Battlespace awareness and the Australian Army battlefield command support system

Paul Gaertner[*a], Mark Slade[b], Fred Bowden[a], Bradley Stagg[c], Samuel Huf[a]
[a] Land Operations Division, DSTO, PO Box 1500, Salisbury, SA, 5108, Australia
[b] CelsiusTech Australia Pty Ltd, Endeavour House, 4th Av Technology Park, Mawson Lakes, SA, 5095
[c] Army Engineering Agency, Support Command Australia

ABSTRACT

Effective battlespace awareness is essential for any defence operation; this is especially true in the increasingly complex and dynamic land component of the military environment. Because of its relatively small force size dispersed piece-wise across a large and largely vacant landmass, the Defence of Australia presents a somewhat unique challenge for the development of systems that support command decision-making. The intent of this paper is to first examine the digitisation effort under way in Australia and describe the Army Battlefield Command Support System (BCSS) being developed for use in the tactical arena. BCSS is essentially a suite of commercial-off-the-shelf and government-off-the-shelf software components provided via a standard operating environment to aid decision-making. Then, we present the development of a Tactical Land C4I Assessment Capability (TLCAC) synthetic environment which is being used to undertake controlled performance evaluations of the various elements of the BCSS suite and provide impact assessments of new technological advances. The TLCAC provides a capacity to assess in near real-time Brigade and below level command post exercise activities. That is, when deployed it provides a mechanism to automatically collect command and control and manoeuvre data, which can aid in the after action review process.

Keywords: Command support systems, Situation awareness, Analysis, Evaluation

1. INTRODUCTION

Digitisation to enhance battlespace awareness is more than connecting systems and gathering information, it's effectively a new paradigm (impacting on everything from training to killing) in which tactical command and control will be performed. In Australia, concepts surrounding digitisation and increases in information technology are expected to radically change Land force capabilities and business processes. The current series of force development activities – known as the Army Experimental Program (AEP), are designed to encapsulate Army's vision for the 21st Century. The AEP involves a series of exercises and advanced simulations aimed at establishing the foundation for an Enhanced Combat Force (ECF). Since most of the individual systems that will make up the ECF are either in place or are in the process of being acquired, force enhancements are likely to be derived from improvements in system synchronisation and by re-engineering staff processes to best exploit the technologies.

Australia is however, not unique in its efforts to evolve its forces to meet the challenges of the 21st century. The United States Army in particular is undertaking a significant development program to create the Army of 2010. Its vision is encapsulated in *Army Vision 2010*[1] document which outlines its aim of achieving full spectrum dominance through: Dominant Manoeuvre, Precision Engagement, Full Dimensional Protection, Focused Logistics, and Information Superiority[1].

This paper describes the current efforts by the Australian Army in relation to the digitisation of the tactical land battlespace. In particular, the implementation of the Battlefield Command Support System (BCSS) developed for Brigade and below operations. In addition, we describe a Tactical Land C4I[2] Assessment Capability[3] being developed to undertake controlled performance evaluations of the various elements of the BCSS software suite, provide impact assessments of new technological advances and for investigating future tactical organisational structures and business processes.

---

[*] Correspondence: Email paul.gaertner@dsto.defence.gov.au; Telephone: +61 8 8259 7377; Fax: +61 8 8259 5624.
[1] The United States notion of information superiority is similar to the goal of knowledge dominance being pursued by the Australian Army.
[2] Command, Control, Communications, Computers and Intelligence.
[3] The TLCAC is essentially a tactical level C4ISR synthetic environment.

In *Digitization of the Battlespace V and Battlefield Biomedical Technologies II*, Homer H. Pien, Raja Suresh, Editors, Proceedings of SPIE Vol. 4037 (2000) • 0277-786X/00/$15.00

2. BATTLESPACE AWARENESS AND THE OPERATIONAL DOMAIN

Tactical Land Forces require high levels of situation awareness[4] in order to coordinate manoeuvre and deliver precision firepower. Land Force commanders therefore need C4I capabilities that provide an enhanced tempo, simultaneous operations and the timely orchestration of manoeuvre elements. This is reflected in an increased requirement for timely and relevant information through digitisation that facilitates dominance of the information environment leading to what is commonly known (in Australia) as the *knowledge edge*. Alone digitisation will not provide the knowledge edge, it provides the ability for commanders to visualise (cognitively understand) the current situation and therefore make more informed proactive decisions.

Within a typical Australian field environment, a Brigade (Bde) size force can be spread over a large vacant area interconnected by reasonably high bandwidth and reliable communication bearers that are provided by the Parakeet radio relay or satellite terminal system. Figure 1 illustrates a typical field structure. The Raven family of VHF & HF Combat Net Radio (CNR) systems is used as the primary communications mechanism from Bde HQ to Battalion (Bn), Company (COY) and below. Communications from the Bde HQ back into the Bde Main and Support areas as well as the strategic networks is supported by the use of telephone lines, satellite communications and civil communication infrastructure. Within the Bde area of operations, specific radio networks are established at the various levels to provide the necessary data/command communications for message traffic. Message forwarding between the nets is an essential function to assist in the dissemination of orders and plans, and the collation and reporting of situation awareness data.

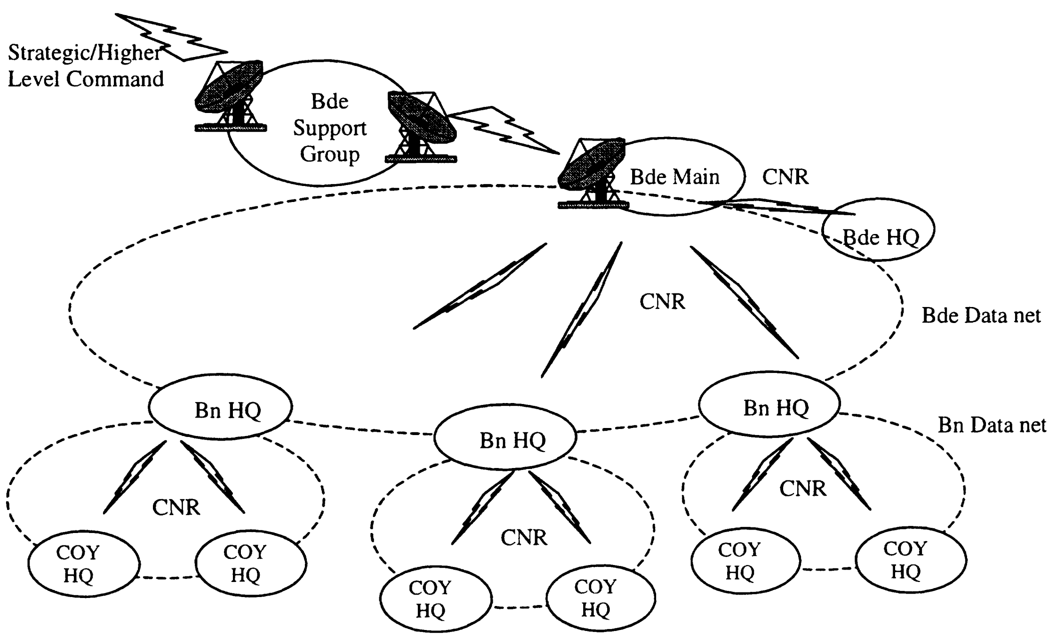

Figure 1. Operational Concept Overview

The BCSS concept offers the potential to improve the management and distribution of information within and between tactical headquarters and units. It is expected, that the more efficient utilisation of information increases the ability of military commanders to command and control assigned assets and therefore increase the tempo of the combat force. Where appropriate, BCSS seeks to explore concepts and the effectiveness of the application technology through the use of prototypes. Essentially, BCSS is structured to support the operations of a Brigade, both its internal planning, and operations and communications with external entities of higher command. Within the Brigade, missions are planned and conducted using battle groups, which can be established for specific tasking and then potentially re-organised and tasked in future operations. This creates a dynamic environment in which small units may be dispersed across vast areas, utilising CNR as the primary communications mechanism between the forward units and the main control group.

---

[4] Including blue (own forces), red (adversary forces), white (neutrals) and green (environment).

3. THE BATTLEFIELD COMMAND SUPPORT SYSTEM

The BCSS is a computer-based information system intended to provide command support functions to Army tactical Commanders and their command teams. The system concept is to support both long range and near real-time tactical planning and decision-making both in barracks and in the field. The system is intended to operate in an environment characterised by, but not limited to geographical dispersion, insignificant and non-existent infrastructure, low bandwidth and potentially poor communications, and highly mobile users and of course conflict. To maximise flexibility and responsiveness to users' needs, the system architecture is based on exploiting, where possible, commercial-off-the-shelf (COTS) technologies.

The key operational objectives of BCSS are to substantially improve combat capability through the application of information technology to the battlefield to enhance decision action cycles. This can be achieved by reducing knowledge to decision time frames; improving the quality of decisions; providing the highest quality of battlefield situation awareness through the delivery and appropriate presentation of strategic, operational and tactical location and sensor information.

An evolutionary development approach has been adopted for the BCSS allowing the project to be responsive to new requirements, technologies and changes in interfaces to external entities and to trial the use of technologies in various areas to determine if they are effective. Users are involved in establishing the requirements and priorities for development through the use of implementation workshops in the development phase. System releases are targeted for release every six months to optimise the development time against the realisation of products and the ability to field the system and gain user experience from trials and real usage. This cycle is repeated with new requirements, products and user experience being used to guide the ongoing development for future releases (Figure 2).

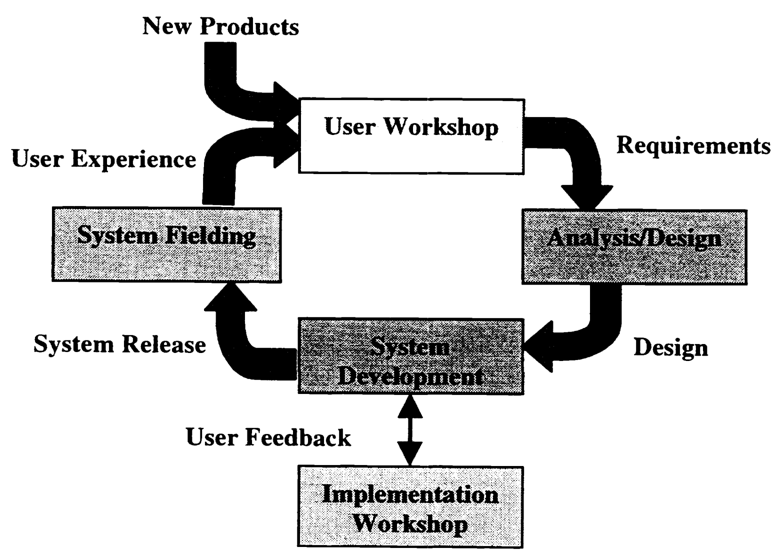

Figure 2. BCSS Development Cycle

Application of technology to this problem is an enabling factor that seeks to provide, filter and clarify the relevant information to each level of the command structure in such a way that it can be acted on in a timely and effective manner. A key factor is that the BCSS provides near real-time ground truth and unit status information, in order to facilitate the development of situation awareness.

3.1. System Implementation

The Bde HQ level incorporates the use of fibre optic LANs, servers and workstations. This caters for operations over a large area requiring high bandwidth communications to support collaborative planning, distribution of personnel and general office functions such as email and document development. The Bn HQ and below operate in a serverless environment and have simple LANs established through the use of workstations, hubs and cables. Communications over CNR is a critical element for operations within the brigade and places severe constraints on the available bandwidth and reliability of communications outside of the Bde HQ LAN.

The key building block for BCSS is based around a ruggedised industrial workstation (IWS) and the command support product Command Data Network System™ (CDNS)[5]. This product supports situation awareness and communications over CNR and is deployed on all workstations at all levels within the brigade. The CDNS product communicates over LANs and CNR (both HF and VHF), and utilises a device called a Micro Internet Controller (MINC) which acts as a modem interface to the CNR.

CDNS enables highly flexible distributed networking of microcomputers using the basic configuration shown in Figure 3. This includes an IWS connected through a MINC to two Raven radios via cryptographic devices for communications security. The MINC is a two channel device and can drive a single or any two Raven radios either HF or VHF in any combination of analogue voice or digital data. The MINC also has an in-built Global Positioning System (GPS) receiver connected to an external GPS antenna. The basic configuration is expected to operate in tents and/or fitted to a vehicle, and provides the primary message distribution and position reporting functions. The MINC provides voice/data connection, enabling the use of both data and voice over a single radio network, reducing the number of radio networks required.

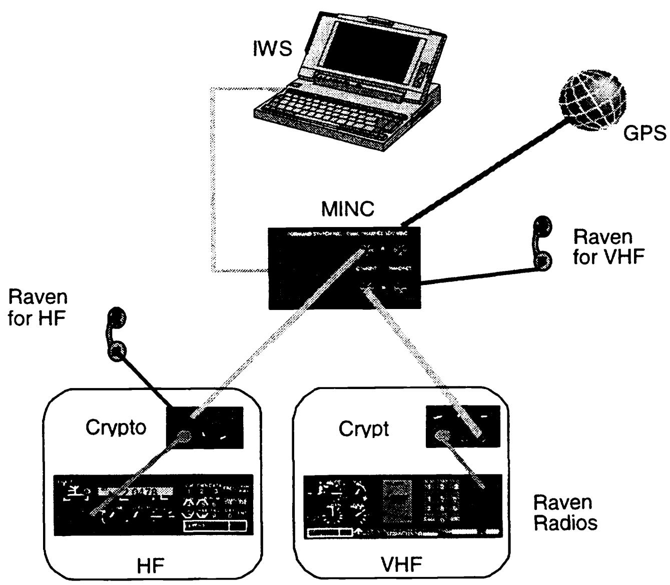

Figure 3. BCSS (CDNS) System Architecture

When more than one user needs to work in close proximity (eg same vehicle), the workstations are connected with a hub via a LAN. This hub allows the workstations to talk to each other and utilise the common radio assets. The building blocks and devices shown in this section form the basis of the system solution, and can be arranged in almost any combination to reflect changing organisational and tactical needs. At Bde HQ, servers and LANs are available in addition to the basic building block described here. Although the primary role of the BCSS is as an operational battlefield command support system, comprehensive planning and preparation can be performed using the BCSS in barracks. BCSS components can be transitioned to the field at any time. After a field deployment, the BCSS can be transitioned back to barracks for post-field de-briefing, analysis and preparation for the next deployment. Although BCSS currently consists of six major capabilities, which are deployed within the Bde, the focus of this paper is on the Operations CDNS (Command Data Network System) tool: for messaging and battlespace awareness. Other tools in the suite such as; the intelligence tool; the geographic information system (GIS) tool; and the engineering tool will be described briefly.

3.2. Operations Tools

Based around CDNS, the operations tool supports communications over various network types, including CNR, LAN and serial communications. Each network can consist of multiple nodes and normally each node can only "see" those nodes on

[5] Command Systems Incorporated (CSI) Fort Wayne, Indiana, USA, developed CDNS.

the same net. CDNS provides two functions for extending the reach of the BCSS networks by linking networks or providing relay stations, namely internetting and intranetting.

Where multiple nets exist in BCSS, it is possible to nominate one or more stations as an Internet node to enable traffic from one net to pass to another. When an Internet node is created all members of both nets are visible to all workstations and the combined networks appear as a single virtual network. For example, internetting enables a workstation to connect to more than one radio network, such as VHF net and a HF net, from the same MINC. This is also true of different types of nets such as LAN, serial, or CNR. Internetting means that stations on one net can see the stations on another net to which they are not themselves connected (which would not be possible if internetting was turned off). To illustrate how this works consider Figure 4 showing three networks of workstations (A, B, C, ... I) using BCSS networks. If there were no internetting then each workstation could only see the other workstations on the network/s it is directly connected to. For workstations with only a LAN connection – they will see only the other workstations on their LAN. For workstations with both a LAN and CNR connection they will see both their local LAN and the CNR net members. Consequently, internetting allows the connection of different CNR nets so that members of one net can see members of other nets.

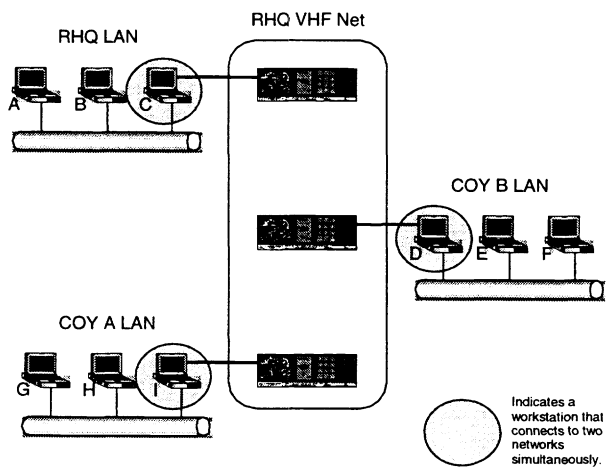

Figure 4: BCSS LAN Configuration

Intranetting is the rebroadcasting or relaying of information within a single CNR net. It only applies to CNR stations and can only be enabled in the CNR MINC configuration panels. To illustrate how this works consider Figure 5 showing a single VHF radio network of four workstations (A, B, C, D) using BCSS. In this case there are four members of the CNR network but due to some reason (eg topology) not all of them can communicate with each other. A can communicate with B and D but not C. B can communicate with A and D but not C. D however can communicate with A, B and C. Here we would set up D as an intranet station on the network by turning on Intranetting at D's MINC interface. Anything received by D from C, B or A would automatically be rebroadcast allowing the other stations to receive it.

Instead of internetting entire nets together, an alternative way of moving information around BCSS CDNS nets is to create forwarding rules. A forwarding rule provides a way of moving a particular message type (or types) received from a particular station(s) on onto other station(s) on different radio networks. A different forwarding rule must be created for each receiver/forwarder pair.

Information to enhance battlespace awareness is achieved through the current situation display (CSD), which includes blue (own) forces and red (enemy) forces overlayed on digital maps. Supporting graphics representing boundaries, objectives, courses of action and objects are intended to facilitate a high level of overall awareness at appropriate levels. Situational data may be pushed or pulled at the various levels, and echelon filters can be established to de-clutter the level of unit data presented (for example, filter out all units at COY HQ and below). The CSD consists of separate overlays, similar to the use of talcs, with each overlay containing a specific functional category. Each overlay can be individually hidden to de-clutter the current situation display. Specific user defined overlays can be created and sent over CNR which enable a user to capture in one overlay all the relevant symbols from the currently available overlays. Drawing tools are provided which assist with the creation and editing of the various symbol types directly on the CSD. Symbols can be offset from their position to assist in de-cluttering of specific areas of the screen.

The reporting of own forces is automated through the use of GPS positioning and automated position reporting. Position reporting is performed either as Own Station Position Reporting (OSPR) or Consolidated Position Reporting (CPR). The OSPRs (and CPRs) received from subordinate units as defined by the command hierarchy are consolidated into a CPR for transmission to higher units. Usage of CNR bandwidth is controlled through user selected OSPR conditions, which include criteria based on time interval, distance travelled, proximity to a point, proximity to a line, user initiated or allowance of remote interrogation. Each station can be configured to individual OSPR conditions, which allows more mobile units to report more frequently. OSPR received at a station result in the automatic update of the Current Situation Display. All received OSPRs can be recorded for subsequent replay at an operator-controlled rate.

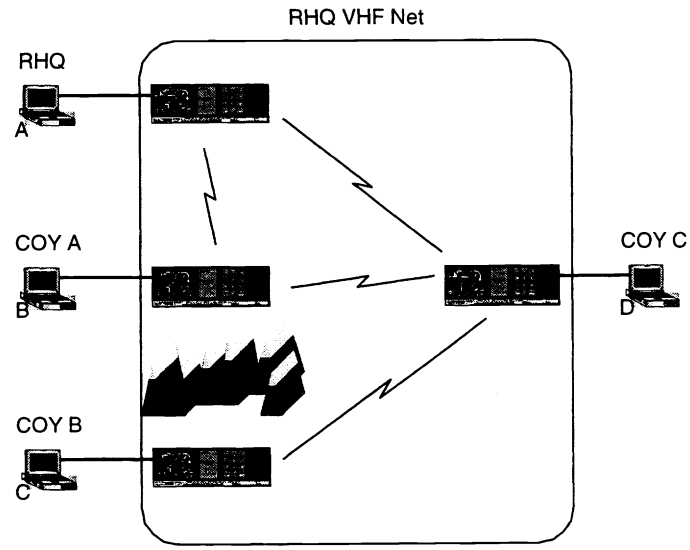

Figure 5: Intranetting (rebroadcasting)

CDNS supports a range of message forms that have been adapted to individual Bde standard operating procedures, covering reports and returns, requests, plans and orders. Standard operating procedures include templates with defined data fields, as well as the ability to attach appendices and situational templates consisting of graphics and unit data. Messages can be automatically completed by the 'drag and drop' of symbols from the CSD to fill out the relevant fields in the message. Messages are addressed by selecting from a list of units, a pre-defined distribution list or by selecting the message and 'dropping' it onto the addresses symbol. A message can be sent to units for action or just for information. A message sender can request that a receiver acknowledge receipt of the message, which is supported with an ACK button that must be activated by a user at the receiver station. All incoming and outgoing messages are logged, along with overheard and partially received messages.

3.3. Engineering Tool

The engineering tool is used to support engineer commanders and staff in the advanced planning and execution of engineer missions. Tools are provided to assist in the assessment of the battlefield, they include the following capabilities:

- Mobility functions that provide the ability to plan engineering missions such as assault river crossings and floating support bridges.
- Counter mobility functions for fencing, minefield design and bridge demolition.
- Survivability functions for blast and ballistic effects and protective measures.
- A link to the GIS tool is supported to support engineering terrain analysis.
- An Almanac spreadsheet allows you to update information on the sunrise and sunset, position of the Sun and Moon, moonrise and moonset for a given date and location.
- Efficiency factors spreadsheet providing the ability to capture information such as the supervision and organisation, conditioning, operator skill, digging ease, blade and bucket ease and tolerances.

Support is provided for the generation of reconnaissance reports. The reports use proformas created as facsimiles of doctrine, which prompt for standard information fields. Each pro-forma is enhanced to include embedded spreadsheets and Visio™ sketch tools where appropriate. The system also supports the classification of masonry arch and non-masonry bridges to obtain the bridge military load class. This enables bridges, for which there is no existing load classification, to be analysed to determine its load carrying capacity. The task design module incorporates automated spreadsheets that include calculation sheets supported by reference data. Each automated calculation is backed up with data sheets complete with data look-up tables and formulae.

3.4. Geographic Information System Tool

The GIS tool is an application designed to assist the military in the intelligence preparation of the battlefield (IPB) process. This is a process that is part of the overall Military Appreciation Process. The GIS integrates military geographic information and non-military spatial and non-spatial information stored on a local computer hard drive, CD-ROM or across a distributed network. The GIS can display data simultaneously at different scales in multiple views. Users may interrogate the metadata attached to this data and display it in table or chart form. A set of drawing tools are supplied to place graphics on user defined overlays. These overlays and drawing tools have automated the capabilities of the hardcopy transparencies that are the traditional tools for performing the IPB process. In addition to the drawing tools, there are tools that perform visibility analysis using elevation data. This can be either point to point visibility analysis, or cover and concealment calculations over a user defined area. A feature of the GIS software is the ability to generate 'going analysis' using terrain data that includes slope, soils and vegetation. This provides an efficient and time saving process of analysing maps to determine the possible routes that can be used to manoeuvre various elements such as tracked vehicles, wheeled vehicles and personnel on foot. The GIS is a customised ArcView™ extension that uses ArcView's 3D Analyst™ and Spatial Analyst™ extensions.

Analysis of the terrain is performed to generate an overlay that describes how movement over the battlefield may be conducted. This can be conducted for various types of movements, such as foot operations, tracked vehicles, wheeled vehicles and large numbers of people. Drawing tools are provided to enable users to draw obstacles that may hinder traffic in the area of operations. Template overlays are used to capture graphics relating to the analysis of the terrain and the situation. Drawing tools are provided to support the definition of avenues of approach and mobility corridors, depicting the direction and breadth of an advancing force. A situation template overlay is a graphic depiction of expected threat dispositions for each course of action. The situation template usually depicts a critical point of an operation. The situation template toolbar menu contains a doctrinal template tool for placing a graphic that represents an enemy battlegroup formation. The event template overlay is a further development of the situation overlay that provides the means for analysing which course of action the threat may choose. The overlay displays the information required to synchronise intelligence collection. The event template shows where indicators can be collected to confirm or deny each enemy course of action. The event template toolbar contains tools for placement of target area of interest, decision point and named area of interest markers.

3.5. Intelligence Tool

The intelligence tool supports the planning of intelligence operations, the logging and analysis of intelligence reports and the ability to generate a red (enemy) picture on the GIS maps. The intelligence tool consists of sources and agencies list, intelligence database, intelligence log, collection worksheet, event matrix, shift handover and Watson analysis.

Each module automates or partially automates one or more of the processes that make up the intelligence cycle. BCSS makes use of COTS software to offer additional capabilities. As an extension to the intelligence database, the Watson[6] Intelligence Analysis™ program is used to query, organise, analyse and graphically represent the database information and relationships. Selected geographic data in the intelligence database can be displayed, using the BCSS GIS. The intelligence tool can be used in a stand-alone mode, or in a workgroup mode of operation where multiple workstations are networked and operate off a centric intelligence database and log.

The BCSS intelligence database contains all basic and current intelligence-related data. Intelligence related data includes information covering weapons and equipment, threat forces, technical intelligence, strategic and tactical activity, the battlefield environment, and any other information considered appropriate to aid intelligence decision making. When a user saves and updates information in a particular module, the information is updated centrally in the BCSS intelligence database.

[6] Watson™ is a customised COTS intelligence analysis tool that enables users to query, organise, analyse and graphically represent information and relationships stored in the intelligence database.

Other modules that draw information from the saved module will automatically receive the latest information from the database. The BCSS database can store and maintain multimedia data, including text, image, graphic, voice, sound and video formats. The database accepts information from numerous sources such as BCSS users, Defence databases, and non-Defence databases. This information builds the threat order of battle in the database and can be used to calculate the threat combat effectiveness of the enemy.

A collection worksheet provides a single location to manage the intelligence gathering effort and results from analysis. The worksheet defines the requirements for gathering intelligence during an operation or exercise, utilising the appropriate sources and agencies. Various sources and agencies are available for the conduct of intelligence gathering tasks. The sources and agencies list enables you to maintain information about the tasks that they are currently performing, so that the most appropriate source can be selected for a particular collection task. An event matrix provides a visual representation of information indicators within named areas of interest, for a given operation. This is used to assist in the planning of operations on the battlefield through the environmental analysis. A shift handover tool enables recording of the details of a shift handover and to view the details of a previous handover.

3.6. BCSS as a Mobile System

Motorised/Mechanised brigades can cover large distances in short periods of time and regularly report their position. BCSS is able to increase positional reliability and decrease operational workload by automating this position reporting process. BCSS provides automated "on-the-move" position reporting to motorised brigades, enabling the assembly of an error-free and real-time view of the battlefield. BCSS equipment is integrated with each vehicle's communication system and can transmit the vehicle's own location to all other BCSS stations via the CNR network. BCSS software accumulates this location information and displays a spatial representation of the entire battlefield.

Vehicle platforms that have a BCSS capability installed include armoured command vehicles, armoured personnel carriers, light armoured vehicles, and soft skinned vehicles such as the Land Rover. Although each platform has it's own BCSS implementation, all designs use the common BCSS "building blocks". These common elements include one or more COTS IWS, a GPS antenna, the BCSS MINC, and a field hub. Vehicle power-supplies and cable-harnesses were purpose built for each of the motorised platforms, enabling integration of the BCSS equipment with the platform's power and communication system. Similarly, mechanical bracing and shock-mount carriage trays were developed to isolate the COTS computers and equipment from the harsh vibration regime of tracked and wheeled vehicles. The use of a field hub in each of the vehicles enables one or more computers to be connected together via a LAN. This LAN may be extended to other vehicles that may be co-located in close proximity, allowing the sharing of data and communication CNR assets.

A rugged vehicle computer is being procured to enhance the robustness of the mobile computing solution. The rugged vehicle computer will be environmentally hardened to provide greater reliability for the harsh in-vehicle and communications conditions. The same functionality as the standard BCSS COTS computer may be provided via an applique solution, comprising a possible hand-held display console, stowed keyboard and rugged processing unit. Similarly, BCSS will be providing a man-pack solution for non-motorised applications. The man-pack capability will comprise a small data entry unit, GPS antenna, and the MINC radio-modem.

4. TACTICAL LAND C4I ASSESSMENT CAPABILITY

In Australia, subjective analysis at a CPX has been the method used to study the effectiveness of C4I systems and structures. The deficiency in this type of analysis is that the results are often nonreproducible and the analysis is usually unable to focus on the major determinants of effectiveness. Since the actions of a military C4I system obviously exert strong influences on mission accomplishment, the value of an objective method for measuring the effectiveness of C4I functions and processes is self-evident.

To aid in the provision of an objective effectiveness capability, Land Operations Division (LOD) has successfully completed the initial coupling of the Janus 6.3.4 brigade level wargame and elements of BCSS. The coupling, which was completed with the aid of Information Technology Division, the BCSS Project Office, Command System Incorporated, Integra and CelsiusTech Australia, provides the modelling and simulation infrastructure of the LOD TLCAC.

Although less realistic than field trials, there are many advantages in utilising this type of synthetic environment for digitisation experiments. The environment provides the opportunity for greater versatility in the range of systems investigated and in the maturity of the technologies involved, allowing developmental concepts to be examined that often could not be taken into the field environment. This enables the development program to investigate capabilities ranging from current COTS technologies to leading edge concepts, and then fine tuning the technologies according to command team requirements. This is also important in demonstrating the potential of enhancements provided by the new systems. In addition, the environment provides the opportunity to study concepts and technologies that do not yet exist in the real world. Figure 6 shows how the TLCAC can be utilised to enhance the current development cycle of BCSS (see Figure 2).

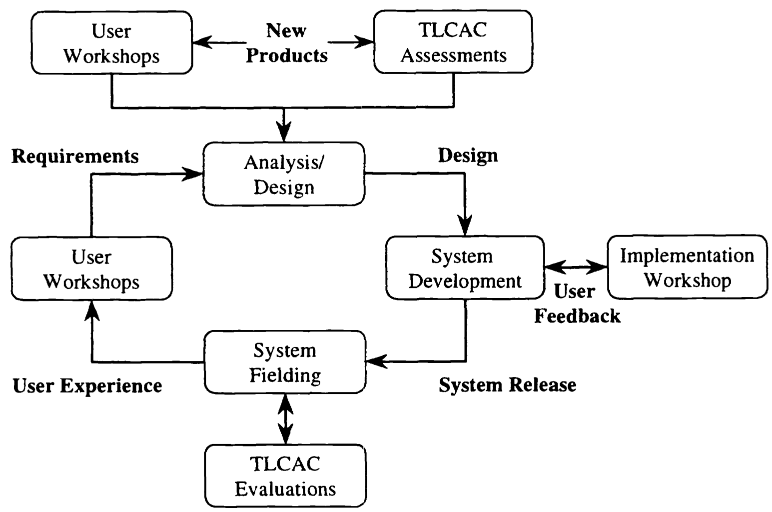

Figure 6: Enhanced BCSS Development Cycle

The TLCAC forms part of the analysis component of the LOD Synthetic Environment Research Facility[2,3]. The TLCAC enhances Army's ability to support the development and implementation of future tactical C4I systems[4]. It does this by creating an environment whereby military users, analysts and developers can interact using real and experimental C4I infrastructure to address issues such as insertion of new technology and changes to organisational structures and thereby providing Army with an increased ability to gain the knowledge edge. In particular, the TLCAC provides:

- A capability to assess in near real-time Brigade and below level CPX activities. That is, when deployed at CPX activities, the TLCAC provides a mechanism to automatically collect command and control data, which can be quickly turned into information to aid in after action reviews.
- A reconfigurable environment that can be tailored to emulate existing tactical C4I systems, and form a basis for investigating implementations of new concepts and technologies.
- An improved ability to constrain the level of human participation within a particular study to relevant components of the command and staff team and so reduce the extent of the deployment requirement. The eventual goal in this area is to provide an appropriate closed model of the C4I system under investigation and so permit more complete quantification of performance within any particular study.
- A simulation environment that supports the assessment of the C4I system under investigation by providing appropriate representation of the battlefield operating systems along with logging of relevant simulation output data to facilitate post exercise analysis.
- An ability to interface military users and analysts to simulation based activities within other application areas such as training or mission planning.

The coupling of Janus with the BCSS operations tool removes the requirement to manually transfer tactical unit locations and detections from the wargame to the Command Support Systems (CSS). Essentially, the wargame provides an artificial environment representing entities which commanders control from their respective operational CSS terminals (Figure 7). The Distributed Interactive C3I Effectiveness (DICE)[7] simulation among other things acts as a GPS "position server", receiving

[7] DICE is a C3I effectiveness tool developed by DSTO's Information Technology Division.

tactical positions from the wargame and transmitting them to the CSS terminals. The position server has the task of arranging information from the war game into a format consistent with that of the CSS "host". The TLCAC environment also enables the passing of detection information directly into the CSS, and therefore providing the CSS with the most up to date red/threat picture as seen by friendly entities in the wargame. From the CSS host information can be automatically disseminated to CSS terminals. Commanders use the information presented to them via their CSS terminals to assist in determining actions to be taken. These actions are passed to wargame operators acting as a lower/higher control organisation under the control of a white umpire. Individual commanders send their commands, either via radio or the CSS, to operators who implement them in the wargame (Figure 7). In order to track and analyse radio communications, a Digital Speech Time Recorder (DSTR) monitors the radio networks. TLCAC can also enhance the realism of a CPX by including models not included in the wargame, such as, an acoustic model used to represent oral cues that low echelon friendly forces may receive.

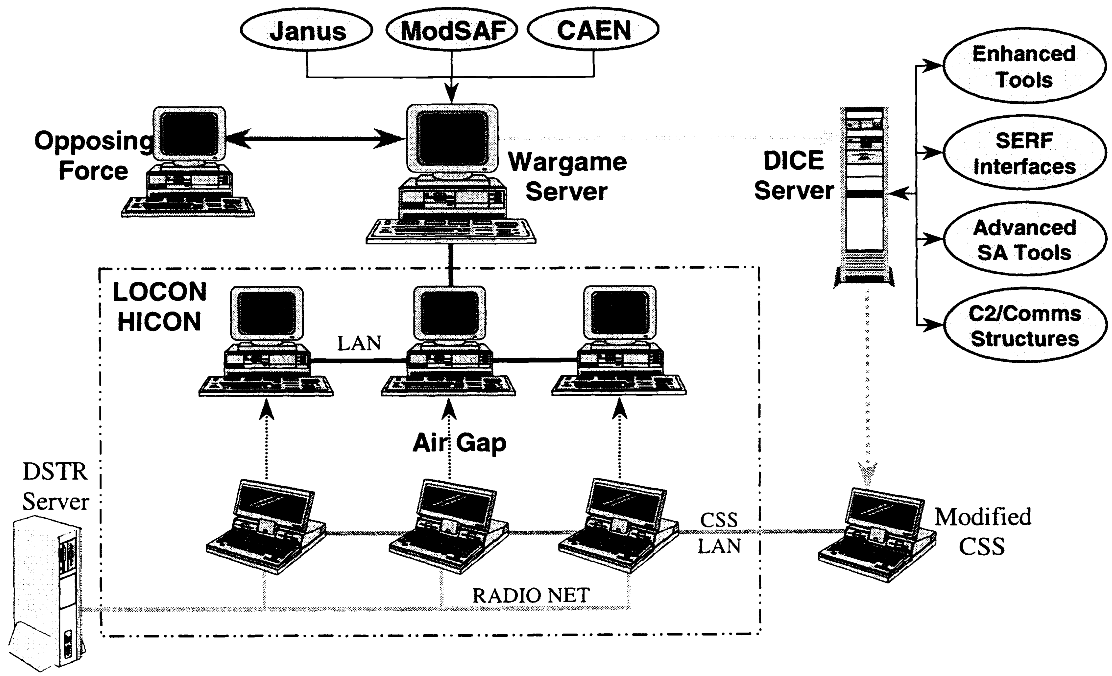

Figure 7: TLCAC Architecture

Measures quantify the degree to which an organisation or system meets its requirements. Essentially, measures of effectiveness are quantities that result from the comparison of the system and mission attributes. They reflect the extent to which the system is well matched to the mission. In order to assess the effectiveness of an organisation; the organisation's measures of performance are compared to the organisation's requirements. Measures of effectiveness are quantities that result from this comparison. They can be computed in the decision strategy space by identifying all decision strategies that satisfy the requirements. In addition, the TLCAC includes a rigorous set of methods and procedures for applying measures to exercises, and for analysing the results. These fall into three broad categories:

- *Process* measures that describe how command staff seek and use information, arrive at decisions, and coordinate among themselves and with other commands;
- *Performance* measures that describe how well the internal HQ's processes are carried out in terms of accuracy, timeliness, consistency, and completeness; and
- *Effectiveness* measures that gauge whether or not HQs accomplishes their mission.

The primary measures used for assessment of information activities are in terms of time consumed and the accuracy of actions. Measures of a system's behaviour can be reduced to measures such as timeliness and accuracy, or a combination that may be interdependent. Time based measures are usually quantitative, while accuracy measures may be quantitative and qualitative. It is important to realise that time-based and accuracy-based measures often bear an inverse relationship, implying a tradeoff between speed of performance and accuracy of performance. Speed of performance must be specified in terms of minimum desired accuracy or completeness, and accuracy measurements in terms of time available. Therefore the specification of threshold or standards for metrics must be referenced in terms of imposed constraints.

To date, the TLCAC has conducted a series of experiments aimed at assessing the effect of digitisation on a combat team within a Mechanised battle group, and to provide evidence to the BCSS project on the useability of BCSS within the experimental environment. The TLCAC has been demonstrated to officers at 1st Brigade. Following the demonstration, a TLCAC remains in Darwin to be used by the Brigade and the Brigade Units for CPX activities. The benefit of this project will be a more flexible and rapid development of command and control experiments by taking advantage of the object-oriented model development paradigm. Other benefits include: a wargaming environment useable for training, autonomous assessment of human-generated courses of action and testing algorithms and automated command decision software; reductions in the number of human-in-the-loop lower controllers at simulation driven exercises; and provision of the basis for a viable low-overhead driver component to stimulate C4I devices and provide inexpensive staff training.

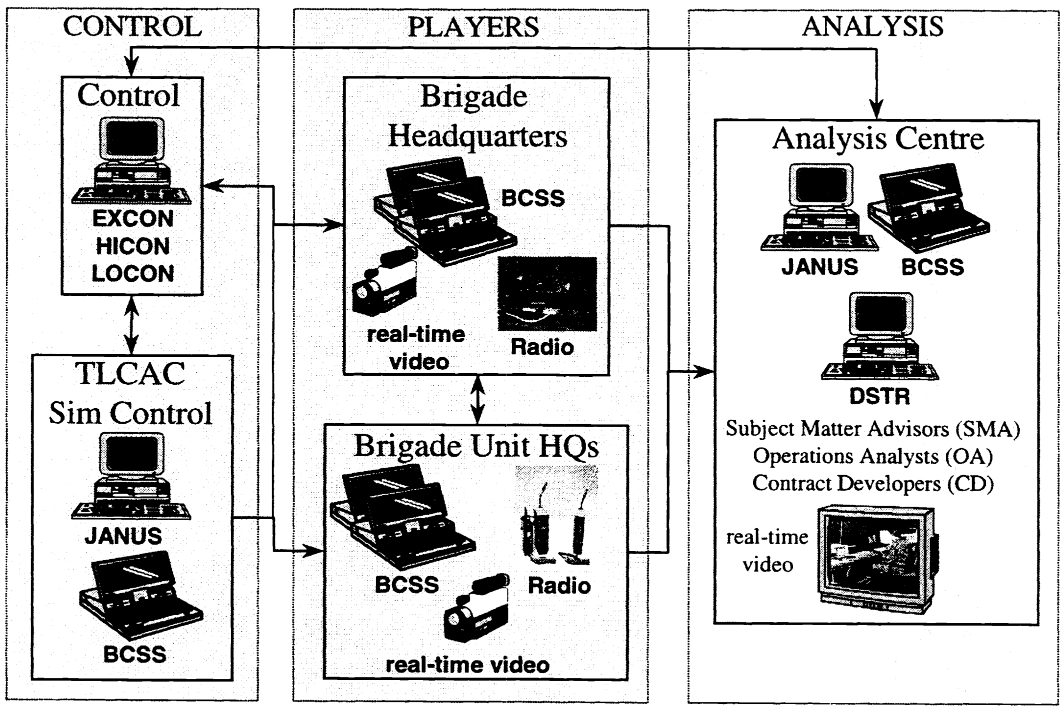

Figure 8: Real-time Command Post Analysis

The TLCAC provides Army with a new capability for performing near real-time command post assessment (Figure 8) throughout the execution of events and the generation of generic effectiveness measures. The usefulness of the environment stems from its ability to identify the critical information requirements, flows and processes to support decision-making at the tactical level and evaluate the collective effectiveness of current and proposed tactical C4I systems and products. In addition, it provides the ability to link other external models, used to enhance a CPX, into the experimental environment (acoustic and computer generated forces).

The current Janus link to the BCSS operations tool is still quite limited. It only allows blue entity positions and blue detections of red to be fed through the system. It is hoped that this interface can be enhanced so that more information can be sent automatically into the operations tool. Of particular interest are Blue contact reports. This would further automate the representation of lower level units during experiments reducing the staff required to operate a lower control. It would also be desirable to develop a link from the BCSS operations tool to DICE. This would allow messages sent from BCSS to be received by DICE nodes and sent to other entities linked to DICE. This would allow artificial agents in DICE to be used to represent entities that the operations tool can communicate with.

5. SUMMARY AND CONCLUSIONS

The rapid development of information technologies is changing the world in many ways, in fact, more than any other industry in recent times. In Australia it is essential that our battlefield digitisation programs intelligently exploit the technologies and understand the implications imposed. It is fundamentally important that our tactical forces strive to maintain a common front end on tactical decision support systems[8]. Consequently, there is a real need to review tactical procedures, organisational structures, and training so that we exploit fully the capabilities offered.

The TLCAC provides Army with a new capability for performing near real-time command post assessment through the execution and evaluation of C2 across phases and levels of conflict, and within specifiable scenarios. The utility of the environment is the ease in which critical information requirements, flows and processes to support decision-making at the tactical level can be evaluated in anticipation of field trials. Further the collective effectiveness of current and proposed tactical C4I systems and products can be addressed before procurement. In addition, TLCAC provides the facility to link other external constructive models, used to enhance the realism of the CPX, into the experimental environment (for example, acoustic models and Computer Generated Forces).

Future battle command support systems will require information technology that provides commanders with the ability to efficiently manage, synthesise and employ the enormous volumes of data and information available through advanced communications and sensor technologies. Simulation technology is a critical component of future decision support systems. Increased operational tempo combined with the speed, flexibility and lethality of advanced technology equipped forces will demand commander-centric enhanced planning and execution monitoring capabilities. These capabilities also must provide integral support for rapid analysis and comparison of competing courses of action. Simulations will provide the commander with a collaborative virtual environment for rehearsing and refining proposed plans. The result will be the ability to fight different or emerging conditions (enemy actions) and quickly adapt to a dynamic battlefield environment. Planning and decision support systems with integrated simulation technology will lead to increased battlespace awareness enabling a commander to initiate adaptive planning and execution.

Finally, although, we feel we have cracked several important domains in the command support continuum, there are still substantial gaps in our capability, even at the prototype level.

ACKNOWLEDGMENTS

The authors are indebted to Mr Dean Bowley and MAJ Pete O'Sullivan for their insightful comments and help in refining the presentation. The authors would also like to acknowledge Mr Ian Heron and Dr Robert Seymour from Land Operations Division and Dr Michael Davies from Information Technology Division for their support. Finally, the authors would like to acknowledge the task sponsor, Director General C3I Development.

REFERENCES

1. *Joint Vision 2010*, Chairman of the Joint Chiefs of Staff, 5126 Joint Staff, Pentagon, Washington D.C. 20318-5126.
2. R. Seymour and A-M. Grisogono, *Architectural overview of a synthetic environment for land C4ISR*, Proceedings of the Fifth International Conference on Simulation Technology and Training (SimTecT00), Australia, pp. 279 – 284, 2000.
3. M. Unewisse, P. Gaertner, A-M. Grisogono and R. Seymour, *Land situational awareness for 2010*, Proceedings of the Fourth International Conference on Simulation Technology and Training (SimTecT99), Australia, paper 55, 1999.
4. F. Bowden, P. Gaertner and P. Williams, *A near real-time tactical land C4I assessment capability*, Proceedings of the Fifth International Conference on Simulation Technology and Training (SimTecT00), Sydney, Australia, pp. 291 – 296, 2000.

[8] Although this kind of distributed information technology is still immature, it is important to build out from an agreed core configuration, rather than attempting to integrate discrete legacy stovepipe systems that have been developed in isolation. This must include the provision of database data for exercises in Australia and for potential areas of operations. Without such a review, it is not possible to establish the extent of the contribution these systems can make to the accomplishment of the operational tasks.