Augmented Synchronised Planning Spaces

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Abstract

Planning of military operations requires specialist teams to engage in intense collaborative activities, often to strict deadlines. The orchestration of and support for such team activities, and the synchronization of multiple teams is of particular concern and common to other non-military domains. Other issues to be addressed include agile approaches for preplanning and rescheduling of team activities, improved team awareness through the ambient display of information, and automated support for information management and the consolidation and presentation of results. This paper discusses research that we are undertaking in the area of ubiquitous workspaces aimed at supporting multiple synchronized teams involved in time-critical military planning activities.

1 Introduction

Augmented Synchronized Planning Spaces (AuSPlanS) is a collaborative project being coordinated by the Collaborative Research Centre for Enterprise Distributed Systems Technology (DSTC) which aims to apply and evaluate the use of enterprise-enable ubiquitous workspaces (or LiveSpaces) for supporting multiple teams engaged in military planning activities. A particular focus of the work is the rapid augmentation and enablement of existing physical spaces, such as meeting rooms, with emerging ubiquitous computing, enterprise computing, new media, and human interaction technologies. This aspect is of key importance in military coalition operations, where command and control facilities, people, roles, processes, information, and technology often need to be quickly configured and evolved in add hoc and time critical situations.

This paper begins by providing background on the notion of ubiquitous workspaces. We describe our LiveSpaces approach which we have developed to provide the common underlying science and technology base for research into ubiquitous workspace concepts, and for projects such AuSPlanS. As part of this approach we have defined a LiveSpaces reference architecture that guides our more fundamental research activities in this area and supports the integration of research and industry artefacts. We then discuss the AuSPlanS project by describing the defence domain context that is driving the work, the AuSPlanS experimental platform, and a set of scenario components and associated data products that have been developed to support experimentation and evaluation. As part of the AuSPlanS work, we have developed a novel approach based on Orchestrated Evaluation Session and meta-applications for conducting domain specific experiments and evaluations. We describe this approach and present the results of the first of a series of three iterative experiments. We conclude with a summary of lessons learned, issues to be addressed and future recommendations.

2 Background: Ubiquitous Workspaces and LiveSpaces

Ubiquitous workspaces are future media-rich environments that employ new forms of operating systems and services to coordinate and manage interactions between people, multiple display surfaces, information, personal devices, and workspace applications [VER04]. LiveSpaces is ubiquitous workspaces approach that is addressing how physical spaces such as meeting rooms can be augmented with a range of display technologies, personal information appliances, speech and natural language interfaces, interaction devices and contextual sensors to provide for future interactive/intelligent workspaces [VER03]. New software infrastructure provides the basis for integrating, controlling and coordinating activities and technologies within these future workspace environments. Enterprise-level infrastructure provides for the integration and synchronization of multiple collaborating workspace environments. Figure 1 shows the LiveSpaces environment that has been set up to support the Commander's Planning Group in the AuSPlanS project.

Figure 1. LiveSpace Environment currently being used for AuSPlanS Experimentation

The LiveSpaces Reference Architecture is shown in Figure 2 (as instantiated for the AuSPlanS Project). Several key architectural features are defined in the model. A key feature of the model is that it defines the ability to connect and synchronise a number of different physical or virtual LiveSpaces and/or other services together through an Enterprise Bus. In the current version of the LiveSpaces infrastructure, the Enterprise Bus is implemented using the DSTC Open Distributed Systems Infrastructure (ODSI) [BON01] that provides a peer to peer infrastructure based on a content-based routing system called Elvin [SEG00]. The various services that are integrated for the AuSPlanS project are discussed in Section 3.1.

The architecture for each workspace instance has at its core a Workspace Infrastructure that coordinates access to various workspace services, devices, computers and applications. The Workspace Infrastructure acts as an operating system for the entire workspace. The current LiveSpaces infrastructure uses the Interactive Room Operating System (iROS) [JOH02] from Stanford University as the basis of the workspace Infrastructure.

A key focus of the LiveSpaces project is to investigate how various workspace support services and knowledge services can be employed to facilitate intense group activities. Knowledge services provide support for those aspects that help make a workspace "intelligent". Workspace Support Services provide capabilities that directly support collaborative activities. For example, we are currently working on services that can be invoked to automatically transcribe speech; media services that allow information to be presented using various technologies such as personal devices, large interactive displays and augmented reality; interaction services that coordinate various modes of interaction including speech, gestures, touch, and gaze; and orchestration services that, in addition to supporting the coordination and delivery of information to workplace participants and devices, facilitates group cognitive activities in relation to specific goals.

These services can be used to implement novel workspace applications such as universal session interfaces, ambient information displays, and intelligent listeners. A new class of ubiquitous workspace applications, called Meta Applications has been to can support the automation of activities such as briefings. Meta Application can automatically control and coordinate a range of workspace services, applications, devices, information and media. In LiveSpaces, they use a workspace orchestration service, currently implemented using the Breeze workflow engine and the Bred graphical workflow editor, as the programming mechanism. Meta applications are used in AuSPlanS to support orchestrated evaluation sessions as discussed in Section 5.2.

3 AuSPlanS Project

The AuSPlanS project focuses on the application and extension of LiveSpaces for distributed synchronised planning within future joint headquarters. The traditional planning environments for the scenarios that we are focusing on use relatively little technology. As we move into the future, decision making spaces are becoming more device and media rich. These technologies are not particularly useful in themselves. Rather, it is the way in which these technologies can be effectively integrated into workspaces and the ways in which they can support workspace participants and activities that have potential for significantly enhancing the effectiveness of planning teams. AuSPlanS focuses on augmenting and enabling workspaces with relevant technologies and knowledge products to form the basis of highly interactive intelligent planning spaces.

There are a number of research issues that AuSPlanS is addressing to support this form of intense collaboration. These include:

- synchronisation of time-critical activities and results across multiple workspaces and teams,
- improved team awareness through the ambient display of information,
- coordination within media rich, multiple display environments for improved situation awareness,
- automated support for information management and the consolidation/ presentation of result, and
- agile approaches pre-planning and rescheduling of workspace activities.

3.1 AuSPlanS Platform

The approach adopted for the AuSPlanS project is based on the use of an evolving experimental platform to support prototyping, evaluation and transitioning activities through a series of research cycle increments, each culminating in a Developmental Exercise involving stakeholders and users. The current implementation of LiveSpaces infrastructure provides the basis of the platform for the AuSPlanS project. The AuSPlanS platform (Figure 2) implements a ubiquitous workspace operating environment which supports the integration and coordination of devices, applications, services and information within a workspace. Workspace Support Services provide capabilities that directly support collaborative activities. Several new types of services will be experimented with during the course of the project including orchestration services, interaction services, speech transcription services, and media/visualisation services.

A range of new workspace applications are also the focus of AuSPlanS evaluations. For example, we are developing new approaches for providing universal session interfaces for users to interact ubiquitously with the various devices and applications and with each other. Applications ubiquitous computing applications such as PointRight [JOH02b] and Multibrowsing [JOH01] are being evaluated together with new planning applications developed by DSTO such as the Course of Action Planning Tool (COAST) [ZHA04] and the Centre of Gravity Network (COGNet) tool [PRI02]. These applications need to be evaluated within the context of real scenarios and associated datasets.

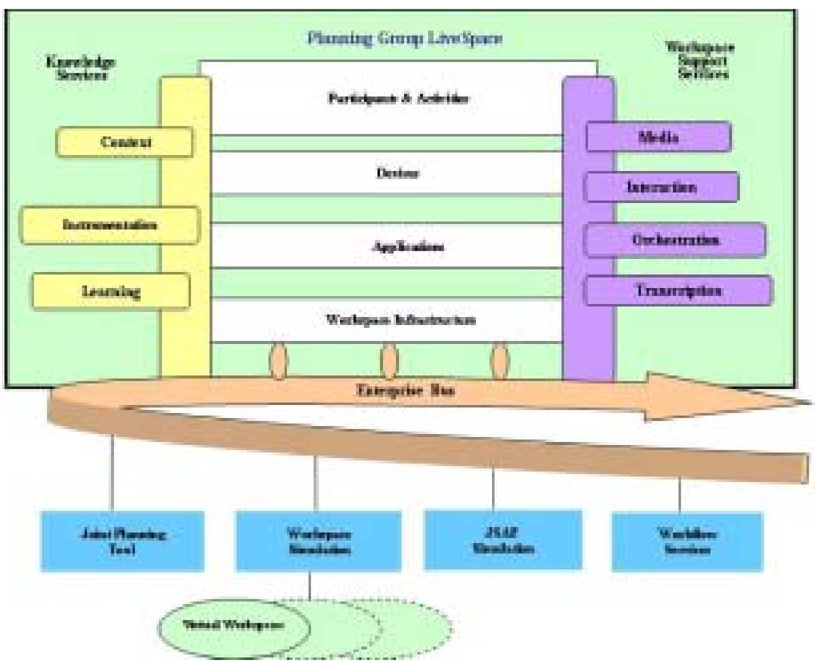

Figure 2. AuSPlanS Platform (based on LiveSpaces Reference Architecture and Infrastructure)

As discussed in Section 2, the Enterprise Bus provides a mechanism for rapidly accessing and integrating enterprise resources and services. It also supports the coordination and synchronisation of multiple workspaces. In AuSPlanS the enterprise bus supports the integration of information management services, workflow services, planning services, and simulation services. As shown in Figure 2, the Joint Planning Tool (a product of DSTO research) provides information management support and distributive data entry for the planning process. Workspace Simulation services are provided to enable the emulation of a

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full scale planning task by simulating a wide range and large number of planning teams. Our implementation [VER04b] uses workflow to coordinate and enact work processes and the Brahms [SIE99] multi agent approach to simulate work practices within virtual workspaces. This approach allows us to simulate a number of virtual spaces that can participate in group planning and other collaborative activities. The virtual spaces appear to people in real workspaces as though they are fully functioning workspaces populated with real people carrying out work tasks. They allow communication between workspaces and produce events and outputs as part of their own work processes

4 Orchestrated Evaluation Sessions

The experimentation and evaluation approach used for AuSPlanS is based on the use of orchestrated evaluation sessions. The concept of orchestrated evaluation is to provide a means of evaluating new concepts and technology within a domain specific scenario enacted in a representative work environment populated with relevant tools and artefacts. Artefacts can include physical products such as maps through to digital artefacts such as imagery, geospatial data, video footage, and planning data. The orchestrated session is a framework which allows evaluation modules to be inserted at particular points in a work process to assess the effectiveness of particular techniques and technologies relative to users' work practices. The approach allows various evaluation techniques to be employed ranging from more formal methods based on task analysis to discount methods and surveys. In addition, it allows for the capture of new concepts and requirements through user interaction. A key benefit of the approach is that it allows more controls than would be allowable in field studies such as exercises and allows for improved validation of evaluation results. Evaluations can be conducted on a range of areas from new concepts through to fielded systems. Moreover, the high levels of automation used in the approach make it a very cost effective way on undertaking these types of evaluations. Many of these technologies are operational to a prototype or concept demonstration standard, and it would inappropriate to evaluation the technologies in an operational field setting. This allows earlier decisions on the effectiveness of technologies during the research and development phase.

Orchestrated evaluation has the following properties:

- Allow the evaluation of new concepts, real systems and prototypes within a scenario-orchestrated environmental context comprising related integrated technologies and representative artefacts.
- Places the evaluation in context of realistic scenarios and situations,
- Accommodates the evaluation of focus technologies in relation to existing concepts and technologies.
- Employs domain experts and stakeholders as a key component to the evaluation process, and
- Provides a means for integrating both specific and open ended evaluation tools.

Orchestrated evaluation differs from "Wizard of Oz" [MAU 93] forms of evaluations. In Wizard of Oz evaluation the task is quite real but the technology is simulated. While in an orchestrated evaluation it is the opposite, the task is simulated and the environment is quite real. This also differs from expert commentary. Expert commentary employs domain experts to trial a single application in a realistic setting. Orchestrated evaluation allows the presentation of an array of technologies in concert hence allows the evaluation of the relationships between various technologies and techniques in relation to particular settings and work processes and work practices.

4.1 Undertaking Orchestrated Evaluations

In the case of Defence planning, it is often difficult to determine which technologies are best suited to the needs of the end users. This is a standard problem, the technologist understands the science and technology and the end user understands the problem domain. Placing the end user in a position to help shape the technologies early in the evaluation phase is a key goal of the orchestrated evaluation approach.

An orchestrated evaluation comprises four phases and these are as follows:
First there is an overview of the technologies or concepts to be evaluated. Secondly, there is an overview of the orchestrated evaluation process to be undertaken. Thirdly, the interactive orchestrated evaluation session is conducted where results are captured for a set of evaluations undertaken within the scenario context. Finally the stakeholders, experts and evaluators conduct a workshop to consolidate and analyse the results of the session and to plan future directions. A meta-application supports orchestrated evaluation of ubiquitous workspace technologies in context of our defence domain specific scenario. The meta-application allows the automatic operation of an evaluation with the following features: introduces the scenario, demonstrates the technologies, supports interactive free play of the technologies for the users, and supports the recording of results.

Each interactive orchestrated evaluation session is broken down into a number of sections exploring different phases of the problem domain. This allows the end users to only evaluate technologies in situ with the proper scenario data. Each section is conducted in the following way: firstly, there is an introduction to the concepts or technologies used in the demonstration in the context of the scenario. After the introduction, an automated demonstration, conducted by way of a Meta Application, is conducted to show the use of the technologies in context. Following the demonstration the stakeholders are invited to participate in an interactive evaluation of the technologies shown in the demonstration. This interactive evaluation is a continuation of the scenario. As such, the environment, tools, data, and media are already enabled and available for use by users.

5 Results of AuSPlanS Developmental Exercise 1

This section discusses the results of employing the orchestrated evaluation approach during the first iteration of the AuSPlanS project which culminated in Developmental Exercise 1 (DE1). The scenario for the exercise was based on the Joint Warrior Interoperability Demonstration (JWID) 2001/2002. The aim of the evaluation was to test the applicability of the evaluation approach. The summary of the results of DE1 are provided at the end of the section.

5.1 AuSPlanS Scenarios and Case Studies

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The scenarios and case studies for this project focus on distributed synchronized planning activities being conducted by the Australian Deployable Joint Force Headquarters (DJFHQ). This headquarters has been responsible for the planning aspects of various operations including the East Timor deployment and more recently operations in the Solomon Islands. A set of scenario components and associated data products has been developed to support experimentation. The scenario is based on a modified version of the Joint Warrior Interoperability Demonstration (JWID) 2001/2002 series which focused on regional coalition peace enforcement situations.

Figure 3 shows a map of the region were the scenario takes place. A part of the meta application script as presented by a virtual assistant using speech synthesis provides an overview of the situation: “In this exercise we are dealing with the three fictitious countries of Rabanneste, which is a westernised democratic country of regional economic and military strength, a large but developing Asian country of Samagaland and a small undeveloped country of South Tindoro. Geographically, Rabanneste occupies the west and centre of what you know as the Mainland of Australia, Samagaland occupies the eastern region of the Australian Continent and the northern part of the Island of Tasmania, called the Island of

Tindoro in this Exercise. The Southern part of the Island of Tindoro is, of course, South Tindoro. The island of Tindoro, North and South, has had a turbulent history since the Second World War. Formerly a European colony, the resource poor South Tindoro has only recently regained its independence after being annexed by Samagaland in the latter half of last century. Some in Samagaland believe that the granting of independence to South Tindoro was a mistake, forced on them by Western Powers and the role played by Rabanneste in supporting the independence process with military forces in South Tindoro is particularly resented.

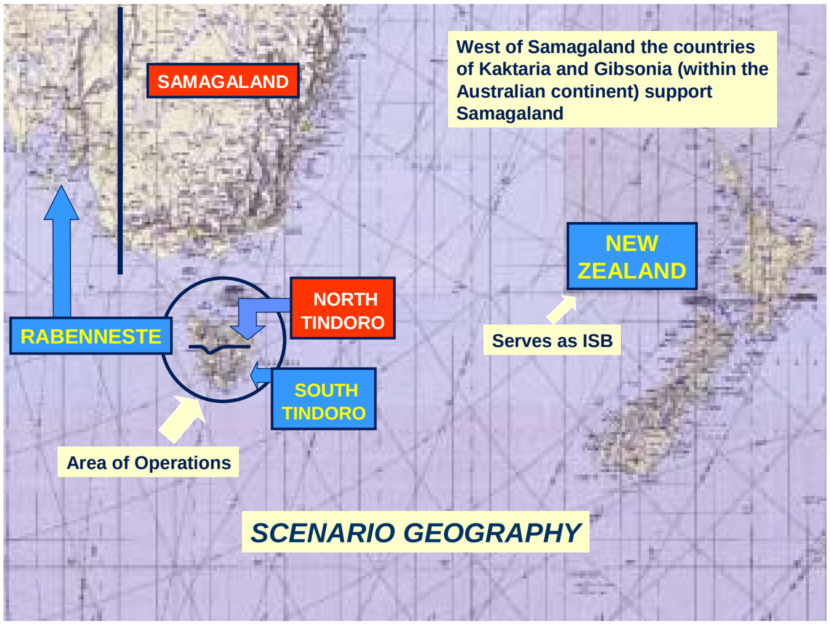

Figure 3. Map of the Region

"Sadly, South Tindoro's woes have multiplied with the occurrence of an Earthquake and associated Tsunami on its East Coast yesterday morning exercise Time. The South Tindoro Government has rapidly acted to provide what help it can for its citizens, and the mobilisation of Media and International Aid agencies has begun, but at this time there is still a deteriorating situation with little on the ground assistance."

5.2 Orchestrated Evaluation Session for D1

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The Orchestrated Evaluation Session is set in the Headquarters of the Rabanneste Deployable Joint Force headquarters, where the staff are aware of the Disaster and familiar with the historical background to the Island.

The demonstration begins with the arrival of a call from the Chief of Rabanneste Defence Force to the Commander of the Deployable Joint Force Headquarters. The Commander with his Chief of Staff was reading a Warning Order, which had arrived in the HQ Operations Centre 5 minutes ago.

The scenario is enacted following the Joint Military Appreciation Process (see Figure 4) and includes four main components:

- Commanders Video Conference (conveying commander's intent),
- Commander's Guidance,
- Pre-Planning, HQ orchestration, and
- Mission Analysis.

Following this, there are further steps in the process however these were not carried out for this developmental exercise.

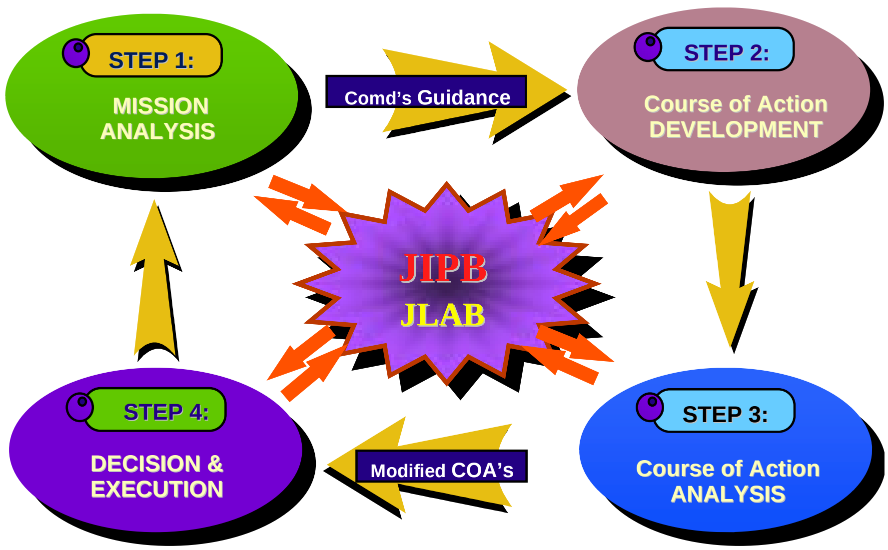

Figure 4. Joint Military Appreciation Process (JMAP)

During the remainder of the session we undertook the roles of Commanders Planning Group and Joint Planning Group situated in the Commanders Planning facilities. Supporting groups such as the Joint Admin Planning Group, Ops and the Legal group were simulated using the workspace simulation service. During the scenario the progress of the entire process was be displayed on one of the monitors.

5.3 Summary of Results

As part of D1, we conducted a one day orchestrated evaluation with the Chief Of Staff of the DJFHQ as a key end user. The two main goals for the D1 were as follows:

1. To expose the new orchestrated evaluation approach and new meta application to a key stakeholder and elicit feedback on the approach
2. To evaluate new ubiquitous workspace technologies for augmented synchronised planning spaces in the context of a defence domain specific scenario.

The results from D1 provided us with an understanding of the scope of resources to mount this form of evaluation. We believe this requires a modest quantity of resources in light of the scope of concepts and technologies presented in short period of time to the stakeholder. A large part of our effort went into building a realistic scenario and automatic presentation of that scenario. It is this particular effort that will be reused over the duration of the entire project, thus provide an aggregate cost savings. Improved approaches for the development and evolution of meta applications would significantly enhance our ability to conduct these types of sessions. In addition to reducing the development effort and time, we identified that new methods were needed to enhance the effectiveness of the applications. For example, meta applications provide the experiential setting for the evaluation sessions. They involve coordinating several displays, speech synthesis, various applications, and lighting. The development of effective meta applications must consider a number of experiential factors such as timing, lighting, sound etc. This is more akin to applying director's art rather than software development. New tools need to be developed to support improved development of these applications.

The stakeholders were able to grasp many new concepts and technologies in a very short period of time. They indicated that they felt comfortable exchanging ideas and making constructive comments for future directions. We felt his comments came on two different levels. The first was about a particular concept or piece of technology, and second was on a broader level of how the planning work practices may be altered in the future. The first level provides a means to pursue solutions to solve immediate problems, and the second level provides a means for our organisations to set a research and develop focus for the future.

The process has shown us the need to have an integrated and orchestrated evaluation process to facilitate stakeholders and decision makers of future directions for complex systems and tasks, such as defence planning. The presentation of individual concepts or pieces of technology by sales representatives, scientists, or engineers out of context of the intricate problem domain is often ineffectual. These concepts and technologies may be disregarded from a lack of proper understanding of how they affect the entire human and machine system, or they may by adopted, having being shown to solve a problem that is more simple than is the actual case.

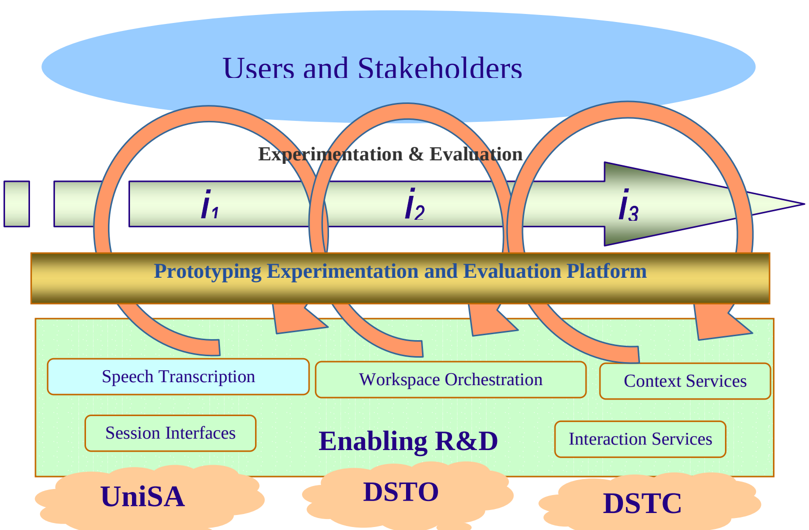

Figure 5. Road Map

6 Future Directions

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AuSPlanS uses these integrated scenario components to support context-based evaluation over three iterations Figure 5. The first deals with disaster relief where planning activities must be undertaken in response to disasters caused by cyclones, tsunamis and Earthquakes. Tasks such as evacuations may be required and this requires a coordinated and efficient effort. Other possible scenarios include peace enforcement due to political or economic unrest.

The overall project is being conducted using three increments; building, incorporating and evaluating new technologies and concepts along the way. Figure 5 depicts the interplay between the three increments of the development path. The first increment established the

AuSPlanS platform, underwent a proof of concept evaluation, and began undertaking orchestrated evaluation sessions with defence stakeholders.

Increment 2 will be the integration of advanced planning and situation awareness technologies in at the DSTO facilities in Adelaide. The first of the next series of orchestrated evaluation sessions will be in October 2004. The main goals of this increment will be the transition of the technologies to a defence environment, and the incorporation and evaluation of further defence planning tools.

The final Increment 3 will be presented and operated at the DJFHQ Brisbane in October 2005. The main goals of this increment are the use of multiple synchronised spaces and transitioning the technologies to operate in a Vital Development exercise.

7 Conclusions

This paper presents a new form of evaluation approach to support the development and evolution of complex team-based activities. We define and use orchestrated evaluation techniques to provide a means for stakeholders to determine new directions of technologies for complex systems; in particular we are investigating technologies to support defence planning. AuSPlanS is our experimental platform for this form of evaluation, and this platform is built upon our ubiquitous workspace approach called LiveSpaces.

A number of conclusions can be derived from the results to date.

1. New concepts and technologies for complex team tasks such as defence planning need to evaluated within the context of their final deployment.
2. Technologies are interdependent. There is generally no one technology that is a complete solution to a particular difficulty facing planners. Multiple technologies should be evaluated side by side to best determine a proper solution. Often innovative combinations of approaches coupled with enhancements to work processes and practices can provide capabilities that are far more effective than can be achieved through the use of individual technologies.
3. The use of orchestrated evaluation sessions together with a rich platform as has been developed for AuSPlanS, shows promise for the effective evaluation of new concepts, real systems and prototypes within a scenario-orchestrated environmental context comprising related integrated technologies and representative artefacts.

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References

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[BON01] Bond, A. (2001) Service Composition for Enterprise Programming Working Conference on Complex and Dynamic Systems Architecture Brisbane 2001.

[BRE04] Breeze. http://www.dstc.edu.au/Research/Projects /Pegamento/Breeze/breeze.html, last accessed March 204.

[ION02] Ionescu A., Stone M., Winograd T. (2002), “Workspace Navigator: Tools for Capture, Recall and Reuse using Spatial Cues in an Interactive Workspace” Stanford Technical Report TR2002-04.

[JOH01] Johanson B., Ponnekanti, S., Sengupta, C., Fox, A, (2001) Multibrowsing: Moving Web Content Across Multiple Displays. Stanford University, USA. In Proceedings of Ubiquitous Computing Conference (UBICOMP) 2001.

[JOH02a] B. Johanson, A. Fox, and T. Winograd (2002) The Interactive Workspaces Project: Experiences with Ubiquitous Computing Rooms, IEEE Pervasive Computing Special Issue on Overviews of Real-World Ubiquitous Computing Environments, April-June 2002 .

[JOH02b] Johanson B., Hutchins G., Winograd, T., Stone, M., (2002) PointRight: Experience with Flexible Input Redirection in Interactive Workspaces. Stanford University, USA. In Proceedings of UIST '02.

[MAU 93] Maulsby, D., Greenberg, S., and Mander, R., Prototyping an intelligent agent through Wizard of Oz., ACM SIGCHI Conference on Human Factors in Computing Systems, Amsterdam, The Netherlands Pages: 277 - 284 , 1993 .

[PRI02] Priest, J., Smallwood, R., Falzon, L., Zhang, L., Lumsden, S. (2002): A Centre of Gravity Analysis Tool to Support Operational Planning. In Proceedings of the *7th International Command and Control Research and Technology Symposium*, Quebec City, QC, Canada, September 2002.

[SEG00] Bill Segall, David Arnold, Julian Boot, Michael Henderson and Ted Phelps (2000) Content Based Routing with Elvin4, Proceedings AUUG2K, Canberra, Australia, June 2000

[SIE99] Sierhuis, M.; Clancey, W.J. & Hoof, R.v. *BRAHMS: A Multi-agent Programming Language for Simulating Work Practice*. 1999, RIACS/NASA Ames Research Center.

[VER03] Vernik, R., Blackburn, T. and Bright, D., (2003): Extending Interactive Intelligent Workspace Architectures with Enterprise Services. Proc Evolve2003, Enterprise Information Integration, Sydney, Australia, 2003.

[VER04a] Vernik M.J., Johnson S., Vernik R.J. (2004) "e-Ghosts: leaving virtual footprints in ubiquitous workspaces", Australaisian User Interface Conference, Dunedin NZ.

[VER04b] Vernik R.J., Johnson S., Bright D., Vernik M.J. (2004) " Using Workspace Simulation to Support the Evaluation of LiveSpaces for Synchronised Planning Activities", SimTecT 2004, National Convention Centre, Canberra, 24-27 May 2004.

[ZHA04] Zhang, L., Kristensen, L.K., Mitchell, B., Gallasch, G., Mechlenborg, P., Janczura, C. (2004): COAST - An Operational Planning Tool for Course of Action Development and Analysis. To appear in Proceedings of the *9th International Command and Control Research and Technology Symposium*, Copenhagen, Denmark, September 2004.