

AwareNet: Persistent, ubiquitous surveillance technologies for enhanced national security

CSIR Defence, Peace, Safety and Security

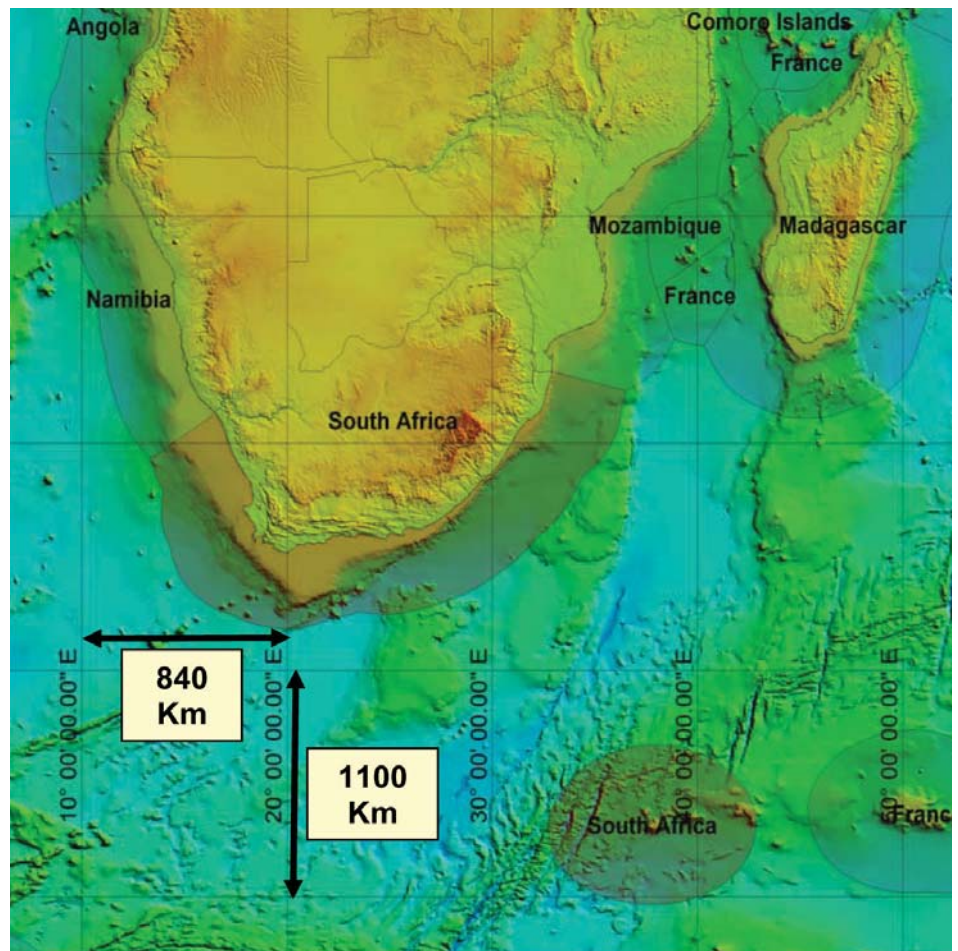
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The challenge

South Africa, like other countries, faces the challenge of protecting its territory and its people against activities such as illegal border crossings, organised crime, weapons trafficking, smuggling, piracy, poaching and terrorism on land, at sea and in the air. It is usually difficult to detect and monitor perpetrators and act against them as they often choose to operate at night, in bad weather or in areas not under surveillance. Others conceal themselves amongst citizens pursuing lawful activities in order to gain an advantage on their victims and/or the security forces.

South Africa has a land area of 1,2 million square kilometres, a maritime economic exclusion zone (EEZ) of 1,5 million square kilometres and an air space covering both these areas. The land borders span 4 862 km and the coastline 3 924 km. However, the country's assets available for monitoring and securing this vast area and its borders are relatively small, resulting in an unfavourable force-to-space ratio. This situation makes it relatively easy for criminals to conduct their crimes undetected and with impunity.

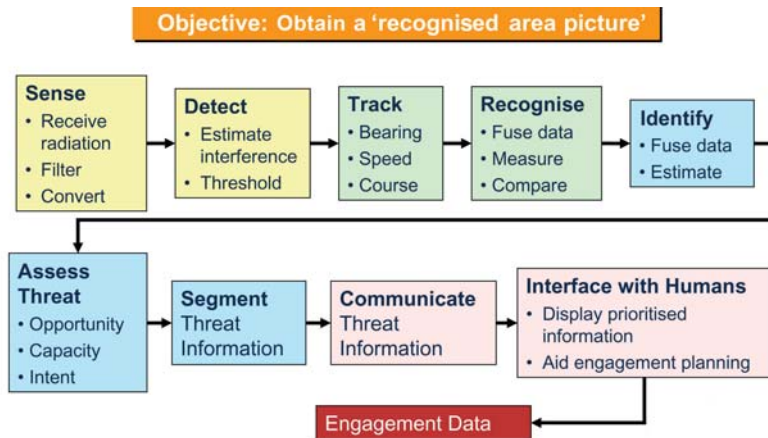
The New Programme for Africa's Development (NEPAD) identifies the establishment and maintenance of peace, safety and security as prerequisites for



Topographic map of southern Africa indicating South Africa's EEZ, including that around the Prince Edward Islands group. Ideally, persistent, ubiquitous surveillance is required over large parts of the South African land border areas, air space and maritime zones.

sustainable development in Africa. This motivates the South African government to deploy its security forces not only inside South Africa, but also in various countries in Africa as part of peace support

operations mandated by the African Union and the United Nations. This makes the challenges faced by our security forces even more daunting.



Functions required to provide persistent and ubiquitous surveillance over large areas with richness and reach.

New technology trends

What can South African science and technology (S&T) do to support the state's agencies tasked with establishing and maintaining peace, safety and security under these conditions? Is it possible to use a mixture of existing and new remote sensing technologies, judiciously combined to provide real-time situational awareness and, through that, a force multiplication effect that would enhance the efficiency and effectiveness of our intelligence agencies and security forces?

Internationally, technology trends in the field of persistent ('all the time') and ubiquitous ('everywhere at once') surveillance offer exciting possibilities in this regard. They are being developed to provide situational awareness by means of an integrated system of systems. The ultimate objective of these systems is to provide real-time information with unprecedented richness and reach.

The richness is achieved by tightly integrating a variety of new-generation, high-performance sensors mounted on elevated platforms in order to provide wide area coverage. This forms an information network, fusing sensed data and extracting enriched information regarding the situation and the way in which it is developing, by combining the individual strengths of various types of sensors deployed at optimum positions in the area of interest.

The reach is achieved by segmenting the resulting information into classes of interest to various user groupings and by providing only that part of the real-time information that is important to each user group in a way designed to optimise its assimilation and use by its commanders. In this way, optimum decision making is enabled regarding the actions to be taken by their respective forces.

Performance that was until recently limited to the domain of science fiction, films and computer games, is becoming feasible by exploiting the exponential increase in performance of modern digital information and communications technology (ICT) and digitised sensors. For this reason this type of system is being referred to as 'digital surveillance' in the non-military environment or as the information, intelligence, surveillance, target acquisition and reconnaissance part of the 'digital battlefield' in the military world.

The AwareNet research and development programme

Since 2003 the CSIR has been involved in developing some of the key elements of a S&T capability based on international technology trends in persistent, ubiquitous surveillance. This is referred to as the AwareNet programme.

Five main technological areas have been identified as underpinning the required capability and innovations.

These are:

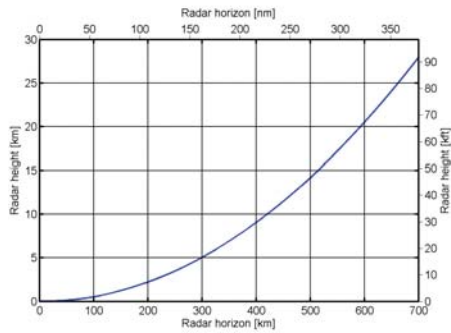
- Elevated, geostationary, long endurance platforms such as tethered aerostats and unmanned airships
- Radar sensors
- Electro-optical sensors
- Radio frequency surveillance sensors
- Data fusion, intent estimation and information extraction algorithms.

Initial work performed at the CSIR allowed researchers to identify a number of important research questions in each of these areas. Some of these relate to new knowledge that is needed in each of these fields. Others address the adaptation of existing S&T to provide solutions for the unique combinations of the natural environment and the operational tasks required by security forces and services in southern Africa.

In the fields of the sensor and data processing subsystems, avenues of inquiry relate to the:

- Detection of entities of interest over wide areas of coverage under naturally occurring propagation conditions while suppressing unwanted clutter and false target detections
- Tracking of all detections and the measurement of the positions and movements of the entities of interest with the required resolution, accuracy and update rate
- Semi-automatic estimation of the class and, if possible, the identity of each tracked entity
- Analysis of the behaviour of each entity over time
- Estimation of the probable intent of each entity, based on all of this
- Determination of the level of threat posed by each entity.

Slowly changing information from geographic information systems, intelligence databases and weather sensors (which provides the context and thereby enhances the extraction of meaning from the sensed information) needs to be seamlessly integrated with each track. If data are available from external sources



The range to the horizon for a radar mounted on an elevated platform.

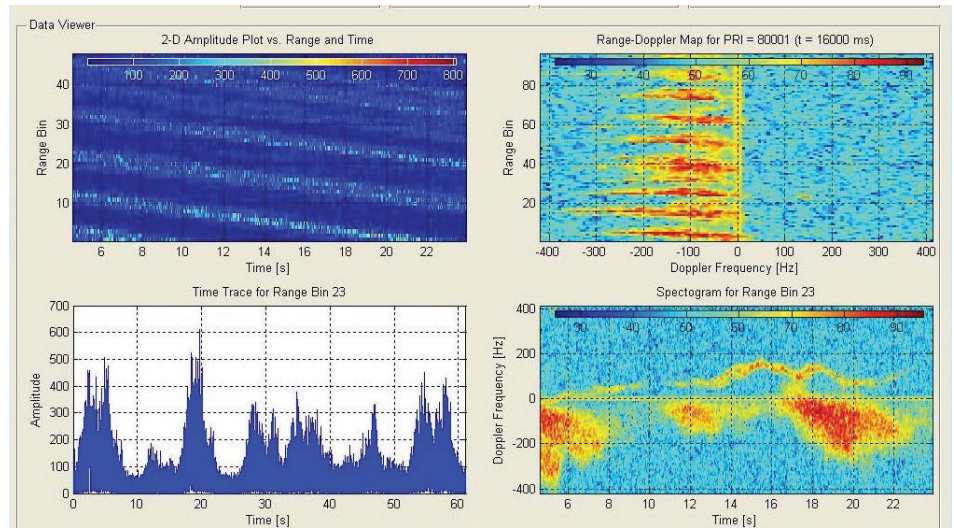
such as beacons, telemetry systems and satellite-based sensors, these need to be solicited and integrated in a way that enhances the probability of correct estimation of the level of threat posed by tracked entities.

Potential AwareNet users

South African users who may benefit from the foreseen AwareNet capability are members of the Justice, Crime Prevention and Security Cluster (JCPS) of government who collectively are responsible for national safety and security. They include the SA Police Service, the Department of Defence (SA Navy, SA Army, SA Air Force, Defence Intelligence and Joint Operations), the National Intelligence Agency, the Department of Transport, and Marine and Coastal Management of the Department of Environmental Affairs and Tourism.

Potential impact on South African S&T

Important elements of the underlying S&T knowledge, facilities and organisations required for the AwareNet programme are already well established in South Africa. This includes components of the National System of Innovation including universities, research institutions, test ranges, the aerospace and defence industry and some parts of the user community. The proposed expansion of the AwareNet programme is intended to refocus and expand these capabilities. The aim is an industrial cluster fostering South African economic growth, job creation and



Coherently processed data from the August 2006 radar measurement campaign indicating differences in the spectral signatures of a rigid inflatable boat and of heavy sea clutter. These may be exploited to design an efficient automatic target detection algorithm for a radar with long dwell times.



The Fynmeet radar measurement facility deployed at the Overberg Test Range to measure the radar characteristics of small boats in sea clutter during August 2006.

international competitiveness by means of innovations leading to a range of persistent ubiquitous surveillance products.

The next phase planned for the AwareNet R&D programme is the design, development, integration and testing of an integrated sensor level technology demonstrator on a mountain top in the Cape Peninsula. It will be used to validate and demonstrate the overall persistent, ubiquitous surveillance concept and its unique value proposition under realistic conditions. It will also be useful as an integrated measurement facility in support of further sensor-level research, as well as research at the level of the integrated sensing system,

including data fusion functions and algorithms.

Later stages of the AwareNet technology road map include technology demonstrators designed for longer ranges and optimised for the simultaneous surveillance of air, maritime and land border zones. It is foreseen that these will first be mounted on tethered aerostats and later on high altitude airships to achieve the desired 'over-the-horizon' performance.

The development and use of such a series of technology demonstrators should be large and prestigious enough to be regarded as a national S&T flagship programme in South Africa, thereby enhancing

the S&T status of the country internationally.

The applications and spin-offs of such a programme should be extendable to satisfy the needs of other countries and can therefore be developed into a cornerstone of regional and international collaboration.

The CSIR is currently playing an important role in South African engineering research, technology development and

human resource development. It has an advanced science and engineering infrastructure and a network of contacts with local and international universities, research organisations, industries and government agencies. The current AwareNet programme already makes use of this network to gain access to international knowledge and training opportunities. It is foreseen that the proposed expansion of the programme will provide inspirational examples of the application of modern science

and engineering, to attract young people in South Africa into these exciting and useful fields of study. The AwareNet programme will also provide attractive R&D opportunities to support human capital development at both undergraduate level (vacation work and final-year projects) and postgraduate level (Master's and PhD research) for those interested in developing professionally in these directions.



One of the potential sites identified for the integrated sensor level technology demonstrator/measurement facility. It is at the historic World War II radar station near the top of Karbonkelberg above Hout Bay in the Cape Peninsula. The line of sight coverage from here includes the approaches to Cape Town harbour, the beaches of Robben Island and the West Coast up to Saldanha Bay as well as an important part of the Cape Sea Route to the west and the south of Cape Town.

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