Supporting Distributed Coalition Planning with Semantic Wiki Technology

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***Abstract*—Contemporary and near-future military coalition environments present a number of challenges for military planning. Not only must military planners create plans against a backdrop of strict time constraints and uncertain information, they must also coordinate their planning efforts with other planning staff (often from different organizational, linguistic and cultural communities). This paper examines the potential for semantic wikis to support collaborative planning activities in the face of these challenges. Whilst we do not claim that semantic wikis could support all aspects of the collaborative planning process, we do suggest that semantic wikis can provide a highly configurable online editing environment which is likely to be of value in at least some coalition planning contexts. The strengths of semantic wikis include their support for distributed editing, their support for flexible forms of information presentation, and the opportunities they provide for new forms of inter-agent coordination. Their weaknesses include the absence of supportive plan editing interfaces and the limited support for the representation of highly expressive planning models. In the current paper, we discuss this profile of strengths and weaknesses, and we also discuss how a specific semantic wiki system, namely Semantic MediaWiki, could be used to support some aspects of collaborative planning.**

I. Introduction

Contemporary and near-future military coalition environments present a number of challenges to those involved in the creation, dissemination and utilization of military plans. Not only must military planners create plans against a backdrop of time constraints and uncertain information, they must also coordinate their planning efforts with other planning staff (often from different organizational, linguistic and cultural communities) in order to ensure that the resulting plans are capable of supporting coordinated military action.

In order to deal effectively with the challenges of the military coalition planning environment, military planners need access to technological solutions that assist them with the task of collaboratively creating military plans in a distributed network environment. Although a variety of 'media-rich' collaboration technologies are likely to prove useful here (e.g. video conferencing facilities, virtual environments, and so on), it is possible that some collaborative technologies developed in the context of the World Wide Web may also prove to be of value to military planners. Of particular interest are technologies that support greater levels of user participation, interaction and engagement with online Web-based resources. Such technologies are commonly seen as epitomizing a transition to what has been dubbed Web 2.0, a kind of catch-all term for Web resources that make increasing use of online collaboration, dynamic content, crowd-sourcing, power decentralization and the principles of user-centered design. Among these technologies, wiki systems (such as the popular online encyclopedia, Wikipedia) have emerged as particularly potent examples of the power and potential of light-weight online collaborative editing environments. At the present time, however, it is unclear to what extent the capabilities of these Web-based systems match those required by military coalition planners working in distributed network environments. The aim of this paper is to gain greater clarity on this issue. The paper describes a potential set of wiki-based planning capabilities which make specific use of the capabilities of the popular semantic wiki system, Semantic MediaWiki (SMW) [8]. By assessing this potential functionality, we aim to gain a greater understanding of the strengths and weaknesses of semantic wikis with respect to the challenges of the military coalition planning environment.

II. Challenges of the Military Coalition Planning Environment

In order to assess the strengths and weaknesses of wiki-based planning systems, it is important to better understand the challenges posed by contemporary and near-future coalition environments. Most of these challenges relate to the dynamic, distributed, time-constrained, informationally-hostile[1] and culturally-diverse nature of the military planning environment. Thus, as part of their analysis of collaborative planning and situation awareness in Army command and control, Riley et al [16] identify a number of critical human factors challenges associated with planning in land-battle situations. These challenges include the need to rapidly develop and disseminate plans, the need to visualize plans and track deviations to planned activities, the need to engage in contingency planning, and the need to rehearse plans prior to deployment. A further

[1]The fact that information is often unreliable, incomplete, ambiguous or conflicting.

challenge identified by Riley et al [16] relates to the distributed nature of the planning process. In this case, planning staff are often physically dislocated, and this leads to problems in terms of the perceived degree and quality of coordination that can be achieved in distributed, network-mediated problem-solving contexts. As Riley et al [16] comment:

> "distributed planners need features, functions, and interaction mechanisms which support effective coordination and promote the intense collaborative process and brainstorming activities which can occur in co-located planning sessions." [pg. 1145]

Related to the challenges identified by Riley et al [16] are the challenges introduced by the multi-cultural and multi-national nature of military coalitions. A number of studies have highlighted cultural differences in the way US and UK military planners evaluate the quality of military plans [14], and such differences may be anticipated to result in conflict, confusion and, ultimately, breakdowns in trust between planning staff, as well as executive agencies, particularly when plans are developed or communicated across cultural boundaries. Compounding this problem, of course, is the potential for miscommunication and misunderstanding between both planners and plan executors (see, for example, [13]). Such problems highlight the need for plan-related content to be easily understandable by culturally- and organizationally-diverse communities of agents. Ideally, coalition plans should avail themselves of features that promote the development and maintenance of understanding and trust between both those who develop plans and those who are ultimately responsible for their execution.

III. Capability Targets for Military Planning Systems

A consideration of the challenges associated with the military coalition planning environment leads to a number of conclusions regarding the kind of capabilities that need to be supported by coalition planning systems. In general, such systems need to support the following:

1) the ability to rapidly create, edit and evaluate plan-relevant content;
2) the ability to deliver planning products that can easily be understood, easily acted upon, and which promote and maintain trust between both planning agents (human and synthetic) and executive agencies;
3) the ability to generate plans that satisfy the possibly disparate and culturally-entrenched (see [14]) criteria for plan evaluation;
4) the ability to optimally coordinate patterns of information flow and influence between planning agents (both human and synthetic) in a way that respects the demands of collaborative planning and the resource constraints of a distributed planning environment (e.g. bandwidth constraints);
5) the ability to easily interface and inter-operate with a variety of distinct planning applications, e.g. reasoners, validators, simulators, visualizers, and so on;
6) the ability to monitor situations during the course of plan execution and anticipate requisite changes to the current plan.

As a rough approximation, we can group these capabilities into a number of categories (each of which serves to guide the discussion of wiki-based capabilities in subsequent sections of this paper). These include effective mechanisms for agent coordination (point 4), flexible modes of presenting plan-relevant information (points 2, 3 and 5), supportive plan editing environments (point 1), and effective situation monitoring capabilities (point 6). In addition, because military planning is likely to benefit from the exploitation of machine-based capabilities, it is important that collaborative systems should provide suitable support for mixed-initiative planning (i.e. they should maximally support the synergistic integration of human- and machine-based planning capabilities). All of these capabilities are obviously predicated, to a greater or lesser extent, on the availability of frameworks for the effective representation of plan-relevant information.

IV. Semantic Wikis in Support of Military Planning

Previous sections highlighted the challenges posed by the military coalition planning environment and the impact these challenges have in terms of the capabilities we might expect of military planning systems. In this section, we examine to what extent a wiki-based planning system, comprised entirely of freely available, open-source components, could be used to support planners in meeting the challenges posed by the military coalition planning environment[2].

Wikis provide an attractive platform for the development of distributed (network-mediated), collaborative capabilities, not least because they have already proved to be very effective at supporting collaborative content-editing efforts in the context of the conventional Web (witness the popularity of the Wikipedia system). The popularity and ease-of-use of wiki systems makes them ideal candidates for military applications that have minimal training overheads and that, in all likelihood, tap into the existing skills base of new military recruits. In addition, the practical benefits of wiki systems in military application areas such as intelligence analysis have already been explored [11, 15]; the current discussion simply extends the scope of these previous investigations to the domain of military planning[3]. The following subsections provide an overview of the potential support provided by semantic wikis in a number of capability areas.

A. Plan Representation

As mentioned above, the key to meeting many of the challenges of the military coalition planning environment is the availability of frameworks for the effective representation of

[2]The discussion of these capabilities is based on the current functionality provided by the Semantic MediaWiki system.

[3]It is for this reason that we do not attempt to explore the potential strengths and weaknesses of semantic wikis with respect to situation monitoring and situation awareness capabilities, at least in the context of this paper.

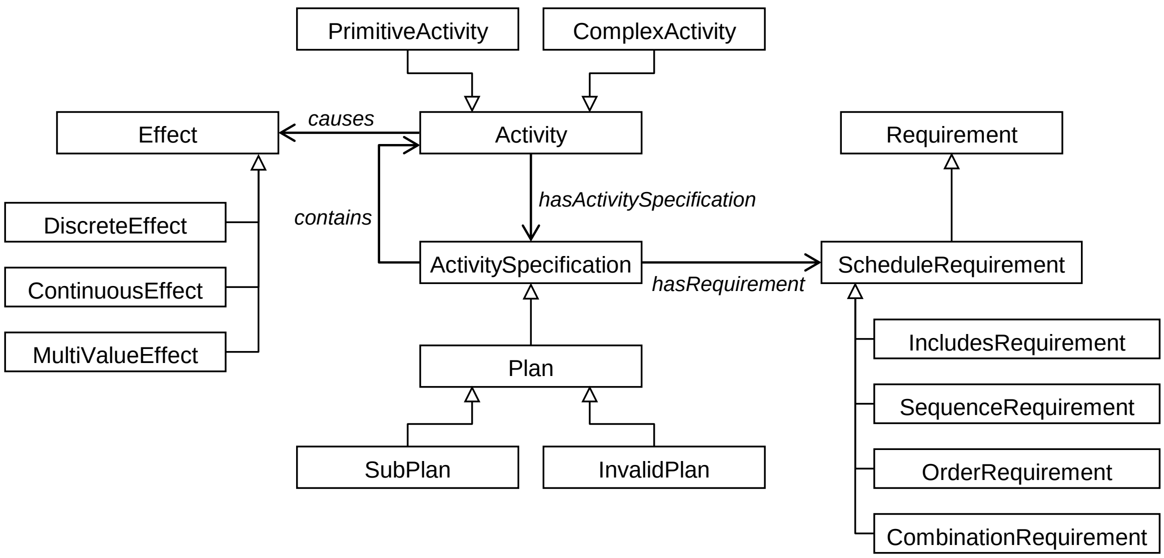

Fig. 1. A UML projection of a planning ontology developed to support the representation of plan-relevant information in SMW.

plan-relevant information. Over the past 15 years, a number of planning ontologies or planning models have been developed to support the representation of plan-relevant information (see [4], for a review). These include SPAR [20], PLANET [6], INOVA [19] and, more recently, the Collaborative Planning Model (CPM) [10]. Clearly, all these planning models contain important information about the kinds of things that should be represented in a plan (as well as how those things should be represented), but accommodating these various planning models within a system like SMW is not straightforward. One of the main challenges is that, like many semantic wikis, SMW provides only a limited form of semantic expressivity: its expressivity is largely limited to a subset of that seen in the Resource Description Framework Schema (RDFS) and Web Ontology Language (OWL) frameworks. Thus, although SMW supports some degree of formal modeling, it is not necessarily well-suited to the representation of semantically-expressive planning ontologies, such as the CPM.

One potential solution to this problem is to make use of the meta-model solution proposed by Bao et al [3]. This solution effectively extends the expressivity of SMW using semantic templates[4] that follow the meta-level structure of the Semantic Web language, OWL. Using this solution, it is possible to extend the expressivity of SMW in order to support the representation of planning models that can be represented as OWL ontologies. This extension in the expressivity of SMW has a number of benefits when it comes to the collaborative development of military coalition plans. Firstly, and most obviously, it enables plan-relevant information to be represented in a semantically-enriched manner: one that supports automated forms of machine processing and semantically-mediated information retrieval. Secondly, it enables members of the planning community to collaboratively edit (and extend) the planning ontology according to their (often dynamic) community-specific representational requirements (the wiki, in this case, serves as a light-weight collaborative editing environment for the planning ontology). Thirdly, the expressivity extensions developed by Bao et al [3] work in concert with the presentational capabilities of the wiki (see Section IV-E) in order to support the generation of various output formats. Thus, Smart et al [18] demonstrate how the expressivity extensions proposed by Bao et al [3] can be used to provide a Controlled Natural Language (CNL) verbalization capability. Given the apparent benefits of CNLs when it comes to both the production and comprehension of semantically-enriched content [5, 7], such CNL verbalization capabilities may act to enhance human end-user comprehension without necessarily undermining the potential for machine-based processing of semantically-enriched content (this may, of course, be of particular benefit in the case of mixed-initiative planning systems).

B. *Rule Representation and Reasoning*

One limitation of wiki-based systems when it comes to capitalizing on the availability of semantically-enriched representations concerns their limited support for automated reasoning. Thus, although semantic wikis can enable plan-relevant information to be represented in a way that supports automated forms of inference, they do not actually support the realization of those inferential capabilities (unless, of course, the contents of the plan ontology are exported to an external reasoner). Similar problems are associated with the representation of rules. For example, SMW does not support the representation

[4]Semantic templates provide a means by which the text of a wiki page can be programmatically generated by the wiki parser engine. In essence, the wiki parser replaces a template with the text given on the template's source page. The template may be parameterized, such that different kinds of text output can be generated by the parser.

of rules in a manner that enables such rules to be exploited as part of the plan development and plan evaluation process.

An initial attempt at dealing with these limitations in the context of SMW is described by Bao et al [2]. They suggest that a combination of inline queries, in conjunction with semantic templates, could be used to support certain forms of rule-based processing with little or no modification to the underlying SMW software. Thus, consider the notion of a sub-activity in the planning ontology illustrated in Fig. 1. A sub-activity is any 'Activity' that is contained in the 'ActivitySpecification' associated with another 'Activity' (the super-activity). In order to support this form of inference, we could create the following semantic template and include it on any wiki article corresponding to an instance of the 'Activity' class:

```
{{#arraymap:{{getValue|[[{{PAGENAME}}]]
|hasActivitySpecification}}|,|Y|
{{#arraymap:{{getValue|[[Y]]|contains}}|,
|Z|[[hasSubActivity::Z]]}}}}
```

This code retrieves all the activities that are contained in the activity specifications associated with the wiki article on which the template code is embedded. It then asserts that each of the retrieved activities is related to the current article via the 'hasSubActivity' property. Given that the output of the template is a series of knowledge statements (that are ultimately encoded as RDF triples), it should be clear that the use of semantic templates within a semantic wiki system can be used to support at least some forms of rule representation and reasoning. One problem, of course, is that it is likely to be very difficult for casual users to create such rules using the aforementioned wiki syntax. Supportive rule editing interfaces will probably be needed support end-users in creating rules for wiki-based reasoning.

C. Plan Content Creation

The ability to rapidly create and edit plan content was identified above as an important challenge for military coalition planning systems (see [16]). This focuses attention on the kind of interfaces and user interaction mechanisms that can be provided within a wiki-based environment in order to support both human and machine editing of plan-related content. A wiki system enables human end-users to easily create and edit content using the text editing features provided by the underlying wiki software (this includes the use of wiki-markup to perform common text formatting and text layout functions). Obviously, such features are most suited to the entry and editing of natural language text and the insertion of multimedia objects; they are somewhat less well-suited to the development of large and structurally complex military plans. Nevertheless, content creation on wiki platforms is not necessarily limited to the editing of plain text, and a number of pre-existing SMW extension components attest to the possibility of supporting more sophisticated forms of user interaction (e.g. the Halo extension[5]).

One relatively straightforward way of supporting the creation and editing of plan-relevant information relies on the use of an open-source extension to SMW, called semantic forms[6]. Semantic forms enable users to create and edit structured data using conventional web form controls, such as text boxes, list boxes, checkboxes and so on. Semantic forms are designed to support the indirect creation and editing of plan ontology elements (i.e. classes, properties and individuals) via semantic templates. What this means, in effect, is that every element of a plan can be associated with a form-based interface that ultimately supports the user in creating and editing the content associated with that element. Fig. 2 illustrates a sample form-based editing interface for a particular plan element, namely an 'Activity'.

Although semantic forms support human end-users in entering structured information, they are not necessarily the most effective interface for the editing of highly complex military plans. The kinds of forms made available by systems such as SMW are primarily geared towards the creation of ontology elements, but this ontology-centric perspective is, we suspect, unlikely to be suitable for most real-world planning scenarios. Future research should seek to assess the extent to which more supportive interfaces can be developed to support the military planning community. In all likelihood, a wide range of Web technologies (Ajax, XHTML, Flex, CSS2, etc.) are likely to be required in the design of such interfaces.

On further issue related to content creation and content editing concerns the level of support wiki systems provide for mixed-initiative planning. In most military planning scenarios some level of support is likely to be provided by machine agents, and the use of semantically-rich representations by semantic wikis is clearly beneficial when it comes to the machine-based processing of plan content. Nevertheless, it is currently unclear to what extent semantic wikis are suited to mixed-initiative planning. Future research and development efforts should consider the kind of capabilities required of semantic wikis in mixed-initiative planning scenarios, and this may call for the development of specific web service interfaces to cater for various forms of agent-based assistance and interaction.

D. Rationale Representation

In its simplest form, a plan is a collection of actions with some sort of organizational structure that governs the sequencing and timing of those actions. This basic view of a plan is, however, very limited, and it ignores a lot of the knowledge that is generated as part of the planning process. Perhaps one of the most important pieces of additional plan-relevant information in military coalition contexts is rationale (see [9]). Rationale information essentially provides an explanation as to why the plan is the way it is: why it contains the elements it does and why those elements are related in the way that they are [12]. It is, in essence, a record of the decision-making processes that planning agents have gone through as part of the

[5]http://semanticweb.org/wiki/Halo_Extension

[6]http://www.mediawiki.org/wiki/Extension:Semantic_Forms

Fig. 2. Use of semantic forms to edit the information associated with a particular plan element, namely an 'Activity'.

planning (or replanning) process. Such information is deemed to be important for a number of reasons (see [22])[7], and a number of efforts have been made to support the representation of rationale information in extant planning models [9, 22].

Rationale information is a form of meta information about plan elements; it is information that applies either to a specific plan object (e.g. a specific action, effect, or goal) or to an object-attribute-value triple (a subject-predicate-object triple in the terminology of the Semantic Web). As discussed by Mott and Giammanco [9], the representation of such meta-level information in a conventional Semantic Web ontology is not straightforward. One invariably has to think about forms of RDF reification using the rdf:Statement construct (see [9] for more details). Relying on this form of RDF reification in the context of SMW is somewhat problematic; however, an alternative approach is to rely on the features of the environment in which the ontological solution is embedded (i.e. the wiki system and associated Web protocols) in order to obviate otherwise difficult or intractable representational problems. The solution we propose here is based on the use of URLs to encode important information about the resource (plan object or subject-predicate-object triple) to which the meta-level information applies. Thus, in the case of a specific plan element such as the activity 'repair bridge bravo', the location of the rationale information that applies to the activity could be located at the following URL:

```
http://localhost:81/wiki/repair_bridge_
bravo/rationale
```

The wiki article corresponding to the activity itself would contain information about the properties associated with that activity (e.g. start time, duration, effects, objectives, responsible agents and so on), and such properties could be displayed in a tabular format on the wiki page. Each property statement could also be associated with a link to an article that contained rationale information for that particular property statement (the hyperlinks could be automatically constructed by a wiki

[7]Perhaps two of the most important reasons for including rationale information in military coalition plans is the support that rationale representations provide for both trust and understanding in planning decisions, particularly those that were made by culturally and mechanistically (in the case of mixed-initiative systems) disparate groups of planning agents.

template based on the specific URL formatting conventions adopted by the wiki system), and each of the links could be structured in the following way:

```
http://localhost:81/wiki/repair_bridge_
bravo/[property name]/
[value name]/rationale
```

When a user clicked on one of these links, they would be transferred to a page that represented the rationale for the specific subject-predicate-object statement that was indicated by the URL. By adhering to this set of URL formatting guidelines, planning agents (both human and synthetic) could easily locate the rationale information associated with any resource or knowledge statement asserted in the plan. Moreover, because wiki systems use a different font for links that do not have an associated wiki article, the wiki can provide a visual cue (for human end-users) as to which statements are associated with rationale information and which are not.

The solution described here clearly applies to the representation of rationale information; however, it should be clear that a similar scheme could be applied in the case of other types of meta-level information, such as information source, certainty, accuracy, time of assertion, and so on. The thing that determines the viability of this solution is the availability of a set of community-wide guidelines that determines how various sorts of information can be accessed based on the reliable and predictable structuring of plan-related URLs.

E. Plan Presentation

While a variety of forms of content may be hosted within a wiki in order to support the development of coalition military plans, much of this content is unlikely to be suitable for direct presentation to the executors of a plan, at least without some form of prior formatting and customization. The ultimate purpose of a military plan is, of course, to guide, constrain and coordinate collective actions in a way that contributes to the realization of strategic military objectives. In order to do this, plans need to be accessible to executors in a form that works in concert with their idiosyncratic cognitive and perceptual biases. In particular, it should be easy for military commanders to rapidly understand, evaluate and act on the plans they are provided with.

Semantic wikis can support the generation of custom output formats via a number of mechanisms. One mechanism is, of course, to create extensions that process and format the plan content by directly retrieving information from an external knowledge store (the database that contains the planning model and associated instance data). Another mechanism is to use semantic templates within the wiki to selectively retrieve and present relevant subsets of plan-relevant information. The advantage of this latter mechanism is that it enables output formats to be edited using all the usual wiki-based editing schemes; it essentially enables users of the wiki to collaboratively create and edit output formats based on a specific set of user, mission or application requirements.

As an example of how custom output formats can be generated using semantic templates, consider the solution proposed by Smart et al [18] for generating natural language serializations of SMW content using the Rabbit CNL. This solution is based on the use of semantic templates that retrieve information from the wiki knowledge store and then structure that information in accord with the syntactic constraints of the Rabbit language (see [18] for more details). The creation of semantic templates to support custom output formats requires considerable knowledge of wiki templates and their associated syntax (and this may be an important shortcoming of template-mediated output mechanisms); nevertheless, the ability to create, edit and discuss semantic templates (e.g. via wiki discussion pages) provides a powerful means to *collaboratively* develop the kind of output formats that are needed to address specific system inter-operability and plan visualization requirements. One potential use of such capabilities is to support the generation of plan visualizations that are tailored to meet the expectations and requirements of distinct (perhaps culturally-disparate) groups of planning agents. Thus consider the finding, mentioned above, that one of the key cultural differences between US and UK military planners relates to the ways in which these planners assess the quality of a plan: for US planners a high quality plan is one that provides a "detailed blueprint for action", whereas for UK planners a high quality plan is one that "can support the effective communication of command intent" ([14]). Perhaps one way of dealing with such differences is to tailor plan content in order to meet the culturally-specific preferences and biases of different end-user communities. In this respect, previous efforts to develop tailored, semantically-driven report generation capabilities (e.g. [1]) may be worth considering in the context of military coalition planning systems.

F. Agent Coordination

One of the key challenges for military coalition planners is the need to engage in effective forms of collaboration. Collaboration is important for a number of reasons. For example, planning agents need to be able to communicate and exchange information in a way that ensures the outcome of the planning process—the plan—is an intelligent and effective solution to the planning problem (one that draws on the respective knowledge and expertise of the agents involved in the planning effort). At the same time, coalition plans need to be able to support coordinated action, and thus collaboration is required in order to ensure that the proposed actions are both coherent and compatible.

The transition to a distributed planning environment poses particular problems for collaborative planning. As Riley et al [16] comment:

> "Many of the challenges of the C2 planning process are related to or will be compounded by the requirements for future Army forces to participate in distributed collaboration. In particular, distribution of task forces will have a serious impact on

> the collaborative planning process and collaborative problem-solving." [pg. 1144]

The main problem here, as identified by Riley et al [16], relates to the effect of physical distance on the opportunities for face-to-face interaction between planning staff, and it is for such reasons that advanced, 'media-rich' collaboration technologies (such as video conferencing) may prove useful in the context of distributed military planning efforts. Despite their advantages, however, such 'media-rich' collaboration technologies are not without their costs. In particular, the bandwidth required for video conferencing, or the time required to instantiate a pseudo-realistic virtual planning environment, may exceed the technological and temporal resources available to the coalition planning community.

What is required, therefore, is a means by which effective modes of information flow and influence between agents can be accomplished without exceeding the resource constraints associated with the military coalition environment. Wiki systems, we suggest, provide a number of interesting ways in which inter-agent collaboration can be coordinated. Firstly, there are discussion (or Talk) pages, which can be used to coordinate collaborative editing efforts. Such pages have been shown to play an important role as a coordination mechanism in the case of the Wikipedia system [21], and they could fulfill a similar role in the case of wiki-based planning systems. Secondly, most wiki systems provide a system of labels or tags which can be used to coordinate collaborative editing efforts. For example, a 'stub' article in Wikipedia is an article that has been tagged with the stub template in order to indicate that the main article content is incomplete and requires further editing. A similar system of tags could be used by both human and synthetic planning agents to indicate or highlight issues with specific plan elements. For example, a machine agent could systematically monitor the contents of the wiki and highlight content that may be misunderstood by coalition partners, perhaps because of linguistic ([13]) or cultural ([14]) differences.

A third way in which collaborative efforts might be coordinated in the context of a wiki-based planning system is by relying on techniques to support an awareness of specific events and contingencies associated with the plan development process. For example, as part of their description of a semantic system to improve information exploitation in military and civilian application contexts, Smart et al [17] describe the use of components, called knowledge monitors, to improve an end-user's awareness of an unfolding situation. The basic idea is that by using semantic queries to register their interest in specific events and contingencies, agents can be alerted as to the occurrence of those events and contingencies by a system of periodic query execution against situation-relevant knowledge bases. Thus, just as knowledge monitors enable end-users to detect and respond to specific contingencies in a situation monitoring context, so they can enable planners to detect and respond to contingencies that might arise as part of the planning process in a distributed planning environment.

Knowledge monitors could be implemented as either Concept pages or inline queries, both of which are features of the SMW system. In this case, whenever a query page was accessed by the end-user, the inline query would return an up-to-date list of activities that satisfied the conditions of the query. Of course, one limitation here is that such queries would only be evaluated when the page containing the query was accessed (i.e. once a request to the web server on which the wiki system was hosted was initiated). This would mean that the user would not be immediately notified whenever a relevant change in the plan occured; instead, they would need to manually access the page containing the query in order to view its updated content. One solution to this problem is to have an external application store the URL of pages containing the queries that an end-user is interested in monitoring. This external application could then periodically post HTTP requests to the wiki server machine and, if the page results differed from that returned on a previous occasion, then an appropriate user alert (popup dialog, email, SMS message, or voice alert) could be generated.

V. Conclusion

This paper has discussed a number of challenges associated with the military coalition planning environment, and it has sought to assess the extent to which semantic wiki systems might be used to support distributed, collaborative planning efforts in light of these challenges. The discussion has highlighted a number of interesting capabilities possessed by semantic wikis. These include the provision of flexible modes of presenting plan-relevant information, the provision of a variety of agent coordination mechanisms, and the provision of semantically-enriched frameworks for the representation of plan-relevant information (including meta-level information, such as plan rationale).

It is also the case, however, that semantic wikis possess a number of significant shortcomings when it comes to the challenges faced by the military coalition planning community. These include limited support for the representation of rules, limited support for automated reasoning and limited support for the editing of plan content via supportive user interfaces. It is also likely to be the case that wiki-based planning systems will need to provide support for mixed-initiative planning, perhaps via the development of planning-specific web service interfaces.

Semantic wikis thus possess a number of strengths and weaknesses in respect of the challenges associated with contemporary and near-future military coalition environments. On the one hand, such systems provide a highly configurable, light-weight and user-friendly online collaborative environment: one which has already proved its worth in the context of large-scale content editing initiatives (recall the case of Wikipedia). On the other hand, such systems show a number of potential shortcomings with respect to (e.g.) their support for automated reasoning, their support for mixed-initiative planning and the general availability of plan-specific editing interfaces. Future research and development efforts should aim to address these issues and further examine the suitability of wiki-based planning systems for collaborative planning in distributed military coalition environments.

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