AFRL

THE AIR FORCE RESEARCH LABORATORY

LEAD | DISCOVER | DEVELOP | DELIVER

THE

National Operational Environment Model

(NOEM)

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Understanding the Operational Environment

Outline

- The Need
- Objective
- What's Available
- Challenges
- Approach
- Major Components
  - The Model
- A Use Case Example
- Summary

The "Need"

- As a nation we currently do a poor job of identifying problems before the ONLY solution left is a military one
- Once we need to take action we lack the ability to understand the ramifications (unintended consequences for both the short / long term) of potential actions on not just the adversary but the environment and the innocent bystanders
- Cannot separate the people from the environment and the environment from its people – they are one in the same → As such there are a lack of tools / understanding of socio-cultural and behavior (aspects of individuals & groups) and how they interact with each other and the environment (physical systems)

WHY AIR FORCE INTEREST?

Joint Pub 3-0 defines 6 versus 4 stages and integrates stability operations as an overarching term that encompasses various military missions, tasks, and activities
→ ALL SERVICES NEED TO CONSIDER STABILITY OPS AT EVERY STAGE!

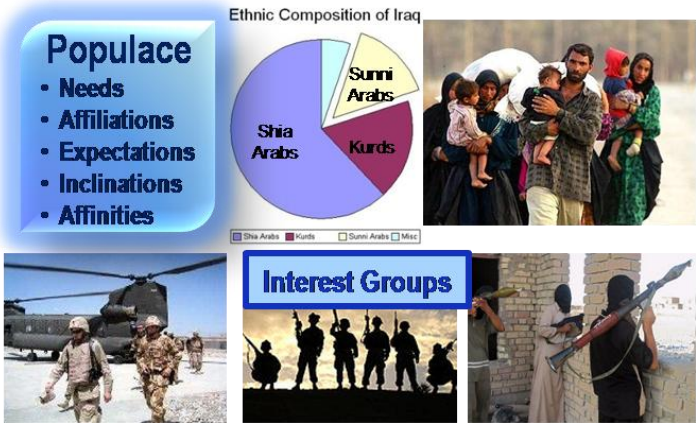
JOE 2010 - What WE do – the early phases of a campaign can significantly affect not only the conflict but also set the stage for the entire campaign (affects other services)

The "Need" (Cont'd)

"…Aerial drones and other collection assets are tasked with scanning the countryside around the clock in the hope of spotting insurgents burying bombs and setting up ambushes. Again, these are fundamentally worthy objectives, but relying on them exclusively baits intelligence shops into reacting to enemy tactics at the expense of finding ways to strike at the very heart of the insurgency. These labor intensive efforts, employed in isolation, fail to advance the war strategy and, as a result, expose more troops to danger over the long run…. The second inescapable truth asserts that merely killing insurgents usually serves to multiply enemies rather than subtract them…"

"…CJ2 shops are overwhelmingly focused on "red" activity – concerning the enemy – devoting relatively little effort to "white" activity – the Afghan population, economy, development, and government. This culture is so entrenched that it would inevitably compromise the mission of the new Information Centers. .."

Major Gen Michael T. Flynn, USA, etal, on the Afghanistan Conflict.



Objective

Provide a Strategic Assessment & Analysis Capability that supports both (1) an Intel Analyst and (2) a Decision Maker & their staff to understand the complex nature of today's Operational Environment. Support to all phases of the campaign:

Phase 0	Forecast/Identify possible area(s) of potential instability & actions to take
Phase I-III	Forecast/Identify ramifications of possible actions (unintended consequences for both short & long term) Identify possible action on "White" to support COINS operations
Phase IV-V	Forecast/Identify where best to invest in the country and when

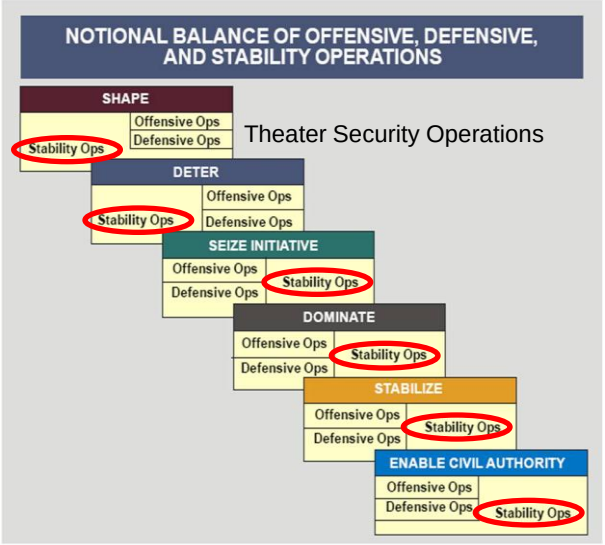


Figure V-1. Notional Balance of Offensive, Defensive, and Stability Operations

Joint Pub 3-0

What's Out There

- BIN 1: Early Warning Systems
  - Based on violence or conflict and 3 – 10 measures
  - Don't provide a "why" or a "what" to do
  - In many cases the forecast is too late for any solution other than a military one
- BIN 2: "Large" scale Modeling & Simulation Systems
  - Very detailed - as such many have long run times and large number of inputs
    - Not conducive to many "What If" analyses (Interactive)
  - Lack overall "System" definition
  - Very difficult for an analyst to modify / use
    - In some cases propriety code (cannot see under the hood)
    - Very costly to move from one country to another one
    - Rely on external "contractor" support

Continued research has yielded a collection of new observations and challenges

The "Key" Challenges

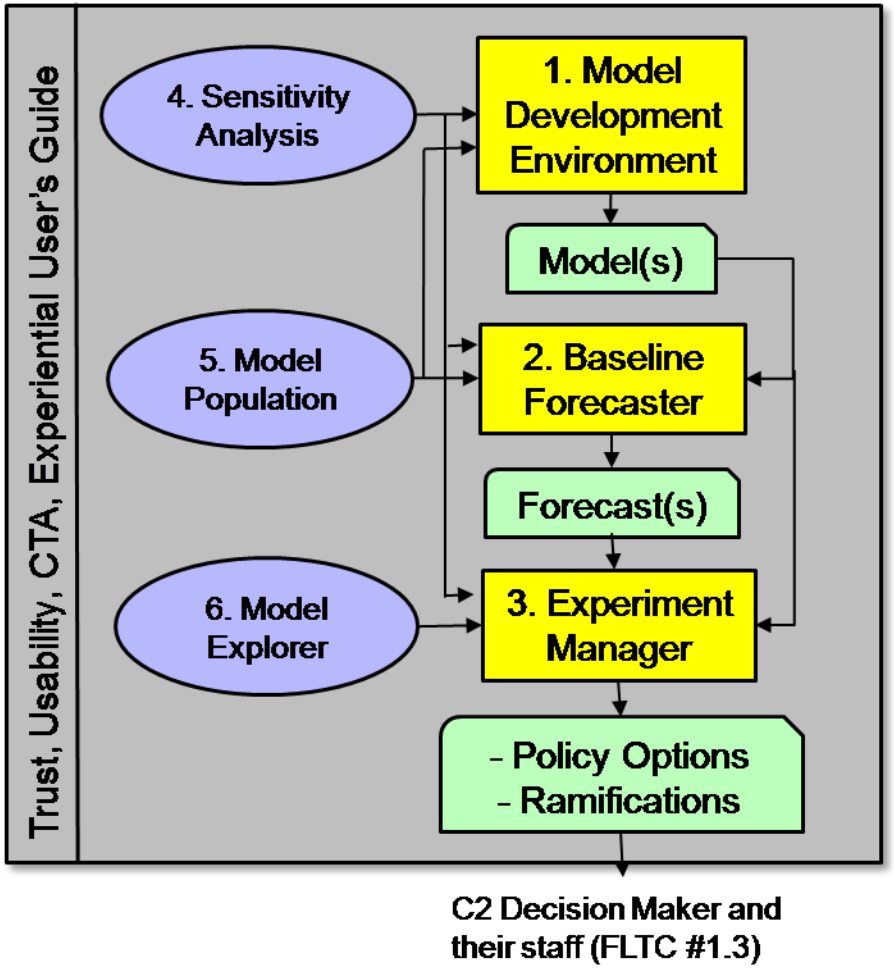
(not in any order, nor exhaustive)

- Seamless support for both Physical and Social Theories
  - What are the social theories and to what level do we model (individuals, groups, organizations)?
- Adapting / Applying the Model to other regions or nations (existing & differing theories)
- Establishing a baseline or starting point
  - What is stability or instability (in terms of its people not ours)?
- Maintaining currency (Data, Theory)
- Gaining the Analyst's Trust/Confidence
  - Understanding/Exploring the Model
- Visualizing the Results
- Support for Continuous and Interactive Training /Learning

Approach

- Model Environment as a region with ability to interconnect regions (Nation-States)
  - Based on Stability Operations Theory (Economy, Governance, Security/Rule of Law, Social Well-being)
  - Support for DIME (Diplomatic, Information, Military, Economic) and PMESII (Political, Military, Economic, Social, Infrastructure, & Information)
- Model People based on age, interest group & their affinity, and occupation
  - Supports group and inter-group behavior, i.e., socio-cultural interaction/understanding
- Leverage Research from AFIT Theses & Operations Research SMEs:
  - AFRL/RIEA Capt Robbins (SROM) – Stability & Reconstruction Operations Model
  - AFRL/RIEA Capt Fensterer (VFT) - derivation of "5 Pillars of Stability"
  - AFRL/RIEA Capt Nysether
- Build Modules based on System Dynamics, Agent-Based and Game Theories
  - Capitalize on Existing Theory/Work where-ever possible
  - Supports continuous/interactive training
- Develop under AFRL/RIEF **In-House** Effort with **AFRL/RH** & **AFOSR** Support
- Package into Self-Contained Suite of Capabilities
  - No cost for users to use or replicate
  - User gets capabilities that are modular and intuitive to implement

Basic Components



Major Thread

1. Model Development Environment - (Adapting to New Regions, New Nation-state or adding new modules/theories
2. Baseline Forecast(s) – Generation of latest forecasts based on most recent data
3. Experiment Manager - Investigation of Potential Policy Sets and/or Analysis of Ramifications of Planned/Proposed "Blue" Actions

Basic Capabilities

4. Identification of Significant Factors for Given Response
5. Maintenance of Current State Information
6. Understand Interdependencies

Component Availability
(A Quick View)

Component	%Complete	TAD	Remarks
➢ Model Dev Environment	30	Jul'10	Configuration Tool Complete, Building Model Config & Repository
➢ Sensitivity Analysis	75	Jul'11	Awaiting MDE for Integration
➢ V&V	20	Jul'11	Studying/Identifying Potential Techniques
➢ Baseline Forecaster	20	Aug'10	Design complete, building initial capability
➢ Model Population	80	Avail	Initial capability complete
➢ Experiment Manager	95	Avail	Fully functional, allows running of experiments "what ifs" against model
the			
➢ Model Explorer	40	May'11	Prototype complete/Integrated with EM

The "Model"….

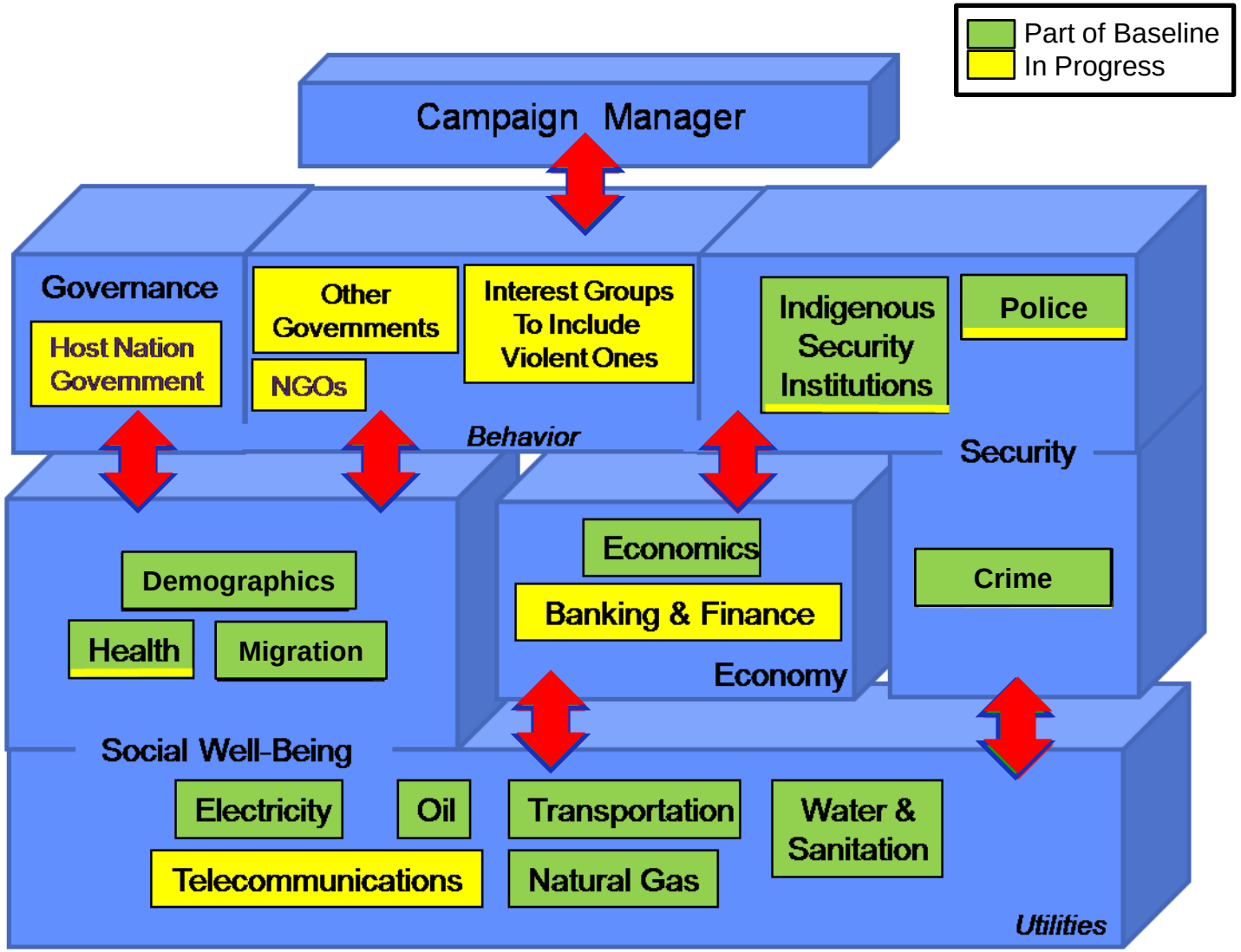
TAD = Technology Availability Date

What Do We Model?

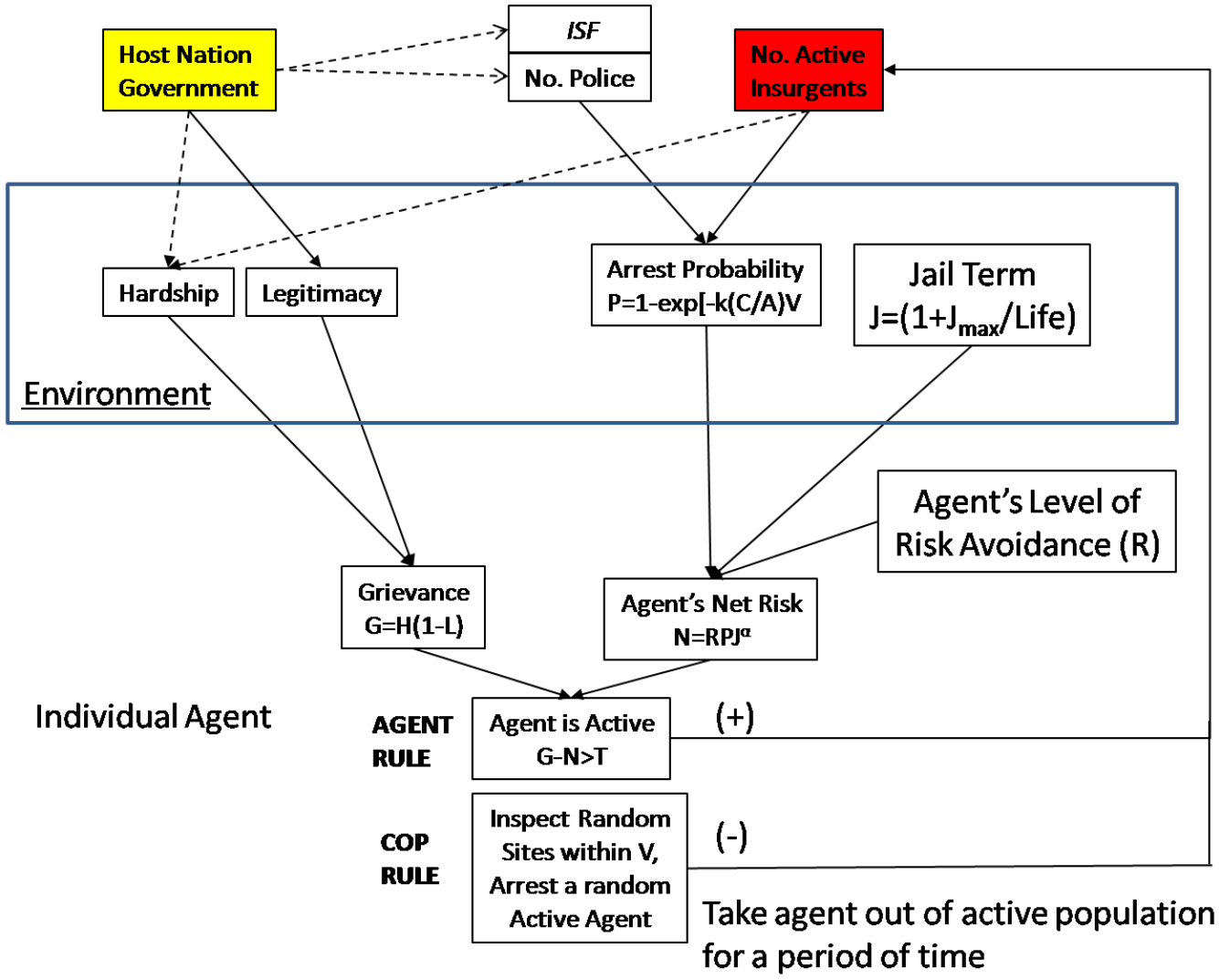
Gaming Engine
TAD: Aug'11

Behavioral Modules
TAD: Aug'11

Environment
TAD: Aug'10

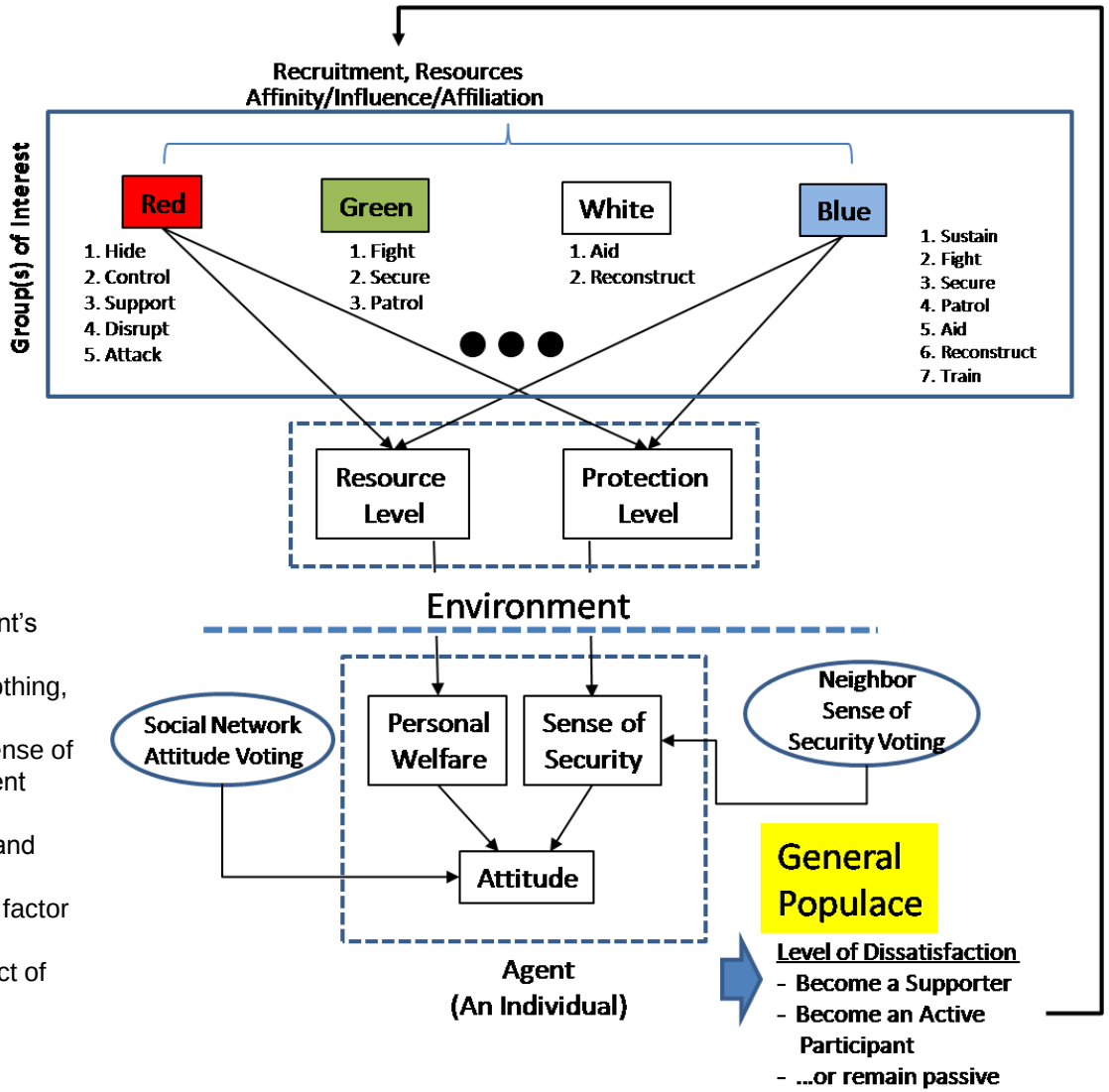


Behavior Modules
(Epstein's Model)



Behavior Modules
(Borger's, etal Model)

QUESTION: (1) Can we generalize individuals as the Other group, non-activists? All above groups are vying for "Other" group support
(2) Can we model groups or are they emergent , complex and derived behaviors of individuals?
(3) Red and Blue can do the same things, i.e., red can provide social programs.



Personal Welfare: Economic element to evaluate if an agent's personal economic situation is getting better or worse (Physiological needs - the need for food, water, shelter, clothing, etc.)
Sense of Security: Based on the history of the perceived sense of security plus the actual protection level at the agent's current location (Safety Needs – need for protection, order, law)
Attitude: Captures the interaction between actor's actions and individual perceptions
Neighbor Sense of Security Voting: A social-psychological factor in an agent's attitude towards an authority
Social Network Attitude Voting: Social and emotional aspect of forming an opinion

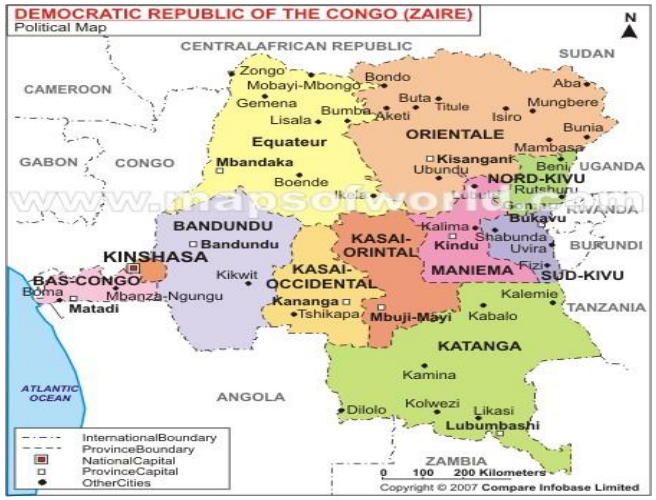
Training Effect Based Reasoning; developing a next generation of training simulators, Borgers, Kwint, Petiet, and Spaans
Based on Epstein, etal: Grievance (hardship & Legitimacy) and Risk

Example Scenarios

- **Reduce Civil Unrest (Job Stimulus) – Phase 0**
- **Achieve Air Superiority (Effect of Power Loss) – Phase I-III**
- **Aftermath of a Nuclear Attack (Counter Red, Gain Host Nation Government and Local Populace Support) – Phase III-V**

NOEM Use Case #1

Job Stimulus



Commander's Objective:

Reduce Civil Unrest in the region

Considerations:

- Which objective should be prioritized?
- How will each decision affect the local populace in terms of stability?
- How will differing COA's affect long-term relations?

Task:

Provide More Jobs for Populace

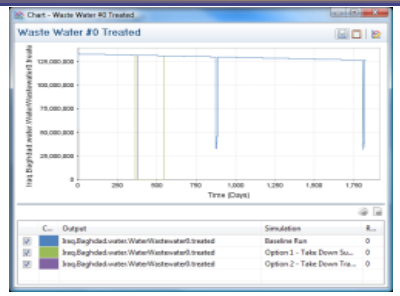
Commander's Policy Options:

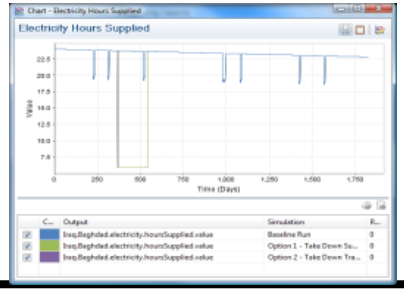
1. Do nothing – Baseline
2. Invest heavily in industry and service sectors
3. Recruit militias and rebel groups into armed forces, by increasing wage rates

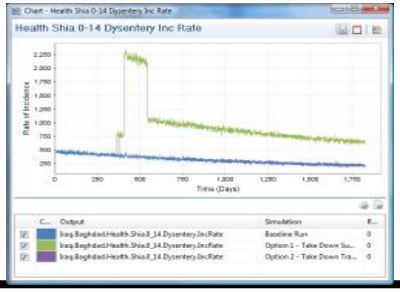
Desired Effect	Trade-Offs	
	Investment:	**Military Recruitment:**
Lower Civil Unrest	Lower unemployment	Lower unemployment
	Self sustaining	Fewer recruits for rebel groups
	Diversifies from resource extraction	Stronger government
	Requires government support	Economic downturn could lead to better armed and trained rebels (if gov't unable to pay wages)
	Longer timeline	

NOEM Use Case #2

Effect of Power Loss







Commander's Objective:

Achieve Air Superiority over a given region

Considerations:

- Which objective should be prioritized?
- How will each decision affect the local populace in terms of stability?
- How will differing COA's affect long-term relations?

Task:

Interrupt Electrical Power to Key Defense Nodes

Policy Options:

1. Do nothing – Baseline
2. Take out high-voltage transmission substation – considerable damage – 6 months to repair
3. Take out high-voltage transmission line – minimal damage – up within a week

Successfully Demonstrated at NOEM Days (Nov 2009)

Desired Effect

Loss of Power

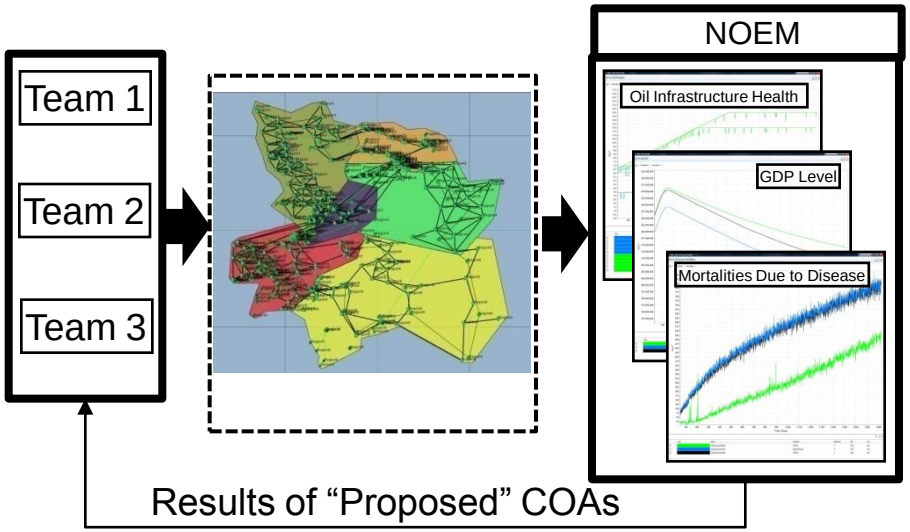
Ramifications

High Order Effects

Amount of Potable Water	Economic Downturn
Increase in Dysentery Rate	Increase in Unemployment
Mortality Rate 0-14	Increase in Crimes
Civil Unrest	Insurgency Support Increases
Resource/hardship	Protection/Security

NOEM Use Case #3

FLTC 1.2 War Game: Aftermath of Nuclear Event



Commander's Objectives:

Red/Blue each vying for country (Host Nation Government (HNG), Populace) support

Considerations:

- Which objective should be prioritized?
- How will each decision affect the local populace in terms of stability?
- How will differing COA's affect long-term relations?

Task:

Counter Red, Gain HNG and Local Populace Support

Policy Options:

1. Do nothing – Baseline
2. Deny Red oil access, control Oil producing regions.
3. Prioritize humanitarian efforts, illegitimating Red presence.

Successfully Demonstrated/Used as part of FLTC 1.2 Wargame (May 2010)

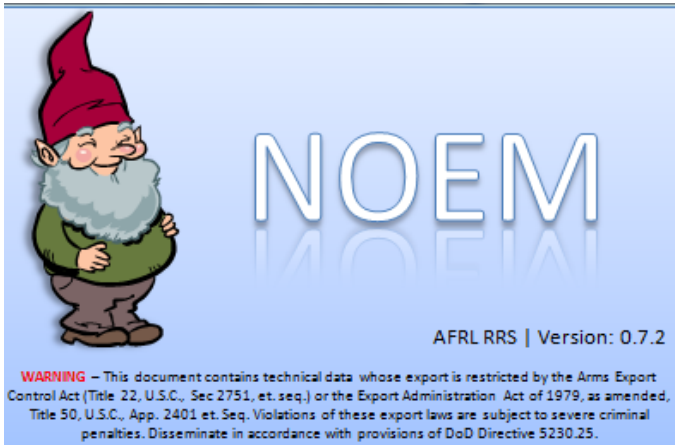
Desired Effect

Counter Red

Trade-Offs

Oil Objective:	Humanitarian Objective:
Humanitarian crisis unaddressed	Oil under red control
Disease rates high	Red foothold strengthened
Food and clean water shortage	Disease rates and mortalities reduced
Blue forces seen as intruders	Populace supports blue forces
Oil infrastructure improved and under Blue control.	

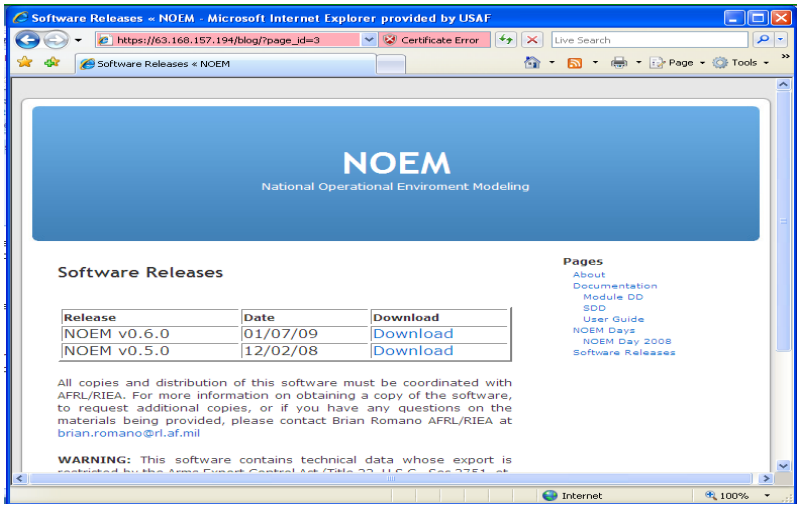
Products
(What's Available)



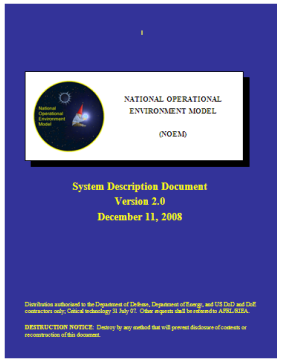
NOEM Software

- Version 0.7.2 Release Available
  - Collection of class files
  - No installation required
  - Unzip folder to desired location
- Focus on ***What If Analysis***
  - Modify Variables of interest
  - Define set of outputs
  - Define stopping or success criteria
  - Conduct simulations
  - Chart outputs
- *On-line Cheat Sheets & User's Guide*
- *Simulation results can be exported*

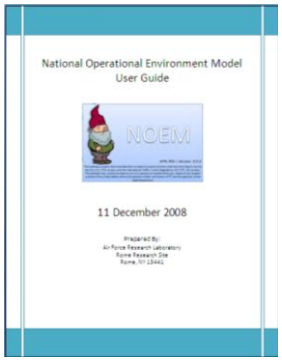
NOEM Website



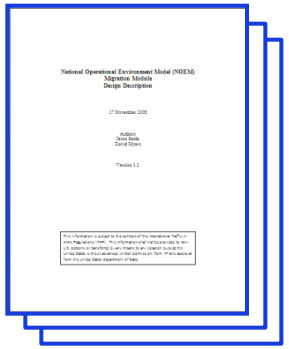
NOEM Documentation



System Design Document v2.0



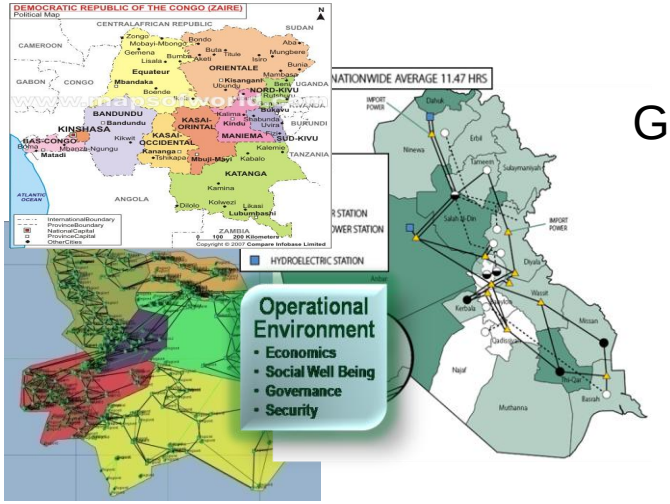
User's Guide V2.0



Module Design Documents

NOEM in Summary

The NOEM is not just a Model – it is an environment that supports the Analyst, Decision Maker and Researcher alike in all phases of the campaign.

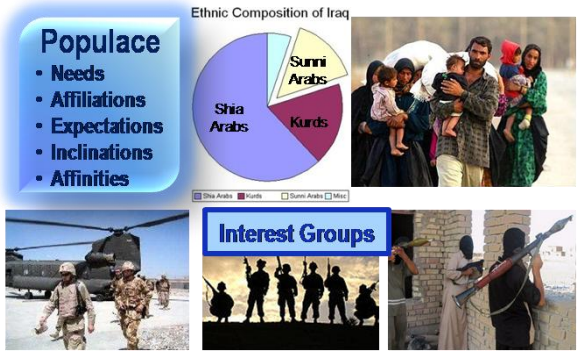


Goal of the NOEM is to investigate:

- Why
- What Can We Do About It
- What are the “Unintended” Consequences

NOEM is Available Today to Download (FREE)

- NOT the end or total solution but one capability in the toolbox
- ONLY the beginning, still have a long way to go! NEED YOUR HELP.



BACKUPS

The Team

- **AFRL Information Directorate**
  - Model Development/Integration
  - Infrastructure
  - Data Visualization & Analysis Tools
- **AFRL Human Effectiveness Directorate**
  - Behavioral Modeling of Groups and Inter-groups
  - Visualization – GUI & High Dimensional Temporal Data
  - Cognitive Task Analysis (CTA), Usability, Trust / V & V
  - Operational Assessment / Synthetic Task Environment
- **AFOSR**
  - Supported Lab Task for Sensitivity Analysis
  - Robust Decision Making
  - Socio-Cultural Modeling

- **AFIT**
- **External Support From:**
  - Sandia National Laboratory
  - Johns Hopkins APL
  - MIT
  - University of Texas, Austin
- **Outside Contractors**