In this Update issue:

22 Helicopters from the Polish Air Mobile Forces are to be upgraded with Terma EW Self Protection systems. This is Terma’s largest EW contract so far and the first on Mi-17 and Mi-24 helicopters. Together with other upgrades, this program aims to ready the helicopters for international operations.

3D-Audio is a powerful tool for situational awareness. It improves the pilot’s and/or the aircrew’s situational perception and thereby also reduces the response time, while at the same time improving speech intelligibility and flight safety through improved communication.

The Advanced Distributed Aperture System, ADAS, is a US Army program conducted by Raytheon designed to fully exploit the options within this field. The demonstration platform for the program is a Sikorsky UH-60 Black Hawk helicopter.
At a ceremony on 26 May 2010 at RNLAF Base Woensdrecht, the Terma Electronic Warfare Competence Center, EWCC, was officially inaugurated.

Long Time RNLAF-Terma Relationship

There is no doubt that the Royal Netherlands Air Force, RNLAF, is Terma Airborne Systems’ most valued customer. Not only does the RNLAF operate the Terma EW Self-Protection Systems in more aircraft types than any other nation, the RNLAF has also been a valued partner in development of new EW products such as the Tactical Threat Display, AMASE and CHASE pods for the Cougar, Apache and Chinook helicopters.

Terma Facilities inside Woensdrecht Logistics Center

For some time Terma and the RNLAF have negotiated the possibilities for closer cooperation still, and have found it in their mutual interest to establish this Terma EW Competence Center at Woensdrecht Air Base. For the RNLAF, it makes maintenance and upgrades easier and for Terma, it is an opportunity to serve our customers better, not only the RNLAF, but in the longer term, also other European nations as a whole.

So when the RNLAF offered facilities inside the Woensdrecht Logistics Center, WLC, Terma was very pleased to accept.

The RNLAF is in the process of centralizing all of its logistics services at Woensdrecht Air Base situated in the southwest
part of the country. That includes maintenance, repair and upgrades of the large number of EW Self-Protection Systems supplied by Terma over the past 20-year period.

**EW Competence Center Opportunities**

The immediate opportunities for the EW Competence Center are the direct tasks connected with logistics support to Terma systems in service with the RNLAF. They include testing, training, installation, maintenance repair and overhaul plus modification and upgrade programs. Initially, the work will be performed in close coordination with and supervision by the Logistics Department at Terma Lystrup. As experience and skill levels increase, EWCC will gradually take over responsibility for still more complicated tasks.

**Terma EWCC to Serve other European Customers**

The ambitions in the longer term are to expand the services of the Competence Center to also serve other European Air Forces that operate Terma EW systems. It is foreseen that this will take place in close collaboration with Woensdrecht Logistics Center, and, to a large extent, depending on customer requirements and policies, it will also include outsourcing or partnerships. It is also foreseen that suppliers and users of other than Terma equipment could have an interest in the Terma EWCC for logistics tasks. One example could be maintenance of the ALQ-131 jammer pod through an agreement with Northrop Grumman and WLC.

**Future WLC-Terma Partnering Agreement**

The immediate tasks, both for WLC and for Terma EWCC, are to consolidate their respective organizations, to identify the areas for collaboration and establish the day by day routines. Based on this collaboration, the intention is, from both sides, to enter into a partnering agreement, much like the agreement Terma has with the US Air Force. The RNLAF and Terma could then, jointly, offer services within the EW fields of expertise.

**Agreement with NLR**

Terma considers it a great asset and a privilege to have entered into a cooperation agreement with NLR, the Dutch National Aerospace Laboratory. This agreement, signed in 2007, gives Terma access to NLR’s wide range of competencies within research, development, testing, validation, certification and to NLR’s facilities such as wind tunnels, simulators and test aircraft. Indeed, without this NLR/Terma agreement, the Terma EW Competence Center would stand a much smaller chance of success.

**Agreement of Cooperation with the Dutch World Class Aviation Academy**

In connection with an Open Day event on 30 January 2010 at the Markiezaat College, situated next to Woensdrecht Air Base, Terma and the World Class Aviation Academy, WCAA signed an agreement of cooperation. The WCAA is an institution from where highly qualified aviation specialists can be recruited, which in turn will enable Terma to offer Electronic Warfare training to the global market. In addition to the Terma facility on the air base, Terma will also have an office in the Aviation Academy building alongside Boeing. Terma sees the agreements and connections between Boeing, Terma, Aviation Academy and the National Aerospace Laboratory (NLR) as a very solid foundation for future business activities.

Steen Lynenskjold, Senior Vice President, Terma Integrated Defense Systems, speaks at the opening ceremony
Terma to upgrade Mi-17 and Mi-24 Helicopters for the Polish Air Mobile Forces

Terma has been Selected as Main Contractor to Provide a full EW Self-Protection Suite for 7 Mi-17 and 15 Mi-24 Helicopters as Part of a Larger Upgrade Program to Prepare the Helicopters for Operations in Afghanistan.

Scope of the Program
The EW suite will be controlled and integrated by Terma’s AN/ALQ-213(V) Electronic Warfare Management System, EWMS. Terma will also supply Modular Aircraft Survivability Equipment (MASE) pods with missile warning sensors and dispensing magazines for flare cartridges to counter infrared guided missiles.

Sub-Suppliers and Partners
In the program, Terma will be working with a number of sub-suppliers and partners. The missile warning sensors, AAR-60 MILDS, will be supplied by EADS, Germany, and the dispensing programs will be delivered in close cooperation with the National Aerospace Laboratory, NLR in the Netherlands. Payloads will be delivered by leading European suppliers of expendables. Throughout the program Terma will work closely with WSL-1, Military Airworks No.1 in Lodz for installation of MASE pods and other hardware parts, and with ITWL, the Air Force Institute of Technology, when it comes to type testing and certification.

Quantum Leap for Terma
For Terma, this project means a quantum leap from two aspects: Terma has been selected as prime contractor to deliver a turnkey solution for a large EW self-protection program. It is also the largest single EW contract Terma has been awarded so far. However, despite this considerable
challenge, with now more the 25 years of experience in development and manufacturing of EW equipment, we are very confident that this program will be concluded to the satisfaction of the Polish Air Mobile Forces.

**The Helicopters**

The Mi-17 is a twin engine, medium-sized multipurpose helicopter with fixed landing gear. More than 10,000 helicopters have been produced over the years, and it comes in a large number of versions for various purposes such as troop transport, combat support, Search & Rescue and others. It is understood, that the Polish Air Mobile Forces have an urgent operational requirement to upgrade this helicopter with the necessary weapons and Self-Protection Systems in order to assist the Polish ground troops in international operations.

The Mi-24 is a twin engine, heavy attack helicopter with retractable landing gear. It can be armed with a variety of guns, rockets and missiles. The design dates back to the 1970s, and the Mi-24 has seen action in many conflicts over the years, notably during the Soviet occupation of Afghanistan 1979-89 and in the later Chechnya conflict. The Mi-24 can also be used to a limited extent for troop transport, MEDEVAC and Search & Rescue. More than 30 countries fly the Mi-24 in various configurations. It is understood that plans are to deploy the Mi-24 to international operations once it has been upgraded with the required EW self-protection systems.

**Standard Modules Ensure Commonality**

This program for the Polish Air Mobile Forces is to a very large extent based on two Terma standard pillars that are well proven over many years in various aircraft types:

- Terma’s EW Management System, AN/ALQ-213(V)
- Terma’s Modular Countermeasures Pod, consisting of standard modules adapted for individual aircraft types.

With this standardization based on two main components, the user achieves a high degree of commonality, that in turn offers advantages in maintenance and upgrade costs and easy component substitution across the entire fleet.

Terma’s EW Management System, AN/ALQ-213(V), was originally developed for the Danish F-16s and introduced operationally in the early 90es. During the following years, with the necessary upgrades, the system has become the standard EW controller in more than 1800 aircraft of all categories worldwide.

**The Family of Countermeasures Pods.**

The pods used for the Mi-17 and Mi-24 helicopters are part of the MASE pod family, which is primarily aimed at helicopters and smaller, slow-moving transports. It is based on a
number of standardized modules dedicated to a number of different defensive aids subsystems. As indicated on the sketch, the pod contains forward and aft missile warning sensors, forward firing flare magazines and pod interface with lateral countermeasures dispenser magazines.

All modules are mechanically interchangeable, which enables future upgrades simply by replacing the affected modules; for instance, the pod interface/lateral CMDS module may be replaced by a DIRCM module.

Missile Warning Sensor modules and the Forward Firing Flare module may be rotated in 15 deg. increments during installation in order to optimize platform-specific missile warning sensor coverage and flare trajectory clearances.

The MASE pod is typically installed on or near a stub wing tip or on out-rigged external stores carriers in order to achieve Missile Warning and other sensor system coverage with minimal obscuration from the airframe. Typically, the platform mechanical interface is bore-sighted during initial installation, enabling removal and reinstallation of pods without need for subsequent bore-sighting tasks.

**Program Schedule**

The program is already well underway at Terma. Deliveries are scheduled to start November 2010, and from then on deliveries will take place at an average rate of one helicopter per month until the program is concluded.

**Other Deliverables**

Since the project is a turnkey solution, it includes a number of other elements besides the actual aircraft upgrades:

- Spare parts
- Test and maintenance equipment
- Chaff and flare payloads
- Programming tools
- Training of aircrews and technicians
- User manuals.

**Further Opportunities**

The Polish Authorities have indicated that standardization is a high priority. The opportunity and the challenge for Terma is therefore to demonstrate the quality, durability and effectiveness of Terma’s EW solution. The Polish Armed Forces are known to have a requirement for EW upgrade of a number of other aircraft types, such as the MIG-29, the M-28 Bryza, and additional Mi-17s. Also, it may be foreseen that the helicopters now being upgraded will later need additional sensors such as Radar and Laser Warning receivers.

Also, assuming a successfully concluded Polish Mi-17 and Mi-24 program, there are large numbers of these helicopters in other countries that could be candidates for Terma’s EW solutions.

![The Terma negotiating team: From the left: Rafal Malewski, Systems Engineer, Omar Echammari, Systems Engineer, Tina Vestergaard Molin, Project Manager and Bjarke Larsen, Director Strategic Business Development, and team leader.](image)
Terma’s 3D-Audio and Active Noise Reduction Selected for US Army ADAS Program


Fusion of Visual Display and 3D Audio Information
Visual displays and mono audio have been part of aircrew interfaces for the best part of the time aircraft have been flying, but developments within such areas as Helmet Mounted Displays, sensors, processing capabilities and not least three-dimensional audio, have created new possibilities to give pilots vastly improved situational awareness. The Advanced Distributed Aperture System, ADAS, is a US Army program conducted by Raytheon designed to fully exploit the options within this field. The demonstration platform for the program is a Sikorsky UH-60 Black Hawk helicopter.

The Visual Segment
The ADAS is a multi-spectral day/night viewing system, consisting of six cameras mounted on the outside of the helicopter. The day/night imagery from each camera is processed and stitched together to provide each aircrew member with an independent, unrestricted spherical view around the aircraft. Each aircrew member independently views the thermal and near-infrared fused imagery as it is projected onto the visor of his Helmet Mounted Display (HMD). Each aircrew member’s HMD is continually tracked by an optical head tracker and the aircrew member determines the imagery he sees by simply turning his head in the desired direction.

Since the cameras are located on the outside of the aircraft, the images appear to “see through” the Black Hawk. Informational symbols from the helicopter instrument panel, called flight symbology, also provide heads-up pilotage and navigation data as an overlay to the multi-spectral imagery. ADAS greatly improves situational awareness by providing aircrew members with the ability to look anywhere around the aircraft to view objects and terrain with minimal or no structural limitation during day/night operations.
The Audio dimension

With the improved ability for the aircrew to see what is going on outside the skin of the aircraft, there is an increased need to be alerted into the direction where interesting events arise. If hostile fire is detected, it is essential that the crew be informed immediately about the direction of this activity. Then what could be more natural than hearing a gunshot from the actual direction of the hostile fire? This is actually possible with the 3D-Audio system that forms part of ADAS. Similarly, a missile launch, detected by a Missile Warning System, is presented to the aircrew as a sound signal from the direction of the actual missile. The directional accuracy of the sound signal in the pilot’s earphones corresponds to the accuracy of hearing a gunshot (or other sound) in the real world. It enables the crew member to immediately turn his head and establish line of sight to the activity.

3D-Audio for Intercom and Radio Transmissions

Another 3D-Audio application which is very useful in a multi-crew vehicle is the ability to separate speech from the individual crew members into the direction of their physical location, e.g. when the co-pilot hears the voice of the gunner located right behind him, the voice appears from right behind him as would have been the case in a quiet vehicle without the intercom system. And when multiple crew members are speaking simultaneously, the listener can actually pick the voice he wants to listen to and sort of “exclude” or suppress the other voices.

The same technology is applied to the radios of the aircraft, allowing each radio to have a distinct direction which indicates to the user which radio is active, and picking the important one to listen to.

Active Noise Reduction, Improved Helmet Design
Increase Aircrew Comfort, Reduces Crew Fatigue

The entire helmet concept has been reconsidered as part of the ADAS program, and during this process, the noise attenuation properties of the helmet have been significantly improved, partly from better earcup design and selection of materials which improve the passive attenuation of the helmet, but also and not least as a result of the introduction of Active Noise Reduction (ANR) system into the earcup. All in all, a significant step towards elimination of protective earpieces/earplugs, while still improving intelligibility.

Sikorsky UH-60 Black Hawk as Demonstration Platform

The complete ADAS suite has been demonstrated and evaluated on a modified UH-60 Black Hawk helicopter over the last two years at the US Army Research, Development and Engineering Command’s Communications and Electronics Center. For periods the Black Hawk has been deployed to other US Army bases and a substantial number of US Army personnel, pilots as well as crew-chiefs and decision-makers have experienced the system.

On a recent flight demonstration at Fort Bragg’s Simmons Airfield, COL Allen Chappel, ARSOC Deputy Chief of Staff, G-8, stated, “I could tell what the pilot was doing without him telling me, which is incredible.”

On a similar flight, US Navy Senior Chief Petty Officer Chris Beck, Special Operations Command, said, “I can only compare it to being blind my whole life, then suddenly seeing!!”

A modified UH-60 Black Hawk helicopter with six outside cameras to provide the aircrew with unobstructed day and night vision

Important Step Ahead for Terma

Torben Jørgensen, Senior Systems Engineer on the Terma part of the ADAS program says “This program is a clear recognition that Terma’s 3D-Audio technology is of world-class standard. The tests and demonstrations so far have shown that it is reliable, versatile and with a high degree of accuracy, meaning that it has fully met the criteria set up to qualify as an important part of the overall success of the ADAS program”.

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What a Difference 3D-Audio and Active Noise Reduction make…

Some of the comments made by USAF fighter pilots, who flew 3D-Audio/ANR equipped F-16s for the first time

“It was quiet up there” – “awesome”
“Radio separation was very intuitive”
“I usually stay off hot mike due to noise, but now I used it all the time”
“MWS direction was spot on”
“RADAR at 6 o’clock gives you exactly what you get in the display”
“Audio worked as advertised”
“Improved radio communication should be emphasized”.

Why 3D-Audio/ANR?
Some of the answers are given in the testimonies above, and they illustrate that improvements in cockpit sound quality have long been overdue.
Imagine you had to work in an office - and the cockpit is the aircrew’s office – where, day in and day out, you had to live with a rock concert going on at full blast, while at the same time you had to make informed decisions within split seconds.
This is the noise level pilots have had to cope with so far, only to most people it is less pleasant than a rock concert.
This noise level, often in the vicinity of 120 dB, becomes very tiring after a while, and it will induce stress and fatigue that influence the pilots’ ability to make sound and timely decisions.
From measurements on various types of aircraft we know that this is a problem that faces pilots and other aircrew members, regardless of whether we are talking about fighter, rotary wing or wide-body platforms.

Active Noise Reduction and 3D-Audio
Active Noise Reduction provides considerable noise attenuation which reduces stress, fatigue and hearing degradation, while at the same time facilitating the reproduction of 3D-Audio.
3D-Audio is a powerful tool for situational awareness. It improves the pilot’s and/or the aircrew’s situational perception and thereby also reduces the response time, while at the same time improving speech intelligibility and flight safety through improved communication. This is achieved by applying spatial separation of simultaneous audio cues in digital stereo sound, which furthermore provides a more natural sound compared to analog mono audio as applied on most platforms today.
The 3D-Audio can be regarded as an audible, three-dimensional display, which, compared to the existing visual display systems, adds an immediate 360 degree spherical sense of
direction based on the direction of the audio cues presented to the pilot and/or crew. This saves reaction time compared to looking at visual displays or listening to mono voice messages, because it requires time, albeit very short, to interpret symbols and “translate” voice message information into for example horizontal and vertical direction of i.e. an inbound missile whereas the pilot can react instinctively on a three dimensional audio warning.

Why Terma 3D-Audio/ANR

The Terma 3D-Audio/ANR is the only existing system that is fully developed, tested and in operational service on military aircraft. Over the past 10 years, a great deal of effort has been invested in perfecting the system, so that today it prompts spontaneous comments from pilots as quoted above.

The capabilities

The Terma 3D-Audio/ANR solution consists of a number of different capabilities and components which either individually, or as a single, coherent suite of capabilities may be implemented based on aircraft type and operational requirements. The capabilities listed below are all operational on fighter aircraft.

Digital Intercom. Terma’s digital intercom solution is designed for the harsh acoustic environment found in most military aircraft. The system is designed as a form-fit replacement of existing intercom systems, including the interphone amplifier and the headset – part of the pilot helmet. Although designed for the F-16, the system can be adapted to other platforms, and especially the noisiest of aircraft, the helicopter platforms can benefit from the Terma system. An analog/fallback mode furthermore supports the use of existing, unmodified headsets, i.e. without the Terma ANR modified Headset Assembly.

The Terma Enhanced Interphone Amplifier (EIA) hosts the Digital Intercom system and provides digital signal processing. The EIA/Digital Intercom is therefore a prerequisite for the capabilities listed below

Active Noise Reduction (ANR). Terma has achieved reduced acoustic noise exposure by means of improved passive noise reduction, a digital headset with built-in Active Noise Reduction (ANR) circuitry powered through a standard intercom interface. The headset provides considerable noise attenuation and is at the same time capable of high-quality stereo reproduction for 3D-Audio.

The reduced noise level also allows the pilot to decrease the volume of the intercom system, yielding significantly reduced acoustic pressure — and a chance to avoid the yellow earplugs.

Electrical Noise Reduction (ENR) is a digital filter function which removes/suppresses the noise in relation to the aircraft electrical system, such as e.g. 400 Hz harmonics.

3D-Audio, or spatial audio, is used in two ways to improve the quality of the acoustical messages presented to the pilot.

First, it means spatial separation of messages (e.g. cues, VHF and UHF radio communication, warnings and intercom). Because the messages are directional in the pilot’s earphones, it allows the pilot to focus on one message, the most relevant one, while he is still being kept aware of other messages.

Second, and perhaps most importantly, 3D-Audio is especially useful when it comes to threat warnings. Not only does the pilot receive the warning from the exact direction of the threat, he will also, compared to a traditional voice message system, be able to initiate evasive manoeuvres a full second earlier, because he can act instinctively without the need to process any information mentally.

The 3D-Audio system makes the pilot aware of activities 360 degrees spherical. To a certain extent, it can be regarded as the audio equivalent of a helmet mounted display, where the visual information moves with head movements. In a similar manner, audio from a given direction will give real time information of direction changes, which is extremely important, especially in a missile attack situation.

Implementation of 3D-Audio/ANR

The implementation effort will differ from platform to platform and will depend on which 3D-Audio/ANR capabilities are to be implemented, and on the specific operational and program requirements. The core of the Terma 3D-Audio/ANR and the underlying technology, however, remain the same.

As an example, the Digital intercom, Active Noise Reduction
(ANR), Electrical Noise Reduction (ENR) and Fixed Radio Channel separation can be implemented on the F-16 platform as a form-fit replacement, requiring only minor Group A modifications, provided that e.g. a HGU-55 or Joint Helmet Mounting Cueing System (JHMCS) helmet is used already. If 3D-Audio is also to be installed, a head tracker is required, which could be that of the JHMCS helmet. Also, already installed RWR, MWS systems would have to be integrated, meaning that Group A and in some cases software changes would be required.

**Add-On Capabilities**

The digital signal processing capacity of Terma’s 3D-Audio/Digital Intercom system offers a platform which can be extended with new capabilities by means of interfaces and software upgrades. Examples of such possible additional capabilities are:

- Directional radio communication within a formation, i.e. the formation leader hears in his earphones the direction from which his wingman is transmitting.
- In a multi-crew aircraft, the crew members hear communication from the individual crewmember’s position. This eliminates – in most cases – the need for call signs and thus gives a much more natural communication.

Other possibilities are:

- 3D-Audio cues based on Hostile Fire Indicator (HFI) sensors
- 3D-Audio directional communication for Forward Air Controllers (FACs)
- Directional cues/communication in relation to SAR operations
- 3D-Audio directional terrain/obstruction warning and cueing
- Use on land/sea platforms. The 3D-Audio/ANR capabilities can also be applied for land or maritime platforms where directional information and noise reduction is required e.g. in connection with sonar on submarines or for communication and warning messages in combat vehicles.

Terma’s digital intercom system can also host software/solutions in relation to other intercom related capabilities such as voice recognition, speech-to-text, text-to-speech, etc.

The 3D-Audio technologies can also be utilized in other contexts such as crew/candidate selection and tests for e.g. prospective pilots and flight controllers where human capabilities such as manual-visual coordination, reaction times and sense of direction can be tested and tracked based on 3D-Audio stimulation.

**Further information**

By its very nature, 3D-Audio/ANR is difficult to explain in writing and to illustrate on paper. However, the system will be demonstrated live at the following air shows and industry events:

- Farnborough Air Show, Farnborough, UK: 19-25 July 2010
- F-16 Technical Coordination Group, Ogden, USA: 13-15 September 2010
- AOC Convention, Atlanta, USA: 3-6 October, 2010
- WEPTAC, Tucson, USA: 17-22 October 2010
- WEPTAC, Nellis AFB, USA: January 2011

Also, visitors to Terma Lystrup will have the opportunity for a demonstration.
Terma’s Business Areas cover:

- **Aerostructures**: Development and production of advanced structures for defense and non-defense aircraft and helicopters.

- **Integrated Defense Systems**: Network and tactical Systems; self-protection equipment for aircraft, helicopters, and ships; and electronics manufacturing and services within the defense industry.

- **Radar Systems**: Advanced radar systems for coastal surveillance, naval surveillance, vessel traffic surveillance, perimeter surveillance, and surface movement surveillance at airports.

- **Space**: Mission-critical products, software, and services for space applications.

Terma develops and markets high-tech solutions, systems, and products for defense and non-defense applications. Our products are developed and designed for use in extreme mission-critical environments and situations, where human lives and valuable material assets are at stake.

Terma A/S was established in 1949, is headquartered in Denmark and maintains international subsidiaries in a number of European countries, the U.S., and Singapore.

For many years, Terma has worked closely with the Defense, public authorities, and international organizations around the world. Extensive dialog and meaningful relationships with our business partners give us an in-depth understanding and appreciation of their strategic, functional, and management needs.

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Financial Highlights

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Number of full-time employees
- Average for the year  1,256  1,183  1,020  965  1,014