CAPRICORN: Using Intelligent Agents and Interoperable Simulation for supporting Country Reconstruction

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ABSTRACT
This paper proposes the development of conceptual models to used in a simulator for supporting operational planners in country reconstruction within complex scenarios affected by natural disasters, asymmetric warfare, crisis etc. The authors developed for this context a a special kind of IA (Intelligent Agents) driving CGF (Computer Generated Forces) able to consider the human aspects as well as the impact of social networks on this context as further development of their IA-CGF. In this paper the authors propose the general architecture of the simulator objects, in their structures, attributes and methods as required to model this kind of applications.

INTRODUCTION

Currently the existing mission environments propose new challenges to military operational planning; it emerge that there is no so much experience and/or support tools to support decision makers and not consolidated simulation models; in fact the current scenarios are characterized by new kinds of threats (i.e. terrorist attacks, information warfare etc.), new kinds of operations (such as country reconstruction peace keeping or stabilization and normalization operations) and they involve several not conventional actors both military and civilian (such as humanitarian organization, insurgents, guerrilla forces, terrorists, hackers, media warriors): due to this fact it emerge that a special attention need to be dedicated to operations that have a strong impact on the local population such as CIMIC (Civil Military Cooperation), PSYOPs (Psychological Operations), Country Reconstruction, Disaster Relief, Crisis Response Operations etc (Bruzzone, Massei, Caussanel 2006; Bruzzone et al.2010; Galula 2006).
The paper focuses on a new generation of CGF able to incorporate IA for reproducing the population behavior combining social network and individual reaction to the country reconstruction activities; by this approach it becomes possible to simulate complex scenarios and to evaluate the most effective decision to succeed considering the reaction/support of the population; obviously this aspect becomes even more critical in stabilization or normalization scenarios.
The authors developed this research within the CAPRICORN project (CIMIC and Planning Research In Complex Operational Realistic Network), sponsored EDA (European Defense Agency), for the development of capabilities in the complex and critical sector of Military Operation Planning, specifically for Not-Article5/San Petersburg Operations (Bruzzone, Frydman, Tremori 2009); in fact the CAPRICORN project get benefits of previous researches carried out by Simulation Team (Avalle et al.1999; Tremori et al. 2009; Bruzzone, Tarone 2011); in particular among the first application in defense of these concept the authors developed a first generation of Intelligent CGF and Objects within in the framework of a previous R&D Project (Research and Development) named PIOVRA (Polyfunctional Intelligent Operational Virtual Reality Agents) (Bruzzone, Massei 2007;). The model and results

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presented in this paper are unclassified, therefore any sensible information and data have been modified due to their confidential nature.

COUNTRY RECONSTRUCTION AND OPERATION AFFECTING THE LOCAL POPULATION: A COMPLEX SCENARIO

The success of country reconstruction deals with the capability to properly handle the relations with the population and local authorities (Bruzzone et al.2011); therefore there is currently a lack of resources for simulating these operation that requires deep capabilities in modeling and multidisciplinary approach; the authors are working currently to develop specific simulation tiles to cover these aspects such as CIMIC, PSYOPS and Country Reconstruction (Bruzzone, Frydman, Tremori 2009; Bruzzone, Madeo, Tarone 2010).

For instance CIMIC operations refer to an operative function that, combined with other operational areas (i.e. Command and Control, combat, support to combat, intelligence, logistics support etc) enable to support harmonic and effective development of combined operations focusing on the interaction among military forces and civil components in crisis areas; usually the main CIMIC objectives are (AJP 9):

- Facilitate the relation between military and civilians
- Create synergies among governmental/international projects and those carried out by NGOs
- Create an interface between the command and the civil environment
- Prepare favorable conditions for operations on the area

Another interesting kind of activity is related to PYSOPS: these operations refer to Psychological Activities planned during peace, crisis or war and directed towards target groups of enemies, friends or neutrals in order to influence attitudes and behaviors that are related to their capability to achieve political and military objective; the main goal of PSYOPS is win the mind and the heart of local population by neutralizing enemy influence and by promoting coalition forces actions (AJP 3.10.1; Chauvancy 2011).

These contexts are very complex due to the presence of several actors (both civilians and military forces) affected by many stochastic components, due to the wide number of interactions among the different actors and due to the strong relevance of human behaviors and attitudes on military actions impacts and effects. As matter of fact in such contexts scenario perception and emotional (i.e. fear, stress) and social aspects are very critical (Amico et. al 2000).

Therefore Modeling and Simulation (M&S) is one of the most effective approaches in order to model unconventional environments and frameworks (Bruzzone, Madeo, Tarone 2010).

In fact for properly apply M&S to this sector of operations, it becomes critical to model Human behavior ModifiersBruzzone (HBM) (Frydman, Cantice, Massei, Poggi, Turi 2009).

Modeling Complex Scenario such as CIMIC and Country Reconstruction requires specific types of models:

- Civilian Attitude Model for describing changes in people attitude
- Social Network Model for simulating people interactions and information and feelings spreading.
- Economic Model to reproduce economic development effects and impacts on the entities attitude.

In particular the authors are involved in the generation of a new intelligent agent driven simulator to support operational planning as well as training for these applications based on the IA-CGF (Intelligent Agents Computer Generated Forces) developed by the Simulation Team. In fact one of the main issues is the development of new CGF (Computer Generated Forces) that guarantee more realism and major fitness to the real operational planners needs by reproducing human behaviors and cultural and social aspects (i.e. religious faith, beliefs, values, education, etc.) (Bruzzone, Massei, Caussanel 2006). The authors achieved a successful result with the development of PIOVRA (Poly-functional Intelligent Operational Virtual Reality Agents) Intelligent Agents. In fact new CGFs, able to simulate “Intelligent” behavior were developed (Bruzzone et al. 2004); as further steps the authors and the Simulation Team complete the creation of IA-CGF Libraries, Units and Non Conventional Frameworks (NCF) (Bruzzone 2008).

In this paper the authors present conceptual models to be implemented in CAPRICORN Simulator based on IA-CGF (Intelligent Agents Computer Generated Forces) for country reconstruction considering support operations related to CIMIC and PSYOPS. The proposed solution evolve in an executable HLA Federation (High Level Architecture) and their specific models result able to operate as federate in other federations as well as stand alone simulator. In fact the use of IA-CGF modules allow to consider both psychological and social aspects and to have agents in the interoperable simulation able to react based on their situation awareness and on their current and previous status.

CAPRICORN PROJECT OVERVIEW

As anticipated CAPRICORN is an EDA Research & Development Project devoted to develop capabilities in the

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complex and critical sector of Military Operation Planning, specifically for Not-Article5/San Petersburg Operations, by using Simulation & CGF (Computer Generated Forces) based on Intelligent Agents (IAs). In order to be effective in operational planning, CAPRICORN integrates new advanced models, developed by the authors that are able to operate stand alone or integrated within an HLA Federation; this guarantee that CAPRICORN will have a potential both for users interested in operational planning decision support (usually short term and limited resources within real mission environments) and for being integrated with other systems for experimentation over complex scenarios.

The main outcomes of CAPRICORN Project are:

- Investigation on the use of Intelligent CGF and Simulation for Operational Planning
- Advanced Human Behavior Hierarchical Models for Intelligent Agents and CGF
- Enhanced Interoperable Multilevel Models for Training & Operational Planning
- Modeling CIMIC & PSYOPS for Interoperable Simulation

Among the different researches carried out by tThe previous the authors in agent driven simulation and intelligent agent development an interesting experience is related to PIOVRA Project that allowed to develop a first Generation of new CGF able to simulate "Intelligent" behavior in order to model friends, foe (including terrorists), neutrals forces, but especially civilians that represent an additional category reacting not based on their party attribute (Friend, foe, civil, neutral), but based on the perception of the situation (Caussanel et al.2007). In fact in particular, PIOVRA project was focused on modeling neutral units representing civilians and their specific behaviors and logic in civil disorders. PIOVRA focuses on the definition of conceptual models able to simulate a co-operative behavior of PIOVRA CGF allowing their aggregation or separation depending on the situation, clearly keeping in mind the command hierarchies for military units and managing their dynamic evolution during actions.

A very critical advance in this area was provided by the new additional elements, developed by the Simulation Team in term of RATS (Riots, Agitators & Terrorists by Simulation) and IA-CGF Modules; these modules was articulated in order to have a structure of human behavior libraries and unconventional units and to create ad hoc non conventional frameworks to simulate specific cases (i.e. IA-CGF Earthquake to reproduce humanitarian support during Haiti Earthquake in term of food distribution analysis) (Tremori et al.2009; Bruzzone, Massei 2010); for instance in IA-CGF is included the capability to reproduce social network representing families and working connection, creating dynamics interactions among people and among groups of people with their own sociological and cultural characteristics (Bruzzone et al.2009).

By moving from Intelligent Agents developed in PIOVRA to IACGF, the authors create new specific CGF that, after their integration with innovative models are able to cover critical aspect (i.e. Human Behavior Modifiers and Cultural Issues); these agents are able to support CIMIC and PSYOPs operations and they represent the building blocks for CAPRICORN Demonstrator, the federation devoted to experiment with users and scientists the capabilities of these agent driven simulation in supporting operational planning and training in this area.

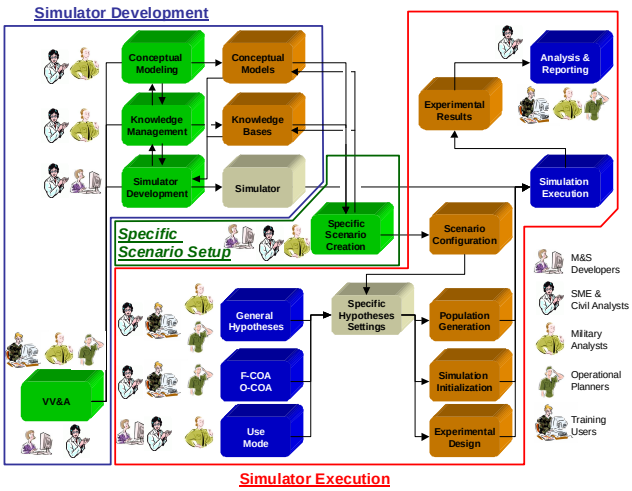

Figure 1: Processes and Key Elements

CAPRICORN DEVELOPMENT, CONFIGURATION AND EXECUTION

The general process to develop CAPRICORN are based on the procedures synthesized in figure 1.; in fact the The developing processes include activities distributed among three main phases: simulation development, specific mission environment setup and simulation experimentation over the mission environment environment. The proposed scheme allows to define a dynamic approach to reuse CAPRICORN developments even in further scenarios or over extended application domains.

The processes include the following functional activities:

- Modeling: this function is devoted to create new models able to reproduce specific phenomena, actions and element. In fact, in the case of CAPRICORN this focuses mostly on modeling population behavior as well as CIMIC/PSYOPs actions and their interactions in the first development phase, but it will be extended for further applications in the future. In this function

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are involved simulation experts therefore it is run in strong contact knowledge management; the main goal related to this function is the creation of the Conceptual Models.

- Knowledge Management: this function is focusing on acquiring and organizing the knowledge relevant to the specific problems; in CAPRICORN, SME (Subject Matter Experts) in operational planning, CIMIC as well as military simulation centers and software science experts interact with scientists operating in knowledge management as well as in M&S. The goal of this activity is to create a set of knowledge bases, where each one is devoted to contain specific information concerning a particular region/context; in this case the human behavior model configuration as well as characteristics of the humans (i.e. population) need to be properly tuned
- Simulators Development: in this process the simulators are implemented involving all the related components; the work is carried out mostly by simulation developers.
- VV&A: Verification, Validation and Accreditation run concurrently the all the processes in order to guarantee that the conceptual models, knowledge bases are consistent and correct as well as the fact that the user needs are satisfied by proper implementation solution; this activity requires continue and effective communications among users, scientists and developers.
- Specific Mission Environment Creation: this process start when it becomes necessary to create a specific instance for a region/scenario; during this phase a set of specific models has to be instantiated starting from conceptual models and knowledge bases available in simulator implementation. By this approach it will be possible to create a specific mission environment (i.e. Afghanistan, Lebanon, Ivory Cost) even getting benefits of previous available CAPRICORN scenarios.
- Specific Hypotheses Setting: during this phase the planners and/or analysts are allowed to define the different hypotheses over a specific mission environment including the possibility to choose alternative F-COA (Friend Course of Action) and O-COA (Opposite Course of Action) as well as general hypotheses (i.e. population). By this approach it is possible to initialize all the conditions to run the simulator and to carry out experimental analysis (i.e. to generate a specific population with characteristics compliant with hypotheses, or to define actions to be defined).
- Simulation Execution: in this phase the simulator is executed in order to generates the results that will be analyzed by the users and decision makers in the following phase; the simulation execution is possible with different operative modes (stand alone or federation) based on user needs and context
- Analysis & Report: it is the phase where the simulation results are available and focus on their analysis by applying techniques and methodologies as well as ad hoc support modules developed to quickly address these issues on operational sites; these approaches are based on comparing and evaluating the different alternatives based on simulation results; obviously despite the application area (training or operational support) it is critical to provide even self automated reports for speed up the final decision making and implementation processes for users.

In order to succeed with the development of a complex simulation framework as that one proposed by CAPRICORN project it is critical to properly address the requirement definition; in fact a simulator devoted to support country reconstruction, CIMIC and PSYOPS should address different utilization requirements considering its possible application on the field by decision makers without strong background in M&S and with limited resources in term of skills, time, data and computing capabilities.

As first step it is interesting to identify the main process for operating CAPRICORN simulator from user point of view as presented in figure 2.

- Specific Mission Environment Definition is a procedure devoted to elaborate the CAPRICORN knowledge bases and models in order to have a reference scenario corresponding to a Mission Environment ready to be used on the specific context (i.e. human, social, geographic)
- Simulation Fine Settings are procedures for changing the simulation parameters related to all the CAPRICORN boundary conditions for analysis over a specific mission environment; this allows to finalize the definition of the parameters in relation to the hypotheses and data within scenario related to a specific Mission Environment

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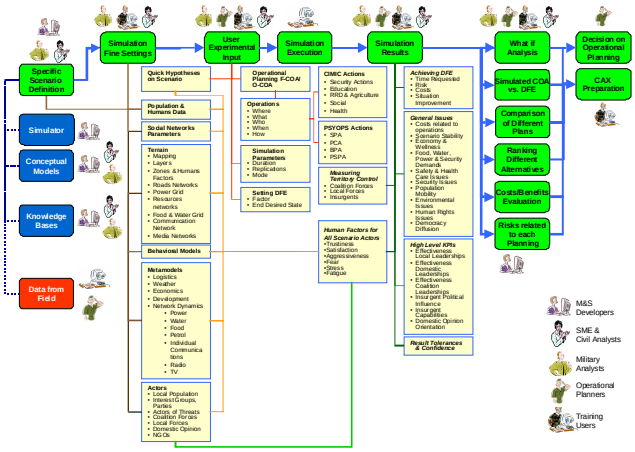

Figure 2: Procedure for Operating with CAPRICORN Simulator and main Input, Output and Elements present in the simulation

- User Experimental Input are procedures for quick changes on the scenario related to mission environment parameters, operations definition (i.e. F-COA, O-COA) and CAPRICORN simulation parameters
- Simulation Execution is the process for executing the CAPRICORN simulator on the predefined experimental settings and campaigns
- Simulation Results procedures include access to the all the output results of the CAPRICORN simulator
- What If Analysis is the analysis procedure based on testing different hypotheses, one by one, by simulating them; for instance if an analyst simulate the scenario with the hypothesis that tribe factors don't have influence it could re-run the simulator enabling tribe influence and then compare the results of both simulated scenarios.
- Simulated COA (Course of Action) vs. DFE (Desired Final Effect) is the analysis procedure based on comparing COAs results respect desired final effect; for instance if the user define as DFE the reduction of the insurgent in the area, then he fixes as COAs the schedule related to supporting local population by creating food storage for winter time in different villages, the simulator is executed and it is analyzed the measures related to this DFE.
- Comparison on Different Plans is the analysis procedure based on comparing final results of different planning respect different KPIs (Key Performance Indexes); the user
- Ranking Different Alternative is the analysis procedure based on creating a ranking list of the different alternatives respect a weighted target function based on KPIs
- Cost/Benefits Evaluation is the analysis procedure based on analyzing costs and benefits of a planning solution respect the different KPIs and MOP
- Risk Related to Each Planning is the analysis procedure based on estimating risk related to each planning based on replicated simulation runs
- Decision on Operational Planning is the procedure to use the synthetic and detailed results of CAPRICORN in the decision making process for achieve the final decisions on the operational Planning
- CAX Preparation (Computer Assisted Exercise) is the procedure to use the synthetic and detailed results of CAPRICORN in the CAX Preparation

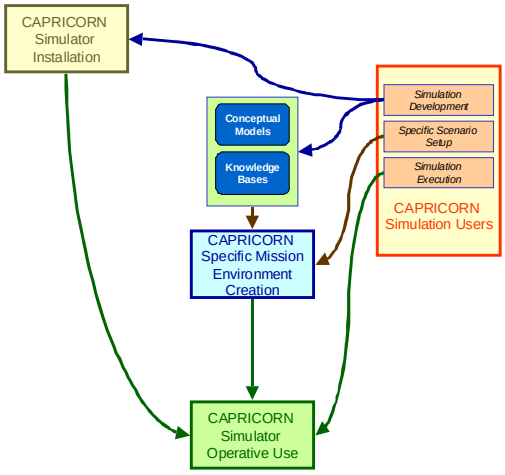

Figure 3. Main Issues from User Point of View

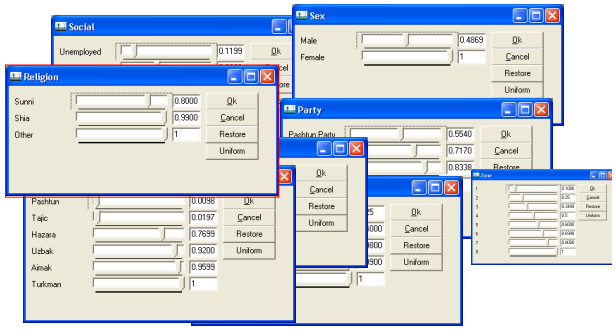

Figure 4. Population Characteristics defined in IA-CGF

It is evident that the general process is based on different main assets and aspects that are necessary to successfully run CAPRICORN; these are related to issues such as:

- CAPRICORN Simulator Installation
- CAPRICORN Configuration and Specific Mission Environment Creation
- CAPRICORN Operative Use
- CAPRICORN Users

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CONCEPTUAL MODELS FOR CAPRICORN

Human Behavior Modeling is a very critical issue and in CAPRICORN represents a main aspect, so it is fundamental to consider the following aspects and factors (Bruzzone 2010):

- Ethnic and Religion
- Psychology
- Cultural and Political Situation

In particular in CAPRICORN the population is driven by agents and the virtual people are generated by applying Montecarlo Technique to specific group statistics in order to reproduce a region. The individual are created by defining in this way their:

- Location: geographic position where the object is located (latitude, longitude and altitude)
- Gender: male or female
- Age
- Health Care Status
- Ethnic Characteristics
- Social Status: level of unit wealthy
- Religion
- Education Level
- Tribe
- Political Party
- Nationality
- Psychological & Sociological Modifiers: characteristics of the object in term of stress, fear, aggressiveness, fatigue, stress and trustiness

The simulated people are driven by Intelligent Agents on the map and over their interactions within themselves and with different groups, they are able to move, to sleep, to wake up, to work, to have lunch, to have social events, to relax, to escape; they react dynamically during the simulation based on their situation awareness, their status and in some way in relation to their previous experiences (Bruzzone 1998).

People objects are connected among themselves through family relationships, friendships, working relationships generating a social network over the map; these social networks among people objects as well as their location over the map are generated by Montecarlo techniques applying specific algorithms; the location of located on the map by implementing and computing their compatibility considering all the different aspects (social status, education, ethnic groups, tribe religion etc.) through social economic algorithms. The Distribution of people on the map is indirectly defined through Zone Objects that define compatibility profile over the areas created over the terrain; all these data are stored in the CAPRICORN Database where relations and object are defined based on available knowledge from military or civilian reports. In addition each people object is connected in term of link and strength of the connection to different group objects; the group objects represent the interest groups and include a certain number of people characterized by same or similar features such as social status, religion, ethnic type, educational level, etc; for instance in rural areas group objects represent farmers, settlers, local authorities, young generation, old generation, a specific tribe, a specific ethnic group etc.

During the simulation the agent drive people objects and groups and allow their interaction to evolve dynamically; people object are enable to reinforce or resolve links with group objects based on their specific interests, while their actions and their perception are driven by the groups they still belonging and by the activities run by units and entities on the map (i.e. a CIMIC activity related to construct a school or an hospital). The groups characteristics are also generated by using Monte Carlo technique based on Configuration Group Objects (CGO); in fact the CGOs define the characteristics of the specific mission environment in term of group of interest and their mutual connections (i.e. mutual friendship, hostility etc.).

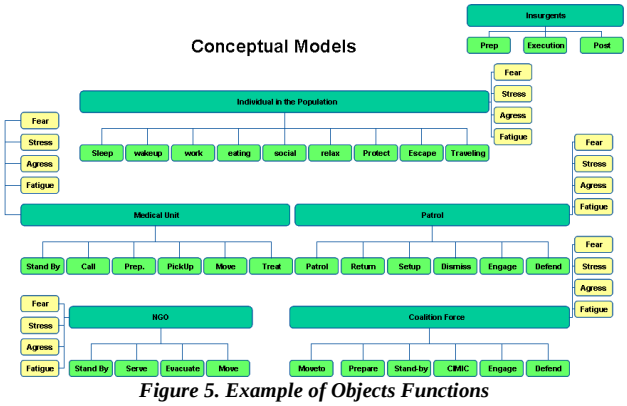

Figure 5. Example of Objects Functions

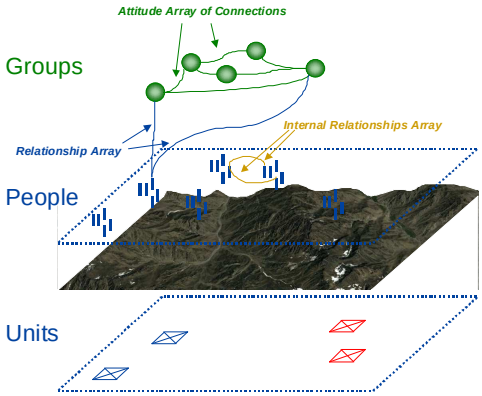

Figure 6. Scheme of Objects such as Units, People and Groups

In synthesis the definition of the population within a mission environment is based on Configuration Groups;

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these identify the different groups in term of social, religious, political, ethnic and physiological aspects. The Population is created for each statistical group in references with their statistical characteristics based on Montecarlo Technique extracting data from defined statistical distributions based on CGOs; CGOs are defined by historical data and hypotheses by the users.

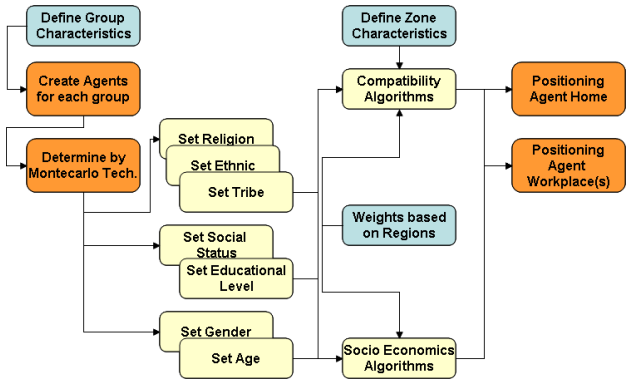

Figure 7. CAPRICORN Population Generation Process

In addition to these objects there are units (i.e. ambulances, convoy, military unit, insurgents etc.) that are part of the simulation; even these Unit Objects are driven by the Intelligent Agents and they are able to move and to perform actions autonomously referring to their tasks and scenario awareness or based on specific pre-assigned orders. The current scenario under analysis is related to South Asia and specifically to a region in Afghanistan. In particular it is possible to distinguish the following type units:

Units/Functions	Move	Stand by	Commit specific Actions	Execute specific Actions	Support specific Actions	Control an Area	Defend	Provide Logistic Support	Perform Surveillance	Promote Riots	Perform Attacks	Recruit Resources	Provide Social Aid	Support Locals
Coalition Forces	X	X	X	X	X	X	X	X	X					
ANA	X	X	X	X	X	X	X	X	X					
ANP	X	X	X	X	X	X	X	X	X					
Insurgents	X	X				X				X	X	X	X	
NGO	X	X	X	X	X								X	X

Figure 8. Example of Units Functions

- Coalition Forces are able to:
  - Move
  - Stand by
  - Commit/execute/support specific CIMIC or PSYOPs actions
  - Control an Area
  - Defend
  - Provide Logistics Support
  - Perform Surveillance
- ANA (Afghan National Army) are able to:
  - Move
  - Stand by
  - Commit/execute/support specific CIMIC or PSYOPs actions
  - Control an Area
  - Defend
  - Provide Logistics Support
  - Perform Surveillance
- ANP (Afghan National Police) are able to:
  - Move
  - Stand by
  - Commit/execute/support specific CIMIC or PSYOPs actions
  - Control an Area
  - Defend
  - Provide Logistics Support
  - Perform Surveillance
- Insurgents are able to:
  - Move
  - Stand by
  - Promote Riots
  - Perform Attacks
  - Control an Area
  - Perform Surveillance
  - Recruit Resources
  - Provide Social Aid
- NGO (Non Governmental Organization) are able to
  - Move
  - Stand by
  - Commit/execute/support specific CIMIC or PSYOPs actions
  - Support Locals

CIMIC or PSYOPs Action Objects are devoted to represent actions on the field and their evolution (i.e. definition, preparation and execution) and are characterized by the following attributes:

- *Id*: identification number
- Action type
- Locations latitude, longitude and altitude
- Time Plan & Duration
- Resources assignment (costs, units)
- Promoting Group: Operative Agent Actors
- Targets: Groups to get benefits of the action and its impact and Groups to get negative effect of the action and its impact

The Zone Object represents an area in CAPRICORN Environment where specific social, political, cultural conditions are applied. It could be sized as a single village or a rural area; zone could include a set of villages and in fact different zone are able to be overlapped in order to represent different mixes of people and groups over the same areas.

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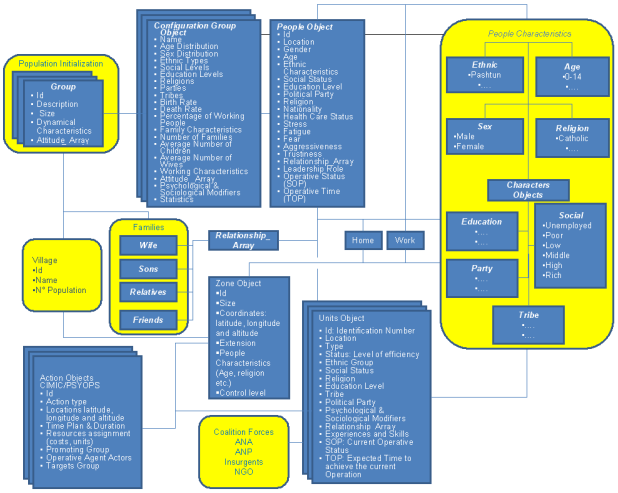

Figure 9. CAPRICORN Objects

CAPRICORN CAPABILITIES

The authors identify the main capabilities required for CAPRICORN simulator to support country reconstruction; these features are synthesized in the following list:

- Generation of the population
  - Generation of People
  - Creation of Networks for People and Group: Generation of families and inter-people connections (i.e. friendship) by building relationships within people, relationships between people and groups and attitudes among groups.
- Basic Visualization of social network for groups and single persons
  - Basic Visualization of Geographic zones and their features
  - Basic Visualization of human factors (i.e. psychological elements such as aggressiveness, fatigue, stress, fear, trustiness)
  - Basic Visualization of Resources and Infrastructures (i.e. food and water demand, power infrastructure)
  - Graphical representation of entities on the map
  - Interoperability with other Simulation systems through HLA

  In particular CAPRICORN Demonstrator allows users to configure a specific mission environment by:
  - Simulating the Mission Environment
  - Changing Hypotheses and Parameters of Human Elements in the Simulation by setting population characteristics
    - Social aspects in terms of percentages of people belonging, for instance, to the following class: Unemployed, Poor, Farmer, Worker, Middle Class, Wealthy, High Society
    - Religious aspects, including for instance the following classes: Sunni Muslim, Shia Muslim, Other.
    - Ethnic aspects by setting percentage of people belonging to ethnic groups in Afghanistan such as: Pashtun, Tajik, Hazara, Uzbek, Aimak, Turkmen, Baloch, Other
    - Tribe aspects by identifying clans (i.e. Safi, Ghilzai) and subclans (i.e. Gharghasht for Safi clan and Kharoti for Ghilzai clan)
  - Implementing human behavior models (fear, fatigue, stress, aggressiveness, trustiness)
    - Reporting on statistics about human factors
  - Grouping people in different groups depending on social, religious, educational, ethnic, political characteristic
  - Simulating social network evolution
    - Reporting on social network changes due to the simulation
  - Setting up different F-COAs and O-COAs by defining CIMIC/PSYOPS/Combat or other actions in term of type, location, target, approach, time, resources and specific attributes
  - Reporting on Output and Target functions (i.e. KPIs)
    - Reporting actions performance indicators
    - Reporting costs, time

Additional capabilities guaranteed by using CAPRICORN are related to the following aspects:

- Capability to conduct replicated runs for measuring the tolerance and confidence band on the output variables and KPIs
- Capability to conduct runs corresponding to an experimental campaign runs for completing Sensitivity Analysis among a set of input variables and their interaction
- Capability to attribute to each out variable a confidence band
- Capability to rank different Simulation Runs and to compare costs/benefits, KPIs in absolute and statistical terms
- Capability to generate simulation evolution log for supporting scenario analysis and CAX preparation

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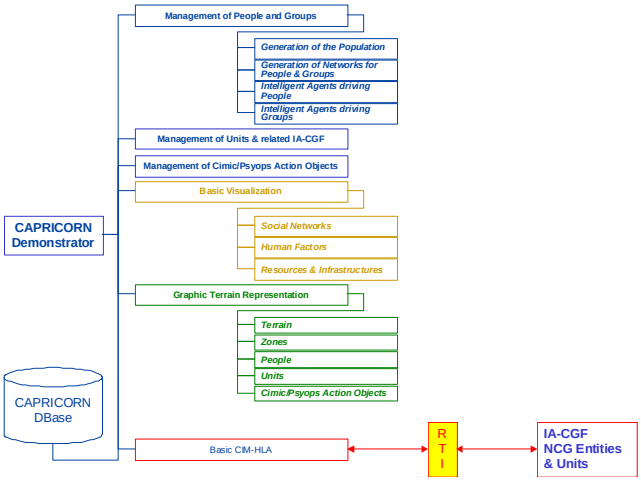

Figure 10. CAPRICORN General Architecture

In order to satisfy the needs and the requirements mentioned above, the authors designed the CAPRICORN architecture including different elements:

- A module for People and Groups Management:
  - Generation of the Population
  - Generation of Social Networks
  - Intelligent Agents driving People
  - Intelligent Agents driving Groups
- A module for Units Management & related IA-CGF
- A module for CIMIC/PSYOPs Action Objects Management
- A module for Basic Visualization of:
  - Social Network
  - Human Factors
  - Resources & Infrastructures
- A module for Graphic Terrain Representation:
  - Terrain
  - Zones
  - People
  - Units
  - CIMIC/PSYOPs Action Objects
- Basic CIM-HLA Module: CAPRICORN Interoperability Module

By this architecture it becomes possible to simulate a complex mission environment for the experimentation by simulating country reconstruction/CIMIC/ PSYOPS and other actions; CAPRICORN objects management and evolution is directed by IA-CGF while a specific NCF allows to define the mission environment by setting up configuration files and by changing aggregate variables; by this approach it is also possible to quickly setup the initial parameters for a complex scenario execution. The graphic representations of People, Groups and Units over the map while they evolve, movie and act is useful for VV&A as well as to support understanding of the different scenario evolution. The proposed CAPRICORN Federation support two operative modes:

- Stand alone Mode: by this approach the CAPRICORN is able to run independently on the mission environment.
- HLA Mode: in this case CAPRICORN guarantees the Mission Environment Management within an HLA (High Level Architecture Federation) interoperating with other simulators; in this case it is proposed to use IA-CGF Entity & Units, a specific NCF constituted by a constructive simulator able to show the situation of the units operating over a town and fully interoperable in HLA.

In particular the Interoperability Module HLA (Basic CIM-HLA) is a Module internal to CAPRICORN Demonstrator for Interoperability and it allows the creation, join and interoperation with a federation involving even other models. Its main functions are related to HLA Federation Management: Create, Join, Resign and Destroy Federation.

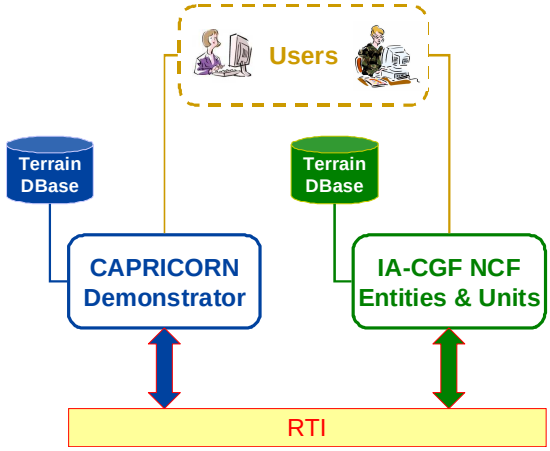

Figure 11. CAPRICORN Federation Architecture

CAPRICORN SCENARIO DEFINITION AND EXPERIMENTATION

Currently the authors are working on the Scenario Definition for CAPRICORN Experimentation; as anticipated the area of interest is a region in Afghanistan. CAPRICORN Demonstrator simulates people life in this afghan region focusing on CIMIC and PSYOPs operations impacts and effects on local population.

In particular, by analyzing users requirements, the following actions are included in the Demonstrator Development for the Experimentation phase:

- Digging Wells
- Canals Irrigation
- Roads and Infrastructures Security
- Police Station Buildings

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- Messages Spreading by radio

CAPRICORN Experimentation is based on involvement of SME and military users and it includes the following phases:

- Phase A: Panels and Review of Concepts
  Reviewing Requirements and Discussing in Panels involving CAPRICORN Partners, Subject Matter Experts, Operational Planners on the different features:
  - Operational Planning Requirements for Stabilization
  - Synthesis on Conceptual Models of HBR, CIMIC and PSYOPS
  - Presentation of M&S Concepts developed for PMSEII
  - Review of CAPRICORN concepts in relation to:
    - Operational Planning overseas
    - Decision Making
    - Scenario Analysis
    - Risk Analysis
    - Training: CAX Preparation
    - Training: CAX execution
    - Concept Development & Experimentation
    - Education: Classes and Interactive Exercises

This Phase will be carried out continuously during the project during meetings and workshop as well as during the experimentation tests; a specific meeting is schedule in DHSS (Defense & Homeland Security Workshop) and Nato CAX Forum during I3M 2011 in Rome (www.liophant.org/i3m).

- Phase B: Execution of CAPRICORN
  - Users, Analysts and CAPRICORN Team working with subject matter experts and operational planners supporting Operational Planning and Scenario Analysis on the key features identified in term of:
    - Specific Mission Environment:
      - Afghan Region
      - Population, Social Networks & Groups Parameters
      - Alternative F/O-COA
      - Set CIMIC and PSYOPS

The CAPRICORN Experience is based on the execution of CAPRICORN Demonstrator over a predefined Mission Environment and to test capabilities and functions in both operation modes (HLA/Stand Alone).

This Experience should be performed by Users and Developers that works together; considering that CAPRICORN main users are in Italy and France the Experience is designed to satisfy the expectations of the two Countries, obviously respecting Project Resource original goals.

METRICS DEFINITION AND VV&A PROCESS FOR CAPRICORN

VV&A (Validation, Verification and Accreditation) process is very critical for simulators of complex scenarios and the authors defined the steps that must be followed along the whole project, especially in relation with SME and military users:

- Conceptual Model Validation: validation of conceptual model through Specifications, objects and State of Diagrams validation by SME
- Execution Testing: validation of Simulator Features and Functions by allowing SME to make tests and to use the demonstrator
- Integration Testing: Testing for evaluate HLA integration and interoperability benefits
- MSpE (Mean Square Pure Error), DOE (Design of Experiment), ANOVA (Analysis of Variance): Application of validation methodologies such as MSpE, analysis of variance and Design of Experiments in order to measure confidence band, optimal duration and optimal replications
- Sensitivity Analysis: Sensitivity analysis in order to identify critical factors for the simulated scenario
- Turing Test:the test measure the fidelity of the results by estimating the capability to discriminate real data from simulated data: for instance a subject matter expert is required to classify as real or simulated a set of reports provided over documented scenarios; in fact obviously Military SME have to propose a real case to be studied and simulated.

In order to support CAPRICORN VV&A the authors defined MOE and MOP; for instance, to measure the evolution of population satisfaction, it is possible to observe stress level, fear level, aggressiveness level, while to measure economic development it could be useful to define parameters in the simulation that provide estimation about the number of established new company, new markets or stores within a time windows.

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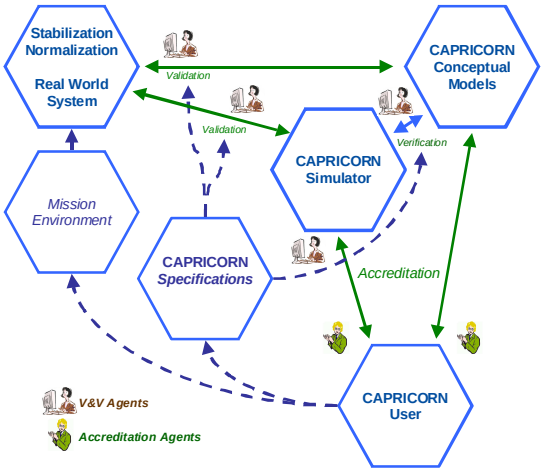

Figure 12. CAPRICORN VV&A Process

CONCLUSIONS

The authors propose a procedure for the development of a simulator as support for country reconstruction; this simulator is designed for being used both by operational planners and trainers.

The development of the conceptual models and general architecture result consistent and it was successfully validated and verified by SME during first phase of CAPRICORN project.

Currently the authors are working on the Scenario Definition for the CAPRICORN Experimentation; the area of interest will be a region in Afghanistan and CAPRICORN Demonstrator is expected to experiment different alternative reproducing people life in afghan villages over a region and to evaluate the CIMIC and PSYOPs operations evolution, impacts and effects on local population.

During the whole project great attention was devoted to VV&A even if this is just a R&D project; not too much to create a real mission environment, but to demonstrate the capabilities of such kind of simulators.

Based on author experience even in real case the data available are affected by strong uncertainty, very quick evolving nature (quick obsolescence) so it is expected that these population simulator should rely more on their capability to quickly test the different hypotheses from decision makers than on acquiring many data (that probably are incorrect and inconsistent); this is a classical example where we move from technology sensor data collection to intelligence report estimation and operational people estimations.

The new models such as CAPRICORN should be able to deal with these aspects, so it is very critical to develop even new VV&A (Validation, Verification and Accreditation) techniques; currently the authors are involved in several projects related to these aspects as further development.

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