Athena
in 2011

JPL
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OR Methods in Support of Countering Transnational Threats

History

1987 *JESS 1.0* (original name of *Corps Battle Simulation*)

1988 GEN (Ret.) Cavazos expressed the need to train with fatigue, morale, combat geometry, suppression, …

1990 *COBRA* expert-system now part of *CBS*

1995 GEN (Ret.) Burba: "*COBRA* is a theory of combat"

2002 TAMU's *Regional Analysis Model* in *Spectrum*

2005 *JNEM 1.0* — effects on civilians are from *RAM*

2007 U.S. Army Modeling & Simulation Award to *JNEM*

2008 Clear need for long-horizon JNEM for S&RO analysis

2009 *Athena 1.0*.

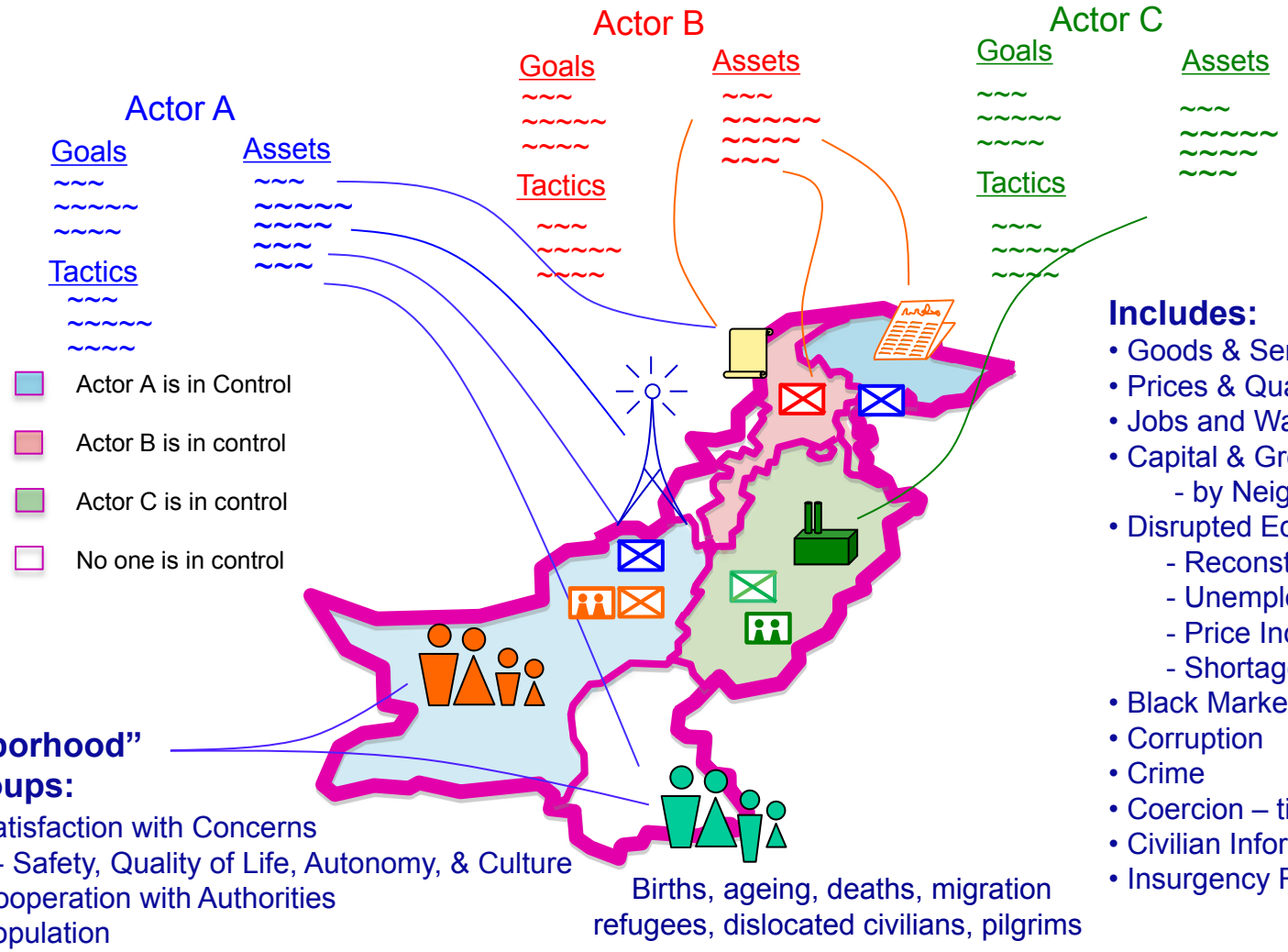
Overview

- Simulation for a well-informed analyst to use on a laptop to compare COAs using DIMEFL in a PMESII+2 environment
  - National or regional scope
  - 1 – 3 month turns, horizon of 3 months to 3 years
  - Cause-and-effect relationships are emphasized
- Many variables are inherently qualitative
  - The analyst deals with narrative values
    - » E.g., *passionately for, very satisfied, aggressive*
  - Athena associates numbers with these values
    - » Computes with numbers
    - » Translates results back into narratives
    - » Experienced users can deal directly with the numbers if they wish
  - Translations of relative amounts are generally logarithmic
  - Absolute amounts have a zero point & asymptotic limits

The model has

- Actors
  - Individuals and groups who are able to influence the situation either through, or in spite of, the appropriate authorities.
- Neighborhoods
  - Where people live & things happen
- Civilian groups
  - The people who live in the neighborhoods
- Force groups
  - *Uniformed* or *non-uniformed*
  - Controlled by actors
- Organizations
  - *NGOs*, *IGOs*, and *Contractors.*

Athena Vision



"Neighborhood" Groups:

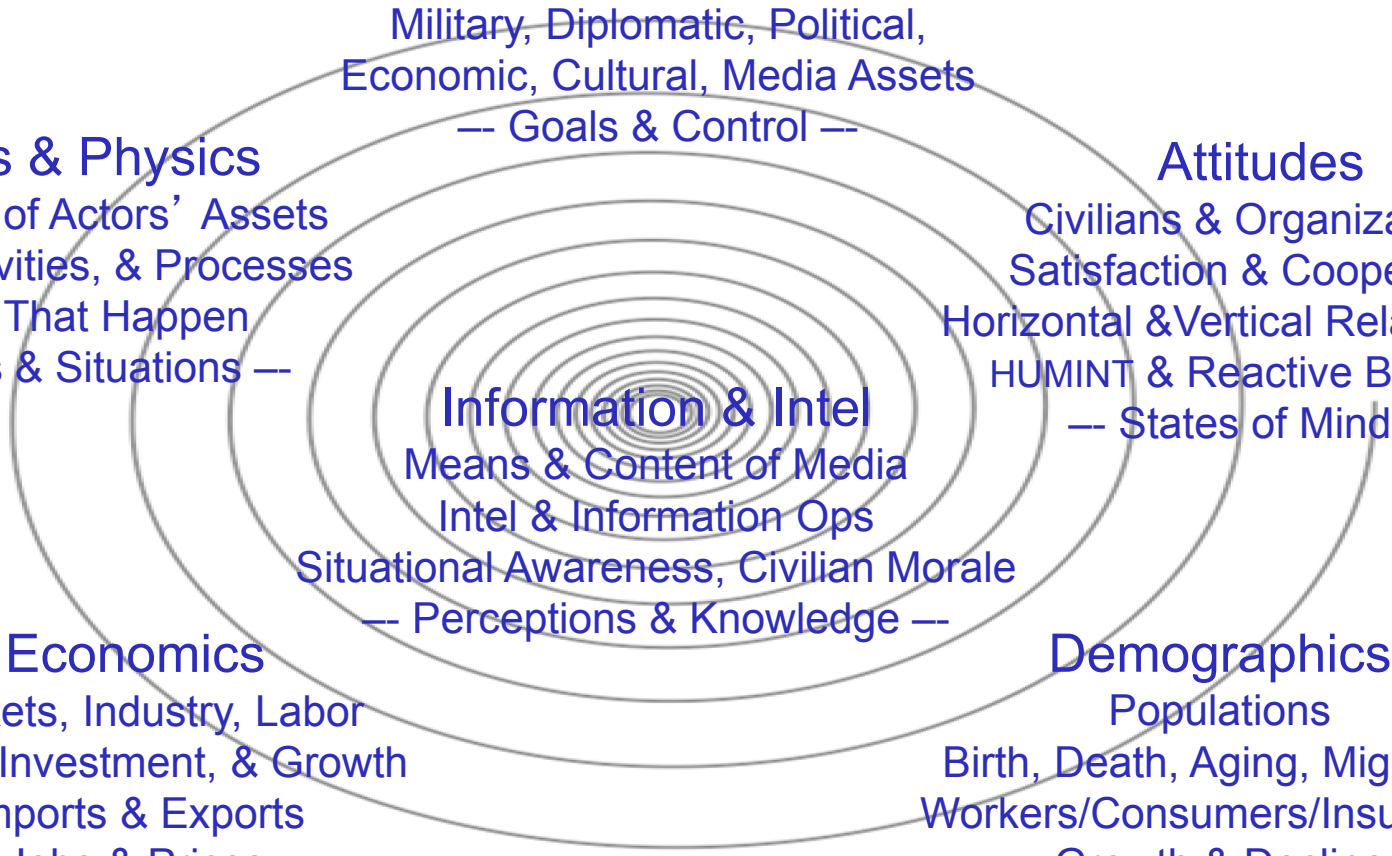
- Satisfaction with Concerns
  - Safety, Quality of Life, Autonomy, & Culture
- Cooperation with Authorities
- Population

Births, ageing, deaths, migration
refugees, dislocated civilians, pilgrims

Includes:

- Goods & Services
- Prices & Quantities
- Jobs and Wages
- Capital & Growth
  - by Neighborhood
- Disrupted Economic Conditions
  - Reconstruction & Repair
  - Unemployment
  - Price Increases & Inflation
  - Shortages
- Black Market
- Corruption
- Crime
- Coercion – tipping point
- Civilian Information Infrastructure
- Insurgency Recruitment

The Six Athena Models



Politics
Actors
Military, Diplomatic, Political,
Economic, Cultural, Media Assets
–- Goals & Control –-

Assets & Physics
Actual Use of Actors' Assets
Actions, Activities, & Processes
Things That Happen
–- Events & Situations –-

Attitudes
Civilians & Organizations
Satisfaction & Cooperation
Horizontal &Vertical Relationships
HUMINT & Reactive Behavior
–- States of Mind –-

Information & Intel
Means & Content of Media
Intel & Information Ops
Situational Awareness, Civilian Morale
–- Perceptions & Knowledge –-

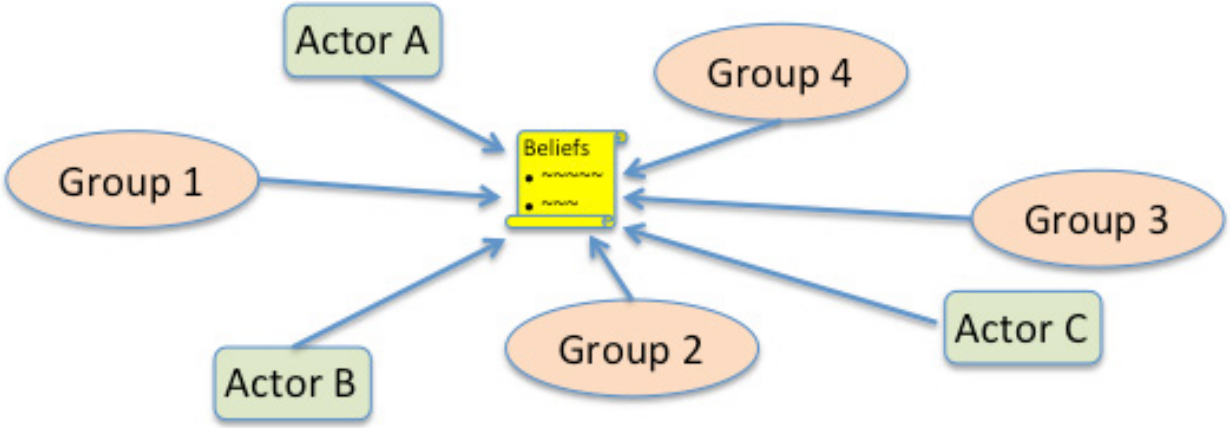
Economics
Markets, Industry, Labor
Taxes, Investment, & Growth
Imports & Exports
–- Jobs & Prices –-

Demographics
Populations
Birth, Death, Aging, Migration
Workers/Consumers/Insurgents
–- Growth & Decline –-

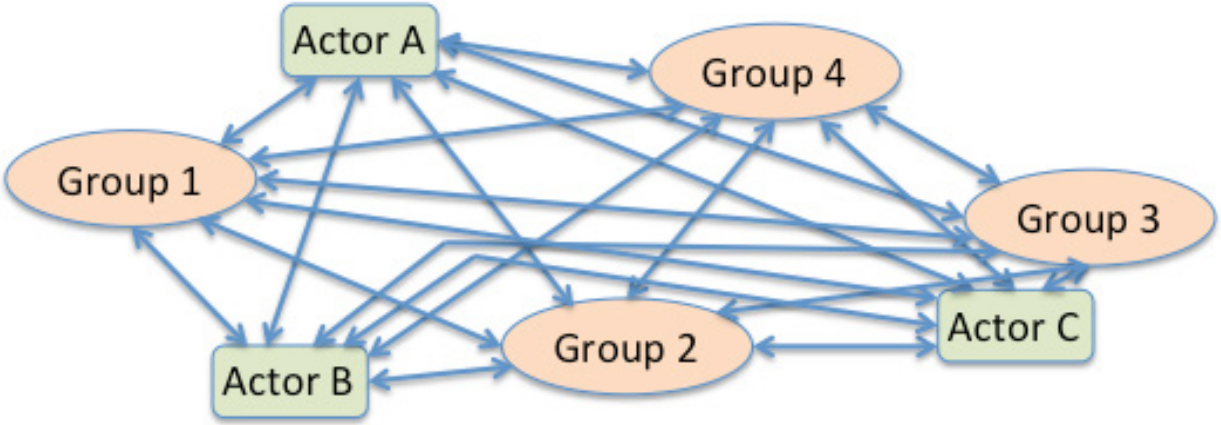
Politics Model

- Actors and Strategies
  - Actors give purpose to the simulation
    - » Their strategies are defined by their prioritized list of tactics
      - ❖ Goals are expressed as conditions on tactics
    - » There is no guarantee that their tactics *will* achieve their goals
  - Actors can change their minds— but outside the simulation
  - Sample tactics:
    - » *Provide essential services*
    - » *Deploy forces*
  - Sample conditions on use of tactics:
    - » While a particular goal is unmet
      - ❖ Such as: Be in control of neighborhoods FATA, NWFP, Islamabad
    - » If the cost is less than the actor's available cash.

- Control
  - Beliefs about topics & willingness to put up with disagreements



  - Agreements and disagreements imply affinities
    - » Athena computes *horizontal relationships* from these affinities



- Group-to-Actor *vertical relationships* are one-way
  - » They *start* with affinity — and are affected by blame and credit
  - » People expect things from actors — especially those in control
- Direct Support depends on all the people in the neighborhood
  - » Civilian support = Σ_{groups} Number of Civilians × Vertical Relationship
  - » Military support = $\Sigma_{force\ groups}$ Number of Personnel × Force Multiplier
  - » Removing an actor's troops can reduce his support by a lot
- An actor can give his direct support to another actor
  - » "80% solution" to modeling coalitions
- An actor's Influence is his share of the total support
  - » But zero if that fraction does not exceed a threshold
  - » It could be that no one has enough influence to matter.

- Bottom line: An actor has control in a neighborhood when
  - » He has enough influence and support
  - » to provide stability, basic services, etc. — if he chooses to do so

  The criterion for being in control:
  - » Have more influence than any other actor
  - » Provided it exceeds a threshold (perhaps 50%)
- An incumbent may be held responsible — seen as "in control" even if he no longer actually *is* in control
- Control shifts when
  - » The actor with the most influence (if it exceeds the threshold) has more influence than the incumbent
  - » If that actor's influence does NOT exceed the threshold, NO ONE is in control
- When control shifts
  - » All civilian groups' satisfaction levels change
  - » and their vertical relationships with actors change
  - » and their cooperations with force groups change.

Attitudes Model

- Tracks impact on civilian attitudes of everything that happens
  - Extended version of JNEM, the *Joint Non-kinetic Effects Model*
  - Satisfaction w/r to four "universal" civilian concerns (next slide)
  - Civilian cooperation with force groups
    - » Based on TRAC's *HUMINT* model
  - Resolved to neighborhood groups
    - » All effects spread over social networks to *here, near,* and *far* neighborhood groups via proximity and the relationship matrices.

- Events and situations cause changes in neighborhood groups' satisfaction with respect to these concerns:

AUT — Autonomy

To what extent does the civilian group feel they can maintain order and govern themselves with a stable government and a viable economy?

SFT — Physical Safety

To what extent do they fear for their lives?

CUL — Cultural / Religious Issues

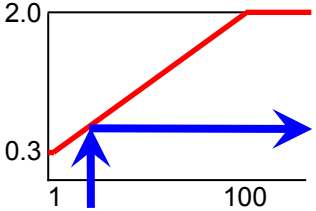
To what extent do they feel their beliefs are being properly respected by others?

QOL — Quality of Life

How do they feel about their property, the physical infrastructure, health care, economic conditions, and all aspects of living other than those covered by other concerns?

"Mood" = Composite of the above, weighted by the importance of each, which is generally different for each group in each neighborhood.

- A large collection of expert-system rules drives changes
  - Civilian casualties
  - Environmental emergencies (lack of water or food, disease,…)
  - Curfews, checkpoints, military patrols, etc., including CMO
  - Some of the rule sets are quite sophisticated (e.g. distrib. food)
- Example: Civilian Casualties rule set
  - Changes in satisfaction levels =

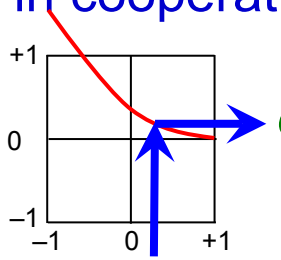


# of casualties

mult × **AUT** **L–** **–7.5%** **SFT** **XL–** **–10%** **CUL** **QOL** **L–** **–7.5%** × *distances from current level to –100*

  - Change in cooperation with the group causing the casualties =

mult ×



horizontal relationship

enmore × **COOP** **M–** **–5%** × *distance from current level to 0*

  - Social networking parameters for *here, near, far* are 1.0, 0.25, 0.1.

Economics Model

- Core: A computable general equilibrium (CGE) model
  - Methodology has been developing since 1960 (w Nobel Prizes)
  - CGEs are routinely used by governments in policy formation
    - » But we must include black markets and subsistence agriculture
  - A social accounting matrix (SAM) calibrates model parameters
    - » Historical data may be of questionable applicability
      - ❖ "Shape" can be inferred from nearby regions and recent times
      - ❖ "Size" is driven by demographic model results

- But, "equilibrium"? In an S&RO environment?!
  - Interpret value flows as rates, not annual amounts
  - Model all slow and delayed phenomena outside of the CGE
  - Only assume prices, production rates, jobs reach equilibrium
  - Multiple passes produce latent demand,
    hence unemployment and shortages.

- Current 3-Sector Model
  - Purpose: Wring out implementation & interface issues
  - Sectors
    - » All the goods in the region
    - » The populace — workers and consumers
    - » The rest of the world
  - Production capacity factor for each neighborhood
    - » Effects of collateral damage
    - » Effects of displaced civilians, in camps or not in camps
  - Observable effects
    - » Unemployment
    - » Shortages of goods
    - » GDP, CPI, and the Average Wage
  - Major shortcoming
    - » The region's economics are not isolated from the rest of the world.

- Planned 6-Sector Model
  - Sectors
    - » The international black market
    - » All other goods in the region
    - » The populace — workers and consumers
    - » Regional political actors
    - » The rest of the region
    - » The rest of the world
  - The black market funds many of the regional actors
    - » Politics model aggregates and disaggregates these funds
  - Isolating the region allows the user to study economic sanctions
  - Many nuances — such as taxes and tax-like payments — added.

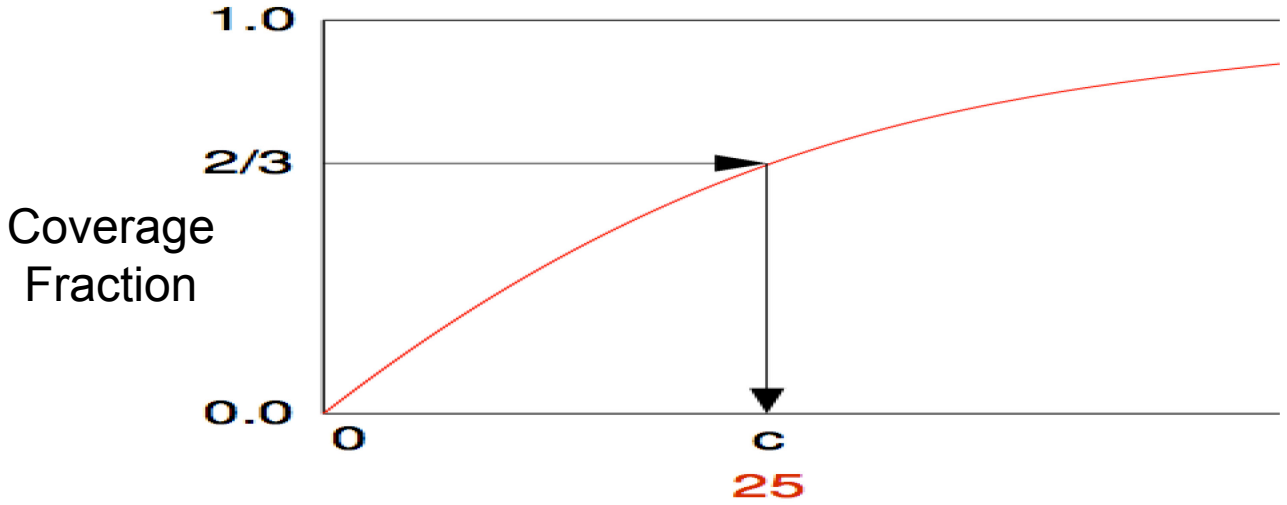
Demographics Model

- Everything is tracked by neighborhood group
  - Workers
  - Consumers
  - Subsistence agriculture
  - Displaced persons — some in camps, some not
  - Much more coming in later versions (maybe)
    - » Insurgency growth & depletion model
    - » Urban drift (and leaving of subsistence agriculture) model
    - » Workforce dependence on wages
    - » Wage distribution, poverty, and survival
    - » Births, deaths, infant mortality, ageing; youth bulge, and so on.

Physical Effects Model
(also known as "The Ground Model")

- What happens when actors use their assets
- Production capacity by neighborhood
  - Later: Infrastructure models
    - » Investments, direct & collateral damage, maintenance & obsolescence
- Forces, security, volatility by neighborhood
  - *Force* is a group's physical ability to control the neighborhood
    - » Civilian population may dominate military forces
    - » But military force multiplier ranges from 8 (*criminal*) to 25 (*regular*)
  - A group's *security* determines what it can do in the neighborhood
  - Neighborhood *volatility* is the likelihood of spontaneous violence.

- Force Group Activities
  - Are assigned by actors as tactics
    - » Mere *Presence* also affects civilian attitudes
  - A wide range of activities are available
    - » 8 kinds of civil-military operations
    - » Patrolling, guarding, PSYOP, checkpoints, curfews, coercion, crime
  - Activity-dependent minimum security is required
  - Effectiveness of additional personnel decreases with density



- Organization Group Activities
  - Construction, education, health care, etc.

- 19 Environmental Situations
  - Essential service shortages and outages
  - Disaster, disease, epidemic
  - Damage to cultural or religious site
  - Minefield, unexploded ordnance

- Armed Conflict
  - Uniformed forces hunting non-uniformed forces
  - Non-uniformed forces ambushing uniformed forces
  - Improvised Explosive Device (IED) attacks
  - Effects depend on coverage fractions, rules of engagement, civilian cooperation, force group security
  - Collateral damage affects attitudes, cooperation, influence
  - Later: Conflicts involving civilians.

Information Model

- Currently, all the participants know ground truth
- Role of the Information Model: To allow actors to use their information assets to affect perceptions of reality
  - Modeling the effects of efforts to “spin” or distort the truth should be an interesting challenge…
  - Civilian morale is not the same as their saliency-weighted average satisfaction with respect to the fundamental concerns
- Texas A&M University is working with us to adapt their model of the civilian information infrastructure (CII)
  - Ownership/control of information assets
  - Coverage of neighborhood groups by actors via the CII.

Planned Future Enhancements

The following list is neither prioritized nor complete

- Implement the 6-sector CGE
- Infrastructure Models
  - Civilian information infrastructure first?
  - Essential services infrastructures next?
  - Consider investment, collateral damage and repair, depreciation
- Information Operations Model
- Coercion Tipping Point Model
  - And others originated at the Naval Postgraduate School
- Force Group Recruitment and Desertion
  - From Old Dominion University's Insurgency Growth Rate Model
- More Armed Conflict Cases (e.g., involve civilians)
- Enrich the Demographics Model (e.g., The "Y Factor").

Is there time for questions?

Is Athena a Systems Dynamics Model?

BLUF: No, but it *is* a model of a dynamic system!

- Systems Dynamics is a powerful modeling paradigm
  - Supporting software facilitates use of influence diagrams
    - » Size is limited (in practice, not in principal) by the need to comprehend the diagram in its entirety
      - ❖ There are notable exceptions—e.g.: "The Hairball that Stabilized Iraq"
    - » Influence diagrams encourage modelers to think they are done before they model structural relationships
    - » There is a tendency to use overly simplistic variables that have no good metrics, such as *governance, economics,* and *gov't capacity*
  - SD stock-and-flow models concentrate on flows & feedbacks
    - » Modelers often omit mitigating factors
      - ❖ They do not allow participants in the model to realize what is happening and take corrective action
    - » *Nature* may be random; but an *enemy* is actively trying to win
- SD can be very useful for relatively simple complex problems.