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Design and Operation of the ICON™ Dynamic Positioning System

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Introduction

Rolls-Royce has a large portfolio of products for the marine market, and is now also becoming a major supplier of dynamic positioning systems. The Poscon™ joystick system from Rolls-Royce has been supplied to the offshore market over the last 30 years. A new version of the Poscon™ joystick was developed and released in 2004. Subsequently the development program for the new Icon™ dynamic positioning systems was started. The first Icon™ DP systems were installed in 2006, and sales has at present reached more than 95 DP systems. This paper presents the main design principles, technical design and features of the Icon™ dynamic positioning systems from Rolls-Royce.

During the development process of the new joystick system, awareness of key system aspects evolved. Four design principles were established for the Icon™ DP development program: Performance, safety, simplicity and proximity. The first two are obvious; the vessel shall stay in position with god performance in a safe manner. The simplicity and proximity principles emerged in the analysis of existing solutions, rules and guidelines.

These design principles are both individually essential and related. For instance, safe vessel operation requires good DP system performance and simple user interface with close proximity to the user. And, close proximity to operator devices makes operation simpler for the operator. The proximity and simplicity principles do not only apply for the design of operator environment, but are fundamental for the technical design of the whole system and its components. The importance of the principles is illustrated in the context of the next chapters that presents how Rolls-Royce with the new Icon™ system has met the challenges with respect to

- bridge design,
- user interface,
- system architecture and components,
- integration,
- simulation and test

Furthermore, some examples of integrated solutions are presented.

Bridge Challenge

Traditional bridge solutions with DP systems are space demanding with large consoles and panels, including many push-buttons arranged in matrices. The first impression in the analysis of competitor systems is a complicated DP operator situation characterized by

- Sequences of operator actions to start a DP operation
- Comprehensive user interface with many menus and options
As Figure 1 illustrates, there is often a variety of equipment mounted in the consoles. The equipment is often of different make and has various user interfaces. In some cases the operational principles of the different equipment are inconsistent. The panels and operator units are often spacious and require large consoles for installation. To save some space the equipment is cramped together, and it is difficult to identify and segregate different systems physically on the bridge. Much of the equipment is hard to reach and monitor for the operator. The large consoles also reduce the visibility of the operator. By making the operational environment simpler and closer the DP operations will gain enhanced performance and safety.

Figure 2 DNV NAUT-OSV Illustrations

Another aspect is system integration and information sharing. Often there is little communication and interaction between the systems onboard, and the information of how systems depend on and affect each other is insufficient. It is difficult to get overview of all relevant systems for certain operations. As a result, it may some times be difficult to identify failure situations and to perform the adequate and safe corrective action.

Comprehensive and standardized interfaces between the systems are established by using network links instead of hardwired digital and analogue signals. The systems become closer by exchanging all adequate information for cooperation and presentation. Easy access of relevant data simplifies operation and monitoring for the user. In the design of network solutions for system integration, precautions must be taken to ensure independence and integrity of the systems.
These aspects have been addressed by the classification societies. The DNV NAUT-OSV class notation is one example that applies to the total bridge system that includes the human operator, human/machine interface, operational procedures and the technical systems. Important factors for the bridge layout are operator visibility and proximity, see Figure 2. Statistics show that contact related accidents are significantly reduced for vessels with class notation NAUT-OSV (or NAUT-AW / NAUT-OC).

“In most cases, marine accidents can be avoided if the human element is duly considered as an integral link to the overall system, but it is wrong to blame a navigator for situation-caused accidents, of which may have been provoked by weaker links throughout the total bridge system chain. In many cases, the accident could be classified as a ‘bridge system failure’ rather than ‘human error’.” — DNV Classification News 3 2003

**Icon™ User Interface**

To enhance the operational performance and safety the *simplicity* and *close proximity* design principles have been emphasized in the design process of the user interface. The basic Icon™ DP operator station simply consists of a touch-screen display unit and two compact operator devices, see Figure 3. Industrial designers and experienced users have been consulted in the design of both the graphical interfaces and operator devices.

![Icon™ User Interface diagram](image)

**Figure 3 Operator Station and Operational Profile**

The essential DP functions are performed from the operator devices without using the touch-screen display. The design goal is that 90% of the operator interaction will be performed by using the devices only. From the devices the operator can

- Activate / deactivate the system
- Transfer command between the different work stations
- Select manual / auto position and heading
- Easily invoke change position and heading operations
- Silence audible alarm and get alarm status indication

Remaining operations and vital information shall be visible on the front page of the graphical user interface. Only rarely, operations will require interaction through sub-menus.
There is one joystick device and one position control device. The devices are ergonomically shaped and comprise 3-axes joystick lever, a heading wheel and logically arranged push buttons. The operator devices are standardized components, i.e. the configuration of push buttons and lamps is not subject to customization. Similar devices have been designed for other Rolls-Royce applications, such as winch control systems and remote thruster control systems. The compact size of the devices makes it easy to obtain close proximity to the operator and, increased flexibility for bridge arrangement. This has increased the opportunities within the framework for bridge designers.

The design of the input devices conforms to the Rolls-Royce Marine ‘common look and feel’ guidelines, and communicates the product series identity. The operator devices have been awarded for design excellence by the Norwegian Design Council.

Unintentional changes of system operation must be avoided. To prevent this, double-action is required on any changes that affect the operation (double-press or single-press followed by acknowledge). The single-press and double-press buttons are clearly labeled with different symbols.
Graphical User Interface (GUI)

A complete GUI framework is developed for operation of the Rolls-Royce control systems. The urge for simplicity is a driving force in the development and design of the graphical interface. Use of touch screen, a library of symbols and status lights, “HUD” components and 3D-scene are key elements in achieving simplicity in operation of the graphical user interface.

“Simplicity is the ultimate sophistication.” — Leonardo da Vinci (1452–1519).

“Simplicity is the property, condition, or quality of being simple or un-combined. It often denotes beauty, purity or clarity.” — Wikipedia.

Touch-screen operation is an intuitive and quick way of interaction that is easy to combine with the operator devices. The graphical user interface is purpose made for touch-screen operation. Standard Windows solutions are designed for office purposes and do not have suitable means for touch screen navigation. Another aspect is safety; Windows does not have the best reputation regarding software stability. Complete control of software source code is also a clear advantage.
Enlarged size on
- Menus
- Push-buttons
- Indicators
compared to Windows.

Extensive use of symbols, accompanied with text when required, is essential for the operator to comprehend system status, operational condition and way of operation immediately. The symbols for graphical interface and operator devices are standardized, and conform to the Rolls-Royce Marine ‘common look and feel’ guidelines. The common graphical solution libraries are essential to obtain uniformity across different products and consistent operation by common operational philosophy. The libraries provide solutions for common presentation and interaction, and comprise:

- Standard symbols and color codes.
- Standard indicators and push buttons. Status lights are examples of indicators. The push buttons have mode dependent interaction. Operations that are not permitted have faded buttons.
- Dialogues and display navigation solutions.
- Alarm and event handling.
- Signal trending solutions.
- Day- and night-color schemes.
- Data storage, logging

3D-Scene

The 3D-scene is the main display area of operation, see Figure 4. The 3D-scene design is inspired by the popular Google Earth application and gaming technology. Traditionally, graphical interfaces of DP systems provide two main display pages, a ‘vessel fixed’ page and ‘setpoint fixed’ / ‘true’ page. The 3D-scene has full three-dimensional capability, and the operator is free to move the angle and position of perspective (camera). Quick selection buttons are defined for easy selection of most relevant camera viewing points.

“HUD” Components

Graphical components, inspired from the head-up displays (HUD) used in aircraft applications, are specially designed to clarify important information. These “HUD” components have their designated location on the 3D-scene. The thrust usage, heading keeping, position keeping and DP class monitoring components are examples of the “HUD” components.
The IMO guidelines for vessels with DP systems (Class 1, 2 and 3) have played a fundamental role for the design and operation of the DP systems. Consequently, the *DP Class Monitoring HUD* has been designed to simplify the situation for the operator. At a glance, the DP Class monitoring HUD will immediately provide an overview of compliance between DP system and the prevailing operational class:

- Status of thrusters active *thrust devices*
- Power split and status of *power system*
- Status of the on-line *consequence analysis* function
- Status of *active sensor and position reference systems*
- Status and configuration of the operator stations, networks and hardware components of the complete *DP control system*, related to the class requirements

From the DP system overview pages, selected from the navigation bar, the operator can easily access more details on the different systems and functions.

**View Panels**

View panels for easy access of information and operation of thrusters, sensors, position reference systems, control mode and settings are available on one side of the display.

**Navigation Bar**

On the other side is a navigation bar with tools for display control, alarm list, DP system details, monitoring and trending, modes and operational details, and operator help, guidance and checklists.

**Status line**

System status is presented at the bottom of the display.
Common Control Platform

The Rolls-Royce Common Control Platform provides the system components for the Icon™ DP system. Most of the other Rolls-Royce Marine control products are currently in the transition phase of applying this common platform. The platform provides common hardware, solutions and software:

- Marine display units, including ordinary displays and the display PC that incorporates graphical display, computer, and power supply in one single unit. The displays have touch-screen functionality as standard.
- Operator devices for the different applications, such as positioning, remote thruster control, deck machinery, etc.
- Standard control cabinets, including hardware components such as controllers, power supply, IO modules, network components, etc.
- Marine controllers with Ethernet and CAN ports for bus communication, USB and serial line ports, IO system interface, etc.
- IO system with units for digital and analogue IO.
- Common network solutions and components for Ethernet and CAN fieldbus.
- Common system software; real-time operating system and middleware.
- Common software libraries; IO drivers, network protocols, alarm handling, and other common solutions.
- Common graphical user interface solutions and libraries.

The common control components have been type approved by major classification societies.

Using common technology in the various control and monitoring systems has several advantages, such as product alignment and standardization, common spare parts and product appearance. Reliability and performance are key factors in the design and development of the common control components. The components are made in large volumes, and high quality is essential. The common technology platform provides standardized means of communication between different products, and opens several new possibilities for system integration. Simplicity and proximity are achieved by using network links that establish comprehensive interfaces between the systems. The hardware and software are component-based, both on application level (e.g. dynamic, positioning, remote thruster control, alarm and automation system, winch control, etc.) and on system platform level. The components are standardized and provide the required flexibility for configuration of the different products. Large system deliveries gain advantage of common ‘look and feel’ across products, common spare parts, reduced spares stock, common tools and procedures, and simplified after market service and support.
Software Architecture

The component-based software is separated in different layers:

- **Operating system.** The DP application runs on a real time operating system.
- **Middleware** provides standardized means for communication and execution of the components.
- **Common Control Libraries** provide the common features across the product range. E.g., alarm handling, communication protocols, redundancy handling, and other common solutions.
- **Application Libraries**, such as dynamic positioning, contains libraries with application specific components.

The middleware is a common control software package that provides an abstraction layer between the real-time operating system and the different product applications (e.g. DP system software), and facilitates component-based and distributed architecture of the control and monitoring systems. The middleware provides standardized mechanisms for signal routing and information exchange between software components, and scheduling of software components.

The middleware level is important for standardization of the different applications and products running on the platform. The libraries of software solutions that can be shared among different products enhance the quality and reliability. The middleware is essential for obtaining effective integration between
The middleware accommodates hardware and operating system independence for the applications. Applications can run on operating systems that the middleware is adopted for, such as real time operating systems, Linux and XP Embedded. The hardware independence of the DP application reduces problems related to hardware obsolescence. In principle, an old application version can run on a new controller unit, as long as the new hardware has the required compatibility with the old hardware.

The DP system controllers are standardized for executing on real time operating system. However, operating system independence opens opportunities for software diversity. E.g. for an application with redundant controllers, one controller could run on real time operating system while the other could run on Linux. Or, one application could run on Linux and another, i.e. a back-up or safety application, could run on real time operating system.

The graphical user interface software is also component-based and layered (application layer and common control layer), facilitating common identity, look and feel across the different Rolls-Royce applications.

**DP System Configuration and Redundancy**

Performance and safety are not only related to positioning, thruster usage and reliability of hardware components, but also to the redundancy solution and failure handling. The redundant Icon™ systems for IMO DP Class 2 and 3 are based on a triple controller solution with a redundant fibre-optic network ring. Interface to sensors and position reference systems, power system and thrusters and steering are split into logical groups, based on class requirements and system segregation.

![Figure 6 DP Class 2 Configuration](image-url)
The motivation for a triple redundant solution even for DP Class 2 is to have a simple and understandable solution for the operator. In the case of a failure you have a simple two-out-of-three voting principle. Serious detectable errors on a controller will also render the controller invalid. In case of controller divergence (either by detectable or undetectable failures) and voting rejection, the operator does not have to intervene. If a controller should fail, the system will still comply with the DP class notation. Redundant networks with double bus topology are most common for DP control systems today. With the ring network topology, network failures are handled locally on network level. The connected nodes do not need special functionality to handle the network redundancy. DP system integrity preserved, the DP control network is separated from the networks of the other applications. The DP cabinets, operator stations, sensors and position reference systems are dual powered from the redundant UPS system.

For vessels with safety requirements that exceed the class notation, optional safety features are available:

- **Separated DP cabinets.** Controllers of the triple redundant solution are placed in three separate cabinets, and common mode failures related to common cabinet installation are eliminated. In addition, the UPS’s could be triplicated for consistency.
- **Redundant thruster interfaces.** The interfaces between the DP IO controllers and the remote thruster controllers are duplicated. If an IO controller fails, the DP system will still have all thrusters intact.
- **Additional Operator Stations** can be installed to increase redundancy.

By applying the safety features the consequence of single failures are reduced and failure tolerance increased. If any single failure in the DP control system occurs, the DP control system will still comply with the classification requirements and all thrusters will be available for DP. And, the total DP system (including power-, thruster-, sensor-, position reference-, and control- system) will comply with class notation if installed sensors and position reference systems exceed the classification requirements.

**Helicon X3™ Remote Thruster Control and Poscon™ Independent Joystick**

The Helicon X3™ remote thruster control system and Poscon™ joystick system are also based on the Common Control Platform. The most evident advances for the remote thruster control system are the touch-screen based graphical user interface and the new thruster lever devices. Similarly as for the Icon™ DP, most vital operations are performed by the lever device. Potentiometers and electronics for both normal and backup system are integrated in the lever. The display in the socket indicates pitch/rpm order. The control lever has a dual CAN-bus interface for each propeller (normal and backup), and comprises all functionality required for backup operation. In an emergency situation, where backup operation is required, the user can proceed the operation using the same lever as in normal mode. The touch-screen display provides detailed information of the thruster system.

The independent joystick is based on the same system software as the DP system, but is configured to provide joystick functionality. Consequently, the joystick operator station has simpler graphical user interface and requires only the joystick input device for operation. The joystick system is interfaced to the thrusters via the remote thruster control system network.

**DP Integration with Remote Thruster Control**

Systems become closer by exchanging all adequate information for cooperation and presentation. Easy access of relevant data simplifies operation and monitoring for the user. The first result of this process was the integration of the DP system with the remote thruster control system.
The traditional solution for interfacing DP and remote thruster control has been hardwiring of digital and analogue IO. In most cases this is how systems from different suppliers are interconnected today. Hardwired interface imposes strong limitations. Simple new features on the DP system may require large expansion of the interface list. Expanding the number of hardwired signals is basically restricted by practical limitations.

For Rolls-Royce integrated thruster control solutions, the DP system is interfaced with remote thruster control by direct fieldbus links between the IO controllers of the DP system and the controllers of the remote thruster control system. The fieldbus solution provides galvanic isolation in all connection points. Optionally, the fieldbus can be duplicated to increase availability. Optical links, instead of twisted pair, are also available.

The integrated solution accommodate independency between the DP system and remote thruster control system, and the solution conforms to classification rules:

- Independent joystick and DP system may not share the bus connection (e.g. DNV).
- Levers must have independent wiring.
- Each sub-system must maintain its own system integrity and potential errors in one system shall not affect or transmit to the other systems.
- Independence of DP Backup system for DP class 3.
- Command control, i.e. exchange of thruster command between DP and remote thruster control, and between workstations.

The integrated solution, based on replacing hardwired interfaces with network interfaces, has clear advantages:

- No IO scaling. For hardwired interfaces scaling of IO signals must be performed on both DP system and thruster control system. This is a time consuming task, where both DP supplier and thruster supplier must be involved.
- Less components and less cabling.
- Expandable interface. Modification of interfaces does not require any modification of the equipment.
- New functionality possible.
- Improved alarm handling and monitoring and diagnostics.
- Information sharing and higher level of integration. Operational safety is enhanced by providing the required information where it is needed to make the correct decision.
- Effective commissioning.
Suppliers of thrusters will deliver the remote thruster control system in order to take responsibility for operation of the thruster and related safety and warranty issues. A common supplier of unified positioning and remote thruster control systems has advantages:

- Single point of contact simplifies communication and coordination.
- Common technology accommodates common way of installation and maintenance, common spare parts, and paves the way for efficient engineering, commissioning, testing, support and service.
- One service engineer can handle thruster signals all the way, covering both remote thrust control and its interfaces to independent joystick and DP system. It is easier to determine root cause of errors for one common supplier.
- When two suppliers are involved, misunderstandings may occur. It may be difficult to establish fail-safe system interaction, especially if the interface is subject to changes. And, it is difficult to detect failures and possibly even more difficult to place responsibility when failures occurs.
DP and Remote Thruster Control Integrated in Chair

The integration of DP and remote thruster control (RTC), and a common technology platform for the Rolls-Royce products gives possibilities to create new bridge solutions and DP workplaces:

- Workstations for DP and RTC can be integrated chair and on bridge wings.

- Generally, dynamic positioning and manual thruster control are the primary operations. The independent joystick is a back-up system that can have a less central location on the bridge. One joystick operator station must be installed on the main work station.

- The compact DP and RTC operator input devices are integrated in the chair’s armrest together with a 10” touch screen display unit. Larger display units are mounted in consoles close to the chair. This gives an operational environment of close proximity, good visibility, and a simple unified way of operation.

- Combined DP and manual lever control can easily be performed. This is useful for anchor handling, and other operations. Typically main propellers are manually controlled by levers for surge control, and thrusters are controlled by DP in auto heading control mode. Command of thrusters/propellers can easily be transferred between DP and RTC.

- A common command control solution simplifies transfer of command for DP and RTC.
between the different workstations. Simplicity of essential functions is vital for safe operation.

- The command control is configurable with respect to which workstations that require ‘Give-before-take’ for command transfer.

Integration with automation and winch control systems features easy utilization and monitoring of important signals such as draft measurements, winch tension, speed, length of wire out, shark-jaw tension. And, control of auxiliary equipment such as wipers and flood lights can be performed from a graphical view panel on the touch screen.

**Simulation Framework**

Extensive use of simulators and mathematical models has been a keystone of the design process of the new products.

The Rolls-Royce Marine knowledge within propulsion systems, ship design and control has been accumulated into a sophisticated real time simulation framework, comprising models of

- Environmental loads due to waves, wind and ocean current,
- Vessel motion in 6 degrees of freedom,
- Propellers and rudders,
- Sensor and position reference systems,
- Power system.

In addition, emphasis is also on simulation of failure modes, either set up as single failures or as sequences of combined failures.

By use of simulation and analysis during development as well as for delivery projects, we obtain

- Early evaluation and correction of new features / prototypes in the design process.
- Product quality assurance. Verification and validation by performance and failure scenario testing.
- Possibility to verify response to conditions and operations that cannot be fully tested in real-life.
- Possibility for factory tests of complete integrated solutions, not only single systems. Combined DP, independent joystick and remote thrust control operations.
- Reduced time for configuration, commissioning and sea trials.
The simulator framework is also an integral part of the positioning system software, and is the basis for the product portfolio of simulators and operator support tools:

- The built-in trainer simulator for operator training (failure) scenario simulation.
- Capability simulator.
- Data logger.

The flexibility and performance of the Rolls-Royce simulation framework is demonstrated by the installation of a complete anchor-handling simulator at the Offshore Simulator Center at the Aalesund University College, Norway. Here, a copy of the aft bridge and its systems on an offshore vessel was replicated, including winch control systems, steering gear, propulsion control and DP / joystick systems from Rolls-Royce. The operation is realistically visualized on 3D screens with different view-points.

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**Extended System Testing – Hardware In the Loop Testing**

Control systems on marine vessels become more complex and more software based. Networks and fieldbus solutions replace the traditional interfaces and the segregation between systems moves from physical level (cabinets and termination points) to logical software units. This is a major challenge both for understanding inter-system connectivity and the failure modes in a system. The DP suppliers have naturally changed their testing regimes as this development has progressed by developing more sophisticated test systems as part of the product development. For the classification societies, ship owners and oil companies, however, the trend towards software dominated system designs has become a concern. The system design is less evident. The traditional hardware-oriented test approach, both at Factory Acceptance Tests and Seatrial Acceptance Tests, is often no longer fully adequate to ensure the quality of advanced integrated control systems. Needs for new alternative test tools and test suppliers have emerged.
Consequently, DNV and Marine Cybernetics started in 2003 to work on a software based functional test regime to cope with this challenge. DNV developed a standard for extended system testing, the hardware-in-the-loop (HIL) testing concept, and they certify the testing and the test supplier according to this standard. DP HIL testing is basically testing of a DP system against a real-time simulator. At present, the HIL test supplier has to be independent of the DP suppliers, and the range of HIL test suppliers is rather limited. In 2006 the first DP HIL tests of a dynamic positioning system were performed onboard a vessel, and a DP HIL certificate was issued. Those who charter the ships (e.g. major oil companies), more often require DP HIL tests for vessels in their service.

The DP HIL testing follows a three steps approach:

1. Test at Factory (TaF). Extensive test of the system during FAT, where sensors, position reference systems, thrusters, propellers and power system are simulated through a dedicated software interface. Approximately one week of additional testing of the system is being executed.

2. Test at Dock (TaD). Preparations for the final seatrial and verification that findings and corrective actions from previous test properly corrected.

3. Test at Sea (TaS). During the DP sea trials the input signals to the DP system are online manipulated by a simulator that is connected in the control loop.

At each of the 3 steps, the findings are categorized (A, B, C) by discussions with test supplier, classification society, system supplier and end customer (often experienced operators).

Note that the DP HIL testing will not replace need for thorough FMEA testing. The DP HIL test is an extension to the existing test regime. While the DP HIL testing focus on the DP control system, and its functionality, interfaces and failure handling, the traditional DP sea trials and FMEA testing cover the total DP system, including power system, thruster system, DP control system, sensors and position reference systems as installed. The DP HIL test will not reveal errors in the power system or thruster system, and the positioning performance must be verified on the total DP system. Anyway, with the DP HIL test approach, a more comprehensive test scheme will be performed, more findings will be unveiled, resulting in reduced probability for undetected errors and increased overall quality.

The introduction of the DP HIL test approach coincided with the launch of the new Icon™ DP system from Rolls-Royce. It became clear that this was an efficient way of ensuring that the system design complies with established industry standards. Moreover, the HIL test approach was very similar to the internal Rolls-Royce system tests being conducted for any system delivery. A HIL interface was developed in cooperation with the HIL supplier company and this additional system test is now an option for any system delivery. At present (September 2007) one vessel with Icon™ DP has completed DP HIL testing and received a formal HIL Certificate from DNV, for three vessels test at factory have been conducted, and another six vessels with complete HIL certification are in order.

Here are some experiences and comments from HIL testing of Icon™ DP systems:

- Some of the tests are very time consuming and repeated for each system delivery, even if there were no findings in previous vessel tests on the same software release.
- There could be more focus on DP functionality and performance and less focus on DP interfaces.
- As a new DP supplier it has been useful to measure the DP system against an “industry standard”. On the other hand, there are concerns regarding intellectual property by revealing system details to a third party.
Software Management

As discussed above, advanced control systems, such as DP, becomes more and more software based. The software is the main asset. It is evident that proper software management and standardization are crucial. Precautions must be taken to avoid ‘smelling’ system software. E.g. short cuts or quick fixes, related to specific delivery projects, may violate the software architecture and layering. Branching of system software for specific delivery projects will cause considerable, or in worst case unmanageable, maintenance problems. The Rolls-Royce positioning products, Poscon™ Joystick and Icon™ DP are based on the same application and system software. Making tailor made features for specific projects is strictly prohibited. No software compilation is done onboard vessels or to specific projects.

![Diagram of System Software and Project Configuration]

**Figure 7 System Software and Project Configuration**

The generic positioning system software is subject to continuous development. The system software is released according to a release plan based on priorities related to marked requirements and product strategy. New features and improvements are gradually added to the system software. Any functionality and interface solution are integral parts of the generic software base. A system (software) release comprise a set of hardware and software components that are compatible. Release notes, describing new features and upgrade handling, are issued for each release. In general, a system can be upgraded from one minor release to another by patches. Change in major release requires new installation of complete system, often followed by a re-test done by the classification society.

The configuration engine auto-generates the project system software from the project specific configuration file, which contains all the relevant data for the specific delivery, in combination with the generic software base. The simulator and operator support tools, such as the built-in trainer simulator, are also part of this configuration scheme.

References

[1] Rules for Classification of Ships, Pt 6 Ch 8 Nautical Safety, Det Norske Veritas