VTS/Coastal Surveillance

Maritime Master

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1.1 Introduction

Vessel Traffic Services (VTS) ensure the safety of maritime operations, improve the efficiency of navigation, and protect the marine environment. VTS is especially important for those areas where traffic congestion increases the risk of incidents or where the environmental consequences of an incident could be severe. Due to the potential risk of human casualties and long-lasting environmental effects caused by maritime disasters, public pressure on government and local authorities has increased. Subsequently, the demand for VTS systems throughout the coastal traffic highways of the world is growing. VTS systems are no longer reserved only for major ports, waterways, and maritime authorities but are increasingly significant for a wide array of smaller though equally important maritime service providers.

Thales Maritime Safety and Security International has long-term experience in efficient development and delivery of VTS and coastal surveillance projects as well as upgrade and integration of existing sensor and applications for management of maritime safety and security.

The result of these activities is Thales Maritime Master, a continuously improved component suite designed to provide an affordable, versatile VTS system fulfilling IALA V-128 requirements for Vessel Traffic Services. It provides state-of-the-art technology and components delivering high-performance and highly reliable vessel traffic management services across a wide range of VTS needs.

This document describes the key functions and characteristics of Maritime Master for VTS and Coastal Surveillance application.

1.1.1 Key Functions

Thales Maritime Master provides features, interfaces and integration capabilities such as:

- User-friendly Traffic Display System for efficient task execution
- Automatic conflict detection
- Multi-sensor fusion for increased track accuracy
- CCTV integration for track classification and identification
- Advanced radar and data processing for small target detection
- Integrated recording and replay (data/voice) for incident situation replay
- Web-based VTS integrated traffic picture (VTSweb) for remote access and dissemination of traffic information
- Auto-adaptive radar video network load management
- User role management based on LDAP
- Traffic simulation tools for training and validation

1.1.2 Key Characteristics

- Modular component-based architecture
- Fully compliant to IALA recommendation V128
- System flexibility and extensibility through open interfaces
- Interoperable with any Radar/AIS equipment and network
- Easy integration of maritime communication facilities (GMDSS, DSC)
- Easy integration with 3rd-party and RDF for search and rescue support
- Highest system availability
- Open standards and open source
    - Eurocontrol ASTERIX Track protocol
    - NMEA AIS protocol
    - SNMP, LDAP and CORBA interfaces
    - Linux Operating System, Java Application Server

1.1.3 Key References

- Vessel Traffic System (VTS) Antwerp
    - Fully redundant system concept including fallback center
    - Integration of harbour-wide CCTV system with VTS
    - Integration of vessel events into existing system via XML
- Coastal Surveillance Estonia
    - Hierarchical system layout including 4 regional and 1 national center
    - Integration with existing vessel information management system
    - Processing of sea/air channel long-range coastal radar data
- Vessel Traffic Control System (VTCS) Portugal
    - Integration of coastal radar stations with port VTS
    - Provision of 2 centers for north and south region fully synchronized
    - Extensive training support including advanced traffic simulator tool
- Maritime Rescue Coordination Center (MRCC) Oostend (see Figure 24)
    - Integration of Maritime Master VTS with SARIS Search and Rescue and VISION Incident Management System and Frequentis Maritime Communication System (MCS) to improve efficiency of maritime rescue missions
    - Integration of Scheldt Radar Chain
    - Integration of North Sea AIS network
    - Integration of Safe Sea Net (SSN)

1.2 VTS System Design

In general, Thales Maritime Master components can be configured to build systems ranging from small VTS to large coastal surveillance systems. Due to its component-based architecture and compliancy to open standards, Maritime Master can interface with all major sensor types and integrate with domain-specific applications and databases on the market.

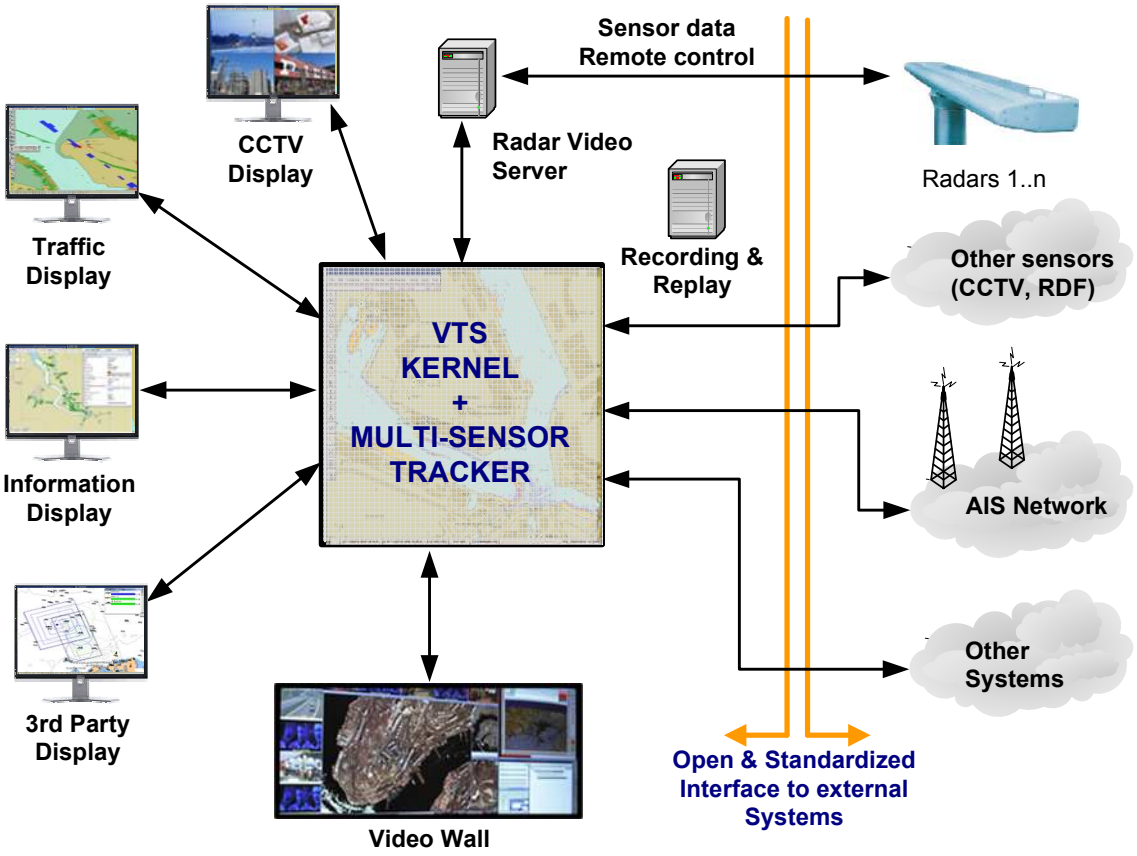


Figure 1: Basic VTS/CSS components

Sensor Systems:

- Radar, AIS, Radio Direction Finder, CCTV/EO systems and meteo sensors.

Domain Applications and Databases:

- Search and Rescue, Incident Management Systems, Vessel Traffic Management Information Systems (VTMIS), Port Legacy Systems, Lloyds Database, Paris MOU etc.

Maritime Communication Systems:

- Voice Communication, GMDSS, DSC

1.2.1 Control Center

The Control Center (Command or Operations Center) is usually located where the main system components and operator working positions reside and where the sensor and other information is processed.

Figure 2: Control Center and Operator Working Position

The centers may range from small single operator workstations to multiple operator workstations and large video walls. They can range from single mission to multi-mission centers or to interlinked centers. The system architecture supports operator collaboration, integrated common and user-defined operational pictures and is fully scalable to future extensions. The integration of existing applications and databases is possible.

1.2.2 Operator Working Position

The Thales Maritime Master solution provides a concept for the operator working position starting from a single traffic display configuration up-to a quad-screen console including a VTS traffic picture, a vessel management and information system, an integrated CCTV display for live video streaming data and one display for the voice communication user interface.

Figure 3: Operator Working Position

The **Traffic Display screen** presents all information relevant to assess the current real-time traffic situation on top of an electronic nautical chart (ENC). The display provides traffic data as AIS and Radar tracks as well as high-resolution radar video. Maritime Master traffic display is compliant with IALA recommendations.

This information comprises:

- Electronic nautical charts compliant to the S57/S52 standards
- Superimposed high-resolution radar video with afterglow
- Superimposed radar/AIS track data
- User-defined traffic sectors, restricted and prohibited areas, guard lines
- Traffic conflict warnings and alarms
- Standard electronic measurements (range and bearing, closest point of approach)
- Zooming and panning of the traffic image
- Track list windows
- Track functions

The **Management Information System screen** presents all information relevant to manage the traffic situation, to dispatch resources to support maritime safety and vessel handling during a port visit or a passage.

- Detailed vessel information
- Detailed conflict and event information
- Filtered track lists
- Resource information (e.g. anchorage areas)
- Voyage information

The **Video Display screen** presents to the VTS operator video pictures of vessel and targets or certain port areas according to the PTZ settings.

- Slave a camera to a track
- Click on the ENC map and retrieve a camera image
- Manually steer the camera
- Replay camera images

The **Maritime Communication Display** is a user interface to handle the radio communication system to receive and answer calls, to send broadcast messages.

The system configuration setup is supported by a comprehensive **user/role management** service. The mapping of TDS features to task-oriented roles is the key to user-/role management in Maritime Master.

Beyond offering standard roles, the VTS system allows to freely define roles to meet the customer's needs: Different users (e.g. supervisor, operator, trainee, trainers or traffic analysts) can be provided with the features they actually need.

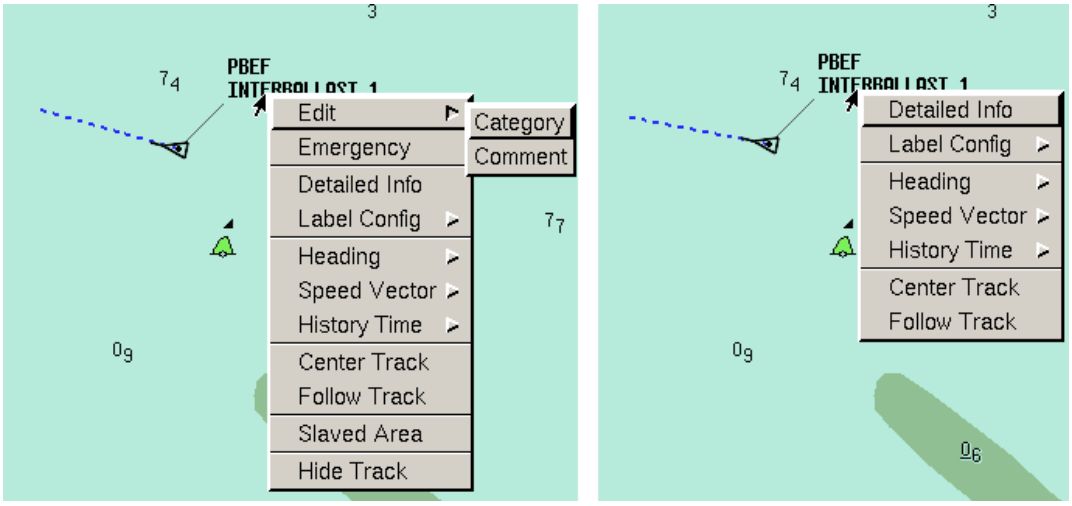
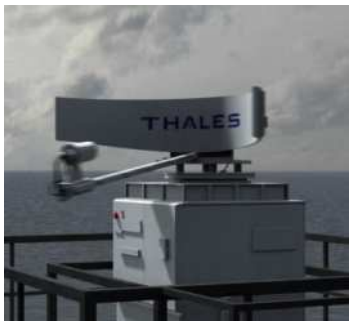


Figure 4: Track context menu with different feature sets

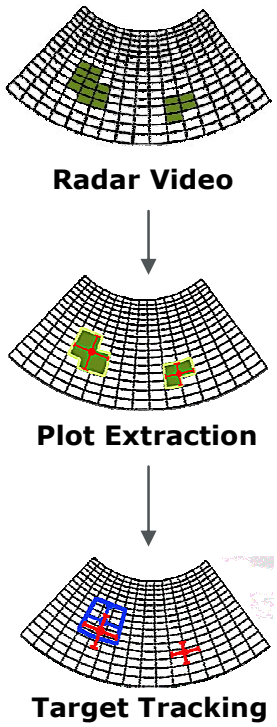
The concept is based on the open standard LDAP to allow for single login even within a heterogeneous application environment.

1.2.3 Sensor Processing and Integration Capabilities



Reliable and high performance sensor data processing is vital to mission-critical systems. Thales Maritime Master offers sophisticated components to process various types of sensor data like radar video and AIS data. Thales offers standardized interfaces for the acquisition and processing of radar data from all common radar sources.

Thales Maritime Master allows interfacing all standard sensor sub-systems to ensure for full sensor coverage of all areas of interest and to obtain diverse and independent data on the traffic situation. This includes long and short range radar sensors, Automatic Identification System (AIS) transponders, Radio Direction Finders (RDF) and CCTV/EO cameras. A suitable maritime communication system can be added to facilitate radio communication between on-shore operators and ships. Relevant measurements of the local microclimate can be monitored using an automated weather observation system.



Thus, the following units comprise the sensor segment:

- Long range approach radar
- Short range port radar
- AIS transponder
- Radio Direction Finder (RDF)
- CCTV/Electro-optical (EO) devices
- Automated Weather Observation System (AWOS)
- Maritime communication systems
- Integrated Recording and Replay including voice and video synchronization

Adequate means of communicating the sensor data to the control center with latencies appropriate for the specific application are provided.

Maritime Master's advanced Multi-Sensor Tracker (MST) processes and correlates data provided by different sensor types (mainly Radar, AIS) in order to produce fused system tracks that are updated by one or more sensors. Flexible input filtering assures sensor specific data pre-processing and prevents undesired target merging.

- Real data fusion (no mosaicking)
- Asynchronous data processing
- Flexible special area handling
- Modular structure, allowing hierarchical and redundant set-ups

1.2.4 System Availability and Robustness

For mission-critical environments such as coastal surveillance, vessel traffic services and port security, continuous system availability is of vital importance. With the Maritime Master system management, Thales provides a tool for comprehensive system control at the highest technical level: System Monitoring, Control and Failover (SMCF). SMCF monitors system health, minimizes downtimes and reduces administration. SMCF is based on SNMP (Simple Network Management Protocol).

SMCF provides system monitoring and control as well as the management and implementation of failover strategies within a distributed environment. The SMCF component keeps the operational system up and running, minimizing system downtime and reducing administration efforts.

Monitored and controlled items comprise of computers, monitors, network, nodes, software processes and hardware devices like power supplies or radar sensors.

SMCF monitors hardware and software states, controls start-up and shut-down activities, (re-)connects processes and I/O-channels, and automatically recovers service from system failures. SMCF observes system parameters such as CPU load, memory usage (on either a system or process basis), and disk space to store this data for further analysis.

SMCF real-time system management features are:

- Monitoring of hardware, software items, database and sensor sub-systems
- Sub-monitoring of customer specific hardware or processes
- Support for redundant networks and redundant radar transceivers
- Definition of failover strategies for automatic reaction making use of all available computing resources (cluster computing)
- Master/standby concept for implementing continuous services
- Automatic restart and redistribution of failed processes
- Graphical user interface to visualize the system status and to control the environment including different views (function versus structure)
- Offline-configurable working environment with different abstraction levels like locations, hosts, processes and capabilities
- Sending of SNMP traps to applications outside the working environment
- Storage of log information via a global logging demon

1.3 Traffic Display System

The Maritime Master Traffic Display System (TDS) presents all the information the operator needs to assess the current traffic situation.

The TDS application provides traffic views, a set of tools, supplementary windows and status information on one or two screens as working environment.

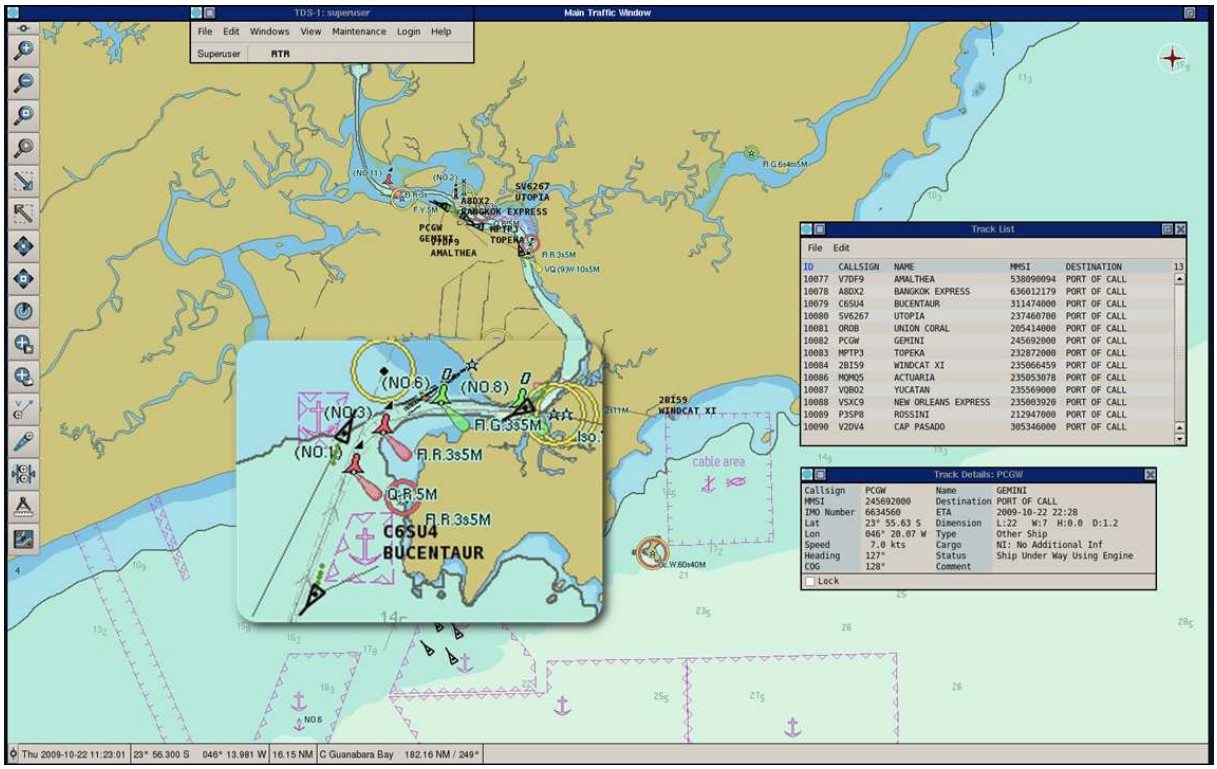


Figure 5: Traffic Display System

The different functions of the TDS are accessible through a menu bar, a tool bar and context sensitive menus. The status bar at the bottom of each traffic window displays system status information.

- Detailed electronic nautical chart of the surveillance area (ECDIS or Inland ECDIS) compliant to the S57/S52 standards
- Superimposed high-resolution radar video with optional radar afterglow
- Superimposed track information including AIS data
- Automatic conflict detection alarms and warnings including support for pre-warning time and distance and complex filter setups
- Standard electronic measurements (range and bearing, closest point of approach)

1.3.1 Basic Functional Overview

Track Label Configuration and Color settings

Track label configuration settings can be modified for all tracks (general settings) or for individual tracks only. In addition to label content configuration, label positions, colors and fonts are also configurable. The track label configuration can be saved with the user preferences. A track label can be tailored according to the track type.

Advanced Track Filtering

The operator can filter each Track list independently. Filtering means to exclude certain tracks from a track list by applying one or more filter criteria:

- spatial exclusion (exclude tracks outside defined sectors)
- exclusion by track type (e. g. exclude non-AIS tracks)
- exclusion by special track property (e. g. exclude all tracks that are not in emergency state)

Multiple Track Lists

Up to 5 track lists can be created (with different filters) in order to observe different types of tracks. Each list may be titled individually.

Track List Filter

For each track list, a different filter can be applied, adjusting it to the specific operator's needs. Track filtering criteria may be the name, current position (sector), the type (e.g. AIS) or specific properties (e.g. emergency tracks) of a track.

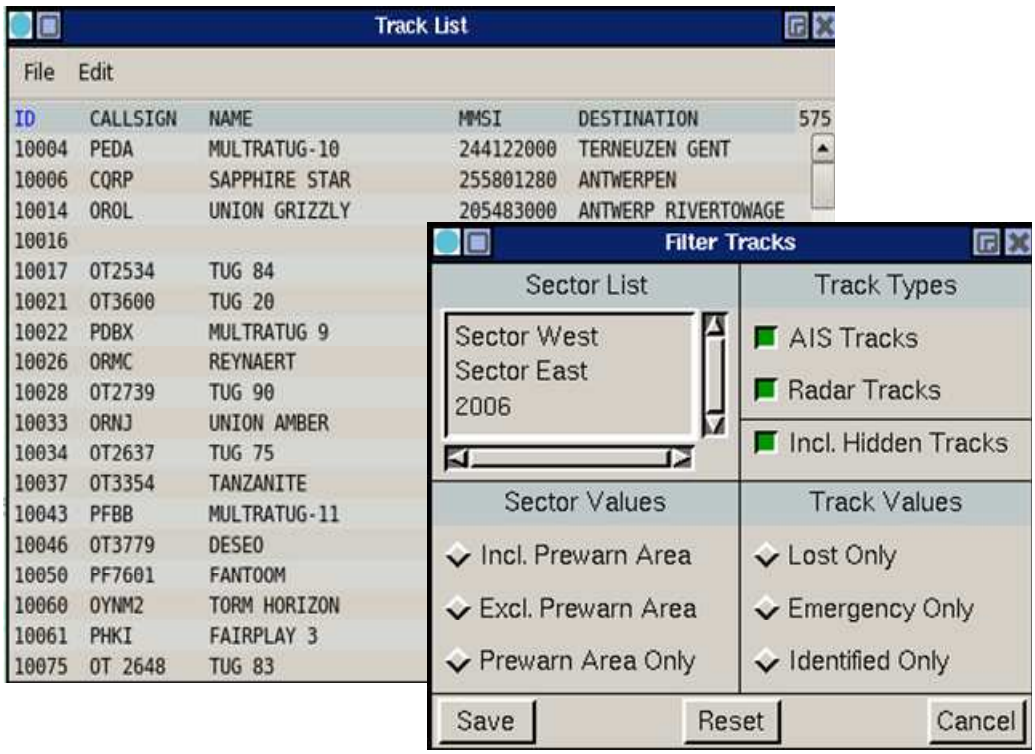


Figure 6: Track list and Track Filter

Navigation Control

A Google Earth-like Navigation Control provides a compass rose and a zoom slider for easy panning and zooming as an alternative to the respective Toolbar buttons.

Safety Depth and Contours

Water depth information relevant for navigation safety can be displayed in the ENC map. Critical soundings can be selected, and areas of defined depth are delimited by contour lines.

Ship Position Backtracking

To identify suspicious tracks or unusual manoeuvres, a track's history can be recalled for a period of up to 10 days. This is especially helpful for tracks coming from outside the VTS area where they could not be observed.

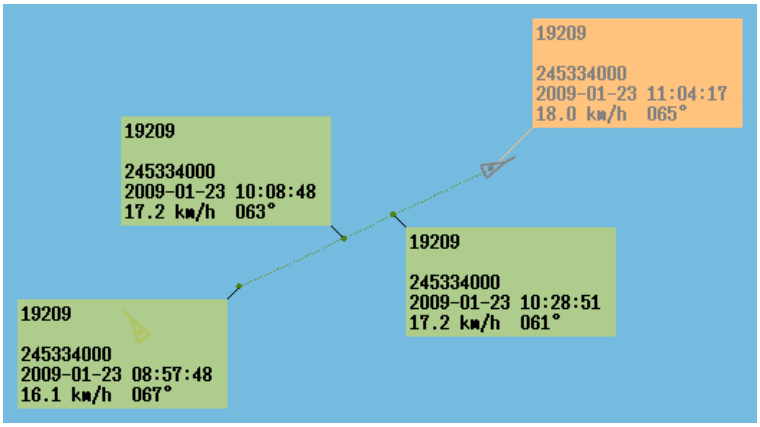


Figure 7: Backtracking of vessel positions

Go-to Marks

An operator may want to store map positions for rapid access to observe locks or other points of special interest. For that purpose, he can use the so-called *Go-To Marks.*

ECDIS Object Picking

The operator can display information on individual ENC elements in a dialog by selecting the desired ENC element in the traffic window by mouse click. The operator can define a picking sensitivity radius and a highlighting flag.

Track Label Depot

Specific information which has been manually assigned to a track can be stored for future use. In the so-called Track Label Depot, these data can be kept after track loss and re-assigned later.

Track Merge and Label Shift

Manually edited track label information can be shifted from an identified (AIS or radar) track to an unidentified radar track. Two tracks considered to represent the same target can be merged into one.

RDF interface

The Radio Direction Finder (RDF) listens to one or more defined radio frequencies - depending on its mode of operation. If a signal is detected, a corresponding azimuth line can be displayed on the TDS (with a label identifying the channel).

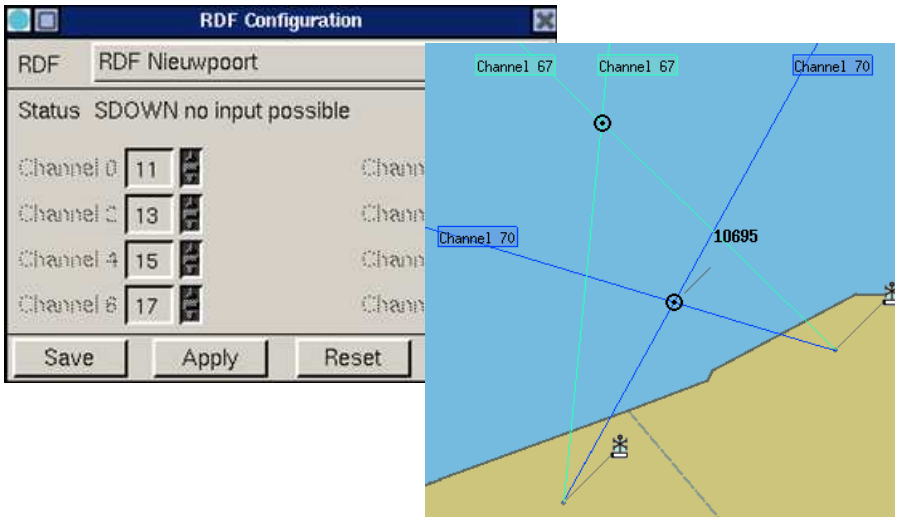


Figure 8: RDF Display of bearings

Weather Information

Access to weather information on the TDS is an optional system feature, depending on integration of meteo sensors into the VTS system.

Sector Definition

Within the VTS surveillance area, sectors can be defined. Corresponding track lists only show tracks in each sector. Sectors can be defined with a Prewarning Area, which further enhances the possibilities for sector-based track list filtering.

Track List Sorting and Highlighting:

A track list can be sorted by a single click on the column header of the list. A track can be highlighted in the list by simply moving the cursor above a track or vice versa.

Track Functions

Track context menus are available for both visual tracks and track list items. The functions available allow to mark tracks for emergency, hide, center or follow track, configure label, set speed vector and history time, assign route and more.

Track List Print

For documentation purposes, the content of any track list can be printed.

Day and Night Color Schemes

To meet different light conditions, the operator can apply various color schemes at his working position.

1.3.2 Track Display

Synthetic tracks are displayed on top of the radar video. All (geo-referenced) images are displayed by north-up map orientation.

- Speed vector
- COG vector
- History plots
- Cargo type
- AIS symbols (dot, triangle or shape, depending on zoom level)
- STANAG symbols (for coastal surveillance)
- Track label

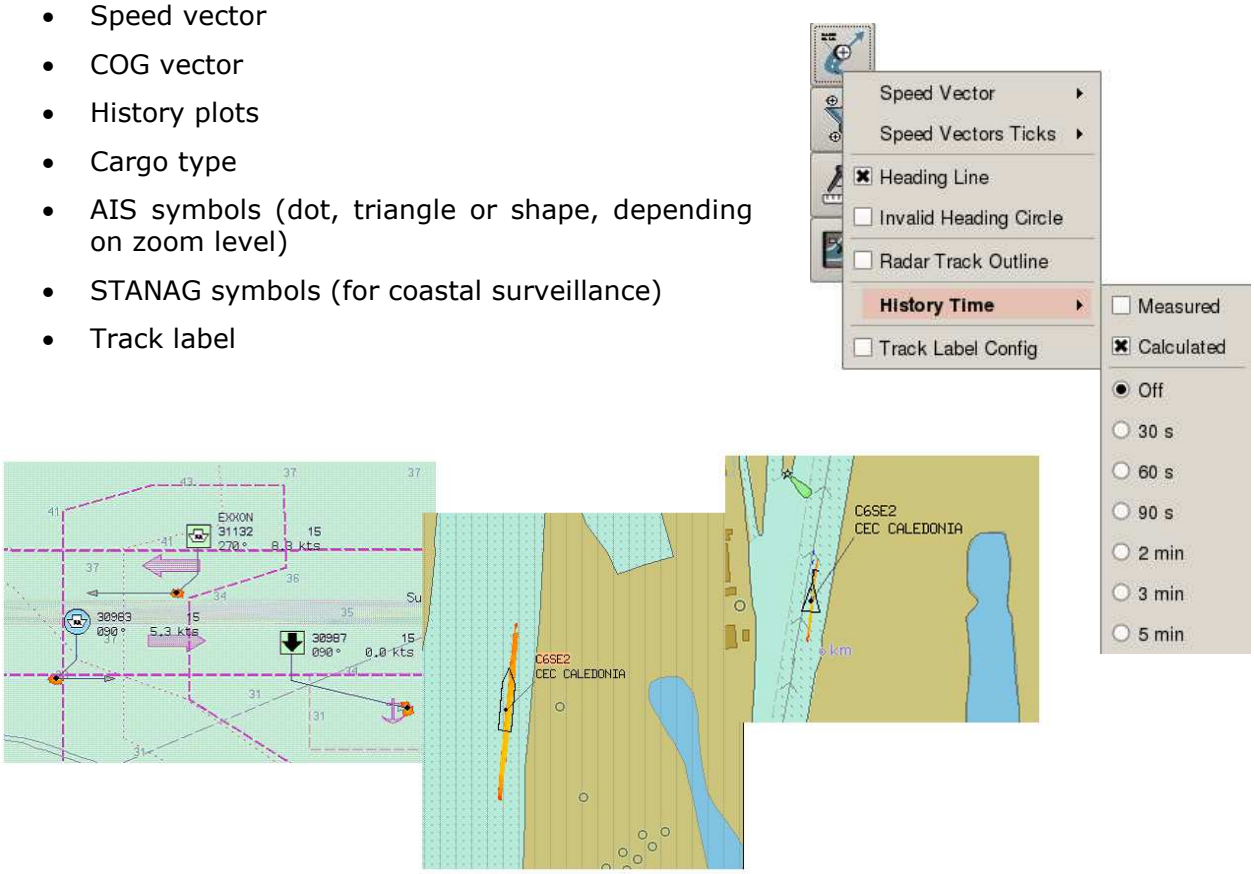


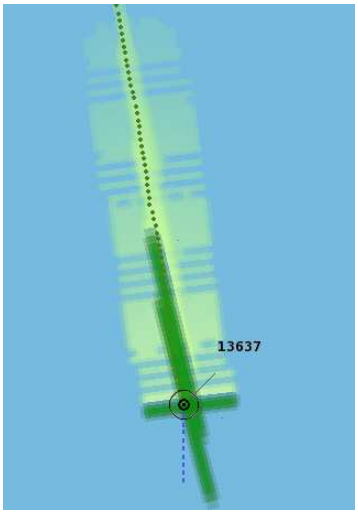
Figure 9: Track symbols

AIS and radar tracks are represented according to the IALA recommendations. The track symbols are configurable in size. When zooming in, vessel shape outlines are shown for AIS tracks.

Figure 10: Radar Track (unidentified/identified)

Track labels can be configured globally, for each individual track or a group of tracks.

1.3.3 High-Resolution Radar Video



Particular threats are usually perceived to come from small craft, such as rubber boats or speed boats in littoral waters. The solution Maritime Master offers is to display the raw, unfiltered high resolution radar video to the operator in addition to the output of the Radar Extractor Tracker. This feature can be of great value to an experienced VTS/CSS operator, since he can detect much more details from the radar video than an extractor is capable of.

Maritime Master advanced raw radar video display provides the following characteristics and benefits:

- Unfiltered radar video data stream
- Display of two radars with a certain double coverage area with translucent mixing of the two radar videos.
- Geographically correct the projection of two radars so the echoes of ships seen by both radars match exactly. This is possible due to the geographic real-time projection where the center of projection does not need to be the position of one of the radars (no need for stereographic projection; "Geowarping").
- Translucent mix of radar echoes and the afterglow with a variable mixing rate: Orientation of the target can be better predicted.
- Loss-less compression for distribution on LAN/WAN

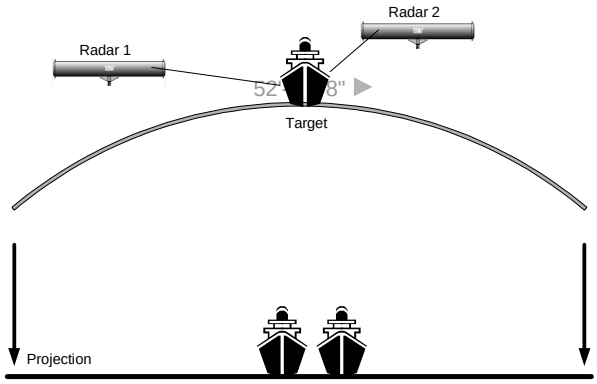


Figure 11: Radar video from two radar sensors

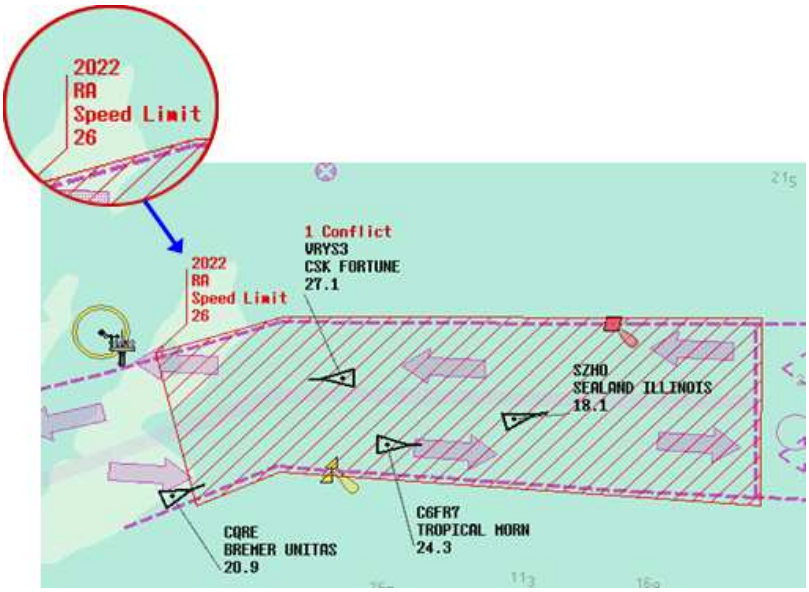
1.4 Conflict Detection

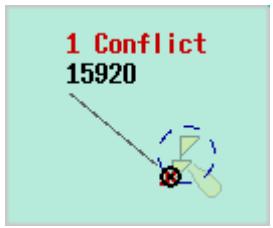
To increase safety and security in the traffic surveillance area, a conflict detection unit will allow automatic detection of traffic conflicts and potential conflict situations.

The automatic conflict detection is based on the evaluation and prediction of the movement of tracks obtained by processing the sensor data and topology data (restricted areas, etc.) the traffic situation is analyzed for typical conflict situations and traffic rule infringements, such as:

- track crossing an active guard line
- track entering an active guard ring or a guard area
- track leaving a buoy ring or a swing circle
- track exceeding an area specific speed limit
- track entering an active prohibited or restricted area
- track entering a special area slaved to another track
- time to and distance at the closest point of approach (CPA) of two surface tracks under collision control being both within the configured values
- track approaching an active special area with the intention to enter it

Via user-editable chart objects, it is possible to demarcate restricted/prohibited areas around anchorage places or perilous areas around obstacles or off-shore constructions). This way, alarm signal can be triggered when a ship approaches or violates the prohibited area.





Buoy Watching

Figure 12: Speed Limit Violation Conflict

Figure 13 shows how detected conflicts are presented to the operator. The tracks causing a conflict are marked; the conflict itself is listed in a designated conflict browser (see Figure 14).

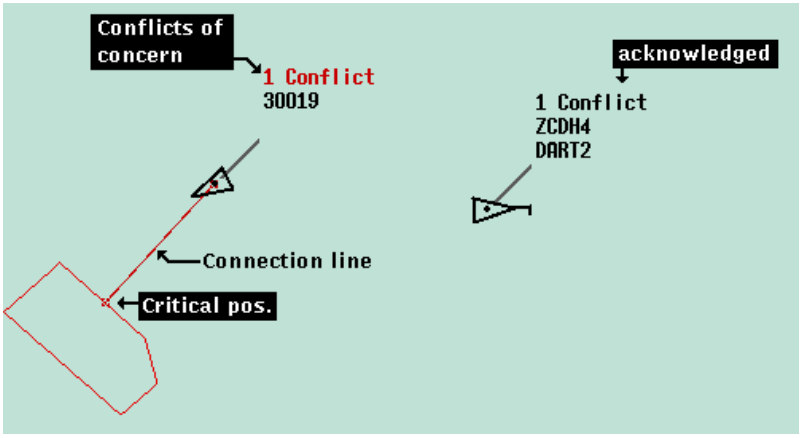


Figure 13: Display of conflict detection (sample)

Figure 14: Conflict list window (sample)

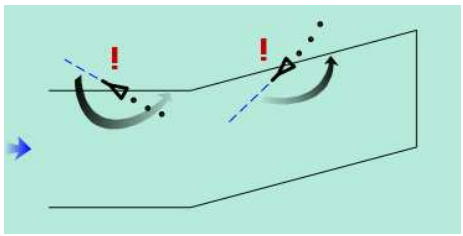
1.5 Traffic Organization

1.5.1 Traffic Lanes

Maritime Master can provide assistance in monitoring vessel traffic corridors by supporting multiple conflict-related features. A traffic lane is a corridor with an orientation. It possesses an entrance, "Traffic Lane (Enter and Leave Angle Violation)"), passageway boundaries and an exit.

Depending on system configuration, Traffic Lanes feature allows monitoring of the following:

- Enter direction of vessel
- Enter angle and leave angle
- Speed minimum and maximum
- Specific restrictions for ship types (according to AIS information)



- Buffer zones between vessels

If a track enters the traffic lane at its exit, a traffic conflict is reported. Likewise, if a track leaves at the entrance.

For crossing the passageway boundaries of a traffic lane, an angle threshold can be defined. A traffic conflict is reported, if enter angle or leave angle exceed the angle threshold.

1.5.2 Route Monitoring

For route monitoring, the following thresholds can be set per route leg:

- Distance to route
- Course over ground deviation
- Speed minimum / maximum

If a vessel assigned to a route violates one of the thresholds, the operator is notified.

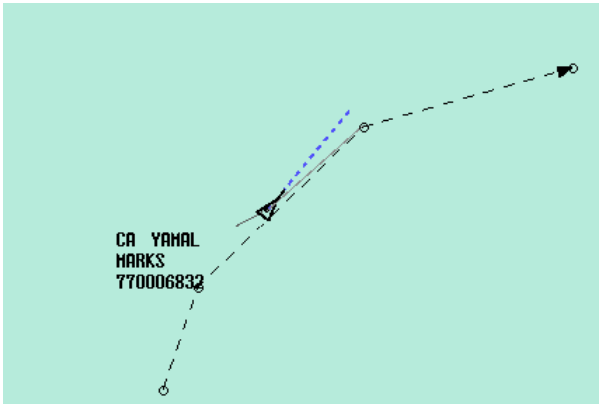


Figure 15: Traffic lane with assigned Track

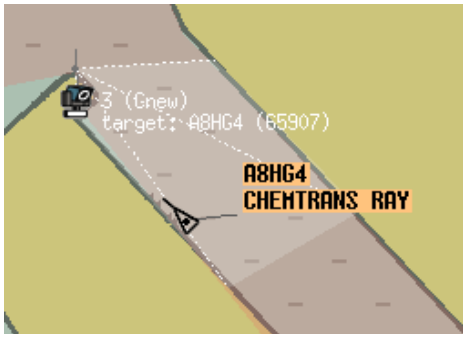
1.6 CCTV Integration

To monitor critical sections inside a port or an anchorage area and to identify vessels and other objects of interest, a CCTV system can be integrated with the Thales VTS/CSS solution.

Closed Circuit Television (CCTV) provides live video streams of determined areas ("Click and View") and moving tracks ("Follow Track"). The video streams are displayed outside the TDS on a separate video monitor.

Click and View

To observe a determined area (bridge, lock, mooring etc.), the operator can click on the map and direct a camera to that area.



Follow Track

Besides fixed targets, it is possible to observe moving tracks (*Follow Track* feature). As the target moves, the camera will automatically follow the track.

Video Recording and Playback

As part of the CCTV integration the video images can be recorded and replayed on demand.

Figure 16: CCTV Integration

1.7 Web-based Integrated Traffic Picture

A browser-based integrated traffic display complements the VTS traffic situation display application employing the same ECDIS charts and further advanced features. The objective is to give external users or remote centers e.g. a crisis room at the responsible authority access to the traffic situation via the internet/intranet.

The VTS web provides the following features:

- Usage of original ECDIS map
- Presentation of tracks and track details
- Track search / filtering
- Display navigation: panning and zooming and view bookmarking
- User access control
- Track history
- Weather information

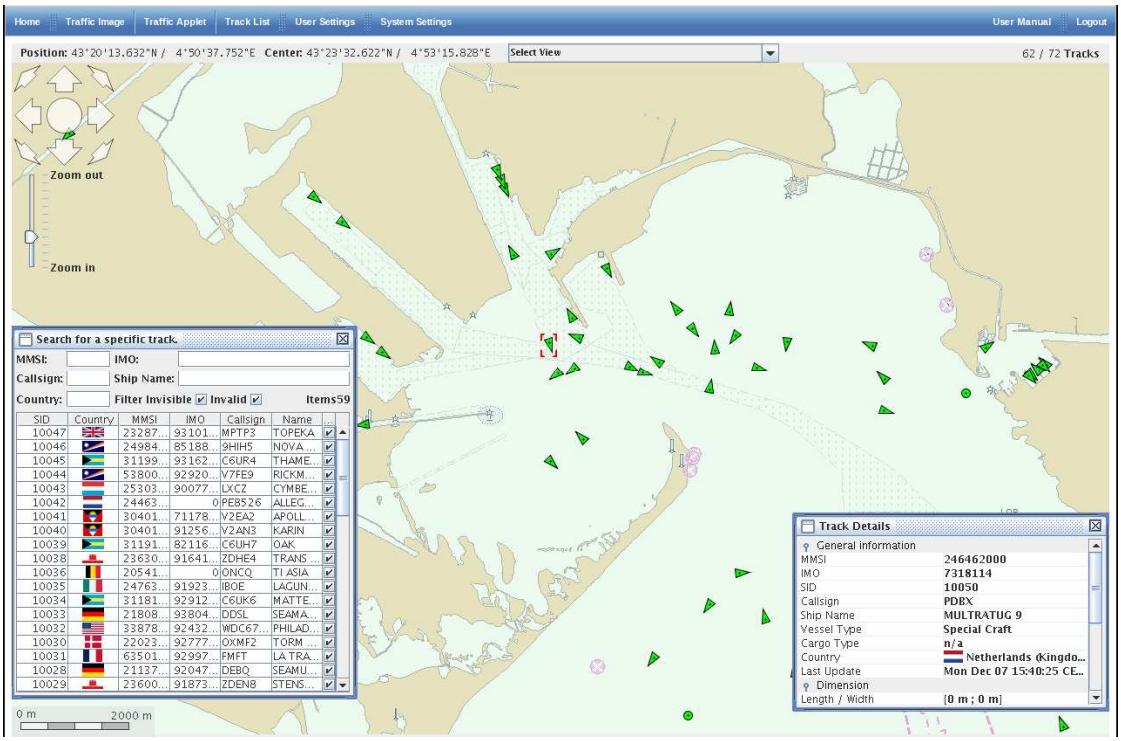
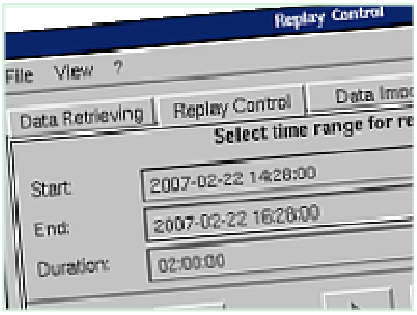


Figure 17: VTSWeb interface

Key Characteristics

- Runs in a standard web-browser served by a Java Application server
- Easy deployment, no installation on client necessary
- Simple user interface, easy to learn
- Easy to administrate
- Easy to extend functionality
- Interface to ship database to display high level track information (AIS)
- Configurable refresh rate (10/min – 1/min)
- Suitable for LAN, WAN and GPRS access
- Designed for low bandwidth consumption
- Deployable on mobile devices like the iPhone

1.8 Recording and Replay



For further traffic analysis and legal purposes, a key feature of Maritime Master is its capability to reproduce traffic situations. For that purpose, the necessary data is permanently recorded. This includes track data, radar video, traffic conflicts, operator actions and voice and system events.

The traffic situation can be replayed in the same graphical and textual form as it was presented during the original operation. During replay, the different recorded data streams are synchronized in respect to a common stored timeline. The user can interact with the traffic display as accustomed from operation. Common actions, like changing range and traffic window, selecting sensors or managing tracks are possible without restrictions.

The following data categories are relevant:

- Radar raw video
- Radar and AIS plots and tracks (output of MST)
- High level information: alerts, conflicts, user actions, system global data
- Audio/voice (VHF)

During a replay session, the screen scenarios can be compiled into a video format which can be replayed in any standard video player software.

1.9 Traffic Simulation and Training Tools

In order to thoroughly validate the functionality of the system and to train operator personnel on the VTS/CSS system, a test and training simulator with the following functionality can be provided:

- Creation, modification and replay of common traffic scenarios, like port approach, imminent collision, ship-pilot docking and separation manoeuvre
- Different types of vessels with realistic kinematical behaviour
- Radar video, radar track, AIS and GPS data generation based on the simulated traffic scenario, including simulation of sensor error and sensor failure
- Online monitoring and modification of a running simulation
- Online manual control of simulated vessels

The Traffic Simulator "Virtual Waterway" (VWW) is a powerful simulator for coastal and inland traffic situations. It is fully integrated into the VTS/CSS system. With this simulator, arbitrary training scenarios can be created, modified and run on-site, using the original VTS/CSS center equipment, thereby allowing to teach trainees in their working environment..

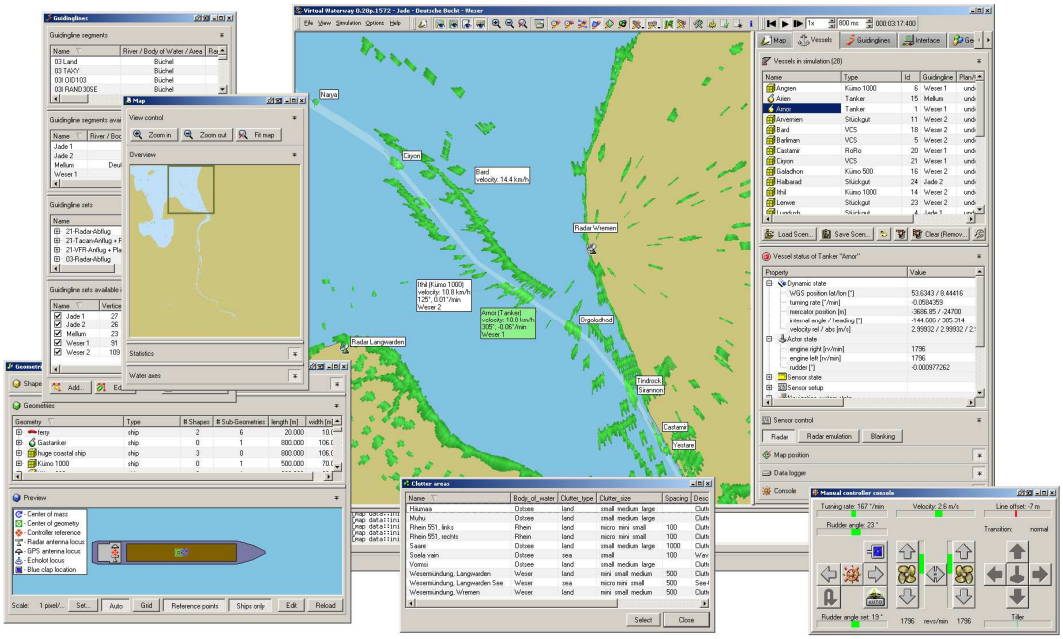


Figure 18: Test and training simulator "Virtual Waterway"

For training purposes, the simulator replaces the radar video server and the AIS server by simulating all sensor input normally delivered by these sensors. The simulator provides a comprehensive graphical user interface which allows monitoring and controlling all aspects of the simulation.

The positions and movements of all vessels in the simulation area are displayed on an electronic nautical chart. The current states and behaviour of all vessels and sensors can be monitored and influenced at run time.

1.10 Management Information System

VTS is used to minimize risks for safety and the environment whilst maximizing the efficiency of waterborne traffic and connecting modes of transport. On the other hand, Port Management Information Systems (PMIS) or Vessel Traffic Management Information Systems (VTMIS) intend, as an information service, to respond to public and private demand for facilitating Vessel Traffic Management and to provide VTS operators at the port with the information they need in order to perform or support their activities.

With regards to a PMIS, the operator has to handle and dispatch anchorage and berth positions, where the vessel can be moored and cargo unloaded and loaded. VTS which uses radar and AIS (LRIT) for localization is aware of the position of the vessel. On the vessel, there is also VHF radio, which can be used for communication with the shore or others vessels.

For further vessel details, Maritime Master can integrate with Lloyd's Register – Fairplay databases where the majority of large ocean vessel is registered. An item in the register contains characteristics of the vessel like physical sizes, incidents, owner etc.

Vessel navigating in ports or unknown waters may need a pilot. There are two categories of the pilots – either for sea or port navigation. There can be more pilots on a vessel at a time. The pilots can be hired by pilot organization which is independent on port organizations. If a vessel needs a port pilot, its captain contacts directly the pilot organization.

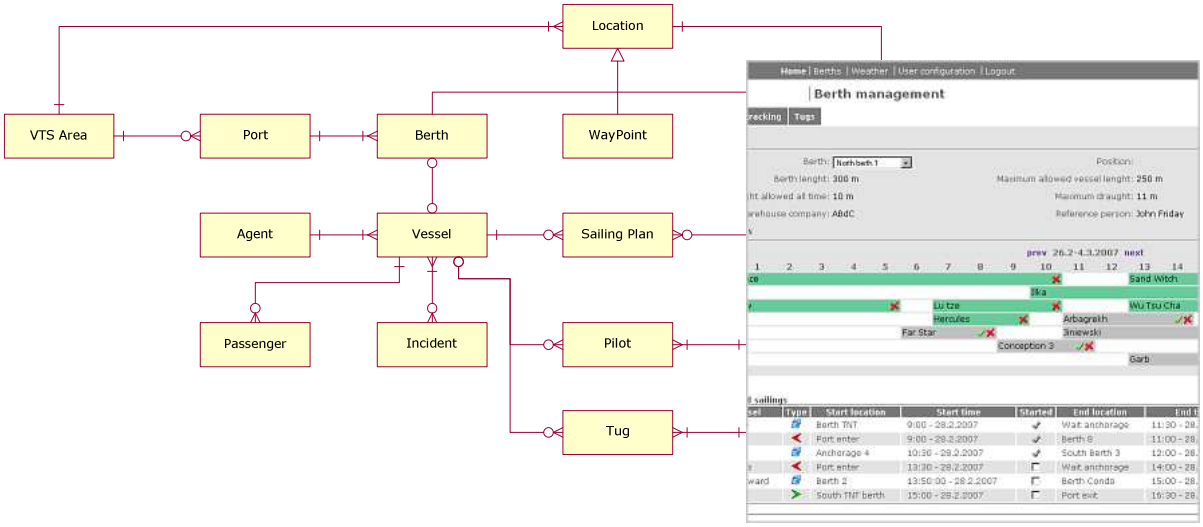


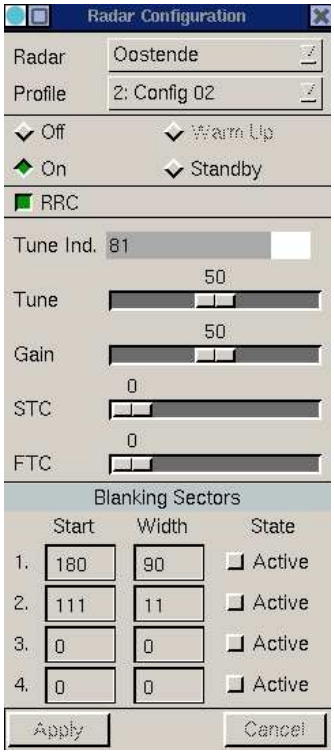
Figure 19: Information System domain data overview

Maritime Master VTMIS provides the tools to create an information infrastructure necessary to achieve the maritime "Safety, Security and Stewardship" challenges of modern VTS.

1.11 Radar Processing / Radar Video Network

In order to monitor ship movements, radar sensors located along a coast or in harbours use electromagnetic waves to identify the range and direction of moving and fixed objects such as aircraft, ships, motor vehicles, weather formations, and terrain. After reception, the sensor signals are passed through several processing steps before they are finally displayed as video image or track report at the operator position in the control center. The radar processing chain, also known as Radar Video Network (RVN), consists of the following components:

- Radar antenna and transceiver
- Radar server / radar interface
- Radar Extractor / Tracker



Radar Antenna

The radar antenna transmits shaped pulses of radio waves which bounce off any object in their path. It captures the radar echo reflected by the objects and transfers this signal to the transceiver. Depending on the requirements of the system, antennas with a variety of properties can be used:

- 9, 12, 18 or 21 ft antennas
- circular or horizontal polarization
- slotted waveguide, parabolic dish, solid state designs
- different manufacturers, like Terma, Thales, Swiss, Furuno, EASAT, Decca, KH

Radar Transceiver

The transceiver generates the radar impulse and processes the received echo return to create the analog radar video signal. As with antennas, transceivers from different suppliers can be used. Frequency diversity and redundant setups are possible.

Radar Interface

The radar interface is an electronic device which serves as the bridge between radar sensor and radar server. It has the following properties:

- Acquisition of analog or digital radar video with high accuracy and quality
- Analog/digital converter resolution: 8bit
- Maximum sampling rate: 100 MHz, trigger synchronized
- Maximum 11000 range cells per beam, max 10 Mio range cells per second
- Maximum pulse repetition frequency (PRF): 10 kHz

Radar Server

The radar server is the first software stage in the radar processing and distribution chain. It has the following properties:

- Masking / land area blanking
- Software filters: STC, FTC, Gain, ASC, Scan-to-Scan
- Auto-adaptive compression and distribution of digital radar video to various processing components (RET, TDS, Recorder) via TCP/IP network
- Radar control and monitoring

Radar Extractor/Tracker

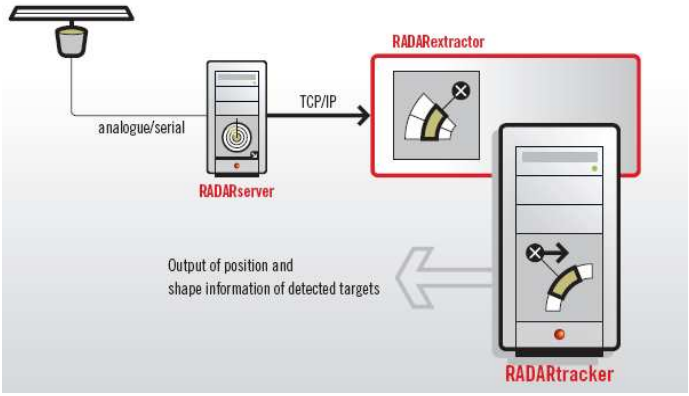


Figure 20: Radar Extractor/Tracker (sample configuration)

The radar extractor receives radar data from the radar server. It detects contiguous echo areas and it determines their size, maximum intensity and center of gravity. Extracted radar plots are feed to the radar tracker. The radar tracker processes the plots of consecutive radar images and produces tracks for repeatedly detected target echoes. A sophisticated extended Kalman filter algorithm, in combination with a mature movement model, guarantee reliable tracking performance and the elimination of statistical sensor errors.

The radar tracker delivers tracks and plots, either on UDP or multi client TCP output channels. Standardized ASTERIX as well as NMEA output is supported.

The Radar Extractor / Tracker supports the following features:

- Network radar interface
- High target processing capacity (>1000 tracks)
- State-of-the-art Kalman filter
- Standardized ASTERIX output
- Standardized NMEA output
- TCP multi client and UDP output
- Integrated CPU load handling
- Integrated output load handling
- Configurable maps for: land clutter, non-automatic initiation, coasting
- Map generation tools for ECDIS available
- SNMP interface for monitoring and control

1.12 Multi-Sensor Tracker

The Multi-Sensor Tracker (MST) is a multi-purpose tracking system, mainly based on extracted radar plot input data and AIS data.

1.12.1 High tracking accuracy with extended Kalman filter

Flexible input filtering assures sensor specific data pre-processing and prevents undesired target merging. The core component of the MST is a state-of-the-art extended Kalman filter algorithm which provides for real sensor fusion and leads to a higher tracking accuracy compared to common alpha-beta-trackers. The algorithm considers quality and reliability of the sensor data during the update of the merged target. All tracked targets have a quality rating indicating the confidence of the track information. Due to the Kalman filter approach, multi-coverage automatically leads to higher track accuracy.

1.12.2 Track continuation in overlapping coverage areas

Track continuation is automatically performed, if coverage areas are overlapping. According to their detection reliability, tracks are either confirmed tracks (objects with high detection reliability) or tentative tracks for lower detection reliability. Confirmed tracks comprise information about position, velocity, acceleration and heading of the specific target.

1.12.3 Efficient ghost target suppression

Flexible non-automatic track initiation areas allows defining additional conditions for track initiation e.g. in double coverage areas it is possible to restrict the track initiation to targets supported by more than one radar, a very efficient method to suppress ghost targets. This is especially important at radar sites inside a port area where e.g. buildings, cranes etc. may make it difficult to select the optimal site.

1.12.4 Route-Stabilized Tracking

Typical tracking problems like passage of bridges, passage through non-covered areas, narrow encounters and sharp curves in harbours are addressed by Route-Stabilized Tracking. Typical traffic routes can be defined to assist tracking in critical situations. The stabilization measures can be precisely governed to optimize the effect by preventing any undesired back draws.

1.12.5 Unrestricted sensor data processing

Due to asynchronous data processing chains the MST will process all incoming sensor data, even if it is delayed. Internal model kinematics and observation equations can be easily adapted to domain and sensor specific parameters. The MST has no restriction on number of input sources. Overload situations are automatically detected and handled by reducing the update frequency and skipping low intensity input plots.

1.12.6 Tracking with Multiple Hypotheses

To help reduce the danger of losing a fast-moving or manoeuvring track in an area with strong sea clutter by wrongly assigning a clutter plot to this track, the MST features multiple-hypothesis tracking. For each track, different assignment options are considered simultaneously. As soon as reliable track data have been re-established, all other options are dropped.

1.13 Integration of 3rd-Party Applications

Maritime Master VTS system allows for upgrade towards a Maritime Rescue Coordination Center (MRCC) system. The major task of a MRCC is to coordinate Maritime Search and Rescue Operations within its area of responsibility. This task involves search and rescue of human life at the sea and the tasks related to combating sea pollution and results from International Conventions such as the International Convention on Maritime Search and Rescue established in Hamburg on April 27, 1979 such as:

- Constant readiness to immediate search and rescue (SAR) action
- Preparation of search action plans
- Coordination of SAR operations
- Cooperation with foreign SAR Services
- Cooperation during the SAR Service with other organizations such as coast guard

1.13.1 Incident Management

Maritime Master VTS system includes a incident management module. It allows for easy managing and logging events and incidents. Users can add new entries or update existing entries as long as they are not closed.

An event or incident always belongs to a particular vessel in the system. The user selects a type ("person missing", "vessel on fire" …) and severity and adds a description and further detailed information on the incident, like the number of persons missing, wounded or killed, and others. The event can be updated as long as it is not closed. All updates will be logged, including the data changed. In addition, the position updates coming from the VTS core will also be recorded, as well as weather information.

Users can add annotations to the event, like additional descriptions or register persons informed about the event. It is possible to send email notifications regarding the event directly through the system. All incidents can be reviewed at any time. This includes the history of the tracks involved in the incident.

1.13.2 Search and Rescue

To facilitate search and rescue activities, Maritime Master VTS has been integrated with the Search and Rescue Information System SARIS of BMT (UK). SARIS is a leading software tool concerned with the accurate determination of search areas for lost people, vessels and objects at sea together with allocation of SAR resources to systematically searching those areas. It is compliant with the UK Coastguard CG3 methodology used by many organizations throughout the world.

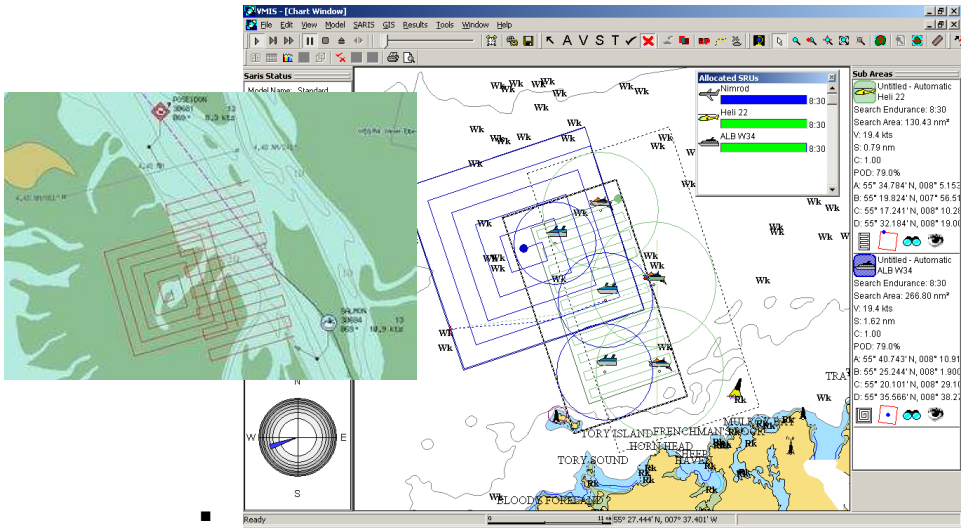
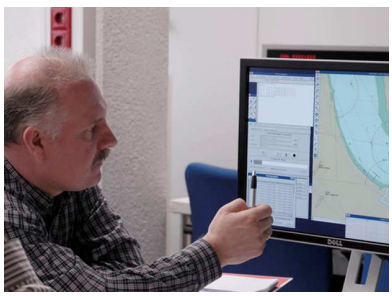


Figure 21: SARIS Search and Rescue System

2 Services

The implementation of a VTS or CSS project will be based on defined and certificated quality standards and processes and will be adapted to align them with the objectives of providing clear accountability, measurable goals, and customer service standards. As a result of these initiatives we have successfully met or exceeded customer expectations regarding contractual performance in similar projects thereby assisting our customer to meet their performance goals. Thales has systematically implemented processes to actively track quality and performance in maritime programs.

Figure 22 shows the project phases which are applied during a VTS project:



Project Phases

Project Definitie
- Kick-off
- Project Management Plan
- Project plan

Design
- Functional Analysis
- Technical Design
- Test plan

Implementation
- Purchase components
- Custom developments
- Preparation of installation

Validation
- Preparation of FAT
- Excustion of FAT

Installation

SAT
- Preparation of SAT
- Execution of SAT

System test & acceptance
- System test
- Acceptance

Training
- Operator
- Supervisor

Support & maintenance
- Within warranty
- Support & maintenance-period

Figure 22: Project phases

3 Conclusion

Advanced VTS/CSS solutions today are no longer reserved for major ports, waterways and maritime authorities, but are becoming increasingly significant for off-shore platform protection, maritime rescue coordination and incident management. Integrated traffic management systems and solutions offering high-performance and highly reliable maritime services are needed to fulfill the continually increasing security standards.

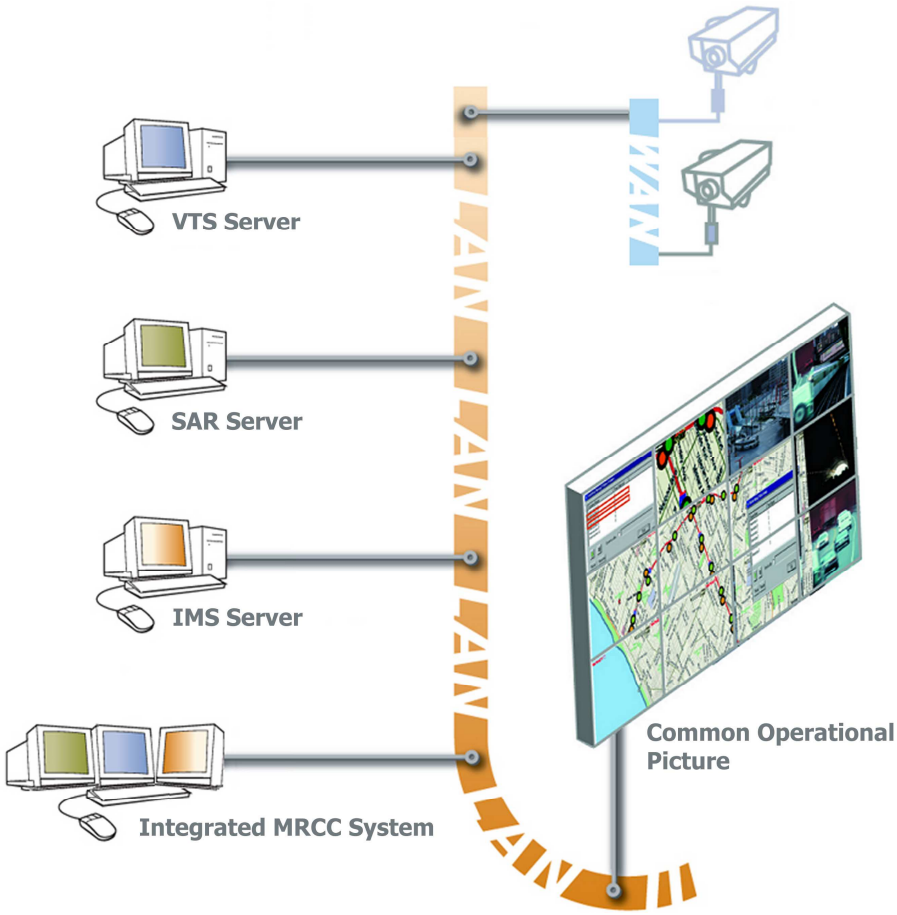


Figure 23: Integrated best-of-breed solution for MRCC operations

Traffic Management solutions should focus on integrating traffic management with rescue coordination services supporting a common-operational-picture visualization for ports, waterways, coastal and maritime security. The nature of maritime crisis management means that different agencies, like the coastguard, search and rescue, anti-terrorist units, emergency response services, security companies, ship owners and harbor organizations, are dispersed in virtual organizations. They need to work together to look at situations, assess the risks, identify potentially critical situations that may develop into crises, develop strategies for avoidance, mitigation or aid, plan for these and then implement. Continual re-planning and updating based on integrated information support is essential as the situation changes. Given this, it is difficult for information and

knowledge to be shared to ensure a high degree of group awareness of how the situation is managed in order to timely, accurate and effective decisions are made throughout the process.

Figure 24: Thales Reference MRCC Ostend, Belgium