

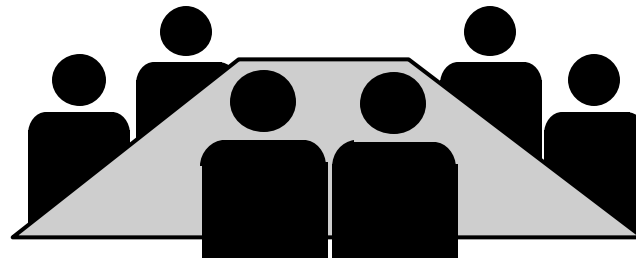


OneSAF Objective System Physical Model Acquisition and Integration

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Outline

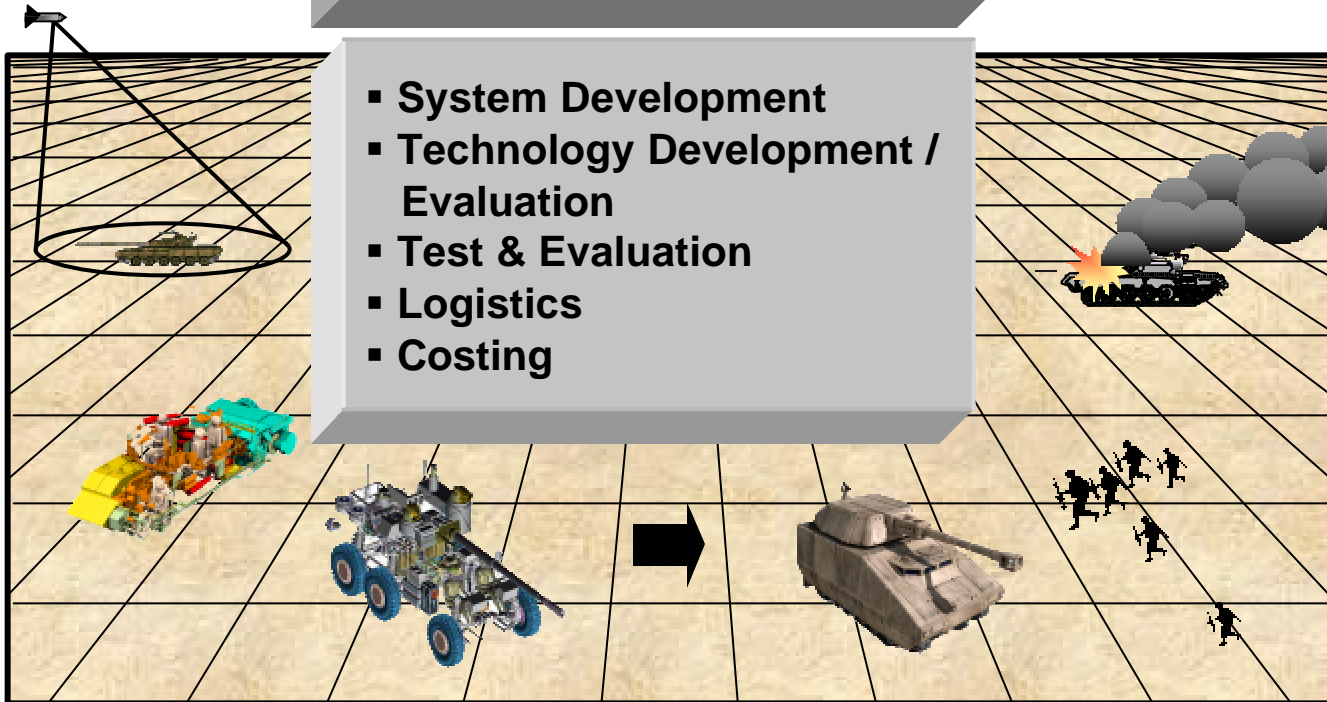
- **Research, Development and Acquisition (RDA) Domain**
 - Background
 - OneSAF Objective System (OOS) Requirements
 - OOS Support
- **Physical Model Acquisition**
- **Physical Model Testing**
- **Physical Model Data**
- **RDA's Perspective**
- **Path Ahead**
- **Questions?**



Army Modeling & Simulation - RDA Domain

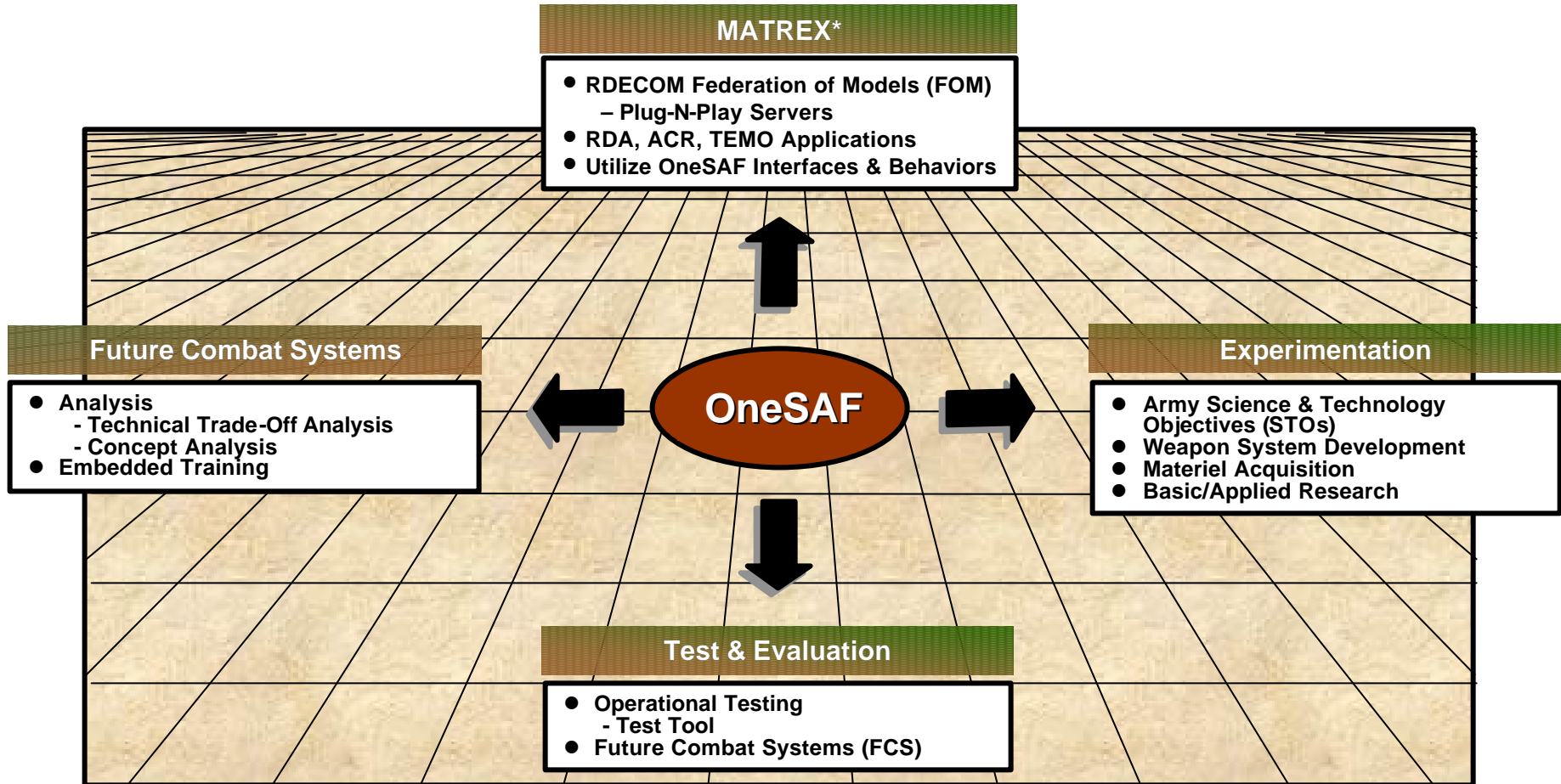
Research, Development & Acquisition

- System Development
- Technology Development / Evaluation
- Test & Evaluation
- Logistics
- Costing



Supporting Current Fielded and Future Forces

OneSAF RDA Applications



* Modeling Architecture for Technology, Research and Experimentation

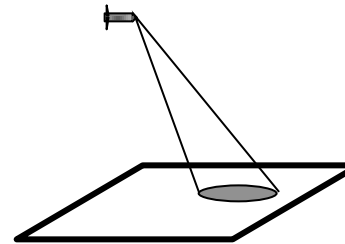
OneSAF RDA Requirements

Aviation & Missile Research, Development & Eng Center



- ✓ Aircraft Survivability Equipment
- ✓ Ground Radar Modeling
- ✓ Signature Modeling
- ✓ Air Vehicle Dynamics
- ✓ Realistic Aviation Behaviors
- ✓ Entity Level Behavior Modeling
- ✓ Digital Messaging Capabilities
- ✓ Hi Fidelity Capability v Table Lookup
- ✓ Night Operations

Aviation & Missile Research, Development & Eng Center



- ✓ Scalability
- ✓ Analytical Requirements
- ✓ Improved Smart Munition Modeling
- ✓ Improved Sensor Modeling
- ✓ Operator Control of Entity Responses
- ✓ Realistic Representation of OPFOR
- ✓ Entity Editor

Tank-Automotive Research, Development & Eng Center



- ✓ Correctly Represent US Army Ground Vehicles
- ✓ Correctly Represent Hunter/Killer Methodology
- ✓ Provide Entity Editor
- ✓ Represent Countermeasure Devices on Ground Vehicles
- ✓ Add Sensors to OneSAF Vehicles
- ✓ Support Digital Command & Control Message- Send & Receive
- ✓ High Resolution Terrain Databases
- ✓ Modifiable Behaviors
- ✓ Represent Ground Vehicle Mobility Correctly

OneSAF Components

- Entity Composer
- Composition Tool
- Behavior Composer
- Scenario Generation
- Model Development Verification Test Tool
- .
- .

The OneSAF

composition tools are helping provide solutions to satisfy RDA requirements.

OneSAF Improved Representation

Behaviors

- Operator Control: HITL* /No HITL
- Automated: Up to Battalion
- SASO:** Not Automated
- Suppression: Direct/Indirect-Fire
- Behavioral Degradation: Stress, Fatigue
- Behavioral Representation: Authoritative

Sources

- **New SAF Capability**
- **Enhanced SAF Capability**

Combat Physical Models

- Physical Model Rep: Validated- AMSAA & Other
- Standardization: Entity Level
- Fidelity: Varying Capability
- Focus: Reuse
- Traceability: PKAD***
- Synchronization: w/COMBAT^{XXI}
- Data Structures: Commensurate w/APEDS****

RDA

Synthetic Natural Environment

- | | |
|----------------------------|-------------------------------|
| ■ <u>Terrain</u> | ■ <u>Obscurants</u> |
| ■ <u>Cultural features</u> | ■ <u>NBC</u> [^] |
| ■ <u>No of sides</u> | ■ <u>CM/CCM</u> ^{^^} |
| ■ <u>Time</u> | ■ <u>Obstacles</u> |
| ■ <u>Atmosphere</u> | ■ <u>Communicate</u> |

- * Human In The Loop
- ** Stability And Support Operations
- *** Physical Model Knowledge Acquisition Document
- **** AMSAA Performance Estimate Data System
- ^ Nuclear Biological and Chemical
- ^^ Counter-Measure Counter-Counter Measures

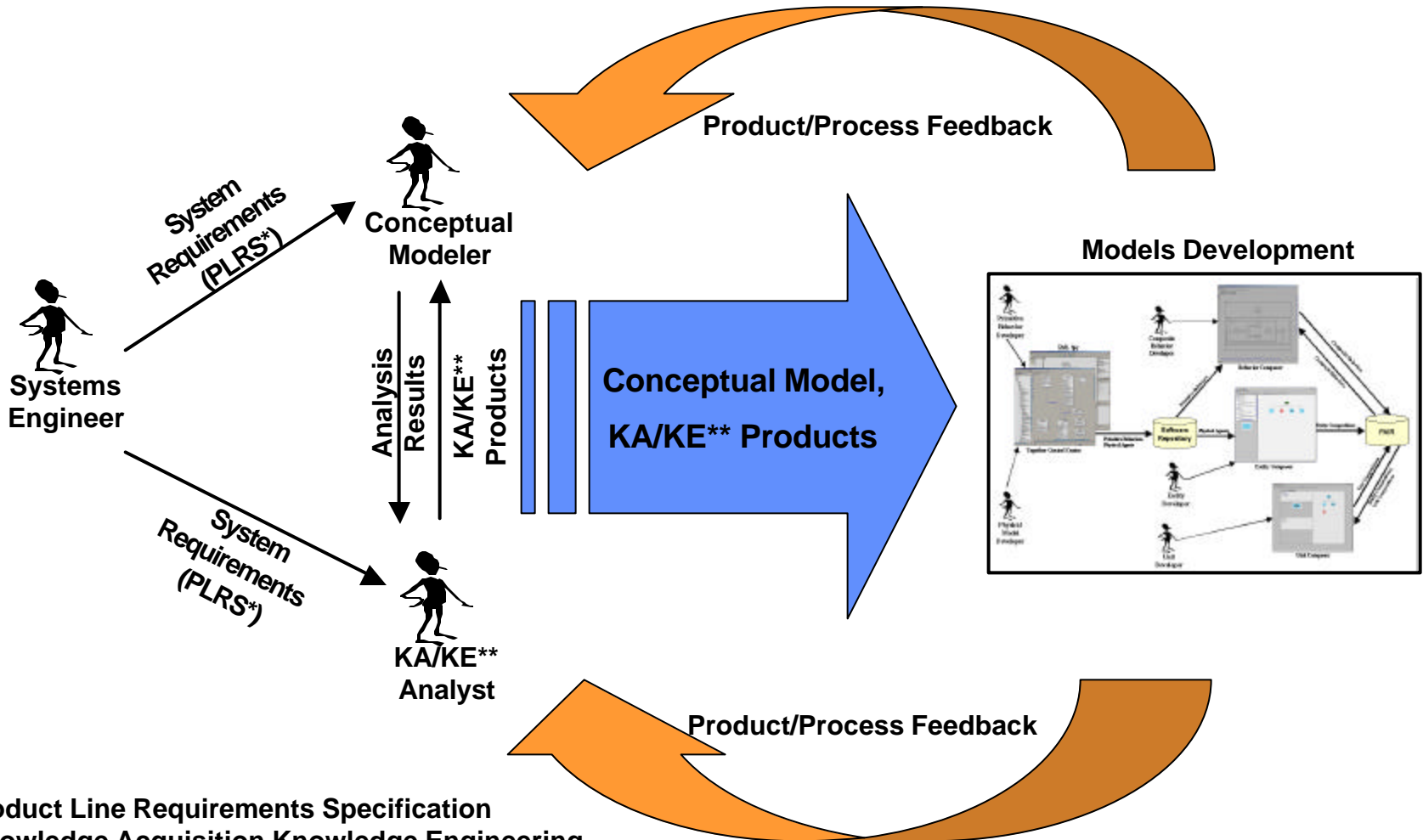
AMSAA OneSAF Support

- **OneSAF POC for Combat Physical Models**
 - Reuse Focus & Standardization
 - Synchronization w/COMBAT XXI
- **Knowledge Acquisition/Knowledge Engineering**
 - Lead - Physical Model Knowledge Acquisition Documents (PKADs)
 - Characteristic & Performance Data – Certified Data
- **Test & Evaluation**
 - Recommended Domain Government Lead
 - Developed Test & Evaluation Plan
 - Participating in Planning, Executing and Documenting
- **Verification & Validation lead for Combat Physical Models**
 - ACAT Level 3 Program Mandates
 - AR 5-11; described in DA PAM 5-11
 - Responsibility of M&S proponent
 - Should be concurrent with model development

Physical Knowledge Acquisition Document (PKAD)

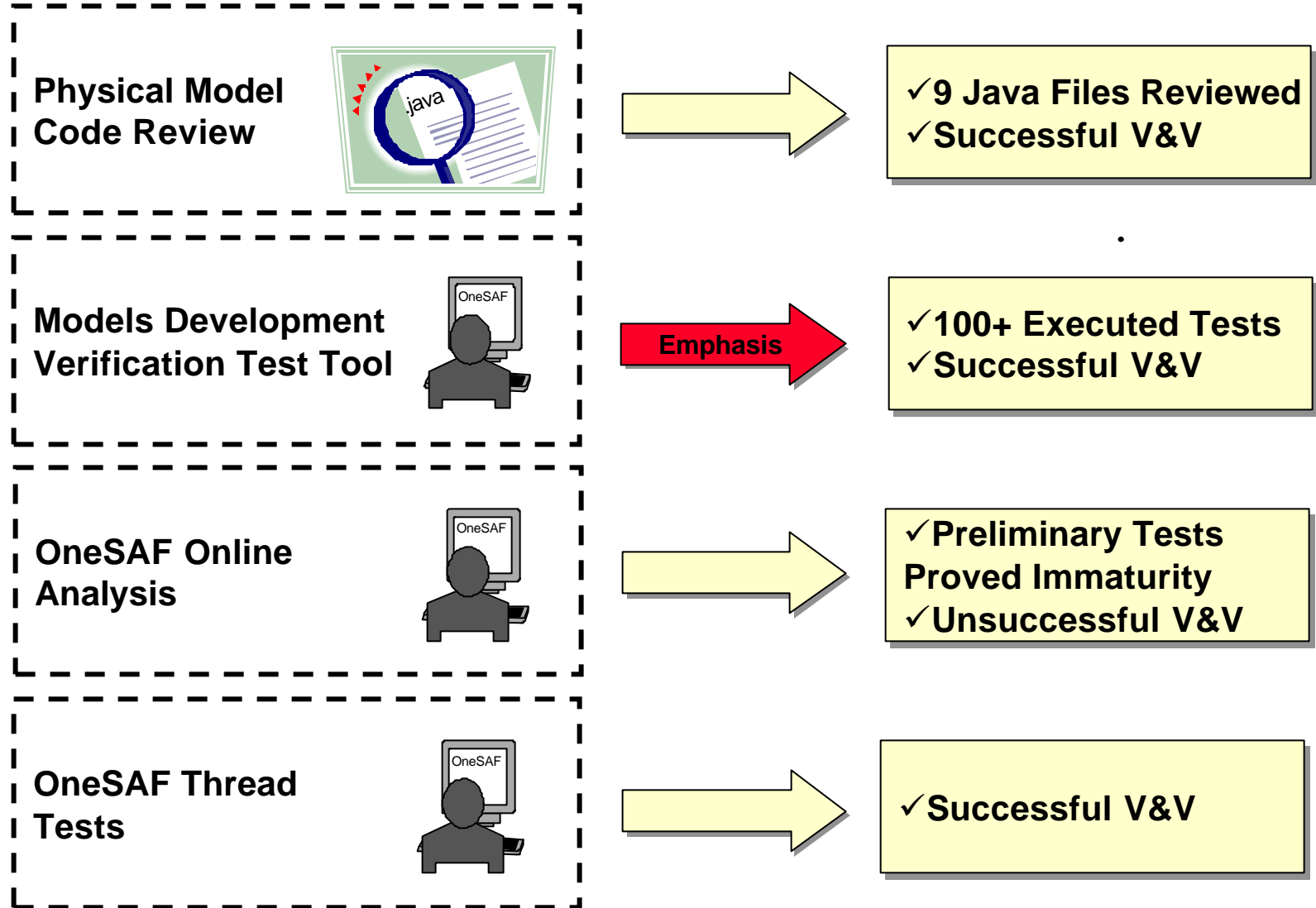
- **PKAD Purpose**
 - To provide guidance to the physical models integrator with respect to the procedural steps and data structures associated with OOS implementation of combat physical models. PKADs do not include definitions and assumptions that are associated with the method.
- **PKAD Content**
 - Consistent Format – OOS KA/KE Team/AMSAA
 - Operational Requirements Document (ORD) Requirement Trace
 - Physical Model Inputs
 - Method and Process
 - Physical Model Outputs
 - Supporting Model Data Definitions
 - Required V&V Data Collection Parameters
 - Examples
 - Sample Input
 - Example Process Using Defined Model Data Structures
 - Sample Output
 - References
 - Unclassified Documents

Battlespace Model Development Context



* Product Line Requirements Specification
 ** Knowledge Acquisition Knowledge Engineering

Block Release Phase II Verification Process



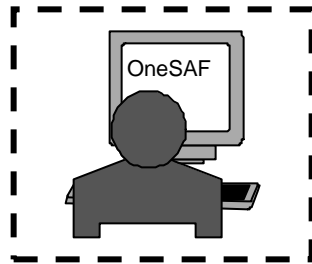
Block B Combat Physical Models (1 of 2)

| Physical Model Implementation | | |
|-------------------------------|---------------------------|---|
| Level | Source Specs Level | Model Development Activities |
| 1 | Harvested Partial/Full | <ul style="list-style-type: none"> Physical models harvested from other simulations (e.g. JCATS, Janus, OTB) Models may be partially implemented or use partial data sets Tasks do not include V&V efforts |
| 2 | AMSAA Partial | <ul style="list-style-type: none"> AMSAA provided/recommended algorithms with limited data sets Selected functionality may be omitted Framework support Not intended for validation |
| 3 | AMSAA Partial | <ul style="list-style-type: none"> Framework support Full data set No V&V support Not ready for validation |
| 4 | AMSAA Full | <ul style="list-style-type: none"> Framework supported Full data set Model ready for validation V&V support |

Block B Combat Physical Models (2 of 2)

| Physical Model: | SFF Definition: | SFF Emulation: | OOS Block B Integration: |
|--|-----------------|----------------|--------------------------|
| Mis-ID Target Acquisition | x (draft) | ✓ | ✓ |
| Ground Vehicle Mobility | x | x (ERDC) | ✓ |
| Dismounted Infantry Mobility | x | x (SAIC) | x |
| Rate of Fire for Direct Fire Weapons | ✓ | ✓ | ✓ |
| Delivery Accuracy for Direct Fire Weapons | ✓ | ✓ | ✓ |
| Delivery Accuracy for Fragmenting and Point Detonating Small Caliber Direct Fire Weapons | ✓ | ✓ | x |
| Vulnerability from Direct Fire Weapons for Ground Vehicles | ✓ | ✓ | ✓ |
| Vulnerability from Direct Fire Weapons for Rotary Wing Aircraft | ✓ | ✓ | ✓ |
| Vulnerability from Direct Fire Weapons for Fixed Wing Aircraft | ✓ | ✓ | x |
| Vulnerability from Direct Fire Weapons for Dismounted Infantry | ✓ | ✓ | ✓ |
| Delivery Accuracy for Indirect Fire Weapons | ✓ | ✓ | ✓ |
| Vulnerability from Indirect Fire Weapons for Ground Vehicles | ✓ | ✓ | ✓ |
| Vulnerability from Indirect Fire Weapons for Rotary Wing Aircraft | ✓ | ✓ | ✓ |
| Vulnerability from Indirect Fire Weapons for Fixed Wing Aircraft | ✓ | ✓ | x |
| Vulnerability from Indirect Fire Weapons for Dismounted Infantry | ✓ | ✓ | ✓ |
| Vulnerability from Conventional AT and AP Mines | x (draft) | x | x |

Block B Test Matrix



- Total of 148 cases run
- All nine Level-Four Models tested using Offline tool approach
- Handful models and cases using Online approach

| Test Case | Shooter (Stationary) | | | | Target (Stationary) | Target Engagement Geometry | | | | | | | | | | |
|-----------|----------------------|---------|--------|-------------------------------|---------------------|----------------------------|--------------------|----|----|----|-----|------------|-----|-----|-----|-----|
| | System | Weapon | Mount | (Common Name) Munition | | System | Aspect Angle (deg) | | | | | Range (km) | | | | |
| | | | | | | | 0 | 30 | 60 | 90 | 120 | 150 | 0.8 | 1.5 | 2.2 | 3.7 |
| DFVSS01 | BMP-3 | 2A70 | Turret | (AT-10) 3UBK-12 | M1A2 | X | | | | | | | | | | X |
| DFVSS02 | T-80B | 2A46 | Turret | (125mm HE Frag) OF-26 | M1A2 | X | | | | | | | | | X | |
| DFVSS03 | T-72BK | 2A46 | Turret | (125mm HE APDS) BM-42M | M1A2 | X | | | | | | | | | | X |
| DFVSS04 | Mi-24D | S-8 | Fixed | (57mm HEAT Rck) RKT_57MM_HEAT | M1A2 | X | | | | | | | X | | | |
| DFVSS05 | BMP-2 | 2A42 | Turret | (30 mm FRA G) CRT_30MM_FRAG-T | M1A2 | X | | | | | | X | | | | |
| DFVSS06 | T-72M1 | PKM | Coax | (7.62 WP Ball) BTZ | M1A2 | | | X | | | | X | | | | |
| DFVSS07 | DI2 | M47 | DIS | (ATGM-Dragon) M220A2 | T-80B | | | | X | | | | | | X | |
| DFVSS08 | M2A3 | M220A2 | Turret | (ATGM-TOW-2) BGM-71F | T-80B | | | | | | X | | | | X | |
| DFVSS09 | DI2 | PzFst-3 | Prone | (Grenade) PZF-3 | T-80B | | | | | X | | | | | | X |
| DFVSS10 | M1A2 | M256 | Turret | (120mm APDS) M829A2 | T-80B | | X | | | | | | | | X | |
| DFVSS11 | M3A2 | M242 | Turret | (25mm HEI-T) M792 | T-80B | | | | | | X | X | | | | |
| DFVSS12 | AH-64D Longbow | M230 | Chin | (30mm HE) M789 | T-80B | | | | | | X | | X | | | |
| DFVSS13 | M2A2 | M242 | Turret | (25mm API-T) PGU/20 | T-80B | | X | | | | | | X | | | |

Vulnerability from Direct Fire Weapons for Ground Vehicles

Physical Model Validation and Verification

- **Verify the implementation of all nine level-four physical models completed for Block B**
 - OOS Tools
 - Offline tool provides a means to run each physical model outside of the simulation
 - Online tool allows a user to setup a scenario within the simulation itself
 - AMSAA Tools
 - Currently using spreadsheets to calculate expected results for user supplied values for comparison against OOS results
 - Creating a MySQL database to load the transformed unclassified data (or classified data) to create an environment for applications to run the entire V&V test matrix to produce an automated means of comparing simulation runs against expected results

Physical Model Code Review

- Conducted an early review prior to formal testing
- Reviewed Java Code for nine level-four Combat Physical Models
- Intent was to ensure algorithms were implemented according to PKAD Specifications
- Analyzed Findings
- Submitted 6 problem trouble reports (PTRs)
- Collaborated with OOS Model Development Team

| Problem Trouble Reports | | |
|-------------------------|------------|--|
| Number | Status | Description |
| 2219 | Fixed | Target Acquisition Modeling - AcquireUtility.java class uses the total transmittance value incorrectly |
| 2220 | Fixed | Target Acquisition Modeling - The class documentation is incorrect when it is determining Apparent Contrast in AcquireUtility.java class |
| 2221 | Fixed | Target Acquisition Modeling - In AcquireUtility.java class the atmosphericAttenuation value for DVO, I ² and IR devices is calculated as (3.912 / meteorVisRange). This estimate is acceptable for DVO and I ² devices but not for IR devices. |
| 2560 | Integrated | Direct Fire Vulnerability - aspect angle is not updated from radians to degrees |
| 2567 | Fixed | Vulnerability from Indirect Fire Weapons for Ground Vehicles - error in an equation in the code produces incorrect PK thermometer values |
| 2570 | Integrated | Direct Fire Rate of Fire - error in code causes interpolation to be done incorrectly |

Target Acquisition {

DF Vulnerability ←

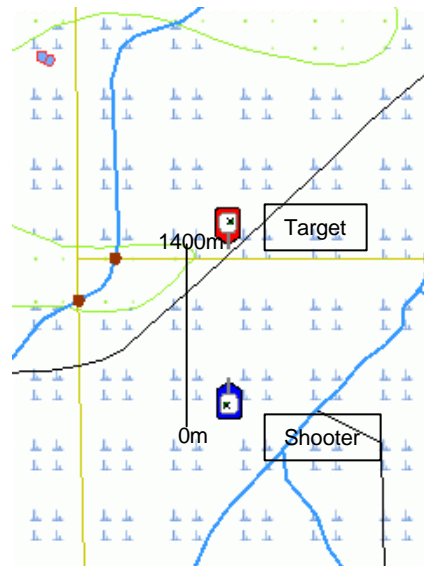
IF Vulnerability ←

DF Rate of Fire ←

Models Development Verification Test Tool

- Component of OneSAF Objective System
- Based on AMSAA Templates and PKADs
- Tool was the primary source for Block B Verification Testing
- Tool designed for Behaviors and Physical Models
- Tool linked directly to the OOS code
- Quick Turnaround Time
- Numerous Problem Trouble Reports (PTRs) written against Tool

Example: Target Acquisition



① TARGET

- ☑ 1 T80B
- ☑ STATIONARY
- ☑ ORIENTATION (270 Degrees)
- ☑ RANGE (1400 meters) Result of Location
- ☑ LOCATION IN GDC (30.113 Degrees, -93.200 Degrees, 8.00 meters)

② SHOOTER

- ☑ M1A1
- ☑ STATIONARY
- ☑ ORIENTATION (90 Degrees)
- ☑ LOCATION IN GDC (30.100 Degrees, -93.200 Degrees, 8.00meters)

③ PKAD # KEMA070005, KEMA070006

Offline Tool was sufficient enough for Block B testing

Models Development Verification Test Tool

| Test Case | Shooter (Sationary) | | | | Target Stationary | Target Engagement Geometry | | | | | | | | | | | | |
|-----------|---------------------|-----------------|--------|-------|-------------------|----------------------------|--------|--------------------|----|----|----|-----|------------|-----|-----|-----|-----|--|
| | ID | System | Weapon | Mount | | (Common Name) Munition | System | Aspect Angle (deg) | | | | | Range (km) | | | | | |
| | | | | | | | | 0 | 30 | 60 | 90 | 120 | 150 | 0.8 | 1.5 | 2.2 | 3.7 | |
| DFVS## | Helicopter | Rocket Launcher | Fixed | | 2.75 in Rocket | Truck | | | | X | | | | X | | | | |

- **Nine spreadsheets were created, each modeled after a PKAD.**
- **“Recommended Test Input” represents test case input.**
- **“Actual Output” represents data output from the OOS tool/simulation.**
- **“Expected Output” represents data in the AMSAA unclassified database.**

| | Recommended Test Input | Expected Output | Actual Output |
|--------------------------------------|------------------------|-----------------|-----------------|
| System | Helicopter | Helicopter | Helicopter |
| Target | Truck | Truck | Truck |
| Weapon | Rocket Launcher | Rocket Launcher | Rocket Launcher |
| Mount | FIXED | FIXED | FIXED |
| Munition | 2.75" Rocket | 2.75" Rocket | 2.75" Rocket |
| IUA Filename | | SHO-TRK | ZDBPA-MI5KU |
| Firer to Target Range [meters] | 800 | 800 | 771.116 |
| Exposure [percent of target exposed] | | | |
| Dispersion [feet] | | 1 | 1 |
| Attack Angle [degrees] | 90 | 90 | 1 |
| Table Values | | | |
| Table Range [meters] | | 800 | |
| Table P(K H) | | | |
| - Mobility (M) | | 0.40 | 0.70 |
| - Firepower (F) | | 0.40 | 0.30 |
| - Mobility Firepower (M F) | | 0.50 | 0.70 |
| - Catastrophic (K) | | 0.20 | 0.10 |
| Mutually Exclusive P(K H) | | | |
| - Mobility (M) | | 0.10 | 0.40 |
| - Firepower (F) | | 0.10 | 0.00 |
| - Mobility&Firepower (M&F) | | 0.10 | 0.20 |
| - Catastrophic (K) | | 0.20 | 0.10 |
| Kill Thermometer | | | |
| - No Kill (N) | | 0.50 | 0.30 |
| - Mobility (M) | | 0.60 | 0.70 |
| - Firepower (F) | | 0.70 | 0.70 |
| - Mobility&Firepower (M&F) | | 0.80 | 0.90 |
| - Catastrophic (K) | | 1.00 | 1.00 |
| Random Number | | 0.426 | 0.426 |
| Kill State | | | |
| Kill State Prior to Round Impact | | No-Kill | NO_KILL |
| Engagement Kill State | | No-Kill | M_KILL |
| Final Kill State | | No-Kill | M_KILL |

OneSAF Online Approach

- **Management & Control Tool (MCT)**
- **Data Collection Specification Tool (DCST)**
 - Instrumented via PKAD Verification Specification
- **Results**
 - **Preliminary Tests found DCST output to be inconsistent with PKAD specifications**
 - **Very large output files**
 - **Difficult to interpret**
 - **PTRs have been written**
 - **Future tests will be conducted Online**

Online approach is very comprehensive

OOS Data Requirement

OneSAF Objective System requires that a set of unclassified data shall be provided within the end product. Three Modeling and Simulation domains within the Army (ARC, RDA, TEMO) are the main proponents that will be using OOS. This requirement allows for the simulation...

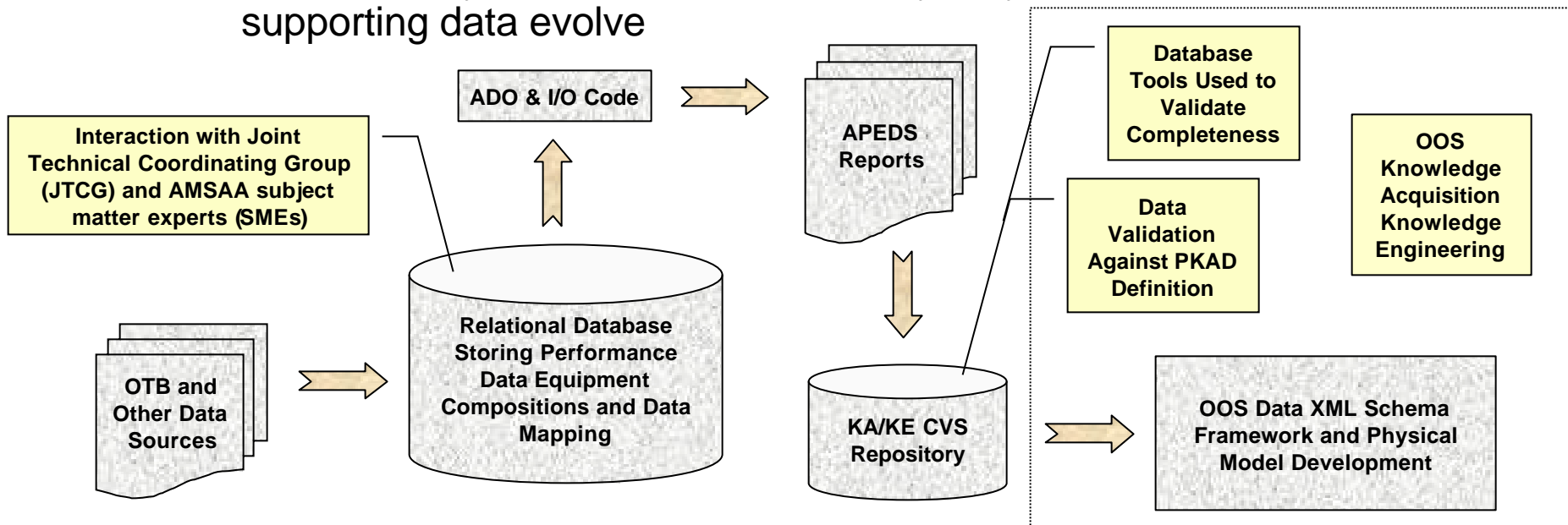
- to be exercised 'out of the box' when it is provided to users before and after FOC**
- to validate the implementation/development of the combat physical models outside of a classified environment**

OOS Block B Data Support (1 of 2)

- **Entity Composition Request**
 - Knowledge Acquisition team provides a baseline set of system:weapon:mount:munition combinations and system:sensor combinations imitating a data portal request
 - The nomenclature from the entity request defines the common nomenclature used within created data provided to OOS thus acting as our SND
 - The request is ad hoc i.e. not submitted through eDRS
 - The data to support OOS is not pulled from APEDS
 - The current SND does not support all systems required by OOS
- **OOS Unclassified Data Transformation**
 - Not generating any new unclassified data; using legacy simulations such as CCTT and OTB
 - Database backend in conjunction with code to query the entity request and applied data mappings to create unclassified data sets conforming to the SFF definitions

OOS Block B Data Support (2 of 2)

- Create sets of data to support all the physical models in OneSAF Objective System
- Engineer the data to conform to the AMSAA Performance Estimates Data System (APEDS)
 - Not defined for all performance areas right now
 - Due to the dynamic nature of the Army, physical models and their supporting data evolve

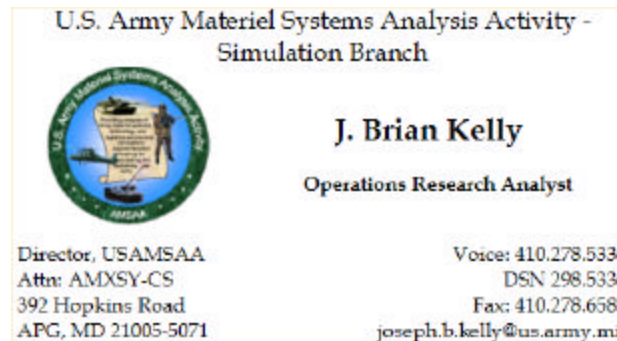


Army M&S Data Portal

- **AMSAA Performance Estimates Database System (APEDS)**
 - Central location of classified characteristics and performance data
 - Data portal requests automatically query APEDS to generate data sets of requested force structure submitted by users of the portal
- **Standard File Formats (SFF's)**
 - Data Interchange Format standard used to define the data structure to be generated from portal requests broken into functional areas
 - The nomenclature used within these data files conforms to the developing Standard Nomenclature Database (SND)
 - Common set of: system names, weapon names, mount names, munition names, and sensors names
 - Defines compositions of components
 - System:Weapon:Mount:Munition combinations (quadtupile)
 - System:Sensor combinations

Summary


- OOS Block C Support
- A Snapshot - Things We Like



OOS Block C Support

- **Produce PKADs for OOS Block C Development (~34 Models)**
- **Update Data Sets to Include OOS Block C Equipment List**
 - Block B Physical Models (9 - Level 4 Models)
 - Block C Physical Models
- **Obtain Block B Build 16 Software in House for Testing**
 - Offline - Model Development Verification Test Tool (MDVTT)
 - Online - Management & Control Tool (MCT)
- **Create Data Verification Application and Integrate into the Verification Process**

A Snapshot - Things We Like

- **Development Process**
 - Early & Continuous Domain Participation
 - Single Development Facility
 -  Focus - Reuse
 - Continuous User Assessments, SMART*
 - Incremental Development (program Blocks)
 - Physical Model Verification Testing
- **Composer Tools**
 - Behavior
 - Unit
 - Entity
- **Combat Physical Models (Composable)**
 - Standard Algorithms
 - Varying Fidelity Capability

* SMART – Subject Matter and Requirements Team

Questions

