Dynamic Multi-level Modeling Framework (DMMF)

Results of the Feasibility Study

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Agenda

- Genesis of DMMF
- Problem
- Approach
- Technology Outreach
- Challenges
- Feasibility

DMMF Genesis

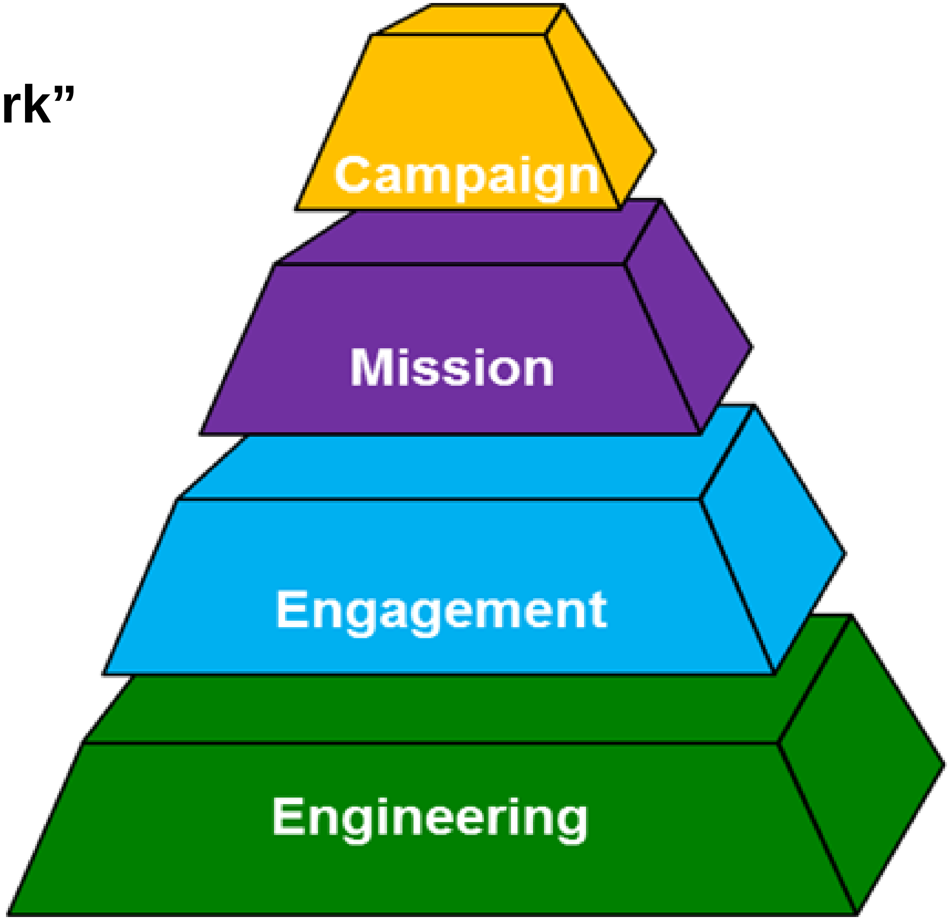
Dec 2011 briefing to ASD(R&E)

Objective:

“Single common framework”

Select Panel of Experts

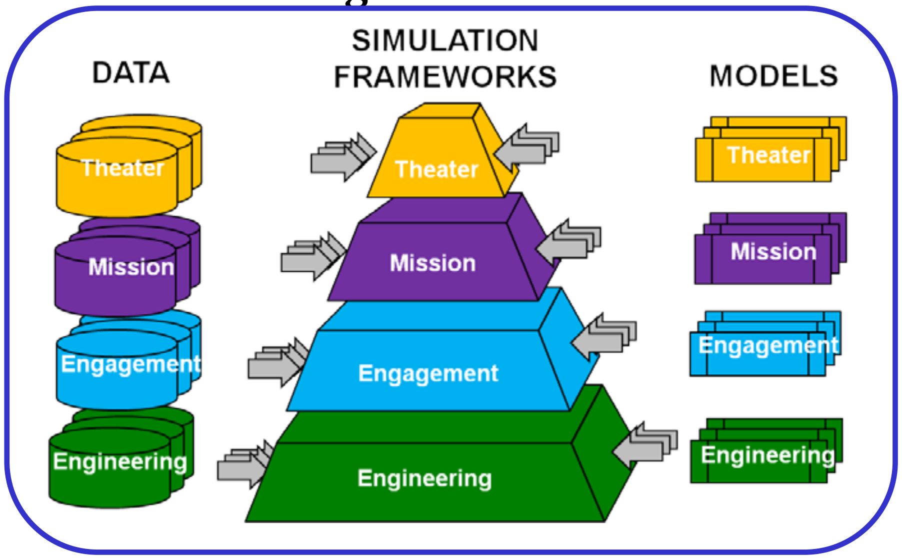
- PEO-STRI
- JHU-APL
- RAND
- SRI
- IDA
- SERC
- MITRE



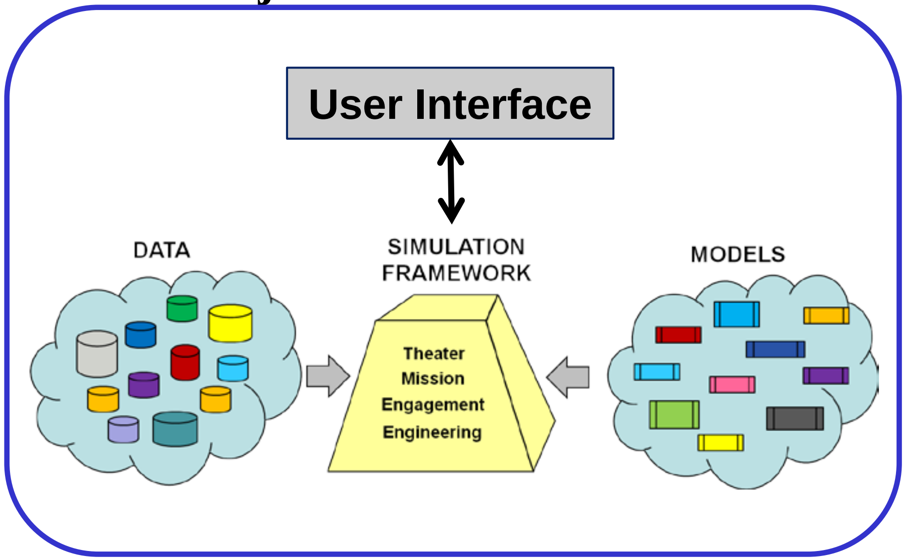
Problem Statement

- **Determine how an analysis capability with the following characteristics can be developed:**
  - A single framework (or small number of frameworks)
  - Engineering to Theater level models
  - Allows composability to quickly reconfigure analysis, address range of options
  - Multi-level modifiable inputs
  - For use by senior DoD decision makers
  - Operable from the desktop or a single location
  - Define an architecture as close to a complete solution as possible

Existing Architecture



Objective Architecture



Technology Outreach

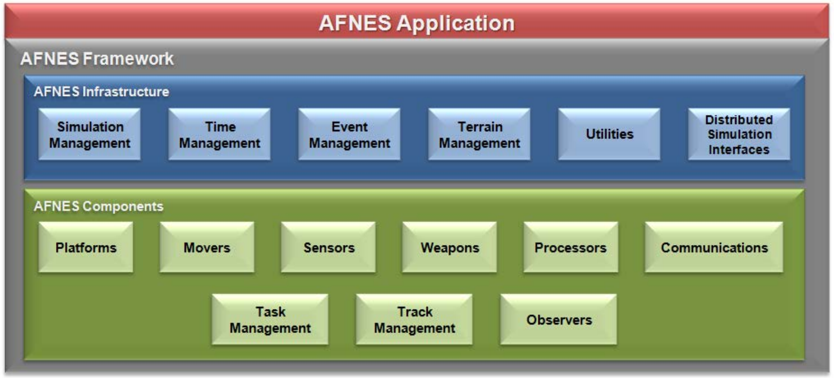
Organization	Format	Resource
*Boeing-Virtual Warfare Center	Demonstration	Architecture Framework for Network enabled Systems (AFNES)
Johns Hopkins University-Applied Physics Lab (JHU-APL)	Meeting	Warfare Analysis Laboratory
MITRE	Conference	Service-oriented Architecture
*Analytics Graphics Inc. (AGI)	Demonstration	Systems Tool Kit-based framework
Warp IV	Demonstration	Open unified technical framework architecture
Innovative Management Concepts (IMC)	Demonstration	Joint resource allocation model
Lockheed (Owego)	Meeting	Data conditioning capability
Center for Army Analysis (CAA)	Meeting	Army engagement/Mission modeling methods
Korean Battle Simulation Center (KBSC)	Meeting	Theater M&S support to exercises
USAF/A9 (United States Air Force Studies and Analysis)	Meeting	Air Force “T” analysis method
ARA (Applied Research Associates)	Meeting	Electronic warfare, and cyber
Alion Science and Technology	Demonstration	SmartMoves
TASC (The Analytic Sciences Corporation)	Meeting	Enterprise capability-based
SURVIAC (Survivability/Vulnerability Information Analysis Center)	Meeting	Integration tools and processes
Adventium (Adventium Enterprises, LLC)	Meeting	Intra-level tool integration

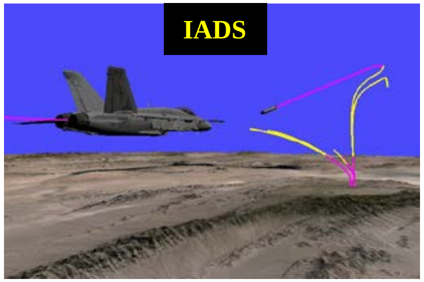
* Exemplars due to advanced development of multilevel modeling techniques and existence of DoD customers for their frameworks

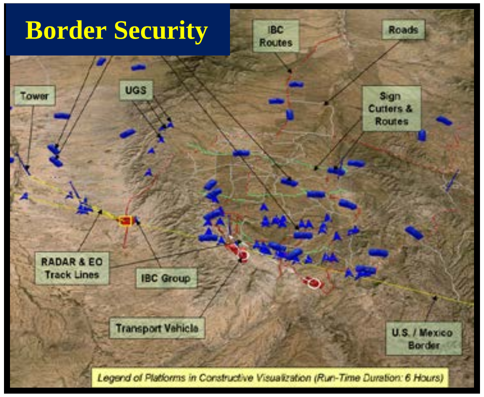
Example 1
Boeing Virtual Warfare Center
St. Louis, MO

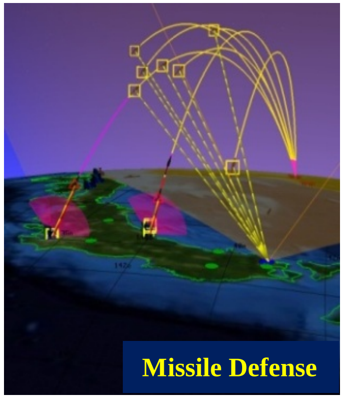
* **AFNES: Analytic Framework for Network Enabled Systems**

- AFNES offers integration and visualization for the engagement and mission level models and simulation
- Engineering data are attached to engagement/mission entities







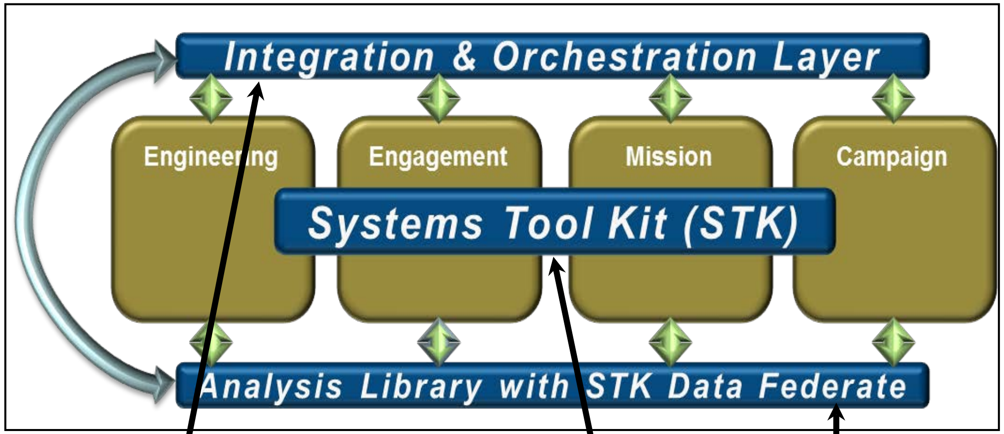


*Figures used with permission of Boeing Virtual Warfare Center

Example 2
Analytic Graphics, Inc (AGI)
Exton, PA

MSAF: Modeling, Simulation & Analysis Framework*

- AGI vision is to support all levels of analysis (Engineering to Campaign)
- Simulations are based on engineering performance, and data is fed up to higher level models
- Offers engineering and engagement level simulations coupled with a high-end visualization capability



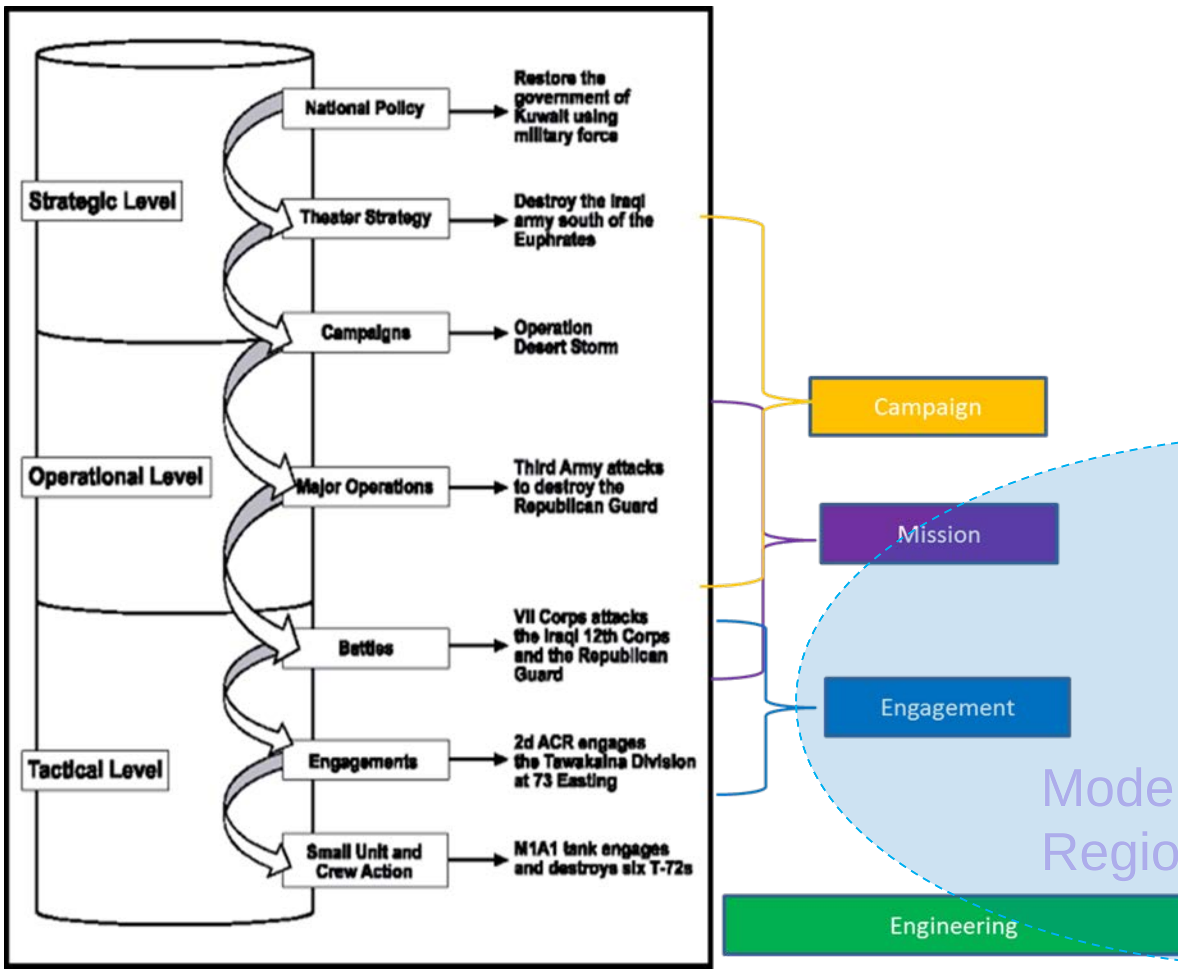
Orchestration
Coord across tools
Data conditioning

Time/Geometry Engine

Data Management
Storage
Model initialization
Configuration mgt
Discovery

***Figures used with permission of AGI**

Challenges



Key influences

Material

- Industrial capacity
- Mobility
- Logistics
- System performance
- Physical law

Human

- Political will
- Strategic vision
- Military leadership
- Morale
- Force resilience
- Joint/Combined training
- Unit-level training

Modeling Framework Region of applicability

Challenges

- **Technical**
  - Timescales
  - Modularity and decomposition
  - Interoperability and composition
    - Horizontal and vertical
    - New and legacy models

Inter-model Transforms
Syntactically correct
Semantically meaningful

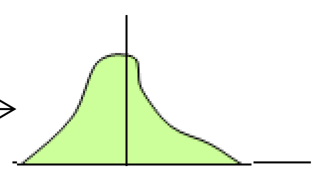
Model 1
Lower level
Higher resolution

$$\begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{m1} & \cdots & a_{mn} \end{bmatrix} \xrightarrow{\text{Transform}} \begin{bmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \end{bmatrix}$$

Model 2
Higher level
Lower resolution

n x m output to 3x3 input

Model 3
Lower level
Higher resolution



Transform

X

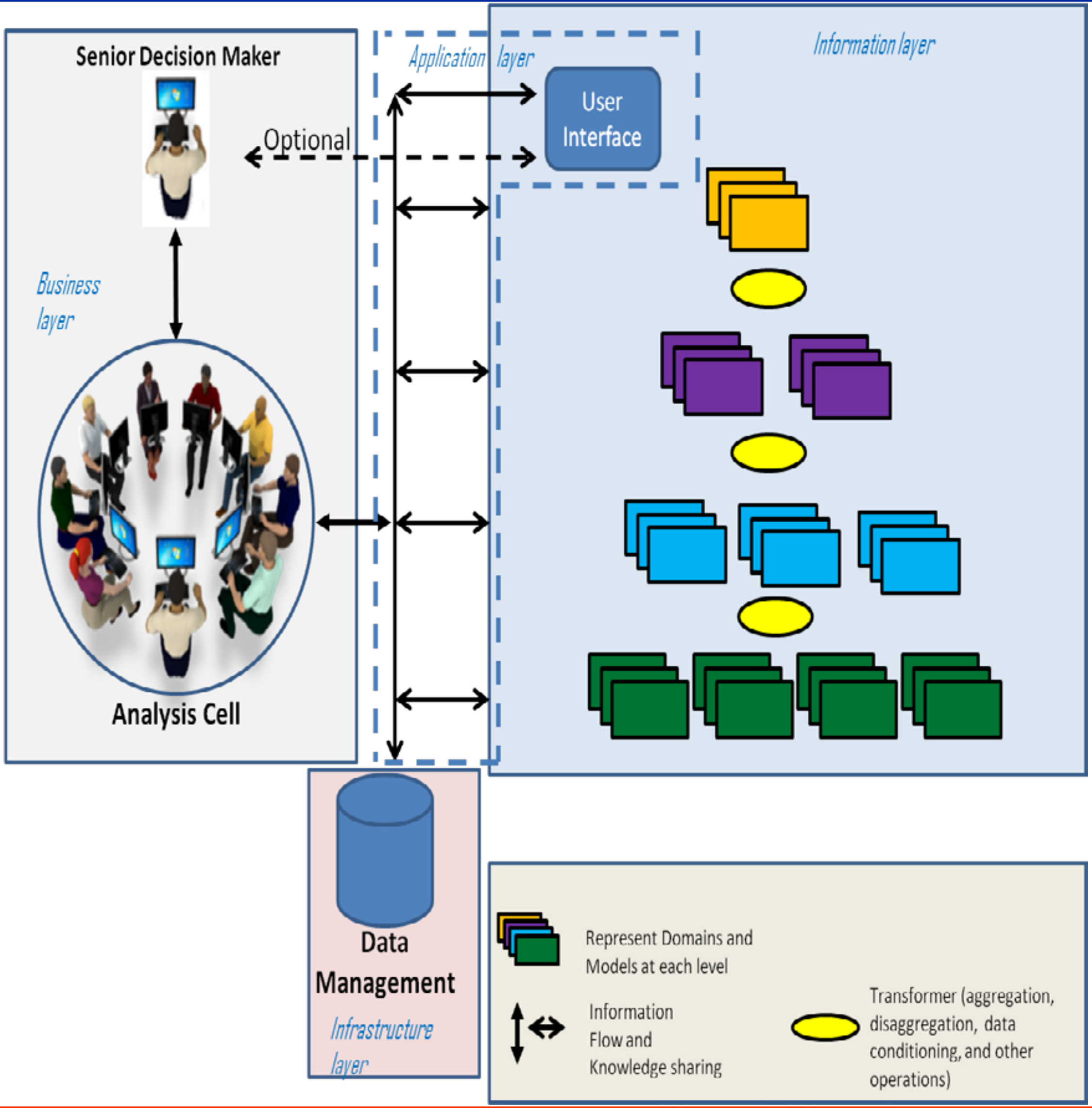
Model 4
Higher level
Lower resolution

Statistical output to single-valued input

Challenges

- **Analytical**
  - Model and/or simulation selection
  - Engineer and analyst selection
- **Process**
  - Analysis and reporting
  - Orienting and selecting an analytic approach before modeling
  - Obtaining and connecting models, data, transformations
- **Organizational/Cultural**
  - Long term ownership-cost and performance
  - Sharing of intellectual property
  - Standards to support reuse
  - Business model that supports rapid identification and acquisition of M&S resources

Feasibility



- **Results of technical outreach**
  - e.g., Boeing, AGI
- **Current practice**
  - Interlevel functions performed by SMEs
- **Suitability of legacy models**
  - May be limited due to semantic compatibility of inputs and outputs
- **DMMF Future**