

5th International Command and Control Research and Technology Symposium

Establishing Theatre-Wide Tactical Situation Awareness

Neil Warner

ADI Limited, C4ISR

Email: neilw@ccis.adisys.com.au

Nick Lewins

Sun Microsystems

Email: nick.lewins@sun.com

Abstract

Traditionally, real-time situation awareness has only been available to tactical units, primarily due to limitations in communications bandwidth. Tactical situation pictures usually cover only the area of tactical interest around a unit or task force. The wide dissemination of a Joint real time situation picture to Operational and Strategic commands would increase their ability to get inside decision loop of any opposing force when performing situation assessment, planning and coordinating responses. The aim of this paper is to discuss the provision of a real time joint COP that provides theatre-wide tactical situation awareness.

The Operational, Technical and System Architectural requirements can be derived from the operational capabilities above. ADI's "Cheetah" situation awareness system is presented as a solution to the above requirement.

It is difficult to determine and discuss, in an unclassified forum, the operational benefits that emerge from the introduction of new situation awareness systems. Assessment of increase in operational benefits of Theatre-Wide Tactical Situation Awareness must be made using imperial measures. An outstanding issue that needs examination is whether the delivery of real time tactical situation awareness data at the theatre level adds to the fog of war by contributing to information overload.

Introduction

Traditionally, real-time situation awareness has only been available to tactical units, primarily due to limitations in communications bandwidth. Tactical situation pictures usually cover only the area of tactical interest around a unit or task force. Command Support Systems (CSS) have been used to provide near-real-time coverage of wider areas by drawing filtered data from one or more tactical systems, integrating this with intelligence information, and disseminating this picture using various non-tactical communications links. Typical features of CSS are that they are typically IT-based, use geographic coordinates rather than a local Cartesian coordinate

system, and cover a wider area (usually worldwide). They are highly reliant on communications, and only draw a filtered set of position reports from the tactical level because of the time delay imposed by the computer system and communications infrastructure. This limited data flow has limited the usefulness of the picture presented by the CSS, as it limits the ability of operational and strategic level HQs to respond quickly in times when responsive action is required.

The wide dissemination of a Joint real time situation picture to Operational and Strategic commands would increase their ability to get inside decision loop of any opposing force when performing situation assessment, planning and coordinating responses. It would remove impediments to the commander's ability to dictate the timing and tempo of operations. This is a critical factor in managing today's conflicts, where intense political interest often exists and diverse groups within the command structure, from Prime Minister to Operational Commander require access to up to date information on the tactical situation. This has been made more complex by the ability of the press (e.g. CNN) to provide live video feeds of low level tactical situations in real time, and high level commanders and political leaders have an expectation that military situation awareness systems can deliver similar results.

Most future operations, especially operations other than war, will be conducted in a joint, allied or other combined environment. This includes the planning, coordination and management of all operations. The ability to provide a joint real-time common operating picture (COP) is essential for the conduct of modern operations, thus allowing all force elements plan and respond to same situation.

The modern communications and computing capability is now at a point where the CSS can keep up with the sum of a number of tactical pictures & feeding back the sum to many tactical units.

Aim

This paper is to discuss the provision of a real time joint COP that provides theatre-wide tactical situation awareness. A discussion of the:

- Required operational capability
- Architectural view
- Implementation and
- Operational benefits

will be undertaken to fully examine this concept.

Definitions

Real Time

The technical/systems engineering community use the term “Real Time” in the sense of:

"the system in question provides guarantees that it will respond to inputs within time limits"

However, the non-technical and broader IT community use the term with a sense along the lines of:

"the system in question processes data without delays noticeable to the user".

Our starting point for this paper is that Command Support Systems are implemented as Information Technology Systems and the underlying infrastructure is based upon Commercial operating systems. These technologies can only provide best-efforts behavior. We use the IT sense of the term in this paper. The systems discussed in this paper are not intended to provide engagement-quality contact data, rather we focus on the highest quality of service that can be provided by commercial IT technology.

Further, in network centric warfare terms, this capability is intended to provide situation awareness in the information grid, as shown in Figure 1, below. It is not intended for this capability to provide targeting of co-operative engagement capability.

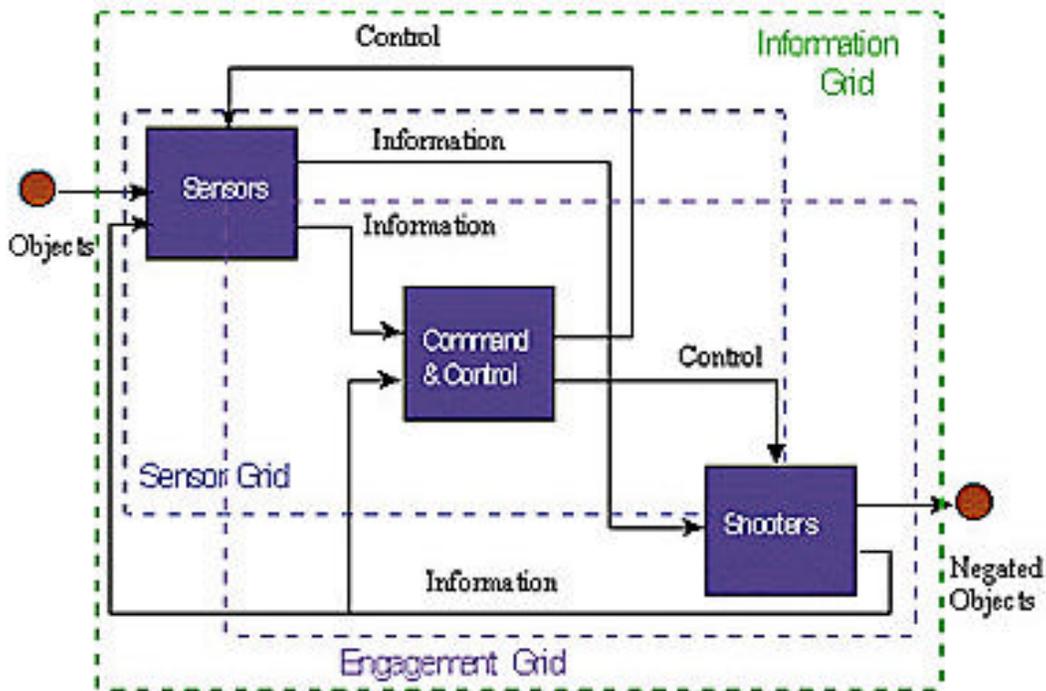


Figure 1 – Logical Model for Network-Centric Warfare

Situation Awareness

The following definitions have been noted in the literature:

“The *understanding* of the situation gained from the sum total of the relevant information provided to make a correct decision regarding the allocated objectives and / or the desired end state”.

“Situation awareness is the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future”.

Both of these definitions are applicable for this paper. The important concept to be defined here is that Situation Awareness is a state of mind rather than a system or piece of knowledge; Situation Awareness systems can present information in such a way to lead a skilled user to attain Situation Awareness but do not create Situation Awareness themselves.

Architecture

“An architecture is a composition of components (including humans) with their functionality defined (Technical), requirements that have been configured to achieve a prescribed purpose or mission (Operational), and their connectivity with the information flow defined (System)”¹.

Required Operational Capabilities

During the Australian Defence Situation Awareness Seminar of November 1998, many views were put forward as to the desirable Operational Capabilities for Situation Awareness. It was generally agreed that:

“Decision Superiority at the theatre level requires decision support enablers including battlespace situation awareness”²

Operation Capabilities were clearly put forward during the presentation titled From Situation Awareness Seminar - Theatre Operational Requirements and the Joint Picture.³ Detailed below is a summary of the key point of the presentation:

Visualisation of the battlespace requires:

- Combined environmental pictures (maritime, air and land)
- Combination of all sources, radar, visual, electronic intelligence and link data
- Data from allied sources

¹ DoD Joint Technical Architecture (JTA)

² [Briggs, 1998]

³ [Pataky, 1998]

- Data from civilian authorities

The key requirements for the ADF Situation Awareness System were described as:

- Real time performance
- Combine environmental pictures
- Multi source
- Provide dissemination
- Suitable display mechanisms
- Interoperability with:
 - Within services
 - Between services
 - With allies and coalitions

We additionally believe that the Situation Awareness System should:

- Provide a "right now" view of the battlespace to non-tactical commands.
- Provide fused tactical and intelligence picture to tactical units.
- Provide joint information to single-service commands/units should it be required.

Architectural Viewpoint

From the high-level operational capabilities detailed above we derive a set of requirements for an ideal Situation Awareness System. We divide these requirements into Operational, Technical and System Architectural and present them below.

Operational Architecture

- A Common Operating Picture (COP) should be provided to each site;
- Filterable (Can provide different views for different force elements);
- Multisource (Handles many input formats, and handles input streams entering the system at different nodes);
- Fused (Automatically matches together tracks and fuses attribute data across all input formats and input streams);
- Joint (Can represent Army, Navy, airforce, intelligence entities, and non-combatants using standard symbology and using suitable attribute sets for each, and can keep up with the data rates required for these - esp. air and intelligence);
- Interoperable (Can send and receive standard allied formats and participate in an allied common operating picture);
- Manageable (Central or distributed picture management and data fusion);
- Graceful degradation in the face of input overload and/or lack of picture management.

Technical Architecture

- Able to operate on JCSS, BCSS and other ADF CSS Systems
- Internet/Intranet compatible
 - Operation over TCP/IP networks
 - Use of DNS
 - Web Enabled
- Distributed Processing Model

System Architecture

- Replicated (Available at many sites using minimal communications bandwidth)
- Scalable (Has the capacity and throughput to track the sum of the entities of interest to the user community at the highest update rate required by any of them; utilises minimal communications bandwidth to communicate)
- Resilient (Continues to operate with local data when communications are unavailable; recovers and resynchronises automatically when connectivity returns; no central point of failure in network)
- User friendly (Highly capable desktop display facility including flexible display filtering, mapping, data drill-down, web integration)
- Minimal hardware requirements (Runs on commodity PC hardware, no special peripherals or UNIX servers)
- Minimal system administration (Simple to configure, and minimal intervention required during operation)

Implementation

ADI's "Cheetah" situation awareness system is presented as a response to the above requirements and represents one way the technical architecture was developed to meet the operational and system architecture. Cheetah is a scalable, Internet/intranet capable, real time situation awareness system that can operate over low bandwidth network connections. Cheetah consists of PC-based display client and PC-based data processing server software. Cheetah is capable of data fusion across many input types without the need for a single central coordinating server. Cheetah performance (> 1000 track correlations per second) provides the ability to include all air tracks at very high update rates, providing for a truly joint real time COP. The Cheetah client provides for 2 dimensional viewing and analysis of current situations. Cheetah uses a network centric model over TCP/IP networks, employing both push and pull data transfer models.

Cheetah Server nodes can be configured into a network in a wide variety of ways. The diagram below show possible configurations, and Cheetah can be configured any combinations of these configurations depending on operational, communications and data fusion requirements.

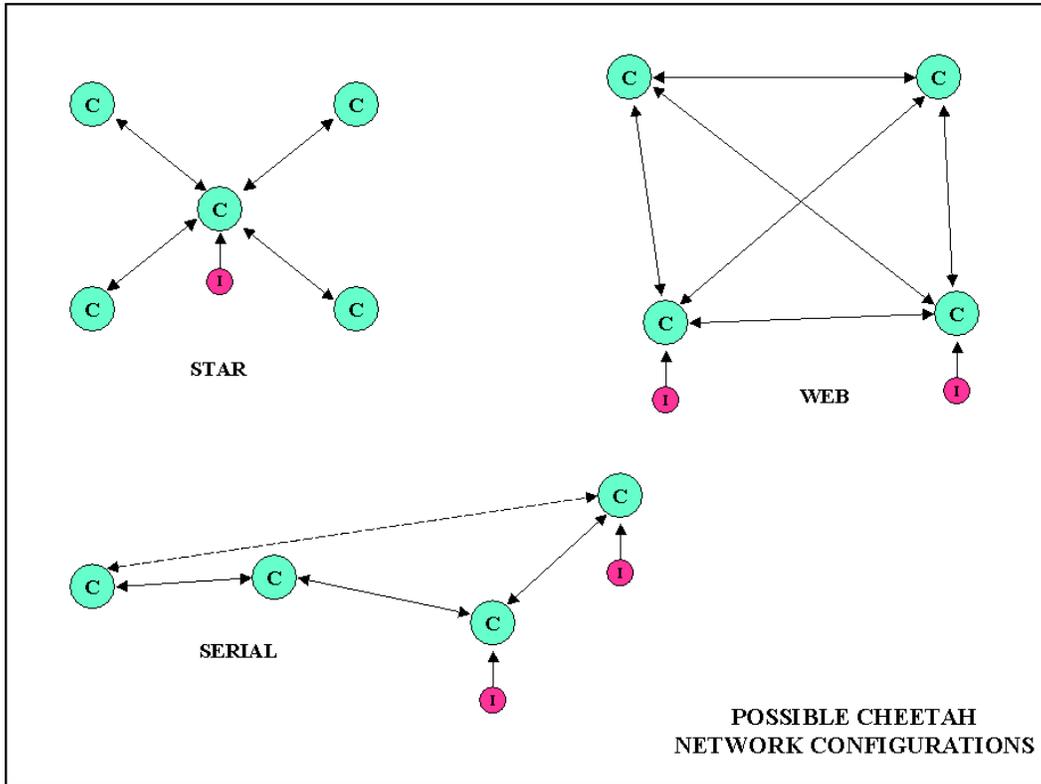


Figure 2. Possible Cheetah Network Configuration

Cheetah servers can communicate over a TCP/IP network or over a store and forward mechanism. This enables support of low bandwidth connections and unidirectional transfer of situation awareness data across data diodes. Non-network communication modes include using serial communications, SMTP email or File Transfer. The diagram below shows a typical layout of this configuration.

Cheetah has been widely deployed within the ADF at strategic, operational and tactical levels. Cheetah is highly flexible in configuration but the optimal operational architecture within the ADF is still a subject of debate.

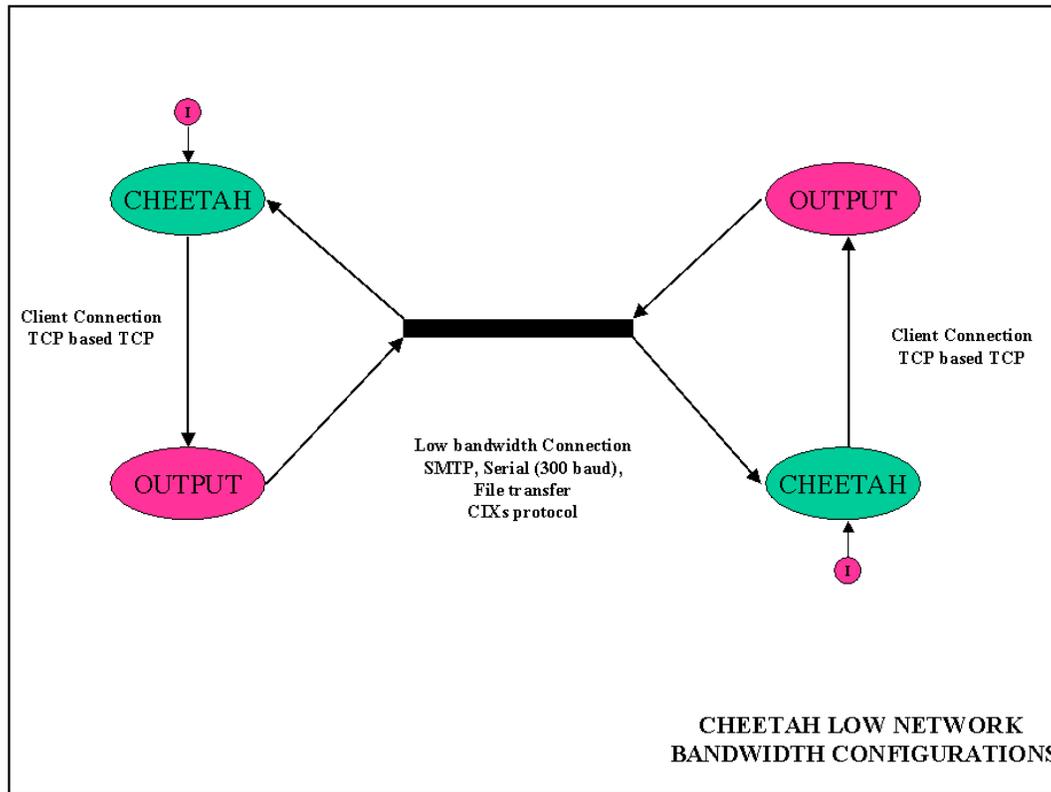


Figure 3. Cheetah Low Network Bandwidth Configurations

Operational Benefits

It is difficult to determine and discuss, in an unclassified forum, the operational benefits that have accrued from the introduction of Cheetah into service with the ADF. Quantitative and Qualitative Evidence of improved operation capability would normally become available in post exercise or operation reports. These reports are not readily available or able to be discussed in open forums. Therefore an assessment of increase in operational benefits of Theatre-Wide Tactical Situation Awareness must be made using empirical measures.

An empirical assessment could be made by the examination of:

- Acceptance of capability and or system by the ADF;
- Introduction and wide spread use of the capability by ADF Headquarters and Operational Units;
- Continuing interest in the establishment of operational procedures to make best use of the new capability;
- Interest in further research and development of the capability.

The Cheetah Situation Awareness System has been used successfully in:

- INTERFET's East Timor deployment, at Tactical, Operation and Strategic levels;
- Demonstrated an unprecedented level of interoperability with legacy allied systems (e.g. GCCS) in JWID 1999 and 2000 exercises;
- Integrated with the ADF's TBS for broadcast data delivery ADF tactical units.

Although this does not imply that an operational benefit exists by the introduction of this capability, the unclassified empirical evidence does give a strong indication of benefit.

Outstanding Issues

In evaluation the operation benefits of this introduction of this capability, the question must be asked if the delivery of real time tactical situation awareness data at the theatre level is adding to the fog of war by promoting information overload. The data fusion properties of the system should be capable of reducing clutter and redundancy of the data presented to the operators, along with the clutter reduction and filtering capabilities of the display client software. But would this be sufficient or would the theatre level commander require further information fusion capabilities to provide the correct level of information?

This issue requires further research. A combination of the Command Support System that is being used and the operational procedures being used will affect the ability of the Operators to absorb and order information. Tactical level situation awareness information is only one of the information sources that may contribute to information overload. This issue may be able to be resolved by the use of an appropriate operational architecture and/or operational procedures.

Conclusion

The overriding imperative for the deployment of Theatre-Wide Tactical Situation Awareness is to remove impediments to the commander's ability to dictate the timing and tempo of operations. This can only be accomplished by providing information superiority, so that commands can increase their ability to get inside decision loop of any opposing force when performing situation assessment, planning and coordinating responses.

Theatre-Wide Tactical Situation Awareness is currently been made available as ADI's Cheetah in Operational and Strategic HQs of the ADF. While there is evidence, even at the unclassified level, of substantial operational benefit, improved operational architectures and procedures to best exploit the new capabilities have not been fully developed. Once the new capability is better understood and integrated into operational practice, we should see operational benefits above and beyond those evident already.

References

The US DoD Joint Technical Architecture (JTA), Version 2.0 was formally authorized for use by a 30 November 1998 memorandum, signed by, among others, the Under Secretary of Defense (Acquisition and Technology).

[Briggs, 1998] Peter Briggs. "Situation Awareness". Defence Situation Awareness Seminar, DSTO Salisbury, 1998.

[Pataky, 1998] Les Pataky. "Theatre Operational Requirements and the Joint Picture". Defence Situation Awareness Seminar, DSTO Salisbury, 1998.