Defence Research and Development Canada
Recherche et développement pour la défense Canada

DEFENCE R&D DÉFENSE

AFV Tactical Visualization Requirements

R.H. Chesney
DRDC Suffield

Defence R&D Canada

Technical Memorandum

DRDC Suffield TM 2010-240

December 2010

Canada

AFV Tactical Visualization Requirements

R. H. Chesney
DRDC Suffield

Defence R&D Canada – Suffield

Technical Memorandum
DRDC Suffield TM 2010-240
December 2010

Principal Author

Original signed by Robert Chesney

Robert Chesney

PM ADVANCE TDP

Approved by

Original signed by Doug Hanna

Doug Hanna

Head Autonomous Intelligent Systems Section

Approved for release by

Original signed by Robin Clewley

Robin Clewley

Chair Document Review Panel

This effort is conducted under the Technology Demonstration Program under Project 12SH - ADVANCE (Advanced Vehicle Architecture for a Net-Enabled Combat Environment)

Abstract

This document defines the requirements identified by the author for map based tactical situational awareness visualization in armoured fighting vehicles. It focuses on functionality that is directly required for the crew to fight the vehicle in direct contact with the enemy. The information displayed, options, and overall functionality are deliberately minimized to reduce cognitive burden associated with the interpretation of the information and to allow a robust user interface to be designed that is fully effective on a small format display. Functionality is further constrained to allow routine user interaction to be completely implemented on a resistive touch screen (single point capable) while the vehicle is in motion. The intent is to provide sufficient functionality to support the operation of small groups of vehicles (nominally up to four) in conjunction with dismounted soldiers. Command requirements beyond that level would require a more comprehensive battle management solution.

Résumé

Le présent document définit les exigences cernées par l’auteur en ce qui concerne la visualisation de la situation tactique à l’aide de cartes dans des véhicules blindés de combat (VBC). Il porte sur les fonctionnalités dont a directement besoin l’équipage pour combattre un véhicule lors d’un contact direct avec l’ennemi. L’information qui est affichée, les options qui sont offertes et les fonctions générales du système sont délibérément réduites afin d’atténuer le plus possible le fardeau cognitif associé à l’interprétation de l’information et pour permettre la conception d’une interface utilisateur robuste et très efficace sur un dispositif d’affichage de petit format. L’utilisateur doit pouvoir interagir avec le système au moyen d’un écran tactile (à point unique) et ce, pendant que le véhicule est en mouvement. Le présent projet vise à fournir une fonctionnalité suffisante pour appuyer les opérations d’un petit groupe de véhicules (idéalement jusqu’à quatre) en conjonction avec des soldats à pied. Les exigences de commandement au-delà de cette capacité nécessiteraient une solution de gestion du combat plus exhaustive.

This page intentionally left blank.

Executive summary

AFV Tactical Visualization Requirements

Robert Chesney; DRDC Suffield TM 2010-240; Defence R&D Canada – Suffield; December 2010.

Introduction or background: Effective exploitation of digital information on the battlefield is expected to be a critical enabling capability for future CF operations. However; it must be recognized that most combat vehicles exploit information solely to execute objectives defined by their command element. The information requirements of a typical AFV are based on their requirement to execute operations rather than to plan operations. Individual soldiers and vehicle crew members are heavily engaged in their primary tasks, so they have very limited time or cognitive effort available to assimilate and interpret information. Development and visualization of information must be implemented in a way that is cognizant of their priorities in the use of information – to fight and achieve their individual objectives in a mission. Traditional battle management systems that support operation planning are poorly suited to this requirement.

Results: This document identifies requirements for map-based, tactical situational awareness visualization in armoured fighting vehicles. It details functionality that is directly required for the crew to fight the vehicle in contact with the enemy. The information displayed, options, and overall functionality are deliberately minimized to reduce cognitive burden associated with the interpretation of the information and to allow effective use while the vehicle is in motion and in contact with enemy forces. The intent is to provide sufficient functionality to support the operation of small groups of vehicles (nominally up to four) in conjunction with dismounted soldiers. Command requirements beyond that level would require a more comprehensive battle management solution.

Significance: Tailoring the functionality of the information system to the specific combat requirements of armoured vehicles is expected to increase acceptance and use of such systems. Integrating operation of the information system into the workflow of the crew, in a manner that respects the extreme time pressures that they operate under, will allow the crews to exploit information to enhance operational effectiveness.

Future plans: The ADVANCE (Advanced Vehicle Architecture for a Net-Enabled Combat Environment) technology demonstration project will implement a tactical visualization system based on the requirements identified. This implementation will be installed in an upgraded 25 mm turret (on a Coyote demonstration platform) and the impact on combat performance will be evaluated by a number of CF armoured vehicle crews in field trials under simulated combat conditions. The results of these trials will be available to inform and guide future CF acquisition / development of tactical visualization software as components of the overall Land Command Support System.

Sommaire

Exigences en matière de système de visualisation tactique pour VBC

Robert Chesney; RDDC Suffield TM 2010-240; R&D pour la défense Canada – Suffield; Décembre 2010.

Introduction ou contexte : On s'attend à ce que l'exploitation efficace des informations numériques sur le champ de bataille constitue une capacité habilitante névralgique pour les futures opérations des FC. Toutefois, il incombe de souligner que la plupart des véhicules de combat n'utilisent les informations que pour atteindre les objectifs définis par leur élément de commandement. Les besoins d'un VBC type en matière d'information s'appuie sur son aptitude à exécuter des opérations plutôt qu'à les planifier. Les soldats et les membres d'équipage de véhicules sont lourdement mobilisés par leurs tâches principales. Ils ont donc peu de temps ou d'efforts cognitifs à consacrer à l'assimilation et à l'interprétation d'éléments d'information. La mise en œuvre de solutions de développement et de visualisation d'informations doit tenir compte des priorités des opérateurs de VBC en matière d'exploitation de l'information – c.-à-d. pour combattre et atteindre leurs objectifs individuels dans le cadre des missions. Les systèmes de gestion de combat traditionnels utilisés en appui à la planification des opérations sont mal adaptés à cette exigence.

Résultats : Le présent document cerne les exigences concernant l'intégration d'un système de visualisation de la situation tactique à l'aide de cartes dans les véhicules blindés de combat. Il énonce des fonctionnalités dont a directement besoin l'équipage pour combattre un véhicule lors d'un contact direct avec l'ennemi. L'information qui est affichée, les options qui sont offertes et les fonctions générales du système sont délibérément réduites afin d'atténuer le plus possible le fardeau cognitif associé à l'interprétation de l'information et pour permettre l'exploitation efficace de ce système lorsque le véhicule blindé est en mouvement ou en combat avec des forces ennemies. L'objectif est de proposer suffisamment de fonctionnalités pour appuyer l'exploitation d'un petit groupe de véhicules (idéalement jusqu'à quatre) en conjonction avec des soldats à pied. Les exigences de commandement au-delà de cette capacité nécessiteraient une solution de gestion du combat plus exhaustive.

Importance : En adaptant les fonctionnalités du système d'information aux besoins précis des véhicules blindés en matière de combat, on devrait contribuer à accroître l'acceptation et l'utilisation de tels systèmes. L'intégration de systèmes d'information dans les activités des membres d'équipage, d'une manière qui respecte les conditions extrêmes dans lesquelles ils doivent oeuvrer, permettra aux membres d'équipage d'exploiter les renseignements fournis par ces systèmes pour accroître leur efficacité opérationnelle.

Perspectives : Le projet de démonstration technologique ADVANCE (Architecture de véhicule avancée pour environnement de combat réseau-centrique) mettra en œuvre un système de visualisation tactique d'après les exigences qui auront été cernées. Ce système sera installé dans une tourelle modernisée de 25 mm (sur une plateforme de démonstration Coyote), et l'incidence de ce système sur le rendement au combat sera évaluée par certains opérateurs de véhicules blindés des FC dans le cadre d'essais sur le terrain en simulation de combat. Les résultats de ces essais serviront à orienter l'acquisition/le développement futurs, par les FC, du logiciel de visualisation tactique à titre de composante du Système global d'aide au Commandement Terrestre.

This page intentionally left blank

Table of contents

Abstract …….. i
Résumé …..... i
Executive summary iii
Sommaire iv
Table of contents vii
List of figures ix
1 Background.. 1
2 Constraints 2
2.1 Display Size and Resolution.. 2
2.2 User Interaction Devices and Limits 2
2.3 Environment 3
2.4 Area of Interest 4
2.5 Time Sensitivity of Data.. 4
2.6 Interaction Speed 4
2.7 Crew Constraints 5
3 Tactical Data Items 5
3.1 Geographical Context Background 5
3.2 Own Vehicle State 6
3.3 Own Vehicle Targets.. 6
3.4 Blue Force Position Awareness.. 7
3.5 Tactical Objective Description 7
3.6 Terrain Visualization 8
3.7 Collaborative Engagement Interaction 8
3.8 Opposition Force Position Estimates.. 8
3.9 Intelligence Analysis 9
4 Tactical Situational Awareness Visualization Capability Requirements.. 9
4.1 Essential.. 9
4.1.1 Map Background Options 9
4.1.2 Area of Interest Display 10
4.1.3 Zoom / Offset 10
4.1.4 Own Vehicle Overlay.. 10
4.1.5 Lase Target Display (Own Vehicle) 11
4.1.6 Lase Target Annotation / Target Reporting 11
4.1.7 Blue Force PA 12
4.1.8 Objective Description.. 13
4.2 Desirable.. 13

4.2.1 Map Background Options ... 13
4.2.2 Area of Interest Display ... 13
4.2.3 Zoom / Offset ... 13
4.2.4 Own Vehicle Overlay ... 14
4.2.5 Lase Target Display ... 14
4.2.6 Lase Target Annotation / Target Reporting ... 14
4.2.7 Blue Force PA / Collaborative Engagement ... 15
4.2.8 Objective Description / Intelligence Analysis ... 15
5 Conclusions ... 15
References ... 17
Annex A .. Notional User Interaction Description ... 19
A.1.1 Power Up Behaviour ... 19
A.1.2 Selectable Overlay Layers ... 19
A.1.3 Initial Pick Options ... 20
A.1.4 Background Pick Options ... 21
A.1.5 Entity Pick Options ... 23
List of symbols/abbreviations/acronyms/initialisms ... 25

List of figures

Figure 1: Vehicle Positions for Map offset 10
Figure 2: Vehicle display positions for map offset (desirable)... 14

This page intentionally left blank.

1 Background

Effective exploitation of digital information on the battlefield is expected to be a critical enabling capability for future CF operations. Automated transfer of information will provide commanders with a much more accurate and timely view of the disposition of their forces and the opposition force. However, it must be recognized that most individual vehicles (or dismounts) in a land force do not exercise routine command responsibility or have relatively limited command roles. Their role in the engagement is to execute objectives defined by their command element.

Individual platform requirements for information are therefore based much more on their requirement to "execute operations" rather than to plan operations. Individual soldiers and vehicle crew members are heavily engaged in their primary tasks, so they have very limited time or cognitive effort available to assimilate and interpret information. Development and visualization of information must be implemented in a way that is cognizant of their priorities in the use of information to fight and achieve their individual objectives in a mission. Wherever possible, development of information for command purposes, including blue force positions, operational state, and even enemy positions should be transparently "mined" from actions that support the combat role.

The ADVANCE (Advanced Vehicle Architecture for a Net-Enabled Combat Environment) Technology Demonstrator Project (TDP) has defined requirements (detailed herein) for map-based, tactical situational awareness visualization to try to meet these objectives within the context of a turreted vehicle. These requirements will be implemented over the coming months and user acceptance and usability will be evaluated in a user evaluation planned for the June 2011 timeframe. The user trial will evaluate the utility of the capabilities in the context of the ADVANCE vetronics demonstrator platform based on a Coyote chassis and the 25mm turret (largely common between the Coyote and the LAV III).

The focus of the analysis supporting map-based visualization is the vehicle commander and the gunner. It should also be noted that the driver of an AFV may benefit from map tools and related overlays. The routine use of GPS based navigation systems in trucks and cars illustrate the potential value; however, most of these systems exploit the rich level of geomatic reference data on road positions, widths and quality available in developed countries. It is unclear that equivalent data would be readily available in areas of interest for combat operations. For the purposes of this paper, it is assumed that the driver would use a customized subset of the tools available to the vehicle commander to exploit use of common map sets and underlying data.

Depending on the specific vehicle implementation, other functionality may need to be combined with the display used for map-based visualization. In the case of the ADVANCE demonstrator, communication control is expected to be integrated, with a common display for map functions, communications / radio configuration, and all digital reporting. While this paper only addresses the digital reports associated with combat operations, the user interface will have to support additional functionality when the vehicle is not in contact.

2 Constraints

Armoured vehicles in motion, and especially when engaged, are not a friendly environment for thoughtful analysis and conventional computer interaction paradigms. Most importantly, it has to be recognized that the crew's "day job" is survival; detecting and engaging enemy forces while executing a discrete, often small, element of an overall mission. Further, the space constraints and the motion environment limit the options for conventional computer usage concepts. Very few computer users climb into their office through a hole in the ceiling, or share a cubicle quite as small as a vehicle turret.

2.1 Display Size and Resolution

As noted, the space constraints in armoured vehicles are severe. The volume for displays is limited and the ergonomics of sightlines, display distance and position must be secondary to the placement of weapons and optics. As a consequence, it should not be expected that display sizes will be large. In an AFV turret it is likely unrealistic to plan for display sizes of greater than a nominal 25 – 30 cm (10 – 12 in) diagonal measurement. Even in AFVs with fewer space constraints than turreted platforms, space claim for a display system will always have to be traded off with other uses. Apart from vehicles that have primary roles of observation or command, displays sizes greater than 38 cm (15 in) diagonal will likely be the exception.

Display resolution at small display sizes can also be an issue. While fine pitch displays are being introduced in commercial applications, transition to displays qualified for severe environments may not be rapid. Current production displays appropriate for AFVs are typically moderate resolution (1024 * 768 pixels) and application software should be evaluated for usability at these resolutions.

2.2 User Interaction Devices and Limits

Most off-the-shelf computer software is designed for use with a keyboard and a pointing device and in most instances is unusable without both. Further, most software is fundamentally tailored to a multi-button mouse as a pointing device, with an underlying expectation the user will be able to designate points on the screen with high accuracy (within a few pixels). It is challenging, and often impossible, to provide equivalent user interaction in vehicles.

The most plausible user interface for AFVs is a touch screen, augmented by mechanical switches at the perimeter of the screen (bezel buttons). Keyboards are hard to use in any motion environment and mounting / stowage of keyboards is a serious challenge. Conventional mice are not usable in most platform configurations, and alternatives such as trackballs, touch pads and joysticks all have issues that limit utility. More recent software developments exploit multi-touch gestures on touch screens and could be an alternative; however, current multi-touch screen designs are based on capacitive touch screen technology and are not usable with a gloved hand. The accuracy and repeatability of gesture interpretation in a motion environment is also not well established. Resistive touch screens are usable with protective gloves, and hence are ubiquitous in the military market. This class of touch screen is limited to indicating single touch positions.

Touch screens present challenges for the user interface designer, primarily in that the accuracy of the pick position is poor[1][2][3]. To a major extent this results from uncertainty associated with finger size, but it also derives from parallax errors that result from the distance (protective glass and digitizer thickness) between the touch surface and the image display. In use, view of the display area is blocked by the user's finger which can also contribute to poor pick accuracy.

The motion environment compounds these issues, as the operator's hand moves in response to vehicle motion. A result of motion is that operators have better accuracy for pick attempts near the edge of the display – where they can partially stabilize their hand on the side casing of the display – and poorer accuracy in the centre (of larger displays) where they have to stabilize their finger position by controlling motion of the entire arm. Pick accuracy is also a function of speed, in that the operator can improve accuracy by concentrating harder on the pick attempt. Software should be designed with an expectation that the operator's effective pick accuracy will not be better than +/- 1 cm. This dictates a fairly large minimum size for button picks or menu selections. If a rapid selection sequence is desired, increasing the button size is desirable.

A stylus can improve pick resolution, but is less usable in motion. In the tight quarters of a turret a captive stylus (secured by a cable attachment) may interfere with other equipment if not stowed properly (weapon operation, weapon loading...), and a non-captive stylus is likely to be misplaced. While a stylus is a plausible adjunct to operations when more time is available, the interface should not be designed to require one for routine operations.

As a result, the user interface environment is very restricted; a handful of buttons on the perimeter of the screen and single picks with coarse accuracy. Further, it would be desirable to design the interface so that the bezel buttons are an alternative to the touch screen to allow operation in the event of failure of either.

2.3 Environment

The physical environment within an AFV is relatively well understood. While heating and air conditioning systems are generally adequate, systems need to be designed to operate at relatively cool temperatures to support periods of silent watch. Hence, it is desirable if basic functionality is maintained with the operator in cold weather gloves. Meeting this objective should also allow for similar functionality if an NBC protective ensemble is required. Glare, dust, moisture and debris are also factors that impair the usability of displays and can motivate the use of larger fonts or symbols than would be required in a pristine desktop environment.

Fatigue and stress are also important contributors to the user environment. The effects of both factors need to be considered in assessing the level of complexity that can be considered for systems. While the effects of fatigue and stress are complex, it is clear that they impair cognitive effort[4], especially for tasks that require sustained attention. Stress and fatigue are not unique to the AFV or dismount environment, but they are typically more concentrated in direct combat roles.

2.4 Area of Interest

Discrete vehicles or small units tend to have an area of interest that is influenced by sight detection limits; weapon range; the range of common enemy weapons; and, the size of a typical tactical bound. It is rare that the area of interest during an operation would exceed 5 km from the vehicle, although display of a larger area might be relevant in preparation for an operation. The area of interest is implicitly vehicle centric, although it is likely to be focussed on a particular sector / direction from the vehicle related to the vehicle's assigned arcs.

2.5 Time Sensitivity of Data

Vehicles and dismounts in direct contact with the enemy have little use for stale position reports, whether they represent friendly or enemy force positions. Position reports are primarily used to guide the vehicle commander in the direction to look and the utility of a position report is related to the accuracy of the bearing between his vehicle and a reported position. In a close range battle, it can take little time for that to change to an extent that the bearing is unusable. For an engagement with mobile forces, displaying information that is even a few minutes old may engender a false belief in its accuracy.

As a trivial example, a vehicle (friend or enemy) achieving a 20 km/hr advance translates to that vehicle moving 300 metres per minute. At a range of 2000 m this results in a bearing change of up to 8.6 degrees / minute (> 150 mils/minute) for an observer in a stationary vehicle. As a result a commander using a target report that is more than a few seconds old can not rely upon the computed direction to a target being sufficiently accurate to ensure that the target is in the field of view of a target acquisition sight.

In a low stress environment it is possible for a commander / analyst to associate a level of uncertainty with positions, predict likely courses of movement, and effectively exploit data with high latency (minutes or hours in some cases) however the cognitive load[1] for that effort is completely beyond a vehicle commander who is primarily engaged in other tasks.

2.6 Interaction Speed

Any user interface for a combat commander has to be exceptionally simple and responsive. The engagement timeline for an AFV is rarely more than a few seconds from the detection of a threat. Measurements from simulation indicate that engagement success is directly correlated with engagement speed[6]. Depending on the circumstances of an engagement, the time window for a vehicle commander to interpret data from a tactical display may be limited to a single glance with a duration on the order of a single second. Simplicity and consistent information presentation is clearly required to meet this goal.

Given the unpredictable nature of combat, it is desirable that the "combat" display be routinely visible for reference. While the commander may choose to focus his attention on the map, or tactical visualization display, the interface should be designed so that any interaction sequence of

[1] Cognitive load / effort refers to the mental concentration required to the interpretation and analysis of information and the related decision process.

more than 1 to 2 seconds is a rare exception; allowing the vehicle commander to focus on other tasks, as required.

2.7 Crew Constraints

Users will be drawn from a broad spectrum of CF members. Generally, good to excellent visual acuity can be assumed; however, it must be accepted that a substantial number of users will lack normal colour perception[2] as the CF does not select for colour perception in vehicle crews. As a result, exclusive reliance on colour to distinguish displayed information should be avoided. In the context of this application, the only other physical characteristic likely to influence design is finger size, further motivating allowance for a higher level of pick uncertainty associated with larger fingers.

As discussed previously, fatigue and stress are endemic to combat. Maintaining usability under stress further motivates exceptional consideration of consistency and simplicity in the implementation of the interface.

3 Tactical Data Items

The tactical data items and the relative importance assigned to each are derived from experience with a variety of projects[3] conducted with an armoured vehicle test-bed simulation environment. This environment has been used to study combat effectiveness of small groups of vehicles (typically four) under a variety of configurations of weapons, sights and situational awareness technologies. Insight from these trials, conducted with CF crews operating in a mix of moving and stationary crew workstation mock ups have resulted in some consistent conclusions on information utility in situational awareness display that is incorporated below.

3.1 Geographical Context Background

Topographical maps are a convenient and well understood tool for providing the geographical context for an area of interest. Digitized versions of these can readily be used for electronic situational awareness systems. The primary concern with this approach is the challenge of matching the detail and feature resolution available in a printed map with that available from a digitized version on a small format, moderate resolution display. Maps are printed with an effective resolution in excess of 300 dots per inch (DPI), yet the display screen resolution is on the order of 150 DPI. This can make it challenging to display a relevant area of interest and maintain the readability of small features and text. An additional concern is that the level of detail on a printed topo map (and its digitized image) is a fixed compromise between information and "clutter" that can not be altered to suit the information needs of the user in a particular role.

[2] Colour perception is impaired, to varying degrees, in up to 8 percent of the male population[5].
[3] Including the Advanced Land Fire control System (ALFCS); Future Armoured Vehicle System (FAVS); Multi-mission Effects Vehicle (MMEV) and the Multi-Role Combat Vehicle (MRCV) projects.

Despite those concerns, a digitized topo map is likely the most appropriate background for tactical situational awareness.

An alternative to the topo map that should also be made available is geo-referenced airborne imagery. In some instances this will allow the user more insight into terrain features and cultural artefacts (buildings, cultivated fields, roads, tracks...) than can be captured from the topo map. Airborne imagery may also be much more current than maps in representing the state of buildings and vegetative cover.

Map and image orientation should be fixed (North up) to allow consistent interpretation. To further assist in rapid interpretation the scale of the map (and the image) should be scaled to the nominal area of interest defined for the vehicle class with a very limited set of scale options.

3.2 Own Vehicle State

Graphical representation of the location, orientation and "state" of the vehicle in a geographical context can aid the commander. Representations should include:

- Vehicle position and orientation – an icon that allows interpretation of direction
- Direction of sight orientation and FOV – Overlay graphic for each sight denoting the horizontal field of view arc for each optical sight
- Threat alarm direction – Overlay graphic indicating the direction (and distance, if available) of a threat raised by a defensive aid suite sensor. Graphic representation may change to indicate direction uncertainty and type of threat.

Other aspects of vehicle state (fuel, ammunition state, weapon selected, etc) are not expected to benefit from presentation in a geographical context.

The vehicle position and orientation in a map based context will also benefit the vehicle driver. Consideration should also be given to presenting threat alarms and directions so the driver is aware of the direction of the threat and can manoeuvre more appropriately.

3.3 Own Vehicle Targets

Graphical representation of locations computed on the basis of returns from laser range finder(s) can aid the commander. By default these would merely represent positions associated with "objects of interest", but the associated location data is available to form the basis of a more formal target report. While the option should be available to annotate a lase return and associate a more complete description with it, in many instances that will not be required. However, it is desirable if the sight image associated with the lase activation can be retained and associated with the target location as an "aide-memoire" for the crew should they desire it. The image could also be associated with a formal target report if one is developed.

As noted above, target data can go stale rapidly, so that representation of the position of an object should have a limited lifespan. Symbols representing targets should change state over time to indicate the age of the target position; if not refreshed, they should be suppressed automatically to reduce screen clutter.

It must be noted that a vehicle crew will often see and geo-locate (lase) targets without an immediate intent to engage. Increasingly, threats need to be discriminated from harmless activity by observation of a pattern of motion or activity rather than by simple classification of the target. It is desirable if the interface can support periods of observation by a simple method to associate successive target reports into a target track – showing the most recent target position augmented by a direction of motion.

3.4 Blue Force Position Awareness

Knowledge of friendly force positions is critical to close combat operations; coordination of manoeuvre, fields of observation and weapon coverage are critical to rapid conduct of operations. The primary requirement for blue positional awareness (PA) is the position of friendly units in the vehicle's region of interest. If data is available, display of additional information about friendly units may be desirable, primarily the vehicle direction of motion / orientation.

It is desirable that the display of blue force PA allow rapid discrimination between mounted units and dismounts, and likely also between forces in a common command structure and those in different reporting chains. Other information about friendly units may be available; however, consideration should always be given to minimizing the complexity of the display.

It is critical that blue force PA displays be "coded" to reflect the age of the position information. Data age infers a positional uncertainty that will grow with time. Information that is not current (related to the current and potential speed of the unit) needs to be distinguished from more current data. The vehicle commander needs to be able to interpret the uncertainty of a position at a glance. The positional uncertainty that merits a change in the way that the data is displayed will generally relate to the region of interest for the unit and the current (and potential) movement speed of the unit displayed.

3.5 Tactical Objective Description

Semi-static overlay graphics that represent the objective location, movement corridors, phase lines and reference points provide important contextual information for the vehicle commander. Provision to display this information is definitely a requirement. The way this information is displayed, and the level of detail provided, needs to be carefully considered to limit screen clutter and allow the operator to rapidly resolve vehicle and target overlays from static information.

The unit / vehicle commander may wish to augment the description of the tactical objective, with additional overlays to indicate assigned arcs of responsibility for individual vehicles. In a mobile environment, these arcs may be expressed in relation to the vehicle orientation. This class of overlay would move with the vehicle.

Route information associated with the objective description, or potentially the identical description of the objective would also be of benefit to the vehicle driver.

3.6 Terrain Visualization

While a map-based, two dimensional representation provides a well understood tool to discern spatial relationships based on distance, the vehicle operates in a three dimensional environment. Understanding the impact of terrain shape on inter-visibility (for observation or direct fire engagement) is important. Numerous terrain visualization techniques are available, from simple colour coded relief maps through airborne imagery “draped” over the terrain shape. Outside of colour coded relief maps, most visualization techniques rely upon controlling the eye-point to provide insight into terrain shape. Use of a fixed eye-point can limit the utility of many visualization techniques.

Terrain height data is rarely sufficiently accurate to completely predict inter-visibility from the limited height of an AFV sight. Minor building and vegetation changes can significantly change the views available near the ground. As a result, the utility of terrain visualization to predict what terrain should be visible by an individual vehicle is limited.

Controlling the eye-point to interpret terrain visualization may result in a richer terrain visualization capability; however, it would require relatively intense cognitive focus during the interaction. An option to temporarily substitute the topographic map background with a colour coded relief map is suggested as the best compromise to provide usable levels of terrain visualization that can be rapidly assimilated.

3.7 Collaborative Engagement Interaction

Low latency target information relayed from adjacent units allow the individual vehicle commander to be aware of potential threats that may not be visible from his (or her) own platform, or that may be in sectors of the area of interest that they are not currently assigned to observe. Threat vectors / locations from defensive aids suite sensors carried by adjacent units are also relevant to nearby units.

It is also desirable to provide the opportunity to observe targets generated by observation units in direct support of an operation (UAVs, unattended ground sensors, dedicated reconnaissance vehicles and the like). Preservation of cues related to target report age is still important for these sources.

3.8 Opposition Force Position Estimates

Opposition threat estimates based on analysis or on dated observations may have little relevance in execution of operations. Wherever the opposition force has the potential to be mobile, the expected validity of a past position will degrade rapidly. Projecting likely current positions and risks associated with error are significant cognitive burdens that require sustained attention and can be a distraction to commanders with high task loadings from other roles. The risk associated with unqualified use of stale data is sufficiently high that its presentation to the vehicle commander should be limited to non-combat scenarios.

3.9 Intelligence Analysis

While stale data presents risks in the conduct of operations, threat estimates definitely play a part in preparation for an operation and an ability to refer to some of them in the course of an operation may be of continuing value. For forces and threats that are static, display of position estimates could aid the vehicle commander. There may also be a benefit in the ability to display information in the JIMP (Joint, Interagency, Multinational and Public) context, providing information on the known operations of third party agencies (aligned forces, NGOs, etc). While the accuracy of this data may be as suspect as the information associated with opposition position estimates, errors in this data entail less risk.

4 Tactical Situational Awareness Visualization Capability Requirements

Traditional command and control systems tend to implement a rich feature set to allow the commander (and his staff) to combine information from a variety of sources to interpret the enemy's intent; to evaluate options to counter that intent; and to manage the execution of the selected plan. More recently, battle management systems (BMS) have been developed that provide those capabilities at a platform level; however, in most instances the functionality incorporated still remains focused on information interpretation and the planning and execution of an overall tactical operation – albeit at a lower organizational level.

While the fundamentals of map based visualization of the battle space are shared with the combat requirements of an individual vehicle, the number of options that a "BMS" provides impairs the ability to implement a sufficiently simple user interface to allow rapid assimilation of critical information and operation of the system on the move. The ADVANCE project team has developed the following set of requirements for a tactical situational awareness visualization (Tac SAV) system, with an initial partitioning between essential and desirable functionality. The project will implement the demonstrator platform with the essential requirements. The evaluation trial will then be structured to measure vehicle combat effectiveness and user satisfaction with the implementation. The user evaluation will also incorporate a structured user assessment of options for additional functionality – based on, but not limited to, the capabilities identified as desirable.

4.1 Essential

4.1.1 Map Background Options

The system must provide the ability to display a rasterized image of a conventional topographical map at a single level of detail (nominally equivalent to a 1:50,000 (50 K) conventional paper map). It must also be able to display a geo-referenced image file representing airborne imagery. Further it must be able to display a colour-coded / shaded topographical relief map based upon terrain elevation data. By default, the display shall be centred at the currently reported vehicle position. All background imagery shall be displayed in a North up orientation[4].

4.1.2 Area of Interest Display

The default display for the area of interest shall be on the close order of 8 km in the maximum dimension. Scaling of map data to display resolution should be considered to maximize fidelity of the displayed topographical map imagery at this nominal scale.

It should be noted that the area of interest for a vehicle driver will likely be less than the area of interest of the vehicle commander. It is also likely that the driver will attach a higher priority to being able to read the map text features. As a result, it is suggested that a map display available to the driver have a default area of interest on the order of 4 km in the maximum dimension.

4.1.3 Zoom / Offset

The display must be able to zoom to both twice and one-half the original scale (nominally 4 km or 16 km in maximum dimension for the commander's display). It should be possible to offset the map display of vehicle position from the centre of the display to one of four cardinal positions biased to the edge of the display (as shown in Figure 1).

Similar zoom and offset capabilities will be required for any map provided at the driver's position.

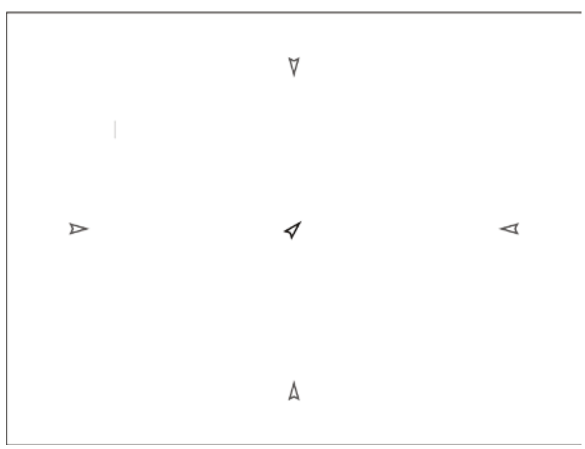

Figure 1: Vehicle Positions for Map offset

4.1.4 Own Vehicle Overlay

The own vehicle overlay shall consist of several elements. The fundamental component is a simple icon allowing interpretation of orientation to be extracted. Notionally this display would

---

4 This limitation is derived from CF Army operational experience with North up versus rotating orientation maps as related by LCol Jacques Hamel in a briefing on Tactical Battle Mangement Systems in August 2010. It is unclear whether this experience has ever been formally reported.

be an "arrowhead" although the detail is left for consideration of the implementer. The own vehicle overlay must also show the orientation of the primary weapon and any independent weapon / sight. Notionally the orientation of the weapon and any independent sight would be polygons with a general "wedge" shape, centred at the vehicle with the arc width denoting the horizontal field of view of the associated sight[5] and the length configurable to represent an associated resolution limit. Sufficient decoration must be added to one of the two overlays to allow rapid resolution of which icon represents the weapon. Detailed design of the overlay is left to the implementer.

4.1.5 Lase Target Display (Own Vehicle)

Display of positions computed o the basis of returns from laser range finders can aid the vehicle commander in operation of the vehicle. In some instances lase returns will be associated with targets that the commander wishes to report to higher command; however, it is expected that the gunner and commander will routinely lase targets to establish a catalog of "objects / positions of interest". These may represent vehicles, persons, or groups that can not be immediately classified as hostile, neutral or friendly; or merely features in the scene that represent cover that could be exploited by threat forces. Once noted, these positions may then be re-visited as part of normal observation. Objects of interest that move between observations will likely be lased to generate a new position on each subsequent view. An easy method to associate the previous position and suppress the display of the same target at multiple positions is required. Associating a sequence of position reports will effectively generate a target track with an estimate of target speed and direction of motion (likely quite coarse given potential error sources).

A simple icon should be displayed at lase positions generated by the vehicle. If the position reflects the most recent position in a target track sequence the icon should include a detail to indicate the nominal direction of motion. A method to rapidly associate two position reports into a single track must be included. As the commander and the gunner may independently lase targets, it must be possible to associate any recent target with a preceding target. A method to confirm the association of the preceding target should be implemented (nominally through the momentary display of the sight image associated with the preceding target).

Lase targets must be implemented with a defined "lifetime". Based on parameters from a configuration file (specific to a vehicle class) the display must transition to an icon variant that implies uncertainty after a specified time. Plausibly this would be represented by the icon being "grayed out"; however additional changes in the icon form may be required to support colour blind users. After a further time, lase targets that have not been annotated, would be completely suppressed and disappear from the display.

4.1.6 Lase Target Annotation / Target Reporting

When required, it must be possible to rapidly transfer target locations to higher command and to adjacent forces. Associating a target description is required in this instance. Three options for annotation must be supported; including:

[5] Where the weapon or the sight may have multiple imagers displayed simultaneously, the overlay shall represent the imager with the narrowest FOV.

- simple attachment of the associated sight image;
- association of a simple structured descriptor; and / or,
- association of a free text descriptor.

The sight image would require the least work on behalf of the vehicle commander; however, it may be more difficult for a remote observer to interpret a static image with the same accuracy that can be done based on the original video sequence. The free text descriptor is a general solution but would require the operator to type in a descriptor on a touch keypad.

A structured descriptor is a plausible compromise allowing the rapid entry of a multi-level description and a quantity. A two level descriptor with 10 to 12 options for each level would provide a significant number of combinations. Tailored specifically for typical targets expected in a current theatre, a limited number of descriptors should provide adequate descriptors for the majority of potential targets.

For initial implementation it is required that the interface support three levels of annotation each with nominally 10 choices. Descriptor keywords for each level of annotation should be parameters that can be read from a file (each nominally less than 12 characters). The report will merely represent the sequence of descriptor keywords, combined with the observation time and position. At each level of annotation the operator should have the option to transmit the report (with or without associating the image[6]). Rapid entry of target designation is imperative, so the user interface must include minimal complexity.

It is expected that one level of descriptor will be dedicated to the numeric quantity of the target with options of 1 – 9 and 10+ (nominally). Should the detailed interface design support fewer (or more) than ten descriptor options at each level, this can be accommodated by adjusting the numeric increments associated with each option button choice.

The annotation sequence must allow for the target to be designated as a “static / permanent” target. This would override the normal behaviour of the system in automatically suppressing targets that exceed pre-defined latencies from the observation that established the position. Removal of targets that have been previously designated as static should also be supported.

It must be possible for target annotation to be added without triggering transmission to higher command and control.

4.1.7 Blue Force PA

Blue force position awareness requires display of icons representing the position and orientation of vehicles and the position of dismounts within the vehicle’s area of interest. The vehicle icon should be similar to that used to represent the host vehicle. Icons representing dismount positions should be very simple to reduce the clutter level when numerous icons are displayed.

[6] The implementation should ensure that the text report be decoupled from the image transfer, in order to ensure that the transfer time for the image not impede receipt of the text report.

It is important that blue PA representations be aggregated for multiple units in close proximity. On a scale of several kilometers, a dismounted squad may be better represented by a single icon at the geographical centre of the unit's position rather than as a cluster of icons. This will limit clutter and preserve the readability of the background, to the extent possible.

While it would be possible to conceive numerous criteria to aggregate unit displays, the simplest method would be to simply use the size of the icon as the test criteria. When multiple icons would overlap if displayed, they should be aggregated. The form of the icon used for multiple units would have to be very similar to the individual representation but still clearly distinct at a glance. Aggregated vehicle icons would lose definitive orientation context in most, if not all, instances. Consideration should be given to ensure that this distinction is implied in the choice of iconic representation.

4.1.8 Objective Description

As noted, several semi-static overlays are expected to be of value in guiding and coordinating an operation in real time. The form and style of these overlays must be identical to those used in higher level command and control, and it is expected the geo-coordinates defining these overlays will be automatically extracted from a BMS at some level within the unit.

4.2 Desirable

4.2.1 Map Background Options

It is desirable that the topographical map background switch scale where data is available; displaying feature details of 25K and 100 K maps as appropriate to the zoom level used by the operator.

4.2.2 Area of Interest Display

It is desirable that the default for the area of interest value be a configuration parameter which can be adjusted for each class of vehicle rather than a fixed value for all vehicles. This may also allow for more specific tailoring of map display resolution to display resolution;

, maximizing readability of map detail for the display variants installed in a particular platform.

4.2.3 Zoom / Offset

It is desirable to allow selection of the displayed position of the "own vehicle" icon at offsets from centre that lie between the cardinal directions (see Figure 2)

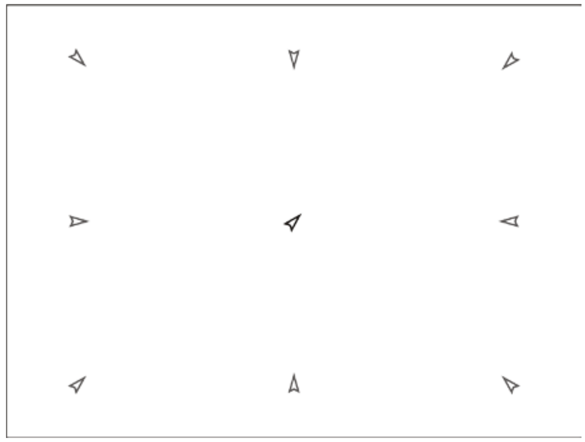

Figure 2: Vehicle display positions for map offset (desirable)

Where the operator has entered observation arcs[7] relative to the vehicle orientation and has selected a map offset, the system should automatically adjust the map offset position as the vehicle manoeuvres – maintaining map coverage of the assigned arcs. Care must be taken in the implementation to avoid situations where the presentation would rapidly switch back and forth.

4.2.4 Own Vehicle Overlay

It is desirable that the own vehicle overlay be augmented by entries representing the arcs of responsibility associated with the unit. These may be either relative to vehicle orientation or bearings relative to a fixed position.

4.2.5 Lase Target Display

It is desirable to allow for the display lifetime parameters to be revised to support unique requirements of a particular deployment (likely based on the expected predominance of vehicle or dismounted threats). While modifications of this sort entail an additional familiarization burden for the crews, it is potentially a valuable tradeoff – especially if the pre-deployment refresher training uses systems / simulators with consistent behaviour.

4.2.6 Lase Target Annotation / Target Reporting

It is desirable to allow additional annotation options, specifically including association of a segment of speech to verbally describe the target. This option could allow for a rapid, natural description that could be accomplished with less focus on the interface. When received in the command and control chain, the voice annotation could be transcribed to a machine readable annotation as required.

It is desirable to consider additional annotation levels to support extension of target reporting to calls for supporting fire. It is expected that this functionality could be added by providing one or

[7] conditional on vehicle responsibility arcs being implemented - also a desirable extension.

two additional annotation choices; however, this would clearly depend upon doctrine and the requirement to integrate a forward observer or a fire support decision cell. Further analysis is required to support specification of requirements for this extension.

4.2.7 Blue Force PA / Collaborative Engagement

It is highly desirable that the system provide an option to display target information from adjacent forces (likely all targets that have been annotated, but potentially only those that the unit has chosen to transmit to higher). This is especially important in respect to vehicles operating in support of dismounted forces. Similar behaviour in respect to cueing the operator in respect to the age of the target observation (latency) must be observed as implemented for targets designated by the vehicle itself.

Should arcs of responsibility display be implemented, it would be desirable to allow these to be displayed collectively to ensure accurate coordination.

In the longer term, it may be desirable to implement a minimalistic whiteboard overlay capability to allow small teams to perform expedient planning in reaction to unexpected opportunities or challenges. Simple overlays over shared target images or over a shared view of the map would likely provide a sufficient tool to allow small teams to adapt operations to unexpected events; however, effort in this regard is beyond scope for the current project.

4.2.8 Objective Description / Intelligence Analysis

Under some circumstances, the commander of an operation may wish to include overlays representing: aspects of the intelligence estimates that shape the operation plan; position estimates of aligned forces that can not be directly received; locations or position estimates of neutral parties; and similar data. It should not be expected that the individual vehicle commander would select the content of these overlays from a list of options; rather that he would have access to one or two additional overlay options with content that the commander has determined is important to executing the operation. The content of the overlay distributed would likely represent selected layers from a more comprehensive battle management or command and control system.

5 Conclusions

The information requirements of an individual vehicle or dismount are significantly different from those required by a higher level commander. As described above, it is expected that individual vehicles will be better served by extremely simple systems that focus on visualizing spatial relationships that are relevant to target acquisition, engagement and manoeuvre. While these systems will exploit the same underlying map and command and control data, the presentation, functionality, and potentially the underlying software tools need to be chosen to meet the user requirements. A visualization system that distracts or overloads the vehicle commander, or fails to be responsive to the threat engagement timelines of land battle, will fail.

Significant emphasis is placed upon the latency of positional information and its importance to ensure that the visualization system can contribute to meaningful situational awareness. This has additional implications outside of data display, in regard to how the supporting communication system transfers data. An implicit assumption has been made in this discussion that relevant communication latencies can be achieved between units in close proximity to each other. It is not immediately apparent that the existing communication methods employed by the CF meet this objective.

The ADVANCE project will implement the essential components of the requirements identified above, using – where possible – existing CF command and control tools. Trials of the result will be conducted with CF members to evaluate the utility of the result and the impact of use of the system on operational tempo. The CF members will be selected to be fully representative of AFV crews, using formed crews (as available) from units operating either LAV III or Coyote AFVs. The trials will be conducted in the early summer 2011 timeframe (nominally June). The observations and results of this trial will be available to guide future development / selection of tactical visualization tools for the land force.

References

[1] Waloszek, Gerd (2000), Interaction Design Guide for Touchscreen Applications, *SAP informal reference publication*, www.sapdesignguild.org/resources/tsdesigngl/index.htm.

[2] Potter, Richard L. et al (1988), Improving the Accuracy of Touch Screens: an Experimental Evaluation of Three Strategies, *Proceedings of the SIGCHI conference on Human factors in computing systems (CHI '88)*, pp. 27-32.

[3] Sun, Xianghong et al (2007), An Empirical Study on the Smallest Comfortable Button/Icon Size on Touch Screen*, Usability and Internationalization, Part I, Lecture Notes in Computer Science Vol. 4559*, pp. 615–621, Berlin / Heidelberg: Springer.

[4] Lieberman, Harris R. et al (2002), Effects of caffeine, sleep loss, and stress on cognitive performance and mood during U.S. Navy SEAL training, *Psychopharmacology, Volume 164, Number 3*, pp. 250-261, Berlin / Heidelberg: Springer.

[5] Nielson, Jakob (1993), Usability Engineering, Cambridge, MA: Academic Press.

[6] Fournier Pierre et al (2007), Vulnerability and Lethality Assessment of a Light Armoured Vehicle equipped with FAVS Technologies in one-on-one engagements (U), (DRDC Valcartier TR 2007-630) Defence R&D Canada – Valcartier.

This page intentionally left blank

Annex A Notional User Interaction Description

This document is not intended to define the details of the user interface in depth; that is left to the implementer of the software based on the functional requirements. However, in the course of ensuring the achievability of the requirements, a notional interface interaction concept was developed. This is intended more to illustrate the level of simplicity desired than as a design guideline.

A.1.1 Power Up Behaviour

It is desirable that the tactical visualization system power up to a state that allows the vehicle to be operated and fought in a basic mode without any user intervention or log on procedure. It is likely that security concerns will require that some user authentication procedure be completed[8] before the system provides full access to all capabilities; however, the basic operation should be no more onerous than that required to access voice radio in existing platforms.

It is assumed that the tactical visualization application will run continuously, even when the user may be using the underlying workstation for other functions (radio setup, orders receipt / acknowledgement, routine reports, etc). An ability to select the visualization display at any time (pausing any other computer interaction) is essential for operational use.

A.1.2 Selectable Overlay Layers

Table 1 lists a nominal selection of overlay layers that support the essential and desirable functions identified above. It includes a priority level as a guide to the user interface designer. Should the number of layer options be constrained by the number of bezel buttons or a limited number of touch regions, the lower priority overlay selections can be grouped into a sub category that would require an additional “menu level / pick” to access.

ID	Description	Default	Priority
Vehicle	Own vehicle icon and gun / sensor pointing	ON	1
Target	Own vehicle target positions	ON	1

[8] Notionally this could be provided by the system automatically launching a default suite of functions under an “unclassified user ID” with an option to switch the user ID to one with greater access rights through a log on procedure that can be completed when the user has time to do so.

ID	Description	Default	Priority
Target History	Own vehicle target positions without time latency filter	OFF	2
Arcs	Own vehicle arcs of responsibity	OFF	1
Blue	Blue force position icons	ON	1
Blue History	Blue force positions without time latency filter	OFF	2
Blue Targets	Reported blue force positions	OFF	1
Blue Arcs	Arcs of responsibility for adjacent units	OFF	2
Orders - Objective	Overlays describing route, objective and other key boundaries	ON	1
Orders - Threat	Overlays describing estimate of enemy intent and positions	OFF	2
Orders - Other	Overlays describing estimate of supporting and neutral force intent and positions	OFF	2

Table 1: Overlay Options

A.1.3 Initial Pick Options

It is suggested that the user interface display solely the map and overlays by default. That is, there would be no space reserved for pick actions (touch screen buttons) in the normal display mode. Touching the screen at any location would initiate a user interaction sequence. The user interaction sequence would be time limited and, if not completed within the time limit, the screen would revert back to the basic display. It is assumed that the speed of screen refresh / re-write in response to pick events will be essentially instantaneous, so that the user has an immediate indication of pick success.

It is expected that the initial pick will first initiate a map zoom around the pick position, likely to a significantly more narrow view (nominally 2000 m width – or 4 * zoom). This would allow a subsequent pick to select a map entity associated with a visible overlay to have a plausible expectation to succeed. The "zoom" pick would also define a "map position of interest (MPOI)" that would be made available to the vehicle control system. This position could be used to align the weapon or observation sights.

If no additional pick was made the zoom level would reset to the previously selected value after a short delay, nominally on the order of 1 second. This would reset the user interaction sequence.

A subsequent pick while the display remained zoomed would raise options under the user interface. The user options raised would depend upon whether the pick position was close to an existing map entity[9] or against the background of the map. Picks against the background would raise a default menu of options, whereas picks against an entity could raise a menu that is specific to that class of entity. In either case, it is important that the menus presented provide an undo / "re-pick" function to allow the operator to rapidly revert to the initial zoomed pick option state should the result not be what the operator had intended.

The subsequent pick position would be used to update / refine the MPOI made available to the vehicle control system. The stored position of the map entity would be expected to be used for the MPOI when picks were deemed to have been against a map entity.

The display time for the user interface options would be small – again on the order of 1 second. This will allow the operator to quickly enter a reasonably accurate MPOI with two clicks and have the display rapidly revert to its normal mode.

A.1.4 Background Pick Options

A limited number of default options are expected for picks against the map background. Each UI option presented may, optionally, raise an additional level of options that the user can select.

First Level Option	Second Level	Notes
Zoom In		Greyed out if at maximum zoom
Zoom out		Greyed out if at minimum zoom

[9] The threshold for "close" would clearly have to be the subject of significant testing to ensure acceptable performance in a movement environment.

First Level Option	**Second Level**	**Notes**
Background	Topo map	
	Image	
	Relief	
Overlay Select	Multiple as noted	Second level selection options may require a “done” option. Equivalent to implicit “done” after timeout
Arc Entry	Left	May require third level (nudge left, nudge right) – might be able to add nudge option to second level... Arc entry would implicitly select appropriate overlay option
	Right	May require third level (nudge left, nudge right)
	Cancel	Default operation on timeout
POI Entry	Annotate	Annotation as per target entity pick sequence
	Permanent	Allow over ride of automated suppression of the screen object
	Transient	
	Cancel	Default operation on timeout
Pause Map[10]	Several [vehicle specific]	Access point for non-visualization functions available on the display / workstation, including radio setup, general vehicles reports, e-mail, etc.

[10] Workstation must implement bezel button / continuously available touch screen function that restores the map display

A.1.5 Entity Pick Options

The tactical visualization system will include several overlays. Some of the overlays are associated with other data that the user will wish to reference or modify. A pick near a graphical feature that has no additional data associated with it should be in the same way as a pick against the background, examples of this class of feature would be the vehicle weapon sight overlay.

Initial system behaviour would update the MPOI value based to the vehicle control with the geo-graphical position of the entity selected (for entities with a single position. Where the selected entity have a geo-graphical extent (phase line, etc), the MPOI would be updated based on the pick position. It is possible that a full examination of user work flow would uncover a requirement to make the MPOI behaviour specific to each entity class.

Entity Class	**Pick Options**	**Notes**
Target	---	Target pick would raise a display of the current target descriptor – to the extent populated – Time and position at a minimum
	Associate	Selection would clear all pick options and overlays – other than target positions that precede (in time) the selected target, Subsequent pick of a target would raise a thumbnail of the associated sight image and both “re-pick” and cancel buttons. Completion of association sequence would return to target pick level
	[Descriptor option 1-n]	Three levels of descriptor options would be presented in sequence (nominally, type, sub-type, quantity). Depending on number of pick options in the UI design it is possible that first level of descriptor options would require another pick of an Annotate option after the target was selected.
	Permanent	Option presentation implies current state (transient or permanent) transient by default Implies “Done”

Entity Class	Pick Options	Notes
Target (cont'd)	Transmit	Completes sequence at any level and transmits descriptor sequence captured. This option may need a confirmation action[11]
	Done	Completes sequence at any level. Default action associated with timeout
Own Vehicle Arcs	Nudge left	Significant arc change would require re-entry
	Nudge right	
	Cancel	
Blue Force Vehicle	---	Pick should momentarily raise an "info box" about unit ID and (as possible) comms channel they would be monitoring. Info Box should include pick option to keep on screen and to close. Timeout would close box
Blue Force Dismount	---	Nominally as per Blue force vehicle
Orders - all	---	Selection of an entity associated with a Orders overlay would raise a information box describing that item

It should be noted that it would be desirable in the longer term to more fully examine the functionality associated with picks against some entities. As an example, a pick against a vehicle might provide an option to look at a status screen associated with the vehicle (fuel, ammunition, high level built in test results, etc), where this status is available.

[11] Should the option to transmit a sight image as part of the target report be available, the confirmation action could be based on selection of one of the recent associated images, or a text only option. Cancel would also be required. Default action on time out would have to be configurable, but may default to text.

List of symbols/abbreviations/acronyms/initialisms

ADVANCE	Advanced Vehicle Network for a Net-Enabled Combat Environment
AFV	Armoured Fighting Vehicle
BMS	Battle Management System
CF	Canadian Forces
DND	Department of National Defence
DRDC	Defence Research & Development Canada
DPI	Dots per Inch
FOV	Field of View
GPS	Global Positioning System
JIMP	Joint, Interagency, Multi-national and Public
LAV	Light Armoured Vehicle
MPOI	Map Position of Interest
NBC	Nuclear, Biological and Chemical
PA	Position Awareness
R&D	Research & Development
Tac SAV	Tactical Situational Awareness Visualization

This page intentionally left blank

DOCUMENT CONTROL DATA

(Security classification of title, body of abstract and indexing annotation must be entered when the overall document is classified)

1. ORIGINATOR (The name and address of the organization preparing the document. Organizations for whom the document was prepared, e.g. Centre sponsoring a contractor's report, or tasking agency, are entered in section 8.) Defence R&D Canada – Suffield P.O. Box 4000, Station Main Medicine Hat, Alberta T1A 8K6	2. SECURITY CLASSIFICATION (Overall security classification of the document including special warning terms if applicable.) UNCLASSIFIED (NON-CONTROLLED GOODS) DMC A REVIEW: GCEC JUNE 2010

3. TITLE (The complete document title as indicated on the title page. Its classification should be indicated by the appropriate abbreviation (S, C or U) in parentheses after the title.)

AFV Tactical Visualization Requirements

4. AUTHORS (last name, followed by initials – ranks, titles, etc. not to be used)

Chesney, R.

5. DATE OF PUBLICATION (Month and year of publication of document.) December 2010	6a. NO. OF PAGES (Total containing information, including Annexes, Appendices, etc.) 38	6b. NO. OF REFS (Total cited in document.) 6

7. DESCRIPTIVE NOTES (The category of the document, e.g. technical report, technical note or memorandum. If appropriate, enter the type of report, e.g. interim, progress, summary, annual or final. Give the inclusive dates when a specific reporting period is covered.)

Technical Memorandum

8. SPONSORING ACTIVITY (The name of the department project office or laboratory sponsoring the research and development – include address.)

Defence R&D Canada – Suffield
P.O. Box 4000, Station Main
Medicine Hat, Alberta T1A 8K6

9a. PROJECT OR GRANT NO. (If appropriate, the applicable research and development project or grant number under which the document was written. Please specify whether project or grant.) 12SH	9b. CONTRACT NO. (If appropriate, the applicable number under which the document was written.)
10a. ORIGINATOR'S DOCUMENT NUMBER (The official document number by which the document is identified by the originating activity. This number must be unique to this document.) DRDC Suffield TM 2010-240	10b. OTHER DOCUMENT NO(s). (Any other numbers which may be assigned this document either by the originator or by the sponsor.)

11. DOCUMENT AVAILABILITY (Any limitations on further dissemination of the document, other than those imposed by security classification.)

Unlimited

12. DOCUMENT ANNOUNCEMENT (Any limitation to the bibliographic announcement of this document. This will normally correspond to the Document Availability (11). However, where further distribution (beyond the audience specified in (11) is possible, a wider announcement audience may be selected.))

Unlimited

13. ABSTRACT (A brief and factual summary of the document. It may also appear elsewhere in the body of the document itself. It is highly desirable that the abstract of classified documents be unclassified. Each paragraph of the abstract shall begin with an indication of the security classification of the information in the paragraph (unless the document itself is unclassified) represented as (S), (C), (R), or (U). It is not necessary to include here abstracts in both official languages unless the text is bilingual.)

This document defines the requirements identified by the author for map based tactical situational awareness visualization in armoured fighting vehicles. It focuses on functionality that is directly required for the crew to fight the vehicle in direct contact with the enemy. The information displayed, options, and overall functionality are deliberately minimized to reduce cognitive burden associated with the interpretation of the information and to allow a robust user interface to be designed that is fully effective on a small format display. Functionality is further constrained to allow routine user interaction to be completely implemented on a resistive touch screen (single point capable) while the vehicle is in motion. The intent is to provide sufficient functionality to support the operation of small groups of vehicles (nominally up to four) in conjunction with dismounted soldiers. Command requirements beyond that level would require a more comprehensive battle management solution.

14. KEYWORDS, DESCRIPTORS or IDENTIFIERS (Technically meaningful terms or short phrases that characterize a document and could be helpful in cataloguing the document. They should be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location may also be included. If possible keywords should be selected from a published thesaurus, e.g. Thesaurus of Engineering and Scientific Terms (TEST) and that thesaurus identified. If it is not possible to select indexing terms which are Unclassified, the classification of each should be indicated as with the title.)

Vetronics; Armoured Fighting Vehciles; AFV; requirements; BMS; Battle Management systems; Situational Awareness; Tactical Visualization

Defence R&D Canada

Canada's Leader in Defence
and National Security
Science and Technology

R & D pour la défense Canada

Chef de file au Canada en matière
de science et de technologie pour
la défense et la sécurité nationale

DEFENCE DÉFENSE

www.drdc-rddc.gc.ca