

Modelling and simulation-based support for interoperability exercises in preparation of 2010 FIFA World Cup South Africa™

WH LE ROUX

CSIR Defence, Peace, Safety and Security
PO Box 395, Pretoria, 0001, South Africa
Email: whleroux@csir.co.za

INTRODUCTION

With less than 650 days to go until the first kick-off of the 2010 FIFA World Cup South Africa, the safety and security of everyone is paramount. All South African departments, agencies and institutes that are part of the team to ensure a safe and successful event, are busy with preparations. Some of these include exercises at the provincial disaster management centres and involve multiple role players. Important aspects of such exercises are the training of personnel, fine-tuning of drills and procedures and the element of surprise. The latter is necessary to ensure effective training. The CSIR was involved in such an exercise - Operation Greenpoint 208. It stretched over 10 days with the actual exercise during the last three days. The CSIR has been supporting the South African National Defence Force (SANDF) with joint command and control development over a number of years with its modelling and simulation capabilities. 'Blue' and 'Red' teams were used at Operation Greenpoint, and this is where the simulation capabilities of the CSIR came in very handy. Simulated aircraft attacks were 'injected' into the system by the Red team. All of this was done to ensure that the Blue team was up to scratch. This simulation capability was also used to support the SANDF, SAPS and other agencies to ensure that the different systems used at the exercise are interoperable at a technical level.

JOINT INTERDEPARTMENTAL AND MULTINATIONAL OPERATIONS

Efforts such as ensuring the safety and security of all involved during large events are typically led by an appointed agency or department, with the rest in a supporting role. In the military context, such efforts, or operations, are referred to as joint, interdepartmental or multinational operations (JIM Ops). Although 2010 FIFA World Cup South Africa is an international event, the security for the event is guaranteed by the South African government by means of the South African Police Services.

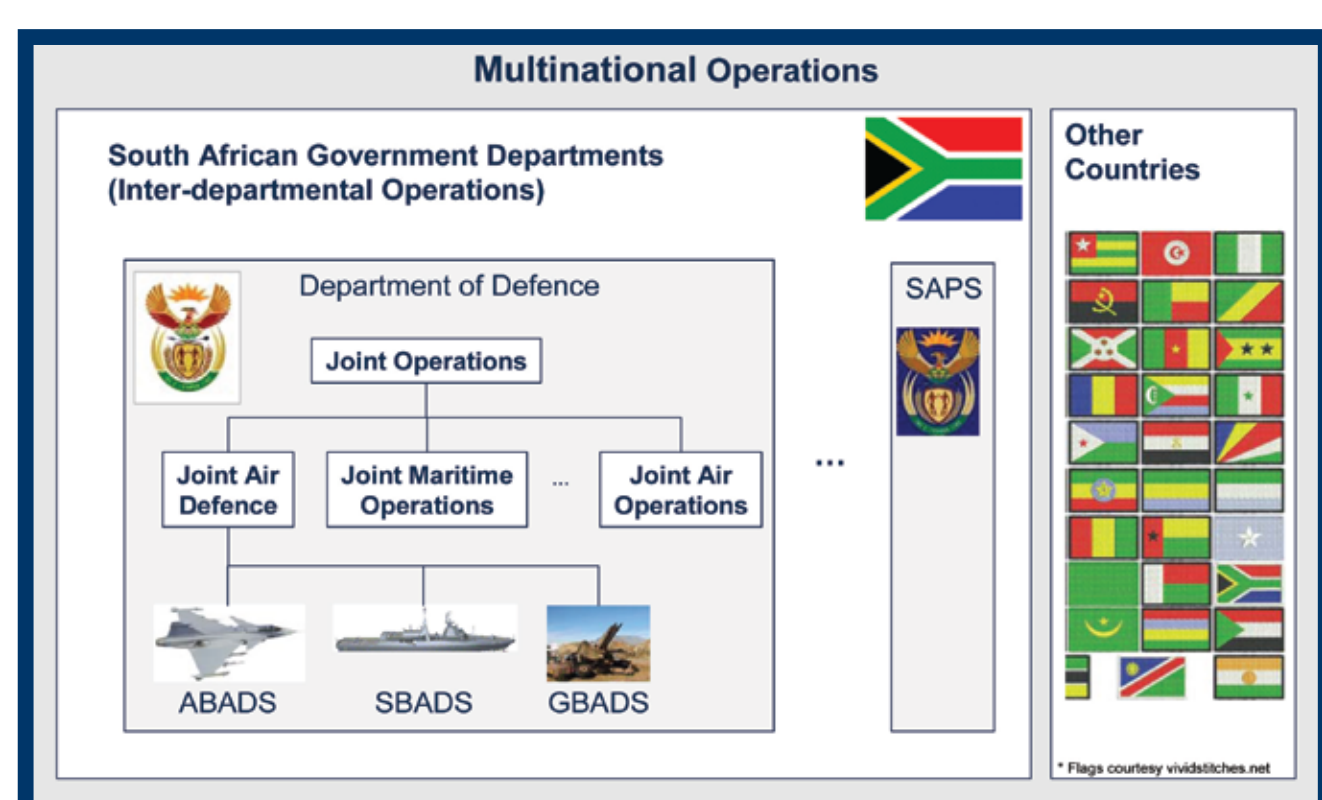


Figure 1: Joint, Interdepartmental and Multinational Operations

INTEROPERABILITY EXERCISES

A series of interoperability exercises are held in preparation of the 2010 event. To kick-start the exercises, air traffic control and air defence are used as initial 'missions'. Air Traffic Navigation Systems are responsible for civilian and commercial air traffic control, and the South African Air Force (SAAF) for military air space control. These agencies have interoperable processes and procedures, but with the inclusion of capabilities from the South African Navy (SAN) and South African Army (SAA), systems, procedures and processes have to be revised and extended. Civilian air traffic is controlled via a set of fixed sensor (radar) installation sites countrywide, which are also used by the SAAF. The SAN and SAA contribute in the form of additional sensors. These are flexible in terms of deployment, since at least one of the new Frigates will be deployed for events close to the coast (Durban, Port Elizabeth and Cape Town). The additional sensors are used to create a richer air picture for enhanced situation awareness within the commanding structures of the operation. In addition to air situation awareness, tracking of land-based, mobile resources are also done by the police, army and emergency services. These include tracking of individuals, both within vehicles or dismounted, or vehicles itself.

COMPUTER-AIDED EXERCISES

As large exercises are expensive, time-consuming endeavours, all avenues of assistance with planning, briefing, execution and debriefing are explored. Modelling and simulation can to some extent support these functions, especially if an infrastructure already exists that relates to the type of operation. The CSIR has been supporting ARMSCOR and the SANDF for a number of years with modelling and simulation capabilities in their acquisition programmes. An example is the procurement of a Mobile Air Defence System, used mainly by the SAA¹.

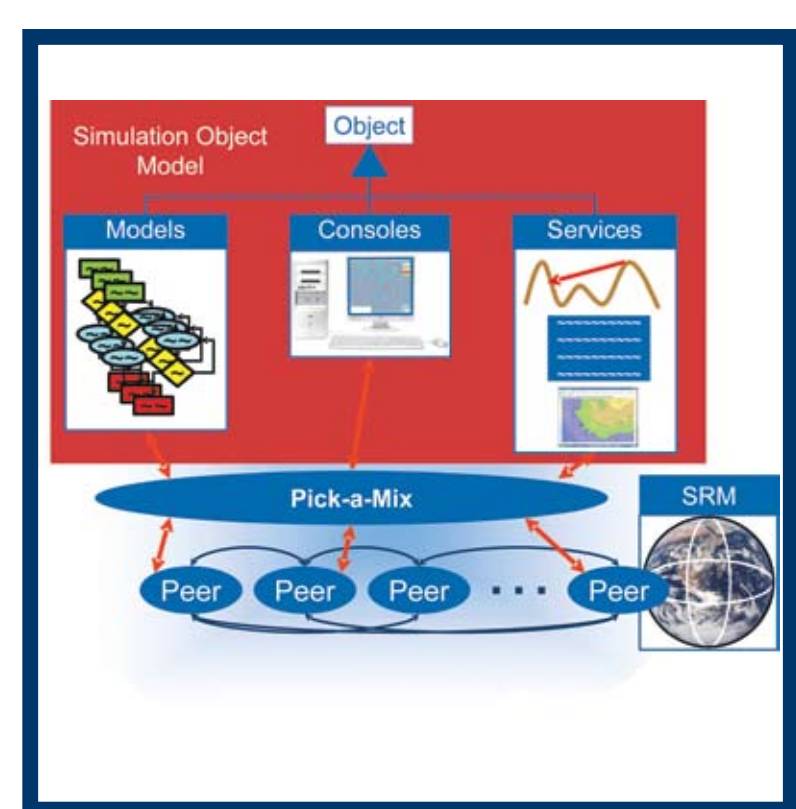


Figure 2: Peer-to-peer simulation architecture

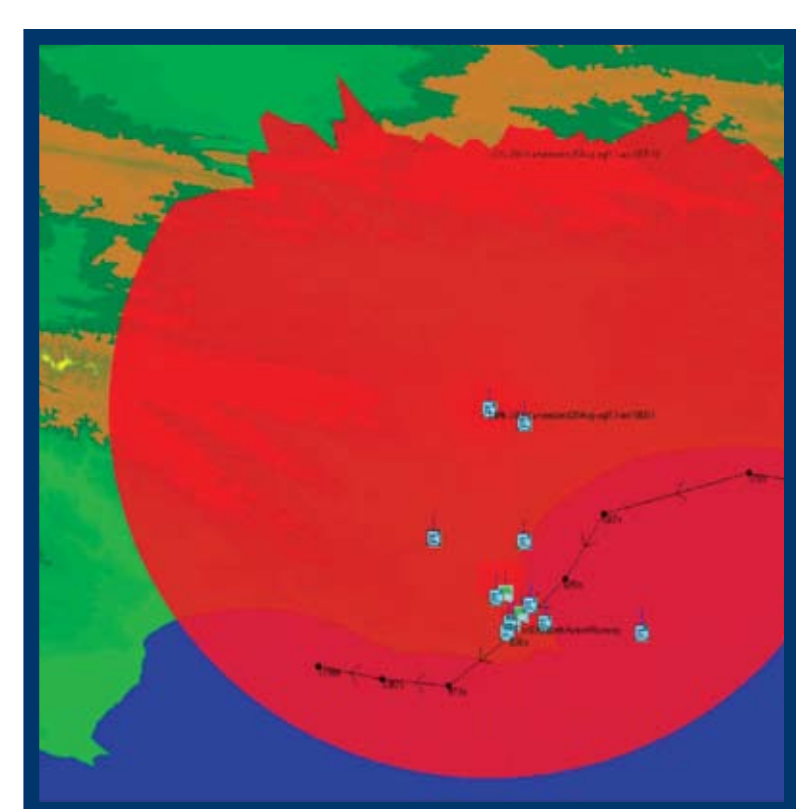


Figure 3: Two-dimensional scenario planner

During the CSIR's support to the SANDF, a simulation infrastructure was established with several peripheral tools that enabled the CSIR to also support the SANDF with their field exercises. The infrastructure comprises a real-time, distributed simulation environment^{2,3}, capable of supporting multiple entity models executing at an update rate of 100Hz, a two-dimensional (plan-view)

scenario tool with relevant Geographic Information System elements, and appropriate military symbology. **Figure 2** depicts the distributed simulation architecture and **Figure 3** the scenario tool. A line-of-sight map for a sensor is shown (red transparent area), based on the position of the sensor, the terrain elevation model and height of the object that line-of-sight is required to. A part of the infrastructure^{3,4} that enabled most of the computer-based exercise support, is a gateway⁵ between the simulation environment and real-life data sources, such as search radars. Coupled to the gateway, an entity injection service allows real-life entities, observed by real-life sensors, to be 'injected' into the virtual world, by means of data interpolation and extrapolation⁶. Once an entity has been injected into the virtual world, it can be engaged by other modelled entities. Human-in-the-loop simulation (virtual simulation) allows human operators to interact with virtual entities, both modelled and created by the injection service through the use of mock-up terminals. The gateway can route multiple connections, whilst at the same time, translate between different protocols.

Furthermore, filtering can be based on spatial, temporal properties or message content. Alteration of message content is supported as well. This allows for a very flexible integration 'tool'. Real-time, on-line data sources, such as Air Traffic Navigation System data (Johannesburg International), can be incorporated into simulated scenarios, to make for more realistic conditions, when using human-in-the-loop simulation.

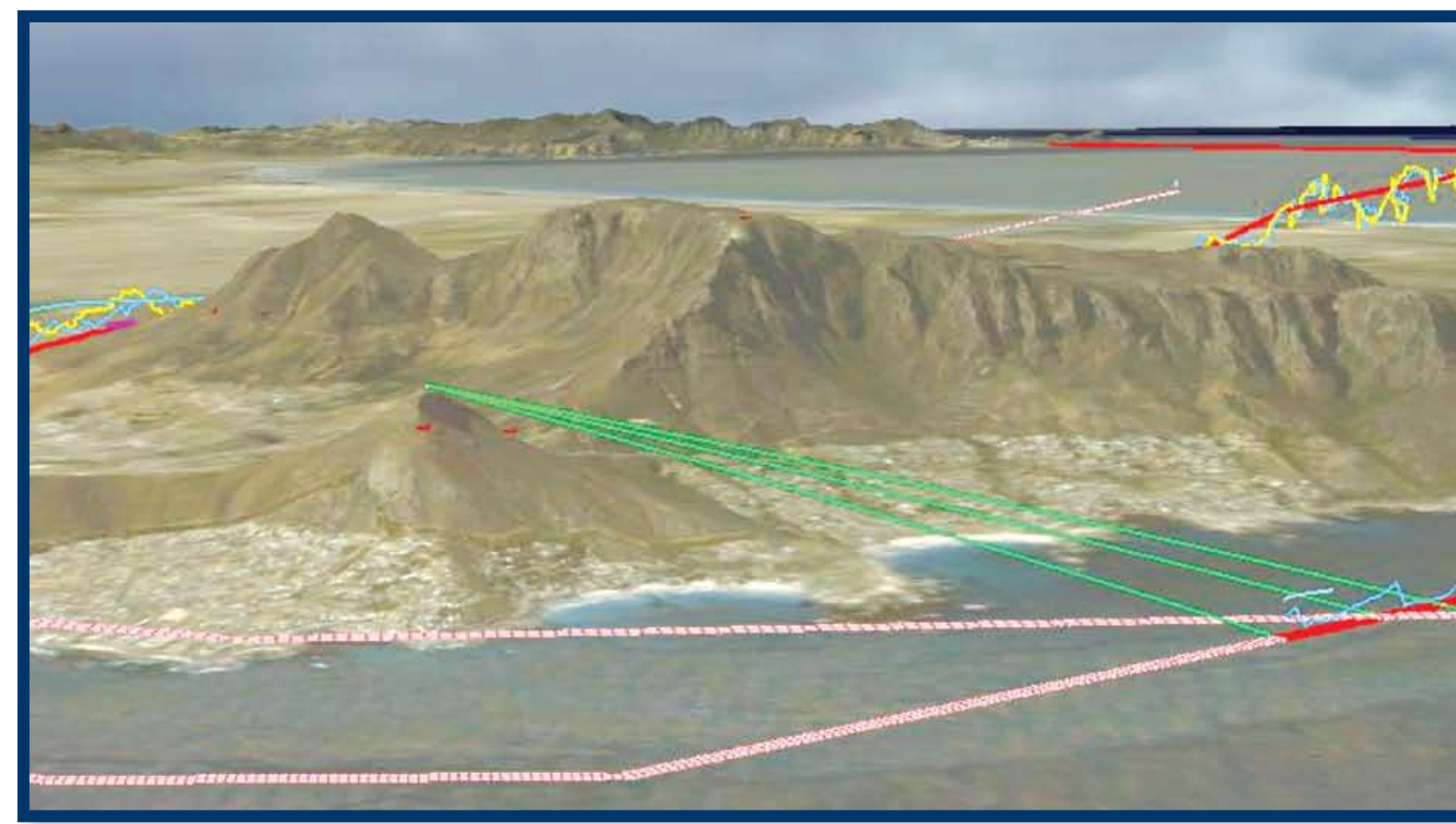


Figure 4: Three-dimensional analysis tool showing an example of a ground-based air defence scenario

Figure 4 highlights a fictional ground-based air defence scenario with deployed ground elements, defending the Green Point Stadium and Cape Town International Airport. Simulated observations of simulated aerial threats are also visualised. **Figure 5** shows entities from different data sources connected to the gateway.

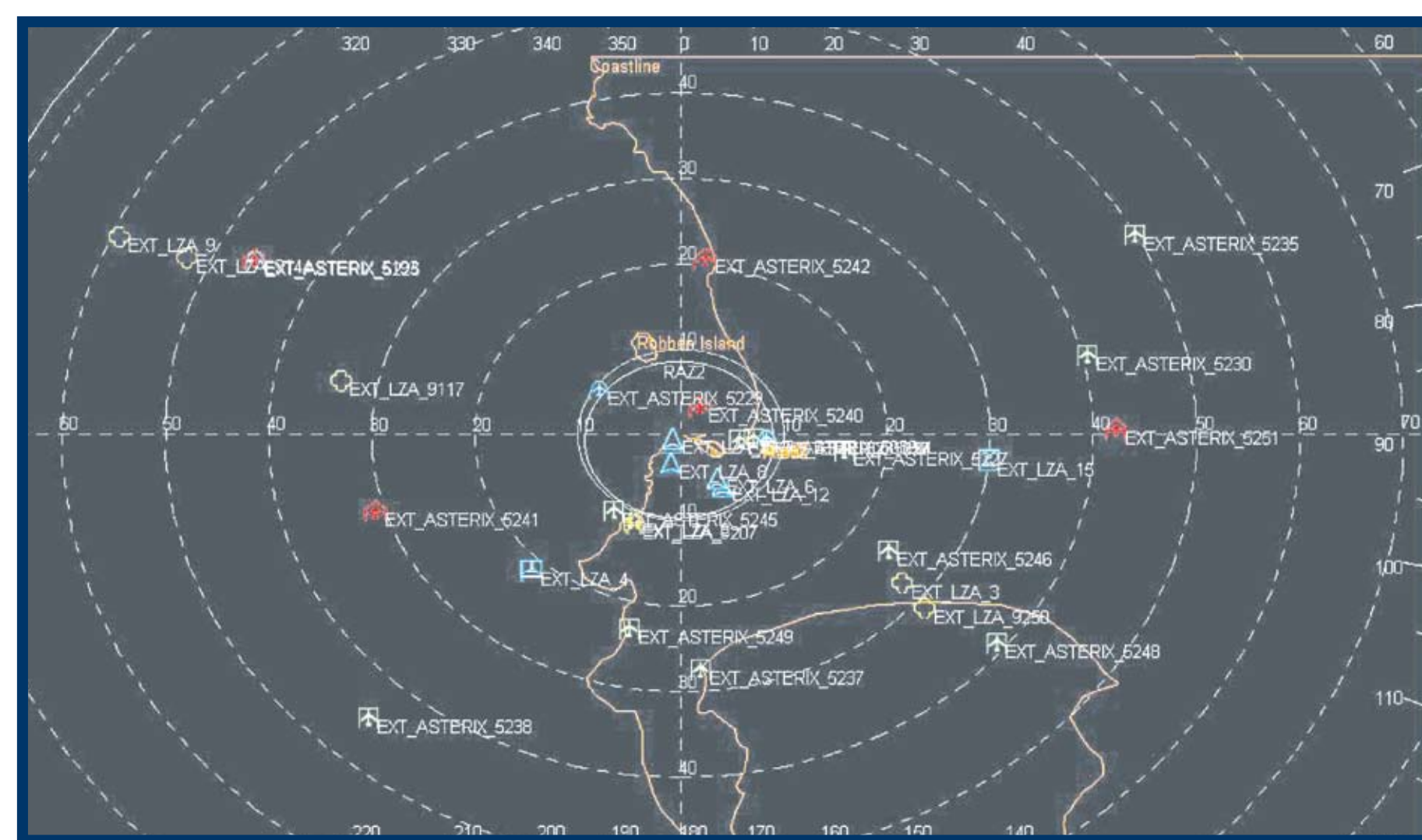


Figure 5: Entities transmitted to the gateway from different connected data sources

DATA MODELS

Different approaches exist for the integration of diverse data and information sources through the use of relevant protocols. In essence, information has to be exchanged in compliance with processes and procedures. Aspects such as situation awareness, information overload and decision-making nodes have to be kept in mind. Integration of legacy systems is not a trivial undertaking, therefore system developers continually strive to reduce this effort upfront – that is before systems are defined, developed and implemented. One such effort is to define the levels of conceptual interoperability⁶, and to take this into account when defining data models. Data models are domain specific, with the dilemma that if the model is too generic, the level of effort to describe entities with it, is a very cumbersome process. If the data model is too specific to a domain or sub-domain, it is difficult to extend the model to other domains. Well-defined data models facilitate the definition of new information exchange protocols.

An important data model in the military context, aimed at joint, interdepartmental and multinational operations is the Joint, Command, Control and Consultation Information Exchange Data Model (JC3IEDM)⁷. The model originated due to language barriers when exchanging military commands during combined and joint exercises between NATO countries. Adoption of the data model became so widespread that some countries are using it as their national data model. For large, concerted efforts between diverse domains, a common data model should be pursued. Data models, in essence, 'list' the world one wishes to describe, but in a standardised manner.

To help secure everyone's safety at the 2010 FIFA World Cup in South Africa, CSIR researchers are using simulations to integrate the different technical systems of the departments and agencies responsible for safety and security.

CONCLUSION

Modelling and simulation is an effective tool to support wide-ranging activities in diverse disciplines. It has successfully been used during exercises in preparation of the 2010 FIFA World Cup South Africa, specifically in support of the SANDF. Virtual threats have been injected into real-world systems, to prepare and refine processes for coordinated, complex exercises.

REFERENCES

1. BAIRD, H.J. & NEL, J.J., "THE EVOLUTION OF M&S AS PART OF SMART ACQUISITION USING THE SANDF GBADS PROGRAMME AS EXAMPLE," TWELFTH EUROPEAN AIR DEFENCE SYMPOSIUM, SHRIVENHAM, JUNE 2005.
2. LE ROUX, W.H., "IMPLEMENTING A LOW COST DISTRIBUTED ARCHITECTURE FOR REAL-TIME BEHAVIOURAL MODELLING AND SIMULATION," EURO-SIW, STOCKHOLM, 2006.
3. LE ROUX, W.H. & DUVENHAGE B., "A PEER-TO-PEER SIMULATION ARCHITECTURE," ECMS, PRAGUE, 2007.
4. DUVENHAGE, A., "EVOLUTION OF A COMMAND AND CONTROL GATEWAY," EURO-SIW, EDINBURGH, 2008.
5. DUVENHAGE A. & LE ROUX, W.H., "A STATE ESTIMATION APPROACH FOR LIVE AIRCRAFT ENGAGEMENT IN A C2 SIMULATION ENVIRONMENT," FALL SIW, ORLANDO, 2007.
6. TOLK, A., MUGUIRA, A., "THE LEVELS OF CONCEPTUAL INTEROPERABILITY MODEL," FALL SIW, ORLANDO, 2003.
7. MULTI-LATERAL INTEROPERABILITY PROGRAMME, WWW.MIP-SITE.ORG, ACCESSED JUNE 2008.