Experimentation Activities with Aerospace Ground Surveillance

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1 Abstract

The NATO Consultation, Command and Control Agency (NC3A) in The Hague, The Netherlands, was involved in 2004 in a set of laboratory and live experiments with Aerospace Ground Surveillance (AGS) sensor and exploitation systems. The experiments and some of the findings are described. Based on collected experience, recommendations are provided for usage of Standardisation Agreements (STANAG) and simulations of ground tracks.

2 Laboratory Experiments

2.1 CAESAR

The Coalition Aerial Surveillance and Reconnaissance (CAESAR) project was initiated by seven nations in 2002: Canada, France, Germany, Italy, Norway, the United Kingdom, and the United States. The tasking of CAESAR was to exploit the military utility of interoperable ground surveillance resources. Interoperability was achieved through development and demonstration among the different nations. The CAESAR nations tasked NC3A in The Hague, The Netherlands, to provide technical management and expertise to help achieve the goal of coalition interoperability.

The CAESAR project's main emphasis was to enhance the current system capabilities, to improve interoperability of the various Aerial Ground Surveillance and Reconnaissance (AGS&R) systems, to develop operational procedures and to integrate new capabilities into existing processes. Interoperable Coalition Ground Surveillance is not feasible without an agreed Concept of Operations (CONOPS) and Tactics, Techniques and Procedures (TTP). This approach covers operational, procedural and technical interoperability. The plan was to achieve this by developing and evaluating technologies for the integration of diverse Ground Moving Target Indications (GMTI) and Synthetic Aperture Radar (SAR) platforms, by maximising the military utility of surveillance and reconnaissance resources and by optimising data collection and exploitation of GMTI/SAR assets.

2.2 Technical Interoperability Experiment

NC3A and the CAESAR nations provided equipment and personnel to participate in working groups and exercises that were focused to identify and solve problems. The CAESAR community conducted a Technical Interoperability Experiment (TIE) in October 2004 to improve technical interoperability. The exercise was based on a combination of simulations and provided the basis for analysis of the use of NATO STANAGs. The exercise took place in a set of laboratories at NC3A in The Hague, The Netherlands. The exercise started with a two day build up on 4 October and lasted until 15 October. The objectives of the tests and the procedures for conducting the tests were laid down in a detailed test plan. CAESAR has also been conducting simulation exercises (SIMEX), during which operators developed and tested CONOPS and TTP. The SIMEX 2003 exercise is described in [Kreitmair and Ross 2004]. The planning aspects for joint coalition Intelligence, Surveillance and Reconnaissance (ISR) assets are described in [Mahaffey 2004].

2.3 Participants

Figure 1 below sketches schematically the participating systems. The capabilities of the various systems are described in [Coalition 2004] and will not be discussed further in this paper. Eight AGS sensor systems in the TIE provide accurately simulated representations of operational capabilities. Some of the systems use operational software to support the sensor simulation. The ground stations and/or exploitation stations, in most cases, are represented by operational equipment.
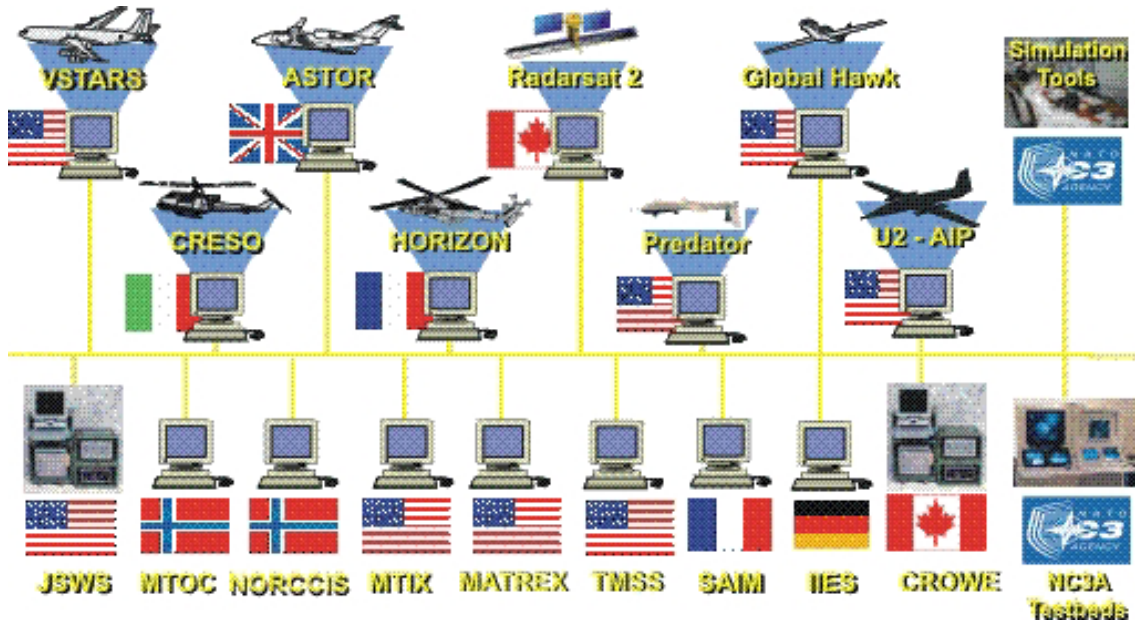

Figure 1 CAESAR TIE 2004 participating systems

2.4 TIE objectives

The TIE objectives included amongst others:

- Compliance verification of the different system's implementation of NATO STANAGs
- Retrieval of near-real-time and historical ISR information from on-line ISR Product Libraries (IPL), employing multiple STANAG 4559 based CAESAR Shared Databases (CSD). The CSD IPLs contained GMTI, SAR images, Link 16 products and Collection and Exploitation plans.
- Usage of a collaboration tool within the exercise architecture for instant messaging across the various national systems
- Evaluating tools to support the Theatre Collection Manager for planning and execution of the ISR collection.
- Track management for ground tracks.

2.4.1 STANAGS

The following STANAG were applied

- STANAG 4545 NATO Secondary Imagery Format for SAR images
- STANAG 4559 NATO Standard ISR Library Interface for accessing CSD

- STANAG 4607 Ground Moving Target Indicator Format for GMTI
- A subset of STANAG 5516 NATO Link 16 messages, mainly J3.5 ground tracks

The details of the formats can be found in the relevant publications such as [STANAG 5516]. For AGS applications, STANAG 5516 is focused on track data, in particular J3.5 ground (land) track/point message, J3.2 air track messages, Precise Position Location Information (PPLI) for air and ground tracks (J2.2 and J2.5 messages) and some related messages, such as the J7.0 track management message. Therefore, only a small subset of the complete STANAG 5516 was tested.

Figure 2 below describes the node connectivity of the simulation architecture. The simulation generator sends Distributed Interactive Simulation (DIS) Protocol Data Units (PDU) to the AGS sensor simulations. Depending on their particular capabilities, they will send GMTI in STANAG 4607 format. If they produce tracks onboard the AGS sensor platform, they send track data according to STANAG 5516. If the ground stations produce tracks, they will also use STANAG 5516. All AGS sensors, ground stations and exploitation stations connected to the track data network use STANAG 5516. All ground stations and exploitation stations connected to the Exploitation data network use and STANAG 4607 for GMTI. In this exercise, SAR images were sent as a pixel stream in NATO EX 2.1 format to dedicated ground stations. In coming exercises, the plan is to apply STANAG 4545 for SAR and other images. STANAG 4545 will also be used to directly populate the CSD with images.
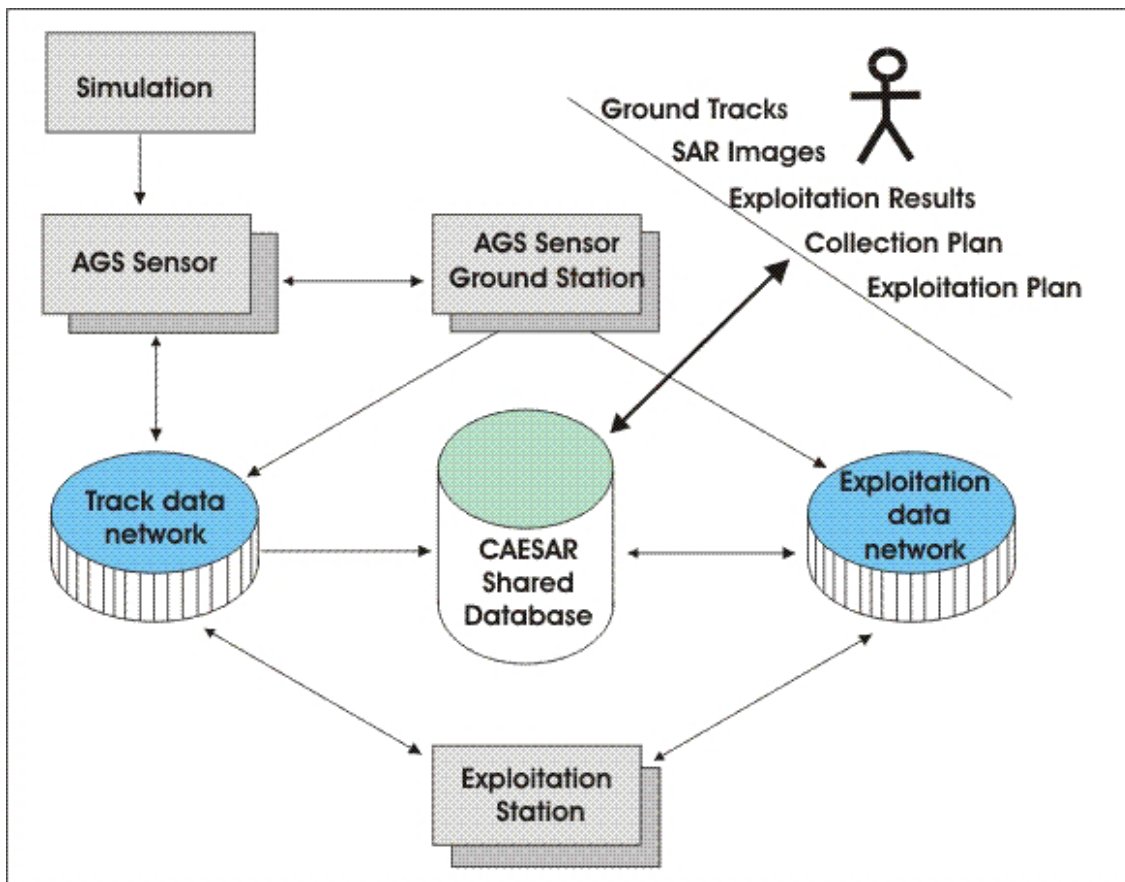

Figure 2 Node Connectivity Description TIE 2004

The access to the CAESAR Shared Database is controlled according STANAG 4559. The ISR products exchanged with the CSD are in accordance with STANAG 4607 for GMTI,

NATO EX 2.1 for SAR and images. For track information and collection plans, the products were formatted as Extensive Markup Language (XML) documents, conforming to CAESAR developed XML schemas.

With the interoperability achieved within the CAESAR community, it is for example possible to have a British and French GMTI sensor (e.g. Airborne Stand-off Radar (ASTOR) and Hélicoptère d'Observation Radar et d'Investigation sur Zone (HORIZON)), feed their GMTI data into the US tracking system (e.g. Motion analysis, tracking and exploitation (MATREX) or Moving target indicator exploitation (MTIX)), and display GMTI, and tracks produced by a US -tracker on a Norwegian Exploitation System (e.g. Mobile Tactical Operation Centre MTOC). In addition, a SAR image of Global Hawk might be overlaid on the display. This is made possible by employment of STANAG regulated formats, and extensive testing of each systems compliance with the STANAGs.

STANAGS and Database Access

It was found that all users which had implemented STANAG 4607 had some difficulties. Most of them were minor problems, erroneous implementations or wrong formats. These mistakes were recorded, a lot of them repaired during TIE. STANAG 4607 has some technical errors, which were reported to the STANAG custodian. For example, the STANAG contains two conflicting descriptions of coordinate representations (negative latitude and longitude angles), causing interoperability problems between different systems if they chose to represent these co-ordinates differently. These problems will be fixed in the new edition of the STANAG. More difficulties were caused by transmission of STANAG 4607 over User datagram protocol (UDP). This problem (which is not a problem with the STANAG 4607 format) is caused by the limited size of UDP packages, forcing the 4607 producers to split their messages over multiple UDP packages. Different policies for splitting 4607 messages over multiple UDP packages were employed causing problems for the 4607 consumers. The result of these problems was that the consumers typically were only able to receive GMTI from some of the producers (sensors). This problem was under discussion among the participants for almost the whole TIE. Finally, a recommendation was forwarded to the STANAG 4607 custodian proposing this recommendation to be incorporated in the Allied Engineering Documentation Publication (AEDP) for the STANAG (this transmission challenge over UDP is not a STANAG issue, and hence the "solution" is instead described as a recommended practice in the AEDP). In summary, STANAG 4607 was found useful, applicable, but not perfect and with room for improvements.

The majority of the simulated SAR sensors were disseminating their SAR images as pixel streams according to the NATO Ex v2.01 format. These streaming images were automatically captured by software agents residing with the CSD (STANAG 4559 based) and converted to STANAG 4545 image files and then published through the CSDs. One particular sensor system (the Canadian RADARSAT II system) was directly ingesting their SAR images as STANAG 4545 files into the CSDs. After the images were published in the CSD, CAESAR systems would be notified about the new images if they had made subscriptions to the CSDs, or they could (periodically) poll the CSDs for these images. The STANAG 4545 images in the CSDs could be ordered "as is", or the CAESAR systems could order smaller image chips through the "Alteration Service" of the CSD to retrieve only the essential part of the image. Ordering chips were particularly useful for network topologies with low bandwidth between the CSD and the client system since the smaller image is transmitted a lot quicker.

For tracks reported in STANAG 5516, there were no errors observed during TIE. STANAG 5516 is, in the AGS application, focused on track data, in particular J3.5 ground (land) track/point message. Therefore, only a small subset of the STANAG 5516 was tested. Also,

STANAG 5516 was tested previously, and format compliance checks had been performed during previous tests.

In summary, the various system implementations of the STANAGs have various maturity levels, not all of them are ready for operational use.

Collaboration tool

The collaboration tool selected for instant messaging across the various national systems was Jabber. Basically, Jabber is a Client/Server system exchanging XML packets and documents. In most of the cases, only a small effort was needed to include the tool. Bandwidth utilization, latency and reliability do not cause problems. However, the chosen Jabber client program for TIE (entitled PSI) might be suitable for software programmers, but its "look and feel" is not optimal for military users in the current form. The tool proved useful to exchange tactical data, planning results, information requests as well as target and status reports.

Since the exercise, NC3A has adapted a different client program (entitled Smack) for a more operational look and handling. In a short statement, collaboration tools are very useful when operationally adapted. With the improvements since the TIE, the operational acceptance in the next exercise is expected to be significantly better.

Tools to support the Theatre Collection Manager

The Theatre Collection Manager (TCM) has the task to plan and monitor execution of ISR collection. For various single national systems, tools are available which support this. The TCM support tool should include the capability to create, store, disseminate and adjust Collection and Exploitation Plans. It should also have the capability to report and display status information of national systems and the ability to detect changes in status of the different systems. However, there is no multi-national, joint multi-sensor ISR planning tool currently available. In addition, the exploitation work necessary after data collection is hardly covered in any known tool. This kind of tool still needs yet to be developed and is currently missing for multi-national, joint ISR collection.

Track management for ground tracks

Track in this context means J3.5 land (ground) track/point messages.

Tracking of ground tracks is already difficult, because of the nature of the target and its possible manoeuvres. The target characteristics can also be quite different, for example from a single vehicle to a train with a few kilometres of length. What is the right spot to mark the position of the track; the head of the train or the middle of the train?

If air tracks reduce altitude and speed and finally disappear, there is a high chance that the air object represented by the track has landed, by own intent, or was landed by intercept and does not exist as an airborne object any more. If ground tracks reduce speed, they may stop, but the ground based object represented by the track still exists as a ground based object.

Track management across multiple ground track producing systems was noticed during the TIE as a difficult problem, a solution in the short term seems not to exist. The problem appears, when multiple ground tracking systems are available with overlapping or neighbouring track production areas. One of the obvious reasons is that the various tracking systems were developed with a clear focus on the tracking itself, as stand-alone trackers. So the trackers are not designed to communicate with other trackers concerning track numbers, hand-over for track continuation or to accept track management messages from other trackers. If airborne systems with on-board tracking leave their orbit, all the track history goes with them. Another airborne platform taking over the ISR collection task for the same area has to develop all tracks and the track history completely from scratch. Now that interoperability is

more and more achieved for ground tracks, and multiple AGS sensors and tracking systems become available, this kind of problem appears. There is no obvious short term remedy. Some basic research is required. This is, for multi-national joint operations, a serious operational problem.

3 Live Experiments

3.1 JTIDS Operator Tactical Meet (JOTM)

The community of Joint Tactical Information Distribution System (JTIDS) operators planned a live flying exercise to test and improve interoperability. The exercise was called JTIDS Operator Tactical Meet (JOTM) and conducted in September 2004. After some hard- and soft-ware upgrades of NATO Airborne Early Warning and Command (NAEW&C) E-3 aircraft and other systems, the use of land (ground) track messages and new procedures, for example time sensitive targeting, had to be tested. NC3A was tasked to provide ground tracks, as no other system e.g. the Joint Surveillance and Target Attack Radar System (JSTARS) was available. NC3A was in the position to provide ground tracks based on previous CAESAR work, previous live exercises and the laboratories and equipment available at NC3A. More details for JOTM are provided in [Kreitmair, Hoekstra and Mahaffey 2005].

NC3A has, since February 2004, a Joint Tactical Information Data System (JTIDS) class 2 terminal which allows communicating with the Link 16 tactical data link and its users. This JTIDS terminal is installed in the Deployable Electronic Countermeasure Resistant Communication System (ERCS) Prototype Terminal (DEPT) and mounted within a container cabin with other equipment on a 5-ton truck. Figure 3 shows the DEPT with the JTIDS antenna.

Figure 3 NC3A DEPT with JTIDS antenna

The DEPT can act as a Data Link Monitoring Centre (DLMC), a must for any exercises using JTIDS. The DEPT can record all JTIDS messages and check message format compliance. The tactical situation and the message exchange can be replayed and compared. The DEPT is de facto an interface between the Link 16 tactical data link (TDL) and local area networks (LAN) and wide area networks (WAN). The DEPT allows NC3A to connect simulation tools with TDL. NC3A is capable of fulfilling parts of a long term critical requirement to connect tactical data links and simulation. As the CAESAR community uses a quasi standard within the coalition, all CAESAR J3.5 ground track producing systems can transmit their J3.5 ground tracks via DEPT into tactical data links.
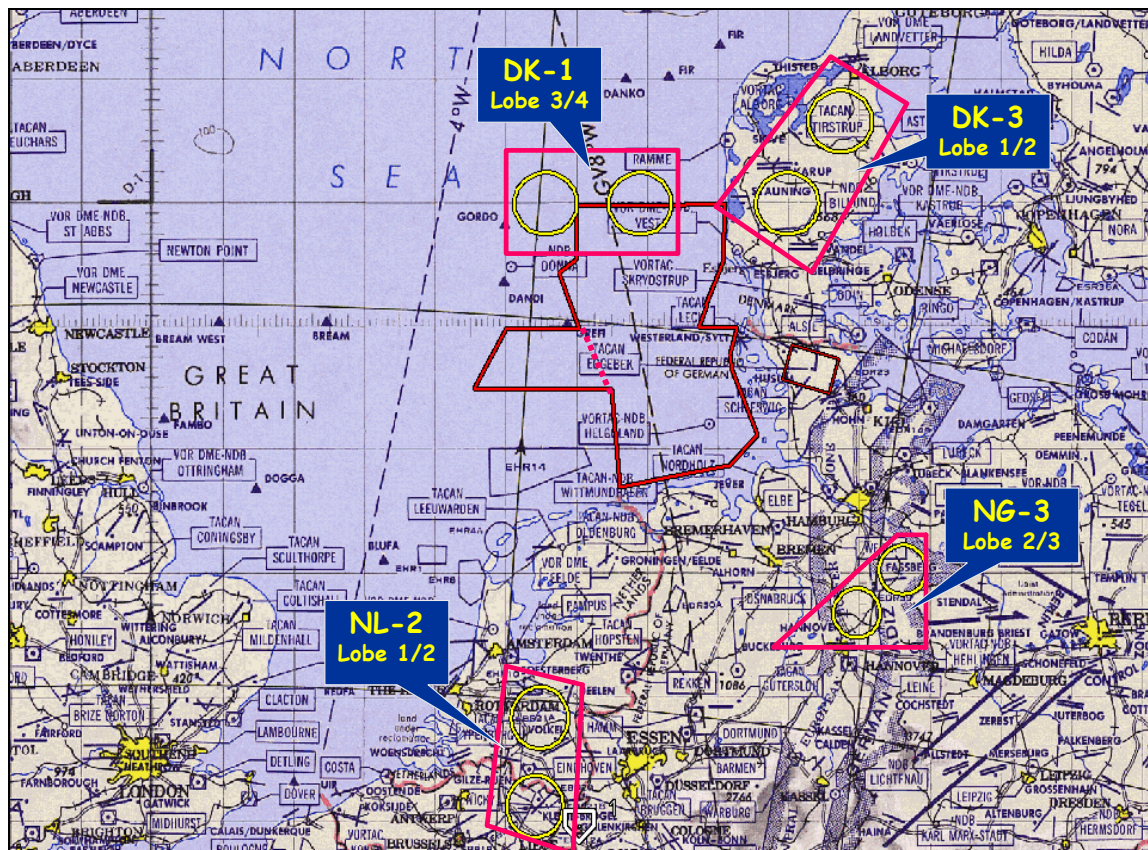

Figure 4 JOTM 2004 Exercise Area

The figure shows the JOTM exercise area over Northern Germany, the Netherlands, Denmark and the North Sea. The yellow orbits inside red shapes indicate NAEW orbits, with blue and yellow designator labels. Flying activities were planned from 14 - 23 September. Due to bad weather, flying activities were cancelled on 20 September.

3.2 Participants

Seven nations, the NATO E-3A Wing Component at Geilenkirchen in Germany and NC3A participated in the exercise, which integrated air force, army, and navy elements. Four NAEW&C orbits were used simultaneously throughout the exercise. The NAEW aircraft fleet included NATO E-3A, French E-3F and Royal Air force E-3D. The German Frigate Bayern was operating in the harbor and in the German Bight. Dutch and German Patriot units participated. Fighter bombers from Belgium, Denmark, Germany and the UK as well as UK and US tankers were also participating. In total, about 18 different JTIDS user systems and a few others without JTIDS participated in the exercise.

3.3 JOTM Objectives

As mentioned above, the objectives of JOTM were to test the hard- and soft-ware upgrades of NAEW E-3 aircraft, command centres, fighter bombers and others JTIDS users. In addition to improve technical interoperability for land (ground) track messages, the procedural and operational interoperability had to be also tested.

Critical for JOTM to achieve these objectives was the provision of ground tracks. As no other system was available for injecting ground tracks, NC3A developed three methods to provide simulated ground tracks for distinct purposes:

1. For specific software testing, test message sequences are generated and transmitted via JTIDS radio to network participants. This method is designated in the following as XML->J3.5
2. For testing Time Sensitive Targeting procedures, real single target vehicles moving in an exercise area were represented continuously with simulated tracks and reported in the JTIDS network. The Global Positioning System (GPS) determined the target vehicles positions. Therefore, this method is named GPS->J3.5
3. For connecting simulations and Tactical Data Links (TDL), the Distributed Interactive Simulation (DIS) output can be used to generate ground tracks of large manoeuvring forces. This method is called DIS->J3.5

The technical realization and the distinct advantages and disadvantages are described below. More technical details are also provided in [Kreitmair, Hoekstra and Mahaffey 2005].

3.3.1 XML-> J3.5

NC3A has filtered STANAG 5516 through a parser for a complete logical and grammatical check. As a result, about 60 problems and errors were identified in the tested edition of the STANAG, which were reported to the STANAG custodian. As a second result, NC3A has a machine-readable description of the Link 16 formats which is used for automated code generation. All defined Link 16 messages are defined in XML format. This allows generating in a very simple way any Link 16 message. Details are described in [Howland 2004].

The XML->J3.5 method can be applied quite generally to check message implementations. For example, a track has to be positioned on exactly 50° N 10° N, heading exactly east, with a speed of exactly 25 km/h. In a test, this message could be used by an operator onboard a real system to compare expected results or accuracy of displays. In a live exercise, this kind of test message is difficult to generate. The method allows injecting test messages which are hardly observed in a real environment or too dangerous in real life. For example, all J3.1 emergency point messages with all possible amplifying information (e.g. aircraft crashed) can be produced.

The NAEW&C operating base in Geilenkirchen, Germany, uses a simulator for testing the operational software. To prepare for JOTM, NC3A sent the Link 16 test sequences to the simulator and tested whether the newly implemented J3.5 ground track message features of the NAEW E-3 were working. It was possible to identify a few crucial bugs at this stage. During JOTM, this method was used to inject a sequence of Link 16 J3.5 ground (land) track/point messages via the DEPT into the real live flying systems.

The advantage of XML->J3.5 is that any Link 16 message can be generated, down to the least significant bit of the message. The method is programmable and can be used for single messages and sequences. NC3A can use the method with simulators of operational software and with live systems. The method can be automated to a certain degree and significantly reduce test labour. The disadvantage of XML->J3.5 is that it is not suited to provide J3.5 tracks of manoeuvring targets over a longer period. Also, the method is not suited to creating load cases of J3.5 ground track messages or to replace real AGS systems.

3.3.2 DIS -> J3.5

The method DIS →3.5 allows the generation of tactical scenarios. For example, it would be possible to model typical manoeuvres of ground forces in Joint Combat and Training Simulator (JCATS) or a similar simulation and use this to teach the operators how these manoeuvres appear on the displays of their consoles. The size of the scenario forces depends on the type of mission, assumptions of the forces involved, and the assumptions on performance of the AGS sensor. Currently, the method does not include a ground target tracker. It would be feasible without any additional effort to introduce an AGS sensor and an AGS tracking system between the DIS source and the XML description part of the existing method. In this case, the simulation of an AGS platform, with all its technical parameters for platform and sensor, performance of platform and sensor and the full set of algorithms for tracking of ground targets would be available. The method is very suitable for operator training. All sensor platforms or tracking stations used in CAESAR would be suitable for this. DIS->J3.5 was only tested in the laboratory and not during JOTM. The use of a full tactical scenario was not an objective in JOTM. The method DIS → J3.5 is suitable for load case testing, but not for software testing of distinct input reactions.

3.3.3 GPS -> J3.5

The German Army Air Defence School participated in JOTM with Roland and Gepard air defence weapon systems as live targets. They were participating on 13, 14, 15, 21 and 22 September. If a JSTARS would have been able to participate in the exercise, the JSTARS would probably have been able to detect and track the live units and provide a track of their position to the other participants. This would allow some procedure testing of TST. Unfortunately, the JSTARS could not participate in the exercise.

The challenge was now to produce "simulated" J3.5 land (ground) track messages with the exact positions of the live targets. The J3.5 tracks could then be used by the NAEW&C aircraft to allocate targets and to monitor the engagement, while the same tracks can be used by the fighter bomber aircraft to vector towards the targets and to attack them. If the tracks were updated frequently enough and were accurate enough, the pilots of the fighter bombers would visually sight the targets. The following figure provides a graphical representation of the concept.
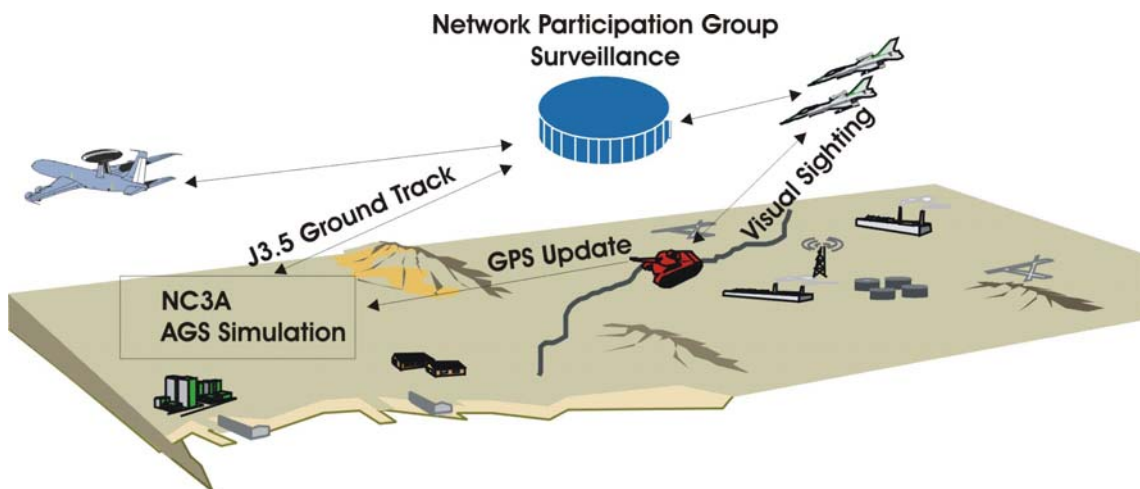

Figure 5 Real targets represented by simulated J3.5 land (ground) track messages

The tanks were equipped with a standard Global system for mobile communications (GSM)/ Gensym message service (GSI) telephone. These telephones were controlled by and communicated with another GSM/GSI telephone at NC3A. The GSM/GSI telephones on the Gepard and Roland determined their positions based on built-in Global positioning system (GPS) receivers. The GSM/GSI telephones on the vehicles sent short message service (SMS) messages containing the position and velocity of the vehicles to the telephone at NC3A. The SMS messages were received, ingested into a laptop computer and translated via XML into J3.5 land (ground) point/track messages. Through Standard interface for multiple platform link evaluation (SIMPLE) as defined in STANAG 5602, the tracks were forwarded to the DEPT. The DEPT transmitted the J3.5 messages into the JTIDS network, where they were received by the NAEW and the fighter aircraft. The concept worked: The NAEW was able to allocate fighters to attack these ground tracks, controlling and vectoring the fighters towards actual vehicles. Reports from the fighters indicate that they were able to visually sight the targets. The Roland and Gepard operators verified that fighter aircraft over-flew their positions without the need to stand off and search for the vehicles.

The tracks were "simulated" in the sense that they were not generated with a radar system but with a GSM/GSI telephone using GPS.

The following figure shows a zoom display of one of the tactical displays used during JOTM. The area shown is Schleswig-Holstein in Northern Germany.

Figure 6 Simulated J3.5 track messages over real targets on live tactical display

The figure shows the German frigate Bayern (red diamond) in the German Bight, a Patriot Information and Command Centre (ICC) (red diamond, track number 04313) and four J3.5 land (ground) point/track messages (yellow clovers), with a large number of air tracks. The

ground tracks 07001, 07002 and 07003 were generated with the GPS→J3.5 method. These simulated tracks represent real targets; two Gepard and a Roland air defence tank. At the same time, the ground track 07005 is displayed in the northern part of the figure. This track was generated using the XML → J3.5 method. With a close look, one can recognize that an air track has just flown over ground track 07003, from north-west to south-east.

The figure also shows ground track 07005, representing an airfield/airbase. It also shows air track 00312, with the description "fighter bomber" and "engaging". The vector of the air track is pointing to the east of the target. This can also be observed by an NAEW&C and a controller could advise the pilot of the fighter bomber to adjust his course.

An update rate of 90 seconds was used for the SMS messages. The delay for routing the SMS messages to NC3A was not measured; it was estimated to be less than a second. The delay between receiving the SMS message at NC3A until it was forwarded as J3.5 to the DEPT was less than a second. The J3.5 message was then transmitted by the DEPT with the next available time slot, often within milliseconds. The message was updated after 48 seconds by the DEPT. At 90 seconds after the first GPS transmission, the next GPS transmission arrived. The GSM/GSI telephones seemed very reliable; the mobile telephone coverage in Schleswig-Holstein seems to be very good and reliable. The telephone bill for five days of exercise with this equipment was 1350 Euro.

3.3.4 Comparison of methods and possible extensions

The following table summarizes the application area, the advantages as well as the disadvantages of the three methods discussed.

Table 1
Comparison of the three methods to generate J3.5 ground track messages

	Application	Advantage	Disadvantage
XML->J3.5	Software tests; after modifications or upgrades	Each Link 16 message down to least significant bit Semi-automated	Not suitable for manoeuvring targets over longer period No load case testing
DIS->J3.5	Simulation of tactical scenarios	Allows to include simulations of AGS sensors and trackers Allows to generate load cases	Not suitable for software testing
GPS->J3.5	Representation of real targets with simulated tracks	Cost efficient, simple, reliable	Not suitable for software testing. Increasing cost for large number of targets

The methods were all using the Link 16 XML definition. As a consequence, it was not difficult to expand the application beyond J3.5 ground tracks. The current available implementations cover J2.2 Air Precise Position Location Information (PPLI), J2.3 Maritime (surface) PPLI, J2.5 Ground PPLI, J3.2 Air Tracks, J3.3 Maritime (surface) tracks, J3.0 Reference point, J3.1 Emergency Point as well as some of the J7 messages for track management. This allows supplementing any live exercise with air, maritime and ground targets, with friendly, unknown and hostile targets.

NC3A can share software and data produced to enable these technologies with NATO nations. NC3A can also provide expertise to users interested in replicating similar efforts or to conduct similar exercises and experiments.

4 Future Work

4.1 Multi-Sensor Aerospace-Ground Joint Interoperable Intelligence Surveillance and Reconnaissance Coalition (MAJIIC)

The CAESAR project and its extension were completed in March 2005. Based on the success of the project, the CAESAR nations and two new nations, The Netherlands and Spain have created a new project: the Multi-Sensor Aerospace-Ground Joint Interoperable Intelligence Surveillance and Reconnaissance Coalition (MAJIIC). MAJIIC will begin in April 2005 and will continue until March 2009. The goal of the project will be to make the information from additional sensor types available to more users; using and expanding on the network enabled methodologies developed in CAESAR. The additional data will include

- Electro-Optic and Infrared (EO/IR) imagery,
- Motion video sensors for EO and IR, and
- Processed Electronic Warfare Support Measure (ESM) data.

In addition, enhancements to planning, tasking, monitoring, and management capabilities will be investigated along with enhanced tracking and sensor fusion capabilities. MAJIIC will continue to interact strongly with the user community and will continue to enhance and support the development of NATO and national doctrine.

Figure 7 MAJIIC logo and participating Nations

The MAJIIC project organization is based on Project Officers representing each coalition nation and NC3A. National programs developing capabilities to support coalition operations will benefit from the new coalition project. The MAJIIC coalition will continue to work on solutions which allow operational usage. Complicated issues require time for solution, and rushing to operations bears many risks.

4.2 Future Exercises

The focus on live fly and simulation exercises will again be used to as the methodology for demonstrating the operational, system and technical interoperability proof of concept for coalition ISR assets. These exercises will also provide a robust training capability and will be used to demonstrate distributed coalition and network enabled capability operations.

The planning for the first MAJIIC exercise has already started. The first exercise will be a TIE exercise, MAJIIC TIE 2005 planned for October 2005, at NC3A in The Hague. Also considered currently are a simulation Exercise (SIMEX) with operators, planned for February

2006, again at NC3A in The Hague: MAJIIC SIMEX 2006. This will be followed by a live flying exercise with all MAJIIC nations in June 2006, probably held in Alberta, Canada. In the long term, a live flying exercise demonstrating all of NATO's net-enabled AGS capabilities is planned for summer 2007, perhaps with the Joint Warfare Training Centre in Stavanger, Norway. The exercise name will be Trial Quest 2007. The MAJIIC nations have already started to prepare and plan this exercise. As the exercise will be a review and demonstration of NATO's AGS capabilities it has already found the interest of many NATO commands and agencies.

5 Summary

5.1 Is AGS ready for operations?

The US forces demonstrated during their last operations that they use AGS sensors to provide their commanders with superior insight into the opponents operations. AGS sensors are used to achieve some forms of information superiority.

For a coalition of multi-national forces, the situation is much more complicated. There is no single agreed concept on the architecture of a future coalition AGS. It is not clear which sensors, ground stations and exploitation stations will be part of the next AGS coalition. Within the architecture, the activity and processes are not well defined. The technical, procedural and operational interoperability were significantly improved over the years, step-wise progress has been made in many areas. Some of the NATO nations have just begun to use the J3.5 ground tracks messages, they are adapting their procedures and developing new procedures where needed. The live experiments have shown achievements, but also gaps and needs for further improvements.

It is necessary to identify the forms of operations in which AGS is applied. For some forms of operations, AGS radar sensors can hardly be used. For example, the war against terrorists and the various operations applied in this form of warfare are relatively new and in the interest of the media. Some of the established sensors, ground stations and exploitation stations were developed based on operations related to mechanized warfare between large troop formations. AGS radar sensors detect vehicles, but not single or small groups of humans. For some of the possible operation forms, AGS radar sensors alone are not the first choice. When combined with other sensors such as electro-optical or infrared sensors, the existing AGS develops into a more complete Intelligence Surveillance and Reconnaissance (ISR) system, which might provide again information superiority in new operation forms.

According to the author's opinion, some of the AGS assets are ready to operate in a multi-national environment, others are not ready to be used outside the laboratories.

On the technical side, a higher degree of interoperability is necessary, with strict applications of STANAGs and testing of STANAGs in a multinational coalition environment. It is not sufficient, if a single implementation is quoted to be STANAG-compliant, as there is a tendency that STANAGs are read different by various people. Consequently, software is designed and programmed differently, which might cause loss of interoperability.

On the procedural side, restrictions prevent in a lot of cases multi-national sharing of reconnaissance and surveillance results. Particularly sensitive are cases in which AGS data are combined with intelligence data during the exploitation process. Some of the intelligence data systems within NATO rely on established but aging security technologies. If the legal and administrative concerns could be overcome, the engineers could provide a wide range of possible technical solutions and improvements.

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