SeaCross®

General overview

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Foreword

High speed navigation is a challenging task for navigators and boat operators. Navigating at high speeds in archipelago and littoral waters makes it even more challenging, and here safety margins are very often counted in only tens of seconds. In poor visibility and darkness, the navigator cannot use traditional optical navigation methods and must instead entirely rely on his navigational aids. Few navigational tasks can be more challenging, and fundamentally requires an experienced and well-trained navigator working in combination with a navigation system that gives him the capabilities to do this safely.

The SeaCross® platform and navigation system was created and developed to meet these requirements, with an emphasis not only on high speed system update rates and immediate system response but equally so on an intuitive user interface and data representation that enables the navigator to make instant and safe decisions. The navigation system itself is an integral part of the SeaCross® platform that entails functionality for training, simulation, planning and de-briefing.

Born in Scandinavia and based on extensive experiences from high speed navigation in archipelago waters, the SeaCross® system was introduced to the market in 2006. Since then the SeaCross® platform has been in a process of continuous evolution driven by requirements formulated in close dialog with professional high-speed navigators all over the world.

The system includes a redundant, scalable and flexible hardware solution uniquely tailored for each project and project requirements.

Today SeaCross® offers unparalleled capabilities to professional high speed operators and navigators.

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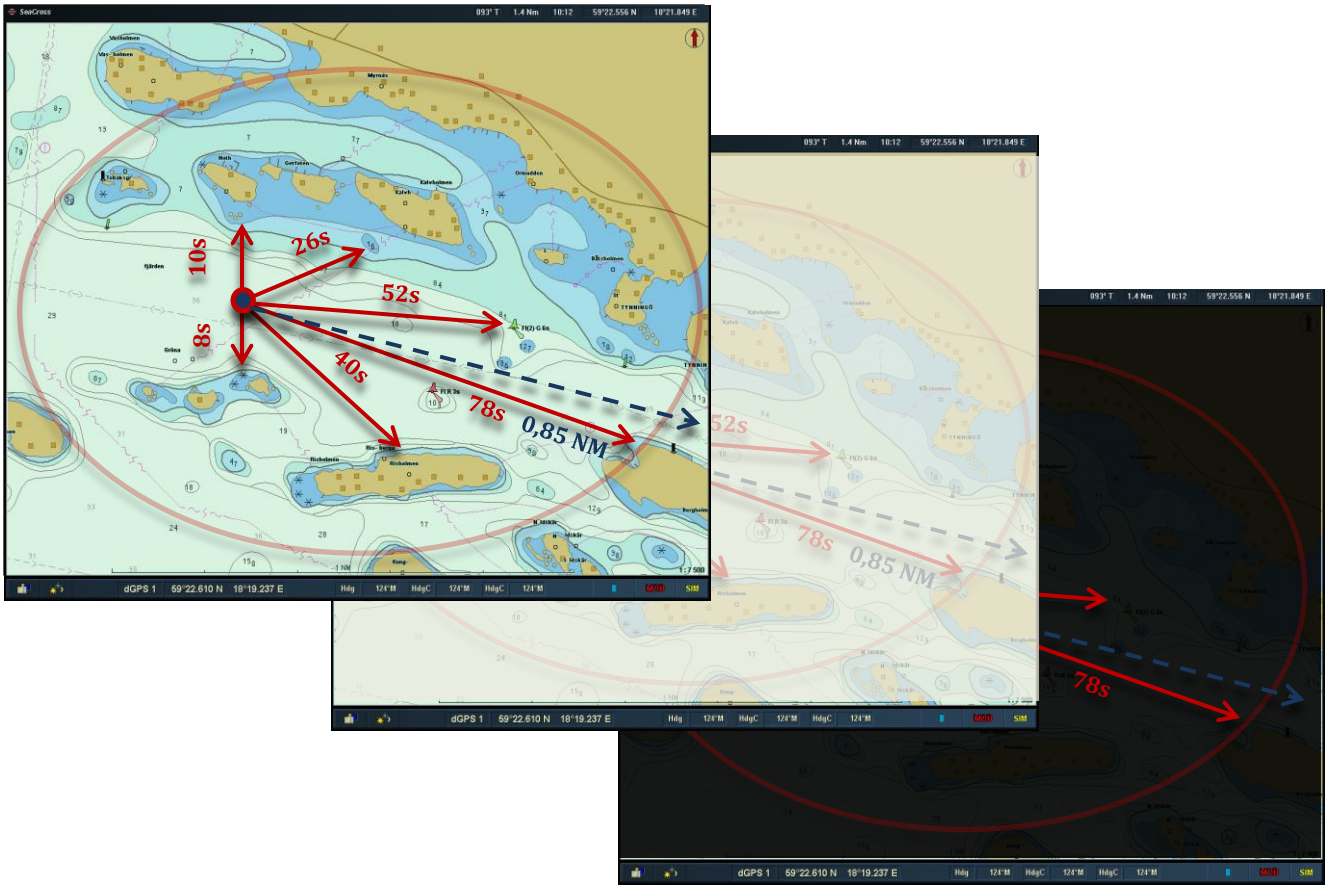
1. Introduction

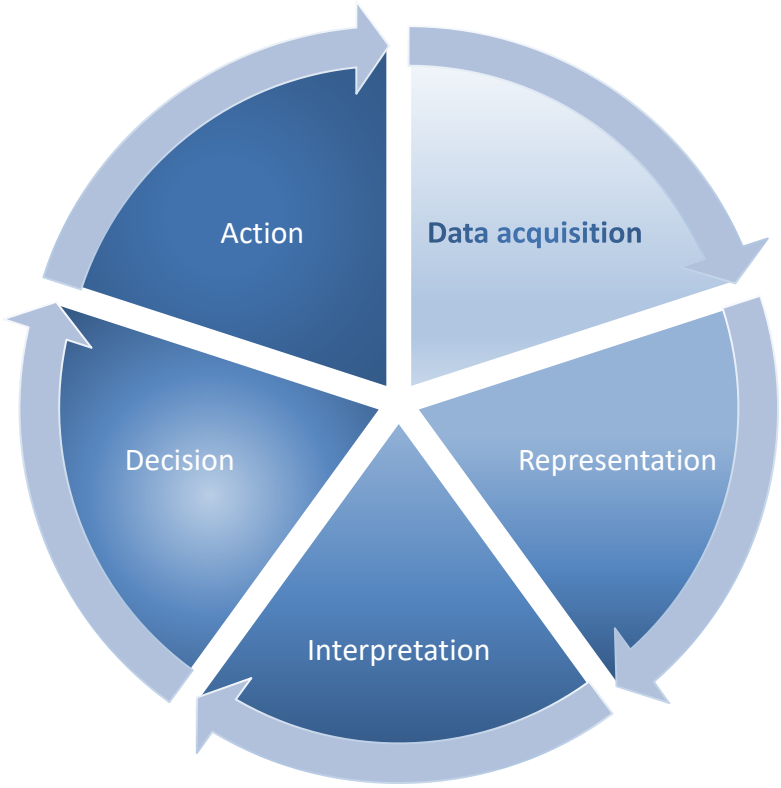
High speed navigation in littoral waters (brown/grey waters) constitutes a great challenge to the navigator and vessel operator. The margins are small due to the combination of high speed and a surrounding dense “terrain” of land, islands, under water rocks and shallow waters not normally found in blue waters. To this one must add other potential dangers such as floating objects in the form of moving vessels, moored vessels or floating vessels at stand still. Safety margins are counted in seconds, not in minutes.



Scale 1 : 7 500 Safety margins in seconds @ 40 knots

Under conditions without optical aids to navigation, i.e. when operating in dusk, full darkness or poor visibility due to rain or fog, the navigator must rely entirely on his navigational aids. To use these aids in a safe manner, it is paramount the system offers adequate and sufficient capabilities but even more so in time to sustain safety margins.

Navigation is a process from real world data acquisition through steps of representation, interpretation and decision making finally resulting in the navigator's action(s) and response. We think of this as the *PON - Process of navigation.* The quicker and more accurate each loop is completed the better the safety margins will be.



Step	System	Latency / Cycle rate
Acquisition	Sensors	0,1 – 3 s
Representation	Navigation system	0,1 – 5 s
Interpretation	Navigation system and Navigator	0,5 - 10 s
Decision	Navigator	0,5 – 10 s
Action	Navigation system and Navigator	0,5 – 10 s
Total		**1,7 – 38 s**

Examples of typical process cycle rates using electronic navigation systems.

Obviously, the *Process of Navigation* latency can be anything from one second to tens of seconds. Modern sensors normally give high update rates, so the extent of latency is primarily dependant on system response and the navigator's ability to fast and accurately interpret his data to make correct decisions and to take adequate actions in time.

In practice this means that for a navigation system to be suitable for high speed operations, it must have response times shorter than any sensor's update rate - *Representation*, have a pronounced intuitive user interface – *Interpretation* and a man-machine interface – *Decisions / Action* that is operable under harsh conditions.

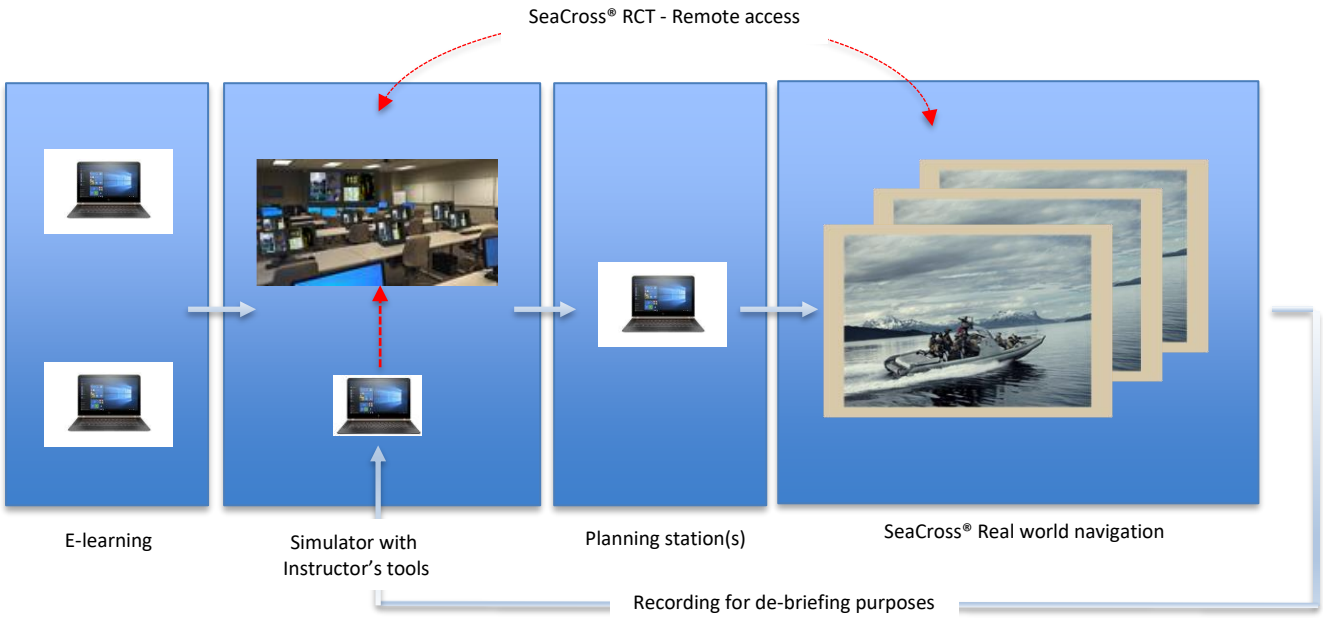
Since safety margins are counted in seconds, not in minutes, the objective of any high-speed navigation system is to offer an overall *Process of Navigation* latency that is substantially smaller than the safety margins imposed by high speed littoral water navigation requirements.

2. The SeaCross Platform - overview

Born in Scandinavia, the SeaCross system's capabilities are based on extensive experience and knowledge derived from operating high-speed crafts in this exceptionally demanding navigational environment. The system is created, designed and developed to offer unparalleled short *Process of Navigation* latency and safety for high speed navigation in brown/grey waters.

The SeaCross Navigation System is built around an intuitive and easy to understand and use user interface, and is operable with equal ease for on shore planning as for navigation at high speeds, heavy sea states and low visibility. To acquire and improve navigator skills, the navigation system has been made an integral part of a suite of tools, The SeaCross Platform.

The platform is a chain of building blocks for training, simulation, planning, real world navigation and de-briefing purposes.



The building blocks and the platform have been designed to help navigators and crews, through training and simulation, acquire the skills and experiences needed to operate the SeaCross® navigation system with ease, accuracy, safety and the expedience needed for minimal *Navigation Process* latencies.

Training can be done individually on standard lap tops using SeaCross E-Learning packages, or in an instructor supervised and managed simulator for single or multiple users. The simulator can be used for not only navigation system training, but also as a simulator for specific mission preparation or training.

The SeaCross® RCT (Remote Control Technology) can be used in conjunction with the SeaCross platform, allowing real time remote pilotage and navigation of vessels from for example a class room or a command post.

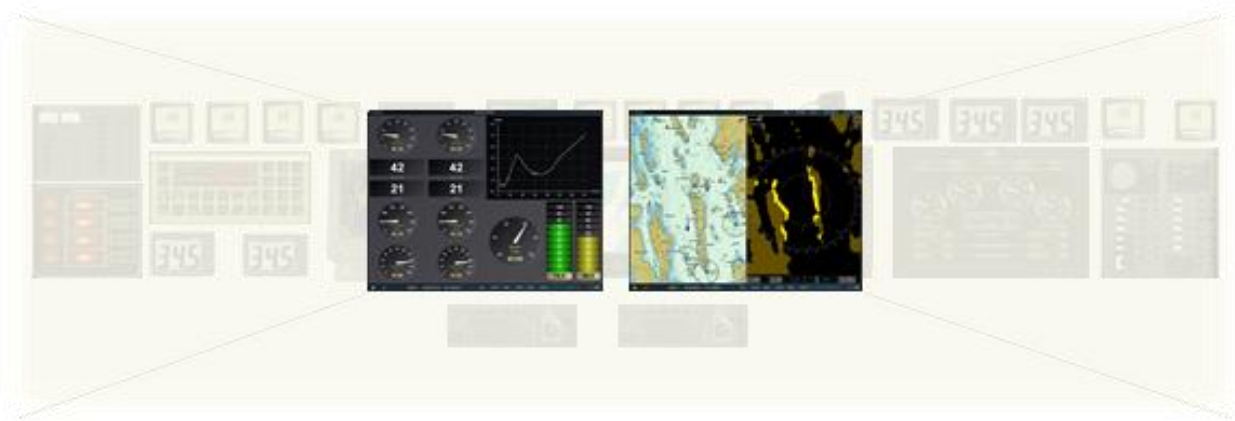
The planning stations(s) are used for pre-mission preparations such as route planning, creation of customized mission oriented templates or for sea chart updates and distribution.

All SeaCross navigation systems can record available onboard sensor data including radar. Recordings from one or several vessels can be loaded, post-mission, into the Simulator and replayed concurrently for de-briefing and training purposes.

3. The SeaCross Navigation System - overview

The SeaCross navigation system is a modular, scalable, system especially designed to meet the requirements for ***High Speed*** operations in archipelago, littoral, coastal and open waters. The navigation system is typically used on board vessels operated by special forces, navy high speed units, police, fire fighters and SAR units. The system is installed and operated on a large number of vessels throughout the world.

Integrated system
Normally a modern bridge consists of a multitude of displays and system controls. On high speed vessels the available space is very often limited, restricting what can be installed and subsequently the on-board overall capabilities. SeaCross integrates all instruments and sensors into one or multiple multifunction displays.



The SeaCross navigation system is at its core a software platform that integrates standard COTS hardware and sensors into one system, making the system's owner sensor brand independent. Hardware and sensors can be chosen to meet the specific requirements for a specific type of vessel or fleet of vessels, and components can be replaced by function. In addition to COTS hardware and sensors SeaCross can be integrated with other types of components, peripherals and sensors using open or proprietary protocols.

Intuitive user interface
SeaCross functionality is built on an intuitive and easy to understand and use user interface. Rather than overloading the navigator with all information available to the system, navigation data is presented with readable data display and is restricted to the information relevant to the ongoing navigational task. As the task changes while under way, the navigator uses the template mechanisms to switch in between different display layouts.

After only a minimum of training, a navigator can access and start using the full functionality of the system.

Mission approach

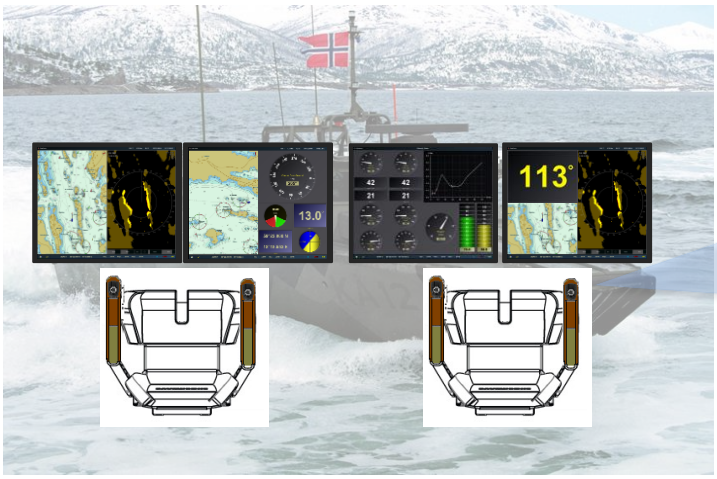
The user interface is mission oriented. This is utilised using a template approach in which the navigator can switch between different operational modes such as for instance *high speed-low-visibility-coastal*, *landing, planning*, *open-sea-crossing* or *intercept operations*. All templates are user designed, automatically stored and interchangeable in between SeaCross units on board or on shore. The number of definable templates is not limited, and templates are recalled with just a click.

Multiple windows user interface

Each template can consist of one or several PIP (picture in picture) windows, where each window can be individually sized, positioned and filled with any combination of the more than two hundred inherit functions such as sea charts, radar, trip meters, navigational aids, ais, echo sounder, sonar, engine data, EO's, cameras etc. Entire templates or individual windows can be tailored with selectable colour schemes, brightness and selectable instrument analogue / digital data representation.

Controls and man-machine-interfaces

The man-machine-interface has been developed to facilitate ease of use and manoeuvrability, to shorten the *Process of navigation* latency**.**



The man-machine-interface is available as any combination of heavy duty joysticks, track balls and short cut push buttons. System controls are detached from the displays, which means the controls can be mounted in the ergonomically most optimal positions. All man-machine-interfaces can be used in full darkness, in heavy sea states and with or without gloves.

Littoral waters navigation, real time update

The SeaCross system is especially designed for high speed navigation in archipelago and littoral waters or for navigation in blue waters. Sensor data input is represented in real-time with a fast-lane-methodology for time critical data, assuring it will reach the navigator instantly. The fast update rate is combined with unique functionality dedicated to instantly convey relevant information for optimal situational awareness and intuitive interpretation.

The system is designed for and used on vessels reaching speeds up to 100 knots, offering unparalleled real-time update and overall system performance.

Radar

With the SeaCross NTE function, radar images are instantly differentiated to display charted and non-charted radar objects differently. The SeaCross RBU function combines radar images with safe water and chart overlay information selectable in layers and detail. Cross window and cross unit linked cursors allows for easy object identification. The SeaCross High Speed ARPA function offers down to instant target acquisition and tracking.

SeaCross supports up to four separate simultaneously operating radars. This facilitates immediate switching between different transmitting technologies as appropriate, accommodating for alternating needs of LPI, Short / Long Range, High Definition etc.

TTD – Target Tracking Devices

The navigation system has in-built functionality to control and command multiple tracking devices such as electro optical sensors, RWS's or for instance motorized spotlights. The TTD-devices are commanded using the standard user interface by clicking on a moving radar target or a position in the sea chart. Tracking devices can be controlled to slew-to-cue, lock-on-target or lock-on-position.

GPS denied navigation

Capabilities originally designed and developed for sub-marine operations, are incorporated standard features in the SeaCross system. These features offer Estimated Position and / or Dead Reckoning (EP/DR) based on any combination of passive sensor input, heading and speed through water, and manual navigator data input, allowing continued high-speed navigation also under circumstances when GPS-data is not valid or is corrupted.
The EP/DR over time accumulated displacement errors, can be instantly corrected by the navigator on the fly using input from the radar's NTE-function or by using the inbuilt LOP and Running Fix functionality.

Log book

A multitude of navigation data is continuously recorded to a logfile while under way, and can be loaded into the SeaCross Log Book software to create records of operations and pdf-based printouts.
The logfile can hold more than 10 000 hours of continuous operation.

On shore planning and training
The SeaCross system includes a standard training module that can be executed on any Windows compatible PC. The training module includes all the SeaCross functionality but in a simulated sensor environment. In addition, the training module serves as a planning tool for rout planning, mission preparations or Mission Template Design.

Pre / Post mission briefing
While under way all sensor data, including radar and operator interactions, can be recorded to a standard removable file. A recording can be replayed, using the Simulator module for debriefing purposes. Recordings from multiple vessels can be replayed concurrently, offering an opportunity to re-enact missions involving more than one craft.

Night vision
All display units are dimmable 0-100%, and are optionally offered as NVIS / Dual Frequency LED displays. In addition, the SeaCross system uses five different colour schemes ranging from day to night according to s57 criteria. Each PIP window can be individually dimmed, offering the navigator an even and properly contrasted display for all different types of night time operations. Commands to change colour schemes are system wide, allowing one unit to control the night vision mode of all units on the platform.

Linkage and cross talk
Although SeaCross units are autonomous, any installed unit will automatically communicate with any other unit as available. This allows for *Linkage* and *Crosstalk,* which means that scale, orientation and cursor pointers can be linked between radars and chart windows facilitating quick image interpretation and target identification. *Linkage* and *Crosstalk* is also available between units, allowing for instance the navigator to point out objects and targets on the coxswain's display(s). All platform-common-data such as for example routes and targets are automatically synchronized in between units.

Redundancy and fall-back options
In a SeaCross system there is no master unit. Instead each SeaCross unit is autonomous and capable of all functions and can display all types of data available to the platform. A SeaCross unit will work irrespectively of the run time status of any other unit installed on the platform. This design philosophy offers flexibility allowing units to be swapped both physically and logically at any point in time.

Multiple sensors and sensor data backbones of the same type can be connected in independent layers, offering multiple levels of redundancy and multiple fall-back options.

Open standards
SeaCross is built on open standards. As sensor data backbone SeaCross uses any combination of NMEA0183, NMEA2000, CAN-J1939, USB and Ethernet. This allows for both backwards compatibility and future integration of other sensors compliant with any of these standards. Radar antennas are integrated using each individual manufacturer's proprietary protocol.

The processor units run on Windows OS, accommodating quick and common practice data transfer mechanisms in between on board and on shore units. Other windows applications can be run stand-alone on the processor unit or concurrently with the SeaCross system software.

The open standard and modular design of SeaCross facilitates efficient integration with other systems and technologies, such as for example existing integrations with RWS or SDV mini submarines.

Sea charts based on standards S57, s63, AML, Arcs, Bsb, and Shp are displayed seamlessly, and multiple route formats can be imported or exported.

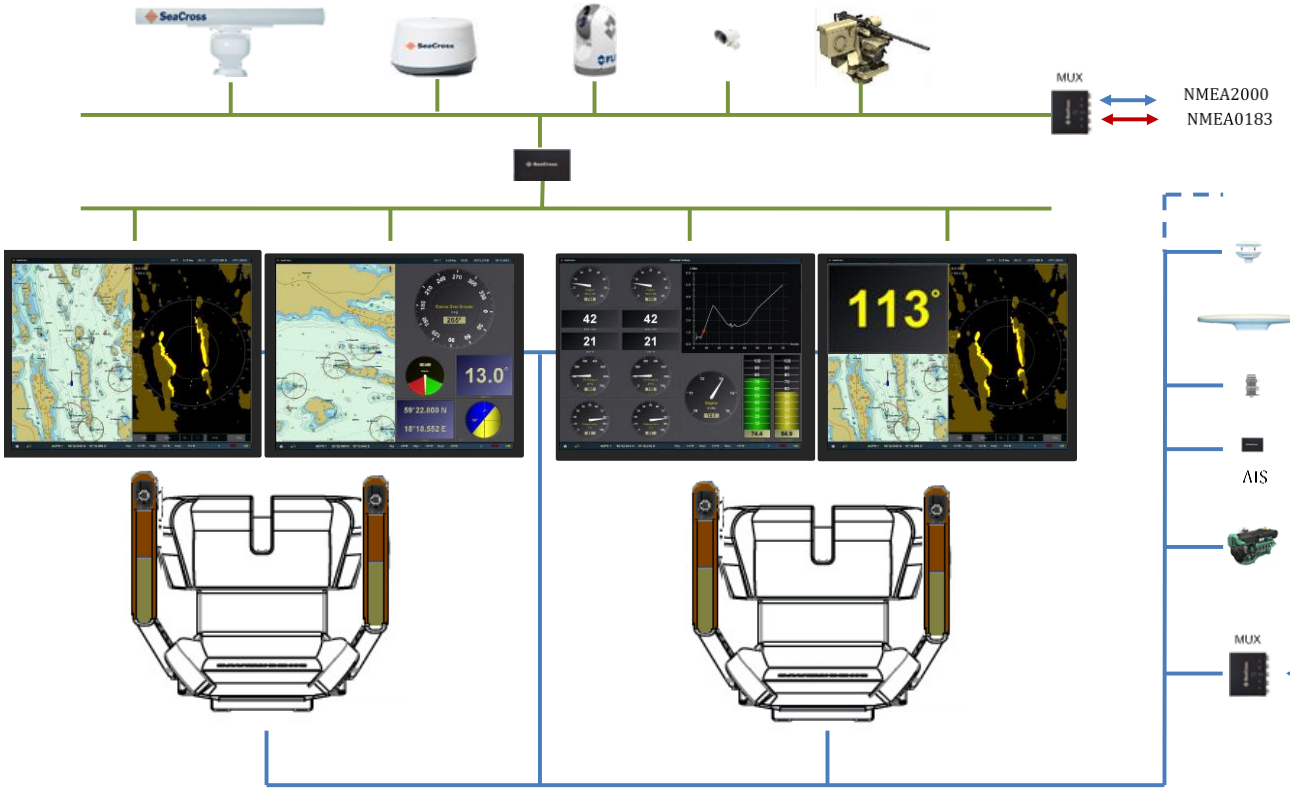
Automatic Setup and Diagnostics functionality

The SeaCross system platform entails a self-configuring setup and diagnostics system that automatically identifies connected and supported sensors. Each senor's data stream can be examined and tailored. The diagnostics module, that runs in the background, continuously checks data streams for abnormalities, and presents diagnostics and test results in a graphic device map in human language. This enables also the non-technicians onboard to handle and diagnose problems experienced under way.

Modular and scalable design

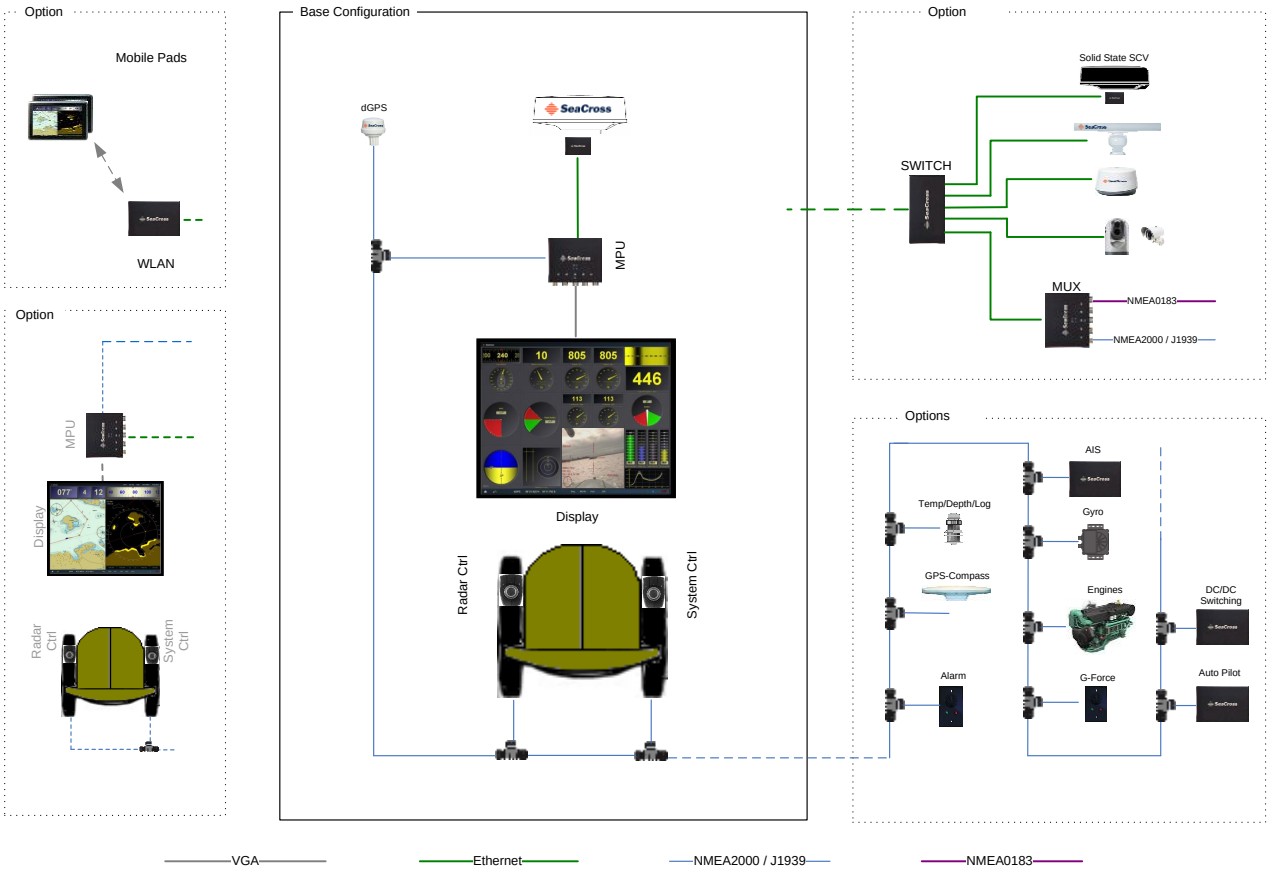
The SeaCross navigation platform is formed using building blocks, modules. Thanks to this modular and

scalable design a SeaCross system can be fitted on any range from small vessel single system to larger vessels multiple systems.



A multitude of sensors and peripheral equipment can be fitted to any of the standardized data transport and command backbones, i.e. Ethernet or CAN-bus. A universal multiplexer is incorporated for legacy protocol compatibility.

Principal layout (Example)



SDK – System Development Kit

As an accessory to SeaCross an optional SDK is available. The SDK allows for other software developers to create and integrate own applications into the SeaCross user environment, while at the same time taking advantage of SeaCross functionality such as for example the sensor data stream, TTD or sea chart engines.

4. Planning, simulator and trainer's tools

SxTraining

All SeaCross navigation systems are delivered with an accompanying training software, the *SxTraining* program. SxTraining emulates all the functionality of the real world SeaCross system including radar, and runs on any Windows XP/7/8/10 computer. The SxTraining software serves dual purposes

Training

Allows the navigator to use the full functionality of the system to acquire knowledge, experience and operational skills.

Planning

SxTraining can be used for planning purposes such as route planning, template creation and editing or a drawing tool. All the generated data in SxTraining is interchangeable in between planning stations and on board SeaCross systems.

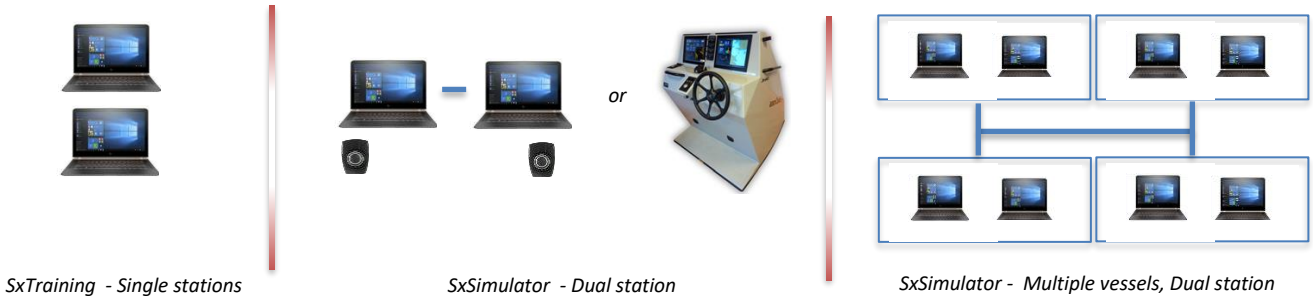
SxTraining is delivered free of charge, and under license of unlimited use within the customer's own organization.

SeaCross E-Learning

For specific training purposes the SxTraining software can be loaded with customizable scenarios such as for instance high speed missions, under way sensor failure(s), intercept or Estimated Position / Dead Reckoning operations. This combines training facility for both mission training and SeaCross operational skills.

SxSimulator

The SxSimulator software is a modular component that can be used on single stations, as a multiple system (i.e. a vessel) simulator or in a network of multiple simulated vessels. The SxSimulator can run on any Windows XP/7/8/10 computer using a mouse and a keyboard or connected to real world controls resembling the onboard working environment. This is all user definable.



SxTraining - Single stations | *SxSimulator - Dual station* | *SxSimulator - Multiple vessels, Dual station*

Any SxSimulator connected to a network, will show up on the radar screens of all other connected SxSimulators.

SxTeacher

Any SxSimulator software operating connected to a network can be monitored and managed remotely over the network from the SxTeacher trainer's tool.

The SxTrainer software offers the trainer a range of training and simulation facilities that can be imposed on individual or multiple connected stations / vessels such as for instance

- Jamming and spoofing
- Sensor malfunction or sensor data corruption
- Sensor data manipulation
- Create and manage other vessel / vessels operating in the same area
- Replay pre-recorded scenarios
- For de-briefing purposes, concurrently replay recordings from multiple vessels that operated on the same mission

5. RCT – SeaCross Remote Control Technology

The SeaCross Remote Technology, RCT, establishes a remote real-time connection between any two or more SeaCross systems. The link can be established between vessels, from mother ship to vessel(s) or from onshore command and control posts to one or more vessels.

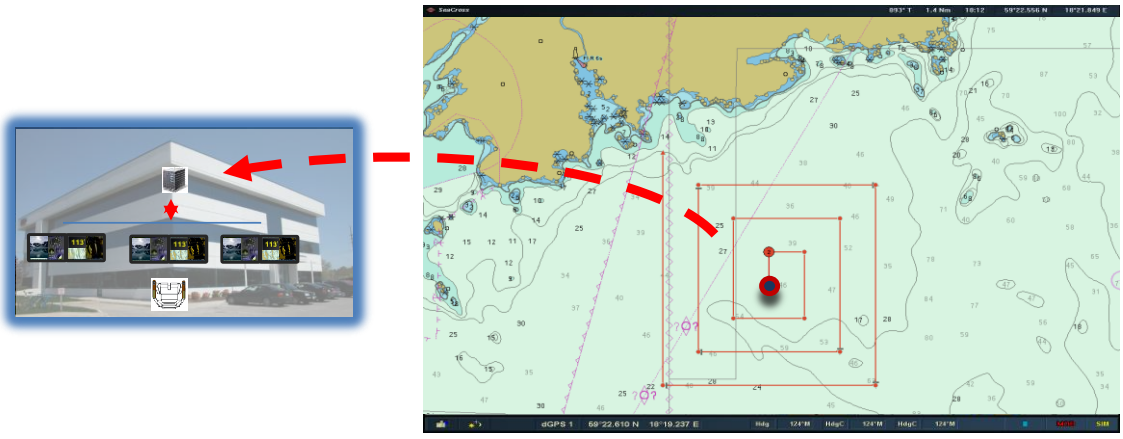
The transfer technology used is standard 4G mobile network, or any other encrypted or unencrypted ethernet based technologies capable of IP-transfers at bandwidths up to 2 Mbit/s.

The RCT – system adds a remote station(s) as one virtual additional onboard system. In practice this means the remote station will be able to receive all onboard available data such as navigational data, radar, cameras, EO's or sounding values etc. as if it was one of the installed SeaCross systems onboard the connected vessel. Conversely the remote station can do anything the navigator can do onboard the vessel. This means managing radars, cameras, EO's but also allows for the remote station to "push out" on to a vessel's system for instance routes, SAR-patterns or other SeaCross related information.

There is a multitude of applications for which the RCT is intended and in use.

Reconnaissance

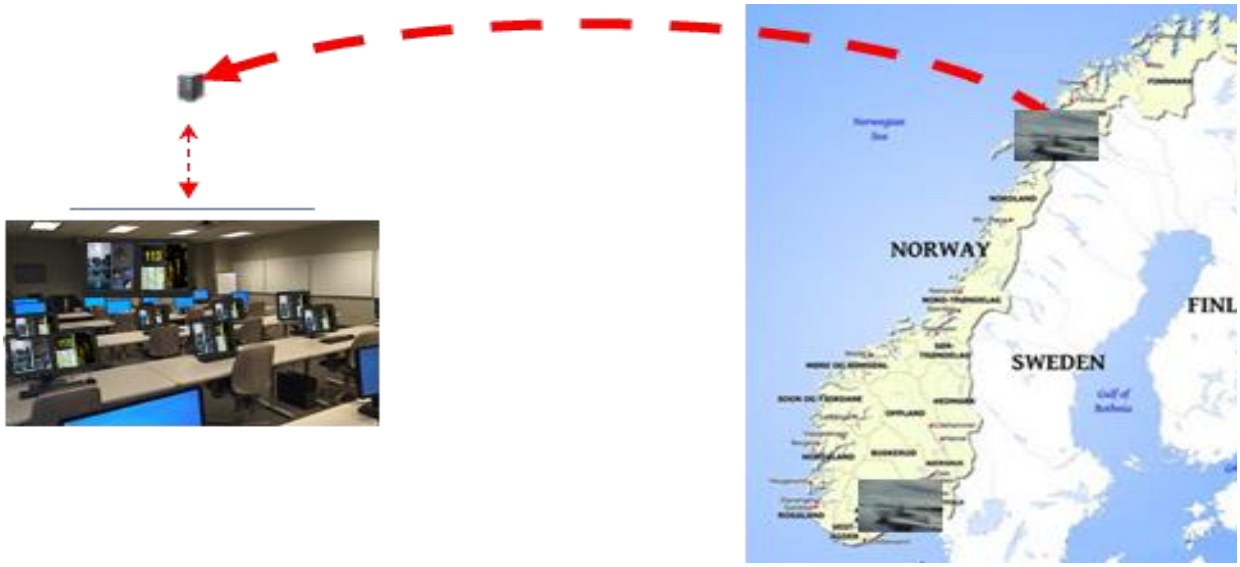
Mother ship and vessel



Command, Control and Observation Post

The RCT – server logs data transferred between vessel and remote station, and data from any enabled vessel that is part of the RCT network. The database created and updated by the RCT-server holds information that can be used for fleet-management and data mining on topics such as service intervals, fuel consumption, voyage recordings etc.

This RCT remote pilotage capability cannot only be used for real time events, but also incorporated into the procedures and processes of training and teaching. Since any remote station in practice acts as an onboard system, a navigator does not necessarily have to be physically onboard the vessel he is navigating. This he can do using a remote station(s).



In practice this means for example that instead of sending out ten vessels on a training operation, nine vessels with crew can stay ashore and remotely navigate the tenth vessel that is put into operation.

Quite naturally this approach will not replace more traditional training methods, but can be used as a complement which will reduce time spent, costs and wear and tear on both crew, vessels and equipment.

Contact

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