**Athena User's Guide**

Athena S&RO Simulation, V3

December, 2011

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# Introduction

This document presents the models and software of the Athena 3.1 Stability & Recovery Operations (S&RO) Simulation from the user’s point of view. Users are advised to read this document before moving on to the other Athena documents.

The Athena simulation is a decision support tool designed to allow a skilled analyst to consider the intended and unintended consequences of various courses of action that might be taken during Stability & Recovery Operations. Athena contains models descended from the Joint Non-Kinetic Effects Model (JNEM), and includes many new models and other changes. In addition, where JNEM is a federated simulation, Athena is a stand-alone single-user application.

The intent of Athena’s models is first to capture and make explicit a wide variety of first order causal links, each of which makes sense on the face of it, and secondly to present the second and third order consequences of events while preserving the causal chain.

Everyone is familiar with the story of the ten blind men and the elephant. The goal of Athena is to model each of the elephant’s parts, and to link them together so that the man who has the elephant by the tail is sure to get thwacked by the elephant’s trunk (not to mention everything in between) and so must pay attention to the entire elephant.

## Overview of This Document

This document covers four major topics.

* Sections 2 through 8 describe the Athena models and philosophy at a conceptual level; those interested in more detail can see the low-level model descriptions in the *Athena Analyst’s Guide* and other documents.
* Sections TBD through TBD describe the Athena application itself: the parts of the application, how to enter scenario data, how to run the simulation, and how to find the results.
* Sections TBD through TBD contain a cookbook of how to make use of Athena’s models and inputs for particular problems.
* Sections TBD through TBD contain reference information, including a complete glossary of terms. Detailed reference information can be found in the Athena application’s on-line help.

## Other Documents

In addition to this user’s guide, Athena is delivered with the following documents:

*Athena Analyst’s Guide*

This document contains a detailed, low-level description of the models used in Athena; it serves as the specification document for the implementation of the models in the Athena code. Consult it when you need to know more about the models than is contained in this user’s guide.

*Mars Analyst’s Guide*

Mars is an infrastructure layer that is shared with the Joint Non-kinetic Effects Model (JNEM). The *Mars Analyst’s Guide* can be thought of as an appendix to the *Athena Analyst’s Guide* that describes the models that happen to be implemented in the Mars code base, including the Generalized Regional Attitude Model (GRAM) and the Mars Affinity Model (MAM). The former tracks direct and indirect effects on civilian attitudes; the latter models belief systems and the resulting affinities between actors and groups.

*Athena Rules Document*

This document describes the events and situations (drivers) that affect civilian attitudes in more detail than does this user’s guide, and also details each of the Driver Assessment Model (DAM) rule sets that assess the attitude change caused by the drivers.

*Athena On-line Help*

The Athena application includes extensive on-line help; see the **Help** menu in the application’s main menu bar. The most detailed reference information for the Athena software is found in the on-line help.

When Athena is installed on Microsoft Windows, these documents are available from the Athena folder on the Start Menu. Alternatively, go to the Athena application directory and open “docs\index.html” in a web browser. Documentation can also be obtained directly from the Athena Project; contact William.H.Duquette@jpl.nasa.gov.

## Changes for Athena 3

In its conception, Athena was intended to be a single-user version of JNEM customized and extended to be a decision support tool for courses of action in the S&RO environment. JNEM depended on an external federation of simulations for much of its simulation input, e.g., combat, civilian casualties, presence and location of military forces, and so forth. Athena versions 1 and 2 relied on the analyst for much of this input as the simulation ran. In particular, the analyst was expected to run Athena forward in short one month to three month time steps; at each pause, the analyst was to role play each of the relevant actors in the region, make appropriate inputs and adjustments, and then advance time again. This placed a great burden on the analyst.

The big change in Athena 3 is the addition of actors and their strategies. By defining the relevant actors and their strategies, the analyst can set up a complete scenario, and then let the modeled actors respond to the changing conditions. It is still possible for the analyst to pause frequently and make course-corrections if desired, but this is no longer an essential feature.

More specifically, in Athena 3 we have:

* Added actors and their strategies (goals, tactics, and attached conditions)
* Added the notion of *belief systems*; comparison of belief systems is the basis for the model of inter-group and group/actor relationships.
* Added a model of actor support, influence, and control of neighborhoods.
* Added a model of Essential Non-Infrastructure Services, which uses a new paradigm for driving attitude change.
* Revised the user interface:
  + Separated Scenario Mode from Simulation Mode. The data presented is now appropriate to the task being done. In particular, data populated only during simulation is now longer visible during scenario preparation.
  + Added the Detail Browser, a web-browser-like window for browsing the scenario and the simulation results.

# Athena Model Overview

Athena is a collection of many models that involve the relations and interactions between a number of kinds of simulation object. This section gives a brief overview of the most important kinds of simulation object, and of the six major modeling areas. The various kinds of simulation object are documented in detail in Section 9; the modeling areas and the models they contain are described more fully in Sections 3 through 8, and are documented in detail in the *Athena Analyst’s Guide*, *Mars Analyst’s Guide*, and *Athena Rules* documents.

## The Simulation and its Objects

At its highest level, Athena models the actions taken by significant decision makers, called *actors*, within a region of interest, called the *playbox*. The playbox is divided into sub-regions, called *neighborhoods*. Each neighborhood is inhabited by some number of civilians, who are divided into *civilian groups*, and who form both the consumers and the labor force in the *local economy*.

The actors attempt to control, aid, or otherwise influence the civilians in the neighborhoods by means of their actions, which are called *tactics*. Executing tactics requires *assets*, of which there are two kinds: money and personnel. Each actor has an income, and may also own bodies of personnel, e.g., army troops, police forces, humanitarian relief organizations, and so forth. These are called *force groups* or *organization groups*, depending on the nature of the group. By attaching *conditions* to tactics, an actor can determine when and under what circumstances tactics are used. The collection of an actor’s tactics and conditions is called the actor’s *strategy*.

The civilian groups have *attitudes*: satisfaction or dissatisfaction with respect to particular, and a willingness or unwillingness to cooperate (i.e., share information with) members of force groups. These attitudes vary over time in response to the events and situations that occur in the simulation, including those triggered by the actors’ actions.

In addition, civilian groups can *support* actors to a greater or lesser degree. Support is based upon shared or compatible beliefs, but is also affected by actors’ actions and by conditions in the civilians’ neighborhoods. Members of force and organization groups also support the actor to whom the group belongs. Actors may use the support they receive, or lend it to other actors. An actor with sufficient support in a neighborhood is said to have *influence* in the neighborhood; and an actor with sufficient influence may *control* the neighborhood.

Thus, we have the following feedback loop:



The actors’ actions determine the situation on the ground, which in turn affects civilian attitudes. This in turn affects civilian support for the actors, which can cause a change in which actor controls each neighborhood. That political situation then drives the actors’ actions. There are, of course, smaller feedback loops within this one; for example, an actor can increase his support in a neighborhood by moving a significant military force into that neighborhood. The force supports him, possibly enough so that he gains control, bypassing (at least temporarily) civilian attitudes altogether. Similarly, there is a feedback loop from the situation on the ground back to the actors’ actions—even politicians look at more than just the latest polls. But at a high level, this is the dynamic that drives Athena execution.

The primary outputs at the end of an Athena run are these:

* The actor in control of each neighborhood
* The stability and security of each neighborhood
* The civilian groups’ attitudes about the state of the playbox
* The resources decisions required by each actor to bring about this end state.

Thus, Athena can be used both to analyze an existing political situation and to assess the results of various courses of action designed to change it, from the point of view of any or all of the actors involved.

## The Six Modeling Areas

Athena’s models fall loosely into six broad areas; the borders between these areas are often fuzzy, and some of the Athena models straddle them. The six areas are as follows:

**The *Ground* Area**

Literally, where things are on the ground, the things they are doing, and what is happening to them as a result. (Section 3)

**The *Demographics* Area**

This area concerns where civilians live and how many of them there are, along with the computation of such population statistics as the number of consumers in the local economy. (Section 4)

**The *Attitudes* Area**

This area deals with the attitudes of the people in the playbox, especially their satisfaction and cooperation levels, but also their belief systems and the relationships between the various groups in the playbox. (Section 5)

**The *Politics* Area**

This area deals with actors and their strategies (goals, tactics, and attached conditions) along with the determination of support, influence, and neighborhood control. (Section 6)

**The *Economics* Area**

This area deals with the local economy, relating changes in population and production to the consumer price index (CPI) and the unemployment rate. (Section 7)

**The *Information* Area**

This area deals with information flow in the playbox, and especially the effect of information flow and information campaigns on attitudes and politics. (Section 8)

The models in each of these areas are inter-related: every area depends on inputs and outputs from the other areas, as shown in the following figure. It is necessary to track all of them to get a complete view of the simulation.



Each of these areas and the models contained within it are described in the referenced sections; for full details on the models, see the *Athena Analyst’s Guide*, *Mars Analyst’s Guide*, and *Athena Rules* documents.

There is a chicken and egg problem here: to understand the models, it is necessary to understand the objects (neighborhoods, groups, etc.) they use; but it is difficult to discuss the objects without describing the models that use them. Because the models are described in detail elsewhere, but the objects are described in detail in the reference sections of this document, we will take the chicken firmly by the horns and discuss the models first. The reader may find it useful to skim the simulation objects reference (Section 9) before proceeding.

# Ground

The Ground Area is quite literally concerned with what is happening on the ground: where people are, and what they are doing, and the results of their actions. It includes:

* The breakdown of the playbox into neighborhoods and the relationships among the neighborhoods.
* Where civilian, force, and organization personnel are located
* The activities that they are performing, including combat activities
* Neighborhood security levels
* Activity coverage
* Environmental situations
* Essential Non-Infrastructure (ENI) services
* The Athena Attrition Model (AAM)
* Where production capacity is located.

Events and situations occurring in the Ground Area affect civilian attitudes, and the demographics and production capacity of the playbox and hence the economy as well. Actors base their decisions on the state of affairs in the playbox.

## Simulated Time

Athena measures the passage of time in integer days. It is a time-step simulation, with a step-size of one day; however, most simulated happenings take place week-by-week, e.g., combat attrition is assessed once each week.

## The Playbox

The playbox is the geographic area in which the simulation takes place. It is modeled as a collection of polygonal regions called *neighborhoods*, which are laid out on a map. In Athena 3, the neighborhoods are simply convenient bins for collecting simulation objects that are near each other; the layout of neighborhood polygons on a map is simply an aid to visualization.

### Neighborhoods

Almost everything that happens in Athena takes place in the context of a neighborhood. Civilian groups reside in neighborhoods; force and organization group personnel are deployed to neighborhoods; personnel and actors act in neighborhoods; attitudes and output statistics are measured in neighborhoods.

Neighborhoods can be of any size, from portions of a city (neighborhoods in the proper sense of the word) to entire cities, counties, districts, provinces, countries, or groups of countries. Neighborhoods can nest, i.e., a neighborhood representing a city can be placed on top of a neighborhood representing a province.

Each neighborhood can be more or less urbanized, and can contain more or less of the playbox’s economic production capacity.

### Neighborhood Proximity

Neighborhoods are simply bins; the geographic layout of the neighborhoods on the map has no effect, in and of itself, on the simulation results. It is clear, however, that some neighborhoods are more closely related than others. Because this is a social distance, not a physical distance, we model it directly rather than deriving it from the geography.

We call this social distance *neighborhood proximity*; it is defined as the distance between two neighborhoods from the point of view of the residents of the first neighborhood. More specifically, we say that with respect to neighborhood A, neighborhood B is near, far, or remote. The degree to which A is affected by events in B tapers off with distance, and is zero if B is remote.

Proximity need not be symmetric. If neighborhood A contains popular destinations, it might be considered nearby by neighborhoods which its residents consider to be far away.

### Neighborhood Effects Delay

Events and situations occurring in the Ground Area drive attitude change. Such drivers usually have a direct effect in a single neighborhood, but may have indirect effects in other neighborhoods. Athena 3 allows these indirect effects to be delayed by some number of days, to reflect the spread of the news across the playbox.

This portion of the model was inherited from JNEM, and makes good sense in a scenario where events are occurring minute by minute, hour by hour. In Athena, events take place day by day, and more usually week by week. The effects delay makes much less sense at this timescale, and in an era of modern communications and transport; consequently, it is likely to be removed in a future version.

### Local vs. Non-Local Neighborhoods

**TBD: Should this go in the Economics section?**

Athena assumes that the neighborhoods that make up the playbox are more or less and contiguous and have a single more or less unified economy. Sometimes, however, it can be convenient to include neighborhoods neighborhoods in the scenario that are outside the economy. Pakistan is greatly affected by the decisions made by actors in India, for example; in a scenario involving the inner workings of Pakistan, it might be desirable to include India as a neighborhood while excluding India from the modeled economy. Thus, we can mark neighborhoods as *local* (participants in the local economy) or *non-local* (excluded from the local economy).

### Production Capacity

**TBD: Should this go in the Economics section?**

The Economics model assigns production capacity (e.g., factories, farms, and other businesses) to neighborhoods at time 0 based on the size of the economy in dollars and the size of the labor force in each neighborhood. Each neighborhood is then assigned a production capacity factor (PCF) of 1.0 that reflects this initial production capacity. The PCF of a given neighborhood can be increased or decreased over time by actors or by the analyst to reflect construction of new facilities or damage to infrastructure, thus increasing or decreasing the production capacity of the economy as a whole.

Note that the costs associated with repairing, replacing, or building new production capacity are not modeled, nor is the nature of the required plant or the training of the labor force.

## Deployment

Every person in the playbox has to be somewhere, i.e., has to be located in some neighborhood. Civilians are simply located in their home neighborhoods (unless displaced; see Section 3.4); force and organization group personnel need to be *deployed* to particular neighborhoods.

As the simulation progresses, deployment is determined by the tactics chosen by the actors; see Section 6. It is also necessary to know where force and organization group personnel were located prior to the start of the simulation; this is called the *status quo deployment*, and is a scenario input.

Troops are deployed by their owning actors during strategy execution, and remain in place throughout the week until the next strategy execution.

## Activity Assignment

Force and organization group personnel deployed to a neighborhood can be assigned activities in that neighborhood: patrolling, guarding, law enforcement, various kinds of humanitarian relief, and so forth (see Section TBD for the complete list, and a description of each). These activities affect the attitudes of the civilian population. Activities are assigned by the actors during strategy execution, and like deployments take place over the following week.

Civilians are displaced by assigning them the **DISPLACED** or **IN\_CAMPS** activities, which are assigned not by actors but by the System agent; see Section TBD.

## Units

All deployed personnel, and all civilian personnel, are placed in *units*. The name derives from the classic military term; in Athena it simply means a collection of personnel belonging to the same group and assigned the same activity. Units have no distinctive or long-running identity; they are created during strategy execution and represent the location and activity of group personnel over the following week. If personnel from force group A are deployed to neighborhood B, and assigned various activities, then A will have at least one unit for each activity, plus an additional unit for those personnel that remain unassigned.

Units are useful for visualization; and many of the subsequent models in the Ground Area operate on units.

## Security and Volatility

# Demographics

The Demographics Area is closely tied to the Ground Area, as it is concerned with how many civilians there are and where they live. The Demographics model proper is responsible for determining the current population (by group, neighborhood, and playbox), as well as the size of the labor force, the number of consumers in the local economy, and similar population statistics. In addition, the Demographic Situation (demsit) model determines the effects of unemployment on each civilian group, which in turn drives attitude change.

## Base Population

The population is divided into civilian groups (Section TBD); each civilian group resides in a neighborhood. At time 0, each civilian group has an initial or *base* population. The base population of the neighborhood is simply the total across the civilian groups, and the base population of the playbox is simply the total across the neighborhoods. Note that we also track the total population of local neighborhoods (Section 3.2.4), because that figures into the Economics Area.

## Current Population

The *current population* of civilian groups and of neighborhoods can change over time. Athena does not model births or natural deaths, but it does model deaths due to civilian collateral damage (Section TBD). The Demographics model tracks attrition to date, subtracting it from the current population. In addition, civilian group personnel can be *displaced* to other neighborhoods (Section TBD), which removes them from the current population of their group and neighborhood, and adds them to the current population of the neighborhood to which they are displaced.

## Subsistence Agriculture

Civilian personnel can support themselves by *subsistence agriculture* or by participating in the local economy. In Athena 3 there is a hard line between the two: any given person is in one subset or the other. The percentage of each civilian group that lives by subsistence agriculture is a scenario input.

When civilians belonging to a group are displaced from their home neighborhood, it is presumed that subsistence and non-subsistence personnel are displaced in proportion to the size of the two subsets within that group. If they later return to their homes, they resume their previous ways of life.[[1]](#footnote-1)

Because subsistence personnel do not (by definition) participate in the local economy, they are neither consumers nor members of the labor force. As a result, they are not directly affected by high unemployment rates.

## Consumers and Workers

All non-subsistence-agriculture personnel are presumed to be *consumers* in the local economy;[[2]](#footnote-2) the total number of consumers drives the size of the economy.

In each group, only a percentage of the consumers (nominally 60%) are members of the *labor force*. For civilians displaced from their homes, whether they remain within their own neighborhood or are displaced to another neighborhood, the percentage drops to 40%. Displaced civilians who are settled in camps do not contribute to the labor force at all.

## Demographic Situations

*Demographic situations* are situations detected by the Demographic model that affect the attitudes of the civilians. Athena 3 defines only one demographic situation, or “demsit”, the Unemployment situation.

The unemployment rate is computed for the entire playbox by the Economics model. It affects civilian groups in proportion to the number of workers in each group. Given that, high unemployment affects civilians in two ways:

* Directly, by economic hardship to members of the group. Groups with a high Subsistence Agriculture Percentage are relatively immune to this.
* Indirectly, by the presence of numbers of unemployed workers in the neighborhood.

See the *Athena Rules* document for specifics.

# Attitudes

The *Attitudes Model* deals with the attitudes of the people in the playbox, and particularly:

* The belief systems of each of the actors and civilian groups
* The vertical relationships between groups and actors
* The horizontal relationships between groups
* The satisfaction of the civilian groups with respect to various concerns
* The cooperation (i.e., willingness to share information) of the civilian groups with respect to the force groups.
* Assessment of the effects of events and situations in the other models on the attitudes.

Note that the term *attitudes* properly applies to satisfaction and cooperation levels, which are managed by the Athena Regional Attitudes Model (ARAM). However, the relationships (which derive from the belief systems, among other things) are also attitudes in a wider sense.

# Politics

The *Politics Model* deals with actors and their strategies (goals, tactics, and attached conditions) along with the determination of support, influence, and neighborhood control. As described above in Section 2, the interplay of actor’s strategies being executed over time is the engine that makes Athena run.

# Economics

TBD

# Information

# Athena Objects

An Athena scenario consists of a collection of related objects created by the analyst, upon which the Athena models operate. This section describes the objects and their data attributes in some detail; we suggest that the reader skim this section on first reading, and then go on to the model areas, returning to this section for details as needed.

## The Playbox

1. This is not realistic; displaced subsistence farmers usually lose their land and livestock, and hence cannot easily go back to subsistence agriculture. [↑](#footnote-ref-1)
2. Except, of course, in non-local neighborhoods. The number of consumers and laborers in these neighborhoods is ignored. [↑](#footnote-ref-2)