dual-Mode (SAL & LWIR) Production Test Bay at TA10
 - Designed to do Tri-mode in custom building
- Second Skeleton HWIL Bay at TA10



AMSTAR Dual Mode Production Bay Interior

AMSTAR Production Facility

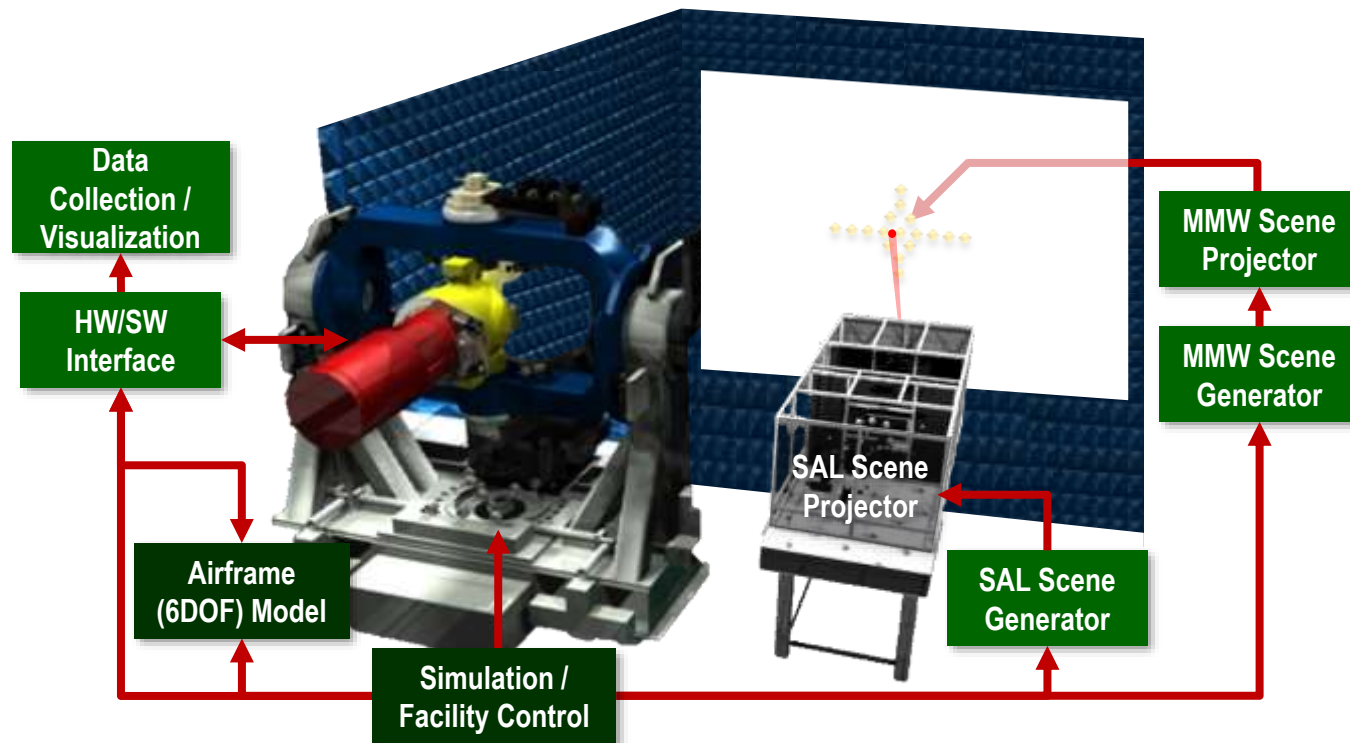


Jointly Developed by





AMSTAR Dual-Mode Concept



- MMW Transparent SAL Projection Screen in Front of MMW Array
- FMS Equipped with Climatic Enclosure for Hot/Cold Testing during HWIL
- Already have LWIR and MWIR optics necessary to augment with an IR projector to complete the Tri-Mode setup





Conclusion

- Production HWIL is a proven test technique as seen by the Longbow HELLFIRE program
- Production HWIL generates more system-level data in all modes of operation versus live fire testing in only one mode of operation, but cannot completely replace live fire
- With good processes, high quantity throughput can be achieved



Questions?

