Self-improving inference system to support the intelligence preparation of the battlefield

Requirements, state of the art, and prototypes

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IMPORTANT INFORMATIVE STATEMENTS

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Abstract

This report presents the results of a research project about the application of automated reasoning and machine learning approaches to support the Intelligence Preparation of the Battlefield/Operational Environment (IPB/IPOE) process. Analysts conducting IPB/IPOE are faced with information and cognitive overload problems. The research initiative described in this report intends on supporting IPB/IPOE analysts with Self-Improving Inference Systems (SIIS).

To achieve this goal, literature and technological surveys as well as expert interviews and workshops were conducted. A functional decomposition of IPOE was also performed. Following the results from these tasks, two prototype systems were developed in order to support analysts performing IPB/IPOE.

Significance to defence and security

This effort lays the ground work and provides a way ahead for the development of an Intelligence analysis system to support IPB/IPOE analysts. This work highlights requirements for IPB/IPOE analysts, and also proposes technological solutions to address them. It will support Canadian Forces analysts performing IPB/IPOE, considerably reducing their information and cognitive overload.

Résumé

Ce rapport présente les résultats d'un projet, l'application du raisonnement et de l'apprentissage automatisé en soutien à l'analyse tactique graphique (ATG). Les analystes qui exécutent l'ATG sont confrontés à une surcharge informationnelle et cognitive. L'initiative de recherche décrite dans ce rapport vise à soutenir les analystes d'ATG à l'aide de systèmes d'inférence auto-améliorants.

Pour atteindre cet objectif, des revues de littérature et de technologie ont été effectuées. Des entrevues et ateliers avec des experts ont aussi eu lieu. Une décomposition fonctionnelle de l'ATG a ainsi été réalisée. Suite aux résultats obtenus dans ces tâches, deux prototypes de systèmes ont été développés afin de soutenir les analystes d'ATG.

Importance pour la défense et la sécurité

Cet effort jette les bases et propose une direction pour le développement d'un système d'analyse du renseignement pour appuyer les analystes d'ATG. Ce travail met en évidence les besoins des analystes d'ATG et propose des solutions technologiques pour y répondre. Ce travail aidera les analystes des Forces canadiennes, réduisant considérablement leur surcharge informationnelle et cognitive.

Table of contents

List of figures

List of tables

1 Introduction

The Intelligence Preparation of the Battlefield/Operational Environment (IPB/IPOE) is a military process designed to provide battlefield commanders with information about the enemy and a particular operational environment. The IPOE is a systematic approach used by intelligence personnel to analyze the adversary and other relevant aspects of the operational environment, which is the composite of the conditions, circumstances, and influences that affect the employment of capabilities and bear on the decisions of the commander [1].

IPB/IPOE is a systematic, continuous process that includes four steps:

- define the operational environment,
- describe the effects of the operational environment,
- evaluate the adversary, and
- determine and describe adversary potential courses of action.

IPOE and IPB products generally differ in terms of their relative purpose, focus, and level of detail. Both processes involve the same four steps, but implement them at different levels. The objective of IPOE is to support the commander by identifying the adversary's most likely intent and Course Of Action (COA). IPB is specifically designed to support the individual operations. IPOE uses a more macro-analytic approach that seeks to identify the adversary's strategy, vulnerabilities, and centres of gravity. IPB may require more microanalysis and more detail, in order to support operations [2].

The Self-Improving Inference Systems to Support the IPB/IPOE project aimed at supporting the IPB/IPOE analysts through the use of inference tools. In addition machine learning has been applied in order to allow the inference system to improve its performance over time. This was the aim of Applied Research Program (ARP) project 02pa.

1.1 Challenges

IPB/IPOE is recognized as being time-consuming and labour-intensive [3]. In addition, the IPB/IPOE process is to be executed in a variety of contexts becoming increasingly complex due to the asymmetric nature of the threat, the use of complex terrain and the expansion of areas of operation [4]. All put together, the complexity and dynamic nature of the IPB/IPOE can easily lead to the analyst being affected by:

- Information overload: too much to be aware of and not enough time; and
- Cognitive overload: too many problems to analyse and solve, and not enough time.

1.2 General approach

The project was divided into separate objectives:

- study the IPB/IPOE process, including the reasoning requirements, the identification of scenario data sets and metrics, and the capture of the domain knowledge;
- develop an inference system to support the IPB/IPOE process; and
- develop a self-improving capability.

The report is structured as follows. The details of the methodology employed are given in Section 2. The IPB/POE functional decomposition and reasoning requirement are discussed in Section 3. Existing tools that can address some IPB/IPOE functions are discussed in Section 4. The prototype systems developed over the course of the project are detailed in Section 5.

2 Methodology

This section presents the methodology used to obtain the results presented in this report. Details are provided on the elicitation of reasoning requirements, the production of a state of the art in tools addressing IPB/IPOE requirements, and the development of two IPB/IPOE support system prototypes.

2.1 Elicitation of reasoning requirements

The first objective was to gain a better understanding of the thought process used by specialists to achieve the four steps of the IPB/IPOE process. In order to obtain such an understanding, a survey of the IPB/IPOE literature and a SME workshop were conducted.

2.1.1 Literature survey

The literature survey considered over fifty documents coming from the international military community (doctrine, manuals) as well as from the academia (scientific papers). From this analysis, a report was produced [5] providing detailed information on the IPB/IPOE, among which:

- IPB/IPOE goals,
- actors involved in the IPB/IPOE,
- products of the IPB/IPOE,
- processes of the IPB/IPOE,
- data requirements for the IPB/IPOE, and
- initial functional decomposition of the IPB/IPOE.

The functional decomposition of the IPB/IPOE set the stage for the precise identification of IPB/IPOE requirements, which was accomplished in an IPB/IPOE workshop. Results from this activity are discussed in more detail in Section 3.1.

2.1.2 Workshop

Following the review of IPB/IPOE background information, a series of knowledge acquisition activities (interviews and a workshop) involving IPB/IPOE subject matter experts (SME) were planned in order to derive a list of IPB/IPOE reasoning requirements.

The interviews were conducted one-to-one, and aimed at validating an initial list of requirements that was extracted from the literature survey. The workshop was held over a period of two days and aimed at validating and refining a final list of IPB/IPOE reasoning requirements.

A total of seven IPB/IPOE experts were involved over the course of the knowledge acquisition sessions. Representatives from Canadian Forces Intelligence Command (CFINTCOM), The

Army G2, and Special Operations Forces Command (SOFCOM) collectively counting over 120 years of military experience, all with operational IPB/IPOE experience in various contexts (Afghanistan, Bosnia), participated to the workshop.

Detailed information on the knowledge acquisition sessions can be found in [6]. The results obtained from this activity will be discussed in detail in Section 3.2.

2.2 State of the art in tools addressing IPB/IPOE requirements

Following the identification of IPB/IPOE reasoning requirements, a survey of existing tools was conducted in order to identify which requirements were already being addressed.

A report [7] was produced, providing detailed information on 27 tools:

- Tool Name
- Vendor/Organism
- Contact information
- Website (URL)
- Licence
- Price
- History
- Last update
- Test version available
- Type of tool (software)
- Technical environment
- Technical support
- Actual clients
- Is the tool military-oriented?
- IPB steps supported
- Screenshot
- Key features
- Strengths
- Limitations

A detailed discussion on the results of this task is provided in Section 4.

2.3 Support system prototype development

Prototype development was conducted over a period of three years. The development was separated in two phases, which allowed for the development of two separate prototypes with different objectives.

The first prototype focused more strongly on inference. More specifically, it applied rule-based reasoning on various IPB/IPOE related problems. Details on the first prototype: how it works and what it accomplishes, are provided in Section 5.1.

The second prototype implemented a different inference mechanism: case-based reasoning. It also provided a means to improve the performance of the inference through the use of machine learning. Details of this prototype are provided in Section 5.2.

3 IPB/IPOE reasoning requirements

This section provides a discussion on the functional decomposition and reasoning requirement elicitation that were conducted for this project. It is meant as a general description of the results which are discussed in much greater detail in [6].

3.1 Functional decomposition

Functional decomposition refers broadly to the process of resolving a process (function) into its constituent parts for the purpose of gaining insight into the global function [8]. The following functional decomposition of the IPB/IPOE provides a means to describe the process in a hierarchical structured form. This functional decomposition of the IPB/IPOE Process is based on the Canadian Forces Intelligence field manual B-GL-357-001/fp-001 [9] and on the Department of the Army field manual 34-130 [10] Intelligence preparation of the battlefield and also Department of Army Field Manual 34-3 [11]. This decomposition was conducted considering a Counter-Insurgency (COIN) context. We highlight a small subset of the IPB/IPOE functions, which can be seen in a mind map and detailed list in Annex A.

3.1.1.1 Step 1: Define the battlefield/operational environment

- Confirm the mission, intent and vision, tasks, deployment posture, limitations, and end state of the friendly forces.
- Identify the geographical limits of the unit's Area of Operations (AO) and battlespace.
- Define AO as per higher headquarters mission orders.
- Identify Priority Intelligence Requirements (PIR).
- Develop and execute an intelligence collection plan.

3.1.1.2 Step 2: Describe the battlefield/operation environment's effects

- Analyze the battlefield environment.
- Conduct military terrain analysis (TERA) in the AO.
- Conduct analysis of military characteristics of weather.
- Analyze other characteristics of the battlefield:
  - consider logistics infrastructures and population demographics, and
  - consider demographic factors.
- Evaluate the effects of terrain on friendly movement and enemy capabilities.
- Visually and orally describe to the Commander and the staff how weather, terrain and other factors will affect their mission.

3.1.1.3 Step 3: Evaluate the threat

- Determine the capabilities of adversary forces and develop adversary models.
- Identify which adversary structured forces are expected to be operating in the unit's AO and AI.
- Describe expected forces with demographics characteristics.
- Prioritize elements for further analysis.
- Use all available intelligence sources to update and refine adversary models.

3.1.1.4 Step 4: Determine the threat courses of action

- Identify the full set of Courses of Action (COA) available to the adversary.
- Verify how battlefield conditions limit the set of possible COAs.
- Evaluate and prioritize the COA.
- Evaluate how well each COA meets the criteria of suitability, feasibility, acceptability, and consistency with doctrine:
    - suitability
    - feasibility
    - acceptability
    - uniqueness
    - consistency with doctrine
- Describe the COA in detail.
- Identify Named Areas of Interest (NAI).
- Develop the Intelligence Estimate.
- Prepare a method of packaging and disseminating the results of IPB.

The functional decomposition summarized here is the foundation for the identification of the reasoning processes employed by the analysts conducting IPB/IPOE. These reasoning requirements are the topic of Section 3.2.

3.2 Reasoning requirements

A reasoning requirements list has been based on the functional decomposition discussed in Section 3.1. It was also the result of a series of interviews and workshops held with numerous IPB/IPOE experts (see Section 2.1.2 for details). Following the survey of literature and the initial functional decomposition, the IPB/IPOE functions were validated and refined through a set of preliminary interviews with SMEs. **Figure 1** shows the decomposition of the higher-level functions that were refined over the knowledge acquisition sessions.

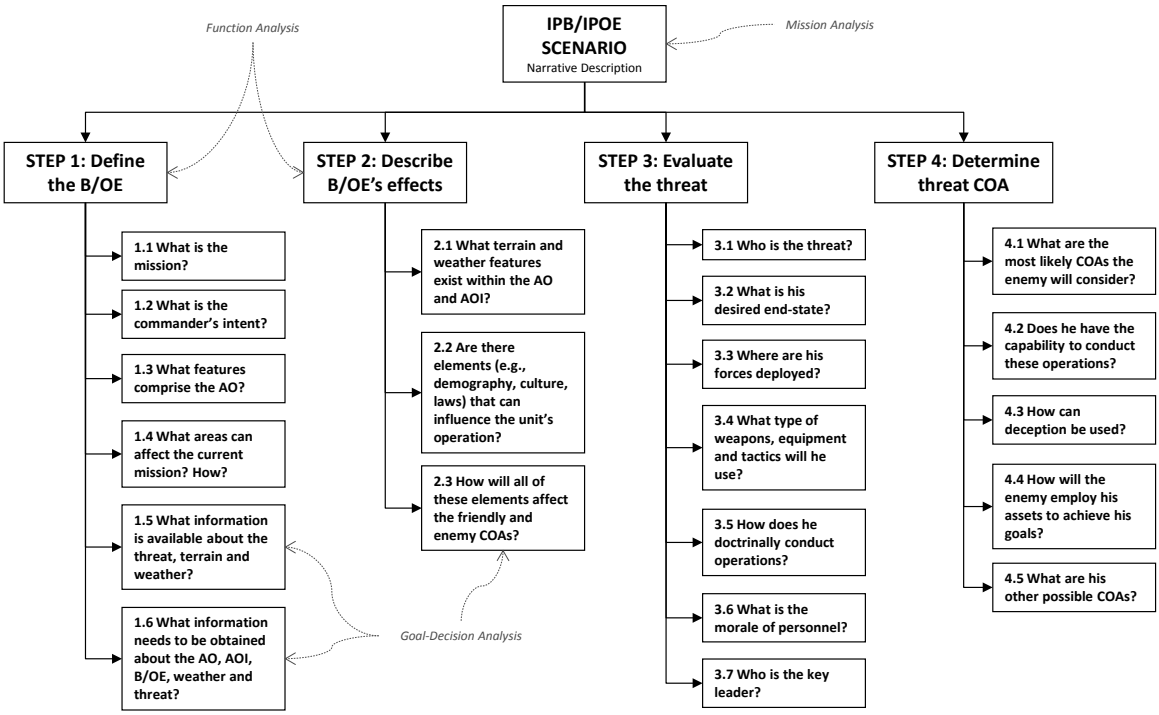


Figure 1: *Refined functional decomposition depicting IPB/IPOE activities.*

These functions were at the centre of the IP/IPOE workshop (described in Section 2.1.2), which aimed at identifying specific reasoning requirements for every higher-level function. Over 160 reasoning requirements were mapped to these functions. The detailed list of reasoning requirements can be found in 0.

The analysis of these requirements allowed for the identification of certain inference mechanisms that would likely be able to support the IPB/IPOE analyst. Over the course of this project, we mainly focused on two reasoning approaches: Rule-based and case-based reasoning. These two inference approaches were implemented and tested in prototypes against the IPB/IPOE problem and are the subject of Section 5.

4 Existing tools

The results from knowledge acquisition activities described in Section 3 allowed for getting a better grasp at the requirements linked to the IPB/IPOE problem. The analysis of the requirements also provided insight on different automated reasoning approaches that would likely be helpful to IPB/IPOE analysts. However, before going into development it was necessary to survey existing tools in order to assess which ones could potentially address some of the requirements. A state of the art study (described in Section 2.2) was conducted on 27 different tools, which were linked to different degrees to the IPB/IPOE process and the identified requirements. The detailed analysis of these tools can be found in [7]. We present here a summary of the information in the form of two tables.

Table 1 shows a mapping between a list of IPB/IPOE requirements, as identified in the previous tasks, and a list of functional requirements that a tool should satisfy in order to meet the IPB/IPOE requirement.

Table 1: *Mapping of IPB/IPOE requirements/functional requirements.*

IPB/IPOE Requirement / Functional requirement	Geospatial	Overlays/layers	Transparency of overlays	Placing events on a map	Heat maps, or blobs visualization	Displaying 2D maps	Displaying 3D maps	Imagery analysis	Dynamic maps, time aspect	Socio-cultural factors	Terrain flooding	Line of sight	Shortest path	SNA visualization	COGs visualization	Uncertainty visualization	Drawing military symbology on map	Other Aspects	COAs development	COAs comparison	Decision points visualization	Decision tree	Display of events matrices	Display of various matrices	Visualization of short and long term effects	Most likely and most dangerous differentiation	Belligerent summary cards	Information visualization	Usability
Identify the area of operations and influence		x	x		x	x	x	x	x								x												x
Analyse the mission and commander's intent		x	x	x																			x	x	x				x
Determine the significant characteristics of the battlespace		x	x		x																								x
Develop a geospatial perspective of the battlespace		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x												x
Develop a systems perspective of the battlespace									x													x							x
Establish the limits of the areas of interest						x																							x
Determine intelligence and information gaps																							x					x	x
Describe the impact of the battlespace on capabilities				x																				x	x				x
Update / create adversary models				x									x						x									x	x
Determine the current adversary situation		x	x	x	x	x	x		x	x				x	x	x											x		x
Identify adversary capabilities and vulnerabilities														x	x	x						x						x	x
Identify adversary COGs														x	x							x							x
Identify the adversary's likely objectives and desired end state														x									x	x	x				x
Identify adversary COAs						x	x										x		x	x	x	x		x	x	x				x
Evaluating and prioritizing each COA									x											x	x	x			x	x				x
Identify initial collection requirements																							x							x
Develop various templates		x	x			x	x																						x	x
Produce analytical matrices																							x							x
Produce events analysis matrix and template (overlay)		x																					x							x
Perform wargaming									x										x	x	x	x	x							x
Develop ISTAR plan		x							x														x							x
Conduct terrain analysis		x							x		x	x	x																	x
Produce high-value targets list																x							x					x	x
Create a graphical intelligence estimate		x	x																								x	x	x	x
Identify critical gaps																							x	x	x			x	x	x

Table 2 shows a mapping between the surveyed tools and the functions listed in **Table 1**.

Table 2: *Mapping tools and functionalities.*

Selected tool / functional req.	Geospatial	Overlays/layers	Transparency of overlays	Placing events on a map	Heat maps, or blobs visualization	Displaying 2D maps	Displaying 3D maps	Imagery analysis	Dynamic maps, time aspect	Socio-cultural factors	Terrain flooding	Line of sight	Shortest path	SNA visualization	COGs visualization	Uncertainty visualization	Drawing military symbology on map	Other Aspects	COAs development	COAs comparison	Decision points visualization	Decision tree	Display of events matrices	Display of various matrices	Visualization of short and long term effects	Most likely and most dangerous differentiation	Belligerant summary cards	Information visualization	Usability
AGI STK		X	X	X	?	X	X	X	X	?		X			?	?	X												?
ArcGIS		X	X	X	X	X	X	?	X	X		X	X		?	?	x												?
CADET		X		X		X											X		X		X		X	X					?
Caleydo																												X	X
Capaware		X	X	X	X		X		X	?																			X
Choosel				X		X																						X	X
CogSketch				X													X		X										?
CommonGIS		X			X	X			X						?													X	?
CPoF		X	X	X	X	X	X		X		X	X	X				X		X				X	X			X	X	X
Deep Green						X											X		X	X	X	X	?	?	X	X			?
ERDAS IMAGINE		X	X		X	X	X	X																					?
FalconView		X	X	X	X	X			?			?	?				X													X
GeoDa		X				X																						X	X
GeoTime				X		X	X		X					X	X													X	X
GeoViz					X	X			X							X								X	X	X		X	X
GRASS		X	X		X	X	X	X							X													X	X
KNIME																												X	X
NASA Worldwind		X	X		X		X		X																				X
Palantir Government				X		X			X	X				X	X												X	X	X
Quantum GIS		X	X		X	X				X					X														X
SAGA		X	X			X		X							X													X	X
Sextant VWT				X			X	X	X			X				X			X										X
Starlight							X																					X	X
Tableau Software																												X	X
uDig		X	X		X	X			X																			X	X
Visdom																			X	X	X	X			X	X		X	X
Multichronia																			X	X	X	X			X	X		?	X

Looking at Table 1 and Table 2, a number of observations can be made. The requirements linked to situation description (e.g., Identify the area of operations and influence, Develop a geospatial perspective of the battle space, Determine the current adversary situation) are better covered than the requirements linked to enemy (or threat) assessment (e.g., Identify the adversary's likely objectives and desired end state, Produce high-value targets list) and COA development and analysis (e.g., Identify adversary COAs, Evaluating and prioritizing each COA). Looking at the more detailed description provided in Table 1, it becomes even more obvious that the requirements relating to situation description (Steps 1 and 2 of the IPB/IPOE) are better covered than the ones that relate to situation, threat and COA analysis (Steps 3 and 4 of the IPB/IPOE).

Steps 3 and 4 of the IPOE are crucial ones in terms of delivering key actionable intelligence products to the commander. They also require more analytics, and are less supported by existing tools. Therefore, it would seem that taking on requirements from IPB/IPOE Steps 3 and 4, although possibly much more challenging, is likely to yield more useful results. This is the subject of Section 5, which looks at two prototypes of support systems implementing automated reasoning approaches to support the IPB/IPOE.

5 Support system prototypes

This section presents two prototypes that were developed over a period of three years. The first prototype focuses strictly on inference. More specifically, it applies rule-based reasoning (RBR) to various IPB/IPOE related problems. The second prototype implements case-based reasoning, it also provides a means to improve the performance of the inference through the use of machine learning.

5.1 First prototype

The first support system prototype implements rule-based reasoning as its main inference mechanism to support the IPB/IPOE. A short description of RBR, an overview of the prototype's functions, and a discussion on the observed results are provided next.

5.1.1 Rule-based reasoning

RBR applies "if-then" rule statements to a set of formalized information pieces in order to infer new pieces of information. A simple example of such a rule would be "IF my car is not parked in the driveway THEN I am not home". In the context of this research, emphasis was given to forward-chaining RBR. Forward-chaining means one work from the data, finds applicable rules and infers new facts. Detailed information about the application of RBR to intelligence analysis problems can be found in [12] and [13].

Let us look at a simple RBR example. This example is taken from a fictitious, but realistic Counter Insurgency demonstration scenario. Let us consider the following propositions:

P1: isMemberOf(Person_A, local_radical_group02)

P2: hasIdeology(local_radical_group02, PRO_INSURGENT)

These propositions would read: "Person_A is a member of the local radical insurgent group 02" and "The local insurgent group 02 has a pro insurgent ideology". These two propositions are formalized using a DRDC Valcartier developed model [14], and could have been gathered from different sources of information.

Let us now consider the following rules:

R1: **IF** isMemberOf(Individual X, Group Y),

AND hasIdeology(Group Y, Ideology Z),

THEN hasIdeology(Individual X, Ideology Z).

R2: **IF** hasIdeology(Individual X, PRO_INSURGENT),

THEN hasIntent(Individual X, ANTI_COALITION_INTENT).

These rules would read: “If an individual is a member of a group which has a certain ideology, then this individual also has that ideology.” and “If an individual has a pro insurgent ideology, then this individual has an anti-coalition intent.”

Using these two rules on the two known facts, one is able to infer first:

P3: hasIdeology(Person_A, PRO_INSURGENT) (from **P1**, **P2** and **R1**),

and secondly:

P4: hasIntent(Person_A, ANTI_COALITION_INTENT) (from **P3** and **R2**).

Starting from a set of two propositions (**P1**, **P2**), using two rules (**R1**, **R2**), one infers two additional propositions about the situation (**P3**, **P4**).

This very simple example demonstrates how having information on individuals’ memberships to groups and group ideologies information can be used to infer individual’s ideology and potential individual’s intents. With a very limited number of propositions and rules, such a demonstration can seem rather pointless. In this limited example, using two rules, one has been able to infer two additional propositions that were not specified by the initial scenario. Given a situation with hundreds (or thousands) of propositions, it is easy to see how this approach could alleviate the analyst’s information and cognitive overload problem in refining the set of propositions.

5.1.2 Prototype functions

The next subsections go over the main functions of the prototype, to highlight the RBR functions.

5.1.2.1 High-level description

Figure 2 provides a high-level view of the first prototype.

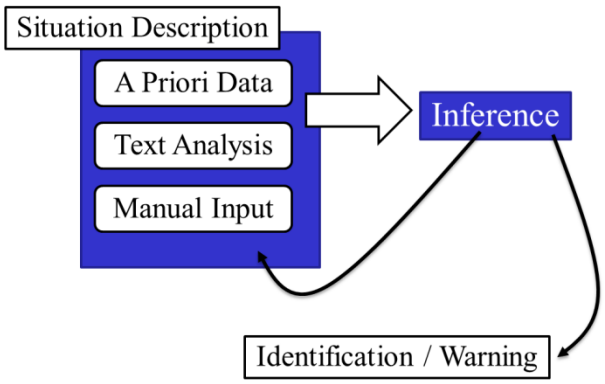


Figure 2: *Prototype 1 high level view.*

A situation description capability is provided to the user. This capability is meant to allow for a proper description of the battlefield/operational environment. The information making up the situation description can come from:

- a priori data
- text analysis
- manual input

A priori data represents all digitized information that can be found in structured data structures (e.g., databases). Data can be found in various sources of this type and, with the development of proper adapters transforming the data into propositions, could be integrated and used by the system. Over the years, automated information processing services achieving text analysis have been developed by DRDC Valcartier [14]. These services allow for the analysis of various types of documents to extract information that is of particular interest. Finally, the user can manually input relevant information that would not have been found in a priori data or text documents.

All of the information making up the situation description is then pushed to the inference service, along with the inference rules derived with SMEs. The RBR was implemented as a service in an inference prototype using a Service Oriented Architecture [12]. The RBR service leverages the Drools business logic integration platform [15]. The RBR inference service then infers new information and proceeds to:

- add inferred information to the situation description, and
- provide the user with indication or warning.

5.1.2.2 Prototype functions overview

Figure 3 shows a screen capture of the prototype's main window.

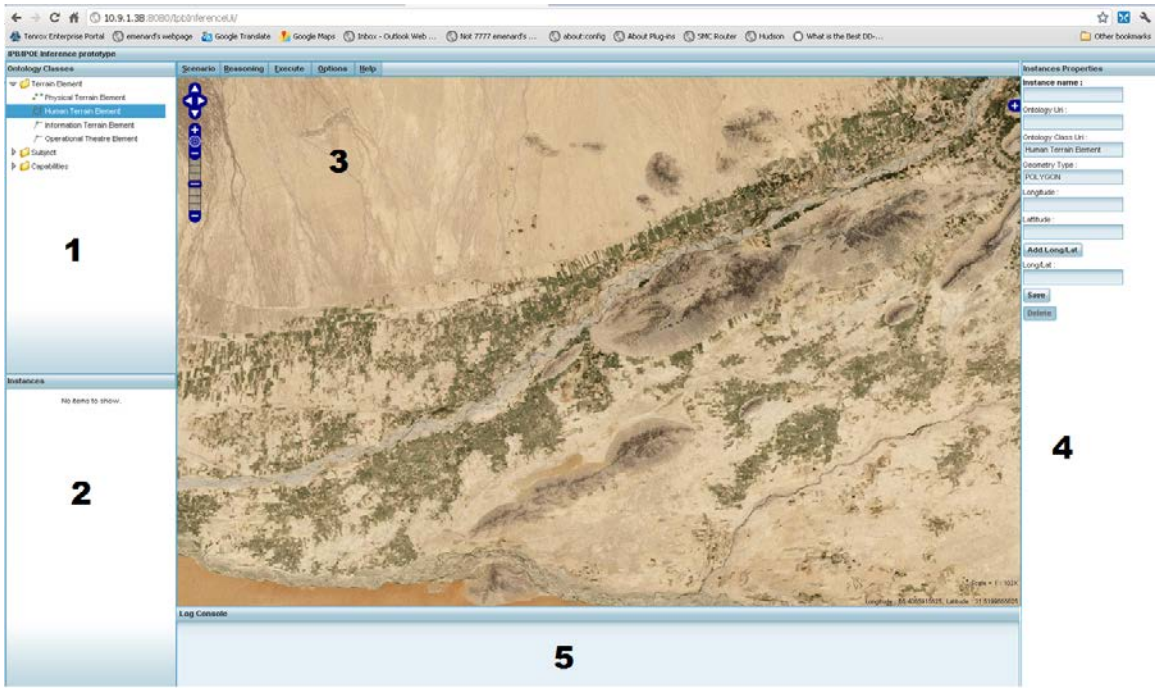


Figure 3: *Prototype 1 overview.*

The user interface (UI) is divided in five sections:

1. Class selector
2. Instance selector
3. Map
4. Instance properties
5. Log Console

The class selector allows the user to select the type of element to represent in the situation. It can be a terrain element (which would also be represented on the map) or, for example, a more abstract concept such as a capability.

The instance selector allows the user to see all the elements that are currently present in the situation. If these elements are physically present in the situation (e.g., a person, vehicle, road), they will also be displayed on the map. More abstract situation elements will only be shown in the instance selector window. The instance selector also shows additional information on the various situation elements. Figure 4 shows a close-up of the instance selector.

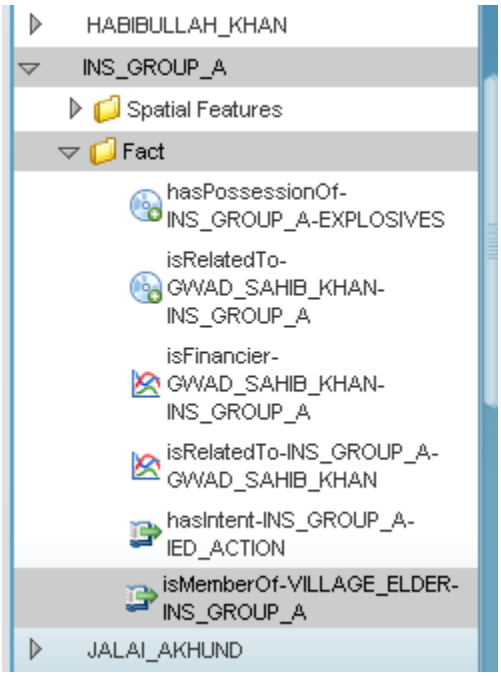


Figure 4: *Instance selector.*

In this particular case, information about a specific insurgent group (INS_GROUP_A) is shown. The "Spatial Features" folder contains the information that allows to plot a given element on a map. The "Fact" folder contains additional information about a given situation element. In this case, one can see that this specific group:

- has possession of explosives,
- is related to Gwab Sahib Khan,
- is financed by Gwab Sahib Khan, and
- has the intent to perform some IED action.

Notice that every information is tagged using an icon, which denotes its provenance, or pedigree. Figure 5 provides details on the different pedigree icons.

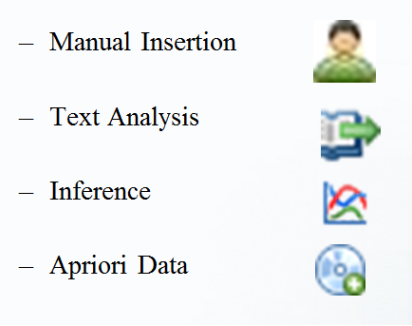


Figure 5: *Pedigree icons.*

The map section allows for visualising elements that are physically present in the situation. Various elements can be represented using:

- an icon
- a point
- a line
- a polygon

Figure 6 shows a close up of the Instance Properties section.

Figure 6: *Instance properties.*

This window allows the user to view and edit information about a given situation element:

- Name
- Ontology Uniform Resource Identifier (URI) (where its type of element is specified)
- Ontology Class (the type of element it is)
- Geometry Type
- Longitude
- Latitude

The log console allows showing system information about ongoing processing and system status.

The UI allows the user to manually specify information about the situation. Figure 7 shows an example of this process.

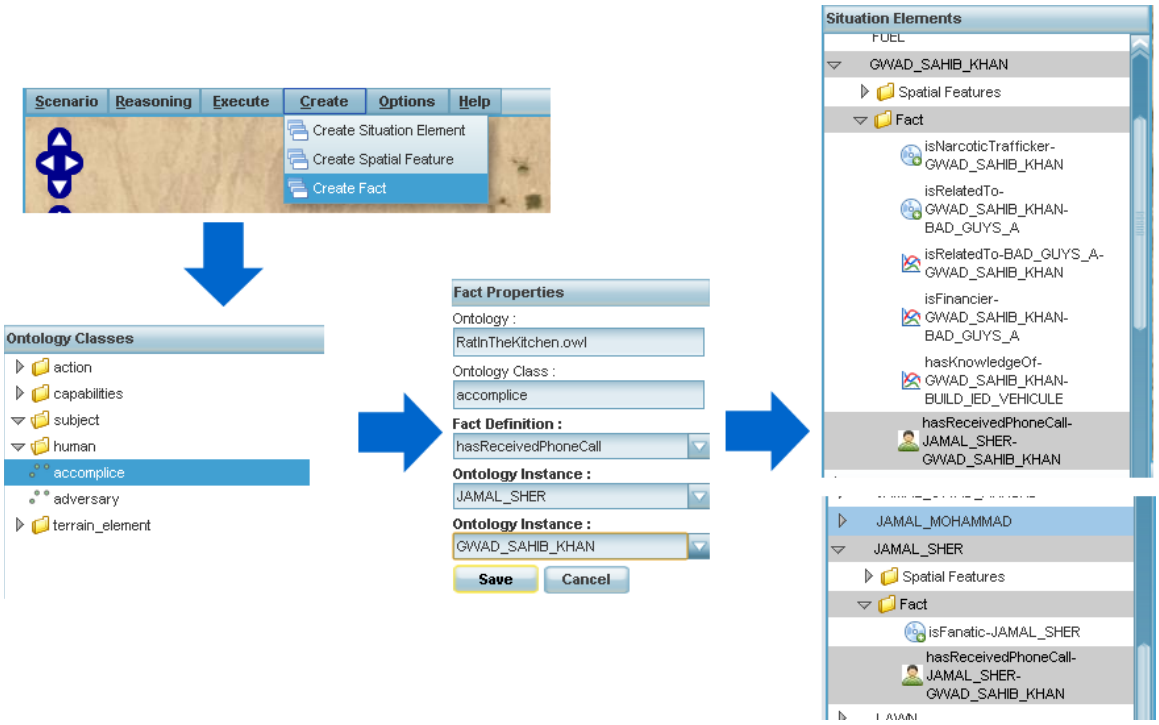


Figure 7: *Manual insertion of information.*

Using the menu, the user is able to specify that he wants to create a new element. Then it is possible to select the type of element to create in the class selector and to save this information. The process is the same whether the user wants to:

- add a new element to the situation ("Create Situation Element"),
- specify additional information about an existing element ("Create Fact"), and
- position a situation element on a map. ("Create Spatial Feature").

Finally, the user is able to launch a reasoning process using the menu shown on Figure 8.

Figure 8: *Launch reasoning.*

5.1.3 Observations

Working from an initial set of information, RBR is useful to infer additional situational elements that enrich the description of the situation. In the context of IPOE, RBR has proven especially useful in the preliminary steps of the process (situation description). RBR is suited to the identification of elements of interest (e.g., compounds, vehicles, or persons of interest). It is also suited to reflect indicators and warnings.

Although RBR yielded very promising results, it needs to be tuned carefully in order to provide meaningful results. In particular, rule authoring needs to be performed by individuals who are both experts of the domain, and who have a keen understanding of the RBR. Being an expert of the domain will ensure that created rules reflect actual expert knowledge or "know-how". Understanding of the RBR will ensure that the created rules do not clutter the system, potentially making it less efficient. Rules that trigger too often also generate a large amount of additional information (potentially of lesser use) and are likely to contribute to the analyst's information overload.

RBR can be used to perform more complex analysis (e.g., threat or high value target identification). However, it will always do so in a dichotomous or discrete manner. This is to say that rules will either fire (be used or applied) or not; there is no in between. For example, when performing threat analysis, a RBR system will either flag an element as threatening or not. In real life however, it is often the case that situational elements will be evaluated in a more continuous fashion, i.e., as being positioned somewhere on an axis between two distinct states. In order to support analysis in a more continuous fashion, the focus of the project has been shifted towards a different automated reasoning approach: case-based reasoning, which is the central topic of the next sections.

5.2 Second prototype

The second support system prototype implements case-based reasoning (CBR) and machine learning approaches. A short description of CBR and of the implemented machine learning methods is provided next, along with an overview of the prototype's functions, and a discussion on the observed results.

5.2.1 Case-based reasoning

Riesbeck and Schank [16] define a case-based reasoner as a reasoner that solves current problems by using or adapting prior solutions to previous problems. The general idea is to emulate the human reasoning process that relies on past experiences to solve new problems, reusing past solutions. A classic example of this process is doctors using diagnoses and treatments that were effective for former patients when a new patient with similar symptoms appears [17]. The premise is that new cases will bear sufficient similarity to past problems to allow for an appropriate mapping. In order for it to work, a CBR system requires cases that are stored in a case-base. A case is a "contextualized piece of knowledge representing an experience that teaches a lesson fundamental to achieving the goals of the reasoner" [18]. Typically, a case is composed of a representation of a problem and its solution. A CBR system will attempt to map the new problem to an existing case and its corresponding solution (Figure 9).

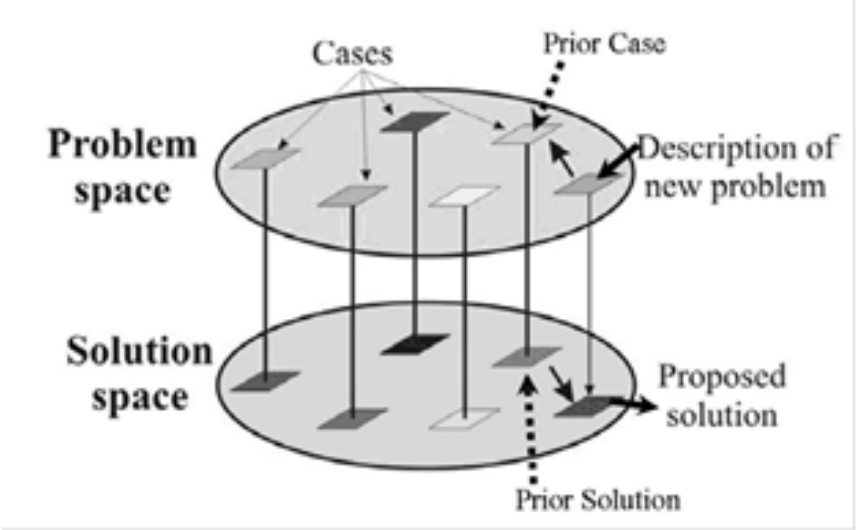


Figure 9: *Case-based reasoning system.*

5.2.1.1 Case-based reasoning and the IPB/IPOE

To perform CBR in the IPOE context, the first mandatory step is to select features from the operational environment that will make up a situation template, which is a formalized description of the situation that is the IPOE version of the problem description discussed earlier. Typically, feature selection entails picking the features that are necessary and sufficient to describe a problem. That is to say that one wants to select a set of features that will allow comparison with past problems effectively. More details on this process are provided in Section 5.2.3.2.8.

The second required step to perform CBR in the IPOE context is building a similarity measure that will allow comparison between the current situation template and past situations (cases). For situation comparison, a feature-based approach has been selected, where each feature of a template is compared individually and the similarity of situations is represented as a sum of each individual feature comparison. Additional details on this approach are given in Section 5.2.3.2.8.

Detailed theoretical information on CBR and its application to IPOE can be found in [19] [20].

5.2.2 Machine learning

Machine learning, a branch of artificial intelligence, concerns the construction and study of systems that can learn from data [21]. In the case of the Self Improving Inference Prototype (SIIP), machine learning is used to improve the accuracy of the CBR retrieval step, based on user feedback. In other words, the user will be presented with past situations that are somewhat similar to the current situation. Based on the feedback provided by the user, the system (with the use of machine learning) will improve its performance and retrieve prior situations that are more similar to the current one.

If the user is not satisfied with the retrieval results, he has the possibility to provide feedback to the system in order to obtain new, improved results. The system handles two main types of feedbacks:

- re-ranking feedback
- relevance feedback

Re-ranking allows the user to reorder the results in function of his perceived similarity to the current situation. Relevance feedback is done by tagging results as either "relevant", "irrelevant", or as untagged.

Detailed theoretical information on machine learning and how it can be applied to CBR and IPOE can be found in [20].

5.2.3 Prototype functions

This subsection goes over the main functions of the prototype, to highlight the CBR and learning functions.

5.2.3.1 High-level description

Figure 10 gives an overview of the approach followed within the system to support the analyst using CBR and machine learning.

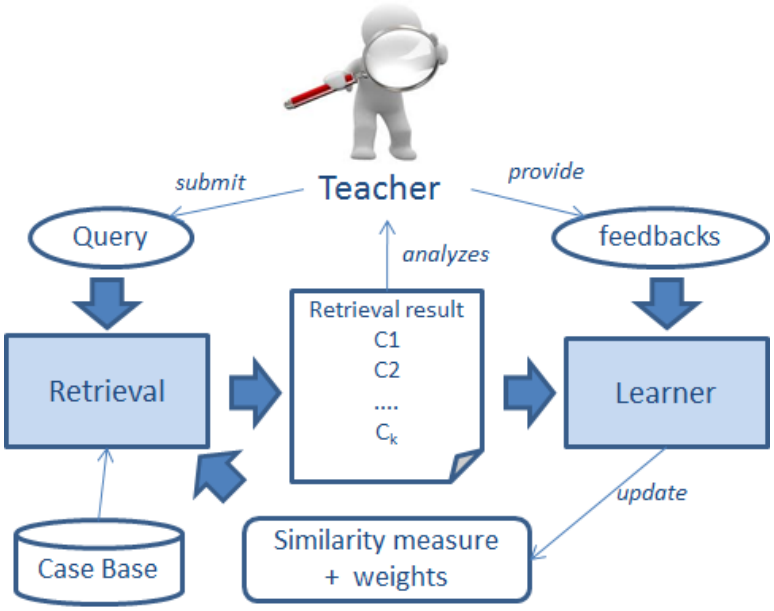


Figure 10: *General approach used in the SIIP.*

First, the user (analyst), or teacher, submits a query to the system. A first set of results is retrieved from the case base and presented to the user. The user then analyses the retrieval results and

provides feedback to the learning module. After having received feedback from the teacher, the learning module proceeds to adjust results in order for the subsequent retrieval results to reflect the feedback of the user. The user is then free to iterate over a new set of retrieval results.

5.2.3.2 Prototype functions overview

This second prototype was build using a collection of widgets that each fulfill a different role. A widget is a small application with limited functionality. In the following sections, each widget's functionality is illustrated and explained.

5.2.3.2.1 Map widget

The Map widget displays elements of a situation using icons on a map. Figure 11 shows the map widget.

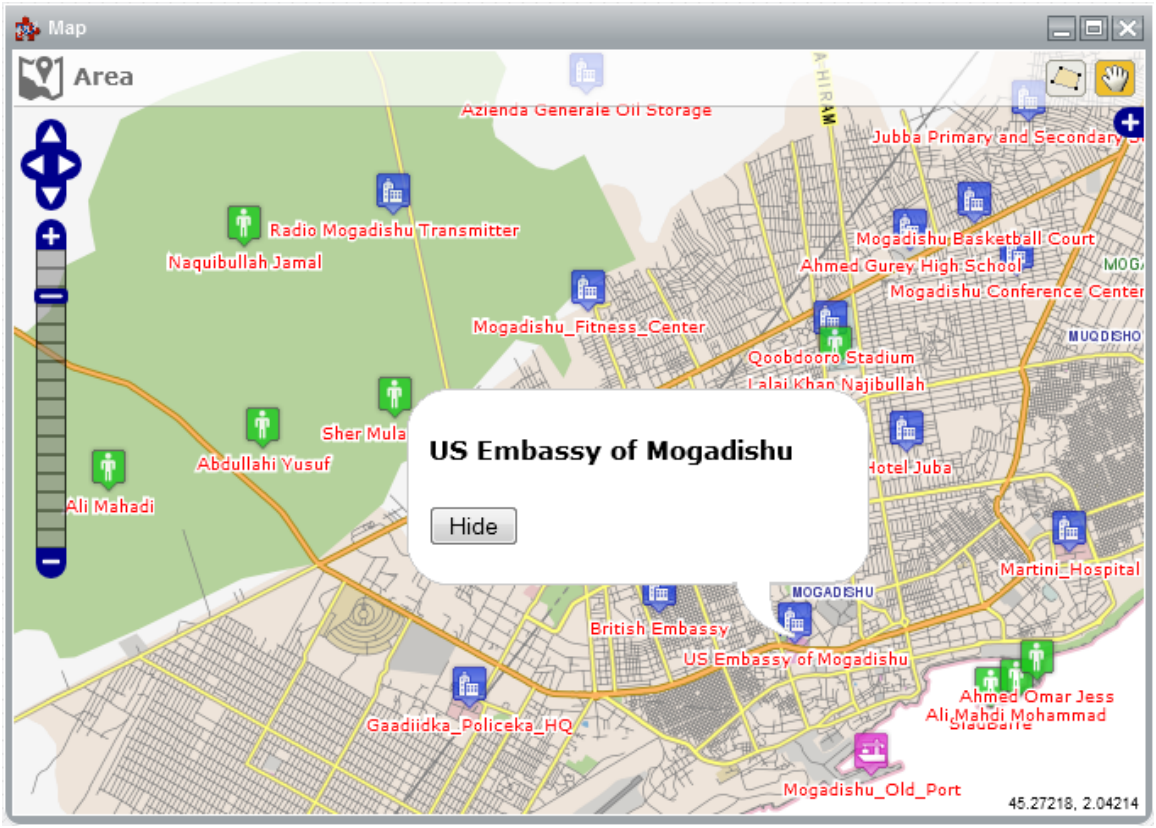


Figure 11: *Map widget.*

Each situation element is represented as an instance of a class of a situation description ontology. Each class of this ontology has a specific icon. The user can navigate on the map using the hand tool. It is also possible to add icons on the map or to draw a polygon to specify an area of operations.

5.2.3.2.2 Element Selector widget

The Element Selector widget allows the user to select situation elements of interest (ontology instances). Figure 12 shows the element selector widget.

Figure 12: *Element Selector widget.*

It allows the user to browse the situation description ontology and to find the elements present in different classes. From this widget, the user can add a new element (instance) to a class.

5.2.3.2.3 Element Inspector widget

The Element Inspector widget allows the user to specify information about a situation element (ontology instance). Figure 13 shows the element inspector widget.

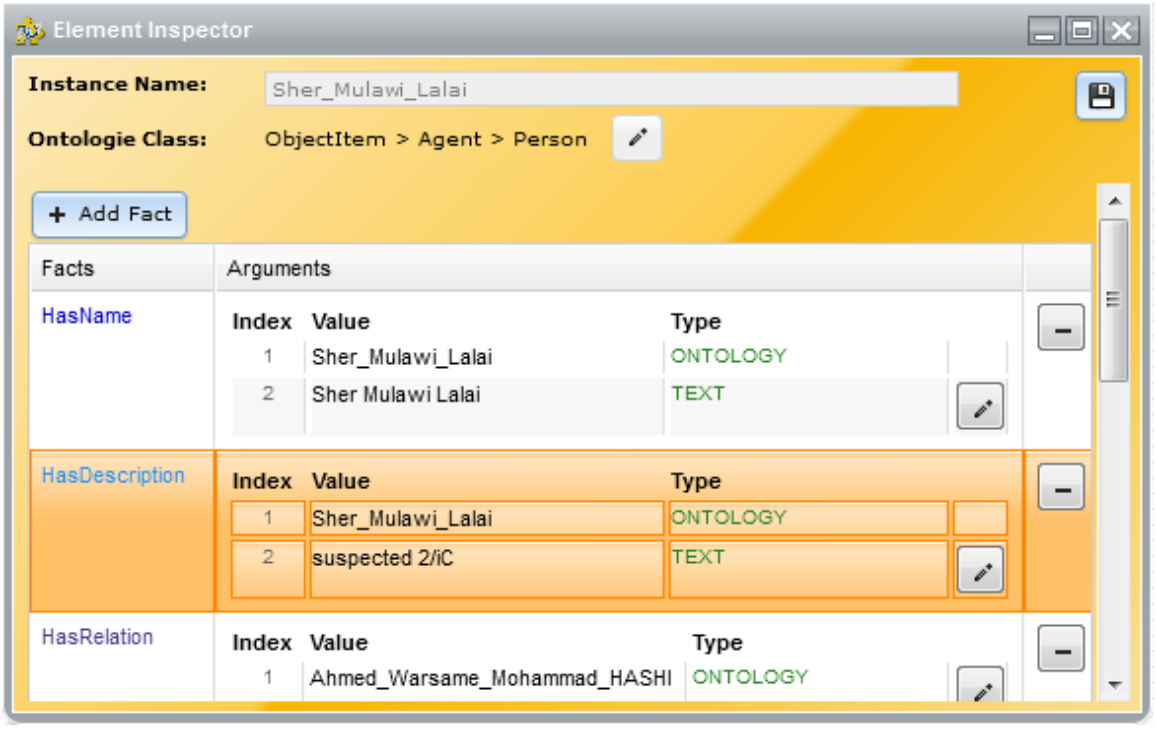


Figure 13: *Element Inspector widget.*

The widget displays the instance name and additional information (facts) about the specified situation element. The user can add additional information (facts) about the element using the "add fact" button.

5.2.3.2.4 Class Selector widget

The Class Selector widget allows the user to select a class in a specific ontology. Figure 14 shows the class selector widget.

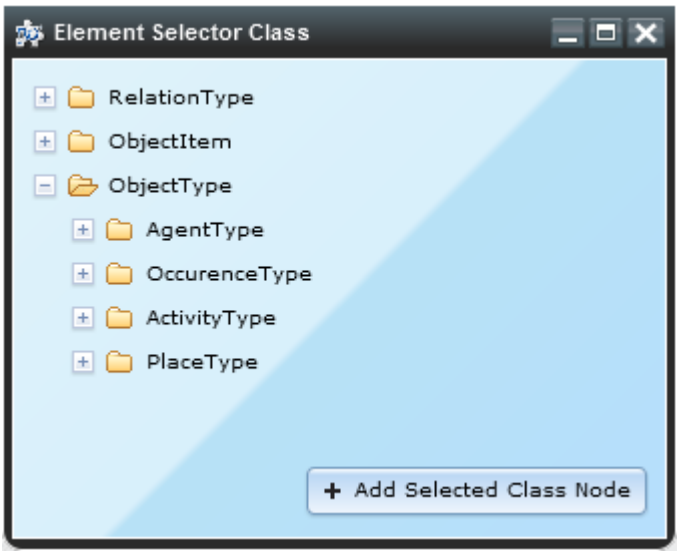


Figure 14: *Class Selector widget.*

The "Add Selected Class Node" button allows the user to identify the selected class. This functionality is useful when the user want to specify the class (type) of a new situation element.

5.2.3.2.5 Operational Environment Elements widget

The Operational Environment Elements widget displays situation elements (ontology instances) that are part of the operational environment. Figure 15 show the Operational Environment Elements widget.

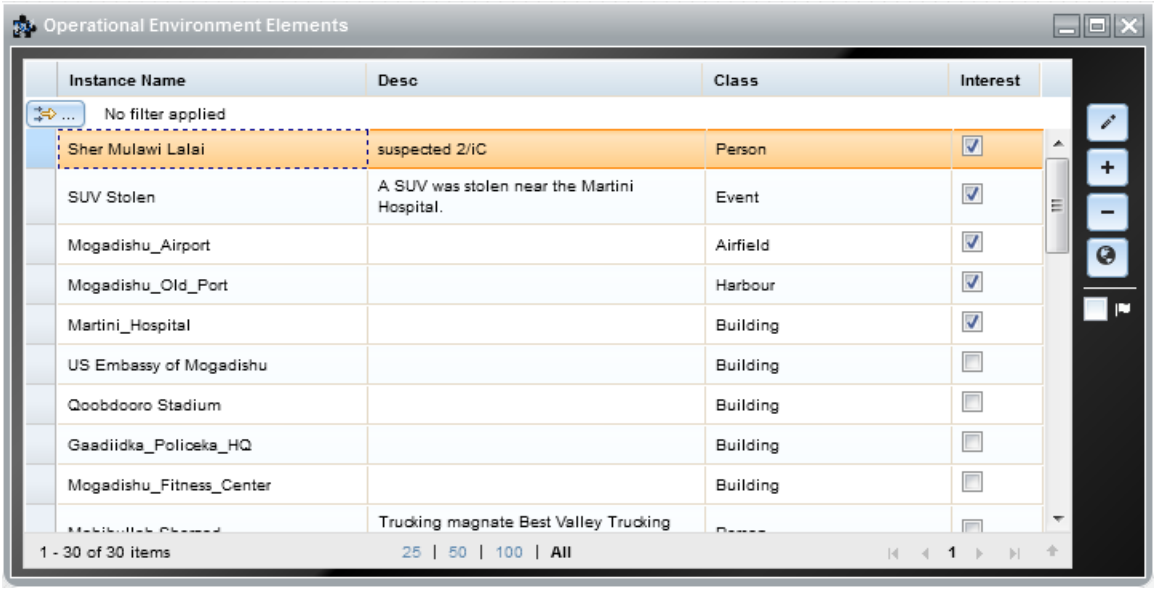


Figure 15: *Operational Environment Elements widget.*

The widget shows situation elements along with their description, class (of the instance), and an "interest" check box. This check box allows the user to specify whether a given element is of particular interest. Elements of "interest" will be forwarded to the CBR module for further analysis. This is detailed in Section 5.2.3.2.7. There are four buttons on the right-hand side of the widget. The top button allows for editing the selected element. The second button allows for the addition of an element to the list. The third button removes the selected element from the list, and the fourth (earth) button displays the selected element on the map widget.

5.2.3.2.6 IntQuery widget

The IntQuery widget allows the user to select a CBR Template and ask the CBR engine to propose a list of potential solutions based on the operational context being investigated by the user and the selected template. Figure 16 shows the IntQuery widget.

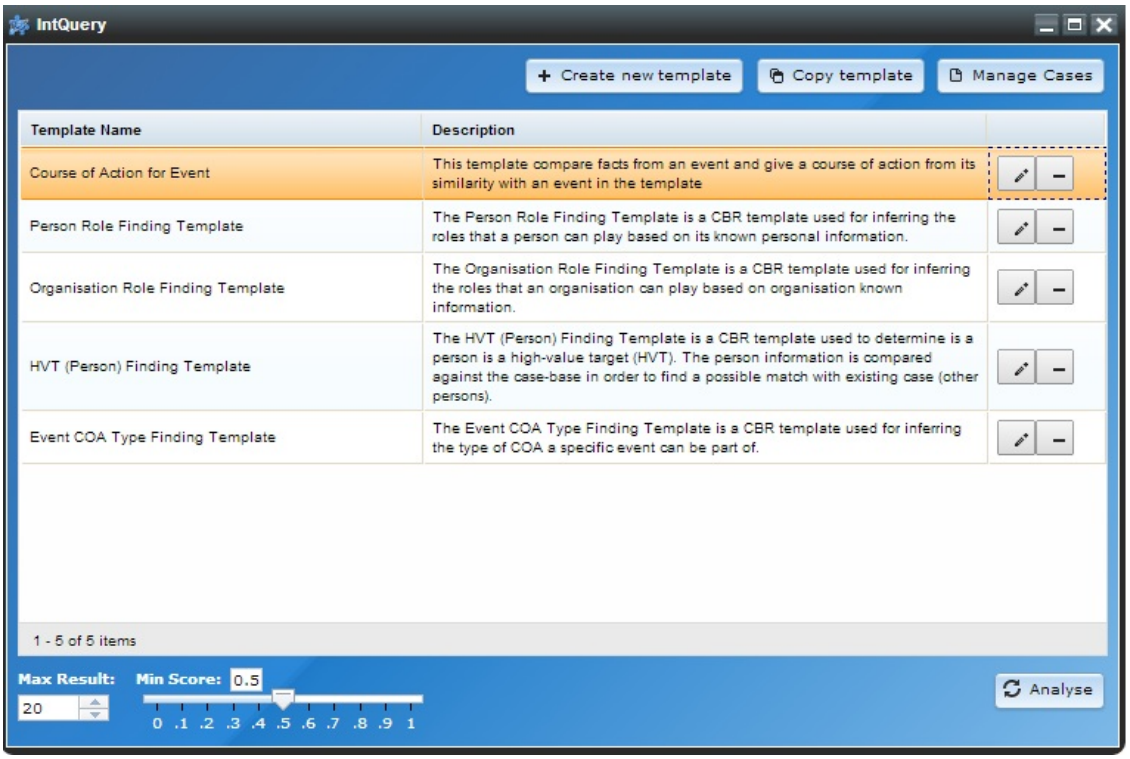


Figure 16: *IntQuery widget.*

The widget shows the name and description of each template. As previously mentioned (Section 5.2.1.1), a template is a formalized description of a situation. Each template points to a particular CBR analysis. A selected template will be automatically populated using the elements that were selected as of "interest" by the user (see Section 5.2.3.2.5).

Using a given template, it is possible that a single, many or no field will be populated. Indeed, the template's fields will be filled with elements of "interest" present in the situation. If no situation element fit the template's fields, then nothing will happen.

The widget provides buttons to create new CBR templates (see Section 5.2.3.2.8), copy a template, or manage cases (see Section 5.2.3.2.9). The buttons at the end of each of the template lines allow for the edition or deletion of a template. By pushing the "analyse" button, the user will launch the CBR analysis with the selected template. In the lower left corner, there is a means for the user to select the maximum number of results to be returned and the minimum required score of the similarity measure (Section 5.2.1.1) for a given analysis.

5.2.3.2.7 Proposed Solution widget

The Proposed Solution widget displays the solutions proposed by the CBR service. Figure 17 shows the Proposed Solution widget.

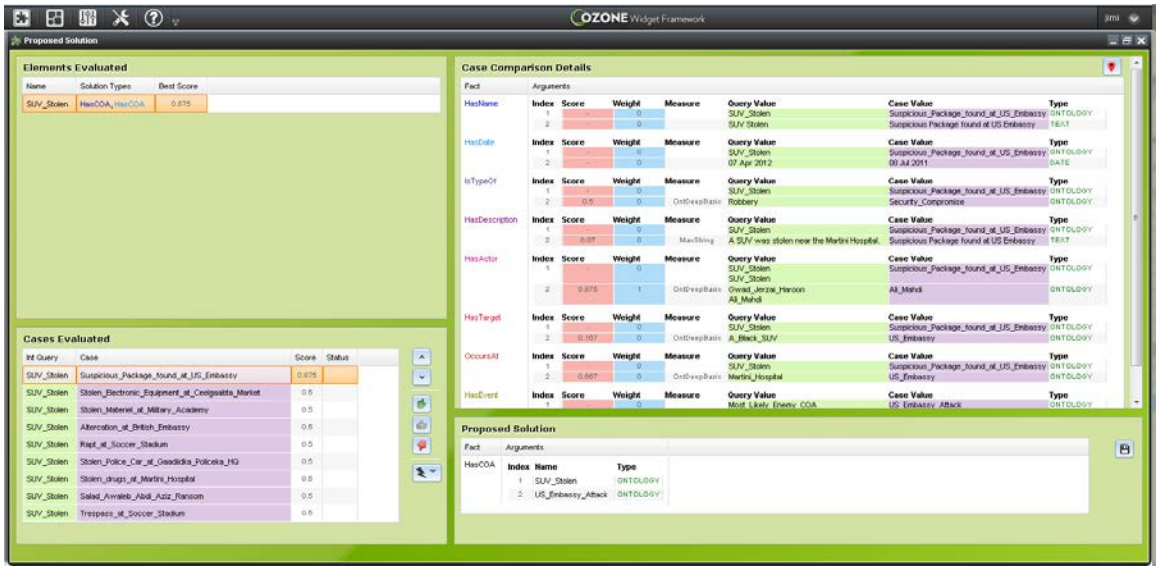


Figure 17: *Proposed Solution widget.*

The widget is divided in four parts: Elements Evaluated, Cases Evaluate, Case Comparison Details, and Proposed Solution. Each part is discussed in detail next.

5.2.3.2.7.1 Elements Evaluated

The Elements Evaluated part of the widget shows the templates that were evaluated against the case base. Figure 18 shows the Elements Evaluated widget pane.

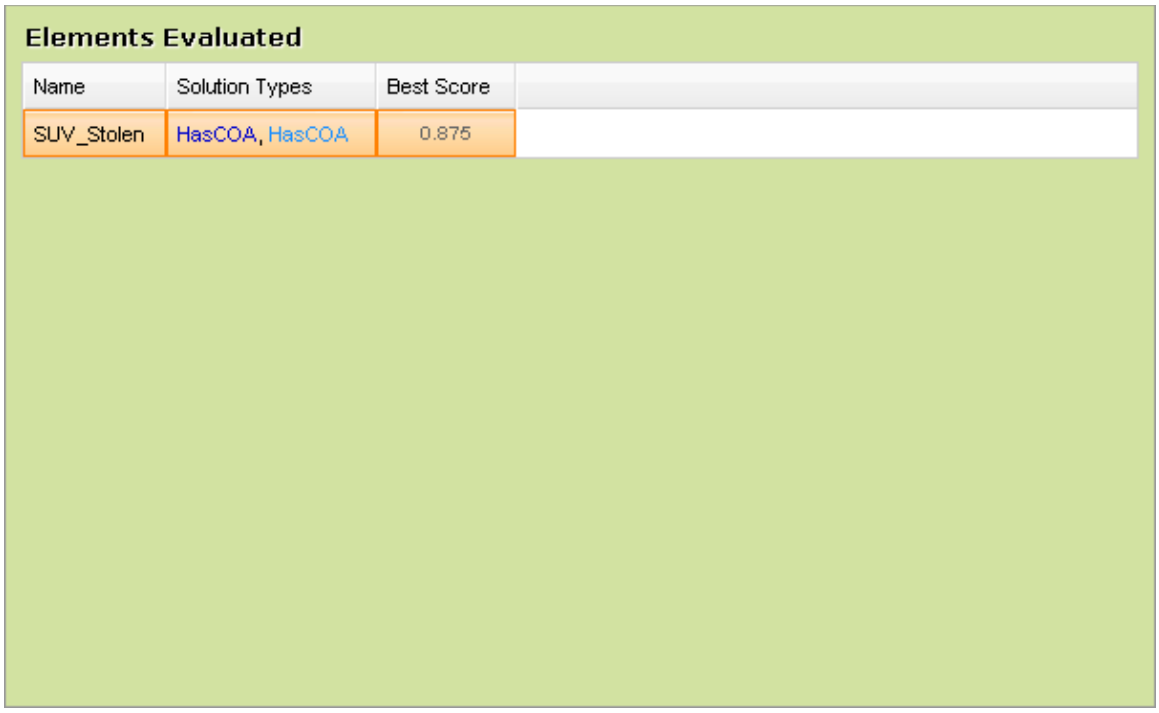


Figure 18: *Elements Evaluated.*

The user is provided with the name of the template, the type of solutions potentially associated with the cases, and the best score obtained from matching with the case-base. When the user selects an item in the list, the Cases Evaluated section is refreshed with the case evaluated against that specific template and the Proposed Solution section is refreshed with the solution proposed by the CBR.

5.2.3.2.7.2 Cases Evaluated

The Cases Evaluated section (Figure 19) shows all the cases that were evaluated by the CBR against the template selected in the Elements Evaluated pane.

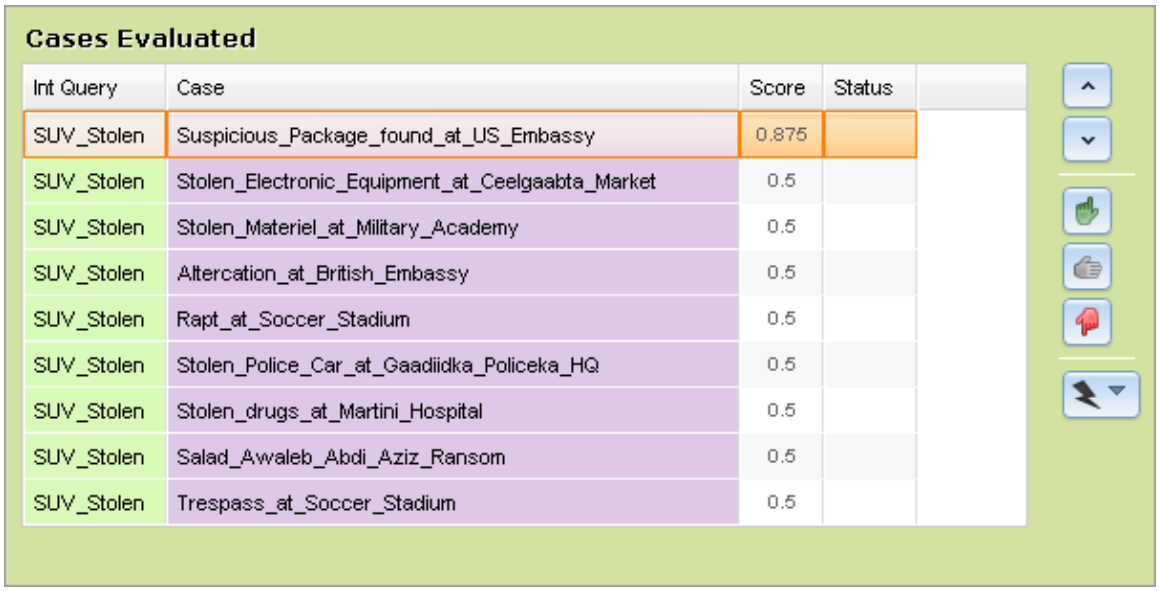


Figure 19: *Cases Evaluated.*

The pane shows the IntQuery (template) used. The name of each retrieved case is also shown, along with its similarity score. The status field reflects the feedback provided by the user (see 5.2.2). The user can provide feedback using the buttons on the right-hand side of the pane. The arrows allow the user to re-rank the proposed cases. The green (relevant), grey (neutral) and red (irrelevant) hand icons allow the user to specify relevance feedback. The lightning icon launches the learning module.

5.2.3.2.7.3 Case Comparison Details

The Case Comparison Details section allows the user to compare the value of the fields of the template (query) and the selected case. Figure 20 shows the Case Comparison Details.

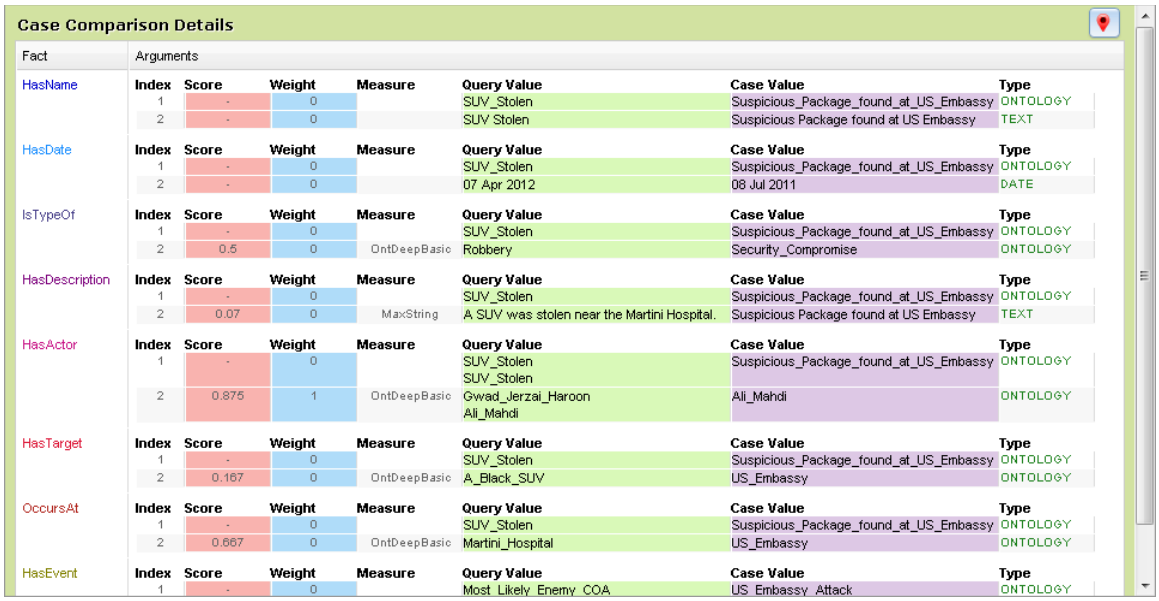


Figure 20: *Case Comparison Details.*

The user can compare the current situation template with the retrieved cases using the following attributes:

- Index: The index of the argument;
- Score: The score obtained by the case value when it was compared with the template value;
- Weight: The importance of the specific argument (or field) argument;
- Measure: The type of local similarity measure used to compare the value of the template with the one of the case;
- Query Value: The value of the argument in the query (template);
- Case Value: The value of the argument in the case; and
- Type: The type of the argument.

5.2.3.2.7.4 Proposed Solution

The Proposed Solution section displays the solutions proposed for a selected case. Figure 21 shows the Proposed Solution Pane.

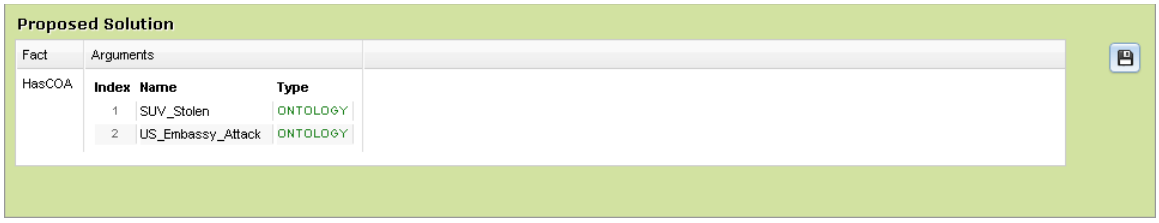


Figure 21: *Proposed Solution.*

If the user click on the save button (located on the right-hand side), the listed facts will be added to the current situation.

5.2.3.2.8 IntQuery Detail widget

The IntQuery Detail widget allows the user to create a CBR template by specifying its fields (facts), its similarity measure and the conclusion associated with it. Figure 22 shows the IntQuery Details widget.

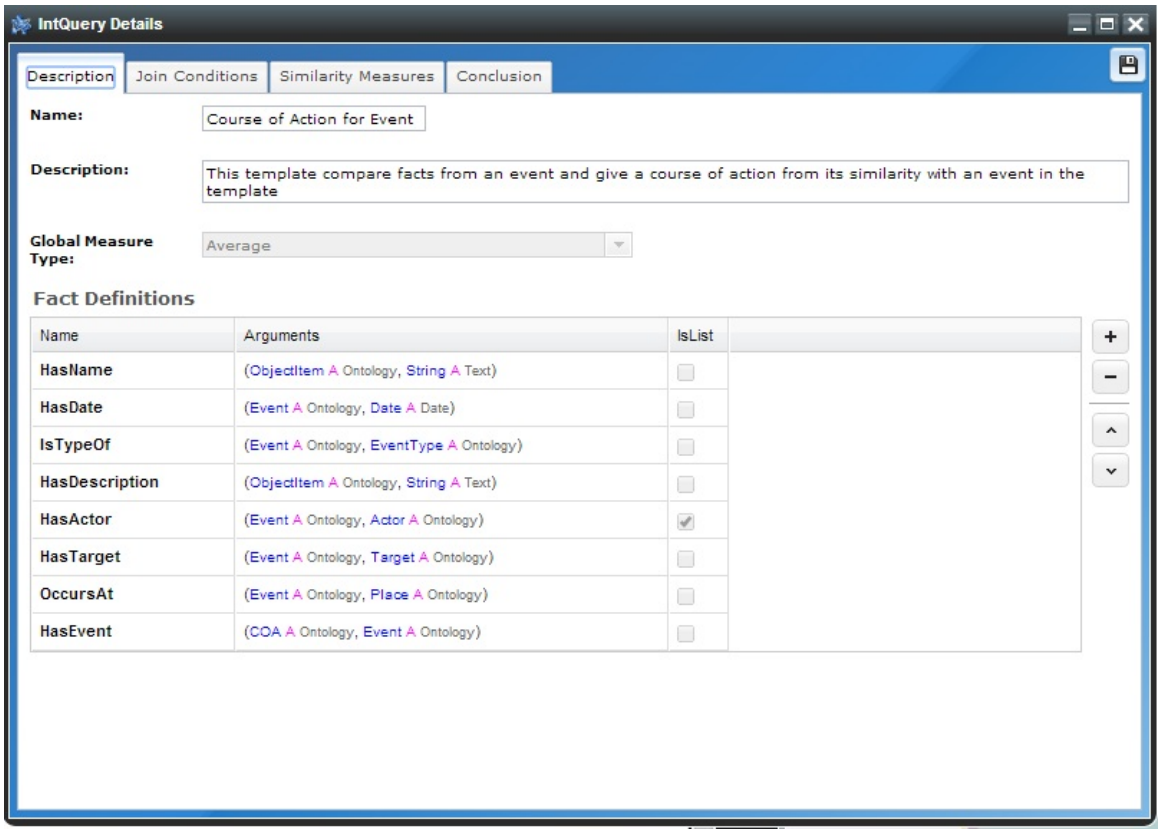


Figure 22: *IntQuery Details widget- Description tab.*

This widget has four tabs: Description, Join Conditions, Similarity Measures, and Conclusion. The Description tab (shown on Figure 22) allows the user to provide a name and a description for the template. It is also possible for to user to specify the type of global similarity measure to use. In the case of this prototype, only the average measure is available. The user can then choose the fact definitions that will make up the template using the buttons on the right.

Figure 23 shows the IntQuery details widget - Join Conditions tab.

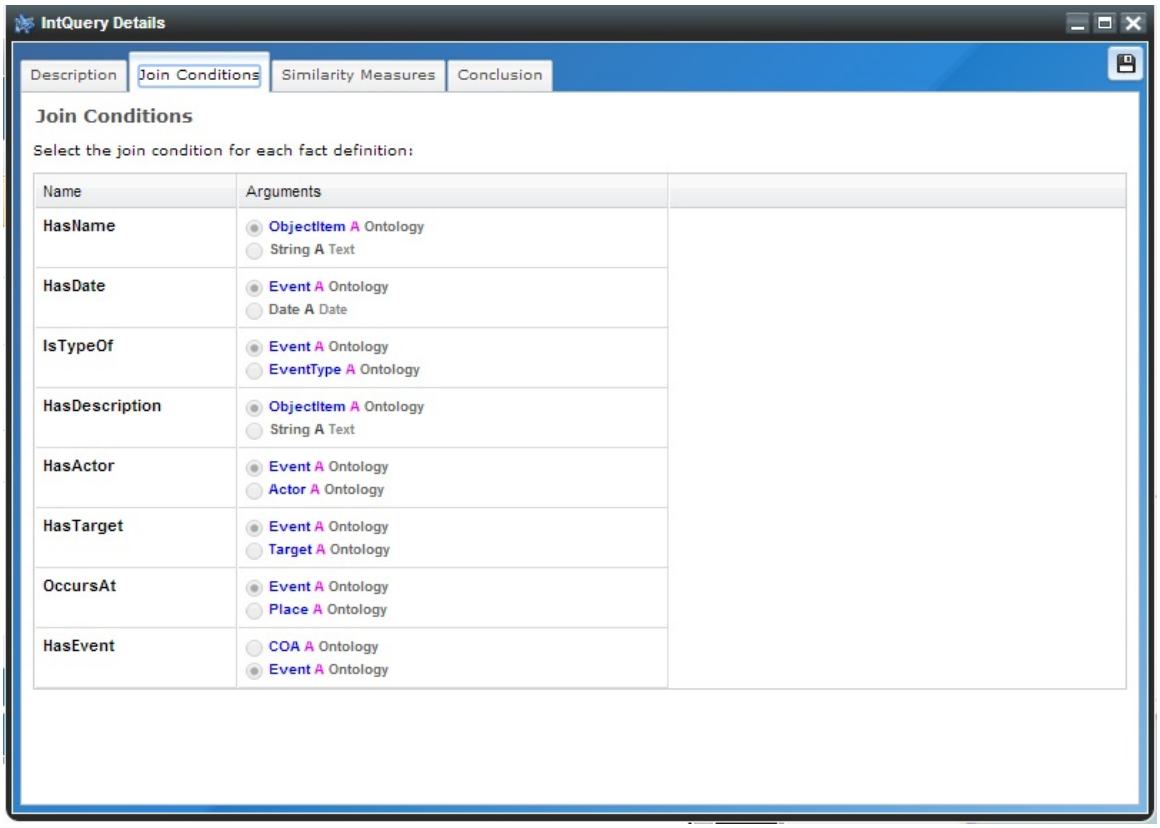


Figure 23: *IntQuery Details widget - Join Conditions tab.*

This section allows the user to specify how the various facts of the template will be linked together. It is not sufficient to describe a situation by enumerating its composing propositions (facts). It is also necessary to specify how the various propositions are linked together. Each proposition has a certain number of arguments. In the case of Figure 23, each fact has two arguments. The user must select the argument that will be common to all propositions in order to automatically join them together in a template. This is called the Join Condition. In the current example, the event "Event A" has been selected as the join condition, and it will have to be common to all facts in order for them to be grouped in a template.

Figure 24 shows the IntQuery Details widget – Similarity Measures tab.

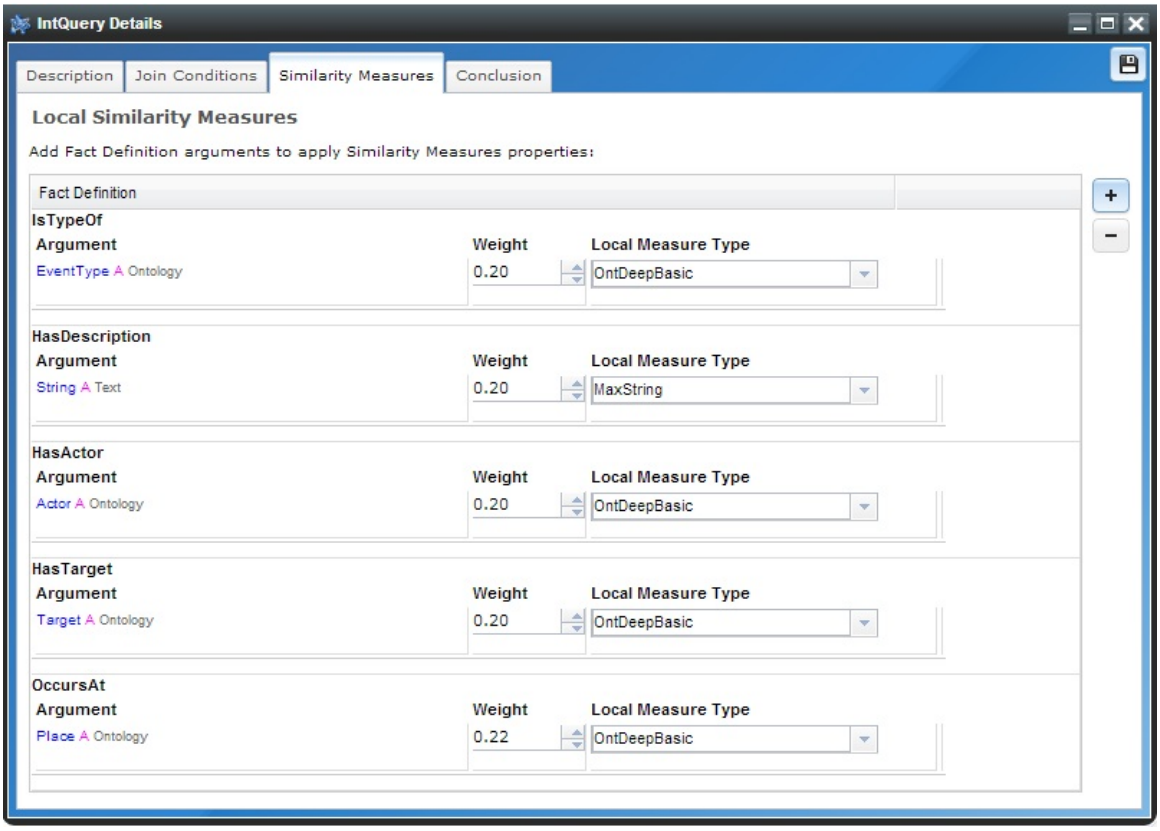


Figure 24: *IntQuery Details - Similarity Measures tab.*

This section allows the user to specify the relative importance of each feature of the template when comparing the current situation to past cases. By adjusting the weight of a given feature, the user will modify the importance of the given feature. It should be noted that all weights must sum up to 1. If a weight is set to 0, the associated feature will not be considered in the comparison. If a weight is set to 1, the associated feature will be the only feature considered in the comparison. The Local Measure Type allows for the specification of a type of similarity measure for a particular data type. For the current prototype, only one local similarity measure is available for each data type.

Figure 25 shows the IntQuery Details - Conclusion tab.

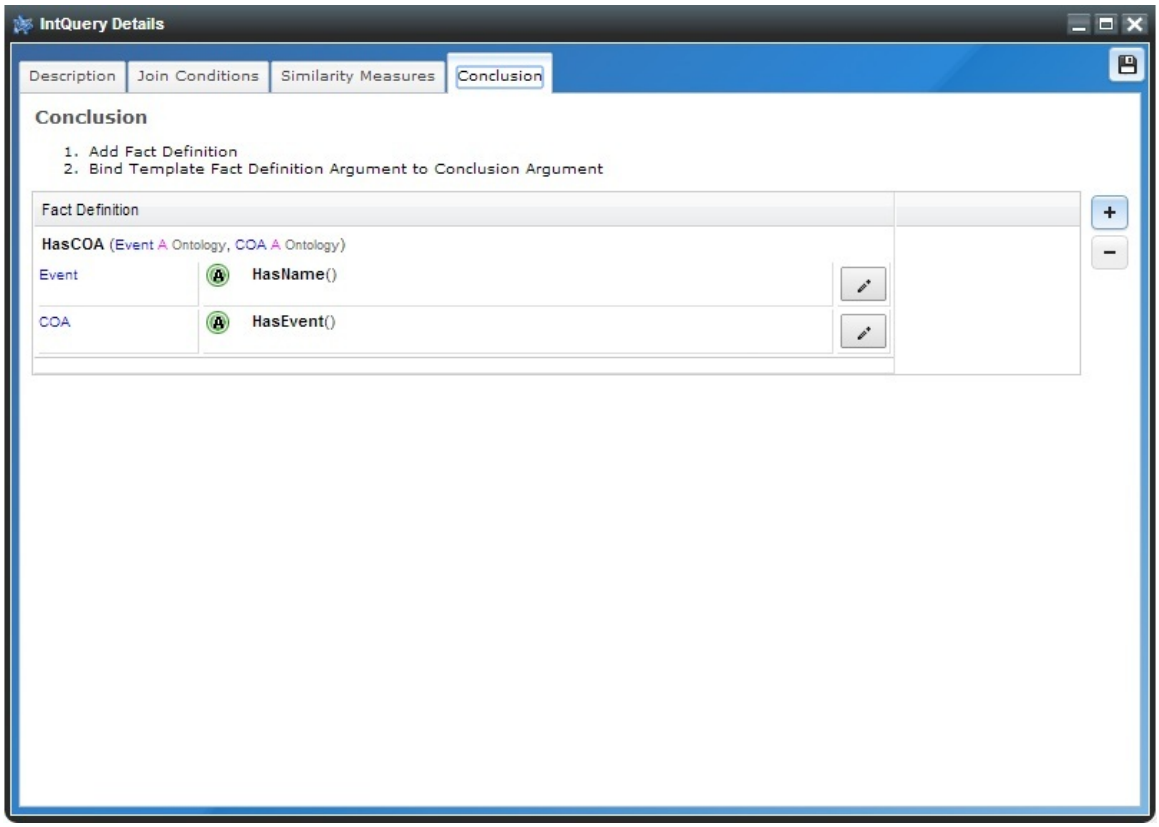


Figure 25: *IntQuery Details - Conclusion tab.*

This section allows the user to specify the conclusion that will be drawn if a current template is validated as similar to a past case by the user. The conclusion is in the form of a set of propositions (facts) that can potentially reuse elements of the template. When drawing a particular conclusion, the specified propositions will be added to the system.

5.2.3.2.9 Cases Editor widget

In order for any CBR system to work, there needs to be a case-base to be used for comparison with the current situation. The SIIP prototype is no exception to this rule, and in order to facilitate the case-base building process, a case editor widget has been developed (shown on Figure 26).

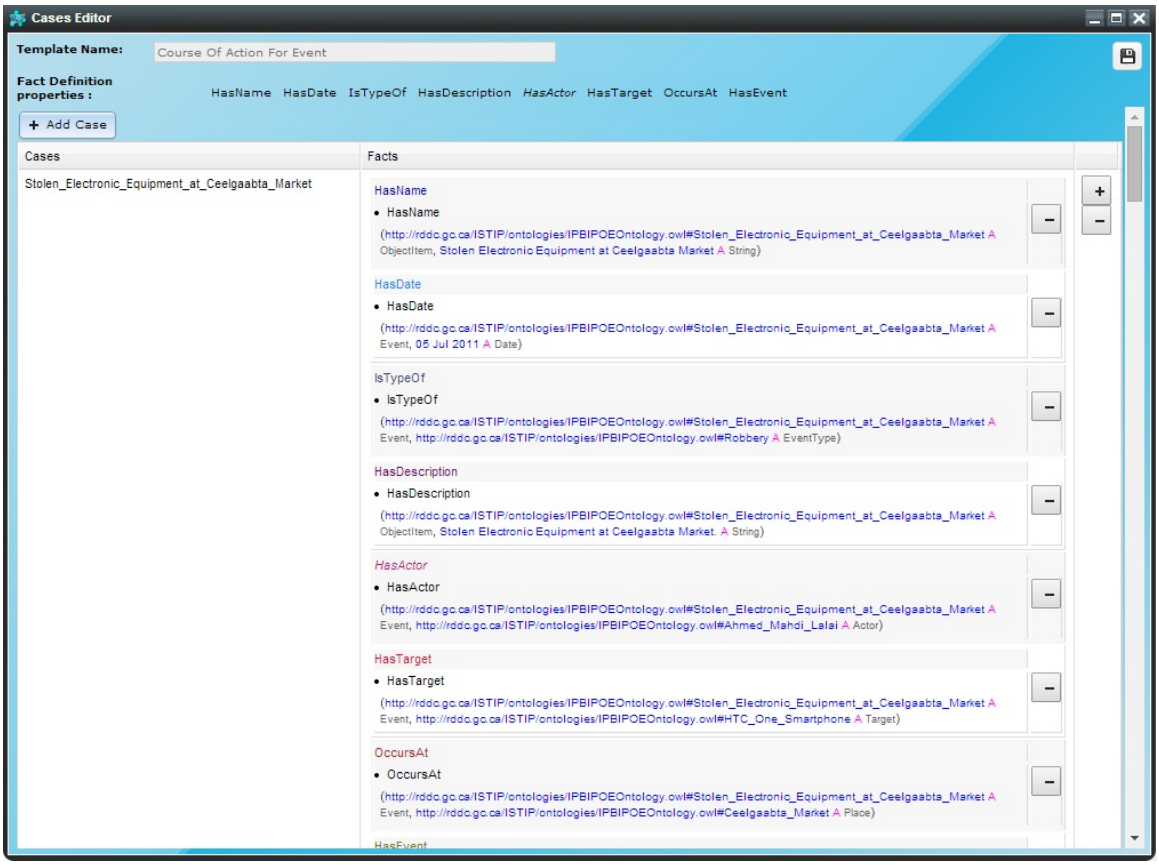


Figure 26: *Cases Editor widget.*

This widget allows the user to add a case to the case-base. The user will be able to select the template that he wants to populate and specify every required feature. Having provided details on the case (description and conclusion details), the user can then save it to the case-base. It will then become available for comparison against emerging situations.

5.2.4 Observations

5.2.4.1 Complexity

A RBR system (as described in Section 5.1.1) analyses a situation and draws conclusions using clear cut, well defined rules or conditions. In a given situation, these conditions are either met or not, which is to say that a RBR system will either draw a conclusion or not.

A CBR system reflects similarity between situations by considering numerous features of various importance. The result is a comparison that is more subtle and less definite. In CBR, the similarity between situations is reflected by a measure (often a number between zero and one). Based on the similarity result and the actual measure employed, an analyst can decide whether or not he wishes the conclusions associated to the retrieved case to be drawn.

CBR provides a means to compare more complex situations in a more sophisticated fashion, which is likely to yield interesting results that are complementary to those of a RBR system. However, as the mechanisms involved in CBR are more complex, they are likely to require a higher level of comprehension from the user in order to make proper use of the tool, and to understand and, potentially, accept the results.

The same remark applies to the learning component of the system. The learning algorithms perform based on the feedback they receive. In order to properly "train" the learning module, a user has to provide feedback that is both relevant and coherent. Relevant feedback will ensure that the direction given to the algorithm effectively reflect the sought after results. Coherence will ensure that the direction given by the user feedback does not change over the course of a set of learning iterations. By being aware and observing these rules, a user will maximise the performance of the learning system, yielding useful results.

5.2.4.2 Case-base

CBR can provide support to analysts performing situation analysis in IPOE. It is obvious that to achieve this, a rich, well-structured case base must first be built and made available to the user.

At early exploitation stages, a case-base is likely to contain only a limited amount of cases to compare against. In order to have users populate a case base, there must be incentive for them to use the CBR system and contribute to it. In presence of an empty case base, as no useful result is going to be returned, it would prove difficult to provide incentive to the user. A way to circumvent this is to populate the initial case-base with a limited number of representative cases. By representative cases, we mean typical, patent cases that are likely to represent situations or problems that a user will encounter. Having a few of such cases will likely provide viable initial support to the user, encourage use of the system, and augment the chances of having users contributing new cases to the system.

Further work would be beneficial in order to augment the maturity of the current prototypes, and bring them closer to potential use in a real-life, deployed environment. This involves: fine tuning actual data sources in order to feed the prototypes with real data, testing the prototypes with analysts in order to refine training procedures, user interface requirements, and high-value use cases.

6 Conclusion

IPB/IPOE is a complex, time consuming, labour-intensive process that is often conducted in time-constrained, highly dynamic contexts. This leads to the analysts being faced with information and cognitive overload problems. This report detailed an approach to address these problems and support the IPB/IPOE process using Self-Improving Inference Systems.

The results from IPB/IPOE literature reviews, technological surveys, SME interviews and workshops were discussed and detailed. Following a functional decomposition of the IPB/IPOE, over 160 reasoning requirements were elicited. Based on these findings, two separate IPB/IPOE support system prototypes were developed. A first prototype focused on Rule-Based Reasoning (RBR), which draws conclusions if a set of well-defined pre-conditions are met. The second prototype focused on case-based reasoning (CBR), which compares a current situation to past ones in order to identify aspects that are likely to be common in both situations. RBR has been proven useful to enrich the environment (situation) description, the identification of elements of interest, as well as to generate indicators and warnings. CBR was used to identify potential actors (for threats), targets, and COAs.

The value of each approach was demonstrated, but additional work is warranted in order to attain the goal of supporting IPB/IPOE analysts in a deployment context. The integration of data sources into the system would allow for the validation of actual results, based on real experience. Having analysts use the tool in a deployment-like context would allow to validate the required training and user interface.

References

[1] US Military, “US Joint Intelligence Preparation of the Operational Environment”, *Joint Publication 2-01.3*, 16 June 2009.

[2] Frini, A., Bergeron-Guyard, A., Caropreso, F., “Intelligence Preparation of the Battlefield and Operational Environment: General Principles and Research Avenues”, *RDDC Valcartier TM 2010-404*, December 2010.

[3] Intelligence Preparation of the Battlefield (IPB), APLN 04.03 & 04.04.

[4] Army, “The Force Employment Concept for the Army - One Army, One Team, One Vision - The Changing Face of Warfare”.

[5] Tremblay, S., Rousseau, R., Bentahar, J., Banbury, S., Miller, J., Becking, I., Rioux, F., “Study of SNA, IPB/IPOE and COIN - IPB/IPOE Chapter”, *RDDC Valcartier CR 2011-091*, March 2011.

[6] Banbury, S., Bentahar, J., Becking, I., “IPB/IPOE Reasoning Requirement Inventory Report”, *RDDC Valcartier CR 2011-094*, March 2011.

[7] Rioux, F., Dumais, E., “SOTA on IPB/IPOE Vis Report ”, *RDDC Valcartier CR 2011-096*, March 2011.

[8] Wikipedia contributors, “Functional decomposition”, *Wikipedia, The Free Encyclopedia*, 14 February 2014, 20:44 UTC, http://en.wikipedia.org/w/index.php?title=Functional_decomposition&oldid=595497406> [accessed 1 April 2014].

[9] B-GL-357-001/FP-001. (2001), “Land force information operations: Intelligence field manual”, Canadian Department of National Defence, Ottawa, Canada.

[10] Field Manual (FM) 34-130. (1994), “Intelligence preparation of the battlefield”, Washington DC: Headquarters Department of the Army.

[11] Field Manual (FM) 34-3 (1990), “Intelligence Analysis”, Washington DC: Headquarters Department of the Army.

[12] Roy, J., “Rule-Based Expert System for Maritime Anomaly Detection”, Proceedings of Sensors, and Command, Control, Communications, and Intelligence (C3I) Technologies for Homeland Security and Homeland Defense VIX, SPIE Defense, Security, and Sensing 2010, Orlando, FL, USA, 5 - 9 April 2010, Paper 7666-97.

[13] Bergeron-Guyard, A., “Multi-Reasoner Framework to Support Situation Analysis and Context Awareness”, Proceedings of Artificial Intelligence and Applications 2013(AIA2013), Innsbruck, Austria, February 2013.

[14] Roy, J., Auger, A., “The Multi-Intelligence Tools Suite – Supporting Research and Development in Information and Knowledge Exploitation”, Proceedings of 16th International Command and Control Research and Technology Symposium “Collective C2 in Multinational Civil-Military Operations”, Québec City, Canada, June 21–23, 2011.

[15] Jboss.org, “Drools, Business Rules Management System”, http://www.jboss.org/drools/, [accessed 15 April 2014].

[16] Reisbeck, C.K. and Schank, R., “Inside Case-Based Reasoning”. New Jersey: Lawrence Erlbaum Associates, 1989.

[17] Mujica, L.E, Vehi, J., Kolakowski, P., “A hybrid approach of knowledge-based reasoning for structural assessment”, Smart Material Struct., vol. 14, 2005, 1554-1562.

[18] Leake, D. B., “Case-Based Reasoning: Experiences, Lessons, and Future Directions”, Cambridge: MIT Press, 2000.

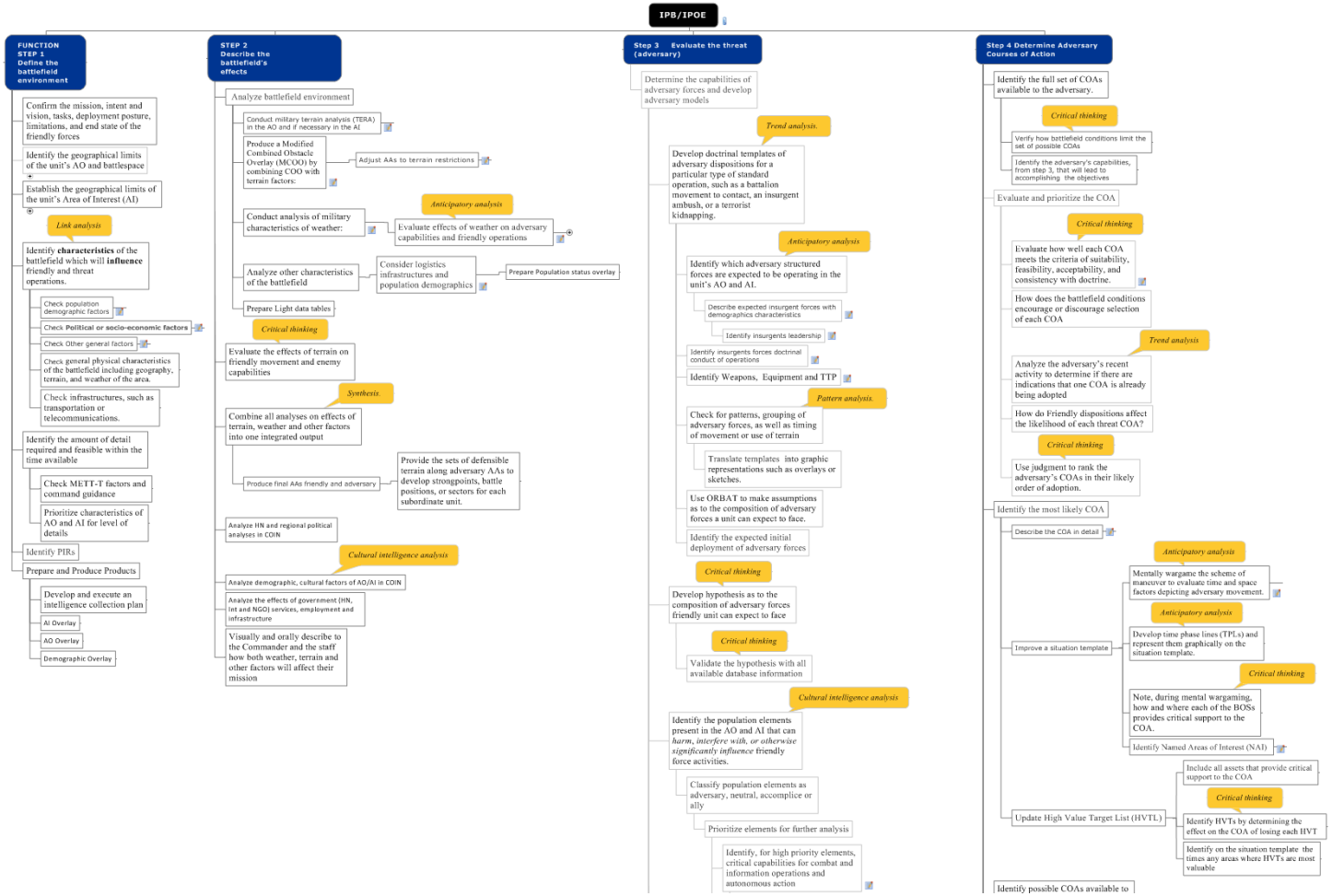
[19] Bergeron-Guyard, A., “Multi-Reasoner Framework to Support Situation Analysis and Context Awareness”, Proceedings of Artificial Intelligence and Applications 2013(AIA2013), Innsbruck, Austria, February 2013.

[20] Bergeron-Guyard, A., Lamontagne, L., “SIIP: A Situation Analysis Prototype Using Case-Based Reasoning and Learning”, Proceedings of Artificial Intelligence and Applications 2014 (AIA2014), Innsbruck, Austria, February 2014.

[21] Wikipedia contributors, ‘Machine learning’, Wikipedia, The Free Encyclopedia, 8 April 2014, 06:20 UTC, http://en.wikipedia.org/w/index.php?title=Machine_learning&oldid=603264698> [accessed 22 April 2014].

Annex A IPB/IPOE functional decomposition

Mind map of the IPB/IPOE functional decomposition discussed in Section 3.1.



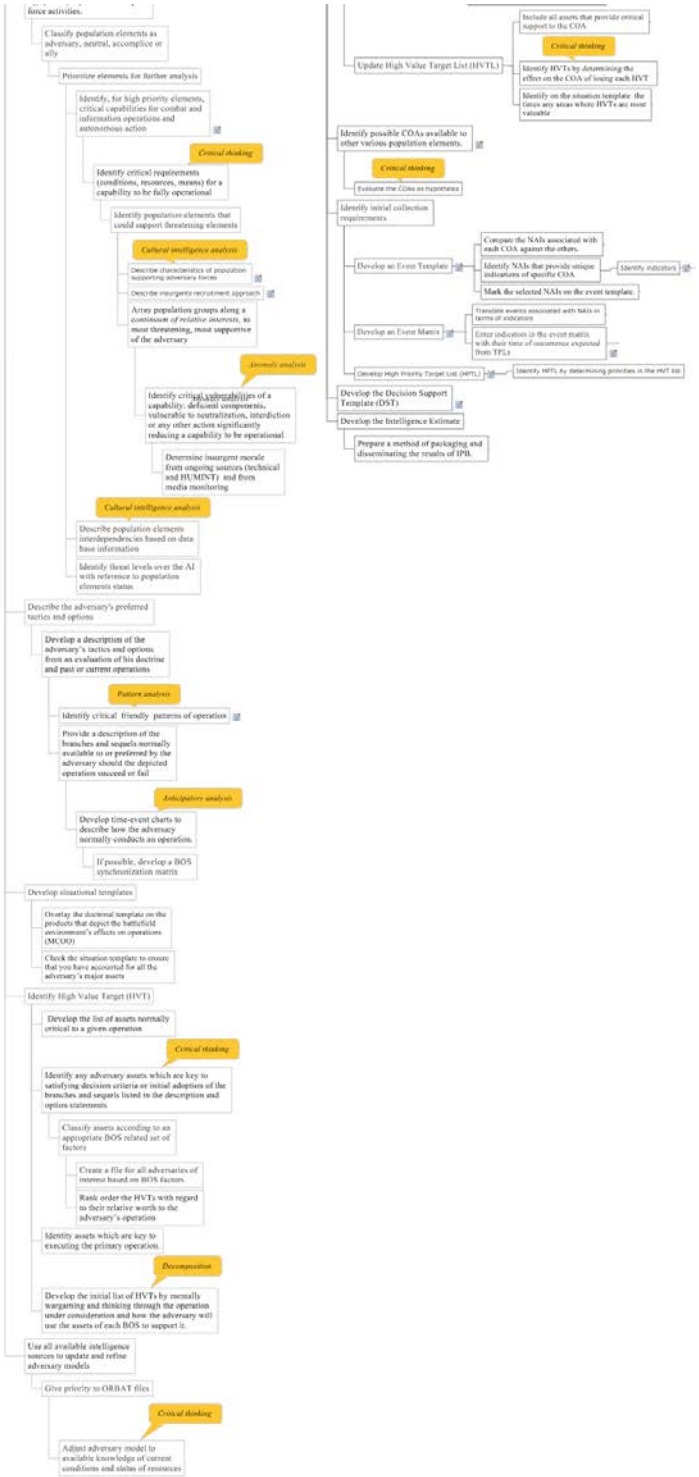


Figure A.1: *Functional decomposition of the IPB/IPOE.*

Step 1: Define the battlefield/operational environment

- Confirm the mission, intent and vision, tasks, deployment posture, limitations, and end state of the friendly forces.
- Identify the geographical limits of the unit's AO and battlespace.
- Define AO as per higher headquarters mission orders.
- Adjust battlespace to the maximum capabilities of a unit to acquire targets and physically dominate the threat.
- Establish the geographical limits of the unit's Area of Interest (AI).
- Identify the different threats to mission accomplishment, air, ground and political, for instance.
- Adjust AI to the threats capability and time constraints of the mission.
- Modify AI with mission progress.
- Identify characteristics of the battlefield which will influence friendly and threat operations.
- Check population demographic factors:
  - Consider:
    - ethnic groups;
    - religious groups;
    - income groups; and
    - age distribution.
- Check political or socio-economic factors.
- Consider roles of clans, tribes and gangs operating within the unit's AO and AI.
- Check other general factors.
- Consider Rules of Engagement (ROE's) and Other Legal Restrictions (e.g., international treaties & agreements).
- Consider Threat Forces in general terms, including para-military forces & reserves.
- Check general physical characteristics of the battlefield including geography, terrain, and weather of the area.
- Check infrastructures, such as transportation or telecommunications.
- Identify the amount of detail required and feasible within the time available.
- Check Mission, Enemy, Troops available, Terrain (METT-T) factors and command guidance.
- Prioritize characteristics of AO and AI for level of details.
- Identify PIRs.

- Prepare and produce products.
- Develop and execute an intelligence collection plan.

Step 2: Describe the battlefield/operation environment's effects

- Analyze battlefield environment.
- Conduct military terrain analysis (TERA) in the AO and if necessary in the AI.
- Apply FLOCARK to the Forward Edge of the Battle Area (FEBA):
  - F–features
  - L–lanes
  - O–objectives
  - C–canalising ground
  - A–approaches
  - R–rate avenues of approach (AA)
  - K–key terrain (KT) and vital ground (VG)
- Produce a Modified Combined Obstacle Overlay (MCOO) by combining COO with terrain factors:
  - Hydrology; vegetation; slope; soil composition; obstacles, natural and manmade;
  - Key Terrain; decisive terrain KT that has extraordinary impact on the mission);
  - Mobility corridors (MC) (unrestricted, restricted, and severely restricted); and
  - Avenues of Approach (ground/air); lines of communication; and road networks/railway systems.
- Adjust AAs to terrain restrictions:
  - Consider minimally:
    - vegetation and soil type,
    - weather and surface drainage,
    - slopes,
    - minefields,
    - trenches, and
    - bodies of water.
- Conduct analysis of military characteristics of weather:
  - Temperature and humidity; precipitation; and
  - Wind; visibility; clouds.
- Evaluate effects of weather on adversary capabilities and friendly operations:

- Identify the periods when weather conditions will optimize mobility, the use of friendly sighting and target acquisition systems.

- Prepare weather effects matrix.
- Analyze other characteristics of the battlefield.
- Consider logistics infrastructures and population demographics.
  - Consider infrastructure factors such as:
    - Land use patterns;
    - Sources of potable water;
    - Bulk fuel storage and transport systems;
    - Canals and waterways, with associated control facilities such as locks;
    - Communication systems;
    - Transportation means and systems, including road and rail networks, transloading;
    - Facilities, and airfields;
    - Natural resources;
    - Industries and technologies;
    - Power production facilities; and
    - Chemical and nuclear facilities.
  - Consider demographic factors such as:
    - Living conditions;
    - Cultural distinctions;
    - Religious beliefs;
    - Political grievances;
    - Political affiliation; and
    - Education levels.
- Prepare Population status overlay.
- Prepare Light data tables.
- Evaluate the effects of terrain on friendly movement and enemy capabilities.
- Combine all analyses on effects of terrain, weather and other factors into one integrated output.
- Produce final AAs friendly and adversary.
- Provide the sets of defensible terrain along adversary AAs to develop strongpoints, battle positions, or sectors for each subordinate unit.
- Analyze Human Network (HN) and regional political analyses in COIN.

- Analyze demographic, cultural factors of AO/AI in COIN.
- Analyze the effects of government (HN, Int and Non-Governmental Organization (NGO)) services, employment and infrastructure.
- Visually and orally describe to the Commander and the staff how both weather, terrain and other factors will affect their mission.

Step 3: Evaluate the threat

- Determine the capabilities of adversary forces and develop adversary models.
- Develop doctrinal templates of adversary dispositions for a particular type of standard operation, such as a battalion movement to contact, an insurgent ambush, or a terrorist kidnapping.
- Identify which adversary structured forces are expected to be operating in the unit's AO and AI.
- Describe expected insurgent forces with demographics characteristics.
- Identify the adversary (Insurgents)?:
  - What are the:
    - Insurgent forces likely to act in the AO?
    - Relationships among the various insurgent groups?
    - Relationship within each insurgent group?
    - Ideological differences between each group that might be exploited?
    - What is the foreign involvement in the insurgency?
- Identify insurgents leadership:
  - Who are the leaders and principal deputies?
  - Where are they located?
- Identify insurgents forces doctrinal conduct of operations:
  - Consider the following questions:
    - What is the insurgents desired endstate?
    - What are the stated goals of the insurgency?
    - Are they attempting to overthrow the government or do they want autonomy?
    - Where are the insurgent forces currently deployed?
    - Which groups are conducting the attacks?
    - Where are the next attacks likely to occur?
    - What foreign entities (governments or groups) are assisting in the attacks in some way?
- Identify Weapons, Equipment and TTP:

- Consider the following questions:
  - What types of weapons are being used?
  - Where do they come from?
  - Where are they cached?
  - Where are the assembly facilities for makeshift weapons?
  - How are weapons delivered to attackers?
- Check for patterns, grouping of adversary forces, as well as timing of movement or use of terrain.
- Translate templates into graphic representations such as overlays or sketches.
- Use Order of Battle (ORBAT) to make assumptions as to the composition of adversary forces a unit can expect to face.
- Identify the expected initial deployment of adversary forces.
- Develop hypothesis as to the composition of adversary forces friendly unit can expect to face.
- Validate the hypothesis with all available database information.
- Identify the population elements present in the AO and AI that can harm, interfere with, or otherwise significantly influence friendly force activities.
- Classify population elements as adversary, neutral, accomplice or ally.
- Prioritize elements for further analysis.
- Identify, for high priority elements, critical capabilities for combat and information operations and autonomous action:
  - Combat capabilities table;
  - Information operations capabilities table;
  - Dependencies capabilities;
  - Capabilities for autonomous operability table; and
  - Relationships with other elements table.
- Identify critical requirements (conditions, resources, means) for a capability to be fully operational.
- Identify population elements that could support threatening elements.
- Describe characteristics of population supporting adversary forces.
- How does the recruitment operates:
  - Who are the insurgency financiers?
  - How are the insurgent groups recruiting members?
  - What part of the population is susceptible to recruitment?

- What are the inducements to join?

- Describe insurgents recruitment approach:
  - Who are the insurgency financiers?
  - How are the insurgent groups recruiting members?
  - What part of the population is susceptible to recruitment?
  - What are the inducements to join?
- Array population groups along a continuum of relative interests, as most threatening, most supportive of the adversary.
- Identify critical vulnerabilities of a capability: deficient components, vulnerable to neutralization, interdiction or any other action significantly reducing a capability to be operational.
- Determine insurgent morale from ongoing sources (technical and Human Intelligence (HUMINT)) and from media monitoring.
- Describe population elements interdependencies based on data base information.
- Identify threat levels over the AI with reference to population elements status.
- Describe the adversary's preferred tactics and options.
- Develop a description of the adversary's tactics and options from an evaluation of his doctrine and past or current operations.
- Identify critical friendly patterns of operation:
  - Consider the following questions:
    - What operational patterns are friendly forces exhibiting?
    - How is this behavior being exploited by the enemy?
    - How can the friendly force alter its behavior to make its patterns more difficult to discern?
    - If its patterns are discerned, how can the friendly force make it more difficult for the enemy to exploit?
- Provide a description of the branches and sequels normally available to or preferred by the adversary should the depicted operation succeed or fail.
- Develop time-event charts to describe how the adversary normally conducts an operation.
- If possible, develop a BOS synchronization matrix.
- Develop situational templates.
- Overlay the doctrinal template on the products that depict the battlefield environment's effects on operations (MCOO).
- Check the situation template to ensure that you have accounted for all the adversary's major assets.

- Identify High Value Target (HVT).
- Develop the list of assets normally critical to a given operation.
- Identify any adversary assets which are key to satisfying decision criteria or initial adoption of the branches and sequels listed in the description and option statements.
- Classify assets according to an appropriate BOS related set of factors.
- Create a file for all adversaries of interest based on BOS factors.
- Rank order the HVTs with regard to their relative worth to the adversary's operation.
- Identity assets which are key to executing the primary operation.
- Develop the initial list of HVTs by mentally wargaming and thinking through the operation under consideration and how the adversary will use the assets of each BOS to support it.
- Use all available intelligence sources to update and refine adversary models.
- Give priority to ORBAT files.
- Adjust adversary model to available knowledge of current conditions and status of resources.

Step 4: Determine the threat courses of action

- Identify the full set of COAs available to the adversary.
- Verify how battlefield conditions limit the set of possible COAs.
- Identify the adversary's capabilities, from Step 3, that will lead to accomplishing the objectives.
- Evaluate and prioritize the COA.
- Evaluate how well each COA meets the criteria of suitability, feasibility, acceptability, and consistency with doctrine:
    - Criteria for COAs: Each COA should meet five criteria: suitability, feasibility, acceptability, uniqueness, and consistency with doctrine:
        - Suitability:
            - If the COA is successfully executed, will it accomplish the adversary's objectives?
        - Feasibility: availability of means and conditions to execute the COA:
            - Time and space;
            - Physical resources;
            - Favorable force ratios; and
            - Capacity to create the conditions for success.
        - Acceptability:
            - Risk level; and Loss of resources.

        - Uniqueness:
            - COA must be significantly different from the others, otherwise it is a mere variation.
        - Consistency with Doctrine:
            - Check consistency with CAF Doctrine.
- How does the battlefield conditions encourage or discourage selection of each COA.
- Analyze the adversary's recent activity to determine if there are indications that one COA is already being adopted.
- How do Friendly dispositions affect the likelihood of each threat COA?
- Use judgment to rank the adversary's COAs in their likely order of adoption.
- Identify the most likely COA.
- Describe the COA in detail:
    - COA must answer five questions:
        - WHAT - the type of operation, such as attack, defend, reinforce, or conduct retrograde.
        - WHEN - the time the action will begin. You usually state this in terms of the earliest time that the adversary can adopt the COA under consideration.
        - WHERE - the sectors, zones, axis of attack, avenues of approach, and objectives that make up the COA.
        - HOW - the method by which the threat will employ his assets, such as dispositions, location of main effort, the scheme of maneuver, and how it will be supported.
        - WHY - the objective or end state the threat intends to accomplish.
    - Factors to consider include:
        - The adversary's intent or desired end state;
        - Apply adversary model about preferred tactics and options;
        - Effects of the battlefield environment on operations and COAs;
        - Adversary's vulnerabilities or shortages in equipment or personnel;
        - Current dispositions;
        - Location of main and supporting efforts;
        - Adversary perception of friendly forces; and
        - Adversary efforts to present an ambiguous situation or achieve surprise.
- Improve a situation template.
- Mentally wargame the scheme of maneuver to evaluate time and space factors depicting adversary movement:

- Take into account effects of the battlefield environment on mobility;
- Do not take into account time taken for planning, issuance of orders or logistical preparation, for instance; and
- Use wargaming to adjust Time Phase Line (TPLs) to effects of possible friendly actions.

- Develop time phase lines (TPLs) and represent them graphically on the situation template.
- Note, during mental wargaming, how and where each of the BOSs provides critical support to the COA.
- Identify Named Areas of Interest (NAI):
  - Areas where you expect key events to occur are called NAIs;
  - An NAI can be a specific point, a route, or an area. They can match obvious natural terrain features or arbitrary features.
- Update High Value Target List (HVTL).
- Include all assets that provide critical support to the COA.
- Identify HVTs by determining the effect on the COA of losing each HVT.
- Identify on the situation template the times any areas where HVTs are most valuable.
- Identify possible COAs available to other various population elements:
  - The following factors can be considered:
    - Does the population element in question have all of the capabilities required to complete the COA?
    - Does the population element have the capability to make the ally forces or other population elements resident in the AO believe that it can complete the proposed COA?
    - Does the population element know of its inherent capability, or is the capability something that can unwittingly affect operations?
    - Are there several different ways to integrate capabilities to achieve the desired end state?
    - What are the interests of the relevant groups? Can they be shaped by the friendly or adversarial force? Have they been shaped already?
    - What are the friendly force vulnerabilities?
    - Which population groups are aware of these vulnerabilities?
    - What are the known tactics of the adversary?
- Evaluate the COAs as hypothesis.
- Identify initial collection requirements.
- Develop an event template:

- The event template is a guide for Collection and Reconnaissance & Surveillance Planning;
- The areas where you expect key events to occur are called NAIs; and
- The activities which reveal the selected COA are called indicators.

- Compare the NAIs associated with each COA against the others.
- Identify NAIs that provide unique indications of specific COA.
- Identify indicators:
  - The activities which reveal the selected COA are called indicators.
- Mark the selected NAIs on the event template.
- Develop an Event Matrix:
  - The event matrix supports the event template by providing details on the type of activity expected in each NAI, the times the NAI is expected to be active, and its relationship to other events on the battlefield.
- Translate events associated with NAIs in terms of indicators.
- Enter indicators in the event matrix with their time of occurrence expected from TPLs:
  - If available, the times identified on the Event Matrix are expressed in terms of Not Earlier Than (NET) or Not Later Than (NLT).
- Develop High Priority Target List (HPTL):
  - HPTs are those HVTs that must be acquired and successfully attacked for the success of the friendly commander's mission.
- Identify HPTL by determining priorities in the HVT list.
- Develop the Decision Support Template (DST):
  - The DST is an operations staff product used in the war-gaming process which graphically, or in written form, represents decision points and projected situations, and indicates when, where, and under what conditions a decision is most likely to be required to initiate a specific activity or event.
- Develop the Intelligence Estimate.
- Prepare a method of packaging and disseminating the results of IPB.

Annex B IPB/IPOE reasoning requirements

This annex shows the detailed list of reasoning requirements as identified over the course of the IPB/IPOE workshop. Each requirement is numbered in reference to the numbers of functions shown in **Figure 1**. This list along with more detailed references can be found at [6].

Table B.1: *IPB/IPOE reasoning requirements.*

No.	Task	Reasoning Requirement Description	Data Requirements (sources)	Tools Used to Support Operators	Tools Used to Support Reasoning Requirements	IPB/IPOE Product Supported	Level of Feasibility	Feasibility Rationale
1	Define the Battlefield / Operational Environment							
1.1	Confirm the mission, intent and vision tasks deployment posture limitations and end state of the friendly force	Ensure complete understanding of the Commander's intent and vision along with the end state of the friendly force.	Mission Orders TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat).			Intelligence Collection Plan	High	Good Access to data, requirement understood
1.2	Identify the geographical limits of the unit's AO and battlespace		Mission Orders, Geographic Data (Maps, digital data or overlays) TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat). geospatial (geo) intelligence support team (GIST) (Maps) Defence Imagery Support Team (DIST) (Imagery database)			AO Overlay		
1.2.1	Define AO as per higher HQ mission orders	Define the geographic boundaries of the AO (static) and the Operation Box (sub-set) within AO. IPB will be focused on Operation Box (more intensive for specific mission)	Mission Orders Mission Secret ISAF (Level 2) Huma	GIS (Falcon View)	GIS, Email Human terrain (e.g., villages in AO). Text from email. Op Box determined by: Range of sensors, size of forces (based on doctrinal norms)	AO Overlay	High	Good Access to data, requirement understood

No.	Task	Reasoning Requirement Description	Data Requirements (sources)	Tools Used to Support Operators	Tools Used to Support Reasoning Requirements	IPB/IPOE Product Supported	Level of Feasibility	Feasibility Rationale
1.2.2	Adjust battlespace to the maximum capabilities of a unit to acquire targets and physically dominate the threat	Using force structure modify AI to ensure wpns coverage	ORBAT (TO&E), Wpns characteristics tables. Sensor characteristics, manoeuvre space (including terrain). Human terrain (e.g., villages in AO / Op Box) . TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat)	Databases (unstructured with DT Search), GIS	Office Software, Databases, GIS	AO Overlay	High	Good Access to data, requirement understood
1.3	Establish the geographical limits of the unit's Area of Interest (AI)					AI Overlay		
1.3.1	Identify the different threats to mission accomplishment, air, ground and political	In order to determine AI, a general threat assessment is needed to determine Area of Interest. This includes a list of influencing threats, effects of area, list of unknown threats – knowledge gaps	Access to higher intsum , intreps and assessment products. Intel from other provinces outside AI. Access to low-level intel (patrol reports – CIMIC, battlegroup, psyops , atmospherics, daily reports). SP___N Level 3 (Canadian Eyes Only) Mission Secret ISAF (Level 2) BICES NATO (Level 2)	Databases	Databases, GIS, Command and Control Software	AI Overlay	High	Good Access to data, requirement understood
1.3.2	Adjust AI to the threat's capability and time constraints of the mission	Adjust AI based on the Threats capabilities and time allocated for mission	Access to threat TTPs, FR Forces CONOPS TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) CAN-US (Level 2) Titan CSNI. SiprNetrel (Level 2). Mission Secret ISAF (Level 2) BICES NATO (Level 2)	Databases, GIS	Databases, Command and Control Software	AI Overlay	High	Good Access to data, requirement understood

No.	Task	Reasoning Requirement Description	Data Requirements (sources)	Tools Used to Support Operators	Tools Used to Support Reasoning Requirements	IPB/IPOE Product Supported	Level of Feasibility	Feasibility Rationale
1.3.3	Modify AO and OP Box with mission progress	Monitor mission progress – re-evaluate boundaries due to changing conditions in Op Box. This is a constant task during IPB process – this can be repeated at the end of each of the four steps.	Ongoing monitoring of OP Box, terrain, human terrain TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat)	GIS, Command and Control Systems	Office Software, Databases, Command and Control Software, Communications systems	AI Overlay	High	Good Access to data, requirement understood
1.4	Identify characteristics of the battlefield which will influence friendly and threat operations							
1.4.1	Check Population demographic factors	This can include items such as gender and days of interest (civic holidays, events, religious festivals etc)	Socio-geographic data, census data if available. Open-Source Internet GST (Maps) DIST (Imagery database)		Psyops reports	Human Terrain Overlay	Medium	Fair access to data
1.4.1.1	Ethnic/tribal groupings	Compare against general characteristics of dominant tribal group	Tribal map if available Open-Source Internet GST (Maps) DIST (Imagery database)	Databases	Databases, GIS, Host nation data	Human Terrain Overlay	Medium	Fair access to data
1.4.1.2	religious groupings	Determine if sub group is dominant local or national element	Religious sub groups Open-Source Internet GST (Maps) DIST (Imagery database)	Databases, GIS	Databases, GIS, Host nation data	Human Terrain Overlay	Medium	Fair access to data
1.4.1.3	Income groupings	Determine locations of wealth and poverty	Tax data if available, HUMINT Open-Source Internet GST (Maps) DIST (Imagery database)	Databases	Databases, Host nation data	Human Terrain Overlay	Low	Lack of available data
1.4.1.4	age distribution	Age breakdown in AO and if possible mapped to actual locations	Census data Open-Source Internet GST (Maps) DIST (Imagery database)	Databases, GIS	Databases, GIS, Host nation data	Human Terrain Overlay	Low	Lack of available data

No.	Task	Reasoning Requirement Description	Data Requirements (sources)	Tools Used to Support Operators	Tools Used to Support Reasoning Requirements	IPB/IPOE Product Supported	Level of Feasibility	Feasibility Rationale
1.4.2	Check Political or socio-economic factors		Socio-geographic data, census data, location and composition of own forces Open-Source Internet GST (Maps) DIST (Imagery database)		Databases, GIS, Host nation data	Human Terrain Overlay	Low	Lack of available data
1.4.2.1	Consider role of families (clans/tribes)	Determine business, political and social connection within families in AO	Tribal map if available Open-Source Internet GST (Maps) DIST (Imagery database)	Databases, GIS, Host Nation Information	Databases, GIS, Host nation data	Human Terrain Overlay	Medium	Good Access to data
1.4.2.2	Role of gangs in area	Determine dominate gang and major activities	Criminal occurrence data Host Nation Data NGO) Data	Databases, GIS, Host Nation Information	Databases, GIS, Host nation data	Human Terrain Overlay	Low	Fair access to data, requirement not understood
1.4.2.3	Role of political parties/movements	Determine level of political activity both for HN government and in favour of the insurgency	Voter Registration data, HUMINT, ALL SOURCE INTELLIGENCE, local news Host Nation Data	Host Nation Information	Databases, GIS, Host nation data	Human Terrain Overlay	Medium	Fair access to data, requirement understood
1.4.3	Legal factors							
1.4.3.1	ROEs and LAC Concerns	Restrictive ROE could potentially affect the conduct of operations. LAC concerns (presence of points of religious or cultural significance) must be identified.	National HQ ROE BICES NATO (Level 2)	Command and Control Systems, Communications Systems	Office Software, Databases, Host nation data	Intelligence Collection Plan	High	Good Access to data, requirement understood
1.4.3.2	Treaties		Legal information			Intelligence Collection Plan, Human Terrain Overlay		

No.	Task	Reasoning Requirement Description	Data Requirements (sources)	Tools Used to Support Operators	Tools Used to Support Reasoning Requirements	IPB/IPOE Product Supported	Level of Feasibility	Feasibility Rationale
1.4.3.2.1	Between HN and other Nationals in AO	What are the treaty obligations of HN towards 3rd country nationals in AO or what relationship does the HN have with the countries whose nationals are in the AO	Does FR Plan violate or cause the HN to violate any obligation. Mission Secret ISAF (Level 2) BICES NATO (Level 2)	Databases	Databases, Host nation data	Intelligence Collection Plan	Medium	Fair access to data, requirement not understood
1.4.3.2.2	Between coalition members in AO	Collect any treaty or legal obligations of allies with AO.	Will FR Plan cause treaty problems with Allies. Mission Secret ISAF (Level 2) BICES NATO (Level 2)	Databases	Databases, Host nation data	Intelligence Collection Plan	Medium	Fair access to data, requirement not understood
1.4.4	Check Physical characteristics of the battlefield.		Physical Geography					
1.4.4.1	Physical Geography (terrain, hydrography, etc.)	Collect as much information within the time available on the physical geography of the AO and, if time permits the AI and update with information from above	Maps, GIS data Open-Source Internet GST (Maps) (IST (Imagery database)	GIS	GIS	AO Overlay, AI Overlay	High	Good Access to data, requirement understood
1.4.4.2	Study of infrastructure transportation, telecommunications, etc.	Collect information on infrastructure	Geomatics data (GIS and Imagery) Open-Source Internet GST (Maps) DIST (Imagery database)	Databases, GIS	Databases, GIS	AO Overlay, AI Overlay	High	Good Access to data, requirement understood
1.5	Check METT-T (Mission, Enemy, Terrain, Troops & Time Available) and commander's guidance	Using METT-T, Int staff or operators depending on the level of the operation determine the priority and level of effort possible in the time available to them (Time appreciation).	Mission Orders, RoM Enemy data, general terrain, FR Orbat	Office Software	Office Software	Intelligence Collection Plan	High	Good Access to data, requirement understood

No.	Task	Reasoning Requirement Description	Data Requirements (sources)	Tools Used to Support Operators	Tools Used to Support Reasoning Requirements	IPB/IPOE Product Supported	Level of Feasibility	Feasibility Rationale
1.6	Identify PIRs (Priority Intelligence Requirements)	Considering the mission, commander's guidance his CCIR and knowledge gaps identified prior to this step, identify PIR.	CCIR, Knowledge Gaps TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) CAN-US (Level 2) Titan CSNI. SiprNetrel (Level 2). Mission Secret ISAF (Level 2) BICES NATO (Level 2)	Office Software	Office Software	Intelligence Collection Plan	High	Good Access to data
1.7	Prepare and produce products							
1.7.1	Develop and execute an intelligence collection plan	Using the PIRs, METT-T and CCIR develop and execute plan		Office Software, GIS	Office Software, GIS	Intelligence Collection Plan	High	Fair access to data, requirement understood
1.7.2	Develop AIR overlay	Graphic depiction of AI and Area of Intelligence Responsibility, (AIR) AII (Area of Intelligence Interest)	Geomatics data Open-Source Internet GST (Maps) DIST (Imagery database)	GIS	GIS	AI Overlay	High (no technique identified in 4.3)	Fair access to data, Good Access to data
1.7.3	Develop AO Overlay	Graphic depiction of Area Operations (AO) which includes Op Box if applicable – comprising Named Area of Interest (NAIs)	Geomatics Data Open-Source Internet GST (Maps) DIST (Imagery database)	GIS	GIS	AO Overlay	High (no technique identified in 4.3)	Good Access to data, requirement understood
2	Define the Battlefield / Operational Environment Effects							
2.1	Analyze battlefield environment							
2.1.1	Conduct terrain analysis of the AO and if necessary the AI							

No.	Task	Reasoning Requirement Description	Data Requirements (sources)	Tools Used to Support Operators	Tools Used to Support Reasoning Requirements	IPB/IPOE Product Supported	Level of Feasibility	Feasibility Rationale
2.1.1.1	Determine terrain features	Conduct mobility studies and determine key features for both friendly and enemy forces	GIS Data, Maps (effect on friendly force movements, posn of obs) Open-Source Internet GST (Maps) DIST (Imagery database)	GIS	Databases, GIS	Intelligence Collection Plan, AO Overlay, AI Overlay	High	Good Access to data
2.1.1.2	Determine potential lanes	Determination of lanes around the key terrain features	GIS Data, Maps- potential rat lines for enemy forces Open-Source Internet GST (Maps) DIST (Imagery database)	Databases, GIS, Command and Control Systems	Databases, GIS	Modified combined obstacle overlay	Medium	Fair access to data
2.1.1.3	Determine potential enemy objectives	Determine objective depending on either an advance, defence or other operation	Enemy Orbat, INTREPS based on enemy goals Open-Source Internet GST (Maps) DIST (Imagery database)	Databases, GIS, Command and Control Systems	Databases, GIS, Command and Control Software	Modified combined obstacle overlay	Low	Lack of available data
2.1.1.4	Identify canalizing ground	Ground that canalizes movement identified both in AO and approaches to AO	GIS Data, Maps Open-Source Internet GST (Maps) DIST (Imagery database)	GIS/Falconview	Databases, GIS	Modified combined obstacle overlay	High	requirement understood
2.1.1.5	Identify potential approaches	All lanes not considered canalizing ground	GIS Data, Maps Open-Source Internet GST (Maps) DIST (Imagery database)	GIS	Databases, GIS	Modified combined obstacle overlay	High	Fair access to data, requirement understood
2.1.1.6	Rate potential approaches	Adjust objectives to relate to the terrain. Identify approaches with ltrs and rate with numbers	TO&E for Friendly Forces, ORBAT for Enemy	Databases, GIS, Command and Control Systems	GIS	Modified combined obstacle overlay	Medium	Fair access to data
2.1.1.7	Determine key terrain and vital ground	Key terrain features, vital ground, potential landing zones, killing zones or other significant terrain features will emerge from the analysis	GIS Data, Maps Open-Source Internet GST (Maps) DIST (Imagery database)	GIS	GIS	Modified combined obstacle overlay	Medium	Fair access to data

No.	Task	Reasoning Requirement Description	Data Requirements (sources)	Tools Used to Support Operators	Tools Used to Support Reasoning Requirements	IPB/IPOE Product Supported	Level of Feasibility	Feasibility Rationale
2.1.2	Analyze other characteristics of the Battlefield/Operational Environment							
2.1.2.1	Logistics infrastructure							
2.1.2.1.1	Land use patterns.							
2.1.2.1.1.1	Arable land	Arable land - land cultivated for crops like wheat, maize, and rice that are replanted after each harvest. Arable land can be also used for illegal crops in which	Geomatics Data, Land use data from national and international sources, Counter Narcotic Data Open-Source Internet GST (Maps) DIST (Imagery database)	Databases, GIS, Host Nation Information	Databases, GIS	Human Terrain Overlay	High	Good Access to data
2.1.2.1.1.2	Permanent Crops	Permanent crops - land cultivated for crops like citrus, coffee, and rubber that are not replanted after each harvest; includes land under flowering shrubs, fruit trees, nut trees, and vines, but excludes land under trees grown for wood or timber. Because of their maintenance requirements, could indicate a higher level of investment in the community than with other crops.	Geomatics Data, Land use data from national and international sources Open-Source Internet GST (Maps) DIST (Imagery database)	Databases, GIS, Host Nation Information	Databases, GIS	Human Terrain Overlay	High	Good Access to data
2.1.2.1.1.3	Other	Any land not arable or under permanent crops; this includes permanent meadows and pastures, forests and woodlands, built-on areas, roads, barren land, etc. Could give an indication of potential weapons caches, routes and concentration areas.	Geomatics Data, Land use data from national and international sources Open-Source Internet GST (Maps) DIST (Imagery database)	Databases, GIS, Host Nation Information	Databases, GIS, Host nation data	Human Terrain Overlay	High	Good Access to data
2.1.2.1.2	Sources of potable water.	Locations of Potable water sources. This includes, wells, reservoirs, holding tanks or other potable water sources. Will affect enemy and civilian activities in the area.	Geographic data Open-Source Internet GST (Maps) DIST (Imagery database)	GIS	GIS	Human Terrain Overlay	High	Good Access to data

No.	Task	Reasoning Requirement Description	Data Requirements (sources)	Tools Used to Support Operators	Tools Used to Support Reasoning Requirements	IPB/IPOE Product Supported	Level of Feasibility	Feasibility Rationale
2.1.2.1.3	Canals and waterways, with associated control facilities such as locks.	Will block or canalize movement area and could be used as a communications route in some areas.	Geographic data Open-Source Internet GST (Maps) DIST (Imagery database)	Databases, GIS	Databases, GIS	Human Terrain Overlay	High	Good Access to data
2.1.2.1.4	Communication systems.	Locations of cellular towers and mobile phone, TV and Radio coverage will affect both COIN forces actions and information operations planning. It will also affect threat communications.	Geographic data (tower locations, coverage polygons, etc.) Open-Source Internet GST (Maps) DIST (Imagery database)	Databases, GIS, Communications Systems, Host Nation Information	Databases, GIS, Communications systems	Human Terrain Overlay	High	Good Access to data
2.1.2.1.5	Transportation means and systems, including road and rail networks	The road network will affect friendly and enemy movement. It will also affect the civilian populations day to day. The type of road will also indicate its potential vulnerability to IED emplacement.	Geographic Data, Transportation usage data Open-Source Internet GST (Maps) DIST (Imagery database)	Databases, GIS	Databases, GIS	Human Terrain Overlay	Medium	Fair access to data
2.1.2.1.6	Power production facilities.	The ability of the citizens to access regular electricity will improve economy of the local area. They can also be targets for the insurgency under certain conditions.	Geographic Data Open-Source Internet GST (Maps) DIST (Imagery database)	Databases, GIS	Databases, GIS	Human Terrain Overlay, High Value Target List	High	Good Access to data
2.1.2.2	Population and demographics factors	RR – impact on Human Terrain						
2.1.2.2.1	Living conditions	Logistics infrastructure, income and potential for agriculture in the region along with subjective observations of the area will give an overall assessment of the living conditions present. Poor living conditions could make the population more likely to be anti-government and possibly support the insurgency.	Data from 2.1.3.1, 1.4.1 Open-Source Internet GST (Maps) DIST (Imagery database)	Databases, Host Nation Information	Databases, Host nation data	Human Terrain Overlay	Medium	Fair access to data

No.	Task	Reasoning Requirement Description	Data Requirements (sources)	Tools Used to Support Operators	Tools Used to Support Reasoning Requirements	IPB/IPOE Product Supported	Level of Feasibility	Feasibility Rationale
2.1.2.2.2	Political grievances.	The presence of political grievances (either against the government or the insurgency) could indicate an increase of the population to either reject or support the insurgency.	Election Results data, media reports, survey data Host Nation Data Open-Source Internet GST (Maps) DIST (Imagery database)	Databases, Host Nation Information	Databases, Host nation data	Human Terrain Overlay	Medium	Fair access to data
2.1.2.2.3	Political affiliation	Members of the ruling political party would be less likely to support the insurgency and more likely, under certain conditions to actively speak out against it.	Election Results data, media reports, survey data TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Databases, Host Nation Information	Databases, Host nation data	Human Terrain Overlay	Medium	Fair access to data
2.1.2.2.4	Education levels.	Education levels within the community could indicate likelihood that the population will be more hesitant to embrace the insurgency.	Education data, number of schools, literacy reports	Databases, Host Nation Information	Databases, Host nation data	Human Terrain Overlay	Medium	Fair access to data
2.1.2.3	Determine Human Geography elements							
2.1.2.3.1	Understand Tribal Map	Within Afghanistan broadly speaking the tribal affiliations are known to have certain characteristics (including support for or against the government).	Geographic data, historic data should be linked with census data if possible. Open-Source Internet GST (Maps) DIST (Imagery database)	Databases, GIS	Databases, GIS	Human Terrain Overlay	Medium	Fair access to data

No.	Task	Reasoning Requirement Description	Data Requirements (sources)	Tools Used to Support Operators	Tools Used to Support Reasoning Requirements	IPB/IPOE Product Supported	Level of Feasibility	Feasibility Rationale
2.1.2.3.2	Understand White SA	Which HN departments and NGOs that operate within the area	List of government officials, overall level of corruption and general effectiveness of local government TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Databases, GIS, Host Nation Information	Databases, GIS, Host nation data	Human Terrain Overlay	Medium	Fair access to data
2.1.2.3.3	Understand Green SA	Levels of deployment of HN military within AO (ANA), Readiness State and Ethnic make-up of forces within AO	ORBATs, List of senior officers, battalion to garrison to checkpoint levels TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat)	Databases, Host Nation Information	Command and Control Software, Host nation data	IPB Intelligence Estimate, Decision Support Template	Medium	Fair access to data
2.1.2.3.4	Understand ANP	Levels of deployment, training and ethnic make up	ORBAT, levels of crime TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat). CAN-US (Level 2) Titan CSNI. SiprNetrel (Level 2). Mission Secret ISAF Level 2 BICES NATO (Level 2)	Databases, Host Nation Information	Command and Control Software, Host nation data	IPB Intelligence Estimate, Decision Support Template	Medium	Fair access to data

No.	Task	Reasoning Requirement Description	Data Requirements (sources)	Tools Used to Support Operators	Tools Used to Support Reasoning Requirements	IPB/IPOE Product Supported	Level of Feasibility	Feasibility Rationale
2.1.2.3.5	Understand parallel governance if applicable	As a result of poor local government, insurgency may create shadow, or parallel governance organizations	Organization charts, databases TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) CAN-US (Level 2) Titan CSNI. SiprNetrel (Level 2). Mission Secret ISAF (Level 2) BICES NATO (Level 2)	Databases, Host Nation Information	Databases	IPB Intelligence Estimate, Decision Support Template	Medium	Fair access to data
2.2	Conduct analysis of potential effects of weather							
2.2.1	Evaluate the effects of weather on friendly operations	Require knowledge of the current, future and historical weather patterns in the AO and AI and the capabilities of the friendly forces. An analysis is performed to determine the potential effects of weather on friendly operations	Current weather forecast data, historical weather data, friendly orbat, friendly mission orders Open Internet TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Office Software, Databases, Command and Control Systems	Office Software, Databases, GIS, automation of Met Tech data	Weather Effects Matrix, Light Data Table	High	Good Access to data
2.2.2	Evaluate the effects of weather on local population	Comparison of weather against the enemy capabilities	Current weather forecast data, historical weather data TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Office Software	Office Software, Databases, automation of Met Tech data	Weather Effects Matrix	High	Fair access to data

No.	Task	Reasoning Requirement Description	Data Requirements (sources)	Tools Used to Support Operators	Tools Used to Support Reasoning Requirements	IPB/IPOE Product Supported	Level of Feasibility	Feasibility Rationale
2.2.3	Understand Impact of Terrain and Weather on Threat Operations	Determine the general effects of weather and terrain on threat operations.	Current weather forecast data, historical weather data, Enemy Orbat TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) CAN-US (Level 2) Titan CSNI. SiprNetrel (Level 2). Mission Secret ISAF (Level 2) BICES NATO (Level 2)	Office Software, Databases, GIS	Office Software, Databases, GIS, automation of Met Tech data	Weather Effects Matrix, Light Data Table	High	Good Access to data
2.3	Analyze the effects of government (HN, Int and NGO) services, employment and infrastructure							
2.3.1	Evaluate effect of government on local population	The government may have fallen out of favour with the local population. This could make the insurgency seem more attractive	Local and regional media reporting TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat)	Office Software, Databases, GIS	Office Software, Databases, GIS	IPB Intelligence Estimate, Situational Template	Medium	Fair access to data
2.3.2	Evaluate effect of HN government on Threat operations	Overall effective of HN security forces and other HN government assets in countering the threat's actions	Threat communications and behaviour patterns (TTPs), atmospherics (cite results of other analysis from RR above) TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) CAN-US (Level 2) Titan CSNI. SiprNetrel (Level 2). Mission Secret ISAF (Level 2) BICES NATO (Level 2)	Office Software, Databases, GIS	Office Software, Databases, GIS, Host nation data	IPB Intelligence Estimate, Situational Template	Medium	Fair access to data

No.	Task	Reasoning Requirement Description	Data Requirements (sources)	Tools Used to Support Operators	Tools Used to Support Reasoning Requirements	IPB/IPOE Product Supported	Level of Feasibility	Feasibility Rationale
2.4	Analyze terrain, weather, demographic, and cultural factors of AO/AI in COIN							
2.4.1	Evaluate the effects of terrain and weather on the friendly operations	Data gathered from 2.1.2 compared against the friendly force structure, mission and restrictions to provide limitations and opportunities for friendly operations	Data from 2.1.2, ORBATs TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) CAN-US (Level 2) Titan CSNI. SiprNetrel (Level 2). Mission Secret ISAF (Level 2) BICES NATO (Level 2) Open-Source Internet GST (Maps) DIST (Imagery database)	Databases	Databases, Command and Control Software	Human Terrain Overlay, IPB Intelligence Estimate	High	Good Access to data
2.4.2	Evaluate the effects on local population	Data from 2.1.2 to determine the overall effects on the local population in order to assess their potential to be for or against the government.	Data from 2.1.2, Census, voting records TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) CAN-US (Level 2) Titan CSNI. SiprNetrel (Level 2). Mission Secret ISAF (Level 2) BICES NATO (Level 2) Open-Source Internet	Command and Control Systems	Command and Control Software, Host nation data	Human Terrain Overlay, IPB Intelligence Estimate	Medium	Fair access to data
2.4.3	Evaluate the effects on threat operations	Data from 2.1.2 assessed to determine demographic effects on threat operations.	Data from 2.1.2, Contact reports TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat)	Databases, Command and Control Systems, Host Nation Information	Databases, Command and Control Software, Host nation data	Human Terrain Overlay, IPB Intelligence Estimate	Medium	Fair access to data
2.5	Evaluate the Political Environment							

No.	Task	Reasoning Requirement Description	Data Requirements (sources)	Tools Used to Support Operators	Tools Used to Support Reasoning Requirements	IPB/IPOE Product Supported	Level of Feasibility	Feasibility Rationale
2.5.1	Evaluate the overall effectiveness of the HN government	Determine how well the HN government is meeting the basic needs of its population	Census data, media reports, CIMIC reports TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat). Mission Secret ISAF Level 2 Open-Source Internet C5 DFAIT	Databases, Office Software	Databases, Office Software	IPB Intelligence Estimate	Medium	Fair access to data
2.5.2	Evaluate the overall effectiveness of the local HN Leadership.	Assess the leadership style and effectiveness of the local leadership. The style of the local leadership compared against the level of effectiveness and corruption of the local government could indicate the potential success of the insurgency in the area.	Census data, media reports, CIMIC reports TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2) Open-Source Internet C5 DFAIT	Databases, Office Software	Databases, Office Software	IPB Intelligence Estimate	Medium	Fair access to data
3	Evaluate the Threat							
3.1	Identify which adversary forces are expected to be operating in the unit's AO and AI.							
3.1.1	Describe expected threat forces with demographics characteristics							
3.1.1.1	How are threat groups likely to act in the AO	Based on the weather, geography, socio-economic and demographics how are threat forces likely to act in AO	Weather data, geographic data, ORBATs, Contact report , historical patterns, HUMINT TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2) Open-Source Internet	Databases, Command and Control Systems	Databases, Command and Control Software, Host nation data	IPB Intelligence Estimate, Situational Template, Decision Support Template	Medium	Fair access to data

No.	Task	Reasoning Requirement Description	Data Requirements (sources)	Tools Used to Support Operators	Tools Used to Support Reasoning Requirements	IPB/IPOE Product Supported	Level of Feasibility	Feasibility Rationale
3.1.1.2	Relationships among the various threat groups	Analyze the interrelationships between the threat groups if any (financial, ideological, military, etc.)	SNA outputs TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2) Open-Source Internet C5 DFAIT	Office Software, Databases, Host Nation Information	Office Software, Databases, Host nation data	IPB Intelligence Estimate, Situational Template, Decision Support Template	Medium	Fair access to data
3.1.1.3	Ideological differences between each group that might be exploited	Determine if there are differing ideological or political ambitions within the threat groups. Related to vulnerability of threat group.	Threat communications, past associations TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2). Open-Source Internet C5 DFAIT	Databases, Host Nation Information	Databases, Host nation data	IPB Intelligence Estimate	Low	Lack of available data
3.1.2	Identify threats leadership							
3.1.2.1	Who are they	Identify key leadership	SNA outputs	Office Software, Databases, Host Nation Information	Office Software, Databases, Host nation data	High Value Target List	Medium	Fair access to data
3.1.2.2	Where are they	Identify the geographic location(s) of the key leadership (residence, meeting, operating area 5Ws + how)	Geomatics data, patrol reports, all source intelligence Open-Source Internet GST (Maps) DIST (Imagery database)	Office Software, Databases, GIS, Host Nation Information	Office Software, Databases, GIS	High Value Target List	Low	Lack of available data
3.1.3	Identify Weapons, Equipment and (Techniques, Tactics, Procedures) TTP							

No.	Task	Reasoning Requirement Description	Data Requirements (sources)	Tools Used to Support Operators	Tools Used to Support Reasoning Requirements	IPB/IPOE Product Supported	Level of Feasibility	Feasibility Rationale
3.1.3.1	What types of weapons are being used?	Determine the type and general capability of threat weapons	Operational reporting TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Databases, Host Nation Information	Databases, Host nation data	IPB Intelligence Estimate	High (no technique identified in 4.3)	Good Access to data
3.1.3.2	Where do they come from?	Determine the country of origin of the weapons	Operational reporting TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Databases, Host Nation Information	Databases, Host nation data	IPB Intelligence Estimate	Medium	Fair access to data
3.1.3.3	Where are they cached?	Determine locations of threat weapons caches	Operational reporting TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Databases, GIS, Host Nation Information	Databases, GIS, Host nation data	IPB Intelligence Estimate	Medium	Fair access to data
3.1.3.4	Where are the assembly facilities for makeshift weapons?	Location of workshops for manufacturing of makeshift weapons (IEDs).	Operational reporting TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Databases, GIS, Host Nation Information	Databases, GIS, Host nation data	IPB Intelligence Estimate	Medium	Fair access to data
3.1.3.5	How are the weapons delivered?	Method used by the threats to deliver weapons (includes logistical considerations)	Operational reporting TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Databases, Host Nation Information		IPB Intelligence Estimate	Low	Lack of available data
3.1.4	Identify threat forces doctrinal conduct of operations							

No.	Task	Reasoning Requirement Description	Data Requirements (sources)	Tools Used to Support Operators	Tools Used to Support Reasoning Requirements	IPB/IPOE Product Supported	Level of Feasibility	Feasibility Rationale
3.1.4.1	Determine what is threat's desired end-state	Determine the threat's desired end-state	Threat communications, media reporting TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Office Software, Host Nation Information	Office Software, Host nation data	IPB Intelligence Estimate	Low	Lack of available data
3.1.4.2	What are the stated goals of the insurgency	Determine threat goals. Are they attempting to overthrow the government or do they want autonomy	Threat communications, media reporting TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Office Software, Host Nation Information	Office Software, Host nation data	IPB Intelligence Estimate	Low	Lack of available data, requirement not understood
3.1.4.3	Where are the threat forces currently deployed	Current general locations of threat elements and key leadership	Threat communications, HUMINT, IMINT TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Office Software, GIS, Host Nation Information	Office Software, GIS, Host nation data	IPB Intelligence Estimate, Decision Support Template, High Value Target List	Medium	Good Access to data
3.1.4.4	Which groups are conducting the attacks?	List main effort of threat if known.	Threat communications, HUMINT TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Office Software, Databases, Command and Control Systems	Office Software, Databases, Command and Control Software, Host nation data	IPB Intelligence Estimate, Situational Template, High Value Target List	Medium	Fair access to data
3.1.4.5	Determine patterns threat behaviour	Threat behaviour will give clues to future activity	ALL SOURCE INTELLIGENCE TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Office Software, Databases, Host Nation Information	Office Software, Databases, Host nation data	IPB Intelligence Estimate, Situational Template	Low	Lack of available data

No.	Task	Reasoning Requirement Description	Data Requirements (sources)	Tools Used to Support Operators	Tools Used to Support Reasoning Requirements	IPB/IPOE Product Supported	Level of Feasibility	Feasibility Rationale
3.1.4.6	What foreign entities (governments or groups) are assisting	Foreign Assistance either financial or advice and training will indicate potential direction of insurgency.	ALL SOURCE INTELLIGENCE, National Reporting SP___N Level 3 (Canadian Eyes Only) TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Office Software, Databases, Host Nation Information	Office Software, Databases, Host nation data	IPB Intelligence Estimate, Situational Template, Decision Support Template	Medium	Fair access to data
3.2	Develop hypothesis as to the composition of adversary forces friendly unit can expect to face	Validate hypothesis of threat force structure in AO/AI based on the capabilities against known information.	ALL SOURCE INTELLIGENCE, historical pattern, output from 3.1 TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Office Software, Databases, Host Nation Information	Office Software, Databases, Host nation data	IPB Intelligence Estimate	Medium	Fair access to data
3.3	Identify the influential population elements present in the AO and AI							
3.3.1	Classify population elements as adversary, obstacle, neutral, accomplice or ally			Office Software, GIS, Host Nation Information				
3.3.1.1	Identify population elements that could support insurgency (adversary, obstacle)	Identify the population in the AO/AI that could be supportive of the insurgency.	Threat communications, media reporting, HN Information TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Office Software, GIS, Host Nation Information	Office Software, GIS, Host nation data	Human Terrain Overlay, IPB Intelligence Estimate	Medium	Fair access to data

No.	Task	Reasoning Requirement Description	Data Requirements (sources)	Tools Used to Support Operators	Tools Used to Support Reasoning Requirements	IPB/IPOE Product Supported	Level of Feasibility	Feasibility Rationale
3.3.1.2	Describe characteristics of population supporting adversary forces	Identify the general characteristics of the population that supports the insurgency (i.e., from one particular village, business, and ethnic group).	Threat communications, media reporting, HN Reporting TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Office Software, Databases, Host Nation Information	Office Software, Databases, Host nation data	Human Terrain Overlay, IPB Intelligence Estimate	Medium	Fair access to data
3.3.1.3	Identify critical vulnerabilities of those supportive of the insurgency	Identify any critical vulnerabilities of the supportive element of the insurgency.	ALL SOURCE INTELLIGENCE, Threat communications, media reporting TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2) Open Internet DWAN C5 DFAIT	Office Software, Databases, Host Nation Information	Office Software, Databases, Host nation data	IPB Intelligence Estimate, Decision Support Template	Medium	Fair access to data
3.4	Describe threats recruitment approach							
3.4.1	Who are the insurgency financiers?	Determine if the financiers come from the area or are foreign based	National level reporting, ALL SOURCE INTELLIGENCE SP___N Level 3 (Canadian Eyes Only) TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Office Software, Databases, Host Nation Information	Office Software, Databases, Host nation data	IPB Intelligence Estimate	Medium	Fair access to data
3.4.2	How are the threat groups recruiting members?	Recruiting methodology and success patterns	HN Reporting	Office Software, Databases, Host Nation Information	Office Software, Databases	IPB Intelligence Estimate	High	Good Access to data

No.	Task	Reasoning Requirement Description	Data Requirements (sources)	Tools Used to Support Operators	Tools Used to Support Reasoning Requirements	IPB/IPOE Product Supported	Level of Feasibility	Feasibility Rationale
3.4.3	What part of the population is susceptible to recruitment?	Determine the at risk segment of the population for recruitment into the insurgency	HN Reporting, SNA results, Socio-economic information TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2) Open Internet DWAN C5 DFAIT	Office Software, Databases, Host Nation Information	Office Software, Databases	Human Terrain Overlay, IPB Intelligence Estimate	Medium	Fair access to data
3.5	Determine threat morale from ongoing sources (technical and HUMINT) and from media monitoring	General Assessment of Threat morale in AO/AI	ALL SOURCE INTELLIGENCE TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2) Open Internet DWAN C5 DFAIT	Office Software, Databases, Host Nation Information	Office Software, Databases, Host nation data	IPB Intelligence Estimate	Medium	Fair access to data
3.6	Describe the adversary's preferred tactics and options	Define Threat tactics	ALL SOURCE INTELLIGENCE TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2) Open Internet DWAN C5 DFAIT	Office Software, Databases, Host Nation Information	Office Software, Databases, Host nation data	Doctrinal Template	Low	Lack of available data

No.	Task	Reasoning Requirement Description	Data Requirements (sources)	Tools Used to Support Operators	Tools Used to Support Reasoning Requirements	IPB/IPOE Product Supported	Level of Feasibility	Feasibility Rationale
3.7	Define the key leader(s) of threat	Identification of the leadership of the threat	ALL SOURCE INTELLIGENCE TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2) Open Internet DWAN C5 DFAIT	Office Software, Databases, Host Nation Information	Office Software, Databases, Host nation data	High Value Target List	Medium	Fair access to data, requirement not understood
3.8	Identify critical friendly patterns of operation							
3.8.1	What operational patterns are friendly forces exhibiting?	Identify friendly forces patterns of operations	Friendly forces operational information TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Office Software, Databases, Command and Control Systems	Office Software, Databases, Command and Control Software, Host nation data	Doctrinal Template	High	Good Access to data
3.8.2	How is the adversary exploiting these patterns?	Determination of exploitation by threat	Threat force operational information TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Office Software, Databases, Command and Control Systems, Host Nation Information	Office Software, Databases, Command and Control Software, Host nation data	Doctrinal Template, Event Template	Medium	Fair access to data
3.9	Develop situational templates							
3.9.1	Overlay the doctrinal template on the products that depict the battlefield environment's effects on operations (MCOO)	Application of the doctrinal template against terrain and socio-economic reality of AO/AI	ALL SOURCE INTELLIGENCE, Contact and Situation reporting TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Office Software, Databases, GIS	Office Software, Databases, GIS	Situational Template	Medium	Fair access to data

No.	Task	Reasoning Requirement Description	Data Requirements (sources)	Tools Used to Support Operators	Tools Used to Support Reasoning Requirements	IPB/IPOE Product Supported	Level of Feasibility	Feasibility Rationale
3.10	Identify High Value Target (HVT)							
3.10.1	Develop the list of assets normally critical to a given operation	Develop list of assets that are normally critical to threat forces for typical operations.	ALL SOURCE INTELLIGENCE TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Office Software, Databases	Office Software, Databases	High Value Target List	Medium	Fair access to data
3.10.2	Rank order the HVTs with regard to their relative worth to the adversary's operation	Rank the HVT based on their relative worth.	Threat force operational information SP___N Level 3 (Canadian Eyes Only) TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2) Open Internet DWAN C5 DFAIT	Office Software, Databases	Office Software, Databases, Host nation data	High Value Target List	Medium	Fair access to data
3.11	What is the foreign involvement in the insurgency	What is the level of foreign involvement in the insurgency	INTSUMs, foreign and local media reports SP___N Level 3 (Canadian Eyes Only) TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2) Open Internet DWAN C5 DFAIT	Databases, Host Nation Information	Databases, Host nation data	IPB Intelligence Estimate	Medium	Fair access to data
4	Determine Threat Course(s) of Action							

No.	Task	Reasoning Requirement Description	Data Requirements (sources)	Tools Used to Support Operators	Tools Used to Support Reasoning Requirements	IPB/IPOE Product Supported	Level of Feasibility	Feasibility Rationale
4.1	Determine the full range of COAs available to the enemy							
4.1.1	Eliminate COAs based on current environment conditions	Eliminate COAs that are not feasible based on environmental conditions.	Data from steps 1 and 2 SP___N Level 3 (Canadian Eyes Only) FK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) CAN-US (Level 2) Titan CSNI. SiprNetrel (Level 2). Mission Secret ISAF (Level 2) BICES NATO (Level 2) C5 - Canadian Embassy DWAN Open-Source Internet GST (Maps) DIST (Imagery database)	Office Software, Databases, Host Nation Information	Office Software, Databases, Host nation data	Situational Template, Decision Support Template	Medium	Fair access to data, requirement understood
4.1.2	Account for enemy capabilities for remaining COAs	Based on the assessment of threat capabilities, rate the remaining COAs	Data from step 3 SP___N Level 3 (Canadian Eyes Only) TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) CAN-US (Level 2) Titan CSNI. SiprNetrel (Level 2). Mission Secret ISAF (Level 2). BICES NATO (Level 2) C5 - Canadian Embassy DWAN Open-Source Internet GST (Maps) DIST (Imagery database)	Office Software, Databases	Office Software, Databases	Decision Support Template	Medium	Fair access to data
4.2	Evaluate and prioritize the COAs							

No.	Task	Reasoning Requirement Description	Data Requirements (sources)	Tools Used to Support Operators	Tools Used to Support Reasoning Requirements	IPB/IPOE Product Supported	Level of Feasibility	Feasibility Rationale
4.2.1	Suitability - will the COA accomplish the adversary's objective?	Will the COA accomplish the adversary's objective	Data from 3.1.1.4 SP___N Level 3 (Canadian Eyes Only) TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) CAN-US (Level 2) Titan CSNI. SiprNetrel (Level 2). Mission Secret ISAF (Level 2) BICES NATO (Level 2) C5 - Canadian Embassy DWAN	Office Software, Databases, Host Nation Information	Office Software, Databases, Host nation data	IPB Intelligence Estimate, Decision Support Template	Medium	Fair access to data
4.2.2	Feasibility - does the enemy have the availability of means and conditions to execute the COA							
4.2.2.1	Time and space	Is the COA feasible in terms of time and space for the threat	Data from Step 2, Data from Step 3.1 SP___N Level 3 (Canadian Eyes Only) TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) GST (Maps) DIST (Imagery database)	Office Software, Databases, Command and Control Systems, Host Nation Information	Office Software, Databases, Command and Control Software, Host nation data	IPB Intelligence Estimate, Situational Template, Decision Support Template	Medium	Fair access to data
4.2.2.2	Physical Resources	Does the threat have the necessary resources (weapons, ammunition, and finances) to execute this COA at this time?	Data from 3.1.1.2 and 3.1.1.3 SP___N Level 3 (Canadian Eyes Only) TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat)	Office Software, Databases, Host Nation Information	Office Software, Databases, Host nation data	IPB Intelligence Estimate, Decision Support Template	Medium	Fair access to data

No.	Task	Reasoning Requirement Description	Data Requirements (sources)	Tools Used to Support Operators	Tools Used to Support Reasoning Requirements	IPB/IPOE Product Supported	Level of Feasibility	Feasibility Rationale
4.2.2.3	Favourable force ratios	Can the Threat generate suitable force ratios for the COA to be successful?	Data from 3.1.1, Contact reports, ALL SOURCE INTELLIGENCE SP___N Level 3 (Canadian Eyes Only) TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Office Software, Databases, Command and Control Systems	Office Software, Databases, Command and Control Software, Host nation data	IPB Intelligence Estimate, Decision Support Template	Medium	Fair access to data
4.2.2.4	Capacity for success	Using the results of the first three criteria what is the general capacity for success of this COA.	Data from 4,2,2,1, 4,2,2,2, 4.2.2.3 SP___N Level 3 (Canadian Eyes Only) TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Office Software, Databases, Command and Control Systems, Host Nation Information	Office Software, Databases, Command and Control Software, Host nation data	IPB Intelligence Estimate, Decision Support Template	Medium	Fair access to data
4.2.3	Acceptability							
4.2.3.1	Risk level	What is the Risk Level of the COA (High, Medium, and Low)? Ideally should be compared against the known risk tolerance of the adversary.	Determination of the risk level of the COA compared to the adversary's overall risk tolerance SP___N Level 3 (Canadian Eyes Only) TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Office Software, Databases, Command and Control Systems, Host Nation Information	Office Software, Databases, Command and Control Software, Host nation data	IPB Intelligence Estimate, Situational Template, Decision Support Template	Medium	Fair access to data

No.	Task	Reasoning Requirement Description	Data Requirements (sources)	Tools Used to Support Operators	Tools Used to Support Reasoning Requirements	IPB/IPOE Product Supported	Level of Feasibility	Feasibility Rationale
4.2.3.2	Loss of resources	Determination of the potential losses adversary will suffer as a result of this COA	What is the loss potential as a result of this COA for the threat and what is their tolerance for losses. SP___N Level 3 (Canadian Eyes Only) TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2) C5 DFAIT	Office Software, Databases, Host Nation Information	Office Software, Databases, Host nation data	IPB Intelligence Estimate, Decision Support Template	Medium	Fair access to data
4.2.4	Unique	Is the COA unique?	Determine if the COA is unique	Office Software, Databases, Host Nation Information	Office Software, Databases, Host nation data	Decision Support Template	Medium	Fair access to data
4.2.5	Consistency with doctrine (if known)	Is this COA consistent with doctrine	Doctrinal Template(s) if available, operational reports (have they done this before) SP___N Level 3 (Canadian Eyes Only) TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2) C5 DFAIT	Office Software, Databases, Command and Control Systems, Host Nation Information	Office Software, Databases, Command and Control Software, Host nation data	IPB Intelligence Estimate, Decision Support Template	Low	Lack of available data
4.2.6	How does the battlefield conditions encourage or discourage selection of each COA	Do the current conditions eliminate a COA	Data from Step 2 SP___N Level 3 (Canadian Eyes Only) TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2) C5 DFAIT	Office Software, Databases, Command and Control Systems, Host Nation Information	Office Software, Databases, Command and Control Software, Host nation data	IPB Intelligence Estimate, Situational Template, Decision Support Template	Medium	Fair access to data

No.	Task	Reasoning Requirement Description	Data Requirements (sources)	Tools Used to Support Operators	Tools Used to Support Reasoning Requirements	IPB/IPOE Product Supported	Level of Feasibility	Feasibility Rationale
4.2.7	Analyze the adversary's recent activity to determine if there are indications that one COA is already being adopted	Through monitoring of the environment determine if the adversary has selected a particular COA.	Operational monitoring, contact reporting SP___N Level 3 (Canadian Eyes Only) TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Command and Control Systems	Office Software, Databases, Command and Control Software	Decision Support Template	Medium	Good Access to data
4.2.8	How do Friendly dispositions affect the likelihood of each threat COA?	Does the dispositions of the Friendly forces make one or more COAs likely	Mission Orders, Concept of Operations TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Office Software, Databases, Command and Control Systems	Office Software, Databases, Command and Control Software	Decision Support Template	High	Good Access to data
4.2.9	Rank the adversary's COAs in their likely order of adoption.	Determine the priority of adoption of the COAs	Data from 4,2,2,1, 4,2,2,2, 4.2.2.3 SP___N Level 3 (Canadian Eyes Only) TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2) C5 DFAIT	Office Software, Databases	Office Software, Databases, Host nation data	IPB Intelligence Estimate, Decision Support Template	Medium	Fair access to data
4.3	Identify the most likely COA							
4.3.1	Describe the COA in detail							

No.	Task	Reasoning Requirement Description	Data Requirements (sources)	Tools Used to Support Operators	Tools Used to Support Reasoning Requirements	IPB/IPOE Product Supported	Level of Feasibility	Feasibility Rationale
4.3.1.1	WHAT -	Describe the type of operation, such as attack, defend, reinforce, or conduct retrograde.	Data from 4,2,2,1, 4,2,2,2, 4.2.2.3 TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Office Software, Databases, Host Nation Information	Office Software, Databases, Host nation data	Decision Support Template	Medium	Fair access to data
4.3.1.2	WHEN -	Describe the time the action is estimated to begin (normally the earliest time that the adversary can adopt the COA under consideration).	Data from 4,2,2,1, 4,2,2,2, 4.2.2.3 TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat internet relay chat Mission Secret ISAF (Level 2)	Office Software, Databases, Host Nation Information	Office Software, Databases, Host nation data	Decision Support Template	Medium	Fair access to data
4.3.1.3	HOW -	Describe the method by which the threat will employ his assets such as dispositions location of main effort the scheme of manoeuvre and how it will be supported	Data from 4,2,2,1, 4,2,2,2, 4.2.2.3 TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Office Software, Databases, Host Nation Information	Office Software, Databases, Host nation data	Decision Support Template	Medium	Fair access to data
4.3.1.4	WHY -	Describe the objective or end state the threat intends to accomplish.	Data from 4,2,2,1, 4,2,2,2, 4.2.2.3 TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Office Software, Databases, Host Nation Information	Office Software, Databases, Host nation data	Decision Support Template	Medium	Fair access to data
4.3.2	Improve a situation template							

No.	Task	Reasoning Requirement Description	Data Requirements (sources)	Tools Used to Support Operators	Tools Used to Support Reasoning Requirements	IPB/IPOE Product Supported	Level of Feasibility	Feasibility Rationale
4.3.2.1	Mentally war-game the scheme of manoeuvre to evaluate time and space factors.	Develop the threat COA in order to assess the relevant time and space factors.	Data from 4.3.1, terrain data of AO TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2) GST (Maps) DIST (Imagery database)	Office Software, Databases, GIS, Host Nation Information	Office Software, Databases, GIS, Host nation data	Decision Support Template	Medium	Fair access to data
4.3.2.2	Develop time phase lines (TPLs) and represent them graphically on the situation template.	Graphically represent the time phase lines of the threat COA	Data from 4.3.1, terrain data of AO Open-Source Internet GST (Maps) DIST (Imagery database)	Office Software, Databases, Host Nation Information	Office Software, Databases, Host nation data	Decision Support Template	Medium	Fair access to data
4.3.2.3	Identify Named Areas of Interest (NAI)	Identify Named Areas of Interest.	Based on the selected threat COA develop NAI in order to validate that particular COA TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2) GST (Maps) DIST (Imagery database)	Office Software, Databases, GIS, Host Nation Information	Office Software, Databases, GIS, Host nation data	Decision Support Template	Medium	Fair access to data
4.3.3	Update HVTL							
4.3.3.1	Include all assets that provide critical support to the COA	Determine all threat assets that support the COA.	Data from 3.7, Resource data for adversary TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2) GST (Maps) DIST (Imagery database)	Office Software, Databases, Command and Control Systems, Host Nation Information	Office Software, Databases, Command and Control Software, Host nation data	High Value Target List	Medium	Fair access to data

No.	Task	Reasoning Requirement Description	Data Requirements (sources)	Tools Used to Support Operators	Tools Used to Support Reasoning Requirements	IPB/IPOE Product Supported	Level of Feasibility	Feasibility Rationale
4.3.3.2	Identify HVTs by determining the effect on the COA of losing each HVT	Determine value of potential targets by assessing the effect on the threat if the asset was removed.	Data from 4.3.3.2 TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Office Software, Databases, Host Nation Information	Office Software, Databases, Host nation data	High Value Target List	Medium	Fair access to data
4.3.3.3	Identify on the situation template the times any areas where HVTs are most valuable	Determine during the course of the threat COA, when the Targets are highly valued and place on situation template.	Data from 4.3.1 specifically 4.3.1.2 TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Office Software, Databases, Host Nation Information	Office Software, Databases, Host nation data	High Value Target List	Medium	Fair access to data, requirement understood
4.4	Evaluate the population COAs							
4.4.1	List potential COAs of Local Population	List potential local population COAs.	Data from 3.3, local reporting, pattern of life reporting from friendly forces TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2) C5 DFAIT	Office Software, Databases, Host Nation Information	Office Software, Databases, Host nation data	Human Terrain Overlay, IPB Intelligence Estimate	Medium	Fair access to data
4.4.2	Capabilities of local population	Does the population element in question have all of the capabilities required to complete the COA.	Local reporting, HN reporting TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2) C5 DFAIT	Office Software, Host Nation Information	Office Software, Host nation data	Human Terrain Overlay, IPB Intelligence Estimate, Decision Support Template	Medium	Fair access to data

No.	Task	Reasoning Requirement Description	Data Requirements (sources)	Tools Used to Support Operators	Tools Used to Support Reasoning Requirements	IPB/IPOE Product Supported	Level of Feasibility	Feasibility Rationale
4.4.3	Effect on friendly operations	Does the local COA have any effect on friendly operations	Mission Orders assessed against most likely COA TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Office Software, Databases, Command and Control Systems, Host Nation Information	Office Software, Databases, Command and Control Software, Host nation data	Human Terrain Overlay, IPB Intelligence Estimate	Medium	Fair access to data
4.4.4	What are the interests of the relevant groups?	Can they be shaped by the friendly or adversarial force? Have they been shaped already?	Data from 3.3 TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2) C5 DFAIT	Office Software, Databases, Host Nation Information	Office Software, Databases, Host nation data	Human Terrain Overlay, IPB Intelligence Estimate	Medium	Fair access to data
4.4.5	Identify initial collection requirements for population	Develop information collection plan for local population.	HN Information, ALL SOURCE INTELLIGENCE TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2) C5 DFAIT	Office Software, Databases, Host Nation Information	Office Software, Databases, Host nation data	Human Terrain Overlay, IPB Intelligence Estimate	Low	Fair access to data, requirement not understood
4.4.6	Develop NAIs for local population COAs	Assign NAI for COAs for Local population	HN Information, ALL SOURCE INTELLIGENCE TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat). Mission Secret ISAF (Level 2) C5 DFAIT	Databases, GIS, Host Nation Information	Databases, GIS, Host nation data	AI Overlay, Human Terrain Overlay, IPB Intelligence Estimate, Decision Support Template	Medium	Fair access to data
4.5	Develop an Event Template							

No.	Task	Reasoning Requirement Description	Data Requirements (sources)	Tools Used to Support Operators	Tools Used to Support Reasoning Requirements	IPB/IPOE Product Supported	Level of Feasibility	Feasibility Rationale
4.5.1	Compare the NAIs associated with each COA against the others.	Conduct a comparison of the NAIs against each other from each COAs. At a minimum the most likely en COA and the most dangerous.	Map Data, Doctrinal Templates if available GST (Maps) DIST (Imagery database)	GIS, Command and Control Systems	GIS, Command and Control Software	Event Template	Medium	Fair access to data
4.5.2	Identify NAIs that provide unique indications of specific COA	Identify the indicators that highlight that the threat has chosen a particular COA	Map Data GST (Maps) DIST (Imagery database)	GIS, Command and Control Systems	GIS, Command and Control Software	Event Template	Medium	Fair access to data
4.5.3	Develop an Event Matrix							
4.5.3.1	Translate events associated with NAIs in terms of indicators	The event matrix supports the event template by providing details on the type of activity expected in each NAI, the times the NAI is expected to be active, and its relationship to other events on the battlefield.	Doctrinal template, NAIs TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2) GST (Maps) DIST (Imagery database)	GIS, Command and Control Systems	GIS, Command and Control Software	Event Template, Decision Support Template	High	Good Access to data
4.5.3.2	Enter indicators in the event matrix with their time of occurrence expected from TPLs	If available, the times identified on the Event Matrix are expressed in terms of Not Earlier Than (NET) or Not Later Than (NLT).	Doctrinal template, NAIs TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2) GST (Maps) DIST (Imagery database)	GIS, Command and Control Systems	GIS, Command and Control Software	Event Template, Decision Support Template	High	Good Access to data
4.6	Develop High Priority/Payoff Target List (HPTL)	HPTs are those HVTs that must be acquired and successfully attacked for the success of the friendly commander's mission. Includes justification of NAI / TAI.	HVT, Mission Orders and Conops TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Office Software, Command and Control Systems	Office Software	Decision Support Template	Medium	Good Access to data

No.	Task	Reasoning Requirement Description	Data Requirements (sources)	Tools Used to Support Operators	Tools Used to Support Reasoning Requirements	IPB/IPOE Product Supported	Level of Feasibility	Feasibility Rationale
4.7	Develop the Decision Support Template	The DST is an operations staff product used in the war-gaming process which graphically, or in written form, represents decision points and projected situations, and indicates when, where, and under what conditions a decision is most likely to be required to initiate a specific activity or event.	Event template, Mission Orders TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Office Software, Command and Control Systems	Office Software, Command and Control Software	Decision Support Template	Medium	Fair access to data
4.8	Develop the Intelligence Estimate	Using the results of the IPB process, and the results of any staff war game or simulation, produce the intelligence estimate.	Results of IPB TFK Internal TacNet Level 2 (includes Orion) - Mirc Chat (internet relay chat) Mission Secret ISAF (Level 2)	Office Software, Command and Control Systems	Office Software, Command and Control Software	IPB Intelligence Estimate	Medium	Fair access to data

List of symbols/abbreviations/acronyms/initialisms

AA	Avenues of Approach
AI	Artificial Intelligence
AO	Area of Operations
ARP	Applied Research Project
ATG	Analyse Tactique Graphique
CBR	Case-Based Reasoning
CFINTCOM	Canadian Forces Intelligence Command
COA	Course of Action
COI	Compound of Interest
COIN	Counter Insurgency
COO	Course of Operations
DIST	Defence Imagery Support Team
DRDC	Defence Research and Development Canada
DST	Deployed Sigint Team
FEBA	Forward Edge of the Battle Area
GIST	Geospatial (geo) Intelligence Support Team
GST	Geospatial Support Team
HN	Human Network
HUMINT	Human Intelligence
HVT	High-Value Target
HVTL	High-Value Target List
IPB	Intelligence Preparation of the Battlefield
IPOE	Intelligence Preparation of the Operational Environment
KT	Key Terrain
MC	Mobility corridors
MCOO	Modified Combined Obstacle Overlay
METT-T	Mission, Enemy, Troops available, Terrain
NAI	Named Area of Interest
NGO	Non-Governmental Organisation
NLT	Not Later Than
ORBAT	Order Of Battle

PIR	Priority Intelligence Requirement
RBR	Rule-based reasoning
SIIP	Self-Improving Inference Prototype
SIIS	Self Improving Inference System
SME	Subject Matter Experts
SOFCOM	Special Operations Forces Command
S&T	Science and Technology
TERA	Military Terrain Analysis
TPL	Time Phase Lines
TTP	Techniques, Tactics, Procedures
UI	User Interface
URI	Uniform Resource Identifier
VG	Vital Ground
VOI	Vehicle of Interest

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This report presents the results of a research project about the application of automated reasoning and machine learning approaches to support the Intelligence Preparation of the Battlefield/Operational Environment (IPB/IPOE) process. Analysts conducting IPB/IPOE are faced with information and cognitive overload problems. The research initiative described in this report intends on supporting IPB/IPOE analysts with Self-Improving Inference Systems (SIIS).

To achieve this goal, literature and technological surveys as well as expert interviews and workshops were conducted. A functional decomposition of IPOE was also performed. Following the results from these tasks, two prototype systems were developed in order to support analysts performing IPB/IPOE.

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Ce rapport présente les résultats d'un projet, l'application du raisonnement et de l'apprentissage automatisé en soutien à l'analyse tactique graphique (ATG). Les analystes qui exécutent l'ATG sont confrontés à une surcharge informationnelle et cognitive. L'initiative de recherche décrite dans ce rapport vise à soutenir les analystes d'ATG à l'aide de systèmes d'inférence auto-améliorants.

Pour atteindre cet objectif, des revues de littérature et de technologie ont été effectuées. Des entrevues et ateliers avec des experts ont aussi eu lieu. Une décomposition fonctionnelle de l'ATG a ainsi été réalisée. Suite aux résultats obtenus dans ces tâches, deux prototypes de systèmes ont été développés afin de soutenir les analystes d'ATG.

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Inference, Reasoning, Machine Learning, Intelligence, Prototype, IPB, IPOE