**Athena User's Guide**

Athena S&RO Simulation, V3

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**Table of Contents**

1. Introduction 4

1.1 Overview of This Document 4

1.2 Other Documents 4

1.3 Changes for Athena 3 5

2. Athena Model Overview 7

2.1 The Simulation and its Objects 7

2.2 The Six Modeling Areas 8

3. Ground 11

3.1 Simulated Time 11

3.2 The Playbox 11

3.2.1 Neighborhoods 11

3.2.2 Neighborhood Proximity 12

3.2.3 Neighborhood Effects Delay 12

3.2.4 Local vs. Non-Local Neighborhoods 12

3.2.5 Production Capacity 13

3.3 Deployment 15

3.4 Activity Assignment 16

3.5 Units 16

3.6 Volatility and Security 16

3.7 Coverage 18

3.8 Activity Situations 18

3.9 Environmental Situations 19

3.10 Athena Attrition Model 20

3.10.1 Rules of Engagement 20

3.10.2 Presence and Intelligence 20

3.10.3 Attrition Assessment 21

3.10.4 Magic Attrition 21

3.11 Essential Non-Infrastructure (ENI) Services 21

3.11.1 The Notion of a Service 21

3.11.2 Services vs. Environmental Situations 23

3.11.3 Measurement of ENI Services 23

3.11.4 Required Level of ENI Services 23

3.11.5 Status Quo ENI Funding 23

3.11.6 Effects of ENI Services 24

4. Demographics 25

4.1 Base Population 25

4.2 Current Population 25

4.3 Subsistence Agriculture 25

4.4 Consumers and Workers 26

4.5 Demographic Situations 26

5. Attitudes 27

5.1 Belief Systems and Affinities 27

5.2 Horizontal Relationships 27

5.3 Vertical Relationships 27

5.4 Satisfaction Levels 27

5.5 Cooperation Levels 27

5.6 The Driver Assessment Model (DAM) 27

5.7 Magic Attitude Drivers 27

6. Politics 28

7. Economics 29

8. Information 30

9. Athena Objects 31

9.1 The Playbox 31

# 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 several 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.

# 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.

## Actors

*Actors* are significant decision makers in the playbox. Depending on the needs of the scenario, an actor may be an individual, a committee, a small group, a ruling body, or an entire country. The essential point is that an actor has:

* Goals it wishes to achieve
* A strategy for achieving them
* Assets to use to achieve them.

In Athena 3, actors have income, which can be spent in a variety of ways, and can own force and organization groups which they can make use of.

Actors can have different domains—military, political, economic, cultural—and although these domains are implicit in the actor’s assets and strategies rather than explicit in the model, they are no less important for all that.

Most actors participate in the political process, seeking control of neighborhoods or supporting those who do. Organization groups, which usually do not play politics in the playbox, are often owned by a “pseudo-actor”, an actor that supports no one politically and exists only to hold the strategy that determines organization group behavior.

There is an additional pseudo-actor, or *agent*, the **SYSTEM** agent. The **SYSTEM** agent is not an actor, and cannot be involved in politics; however, it does have a strategy, which allows the analyst to set up various events and situations to occur when conditions in the simulation are right. In particular, the **SYSTEM** agent is responsible for displacing civilians to other neighborhoods.

## Groups

Athena represents masses of human beings as *groups*. There are three kinds: *civilian groups*, *force groups*, and *organization groups*. Every group has a demeanor, **apathetic**, **average**, or **aggressive**, that indicates its propensity for violence.

### Civilian Groups

The population of the playbox is broken down into a number of *civilian groups*. Each civilian group resides in a particular neighborhood, and has a *belief system* that gives it its identity (Section 5.1) and determines how it relates to other groups and actors. It also has greater or lesser *satisfaction* with the current state of affairs, and a greater or lesser *cooperation* with (willingness to give information to) the actors’ various force groups (Sections 5.4 and 5.5). Civilian groups support actors to a greater or lesser degree; ultimately, any successful actor must either derive his power in a neighborhood from the resident civilians, or expect to keep a significant body of troops in place.

In JNEM, and in earlier versions of Athena, it has been usual to think of civilian groups in ethnic terms, as clans, tribes, or related groupings of such. At the beginning of the Athena project, in particular, we expected each group to be a stovepipe containing individuals from cradle to grave. In Athena 3, by contrast, groups are collections of people living in the same area who share a belief system. When an ethnic grouping contains significant divisions, e.g., a “generation gap”, it may be prudent to split the ethnic grouping into multiple groups. Similarly, if a particular belief system cuts across ethnic groups, it may be wise to treat it as a single group.

At present, individuals cannot move from one group to another group. In future versions of Athena we might support this, as a way of indicating the erosion of one belief system in favor of another.

### Force Groups

A *force group* is an organized group of personnel intended to project and use force in a neighborhood. Force groups belong to actors, and do their bidding according to the actor’s strategies. In particular, an actor can increase his support in a neighborhood by moving his troops into that neighborhood. There are five kinds:

* Regular military
* Irregular military (e.g., militias)
* Paramilitary (e.g., SWAT teams, militarized police forces)
* Police
* Criminal

Each force type has a different force multiplier; regular military, for example, is much better at projecting and using force than normal police.

Force groups can carry out military duties of various kinds, and can also participate in humanitarian relief efforts (Sections 3.5 and 3.11.1).

Each force group starts the scenario with a certain number of troops, which can increase and decrease as the simulation runs. At present, force groups cannot recruit from the civilian population, though this is an area in which we are actively working.

Force groups do not have belief systems of their own; rather, they inherit them from their owning actors.

### Organization Groups

Organization groups are similar to force groups, but have some mission other than the projection and use of force. There are three kinds:

* Non-Governmental Organizations (NGOs), e.g., Doctors Without Borders
* Inter-Governmental Organizations (IGOs), e.g., UNESCO
* Contractors, e.g., Halliburton

Like force groups, members of organization groups can be assigned activities in neighborhoods, though they are limited to humanitarian relief activities of various kinds. In principle organization groups can support the political goals of actors by their presence in one neighborhood or another; however, organization groups are usually owned by pseudo-actors who are not politically active.

## 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.

Force and organization group activities have security requirements; a body of troops might be tasked to do humanitarian relief of some kind, but if they have insufficient security in the neighborhood their efforts will be of no avail. (See Sections 3.6 and TBD.)

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.

## Volatility and Security

A neighborhood can be a safe or unsafe place to be for the people within it—and to a great extent, that depends on who they are and who is in the neighborhood with them. Athena computes two measures, the *volatility* of each neighborhood and the *security* of each group in each neighborhood.

Both depend on the personnel in the neighborhood and in nearby neighborhoods, and on their relationships with each other (see Section 5 for more on relationships).

First, each group in the neighborhood (whether civilian, force, or organization) can project a certain amount of force, given the kind of group it is and the number of personnel present. This is its power to defend itself. Civilian groups project minimal force per person, given that civilian groups include the very old and the very young, and many adults who are not inclined to project force. Force groups exist to project force, and do it rather better; their effectiveness depends on the kind of force they are. Regular military projects the most force per person. Of organization groups, only contractors project any force (private security guards)—more than civilians but less than any force group. (See Section TBD for more on the different kinds of group.)

But a group’s ability to defend itself does not depend solely on its own force—they may have friends to help them; and unless they have enemies they will not need to defend themselves. Athena totals up the force available to each group, including friends in the same neighborhood and (to a lesser degree) friends in nearby neighborhoods; and similarly it totals up the force available to the group’s enemies in the same neighborhood and (to lesser degree) in nearby neighborhoods.

The *volatility* of a neighborhood ranges from 0 to 100, and is a measure of how dangerous the neighborhood is to a random passerby given the degree of enmity present in the neighborhood, i.e., how likely a person is to get caught up in random violence that does not directly concern him.

Danger to a group comes from its enemies and from the kind of random violence measured by volatility. We capture this as the *security* of the group in the neighborhood. Security is an abstract measure ranging from -100 to 100. For actual use we convert it to a qualitative measure (high, medium, low, or none), or to a multiplicative factor using a Z-curve function.[[1]](#footnote-1)

In Athena 3, *volatility* is primarily a component of *security*, whereas *security* affects many things, including:

* Whether force and organization groups can carry out particular activities in a neighborhood.
* The degree to which groups can actively support the actors of their choice.

The addition of a military force to a neighborhood can greatly change the security of all groups in the neighborhood. In Athena 3, this change is due purely to the number of troops and the relationship between the force group and the other groups in the neighborhood: the security of the force group’s enemies will decrease, and the security of the force group’s friends will increase.

Consequently, further work needs to be done here; a force assigned peacekeeping duties should have a different effect than a group intending rapine and pillage.

## Coverage

*Coverage* is a measure, from 0.0 to 1.0, of the fraction of a neighborhood or group affected by some situation. The notion of coverage is used in a number of places in Athena:

* Environmental situations are assigned a coverage when they are created. (Section 3.9)
* Coverage is computed for the mere presence of a military force deployed in a neighborhood.
* Coverage is computed for activities assigned to groups of all kinds. (Section 3.4)

For environmental situations, the coverage is simply an input. For presence and activities, it is a function defined by the number of troops required to achieve 2/3rds coverage given the size of the population. For presence, for example, presence coverage is 2/3rds when there are 25 troops present for each 1000 people in the civilian population. Coverage drops to zero when there are no troops present or engaged in the activity, and increases asymptotically to 1.0 as troops are added above the 2/3rds mark.

Assigned activities usually have a security requirement. If there are 25 troops per 1000 people assigned to do the “CMO – Healthcare” activity, but the security of those troops is low, they cannot carry out the activity effectively and hence the coverage of that activity by those troops is 0.0.

The coverage fraction is used as a multiplier in the relevant rule set in the Driver Assessment Model (Section 5.6); and presence coverage is used in a variety of places, most notably in the Athena Attrition Model (Section 3.10).

## Activity Situations

When a group is conducting an activity of a particular type in a neighborhood with coverage greater than 0.0, we have what we call an *activity situation*,[[2]](#footnote-2) or “actsit”. Activity situations are created when coverage exceeds 0.0, and are destroyed when coverage returns to 0.0. So long as the situation persists it will have affects on civilian attitudes as determined by the relevant rule set in the Driver Assessment Model; see Section 5.6 and the *Athena Rules* document.

Force and organization group activities can mitigate particular environmental situations, e.g., the “CMO – Healthcare” activity will have a greater effect on civilian attitudes when there is a “Disease” environmental situation in the neighborhood.

## Environmental Situations

*Environmental situations*, or “ensits,” represent problems in a neighborhood’s environment that adversely affect the resident civilians, e.g., power outages and food shortages; see Section TBD for the complete list.

Environmental situations are usually created by the analyst, or by actors using the **EXECUTIVE** tactic. An ensit will typically have a big negative effect on satisfaction on inception, a continuing negative effect so long as the situation persists, and a big positive effect when the situation is resolved.

The duration of an ensit can be set when the ensit is created; it can also be resolved explicitly by the analyst or by an actor using the **EXECUTIVE** tactic. Each ensit also has a coverage fraction, nominally 1.0, which can be decreased to decrease the ensit’s effects.

The effect of certain environmental situations can be mitigated by appropriate force and organization group activities, as indicated in the *Athena Rules* document.

The environmental situation model is one of the oldest parts of Athena, being adopted with minimal changes from JNEM. It was designed for five-day real-time training exercises with the intent of rewarding commanders for quick resolution and punish them for delayed or omitted resolution of the problems represented by the ensits. As such, it will tend to run “hot”; when ensits are used in an Athena scenario, the analyst should monitor them closely, and should consider using smaller coverage fractions to reduce the effects if they are overstated.

In the future, it is likely that many of the existing ensit types (e.g., power outages) will be replaced by service-oriented models like the current Essential Non-Infrastructure (ENI) Services model (Section 3.11), which is more suited to the Athena time frame.

## Athena Attrition Model

Athena was designed to support Stability and Recovery Operations (S&RO); i.e., to model regions in which the heavy metal force-on-force battles are over (or have not yet begun). Thus, Athena 3 does not model full-on force-on-force attrition. Rather, it deals with two kinds of conflict: the efforts of conventional uniformed forces to hunt down and kill non-uniformed insurgent/terrorist forces, and the efforts of these non-uniformed insurgents and terrorists to use guerilla tactics against the uniformed forces. Such combat results in attrition to the relevant forces, thus reducing their numbers in the playbox, and also in civilian collateral damage with the relevant effects on civilian attitudes.

In short, uniformed forces can seek to attack non-uniformed forces, and non-uniformed forces can seek to attack uniformed forces, neighborhood by neighborhood.

### Rules of Engagement

Whether force group A seeks to attack force group B in neighborhood N is determined by A’s rules of engagement (ROE), which are set according to the strategy of the actor that owns group A. Using the **ATTROE** tactic, the actor can direct that A may attack B in neighborhood N up to some number of times over the next week. If A is a non-uniformed group, then the actor may also specify whether A is to minimize its own losses or maximize damage to B.

In the current model, civilian collateral damage occurs when a uniformed force attacks a non-uniformed force, and when a uniformed force defends itself against attack by a non-uniformed force. Thus, uniformed forces also have a defending ROE in each neighborhood, which determined whether and how quickly they fire back at attacking non-uniformed forces. This directly affects the quantity of civilian casualties.

### Presence and Intelligence

Just because force group A has been directed to attack force group B in neighborhood N, it is not certain that it will be able to. Whether attacks occur or not depend on a number of circumstances:

* Both A and B must have troops in neighborhood N.
* The more troops A has, the more likely it is to be able to find and attack B.
* The more troops B has, the more easy it is to find.
* Intelligence, as indicated by the cooperation of the neighborhood with both groups, also plays a role.
  + If A gets better cooperation than B, it will have an easier time finding and attack B.
  + If A gets worse cooperation, then it will have a harder time.
  + If A is a non-uniformed force, then the expected losses must be acceptable, and this also depends on the quality of the intelligence received by A, as indicated by the neighborhood cooperation.

Cooperation is discussed in Section 5.5.

### Attrition Assessment

The number of successful attacks by all parties, and the resulting civilian casualties, are assessed at the end of each week just prior to the next strategy execution. The casualties are then given to the Driver Assessment Model (Section 5.6) so that the attitude changes can be assessed.

### Magic Attrition

The Athena Attrition Model does not address terror bombings, assassinations of political figures, or deaths due to other kinds of armed combat than those described above. And yet, these kinds of deaths occur. For this reason Athena provides the ability to do “magic attrition,” which can be initiated by the analyst, or by an actor or the **SYSTEM** agent using the **EXECUTIVE** tactic. Magic attrition can affect members of any group; and in particular, civilian casualties will be assessed by the Driver Assessment Model just like casualties resulting from the kinds of combat Athena *does* model.

Note that magic attrition should not be used for civilian deaths due to natural disasters, epidemics, or other causes that do not involve combat. For those kinds of things, the attitude effects should be handled by either environmental situations (Section 3.9) or magic attitude drivers (Section 5.7).

## Essential Non-Infrastructure (ENI) Services

Essential Non-Infrastructure (ENI) Services are services provided to civilians in a neighborhood by an actor, the absence of which causes hardship but which do not require substantial infrastructure to provide. Provision of services is controlled by the actor’s strategy, and can be targeted to specific groups in the neighborhood, ignoring others.

### The Notion of a Service

A service is something provided to the civilians (possibly by their own efforts, as enabled or supported by actors) that has a level that can increase or decrease over time. Examples are power service, postal service, communications, water supply, the court system and other governmental services, and the like (though not law enforcement, as that’s an assigned activity). We call the level of service for a particular service the *LOS*. For any given service there are four specific levels of service that are of interest:

**The Actual Level of Service (ALOS)**

How much of the service is the group actually receiving at the present time?

**The Required Level of Service (RLOS)**

How much of the service does the group need to live without significant hardship?

**The Expected Level of Service (ELOS)**

How much of the service is the group accustomed to getting?

**The Saturation Level of Service (SLOS)**

What’s the level of the service which saturates the demand? Once the civilians have all they want, they don’t care if more is available.

The units appropriate for measuring a particular the level of a particular service will vary from service to service.

The expected level of service will slowly approach the actual level of service over time; in other words, the civilians will eventually become accustomed to whatever level of service they receive. Expectations will rise more quickly than they will fall: we become accustomed to good things more quickly than we become resigned to bad things.

For example, in most of America ELOS for the power supply simply *is* the SLOS. We most of us have all the power we are willing to buy. If the power is out, we are immediately unhappy, and would takes us quite a while to get used even to power provided on a regular if intermittent schedule; but when the power goes back on, we get used to it with great rapidity.

Civilian attitudes improve when the ALOS is greater than expected (though not more than the SLOS), and worsen when the ALOS is less than expected, and especially if it is less than required.

There are four cases of particular interest:

* Case R-: Service is less than required
* Case E-: Service is less than expected
* Case E: Service meets expectations
* Case E+: Service is better than expected

Note that case R- trumps all of the others; and that case E+ can only occur if the expected level of service is less than saturation.

At the present time we have used this paradigm only for ENI services; we expect to make use of it for infrastructure-based services in the future.

### Services vs. Environmental Situations

As such, the service paradigm is an improvement over the Environmental Situation paradigm for services like the power system and the water supply. Using the power system for illustrative purposes, the ensit paradigm implicitly assumes that the ALOS is normally at its expected value, and that when problems occur it drops down to 0.0. Horrors ensue until the problem is resolved, at which point it service returns to its previously expected level.

In a long-run scenario, however, it is quite possible that the power service may be substandard (though not zero) for quite long periods of time. Power for 12 hours a day is much better than no power at all; and after a few weeks’ time, the civilians will begin to adjust to it (and the attitude effects will cease). If power then drops to 4 hours a day, they will again react negatively; but if it returns to 24 hours a day they will react positively.

We expect service-orient models to replace many of the existing ensit types as time goes on.

### Measurement of ENI Services

Actors provide ENI services to groups in neighborhoods by spending money on them using the **FUNDENI** tactic. No infrastructure is required, by definition; and we assume that every dollar spent translates (not necessarily linearly) into service provided.

For convenience, we measure the provision of ENI services to a group in a neighborhood as a fraction of the saturation level of service (SLOS) for that group: 0.0 implies no service, and 1.0 implies the saturation level of service. Then, we specify the saturation level of service by the per capita funding required to achieve it. If actors provide funding for more than the saturation level of service, the ALOS will be greater than 1.0.

### Required Level of ENI Services

The required level of ENI services is set in the model parameter database as a fraction of the saturation level of service, according to the urbanization level of the neighborhood.

### Status Quo ENI Funding

The level of ENI service provided to a particular group depends on the actor’s strategies; but how the actors execute their strategies depends on the current state of affairs, which includes some level of spending on ENI Services. Thus, we need to know the funding for ENI services prior to time 0; this is a scenario input called the *status quo ENI funding*.

### Effects of ENI Services

The current level of ENI services affects two things:

* Civilian satisfaction levels; see Section 5.6.
* The vertical relationships of civilian groups with actors; see Section 5.3.

In each case, the fundamental questions are whether the civilians are receiving the required level of service; and if so, whether they are receiving more or less service than they expect.

In terms of the vertical relationships, it also matters whether or not the actor providing the service has control of the group’s neighborhood; see Section 5.3 (and the *Athena Analyst’s Guide*) for details.

# 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.[[3]](#footnote-3)

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;[[4]](#footnote-4) 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 horizontal relationships between groups
* The vertical relationships between groups and actors
* 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 Generalized Regional Attitudes Model (GRAM) (see the *Mars Analyst’s Guide*). However, the relationships (which derive from the belief systems, among other things) are also attitudes in a wider sense.

## Belief Systems and Affinities

Every civilian group and actor has a *belief system*, a statement of the ideas and issues that are important to the group or actor, along with how important they are and how the group or actor feels about those who disagree. For a civilian group, the group’s belief system is the source of the group’s identity and the basis for its relations with all other groups. An actor’s belief system may indeed reflect the actor’s deeply held beliefs, or it may be a construct intended to garner support from the civilians.[[5]](#footnote-5)

Given the belief systems of two entities, A and B, we compute the *affinity* of A with B, and of B with A. The affinity is a number from 1.0 down to -1.0 that indicates whether A supports or opposes the same things as B. Note that affinity need not be symmetric.

All horizontal and vertical relationships in Athena are ultimately based on affinities, and hence on belief systems.

Belief systems and affinities are computed by the Mars Affinity Model (MAM), which is documented in the *Mars Analyst’s Guide*.

### Beliefs and Topics

A belief system consists of an entity’s beliefs about one or more topics. A topic is some value, principle, or issue about which there is some disagreement in the playbox. In Pakistan, for example, Islam is a significant fault line between the Pakistani citizens and the United States. Topics are chosen by the analyst; there is no default set.

A belief consists of two values, the entity’s *position* for or against the topic of interest, sometimes known as the *zeal*, and the entity’s *emphasis* on agreement or disagreement with that position. The former indicates how much the entity cares, and the latter determines how it feels about those who agree or disagree.

The position and emphasis are usually entered qualitatively, using the following values. For position, the entity may be:

* **Passionately For (P+)**
* **Strongly For (S+)**
* **Weakly For (W+)**
* **Ambivalent (A)**
* **Weakly Against (W-)**
* **Strongly Against (S-)**
* **Passionately Against (P-)**

The entity may put its emphasis on agreement or disagreement, as follows:

* **Agreement—Strong**
* **Agreement**
* **Neither**
* **Disagreement**
* **Disagreement—Strong**
* **Disagreement—Extreme**

If the emphasis is on agreement, the entity will tend to have a higher affinity with those entities with whom it agrees on this topic, while to some extent disregarding disagreements. If the emphasis is on disagreement, the entity will tend to have a lower affinity with those with whom it disagrees on this topic, while to some extent disregarding agreements.

Note that strong beliefs do not thereby imply a propensity to use violent action (though they may engender violent action in those groups that are so inclined). Propensity to violence is driven by a group’s *demeanor*; see Section 3.4. For example, I might be passionately in favor of chocolate ice cream, and greatly dislike anyone who passionately dislikes chocolate ice cream without being inclined to take violent action against the chocolate ice cream haters. It depends on my demeanor.

Levity aside, a strong position and emphasis on a topic *does* indicate some willingness to take action. It simply does not indicate a propensity for violence.

### Affinity

The affinity between two entities is computed by comparing their beliefs on each topic, and tallying the effects of their agreements and disagreements given their positions and emphases.

As stated above, affinity is a number from -1.0 to 1.0 that is used as the basis for computing relationships.

Affinity is computed when the scenario is locked and simulation begins; in Athena 3 it is constant thereafter. In future versions we expect to allow it to vary.

### Playbox Commonality

Selecting the relevant set of topics for a given playbox is more of an art than a science, and by the nature of things the tendency is to accentuate the negative—it is simply more easy to identified fault lines rather than the significant areas of agreement. When commonality is ignored, however, the resulting affinities tend to indicate that all parties concerned hate each other with a deep and abiding hatred.

The Mars Affinity Model handles this using the *playbox commonality* slider, a numeric factor nominally set to 1.0. We assume that the entities in the playbox have significant commonality, and in fact generally agree on about as many things as they disagree. More specifically, for each topic entered by the analyst, we add an implicit pseudo-topic of general agreement.

The number of these pseudo-topics is determined by the slider. If it is set to 1.0, there are as many pseudo-topics as real topics. If it is set to 2.0, there are twice as many; if it is set to 0.5, there are half as many. Moving the slider up and down will tend to move affinities up and down accordingly.

### Entity Commonality

The playbox commonality lets you establish the degree of belief that is generally common to all groups in the playbox. But in fact, different entities will share in that common pool of belief to different extents, and foreign groups and actors will often have significantly different beliefs. Consequently, each group and actor has an *entity commonality* slider: a number from 0.0 to 1.0 that indicates the extent to which the entity participates in the general consensus indicated by the playbox commonality. If the entity commonality is 1.0, the entity shares the general consensus completely; if 0.0, not at all.

Decreasing an entity’s entity commonality will tend to decrease the entity’s affinity with other entities.

## Horizontal Relationships

Every group, whether civilian, force, or organization, has a horizontal relationship with every other group. The relationship is represented as a number for -1.0 to 1.0, where 1.0 indicates that the groups are bosom friends (every group automatically has a relationship of 1.0 with itself) and -1.0 indicates that the groups are the bitterest of enemies. The realistic range is from about -0.8 to about +0.8.

In Athena 3, these relationships are simply equal to the relevant affinities, and are constant for the duration of the simulation. Force and organization groups do not have belief systems, but they are owned by actors that do; and for the purpose of computing horizontal relationships we simply presume that they inherit the belief systems of their owners.

This horizontal relationship is one of the most basic concepts in Athena, and has significant effects across the entire simulation.

### Relationship Overrides

Every computed horizontal relationship can be overridden by an analyst’s preferred value during scenario preparation.

## Vertical Relationships

Groups have vertical relationships with actors. Unlike horizontal relationships, which are bidirectional (though asymmetric), vertical relationships are unidirectional—that is, we measure each group’s relationship to each actor, but not the actor’s relationship to each group. Actors are what they do, and what they do is determined by their strategies, not by their affinities.

Like horizontal relationships, vertical relationships are measured from -1.0 to 1.0, a range which is often expressed qualitatively:

* Supports
* Likes
* Is Indifferent To
* Dislikes
* Opposes

Vertical relationships play a major role in the political model, for they are the basis for computing each actor’s support and influence and for the determination of neighborhood control (Section 6.2).

### Force and Organization Groups

Every actor has an affinity for every other actor, and every force and organization group is owned by an actor. A force or organization group’s vertical relationship with its owner is always 1.0, and its vertical relationship with any other actor is simply its owner’s affinity for that actor.

### Civilian Groups

The vertical relationship of a civilian group with an actor is rather more complicated, as it can vary dynamically as the simulation runs. It is based on the affinity of the group for the actor, but this is adjusted by a number of factors:

* Whether the actor is or is not in control of the group’s neighborhood
* How the group’s mood (see Section 5.4) has changed
* Whether and to what extent the actor is providing Essential Non-Infrastructure (ENI) services to the group

The baseline for assessing these factors is the start of the simulation; or, later on, the time at which control of the neighborhood last shifted—an actor newly in control is judged on the state of affairs on his watch, rather than his predecessor’s.

Future versions of Athena will probably take additional factors into account:

* Tactics chosen by the actor, and how they accord with the group’s belief system
* Changes in the group’s or actor’s belief systems, resulting in a change in affinity.

## Satisfaction Levels

Every civilian group has a sense of satisfaction or dissatisfaction with the state of affairs in the playbox. Satisfaction in this sense is not a feeling, *per se*, though we often use the language of feelings and take about the group’s “mood” or say that the group “likes” or “dislikes” some event or situation. Rather, dissatisfaction is the will to change the current state of affairs, and satisfaction is the will to preserve the current state of affairs.

Satisfaction is measured as a number from 100.0 to -100.0, where 100.0 is perfectly satisfied and -100.0 is utterly dissatisfied.

The initial satisfaction levels are set by the analyst during scenario preparation; once simulation begins they vary depending on the events and situations that occur (Section 5.6).

### The Four Concerns

We measure satisfaction on four axes, called the four *concerns*, also known as the four *soft factors*:[[6]](#footnote-6)

**Autonomy (AUT):** Does the group feel that it can maintain order and govern itself with a stable government and a viable economy?

**Safety (SFT):** Do members of the group fear for their lives, either from hostile attack or from collateral damage from force activities? This fear includes environmental concerns such as life-threatening disease, starvation, and dying of thirst.

**Culture (CUL):** Does the group feel that its culture and religion, including cultural and religious sites and artifacts, are respected or denigrated?

**Quality of Life (QOL):** QOL includes the physical plants that provide services, including water, power, public transportation, commercial markets, hospitals, etc., and those things associated with these services, such as sanitation, health, education, employment, food, clothing, and shelter.

### Saliencies

Each group has a *saliency* for each concern: a number from 1.0 to 0.0 that indicates how important that concern is to the group, where 1.0 is crucial and 0.0 is negligible.

### Group Mood

A group’s *mood* is the average of its four satisfaction levels, weighted by the group’s saliency for each concern. Mood is a convenient summary statistic, and is an input to a number of other models.

## Cooperation Levels

Civilian groups are more or less willing to share information with members of force groups. Following standard HUMINT terminology, this willingness is called *cooperation*, and each civilian group is said to have a *cooperation level* with respect to each force group. The cooperation level is a number from 0 to 100, and represents the probability that a member of the civilian group will give information to a member of the force group.

Like satisfaction levels, cooperation levels are initialized during scenario preparation and vary thereafter based on the events and situations that occur (Section 5.6).

Note that having a high cooperation does not imply that the civilian group will overtly aid the force group in any way—they might or might not.

## Trends and Thresholds

Each satisfaction and cooperation curve has associated with it an ascending trend and threshold, and a descending trend and threshold; these allow the curve’s value to regress to a mean value, or at least a mean range. A trend is simply a slope effect (Section TBD) that is applied to the curve each day; the ascending trend increases the level, and the descending trend decreases it. Each is associated with a threshold. If the current level is above the ascending threshold, the ascending trend is ignored; if the current level is below the descending trend, the descending threshold is ignored.

For example, it might be reasonable to assume that a group’s satisfaction with Quality of Life (QOL) is 0.0 in the long term: the civilians get used to current conditions and don’t think about them one way or another. This can be modeled by setting an ascending trend with an ascending threshold at or just below 0.0, and a descending trend with a descending threshold at our just above zero. The ascending trend will then drive the current QOL level up to 0.0 and stop, and the descending trend will drive the level down to 0.0 and then stop.

All trends default to 0.0, and thus have no effect.

## The Driver Assessment Model (DAM)

The *Driver Assessment Model* (DAM) is responsible for assessing the satisfaction and cooperation effects of the various events and situations that occur in the simulation, e.g., civilian casualties (Section 3.12.3) and activity situations (Section 3.10). Collectively, these events and situations are called *drivers*. Athena contains a rule set for each kind of driver; the rule set assesses the driver, and gives *level inputs* and *slope inputs* (see below) to GRAM, which tracks satisfaction and cooperation effects as they play out over time. These rule sets are documented in detail in the *Athena Rules* document.

### Level and Slope Inputs

A *level input* is a step change that takes effect over a short period of time, usually two days. A *slope input* is a slope (e.g., 5 points per day) that takes effect each day for the duration of a situation. Level inputs are usually used to model the effect of significant one-time events, and slope inputs are usually used to model the effect of on-going situations.

Both kinds of input have a *magnitude* which is applied to a particular curve.

### Direct and Indirect Effects

Every level or slope input targets a specific curve: group A’s satisfaction with QOL, or group B’s cooperation with group C. This is called the direct effect. But other groups are affected as well. If group A takes casualties, for example, the satisfaction of the other groups in the neighborhood will be affected as well. This is called an indirect effect, and it is usually modified by the relationship between the groups.

Indirect effects can occur in the same neighborhood, in nearby neighborhoods, and in far-away neighborhoods (see Section 3.2.2 for a discussion of neighborhood proximity). The spread of indirect effects is determined by the input’s *here factor*, *near factor*, and *far factor*, which is a simple multiplier of 0.0 to 1.0 applied to the magnitude of the indirect effect in the same neighborhood (here factor), in nearby neighborhoods (near factor) and in far-away neighborhoods (far factor). These factors are also commonly referred to as *s*, *p*, and *q*, respectively. The here factor, *s*, is 1.0 in all of the built-in rule sets, but may be set to other values by magic attitude drivers (Section 5.8). The near and far factors, *p* and *q*, are set in the model parameter database for all of the built-in rule sets; see the *Athena Rules* document for the default values, or query the model parameter database in the Athena application (Section TBD).

## Magic Attitude Drivers

The Driver Assessment Model’s rule sets cover a wide variety of events and situations, but they don’t cover everything; and in particular, they don’t cover one-of-a-kind events like the assassination of a government leader or the World Trade Center attack. *Magic Attitude Drivers* (MADs) allow the analyst to create rule sets “on the fly”. MADs can be created interactively by the analyst while the simulation is paused; alternatively, they can be created by an **EXECUTIVE** tactic. One way or another, they can affect both satisfaction and cooperation levels with both slope and level effects. See Section TBD for the mechanics.

# 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.

## Strategies: Goals, Tactics, and Conditions

## Support, Influence, and Control

# Economics

TBD

# Information

Information, its use, and its spread are crucial in the kinds of scenarios Athena has been designed to address. The Information Area includes the following:

* Command and control of troops and organizations
* The spread of information within the civilian population and across the playbox
* Intelligence received by force groups (and hence by actors) from the civilian population
* Information operations: propaganda and other media techniques intended to affect the perceptions of the people in the playbox, so as to:
  + Increase support for an actor
  + Decrease support for an actor
  + Skew the intel available to an actor, thus affecting the activities driven by it.

At present, Athena’s information modeling is fairly simple:

* GRAM tracks the cooperation (willingness to give information) of civilian groups with force groups; cooperation has a number of effects across the playbox, and especially on combat.
* GRAM includes a simple model of information flow across the playbox as it applies to attitude effects.

For the rest, information flow is implicit in Athena’s models. This is a major area for future work.

# 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. A piece-wise linear approximation to an S-curve. See the *Mars Analyst’s Guide* for details. [↑](#footnote-ref-1)
2. For the purposes of this section, both mere presence and assigned activities count as activities. [↑](#footnote-ref-2)
3. This is not realistic; displaced subsistence farmers usually lose their land and livestock, and hence cannot easily go back to subsistence agriculture. [↑](#footnote-ref-3)
4. Except, of course, in non-local neighborhoods. The number of consumers and laborers in these neighborhoods is ignored. [↑](#footnote-ref-4)
5. Cynical? Yes. Your point? [↑](#footnote-ref-5)
6. The Athena team invariably uses the term “concern”; our sponsors seem to prefer the term “soft factor”. [↑](#footnote-ref-6)