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Joint Command and Control (JC2) capability development utilising a Modelling and Simulation Framework

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INTRODUCTION

The command, control and information warfare competency of Defence, Peace, Safety and Security (DPSS), an operating unit of the CSIR is using systems modelling and simulation in its Joint Command and Control (JC2) research.

JC2 encompasses systems from the air, land and maritime arms of services. A unique modelling and simulation framework has been developed. The framework is used as a platform to develop prototype consoles to experiment with Ground-Based Air Defence Systems (GBADS) concepts: situational picture management; data and sensor fusion; user interaction; tactical simulation; incident management; and system interoperability.

An overview of a live simulation during the development of a pedestal sensor system [OSS, Image Processing group]

Applications developed with the framework can be executed and distributed over multiple hosts through a proprietary internal publish-subscribe backbone. The result is the speeding up the simulation of command and control (C2) equipment and systems. Applications developed with the framework enable interoperability among distributed (i.e. not at the same location) Command and Control applications. Interoperability is achieved by supporting the native protocols of the Command and Control systems and being able to translate between them.

The next generation of C2 applications are expected to be web-based (or follow a service-oriented architecture). Common sets of enterprise middleware would enable integration of these next generation C2 applications, but enterprise middleware does not address interoperability with existing (or legacy) C2 applications nor does it address interoperability with existing and future tactical systems (like fighter aircraft).

Applications developed with the framework enable tactical systems to communicate with each other and with the C2 enterprise as well as filling gaps in the command and control deployment (i.e. modelling systems and equipment that are not available or maybe do not even exist yet).

The framework also employs a third party visualisation component, Sentience, for 2D and 3D display, which is developed in the Optronics competency area of DPSS.

By combining the framework with a 2D/3D visualisation component and a third party graphical user interface, a complete application development platform is created where researchers can experiment with new ideas and concepts.

Developing a framework "in-house" allows flexibility and full control of the development cycle.

Applications developed with the framework have proved to be extremely successful during SANDF field exercises. Within the command and control domain, field exercises provide optimisation opportunities to the system and process.

VIRTUAL GBADS DEMONSTRATOR (VGD) SIMULATION

During the early development phase of the framework, a GBADS simulation was created to simulate static ground-based weapons on a systems level with real or simulated threat engagements. The focus is on simulating the respective entities within a GBADS environment and evaluating the higher system level requirements. A live link to a radar system allowed fire control to be exercised in which an operator virtually engaged real aircraft. **Figures 1** and **2** show the GBADS 3D visualisation with an aircraft attacking a defended asset (left) and being fired upon by the defending weapons (right).

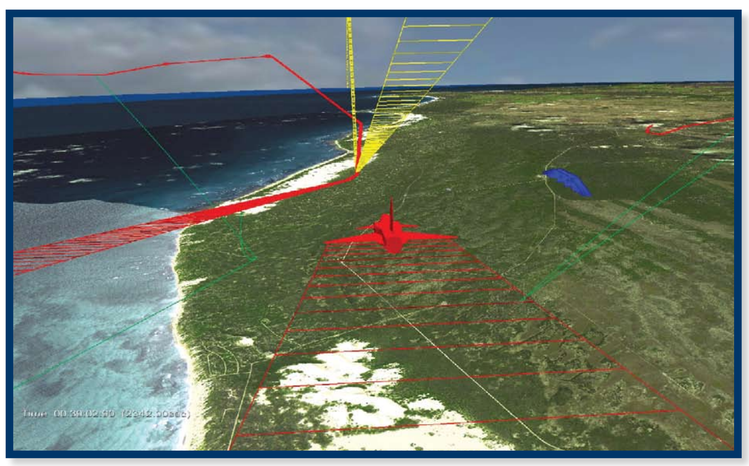

Figure 1: Aircraft attacking defended asset

INTEROPERABILITY DEVELOPMENT ENVIRONMENT GATEWAY

Through the establishment of an interoperability development environment (IDE) within DPSS, the CSIR has produced the IDE gateway, built with the framework. A significant part of the required communications between systems is experimented with within this IDE facility.

RADAR EMULATOR

A Radar emulator has been created to inject data into systems by adding emulation capability for sensors. The emulator has been used to link to unmanned aerial vehicles UAV, Gripen aircraft, frigate and radar from Reutech radar systems. The link to these sources highlights the joint capability of the M&S framework to link to live systems and increase situation awareness.

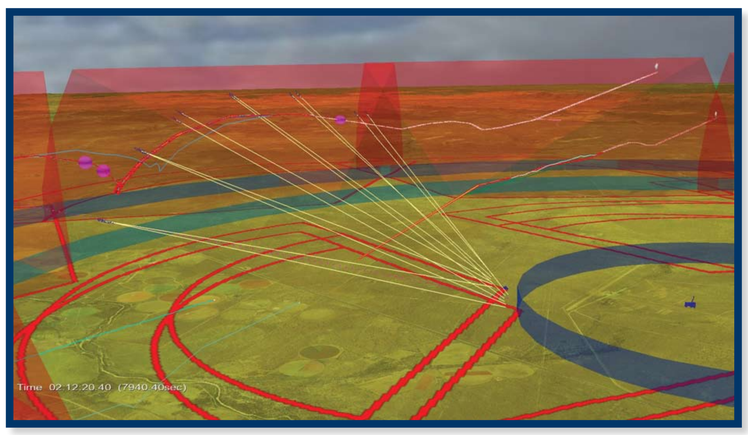

Figure 2: GBADS Weapons engaging threat aircraft

JOINT OPERATIONS OPERATORS CONSOLE (JOOC) SYSTEMS MODELLING

Joint command and control comprises a combined utilisation of systems from multiple sources. The elements of hardware systems, software systems and human thought all needs to be collected and presented in a manner that aids the decision-makers. The framework is evolving constantly to cater for new requirements that include user interaction and fusion to evaluate JC2 concepts. Situation awareness and (automated) decision support are key components within a command and control system. The JOOC has begun to experiment with concepts towards aiding the commander's decision-making process. Automated decision support, as well as user interaction and human reaction, has been evaluated. **Figure 3** shows the console developed.

Figure 3 - Joint Operations Operators Console

MISSION SIMULATION FRAMEWORK 2

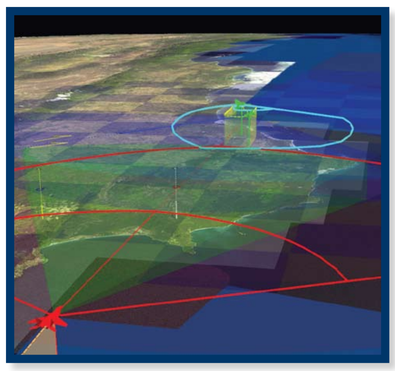

Figure 4 - CSIR Aeronautics Mission Simulation Framework 2

A tactical simulation tool used to evaluate new tactics and operations for the Gripen aircraft acquired by the SANDF. This tool is an aeronautics competency of the CSIR. DPSS utilised the M&S framework showing its versatility and capability. **Figure 4** shows one of the scenarios using the tool where a threat aircraft is approaching a pair of Gripen aircraft on patrol.

UAV INTEGRATION

Figure 5 - Denel Seeker UAV Integration

Unmanned aerial vehicle integrations have been demonstrated by linking via the M&S Gateway to the UAV ground station that links to the actual UAV. The Denel seeker UAV track was injected into the South African Air Force (SAAF) air picture display system (APDS) via the radar emulator (see the radar emulator section) and into the JOOC (see the JOOC section). This demonstrated the feasibility of flying civilian and military UAVs in civilian controlled airspace, mitigating some of the fears of flying UAVs as part of everyday life. **Figure 5** shows the JOOC display and the Denel seeker UAV used in the integration that was held within the IDE environment at the CSIR.

A systems Modelling and Simulation (M&S) capability is continuously being developed in support of JC2. The resultant M&S framework provides a versatile and powerful platform for demonstrating M&S, interoperability and application prototype development within the South African National Defence Force (SANDF) environment.

INCIDENT MANAGEMENT

The recent hosting of large football tournaments in South Africa (2009 Confederations Cup and 2010 Soccer World Cup) brought on the need for an incident management tool to be prototyped for experimentation purposes. The incident tracker displays a live air picture via the use of the IDE Gateway is used to log incidents and allocate resources to an incident. **Figure 6** shows the incident tracker air picture with an associated incident example.

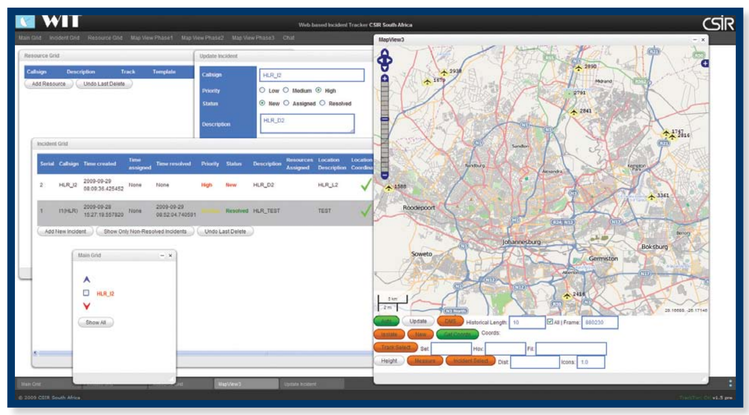

Figure 6 - Web Based Incident Tracker

REFERENCES

1. Duvenhage, A., Kourie, D.G. & Hancke, G.P., 2009. Layered distributed simulation architecture to support the C2 enterprise. SISO (Simulation Interoperability Standards Organisation) Fall SIW 2009. Orlando, USA. 21-25 September 2009. p. 1-15.
2. Le Roux, W.H., 2008. Modelling and simulation-based support for interoperability exercises in preparation of 2010 FIFA World Cup South Africa. Science Real and Relevant: 2nd CSIR Biennial Conference, CSIR International Convention Centre Pretoria, 17 & 18 November 2008, pp 1.
3. Ramadeen, P., Duvenhage, B. & Duvenhage, A., 2009. Effectively utilising a 3rd party 3D visualization component in a discrete event simulation environment for Joint Command and Control (JC2). Fall Simulation Interoperability Workshop 2009, Orlando, Florida, 21-25 September 2009. pp 1-12.
4. REUTECH RADAR SYSTEMS, WWW.REUTECH.CO.ZA, Accessed July 2010.

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