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T-Core is the brand for Terma’s fourth generation C4I software, which can provide the base of any Combat Management System (CMS). It executes real-time data operations and holds all the basic functions that must be included in any navy, army, or air force system, providing situational awareness, data communication, and control of weapons, sensors, and other units.

Terma offers complete CMSs directly to end-users. In addition, other companies may license the T-Core SW-platform on an OEM basis to build their own in-country CMS. The software is designed to be a part of any Combat Management System – despite choice of hard-ware, operating system, weapon and sensor interfaces, and Human/Machine Interface (HMI).

With T-Core, other organizations may benefit from the thorough know-how, which Terma has obtained from integrating customized combat management systems. T-Core enables end-users to rapidly build an open and modular system, where subsystems may be upgraded independently.

T-Core Features
The T-Core development process has been governed by a set of internal requirements, which were not derived from the customer’s normal operational and technical demands, but which were established in order to develop a truly reusable system, including features like:

- **Flexibility:** The system architecture encompasses all defined operational features, meaning that there will be only one release for all systems based on this generic software platform.
- **Scalability:** The same software release is able to run very small systems as well as very large systems without modification.
- **Reliability:** The software supports construction of the CMS with no single point of failure – and allows for a wide ranging, graceful degradation. The software — with no changes — is able to accept from none to very elaborate redundancy measures in the hardware configuration.

The new C-Flex C4I system installed in the HMS “Lommen”.

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**Terma UPDATE. OCTOBER 2004**
· **Modifiability:** The CMS supports addition or modification of functionality or interfaces without causing a ripple effect of changes through the entire software. As a consequence, the system also supports a test strategy, in which additional features and functionality can be tested without testing the entire CMS.

· **Portability:** The CMS functions are independent of hardware and operating system. COTS features are encapsulated and can be upgraded or modified separately.

· **Security:** The CMS architecture takes into account the requirement set forth in the Orange Book for C2 security accreditation.

· **Affordability:** Development will not repeat what has already been developed by others – thus the CMS uses COTS products wherever feasible.

The new core system software — defined as the Common Operational Environment (COE) — is developed in a layered architecture. The application interfaces (API) to the core software are open and thoroughly documented and may be used by any software developer to build his own extensions.

**Operational Implementations**

T-Core was originally developed for the Royal Danish Navy (RDN) C4I upgrade program of the Standard Flex ships and for the new Flexible Support Ships and Patrol Ships.

The system, however, was not developed as a dedicated naval system, but rather as a generic C4I platform. Hence, specific applications and HMI features were applied in order to meet the requirements of the RDN. The first ship-set was delivered and installed in December 2003, and the system went into operational use at the first quarter of 2004.

The Danish Army STINGER-based air defense system, DALLADS, is currently undergoing an upgrade based on T-Core.

In conclusion, as the system is fully capable of operating weapons, sensors, and fast data links in real or near real-time, it also stands as a viable contender for battle management systems in army vehicles and an excellent tool in support of network centric operations right from the individual soldier to battalion tactical headquarters.
Rapid Development of New C4I System for Navy Ships

Terma conducted a quick and precise development, delivered on time. The system introduces novelties in function, management, and maintenance, which we have never seen in a system before, states Cdr.sg. Per Bigum Christensen, Navy Materiel Command Denmark (NMCD).

The Royal Danish Navy has long pursued a policy of creating and building multi-role ships. The first generation was the Standard Flex 300 series which have successfully proven the multi-role concept. With our next generation of multi-role ships – the frigate sized Flexible Support Ships and Patrol Ships – of which the first Flexible Support Ship “Absalon” was delivered from Odense Steelship Yard in October of this year – it has been decided to introduce a new generation of Combat Management Systems (CMS), which will give us the benefits of the latest technology. Also, we decided to upgrade some of the current Flex-ships with this new system.

Broad Set of System Requirements
In 2001, the NMCD contracted Terma to develop the future CMS, which should meet the following broad set of requirements:

- Provide maximum operational functionality as specified in the various mission models – including interfacing of current and future weapons, sensors, and communication systems.
- Provide a system which makes the maximum use of COTS and mainstream technologies.
- Provide a software system which accepts changes and upgrades without major rewrites of current software and which can be used in all types of ships without changes.
- Provide the system at the lowest possible cost.

Terma has successfully executed development of the new CMS under a very tight time schedule. In November 2003, the new CMS was installed in the first Standard Flex 300 ship, the HDMS LOMMEN. Passing the functional delivery tests, it has been operational since spring 2004.

During the software production, Terma and the navy have been working closely together to design the optimum functional features of the CMS. This process has been very rewarding for both parties, and it has provided the navy with novelties in function, management, and maintenance, which we have never seen before, and which is well accepted by the operators.
The Terma Naval Decoy System is an intelligent and comprehensive decoy system solution. It includes launchers, electronics equipment, software algorithms, and a console with a simple and intuitive user interface.

The system is open and flexible and has been designed for easy integration into the ship’s command and control systems for combat management and electronic warfare. Terma has developed a unique automatic ammunition identification system, which shortens the loading cycle and prevents the potential devastating effect of using the wrong decoy.

In order to achieve the best decoy defence on modern naval ships today, it is important to evaluate not only the parameters of the ship, but also which decoy solution that provides the best own ship protection. Launching platforms and the number of tubes required in order to fully benefit from the advantages of the new types of decoys available today have to be addressed in order to achieve effective self-protection.

Prime requirements to the decoy launching system has so far been to protect own ship against RF (Radio Frequency), IR (Infra Red), and dual mode missiles. During the last few years, anti-torpedo defense, using an acoustic decoy, has also been possible.

New decoys that protect own ship against laser guided missiles and visual guided missiles are under development.

The Terma SKWS Decoy Launching System has proven highly effective through multiple tests performed by the Royal Danish Navy (RDN) for more than ten years. The cooperation with RDN is ongoing, and the system is in continuous development in order to counter the new challenges in modern Electronic Warfare. The Terma Naval Decoy System is well on its way to being established internationally with the system in service in different configurations in Romania, Australia, Norway, the Netherlands, and Denmark.

Decoy Launching System for the Modern Frigate

12 tubes SKWS Decoy Launcher - with the royal ship, the “Dannebrog” in the background.
Working with Naval customers requires a broad spectrum of expertise. Understanding user requirements and not least understanding all the technical disciplines are vital in order to create solutions for today’s navy.

The prime solution for Terma is Combat Management Systems or C4I (Command and Control systems), but in fact the knowledge from C4I and Microwave technology has also enabled Terma to develop and sell our SCANTER Radar systems and SKWS Naval Decoy system (SKWS: Soft Kill Weapon System) worldwide.

A less known segment is our solutions related to missiles, including missile production, missile launch controllers, and missile test equipment.

The Evolved SeaSparrow Missile (ESSM) is the preferred self defense missile in NATO, and Terma produces prime components for this missile. The Evolved Missile Launch Controller for the Raytheon MK-56 system is developed by Terma, and was one of the first systems to go into service with the ESSM.

Supporting both ESSM and the RIM-7 SeaSparrow Missile, Terma has developed a fully computerized test-set, providing full test coverage with go/no-go indication and detailed log indications in case of error detection.

A key enabler for the missile solutions has been the cooperation with Boeing for the Harpoon Missile Simulator. The requirements included harsh environmental requirements and internal temperature management solution.

SeaSparrow and Harpoon missile simulators for pre-load of launch systems on a wide range of platforms.

Terma has developed the Evolved Missile Launch Controller that provides functionality in the Raytheon MK-56 Evolved Launch Controller.
During the last two years, Terma has been awarded contracts for more than 35 radar systems to the U.S. Coast Guard’s Ports and Waterways Safety Systems (PAWSS) program. As a sub-supplier to Lockheed Martin, Syracuse, Terma has supplied new radar sensor systems to be installed in several U.S. ports, including Houston, New York, and Seattle.

In the New York area, the Vessel Traffic Service system consists of a vessel traffic center as well as radars, situated along the East and Hudson Rivers up to the George Washington Bridge, on waterways connecting to Ports Elizabeth and Newark, N.J., and at the approaches to New York harbor from Sandy Hook, N.J. to the Verrazano Bridge.

The high-resolution SCANTER 2001 radar sensor systems provide an extensive surveillance capability to the Coast Guard. Thus, enhancing overall system safety and security.

The U.S. Coast Guard’s decision to base their safety, security, and surveillance concept on the SCANTER 2001 radar is indeed a very positive outcome of the engineering efforts. As new technologies become available, the operation of as well as requirements to VTS and Coastal Surveillance systems are changing rapidly.

Yet, the radar remains the primary sensor for both cooperative and non-cooperative targets. Especially in congested waterways, successful implementation of AIS makes heavy demands on radar performance to ensure a consistent correlation between the two sources of information.
New Radar System for Naval Sea and Air Surveillance

Today’s naval sea and air surveillance systems must provide means to cost-effectively, automatically, and reliably detect and track surface targets as well as targets in the airspace.

Recent intensive design and development has enabled Terma to offer a complete radar system package, the SCANTER 4100, including high-performance antennas, advanced signal processing, and automatic target tracking, tailored to cope with the above challenges.

The SCANTER 4100 is designed to provide optimum performance with respect to both sea and air targets - being well aware that this has always been a challenge, compromises must be accepted.

Basic Radar Requirements:
The requirements to radar systems for sea and air surveillance are:

- Simultaneous, continuous coverage from very short to medium/long range combined with high resolution and high sensitivity.
- High antenna gain and narrow beam-width in order to obtain sufficient range coverage, sufficient weather penetration, and reduced susceptibility to noise.
- Efficient sea clutter suppression by means of MTI processing (Moving Target Indication).
- Fully automatic operation and ideally that the system is able to cope with all weather conditions.
- Automatic initiation and tracking of sea and air targets from 0 NM to radar horizon, and the supply of accurate plot and track data to a Local Area Network for distribution to bridge displays and command system consoles.

All these aspects form an integral part of the SCANTER 4100 Radar system concept. In addition, Terma has been successful in keeping a low cost structure which makes the SCANTER 4100 well suited to meet the needs of a wide range of surface ships, ranging from patrol boats to Ocean Patrol Vessels, frigates, and other major surface combatants. Life cycle costs have become a major issue to customers all over the world. It is well understood and recognized, and Terma’s products are known to fulfill the expectations.
Small Target Detection in Harsh Weather Conditions

Terma offers a complete radar sensor system designed to assist authorities in their efficient monitoring of illegal activities such as drug and weapon trafficking, smuggling, illegal immigrants, piracy, illicit fishing, terrorism, etc.

There is growing certainty that the global campaign against terrorism should be merged with the long standing war on illegal narcotics and transport of illegal immigrants. Most of the organizations designated Foreign Terrorist Organisation (FTO) by the Secretary of State in the U.S. have some connection to those illegal activities.

Not surprisingly, the policy makers worldwide and in particularly in the U.S. view narcotics, illegal immigrants, smuggling, and terrorism as part of the same transnational threat to the homeland.

The primary method for smuggling large quantities of drugs through the Caribbean is via maritime vessels. Go-fast boats (a small target) remain the most common conveyances for moving multi-hundred kilos of drugs. Also traffickers often transport drugs in single- or twin-engine aircraft to clandestine landing strips, or by air dropping drug loads to waiting maritime vessels.

The Terma solution

Intensive design and development has enabled Terma to offer a complete radar sensor system with a proven small target detection capability. The system has been designed to assist authorities in their efficient monitoring of illegal activities such as drug and weapon trafficking, smuggling, illegal immigrants, piracy, illicit fishing, terrorism, etc.

Generally, any security organization needs to see and follow everything on the sea surface, including very small, slow, as well as fast craft.

Reflections from large targets like coasters, ferries, larger cargo vessels, and tankers must not prevent the detection of nearby small targets. Consequently, today’s naval surveillance and costal surveillance systems must provide the means to cost-effectively detect and track targets both at the sea surface as well as in the airspace.

Small Target Detection

To comply with the requirements to small target detection even in harsh weather conditions, radars must have efficient radar signal processing techniques and large high gain antennas with either horizontal or circular polarization and use advanced tracking techniques, including parallel trackers individually optimized for the different types of targets.

Terma used their SCANTER 2001 radar sensor system configured as a transportable radar system together with a calibrated reference target.

A long series of trials to improve detection and tracking of very small objects have been carried out in recent years in the U.S., the Caribbean, and in Europe. Additionally, tests have been carried out during setting-to-work and commissioning of operational systems.

Results from more than 30 locations worldwide have been obtained and analyzed. This includes climates ranging from tropical to arctic and sea (inland waterways and open sea). Controlled targets were the primary test objects. Actually, illegal activity occurred on several occasions, proving the systems being well-suited for the application.
Terma has a long tradition of supplying high performance radars for VTS – Vessel Traffic Services – worldwide. The company is an industrial member of IALA, the International Association of Lighthouse Authorities, and participates in its VTS committee work.

During an IALA Symposium in Singapore, VTS 2000, it was decided to develop performance standards for VTS equipment.

The assignment was handed over to the VTS Committee. Industrial members and National representatives provided comprehensive expertise on the matter. Jens Christian Pedersen from Terma was asked to be the Editor.

So far, the work has resulted in the IALA recommendation V-128 with an annex covering radar services that was approved by the IALA Council in May 2004. The intention is that the recommendation will cover all aspects of VTS. Annexes for remaining services are in preparation.

V-128 is structured as a comprehensive performance guideline, rather than an equipment standard. It is targeted at competent authorities, specifying generic performance requirements and factors to be taken into account as to the environment, local conditions, etc.

The obligation of IALA is safety and safety is the focus of the V-128 recommendation. However, Security in ports and waterways is of increasing concern and is referenced in the recommendation.

The performance recommendation for radar service is divided into three levels:

1. Standard recommendations applicable to all three levels of VTS as identified by the International Maritime Organization, IMO – Information Service, Navigational Assistance Service and Traffic Organisational Service – for areas with medium to high traffic density and/or without specific navigational hazards.

2. Relaxed recommendations applicable to two levels of VTS as identified by IMO – Information Service and Navigational Assistance Service – for areas with low to medium traffic density and without specific navigational hazards.

3. Extended recommendations applicable to VTS areas with high traffic density and/or specific navigational hazards.

Jens Christian Pedersen states about his commitment in the IALA VTS Committee:

“It is extremely interesting being a committee member and an active contributor to an organization like the IALA. The work is a tremendous challenge. In the committee, all

New International Performance Standard for VTS
IALA RECOMMENDATION V-128:

Jens Christian Pedersen is the Product Line Manager for Terma SCANTER Radar systems and Terma representative in the IALA.

After graduating in electrical engineering, he was employed as a research assistant at Queens University in Kingston, Ont. Canada. He has been employed in Terma A/S since 1982, and pioneered the company’s activities in Radar Sensor Systems for VTS, Coastal Surveillance and Airport Surface Movement Radar applications.

Mr. Pedersen specialized in combining radar technology with operational and meteorological knowledge, and he has been the principal engineer in the definition of hundreds of radar systems for customers worldwide. He is a key employee behind the SCANTER radar sensors and is renowned internationally as a highly experienced and capable radar expert.

International Association of Marine Aids to Navigation and Lighthouse Authorities, IALA, is a non profit making international technical association. Established in 1957, it gathers together marine aids to navigation authorities, manufacturers, and consultants from all parts of the world and offers them the opportunity to compare their experiences and achievements.

IALA is encouraging its members to work together in a common effort to harmonize aids to navigation worldwide and to ensure that the movements of vessels are safe, expeditious, and cost effective and at the same time protect the environment.

Link to IALA’s website: http://www.ialaonline.org

aspects of the VTS trade are represented; operators, authorities, and the industrial members – all gather in the same forum. The professional level is high, and the organization is an extremely valuable forum for knowledge exchange. At every VTS committee meeting about 50 representatives are present, making the IALA the perfect opportunity to meet competent persons within the VTS community.”

The IALA committees meet regularly, normally twice each year, and the IALA Conference / Symposiums are held every two years.
We Provide Mission Critical Solutions

Terma develops and markets high-tech solutions, systems, and products for civilian and military applications. Terma A/S headquarters is located at Lystrup near Aarhus, Denmark. Terma is a 100 % Danish owned company.

Terma’s high-tech solutions and products are developed and designed for use in extreme mission critical environments and situations, where human lives and valuable material assets are at stake.

The main business area, Aerospace & Defense, covers:
- Aerostructures for aircraft
- Self-protection systems for aircraft and ships
- Audio system solutions for pilots
- Reconnaissance systems for fighter aircraft
- Command and control systems for navy, army, and air force applications
- Tactical communication solutions
- Electronics manufacturing.

In addition, Terma has business areas within:
- Radar surveillance systems
- Solutions, services and products for space applications
- Air traffic management systems
- IT services.

Domestic Terma facilities are located at Lystrup, Grenaa, and Herlev.

Abroad, Terma locations include Leiden, the Netherlands; Besozzo, Italy; Weiterstadt near Frankfurt, Germany; Washington DC, and Warner Robins, GA, USA.

Terma A/S was established in 1949. For many years, Terma has worked closely with defense forces, public authorities, and international organizations around the world. Through these relationships, Terma has gained in-depth knowledge of and insight into our customers’ working environment and an equally deep understanding of their situations and needs.

Terma is ultimately owned by the Thomas B. Thrige Foundation.

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