ISO/TC8 - SHIPS & MARINE TECHNOLOGY

"STRATEGIC STANDARDIZATION"
(BUSINESS & REGULATORY IMPORTANCE)

ISO / TC8 Seminar
MARINTEK
Trondheim, Norway
2006-06-08

CAPT Charles H. Piersall
Chairman, ISO/TC8

ISO/TC8 - A LINKING INSTRUMENT

IMO

- **REQUIREMENTS**
- **REGULATIONS**

ISO

TRANSFORM REQUIREMENTS TO INDUSTRY STANDARDS &

INDUSTRY

- **SHIPYARDS**
- **SUPPLIERS**
- **SHIP OWNERS/ OPERATORS**

PROVIDE INDUSTRY STANDARDS FOR CONSIDERATION BY IMO, ILO, IAPH, WCO

REQUIREMENTS FOR TODAY'S STANDARDS

- **Management, systems based**
- **Market driven**
- **Universally accepted - "Standard of choice"**
- **Timing and Timeliness**
- **Developed concurrently with new technology**
- **Focused on interchangeability and performance**
- **Must define a product that can be manufactured, installed, used, maintained and supported safely and efficiently at competitive cost**

TIMING & TIMELINESS

- Timing -
  - You have to be there, be active, be accepted and be known for delivering results
- Timeliness
  - You MUST deliver When the Customer Needs It
  - "Business as usual" means failure- customer seeks another venue

PERCEPTIONS & REALITIES

- Common statements to attack & defeat
  - Standards take too long to develop
  - Standards are a technical document - leave it to the Engineering Dept Drafting Room
  - Standards Organizations are not responsive
  - ISO is not a true voluntary consensus body

DEALING WITH PERCEPTIONS & REALITIES

- **Too long to develop-**
  - **Make Full Use of the PAS**
    - **Explain it to the customer- in fact explain it in your TC**
  - **use all the available options - short circuit the CD, lobby membership to get solid DIS to avoid need for FDIS**
  - **Produce in Single Language**
  - **Keep your SCs & WGs to an aggressive target schedule. Hold program reviews & don't just allow new target dates without full justification**
  - **ISO/CS must expedite processing & publication!**

DEALING WITH PERCEPTIONS & REALITIES (Continued)

- **Standards are just a technical document**
  - **Explain "Strategic Standardization"**
    - **To all your stakeholders**
    - **To your TC & SC Leadership**
  - **Communicate with Top Executives in Government & Industry**
    - **Educate your customers**
    - **Market your abilities**
    - **Publish articles in trade journals, etc.**
    - **Actively participate in seminars/conferences**

STRATEGIC STANDARDIZATION

- **Standardization is a Strategic Business Decision**
  - **more than a technical document**
- **Effective Market Tool**
  - **open new markets**
  - **reduce trade barriers**
  - **ensure company's competitiveness**
- **If you are not participating in the standards process, your competitors are**
  - **influencing business issues**
  - **gaining competitive edge**

DEALING WITH PERCEPTIONS & REALITIES (Continued)

- **Standards Organizations are not responsive**
  - **Unfortunately there are examples, BUT ISO has taken an aggressive forward looking strategy**
    - **Program Management improvements & accountability,**
    - **more use and understanding of IT, greater sensitivity to the Market requirements**
    - **Develop and use a Business Plan, Operating Plan & Marketing Plan- This is standard business operating procedure -Format it for your use!!**
    - **“Timing & Timeliness”!!!**

ISO/TC8 STANDARDS ACTIVITY

1947-1994 ------Equipment Standards

1994-2001 ------Systems Standards

2002-2010 ------ Safety, Security, Environment, Information, Intermodal

PROACTIVE	REACTIVE	DORMANT
Write Industry Standards for Consideration by Regulatory Bodies	**Implement Regulations**	**Do Nothing Accept Actions of Others**
BEST SOLUTION		***UNACCEPTABLE***

STATUS OF WORK PROGRAMME
(ISO/TC8 N 1000)

- **Comprehensive, "living" document, regularly updated which is the "official TC8" Working Status Document**
- **Subcommittee Status identified - published standards, registered work items, possible proposals for new work**
- **Work Items of Mutual Interest to IMO and ISO/TC8**
- **Listing of IMO Resolutions**
- **Index of ISO Standards Numbers referring to Work Items**
- **Allocation of Number of Work Item to Each TC8/SC**

ISO/TC8 PARTNERSHIPS

- **IMO/IACS/IAPH Participate in ISO/TC8 Meetings**
- **IMO/WCO/IACS/IAPH Active in ISO Subcommittees and Working Groups**
- **ISO Active in IMO Committees and Subcommittees**

- ***ISO TC8 Strategic Alliance with ISO TC67 (Petroleum and natural gas industries)***
- ***ISO TC8 Strategic Alliance with ISO TC104 (Freight Containers) on Freight Movement in Freight Containers***

MARITIME & INTERMODAL SUPPLY CHAIN SECURITY PARTNERSHIPS

- **ISO Active in IMO Maritime Security WG**
- **ISO Active in ILO & IMO/ILO WG**
- **ISO and WCO Collaborate on Data & Supply Chain Security Standards**
- **ISO Participates in IMO FAL (SPI) with IAPH**

- ***ISO TC8 MoU with Strategic Council on Security Technology***
- ***ISO TC8 Liaisons with ITN, WSC and BIMCO***
- ***ISO/TC8 Liaison with WCO***

TC8 SUCCESSES

- **Working closely with the IMO we have successfully been major reference in many IMO Codes & Conventions**
  - **Fire Protection; High Speed Craft; Other**
  - **SOLAS/MARPOL/STCW**
- **Requires continuing presence & participation with IMO Committees Subcommittees**
- **> 100 TC8 work items directly related to support IMO**

TC8 SUCCESSES (Cont.)

- **SUPPLY CHAIN SECURITY**
  - **ISO 28000 Series**
  - **ISO 20858 - Implementing IMO ISPS Code**

- **Maritime & Intermodal security initiative supporting IMO, Governments , Industry**

- **Similar Supply Chain Success with IAPH, WCO and ILO, Governments, Industry**

WHAT IS ISO/PAS 28000?

- The management systems standard for Supply Chain Security An overarching “tool” – Published 2005- 11- 15
- A major initiative - industry and governmental cooperation
- Provides requirements for establishing, implementing, maintaining and improving a security management system for the supply chain
- Applicable to a broad range of organizations
- Risk based, follows 14001, the environmental management system standard

OTHER DEVELOPMENTS

- ISO / PAS 20858
  - **Published 2004; Uniform industry implementation of IMO's ISPS Code**
- ISO / PAS 28001
  - **Assist industry in Best practices for custody in supply chain**
  - **Consistent with WCO Framework of Standards; Being balloted**
- ISO 28003 - auditing/conformity assessment; Draft completed
- ISO 28004
  - **Guidance for 28000 - Consensus achieved;**
  - **Ready for Balloting**
- ISO 28005
  - **Electronic Port Clearance (EPC); Under development**
  - **Computer –to - Computer data transmission**

ISO ASSISTS IN IMPLEMENTATION

- Assisting 5 Major Ports in implementing ISO 28000
- ISO PAS 20858 being used as teaching tool for developing nations in concert with the ISPS Code
- Assisting Major Ports in implementing ISO 14001 (Environmental management systems standard)

IMO MSC # 81 - 2006-05

- **Passenger Ship Safety**
- **Maritime Security**
- **Goal-based Standards**
- **Ship Design and Equipment**
- **Bulk Liquids and Gases**
- **Stability, Load-lines and Fishing Vessel Safety**
- **Fire Protection**
- **Formal Safety Assessment**

……Potential New Work Items for ISO/TC8

SUMMARY

- **International Linkages already well established**
  - **ISO Secretary General Assigned Responsibility to ISO/TC8 as follows:**
    - **Principal Liaison to IMO - we attend all IMO Committee and most SC meetings - for past 11 years, active member of Maritime Security WG**
    - **ISO/TC8 Chair is designated ISO Rep to IAPH - for past 15 years**
    - **ISO/TC8 Chair is ISO Rep to ILO for Maritime**
    - **ISO/TC8 is Principal Liaison to WCO**

SUMMARY (Cont)

- **ISO/TC8 has ongoing active collaboration with International Organizations in Shipping & Shipbuilding-**
- **ISO/TC8 is active participant in UN/ECE Committee on Water Transport**
- **ISO/TC8 actively working with EU leaders on "Intermodal and short sea shipping" to provide international standards for use by the EU**
- **ISO/TC8 presenting to APEC in Singapore**

ADDITIONAL REFERENCE SLIDES

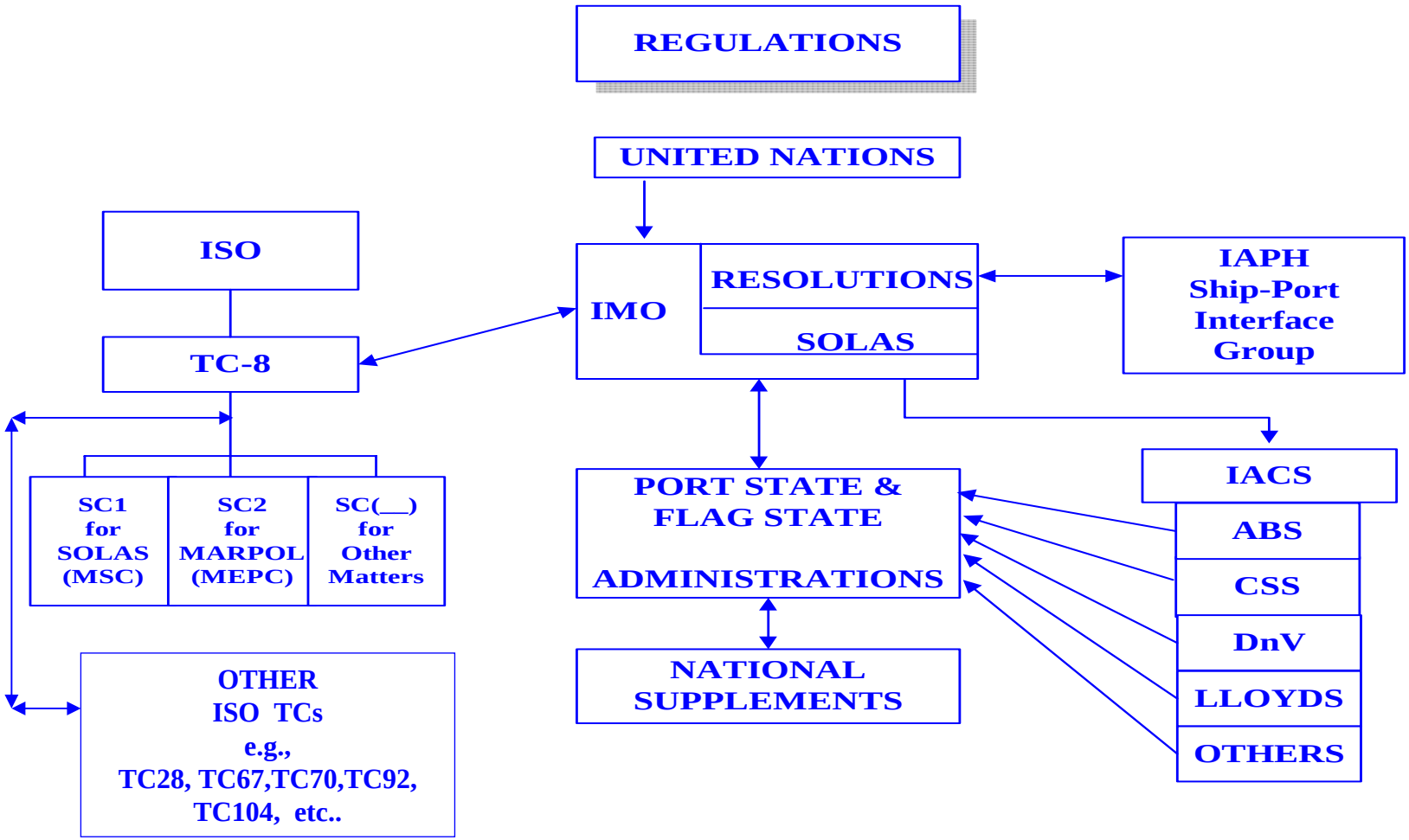
ISO/TC8 ADVISORY GROUP MEMBER BACKGROUND REQUIREMENTS

- **Industry - Shipping, Shipbuilding/Repair, Intermodal**
- **Government- Port state, regulatory needs**
- **Possess skills in:**
  - **Strategic planning, business planning**
  - **Organizational planning and resource allocation**
  - **Business management**
  - **Program management**
  - **Business development and marketing**
  - **Information technology**
- **Facilitate the "linkage" to IMO**
- **Appointment limited on basis to "balance expertise"**
- **NO STANDARDS EXPERTISE REQUIRED**

SUMMARY (Cont.)

- **Program Status Update Presented to**
  - **IMO Maritime Safety Committee - December 2002**
  - **IMO SOLAS Diplomatic Conference - December 2002**
  - **IMO Facilitation Committee and Ship/Port Interface Working Group - January 2003**
  - **Numerous U.S. and World Leaders**
- **Active Participation with IMO in Development of the ISPS Code**

INTERNATIONAL RELATIONSHIPS



TC8/TC67 STRATEGIC ALLIANCE

- **MoU SIGNED BY TC CHAIRS - 2000-09-11**
  - **DOES NOT MODIFY COMMITTEE SCOPES**
  - **FIRST SUCH AGREEMENT IN ISO HISTORY**
- **INSURES COOPERATION & PARTICPATION IN DRILLING & PRODUCTION FLOATING SYSTEMS**
  - **Hulls Basically TC8**
  - **Systems & Requirements TC67**
  - **FPSOs, FSUs, OSVs, ATBs**
- **TC8 CONTINUES AS PRINCIPAL INTERFACE WITH IMO**

ISO TC8/TC104 STRATEGIC ALLIANCE

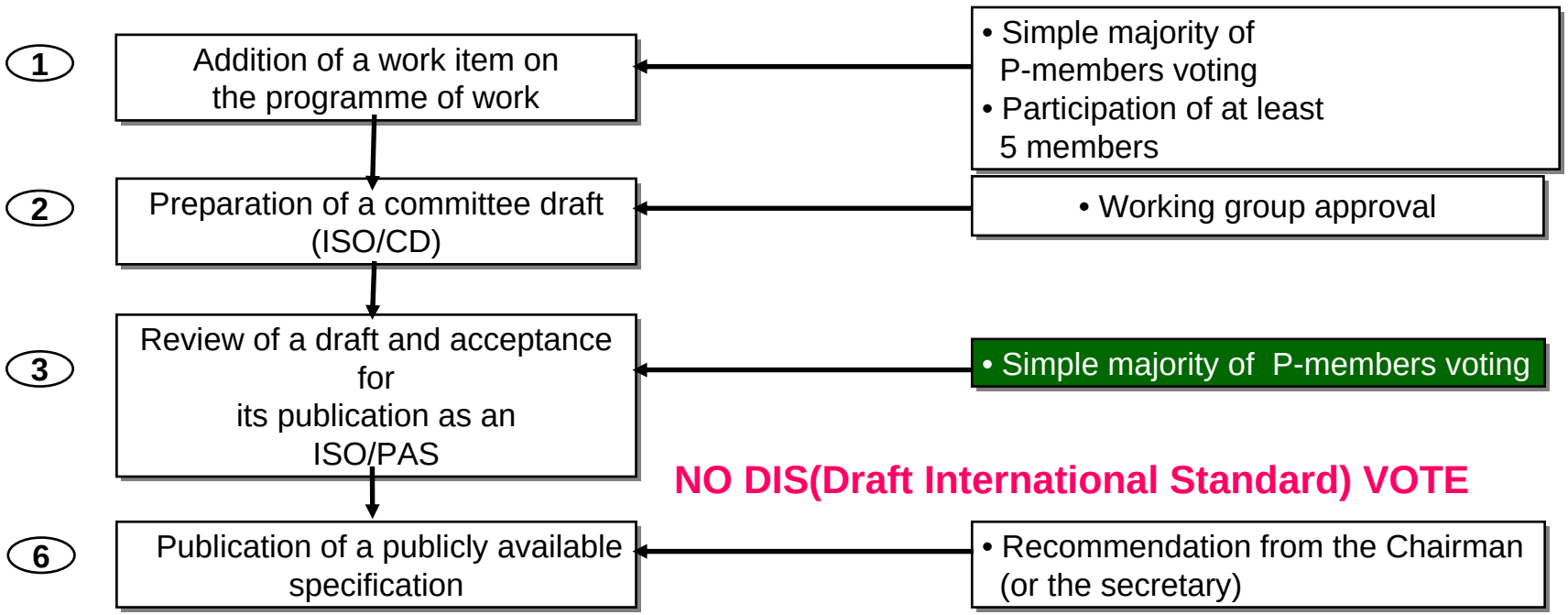
- **MoU SIGNED BY THE TC CHAIRMEN**
  - **TC8 (Ships & Marine Technology)**
  - **TC104 (Freight Containers)**
- **Insures Active Cooperation & Participation with Each Other in Writing Standards to Insure a Seamless, "Intermodal" (Ships and Ship/Port Interface) Movement of Freight in Freight Containers**
- **ISO/TC8 Continues to Provide Principal ISO Interface with IMO**
- **Agreement Dated 2002-06-20**

Main Steps of a Draft and Required Approval

Special case: Publicly available specification (PAS)

JUSTIFICATION - Urgent market requirement

PROCEDURE



Can Be Amended as Necessary at Anytime

After 3 years: review for reconfirmation

After 6 years: transformation into an ISO standard or withdrawal

INTERNATIONAL STANDARDIZATION

“We cannot engage in a level playing field,
equal trade, open up markets and get rid of
trade barriers unless we harmonize standards”

An essential ingredient for achieving the
“well-balanced optimum” of safer, secure and cleaner seas together with a prosperous maritime industry

SUMMARY (Cont.)

- **The initiatives undertaken by ISO/TC8 in maritime and supply chain security are "inclusive", not "exclusive".**
- **The Maritime Industry is "International" - Regional or National solutions are not best interest of the industry.**

Marine Cybernetics and DNV HIL Presentation

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2006-06-08

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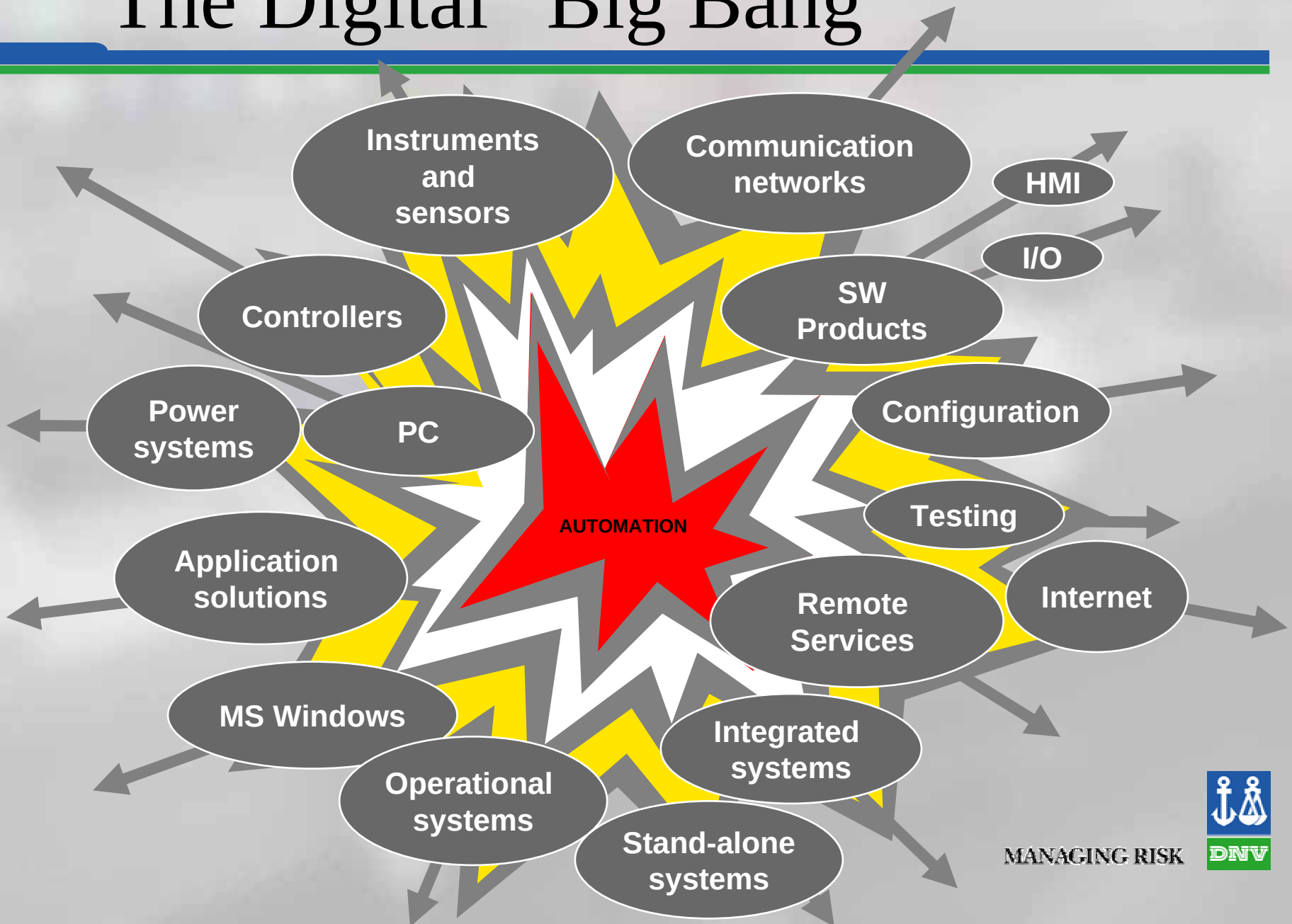
MARINE CYBERNETICS

The Digital “Big Bang”



MANAGING RISK

Industry Challenge – Background

Modern maritime machinery plants

- Mechanical ship ➔ computer-based ship
  - *large number of computer control systems*

omplexity

integrated

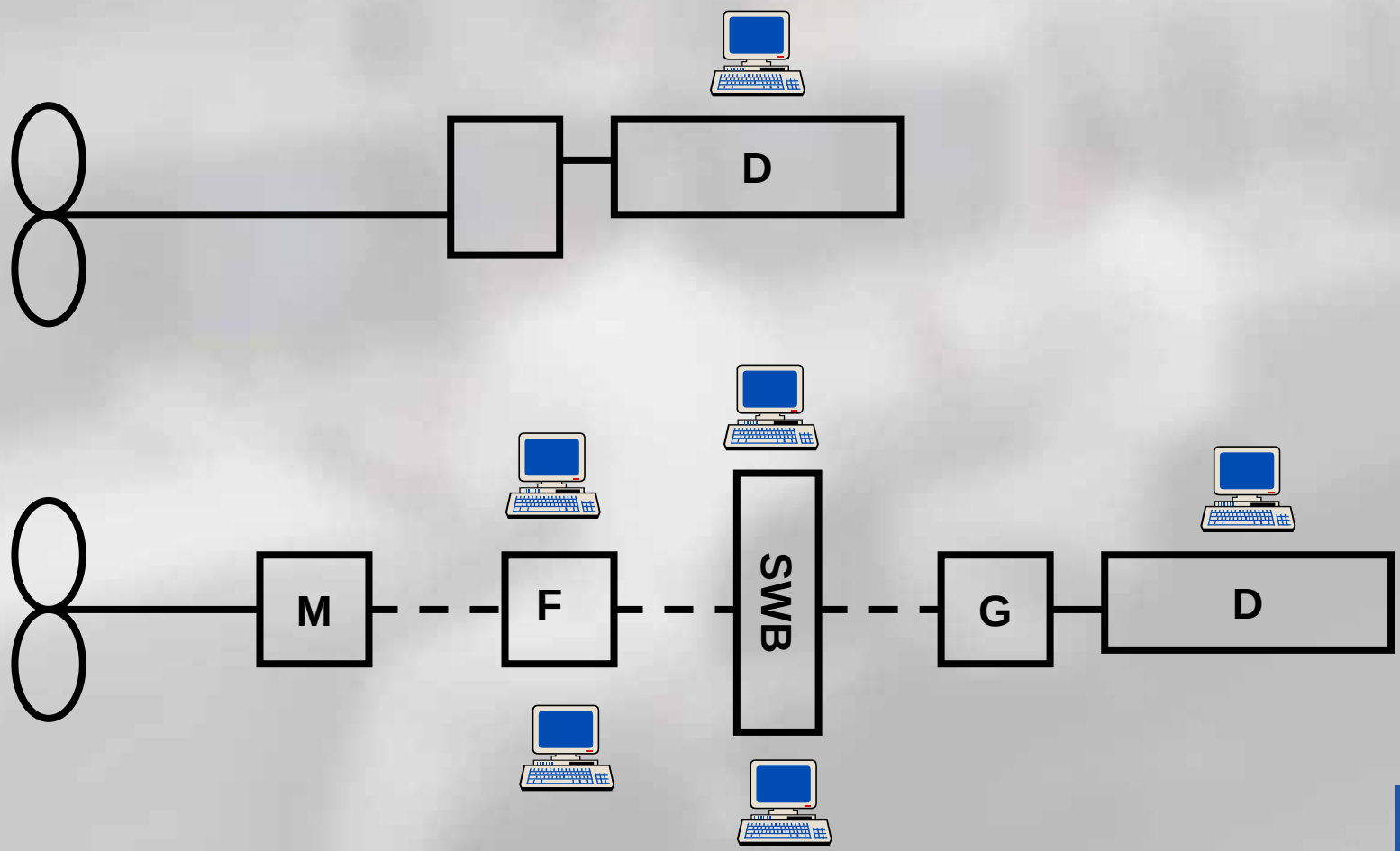
ivered by

ation

Testing methods are
lagging behind the system technology development!

MANAGING RISK DNV

Propulsion Layout (principle sketch)



MANAGING RISK

Industry Challenge

As a result of this development:

- Need for more comprehensive testing, but integrated systems are difficult to test
- Failure situations are difficult to handle

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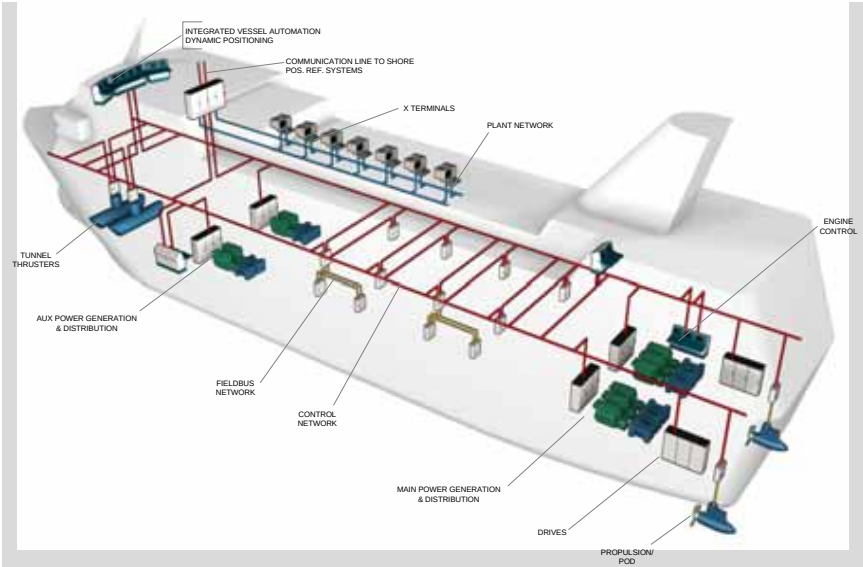
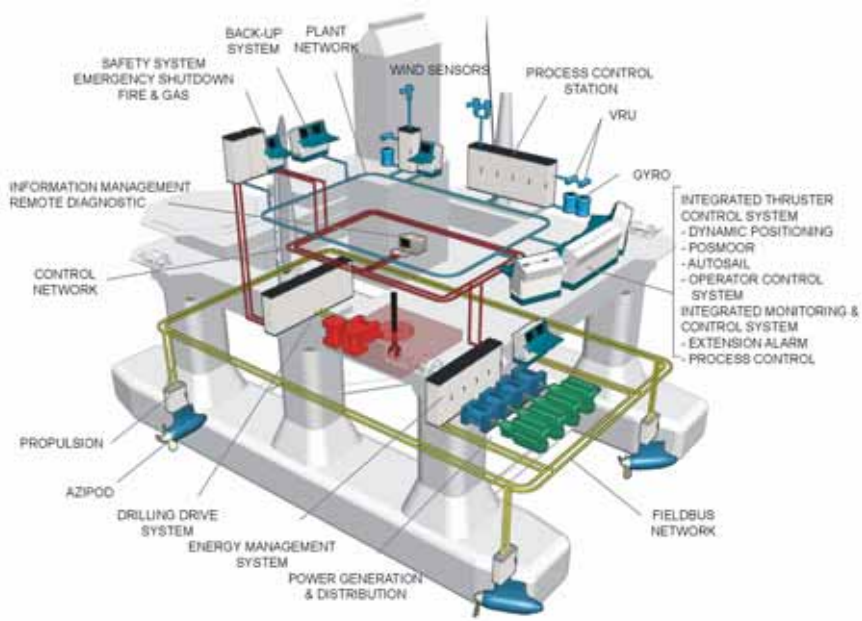
n complex

Marine Control Systems





Diesel-electrical systems

- Electric power generation and distribution
- Electrical propulsion
- Electrical drives and rotating machinery

Marine Control Systems

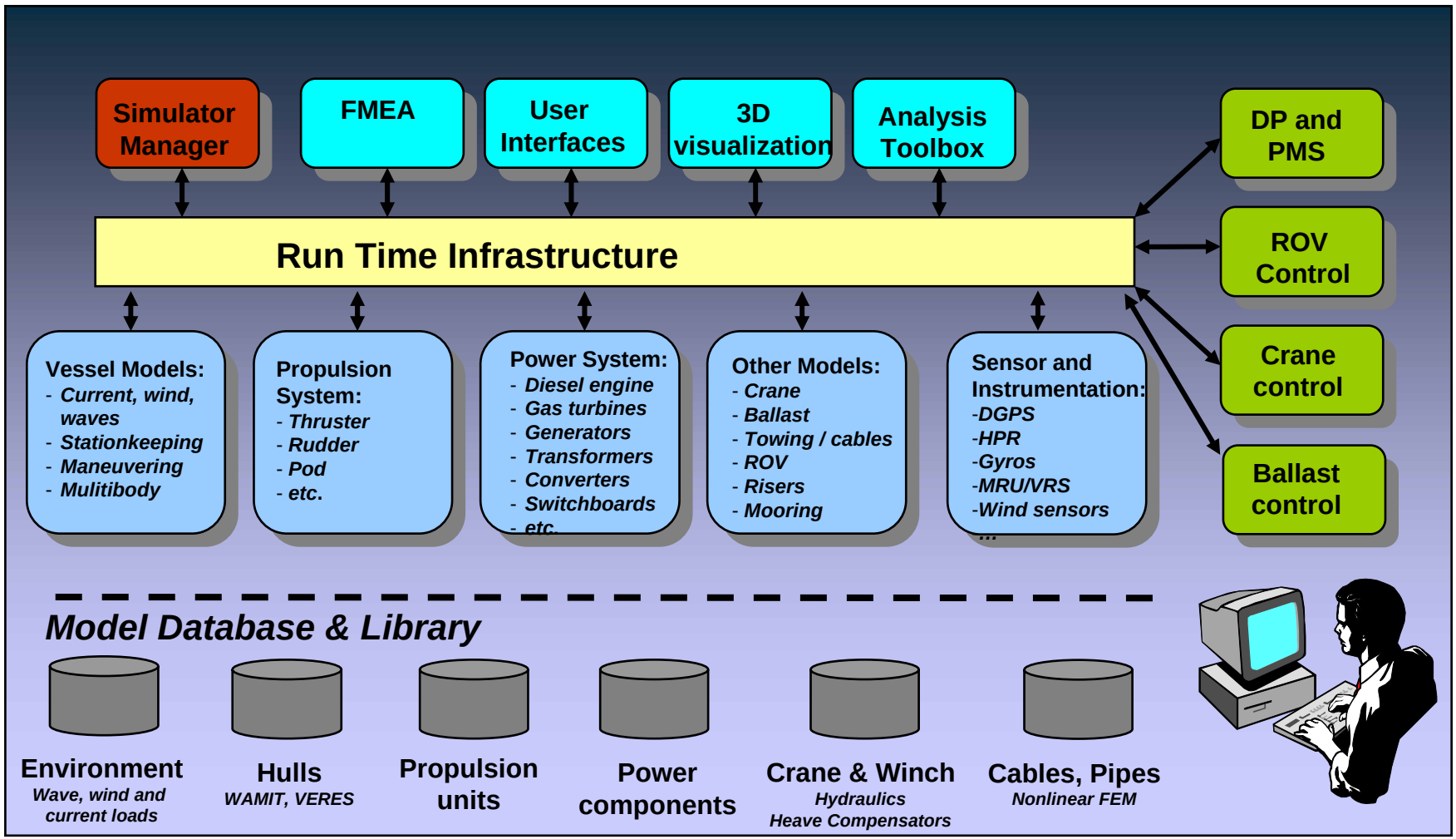
- Machinery system
- Ballast system
- Loading system
- Power management
- Dynamic positioning system
- Autopilot
- …

MARINE CYBERNETICS

Examples of findings from
DP-HIL Safety and Performance Testing

- **Sensors**
  - Single VRU failure caused simultaneous loss of all position reference systems
  - Wind sensor failure caused loss of position. Too little time for DP operator to react after warning and eventually alarm was given.
  - Incorrect NMEA telegram format gave no alarm
- **Position Reference Systems**
  - Drive-off due to DGPS slow drift in combination with hidden failures
  - Weighting and voting settings found important for resistance to common mode failures when using two DGPS
- **DP Computer System**
  - Controller gave incorrect thrust commands after operating on capability limit for some period of time
  - All controllers crashed simultaneously after mode change
  - Inconsistency in alarms reported on different operator stations
  - Incorrect alarms, incorrect alarm texts, incorrect alarm description
  - Hidden failure in I/O card made one controller in-operable. No alarms indicating failure was given, even after this controller was selected in use.
  - An alarm was changed to a warning after some time, it appeared that the alarm never occurred
- **Thruster and propellers**
  - One azimuth thruster was not actively used when operating at the capability limit
  - Thruster feedback sensor or signal failure may lead to drive-off and loss of position
- **Power System**
  - Reduced redundancy due to incorrect cabling in UPS fusing
  - Circuit breaker failure caused no alarm

CyberSea Simulator: HIL Simulation

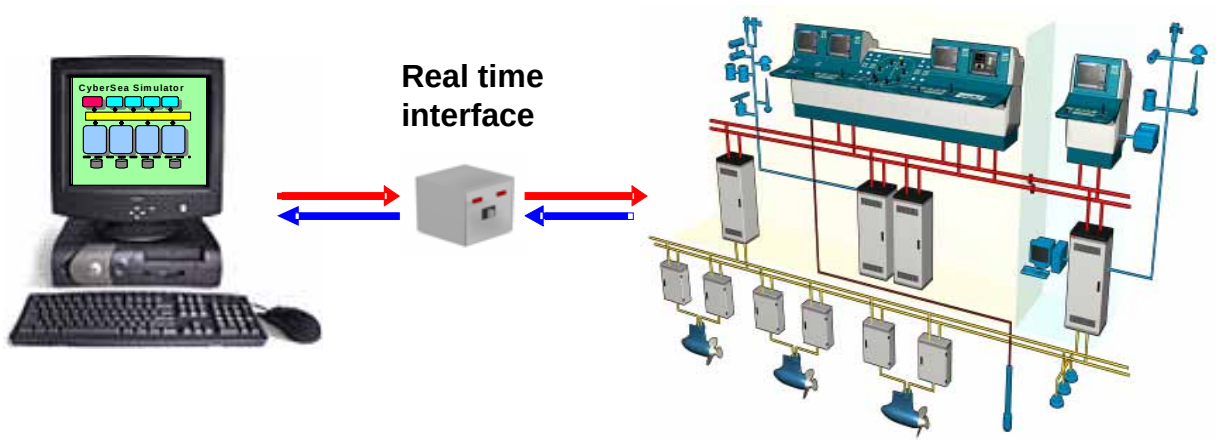


HIL: Hardware-In-the-Loop

MARINE CYBERNETICS

Hardware-In-the Loop (HIL) Testing

- **A NEW TECHNOLOGY** for HIL testing of control systems as input to DNV Standard for Certification of control systems
- To be used in FAT (Factory Acceptance Tests), sea trials, annual tests, periodical tests and after upgrades



Customers:

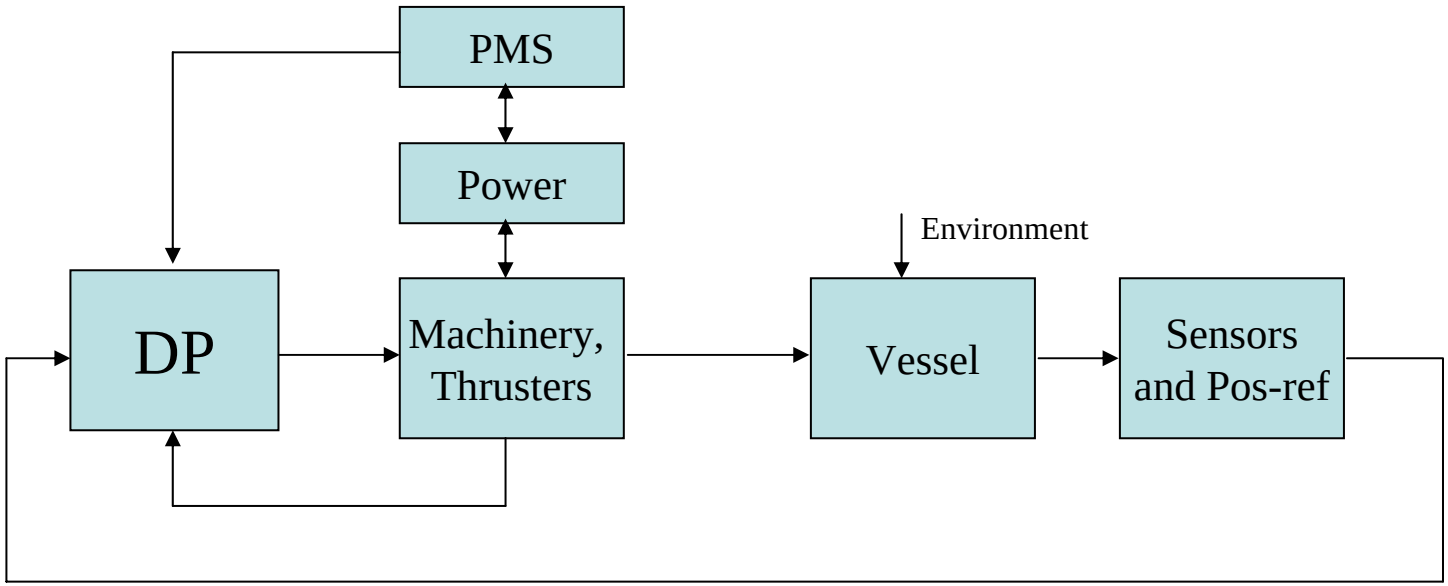
1. Oil companies
2. Vendors and Yards
3. Ship Operators
4. Contractors
5. Class societies

HIL Safety and Performance Testing

- DP-HIL (since 2004)
- PMS-HIL (since 2006)
- *Propulsion-HIL (new)*
- *Autopilot-HIL (new)*
- …

MARINE CYBERNETICS

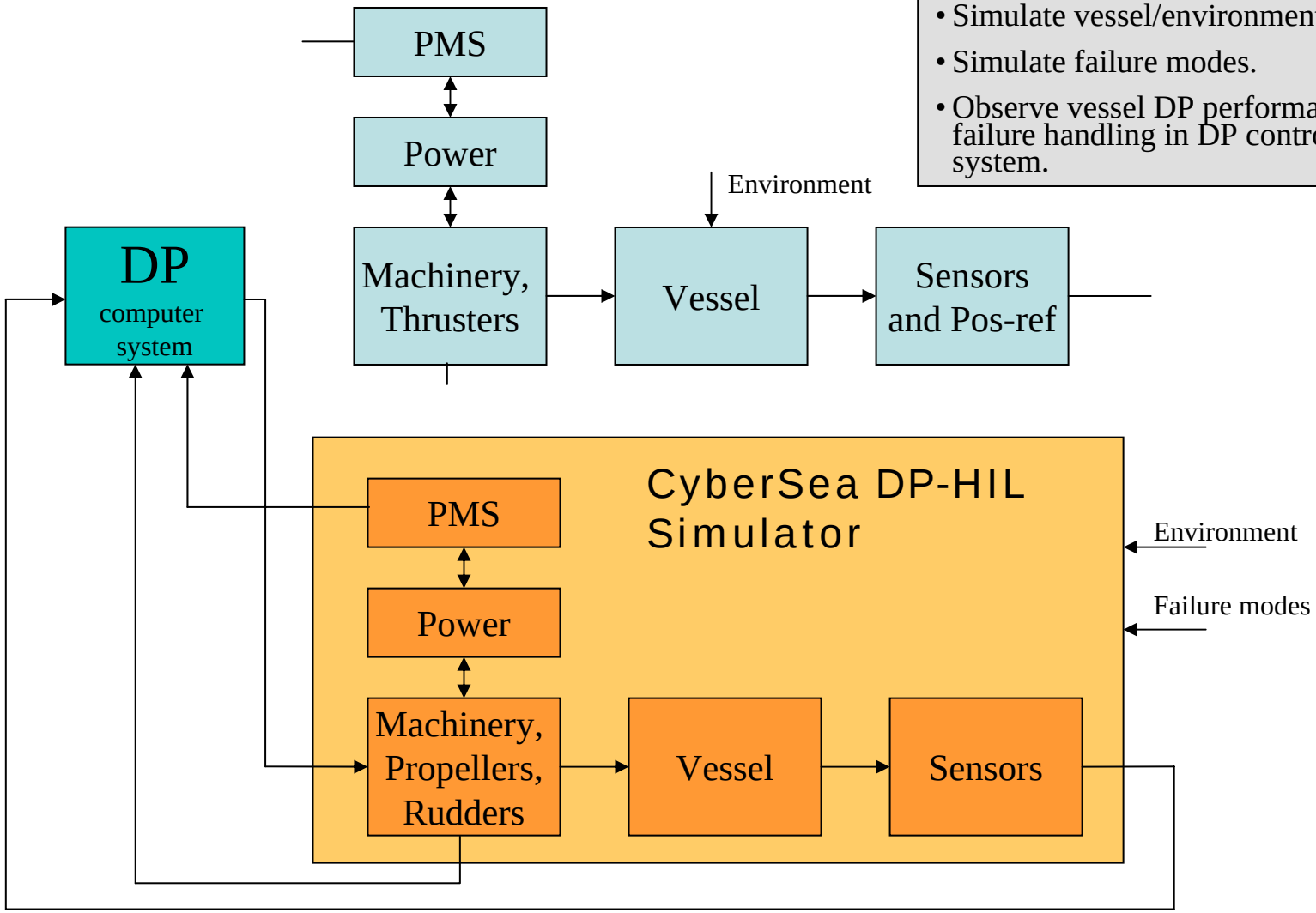
DP System Overview



MARINE CYBERNETICS

CyberSea DP-HIL Simulator (FAT/dock)

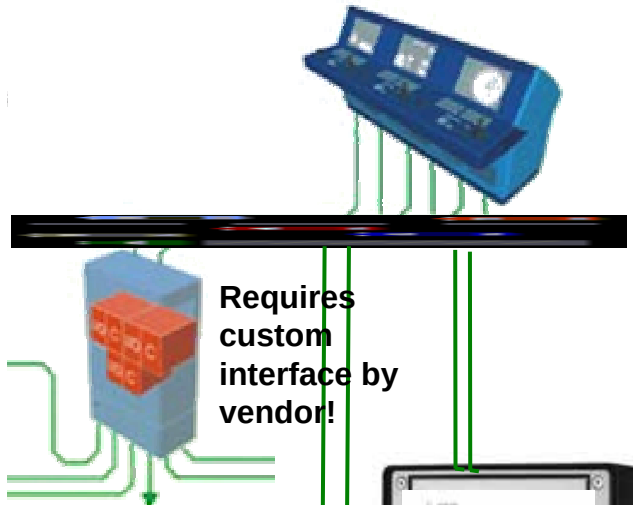
- Isolate DP control system.
- Simulate vessel/environment.
- Simulate failure modes.
- Observe vessel DP performance and failure handling in DP control system.



MARINE CYBERNETICS

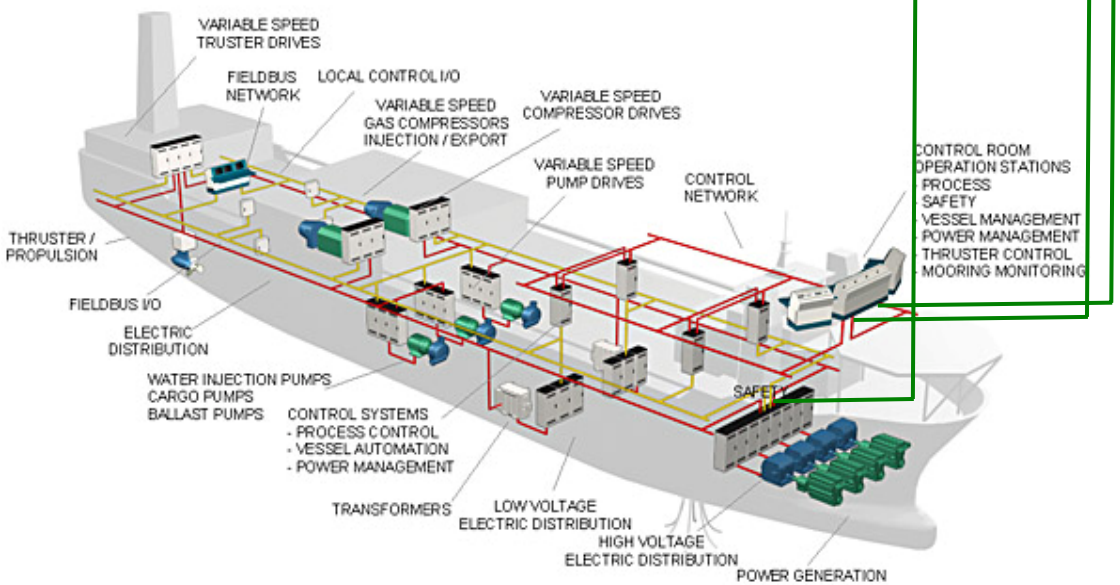
Option 2:

CyberSea Simulator connected to DP computer or integrated automation system via network



Requires custom interface by vendor!

CyberSea Vessel Simulator

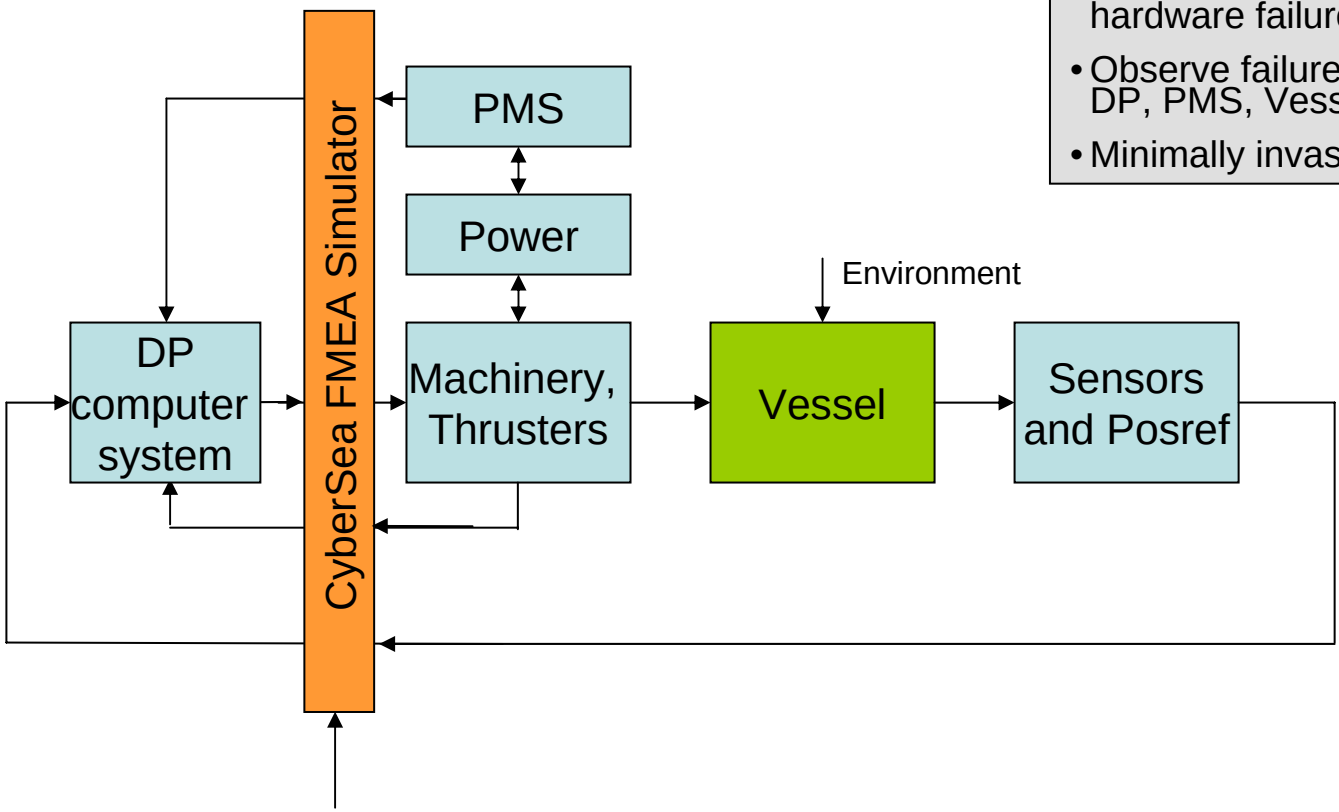


CyberSea Simulator Manager

MARINE CYBERNETICS

CyberSea FMEA Simulator (Sea trials)

- Simulate sensor and position reference signal failures/errors.
- Simulate thruster signal failure modes.
- Simulate network and system hardware failures.
- Observe failures and errors in DP, PMS, Vessel control, etc.
- Minimally invasive FMEA.



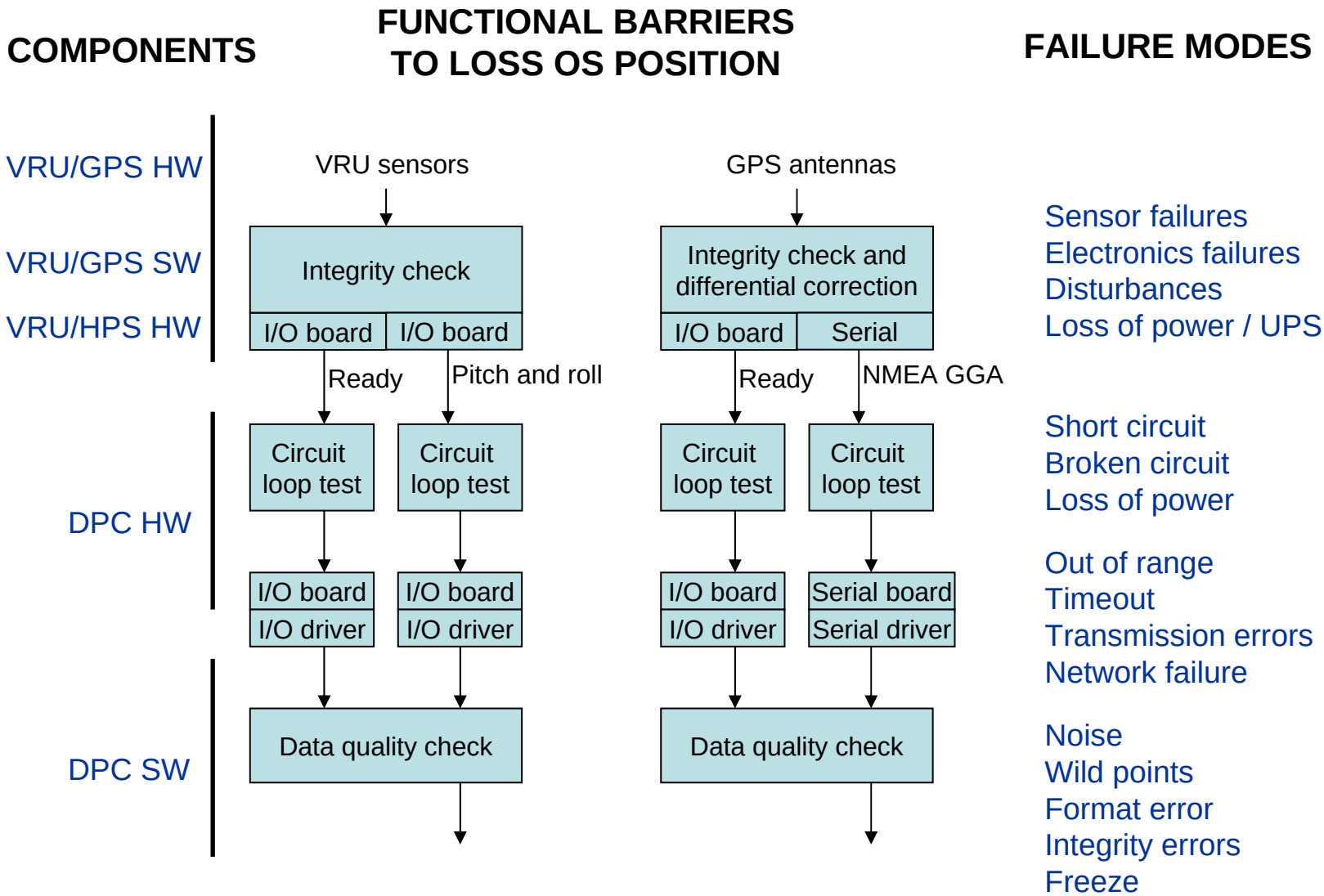
MARINE CYBERNETICS

HIL Testing and FMEA

Observations

- There are no requirements for redundancy of software. Software errors should be considered a common mode failure. The consequence of software errors are therefore potentially much larger than component failures.
- A focus on functional barriers in FMEA studies is useful in order to understand the possible impact of complex failure modes, the role of software, and how to efficiently analyse and test DP systems.

Example: Barriers to loss of position due to VRU and DGPS failure modes

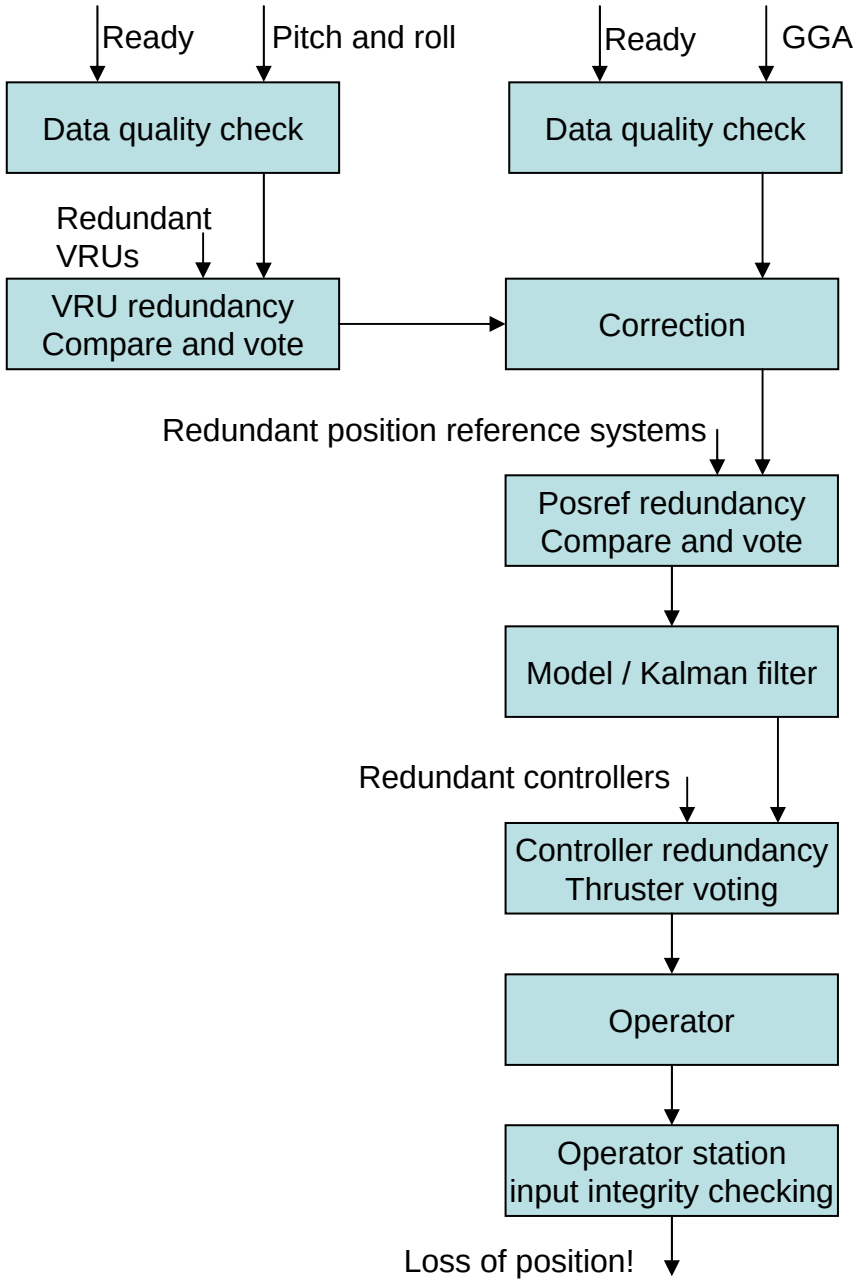


MARINE CYBERNETICS

COMPONENTS

FUNCTIONAL BARRIERS TO LOSS OF POSITION

FAILURE MODES



DPC SW

PSU HW

Operator

Operator station

Noise
Wild points
Format error
Integrity errors
Freeze

Bias (difference or median reject)
Drift (difference or median reject)

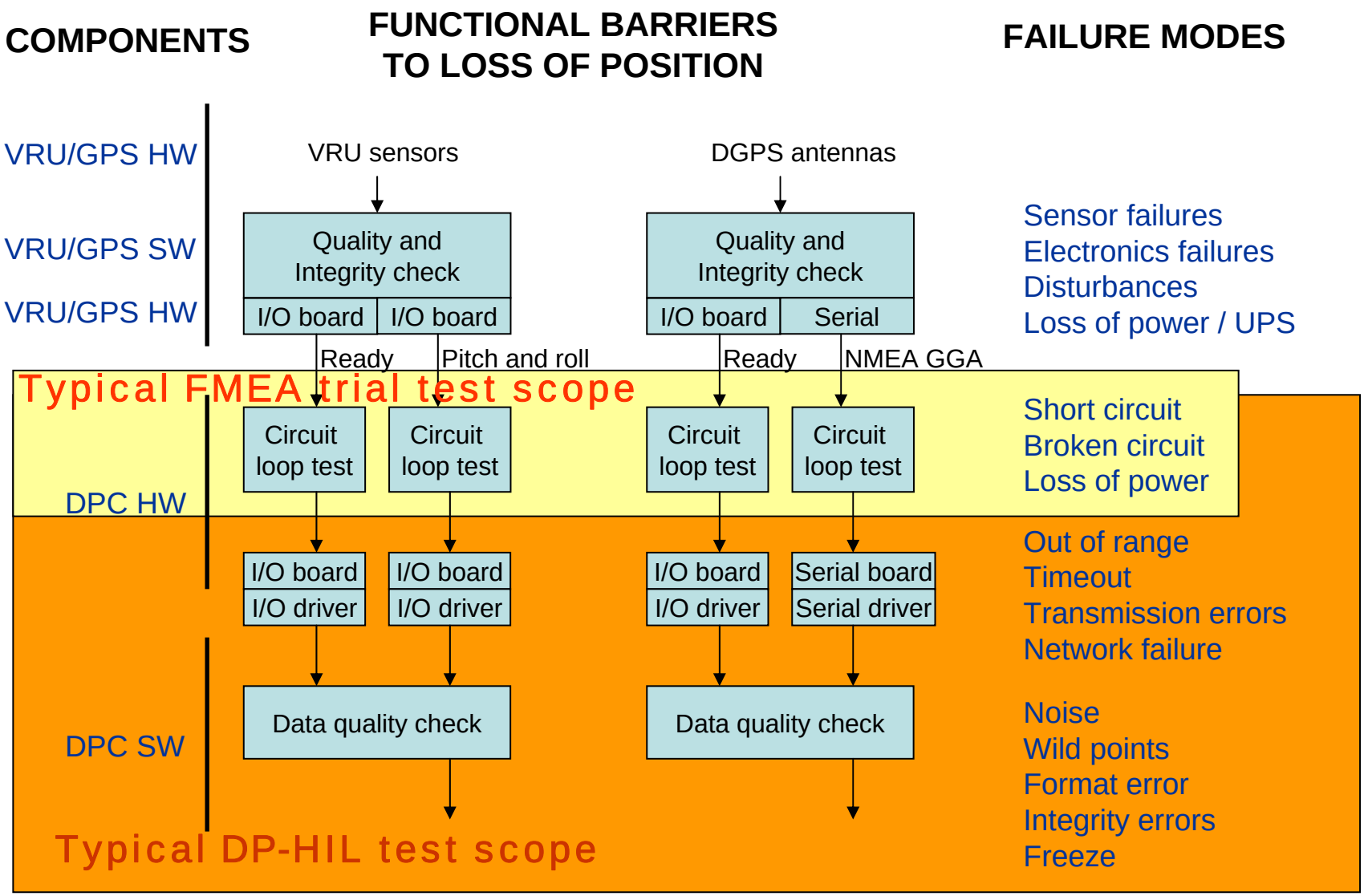
Noise
Bias (prediction error)
Drift (prediction error)

Controller HW failure
Controller SW errors
Loss of power / UPS
Transmission errors
Network errors

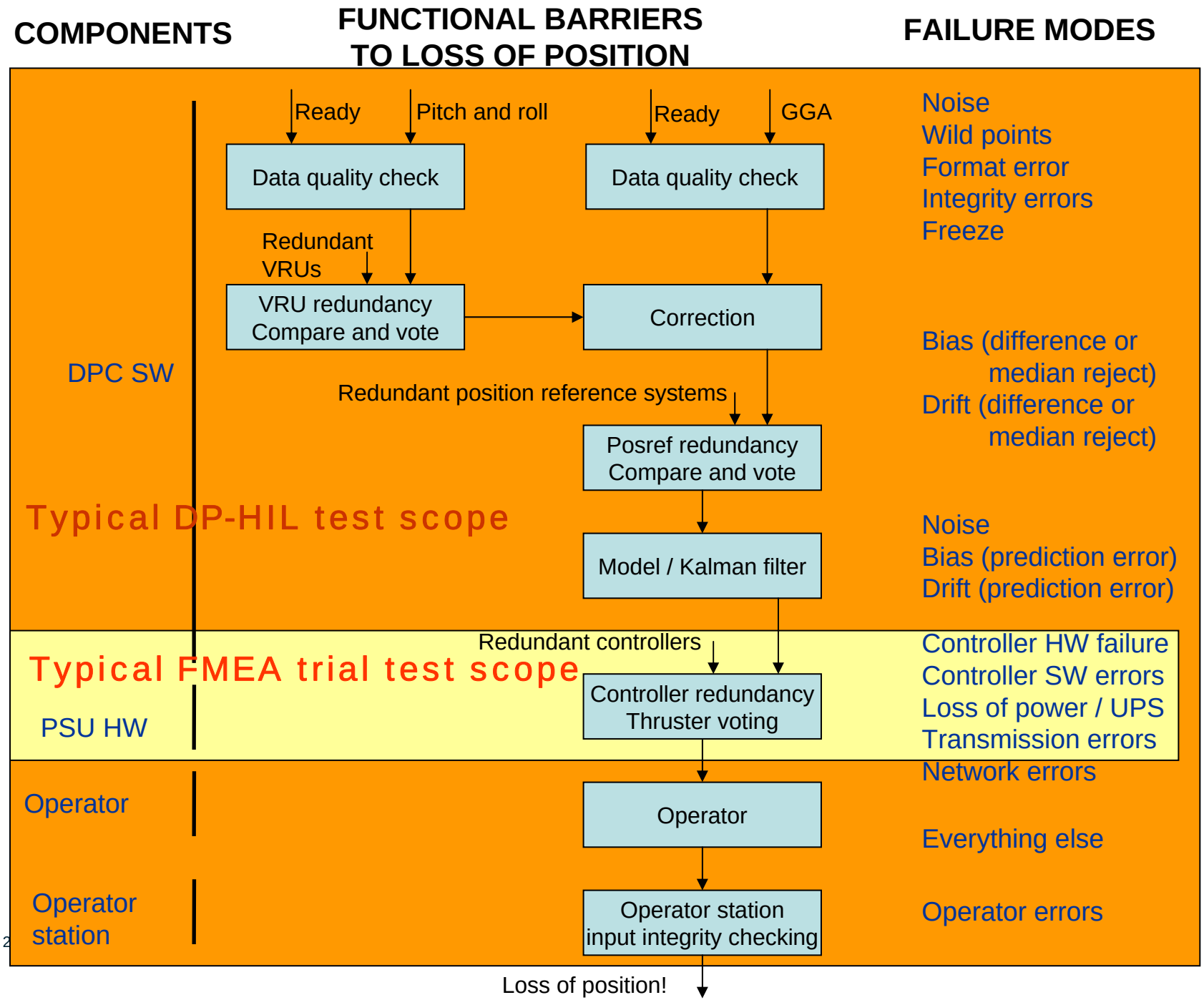
Everything else

Operator errors

MARINE CYBERNETICS



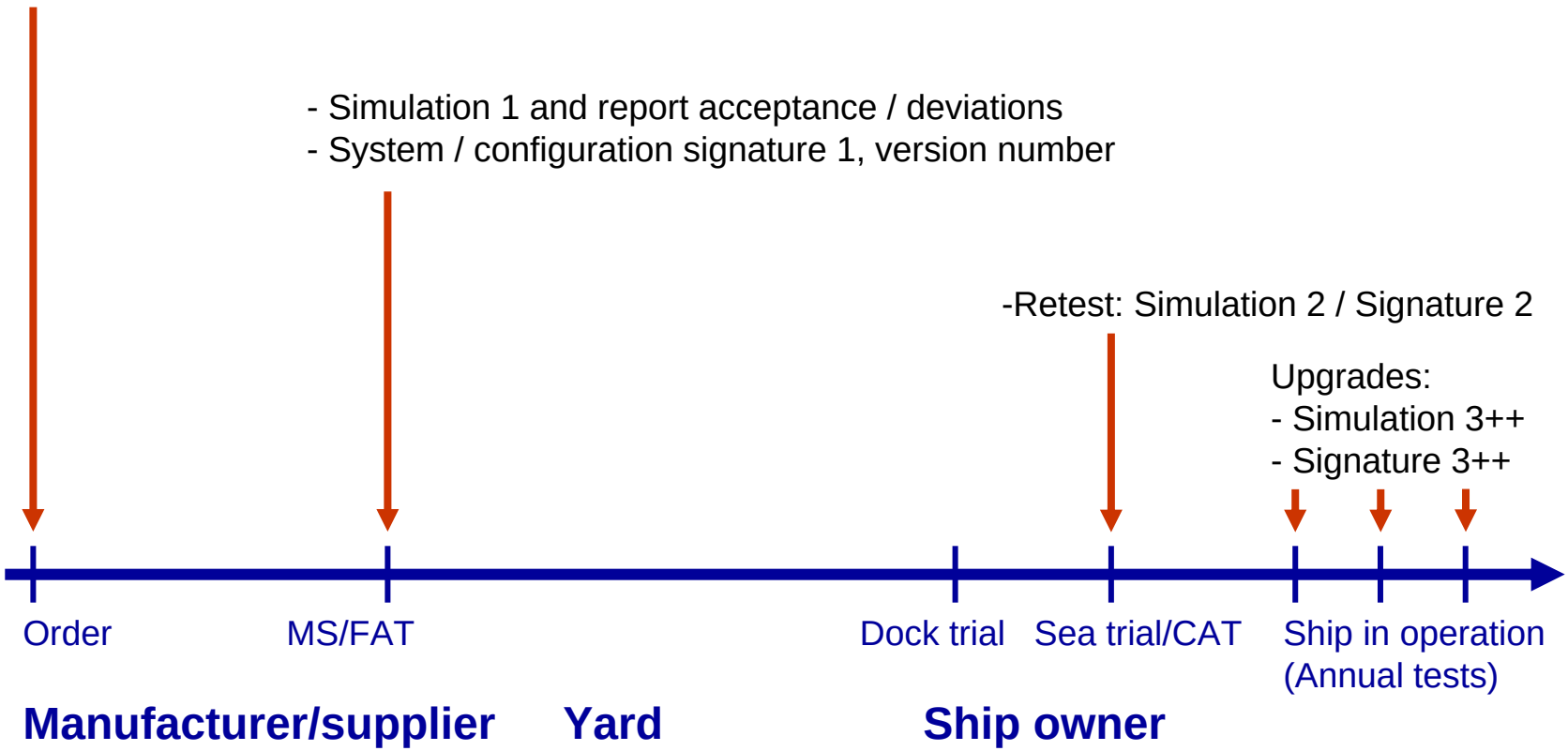
MARINE CYBERNETICS


COMPONENTS
FUNCTIONAL BARRIERS TO LOSS OF POSITION
FAILURE MODES
Ready
Pitch and roll
Ready
GGA
Data quality check
Data quality check
Noise
Wild points
Format error
Integrity errors
Freeze
Redundant VRUs
VRU redundancy Compare and vote
Correction
DPC SW
Bias (difference or median reject)
Drift (difference or median reject)
Redundant position reference systems
Posref redundancy Compare and vote
Typical DP-HIL test scope
Noise
Bias (prediction error)
Drift (prediction error)
Model / Kalman filter
Redundant controllers
Typical FMEA trial test scope
Controller HW failure
Controller SW errors
Loss of power / UPS
Transmission errors
Network errors
Controller redundancy Thruster voting
PSU HW
Operator
Operator
Everything else
Operator station
Operator station input integrity checking
Operator errors
Loss of position!

Certification and Class Process

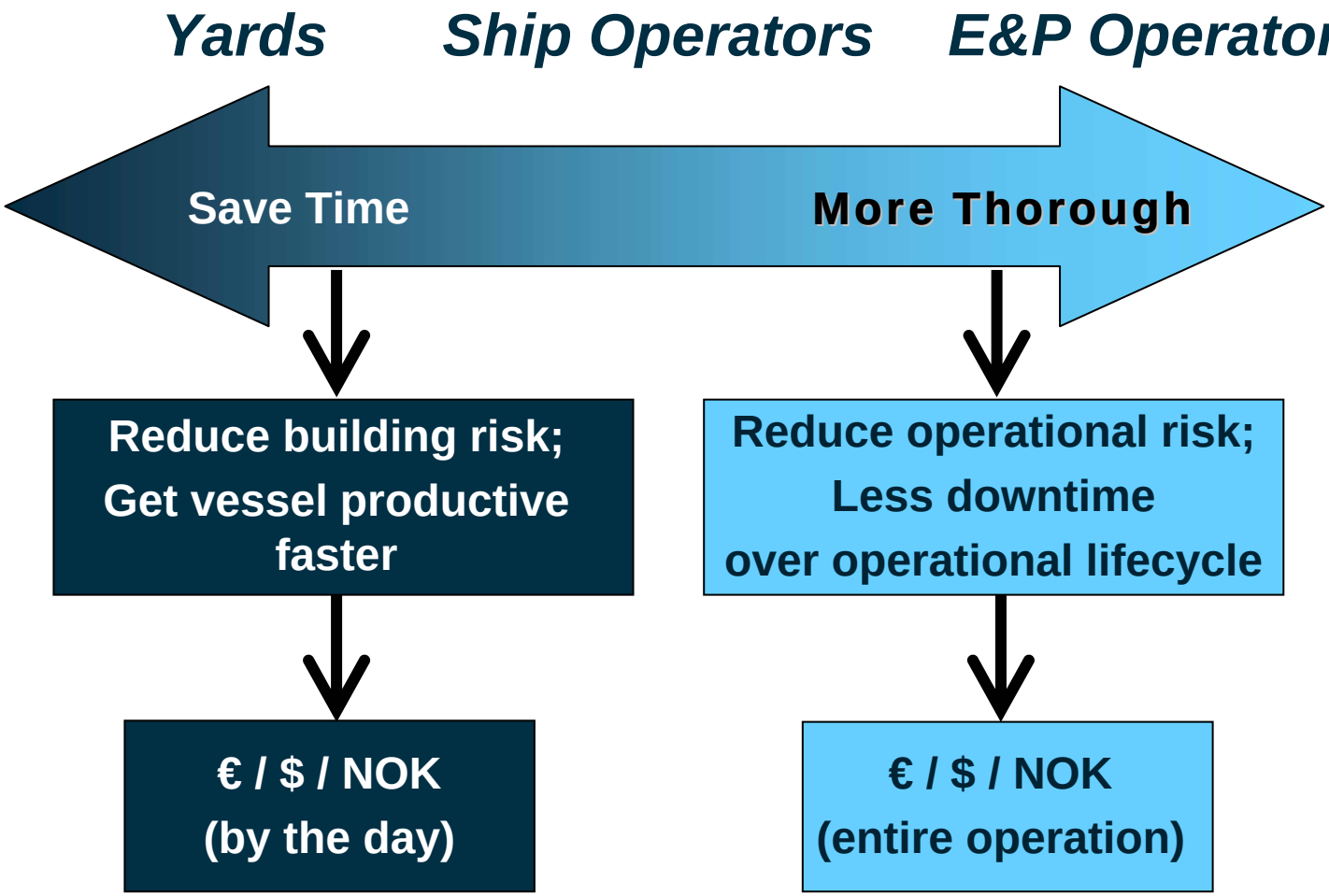
New Buildings and Sailing Ships

- Request for CyberSea test and verification services
  - Engineering: simulator configuration, test plan with acceptance criteria for safety / performance



MARINE CYBERNETICS

Customer Value (1)



HIL testing improves building efficiency and operational availability

MARINE CYBERNETICS

“Big Picture” Value Drivers

Main Players	Vendor	Yard	Ship Operator	E&P Operator
Value of improved testing and verification for Offshore Service Vessels, Drilling, FPSO,..	~ 10.000 USD Design/ engineering team efforts	~100.000 USD Increased sea trial costs and delayed delivery	~10^6 USD Off-hire cost, damage cost, (vessel day rates)	~10^7 USD Lost revenue and production, damage cost, HSE, ..

References: Ships in Operation 2006

Acergy Osprey, Acergy (DSV)

Kongsberg Maritime DP 3

Island Frontier, Island Offshore (IMR)

Marine Technologies DP 3

Far Fosna, Farstad Shipping (AHTS)

Rolls-Royce DP 2

Bourbon Orca, Bourbon Offshore (AHTS)

Kongsberg Maritime DP 3

MARINE CYBERNETICS

References: New Buildings 2006

NB 275 Ulstein Yard, Bourbon Offshore (PSV)

Marine Technologies DP 2

Ulstein/Megacon PMS

NB 275 Ulstein Yard, Bourbon Offshore (PSV)

Marine Technologies DP 2

Ulstein/Megacon PMS

MARINE CYBERNETICS

Reference: Ships in Operations

Acergy Osprey

- **Diving and Construction Ship**
- **DP Class 3: Kongsberg Maritime**
- **E&P Operator: Statoil**
- **Class: DNV AUTRO + SfC of HIL testing**

DP-HIL Safety and Performance Testing

FAT:

- January 2006

Dock Trials:

- February 2006

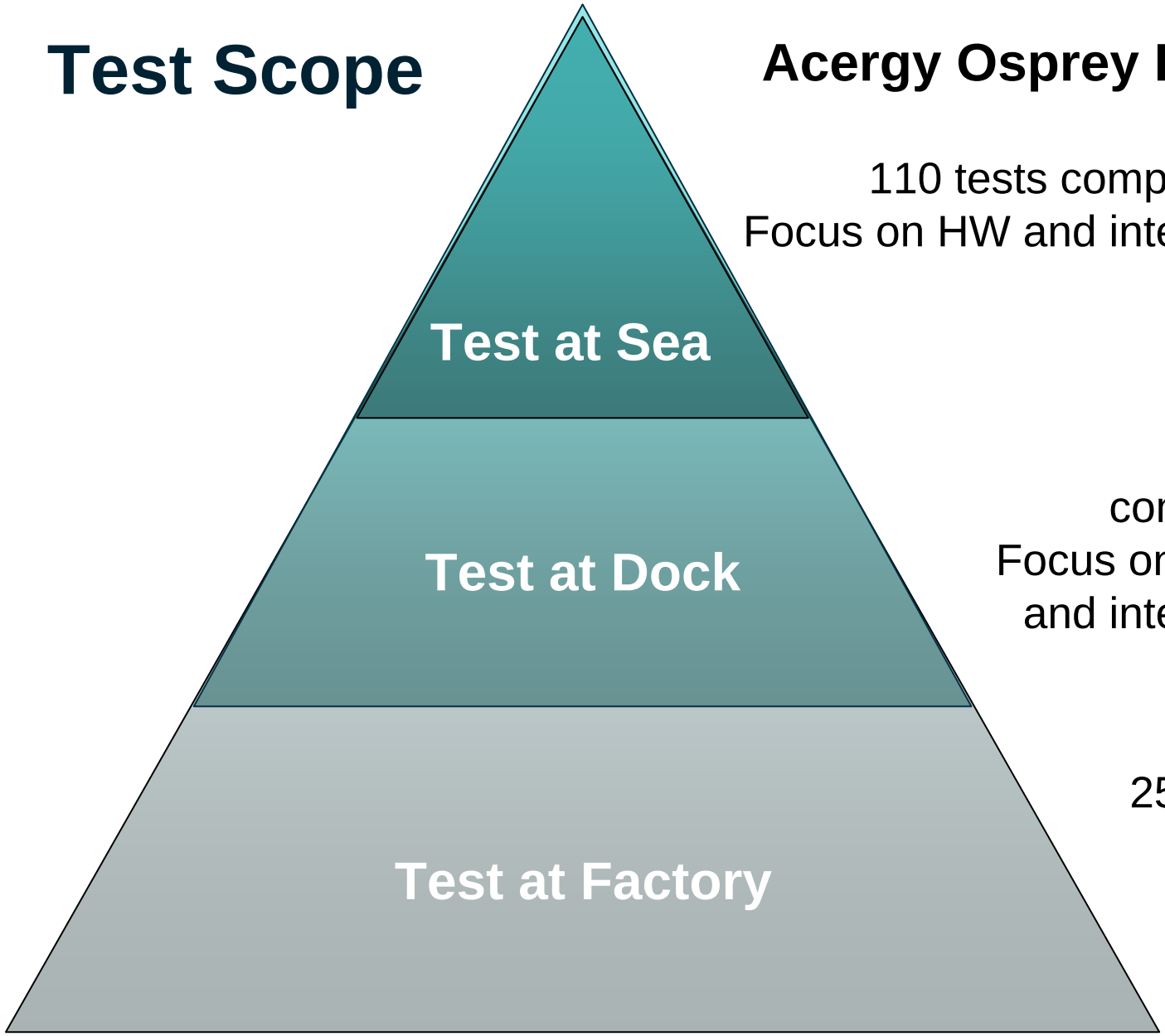
Sea Trials:

- March 2006

MARINE CYBERNETICS

Test Scope

Acergy Osprey DP-HIL Testing



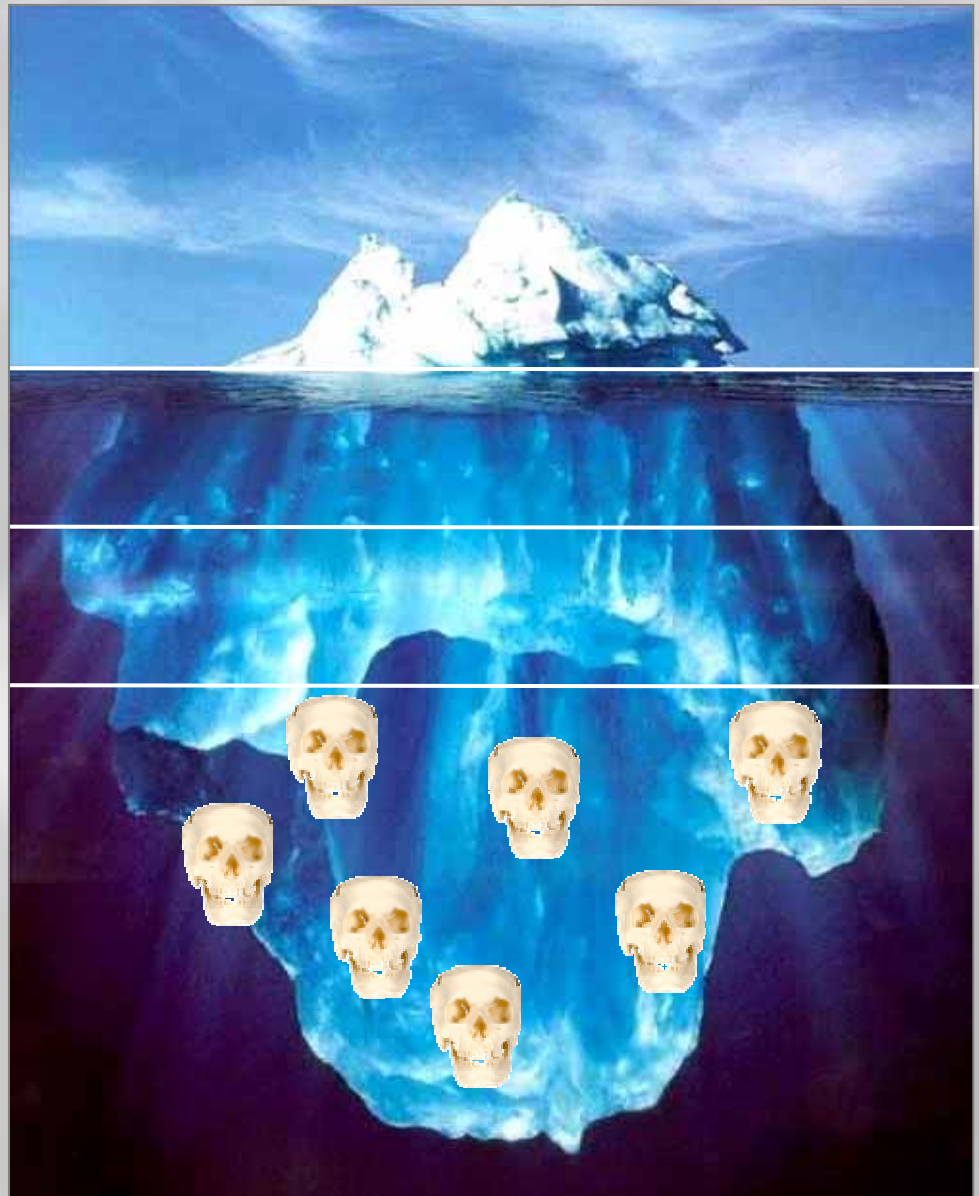
110 tests completed in 19 hours.
Focus on HW and integrated functions.

111 tests at dock completed in 30 hrs.
Focus on SW functionality and integrated functions.

259 tests at factory completed in 3.5 days.
Focus on SW functionality.

MARINE CYBERNETICS

Software Problem Identification



System tests (FAT) **+ HIL**

Tests on board (CAT) **+ HIL**

Revealed during normal operation **+ HIL**

Identified during accidents and emergency handling ... or that are never identified

"Soft-ware Bugs"

MANAGING RISK DNV

Software Problem Identification

Goal: Reduced number of possible ”Software bugs” will give a safer system after HIL testing

System tests (FAT) + HIL

Tests on board + HIL

Revealed during normal operation + HIL

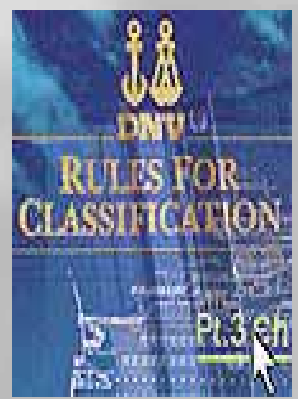
Identified during accidents and emergency handling ... or that are never identified

“Soft-ware Bugs”

MANAGING RISK DNV

Why does DNV believe in HIL testing in the maritime industry?

- HIL technology is successfully applied to other industries
- Reliability of control systems is of great concern to stakeholders in the offshore and the maritime industry



MANAGING RISK

DNV

DNV Deliveries related to HIL

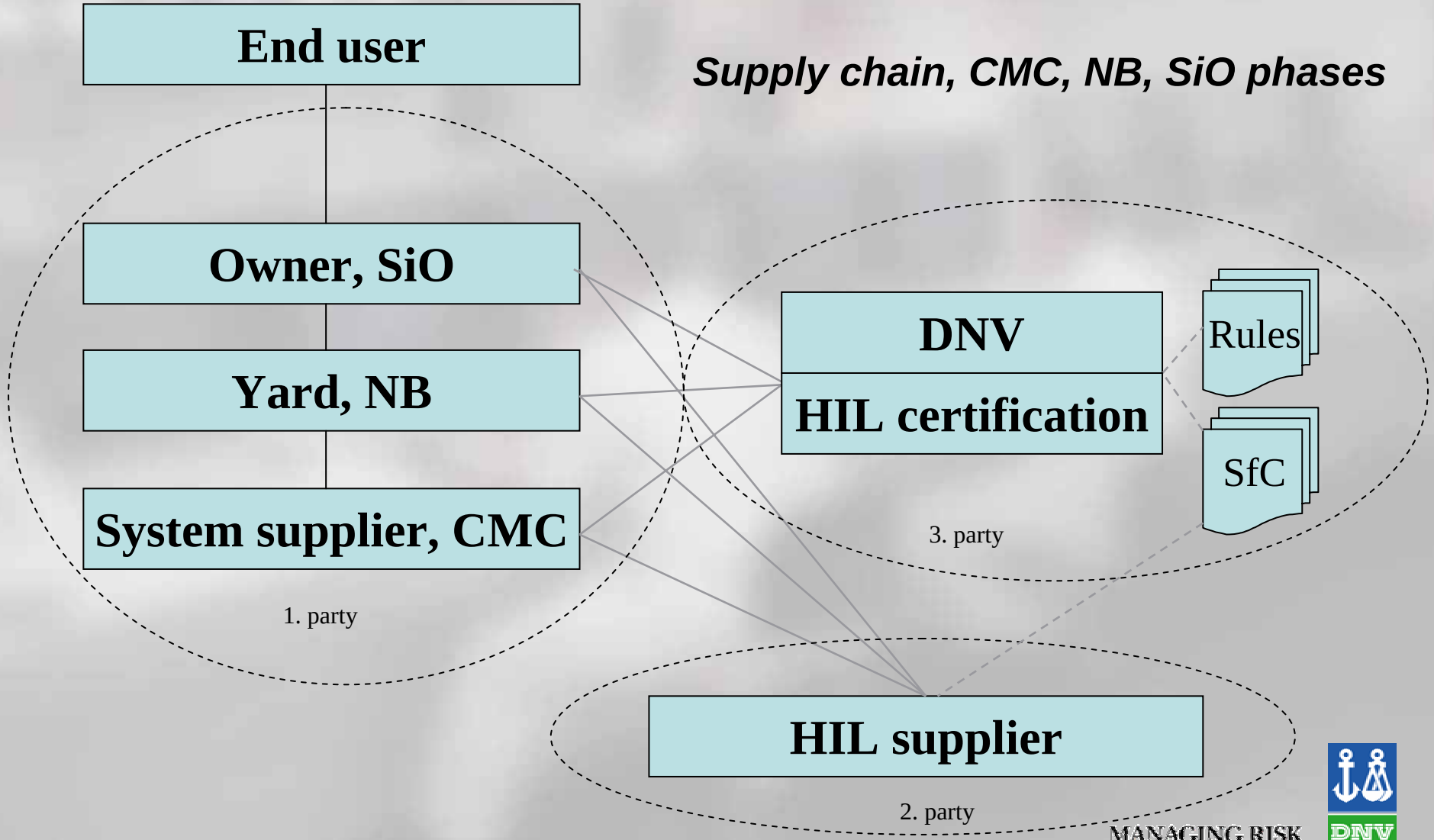
DNV can offer an independent certification of the HIL process

- *DNV approves HIL test suppliers*
- *DNV has a standard for HIL testing*
- *DNV issues HIL certificates*

Standard for Certification of HIL testing

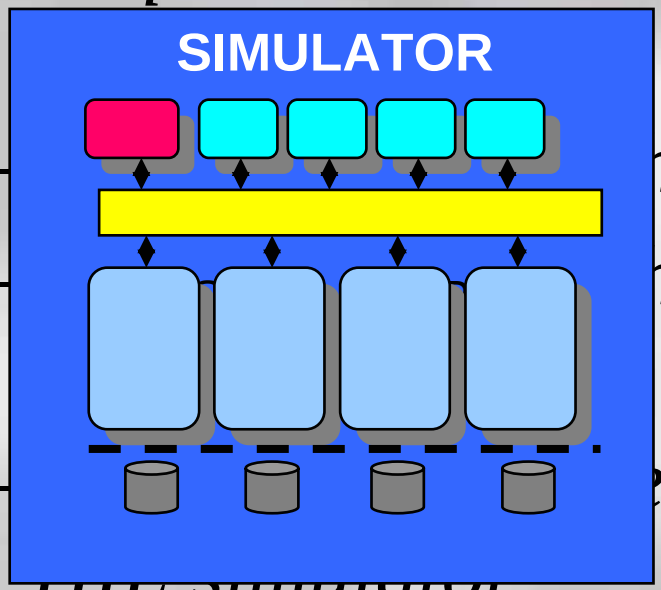
- Defines responsibilities for the involved parties
  - *Target system owner*
  - *HIL Supplier*
  - *HIL Test organisation*
  - *HIL Certification body*

Standard for Certification of HIL testing



Standard for Certification of HIL testing

- Defines general requirements for the HIL test package
  - *Requirements to configured HIL/Plant*
  - *ne H tor*
  - *ne H test*
  - *eme red*
  - *HIL simulator*



MANAGING RISK

Standard for Certification of HIL testing

- Refers to functional requirements for the target system
  - *E.g. class rules for DP, PMS,…*

- Defines the content of the HIL test certificate

Conclusion

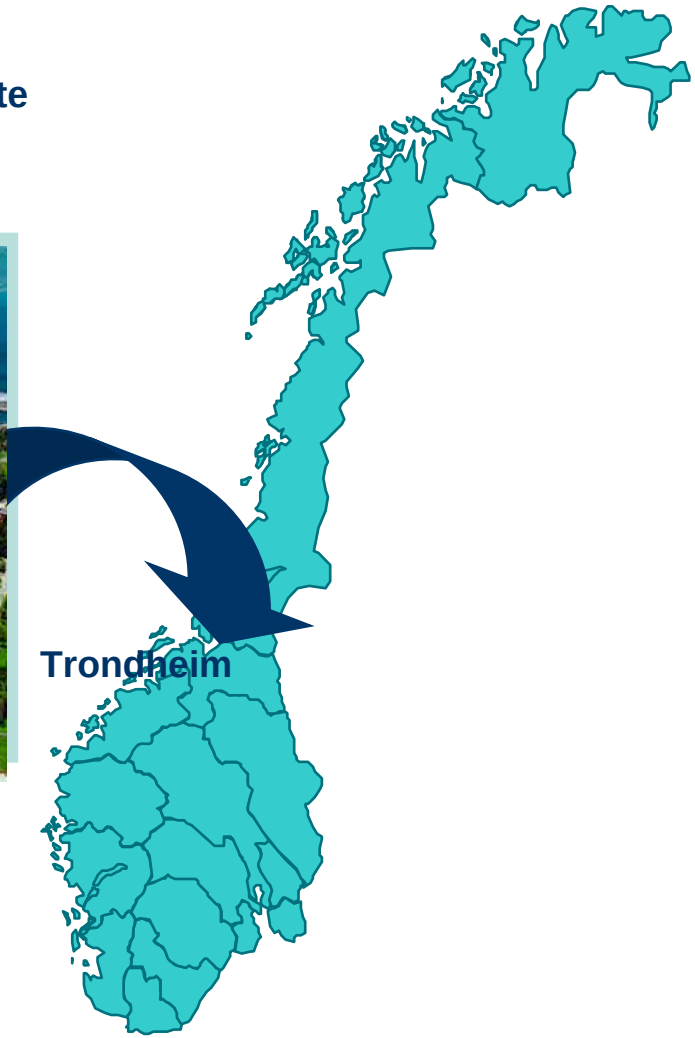
- HIL
  - makes possible improved testing compared to today's maritime test standards
  - makes the system become safer
  - will become part of the future industry standard
  - is available today

<u>HIL represents a significant step forward</u>

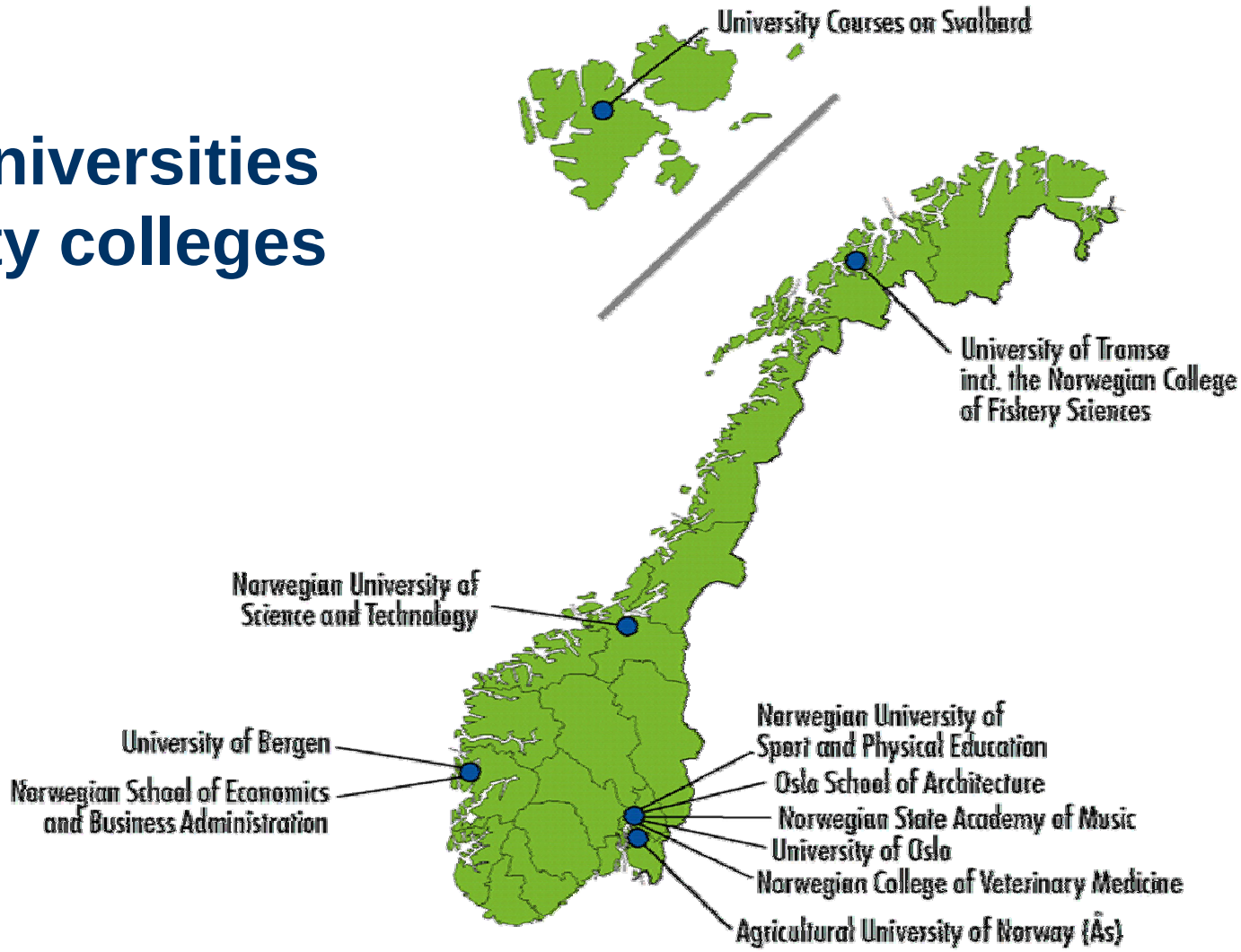
- The maritime and offshore markets request improved testing regime for safety critical onboard computer systems. HIL testing and HIL test certification are an answer to this request.
- DNV can deliver certification of HIL testing today

MARINTEK

Norwegian Marine Technology Research Institute



Norwegian universities and university colleges



Gløshaugen-Campus

SINTEF

Technology for a better society

Our partners

- The Norwegian University of Science and Technology, NTNU:
  - 20000 full-time students
  - 973 scientific employees
- University of Oslo, UiO,
  Faculty of mathematics and natural sciences:
  - 4500 full-time students
  - 518 scientific employees

NTNU and the SINTEF Group Collaboration in R & D

The SINTEF Group

SINTEF's Council
SINTEF's Board

President
Senior Executive Vice President

SINTEF Health Research
SINTEF ICT
SINTEF Marine
SINTEF Materials and Chemistry
SINTEF Petroleum and Energy
SINTEF Technology and Society

The SINTEF Group (cont.)

SINTEF Marine	consists of:	MARINTEK SINTEF Fisheries and Aquaculture SINTEF Marine Environmental Technology
SINTEF Petroleum and Energy	consists of:	SINTEF Petroleum Research SINTEF Energy Research

Marine Technology Centre in Trondheim, Norway

Market Profile

MARINTEK carries out contract R&D for marine related industries:

- **Offshore oil/gas industry**
- **Ship building industry**
- **Shipping**
- **Marine equipment industry**

MARINTEK is heading for technologically challenging R&D projects:

- **New advanced product concepts and prototypes**
- **New advanced services**

for the benefit of our customers, and the society through:

- **Reduced risks for human lives, environment and capital assets.**

MARINTEK undertakes multidisciplinary projects and co-operates with associated partners within the SINTEF Group.

Technology Profile

MARINTEK is a contract research institute within marine technology.

- **Hydrodynamics and structures**
- **Energy and machinery technology**
- **Operations technology**

MARINTEK is co-operating closely with the Norwegian University of Science and Technology (NTNU) - Institute of marine technology.

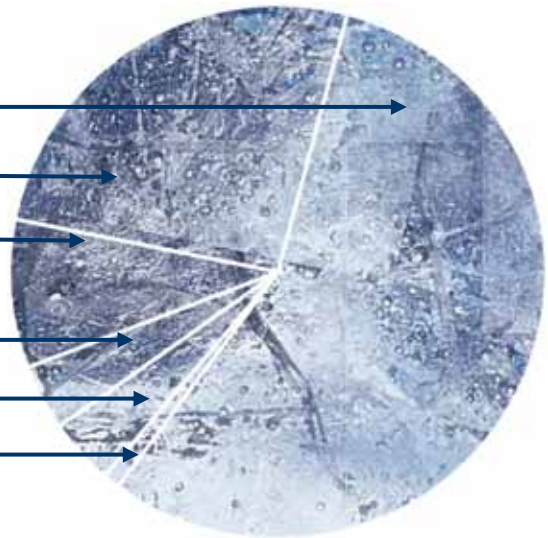
MARINTEK operates national marine technology laboratories together with NTNU.

- **Ocean basin (80x50x10 m)**
- **Ship model towing tank (260 m)**
- **Cavitation tunnel**
- **Machinery laboratory**
- **Marine structures laboratory**

Ownership

MARINTEK has the following shareholders:

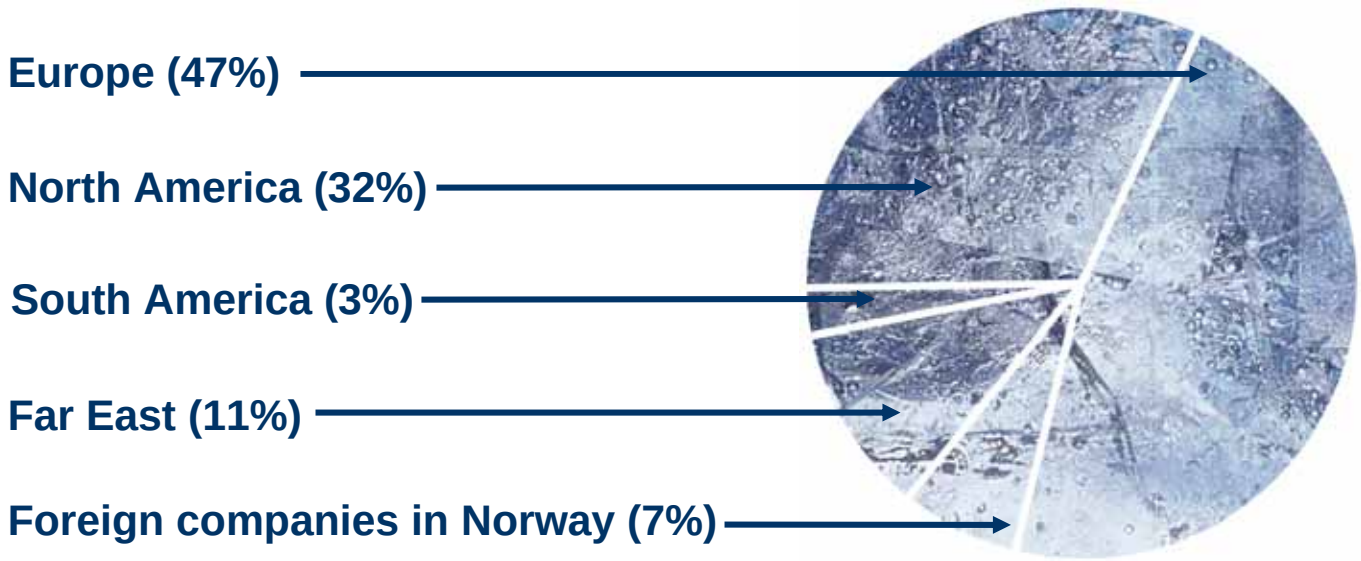
SINTEF ……:	6.5 MNOK	56%
Norwegian Shipowners' Association :	3.0 MNOK	26%
Det Norske Veritas ……:	1.0 MNOK	9%
Found. of Shipbuilders' Fund for Research and Education ……:	0.5 MNOK	4%
Directorate of Shipping ……:	0.5 MNOK	4%
Fed. of Norwegian Coastal Shipping :	0.1 MNOK	1%



Total Share Capital: 11.6 MNOK

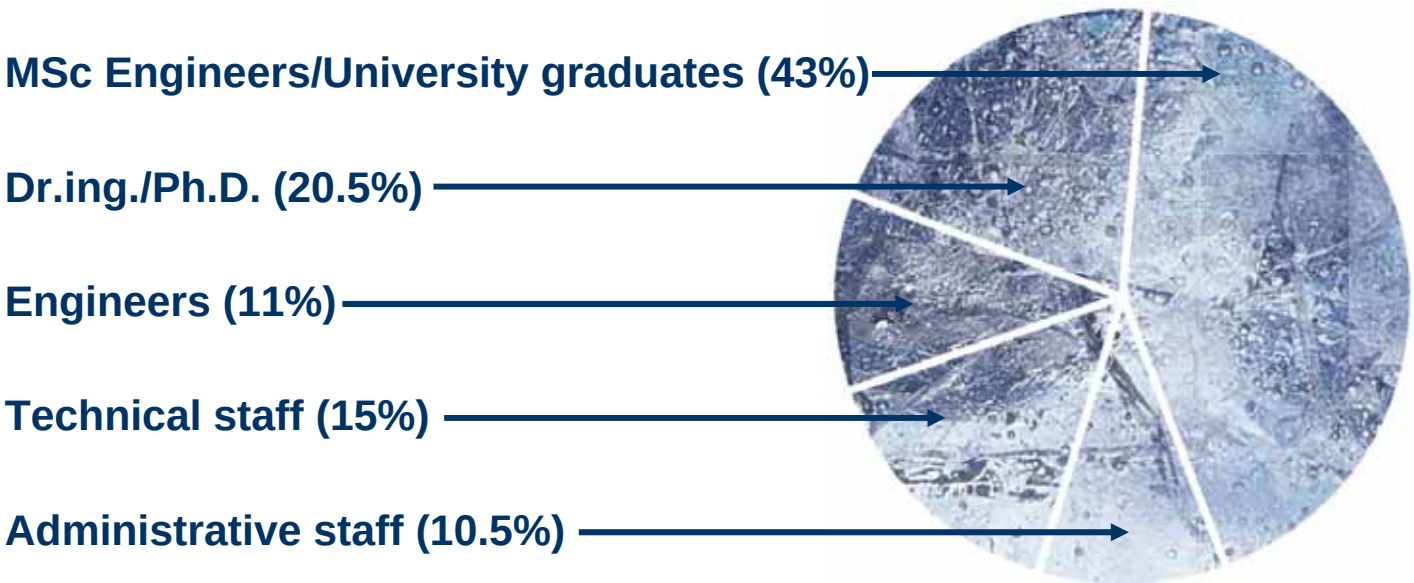
Foreign trade

34% of total turnover
Total turnover 2004: 189 mill NOK



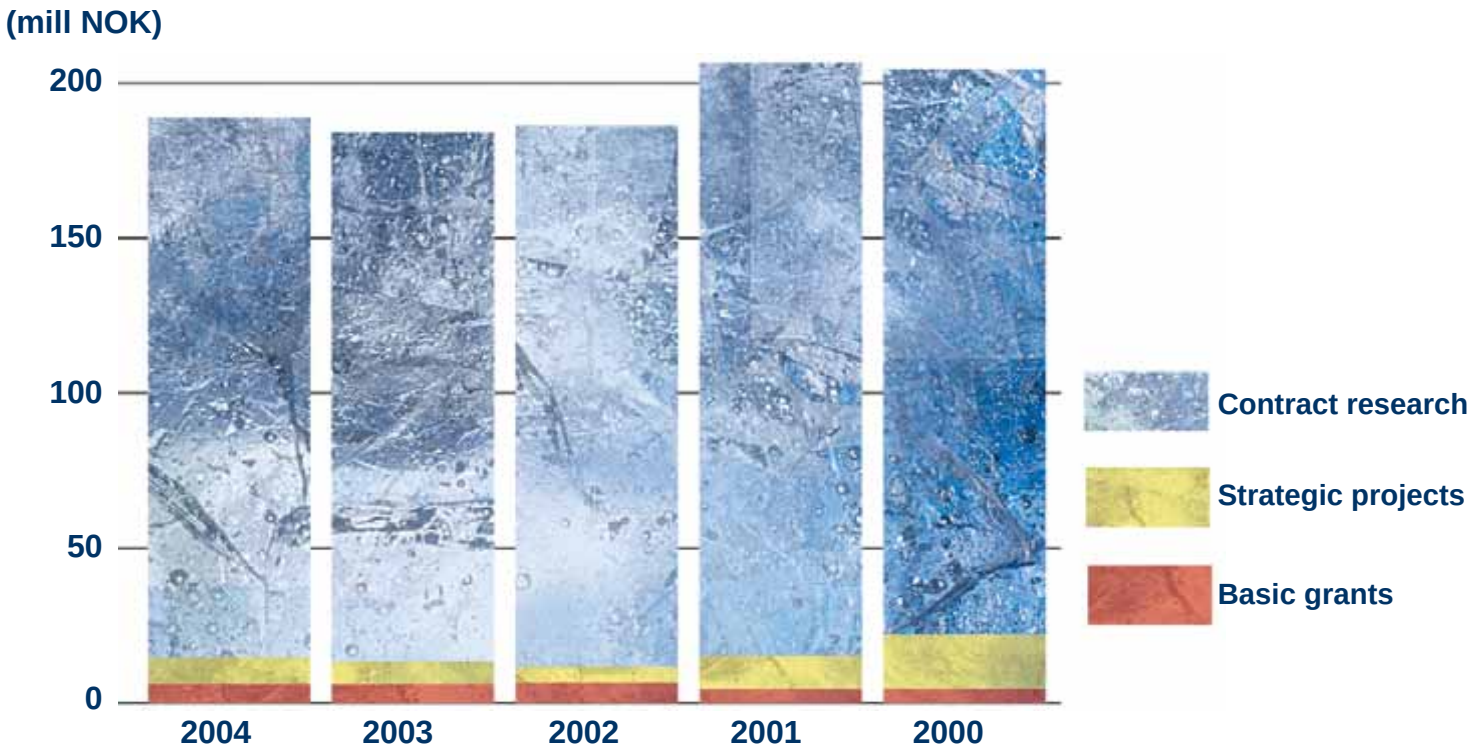
Personnel

176 employees (2005-01-01)



Project-related specification of turnover

Total turnover 2004: 189 mill. NOK



MARINTEK projects in EC – FP 5

STID		-	Steam Injection Diesel Engine
Waterman-Ts		-	Waterborne Traffic and Transport Management - Thematic Network
THEMIS	(TN)	-	Thematic Network in Optimizing the Management of Intermodal Transport Services
THEMES	(TN)	-	Thematic Network on Safety Assessment in Waterborne Transport
IP - Intermodal Portal		-	Integration of Ports into Intermodal Transport Chains
TRESHIP	(TN)	-	Technologies for Reduced Environmental Impact from Ships
MARPOWER	(TN)	-	Concepts of Advanced Marine Machinery Systems with Low Pollution and High Efficiency
FLOWMART		-	Efficient Low Wash Maritime Transportation
SWAN		-	Standardization and Dissimination Support Actions for Waterborne Telematics Networks and Applications
ITEA-DS		-	Intelligent Tools for Emergency Applications and Decision Support
D2D		-	Demonstration of an Integrated Management and Communication System for Door 2 Door Intermodal Freight Transport Operations
MARTOB		-	On board Treatment of Ballast Water and Application of Low Sulphur Marine Fuel
HullMon+		-	Intelligent Hull Monitoring Systems
ENCONA		-	Encouraging Co-operation between Community Funded and National Research in Maritime Sector

MARINTEK projects in EC – FP 6

ERAMAR	(TN/CA)	-	**European Research Area Application in the Maritime Domain**
ERASTAR	(CA)	-	**The Network for the Shipbuilding Technology applied Research**
DSS-DC	(STREP)	-	**Decision Support System – Damage Control (MARINTEK Coordinator)**
MTCP	(CA)	-	**Maritime Transport Coordination Platform**
INMARE	(CA)	-	**Best Practices of Ship Management**
HERCULES	(IP)	-	**Reduction of CO_2 Particles from Engines**
ENCOMAR	(SSA)	-	**Enhanced Co-operation between EU Member States and Associated Candidate States in Maritime Research on Transport (Extension of ENCONA project)**
SPREEX	(STREP)	-	**Spreading of Oil Pollutions in Sea**
SUPERPROP	(STREP)	-	**Superior Life-Time Operation Economy of Ship Propellers**
MARNIS	(IP)	-	**Maritime Navigation and Information Services**
VISIONS	(NoE)	-	**Visionary Concepts of Vessels and Floating Structure**
FREIGHTWISE	(IP)	-	**Intermodal Freight Transport Information System**

Ship Technology and Operation

Ship performance and operation

- Ship performance
- Manoeuvring and ship handling
- Sea-keeping performance and operational criteria
- Sea loads
- Propellers, cavitation and noise
- Waterjets
- Thrusters, positioning capacity

Efficient production

- Pre-outfitting principles and methods
- Procurement principles and methods
- Preliminary design tools
- Cell-oriented construction methods
- Preliminary design tools
- Information technology for the shipbuilding industry

Energy technology

- Diesel and gas engine processes R&D
- Ship equipment design analyses and development
- Energy conservation and pollution control
- Liquid and gaseous fuels, quality validation and testing
- Prototype testing and verification

(Cont.)

Ship Technology and Operation (cont.)

Shipping and logistics

- Supply Chain Management
- Transport scenarios and logistic support systems
- Management and decision support systems
- Condition assessment and maintenance program
- Qualification testing of personnel and computerbased training

Control and monitoring systems

- Integrated bridge systems and operational procedures
- Marine cybernetics, anchoring and dynamic positioning
- Marine crane operations and heave compensation

Offshore Oil and Gas Industry

Floating systems

- Loads and motions of floating support vessels
- Loads and motions of risers and other connecting elements
- Capacity of anchoring and dynamic positioning systems
- Operation and operability criteria in specified environments

Structural analysis and testing

- Ultimate strength and collapse behaviour of steel structures
- Dynamic analysis and fatigue design
- Dynamic analysis of slender marine structures; risers and pipelines
- Stress analysis of flexible risers including thermal effects, service life assessment
- Reliability assessment of steel structures, risers and pipelines
- Integrated fire analysis of steel structures
- Re-assessment of ageing structures

Cont.

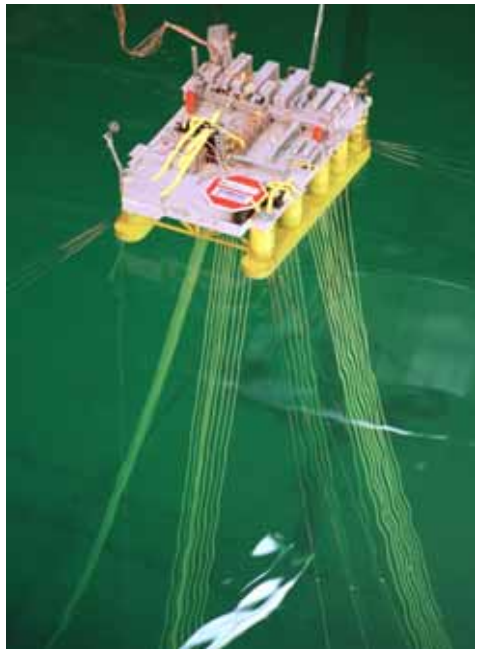
Offshore Oil and Gas Industry (cont.)

Offshore operations

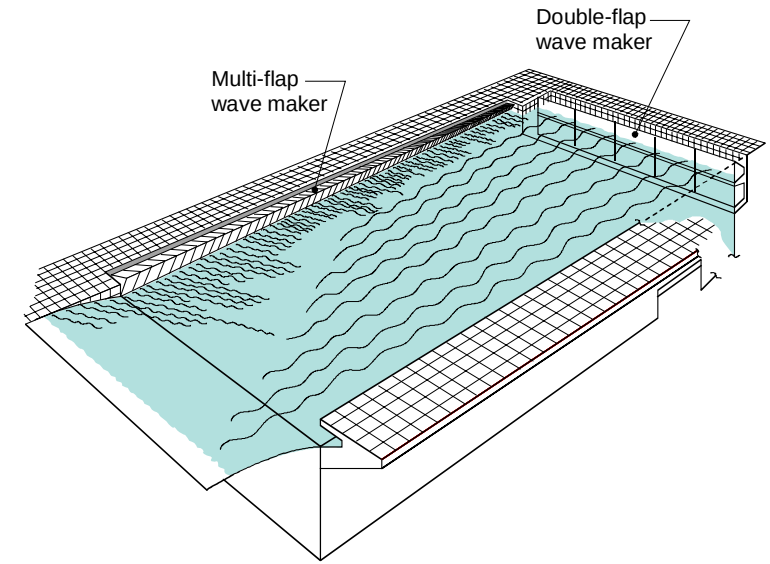
- The positioning of surface vessels
- Forces on, and motions of, complex geometries
- Heave compensation devices
- Simulation of subsea operations

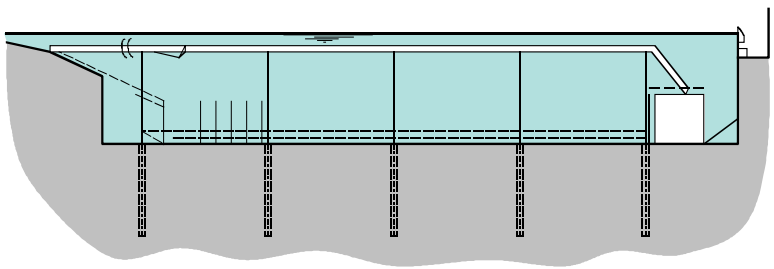
Efficient design and operations

- Operational scenarios and logistics support systems
- Condition assessment and maintenance program development
- Qualification testing of personnel and computerbased training
- Management information systems for operations

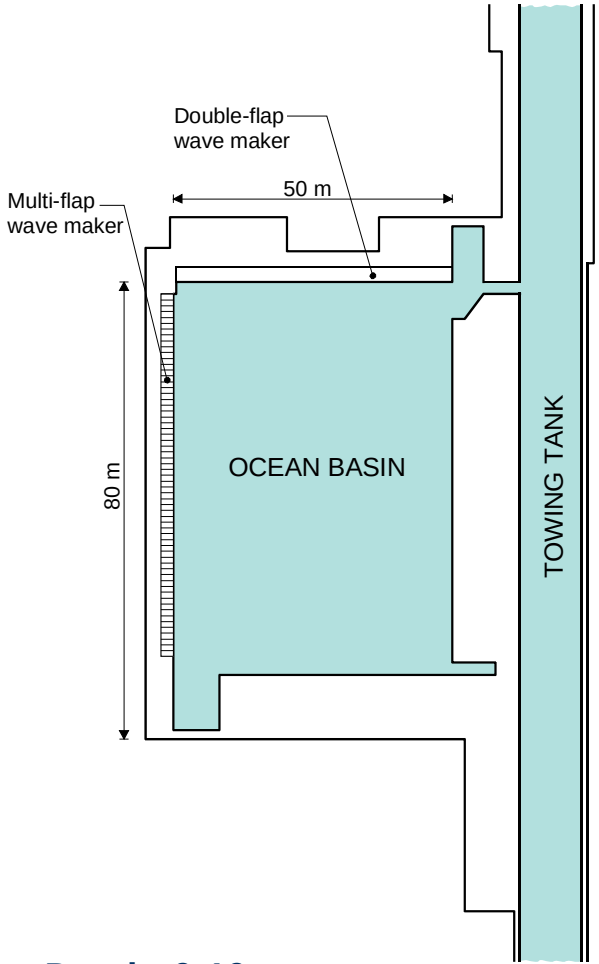


The Ocean Basin Laboratory





Cross-section of Ocean Basin



Length: 80 m - Width: 50 m - Depth: 0-10 m

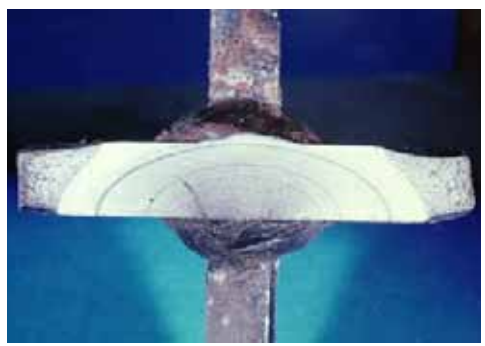
Marine Technology Centre in Trondheim, Norway

Model tests in the Ocean Basin

Model tests in the Ship Model Tank

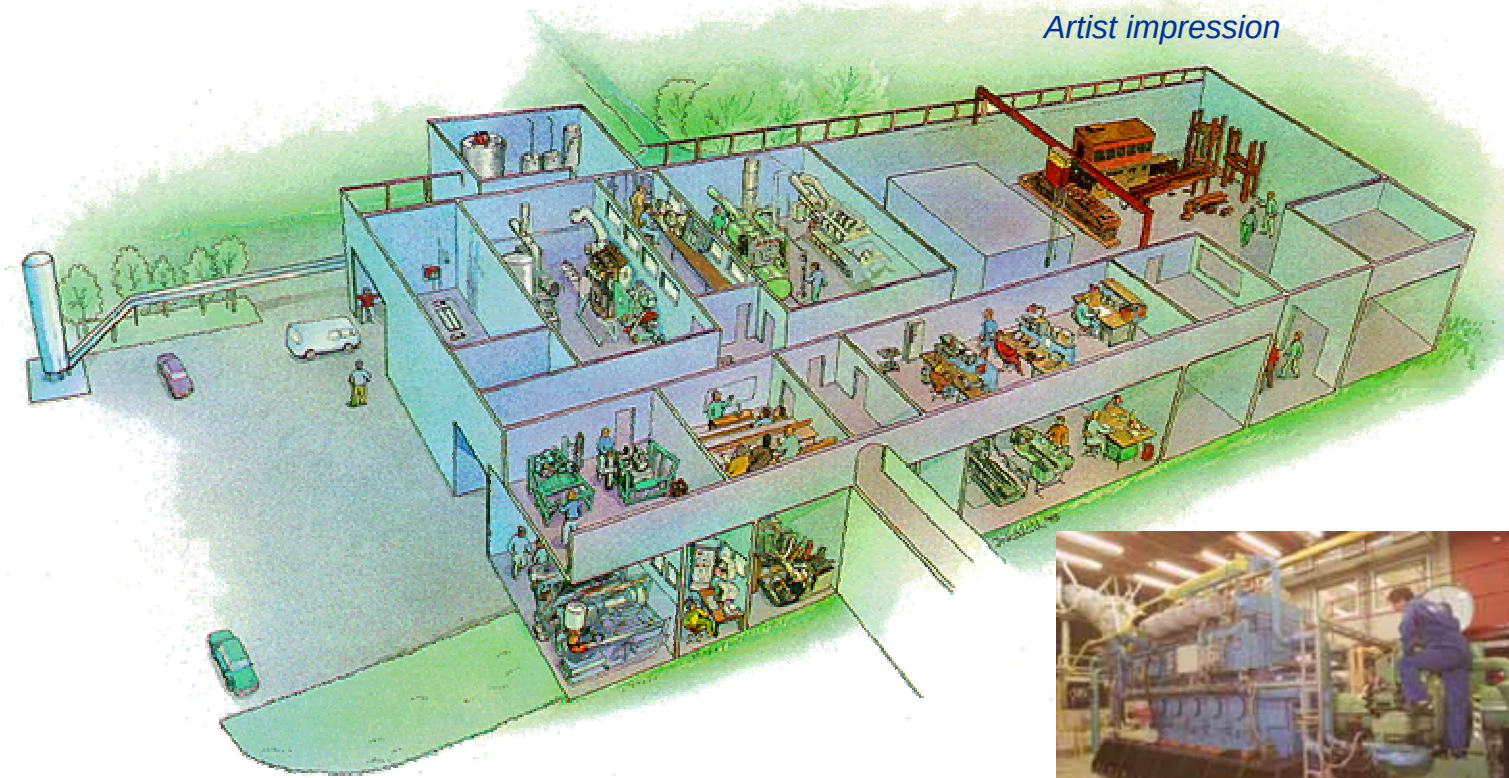
The Cavitation Laboratory

Structural Testing



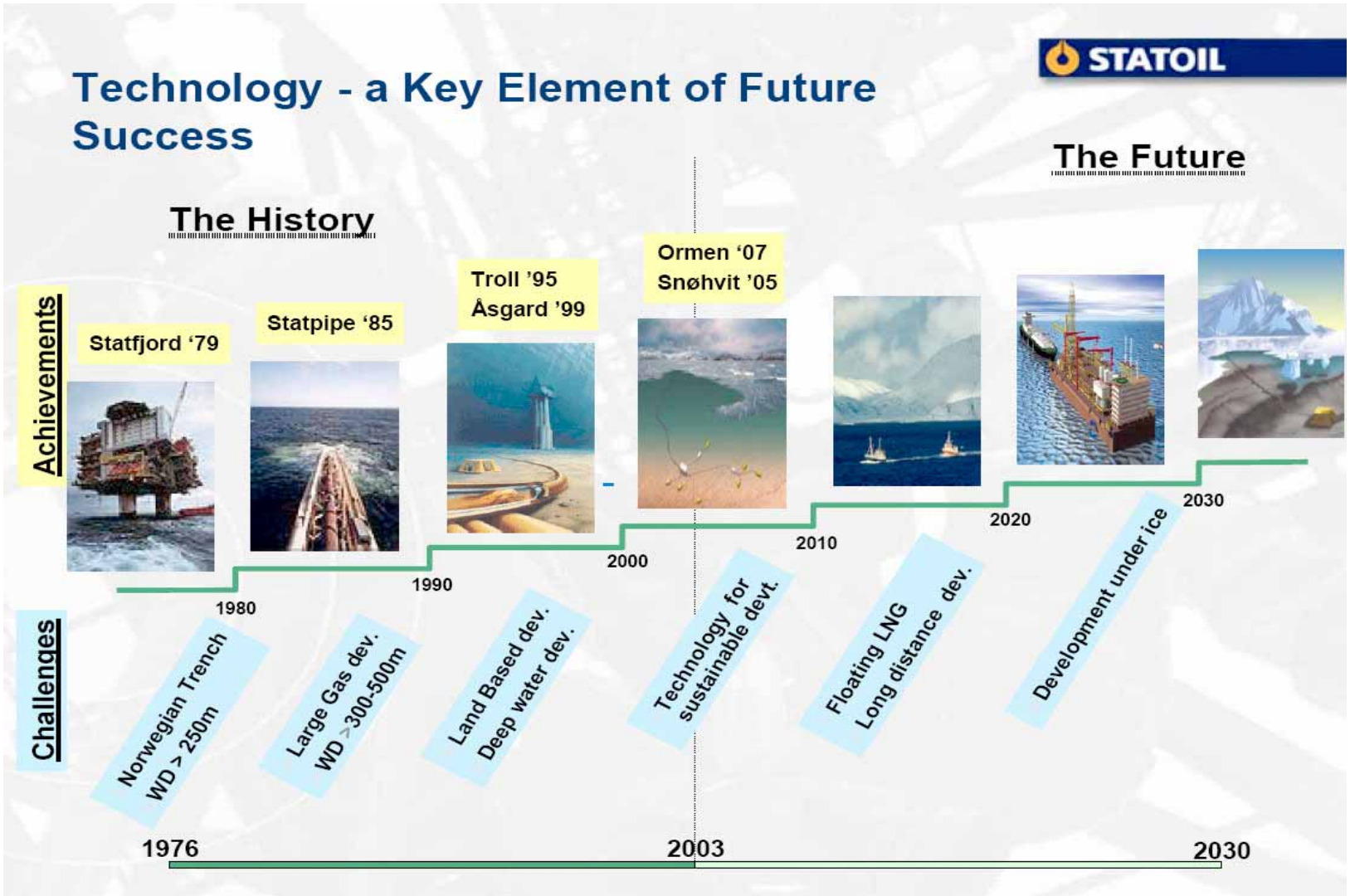
The Machinery Laboratory

Artist impression



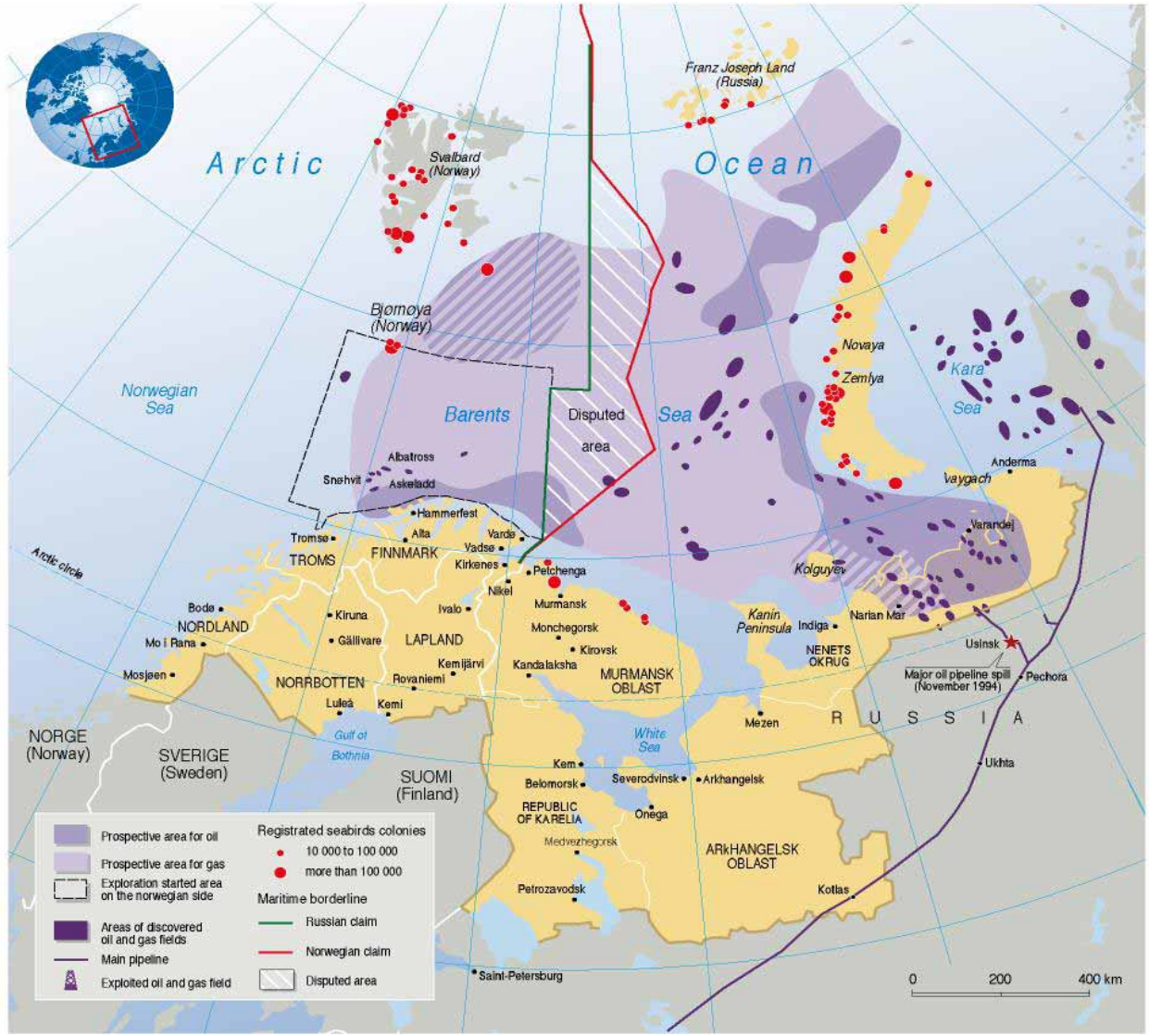
Heading North!!

Development of the Norwegian Offshore Industry



Oil exploitation and transport in the Arctic

- 25% of the world's undiscovered oil resources are expected to be found in the Barents Sea
- EU imports 70% of her energy-demand. Only Danmark and UK net exporters.
- Politically stable area
- Strategic location wrt. the EU
- EU's "Northern Dimension" Programme
- Close dialogue EU, Norway, Russia on the energy field

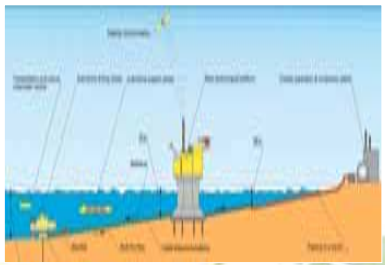


New drivers for the Norwegian Ocean Dimension

Stortingsmelding: / Governmental White Paper :

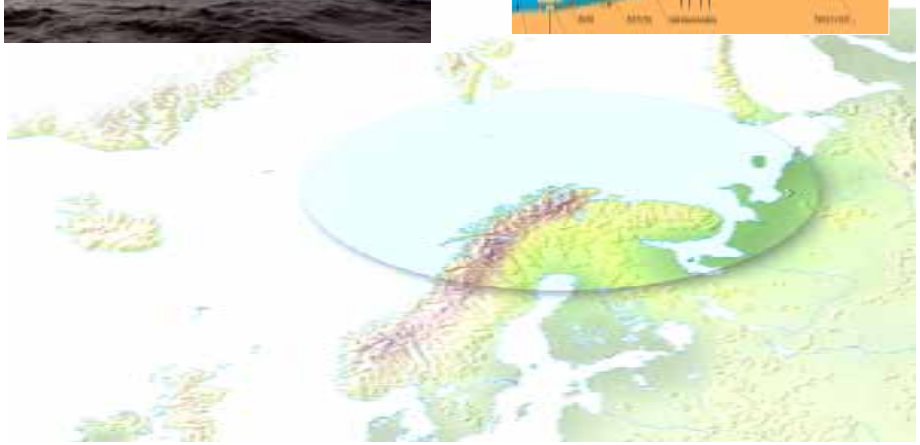
”Challanges and Possibilities in the Northern Areas” April 2005.

Environmental and safety issus



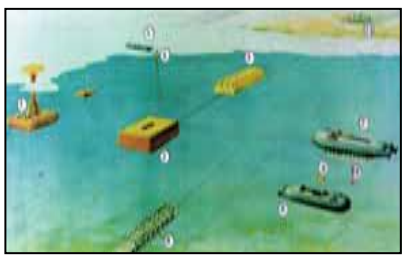
Oil and Gas Exploitation

Surveillance and Defence



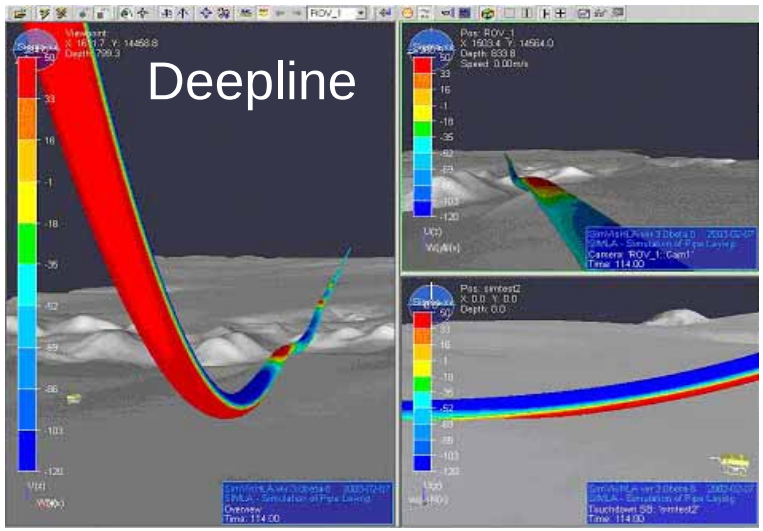
Industry in North of Norway

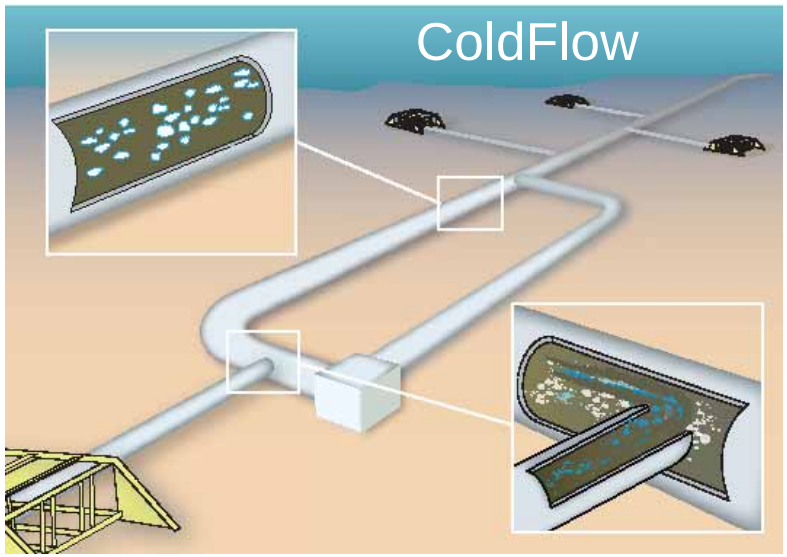
North East passages

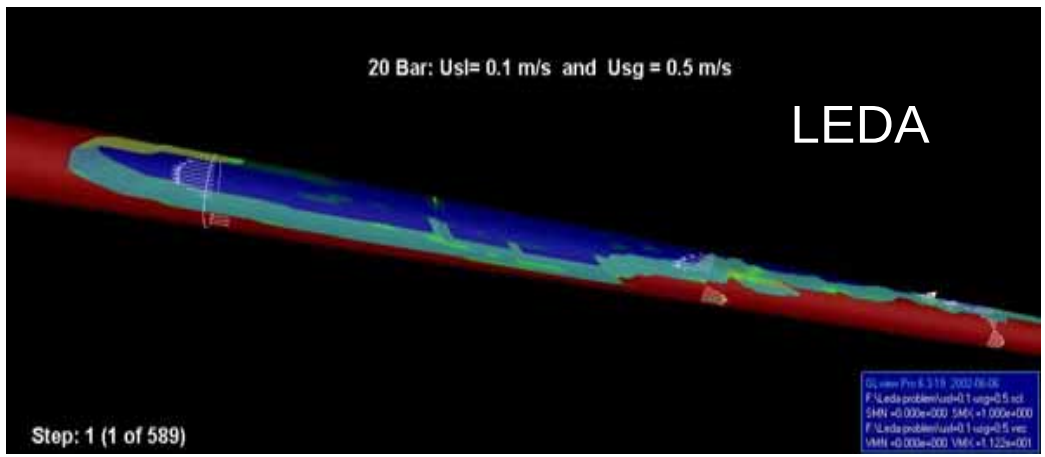


Increased Russian business

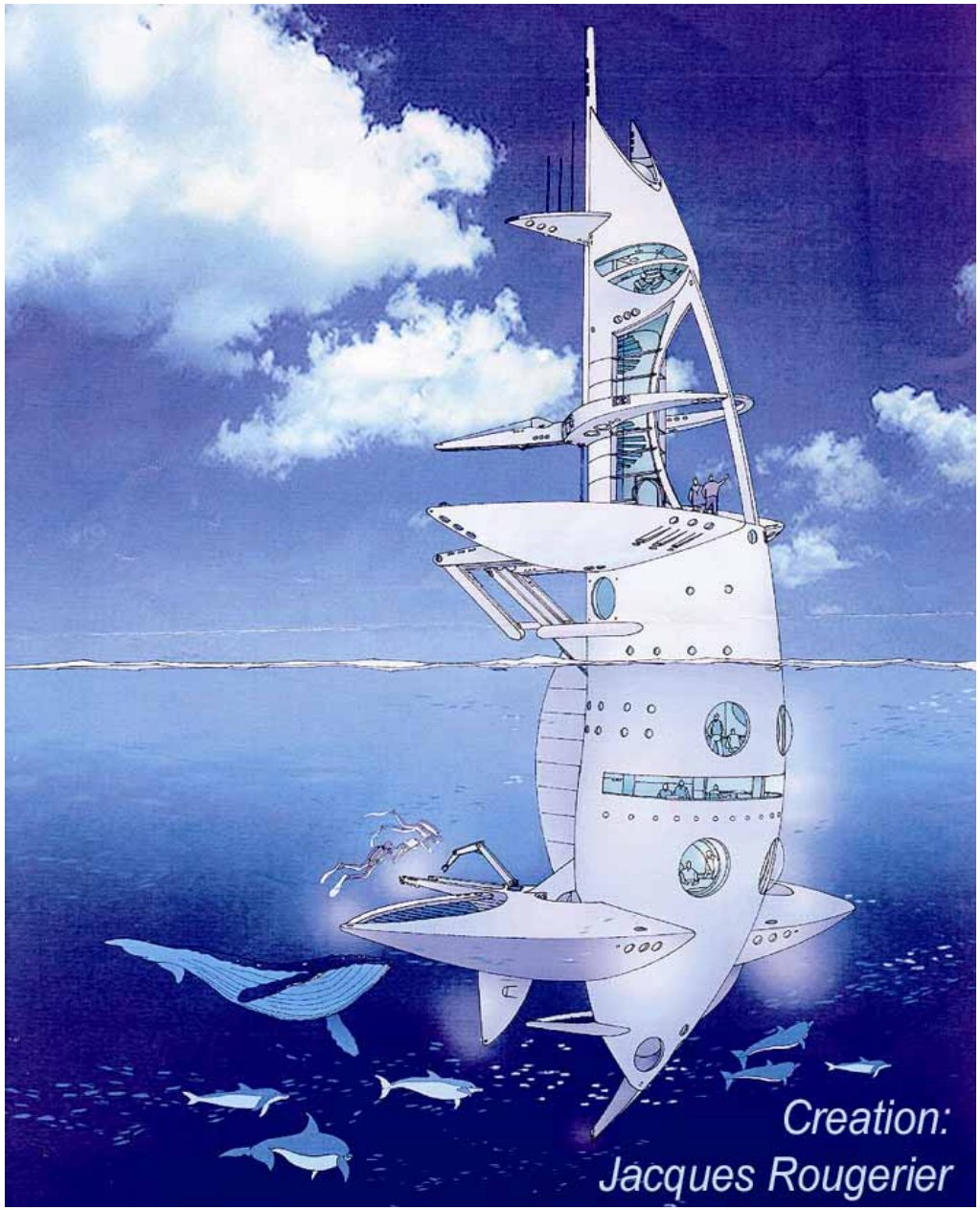
A game-changing combination of technologies from SINTEF







SeaOrbiter at the Jules Verne Exhibition in Paris 2005

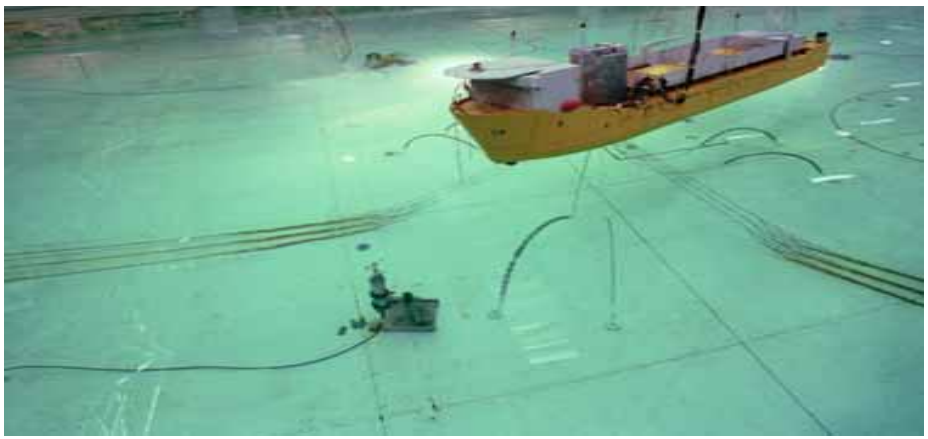


Verification tests

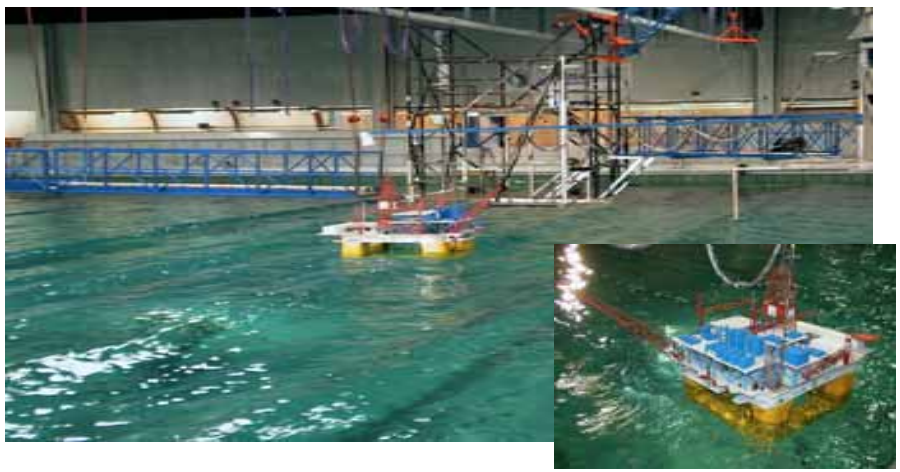
Åsgard A in Norway

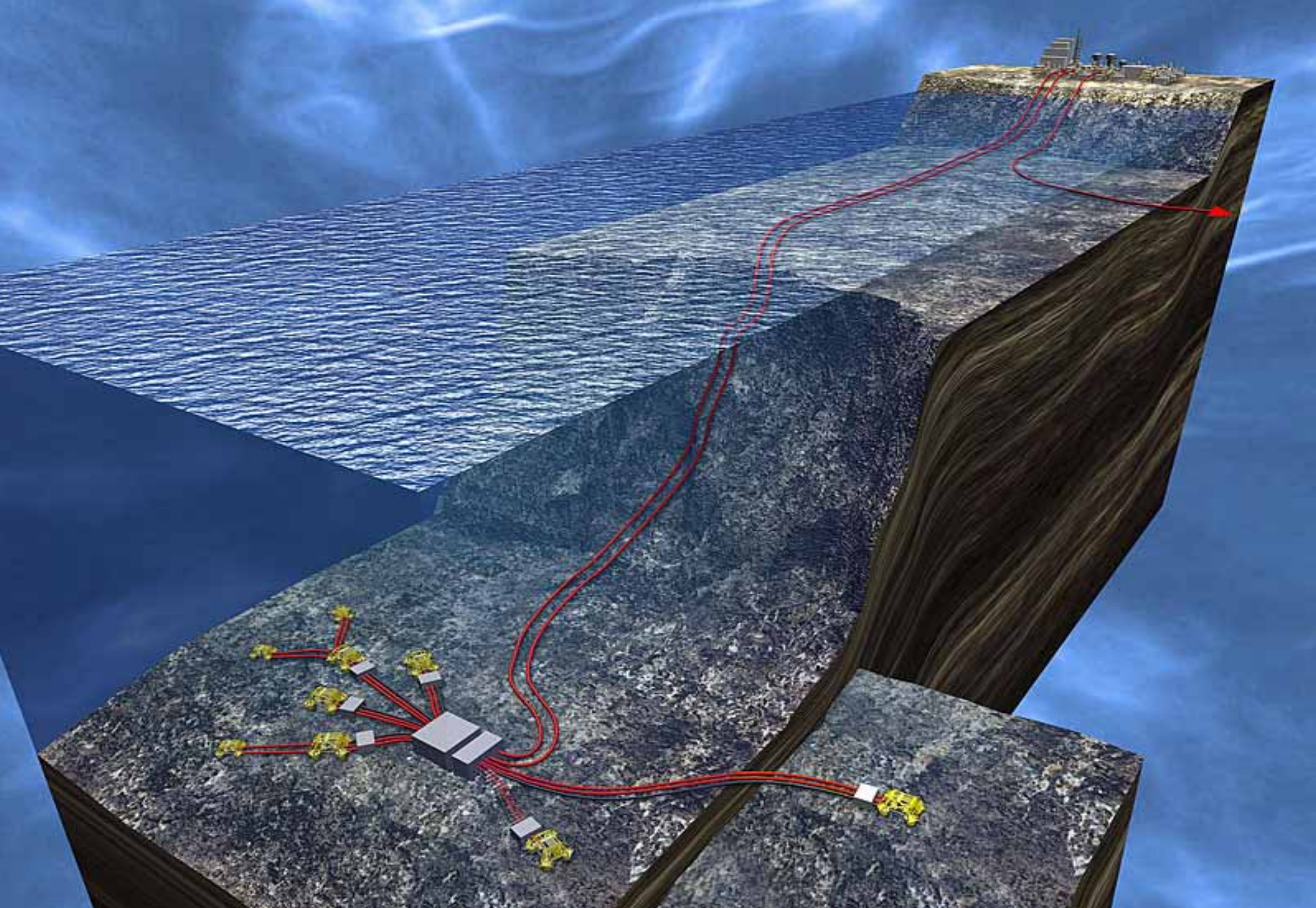
Snorre II (B) in Norway

Terra Nova Project in Canada



Thunder Horse, Gulf of Mexico





LNG-Chain to US and EU:

Small scale distribution of LNG

Covering the coast of Norway

- LNG source - base load LNG or receiving terminals or small scale LNG production
- LNG could be further distributed by truck or rail way or distributed by locale pipeline.

The natural gas chain

Production

Processing and liquefaction

Shipping

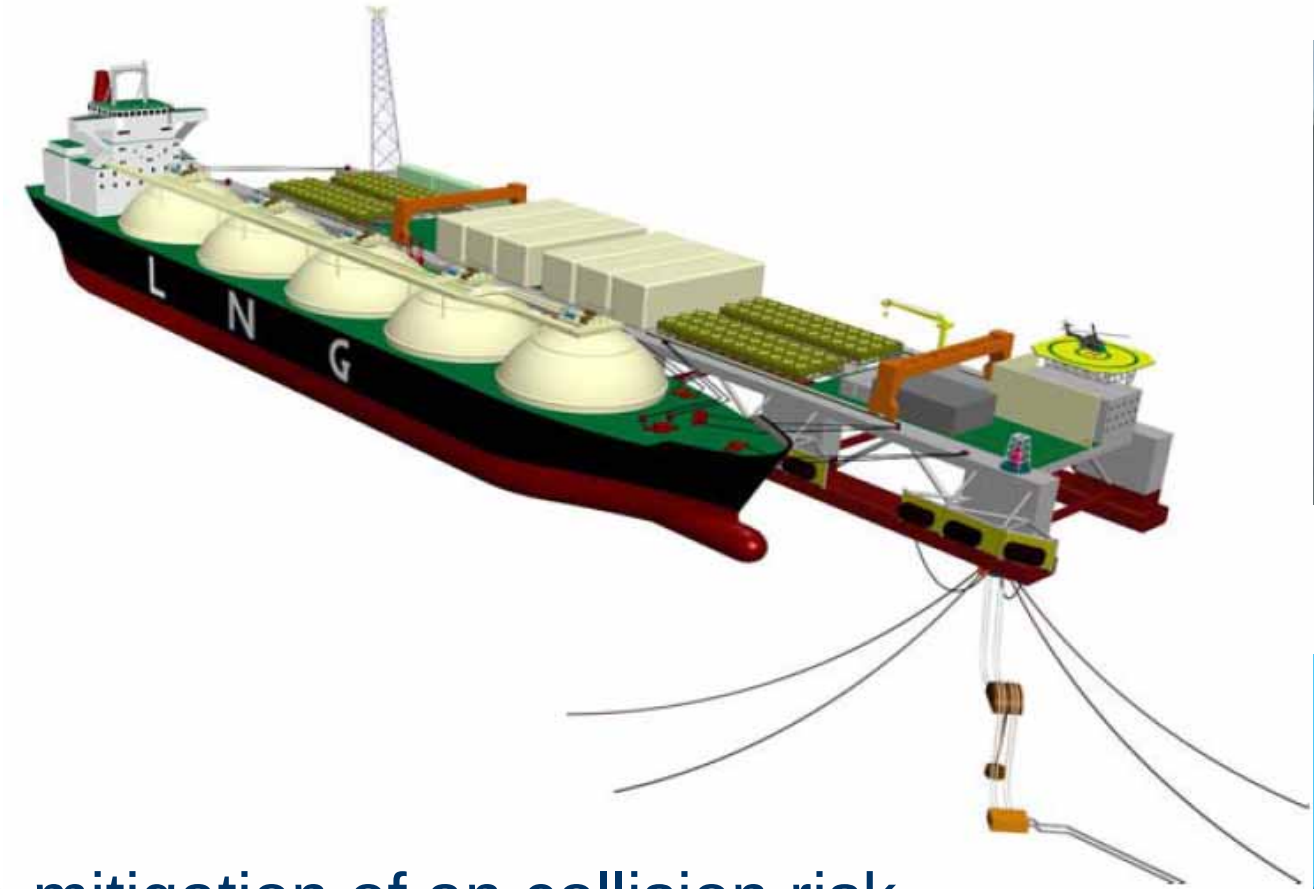
Transmission/distribution

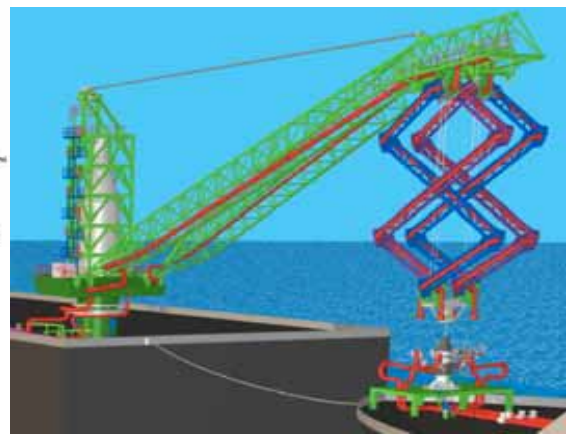
End use

Main areas for MARINTEK activities are:

- Technologies for loading and transport of LNG
- Technologies for end use
- Analysis of supply systems for natural gas

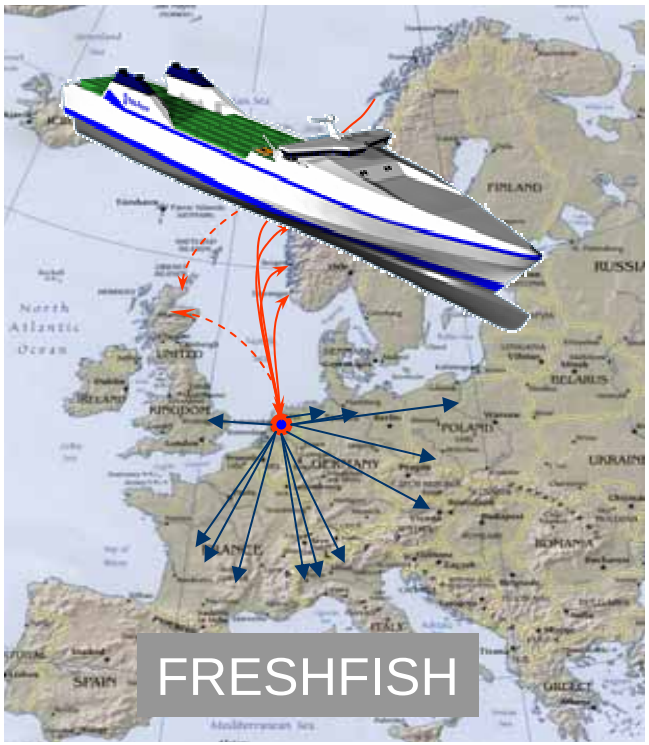
Offshore offloading & LNG FPSO



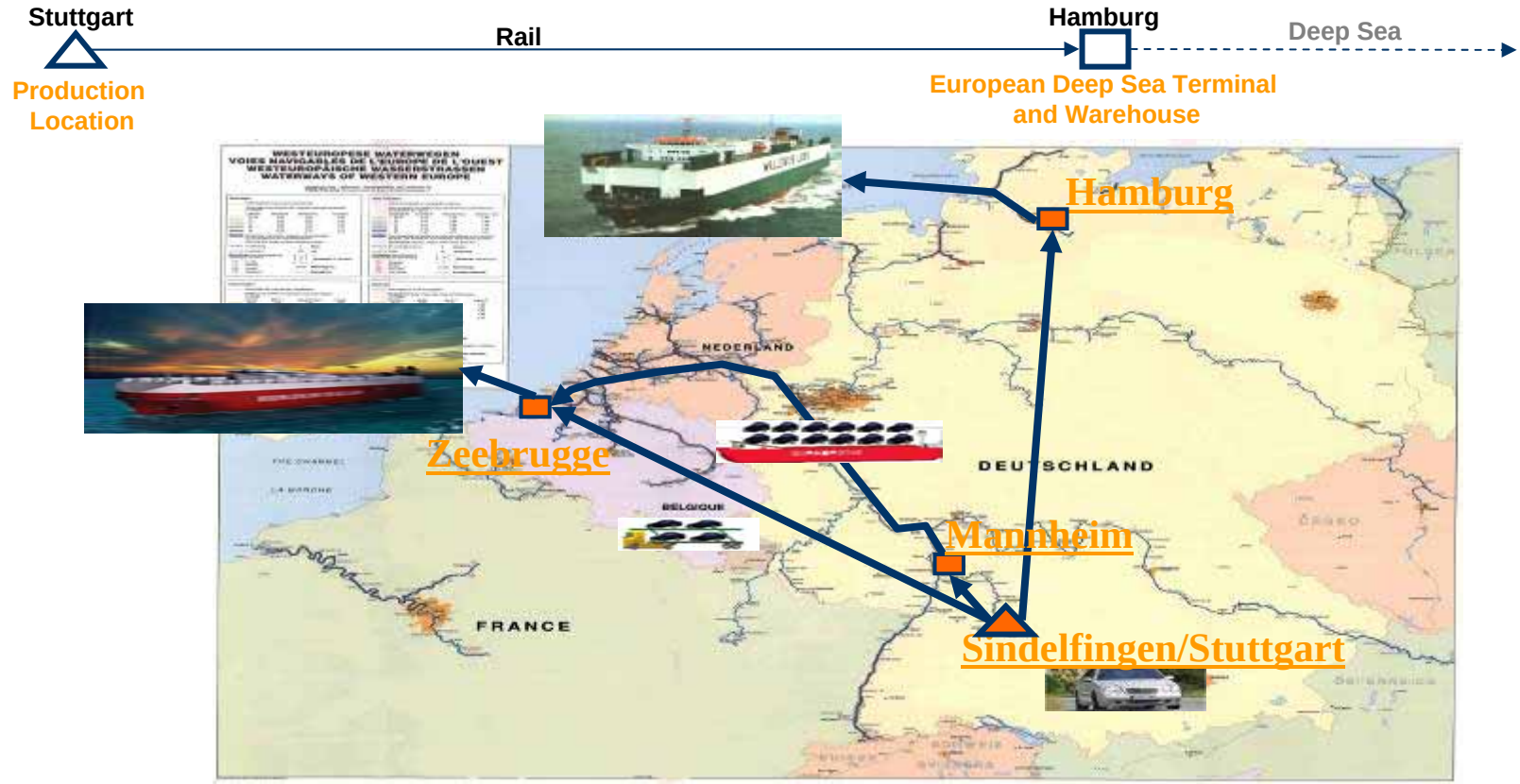


- mitigation of an collision risk
- reducing terrorist attack threat
- preventing costly civil works

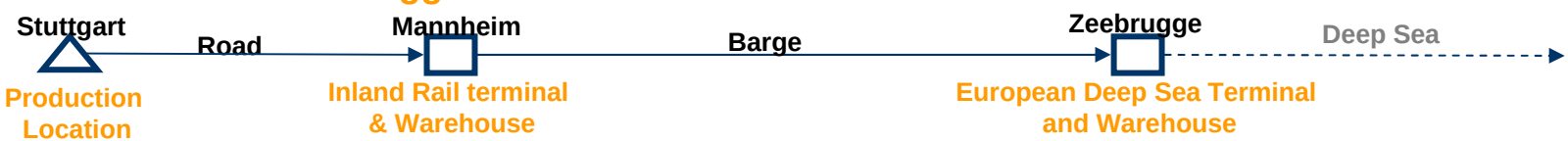
Maritime Transport solutions



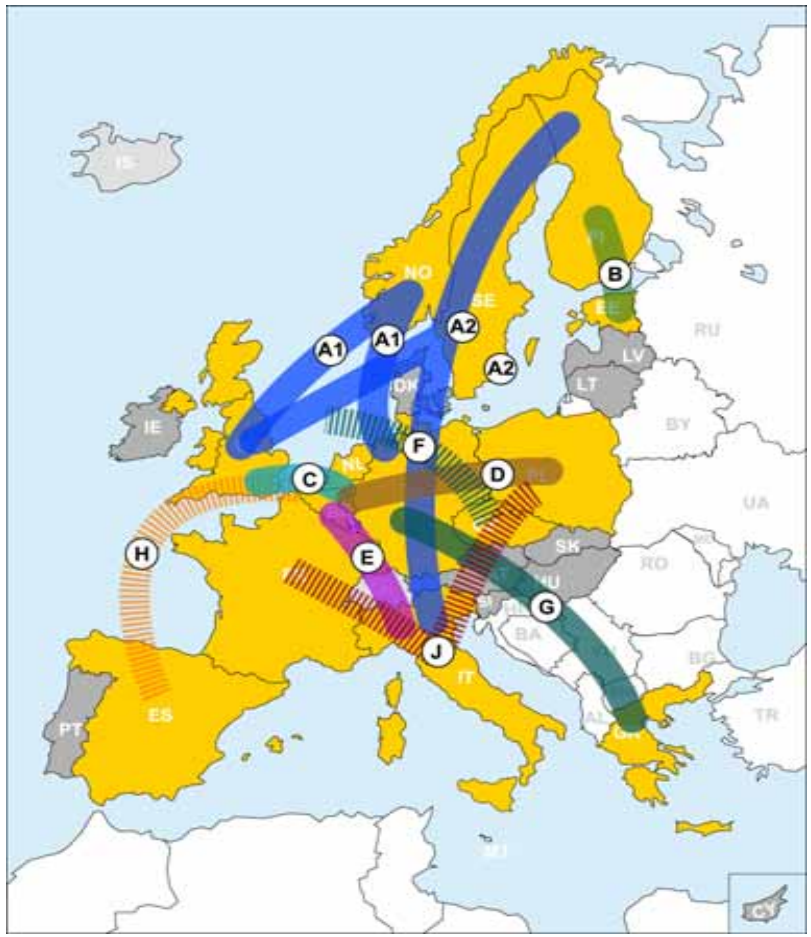
Multimodal logistics – combining deepsea, shortsea and inland waterways



Alternative via Zeebrugge:



Business cases provide practical improvements and realistic recommendations



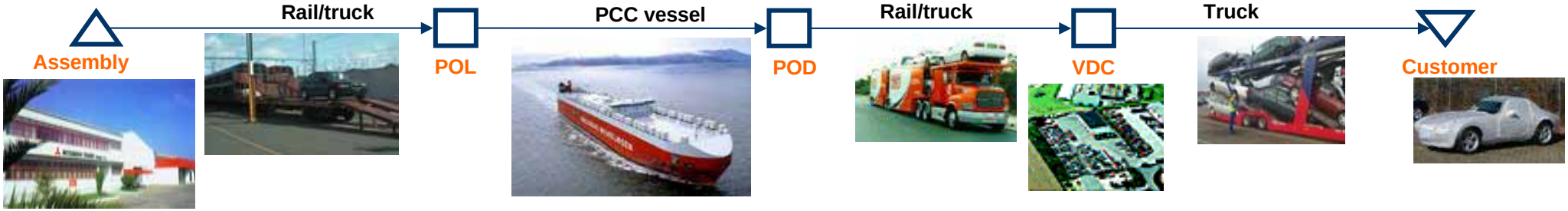
Several pan-European real-life business cases

- Demonstrations (continuos lines) full project duration
- Feasibility studies (dashed selections) in 1st project phase

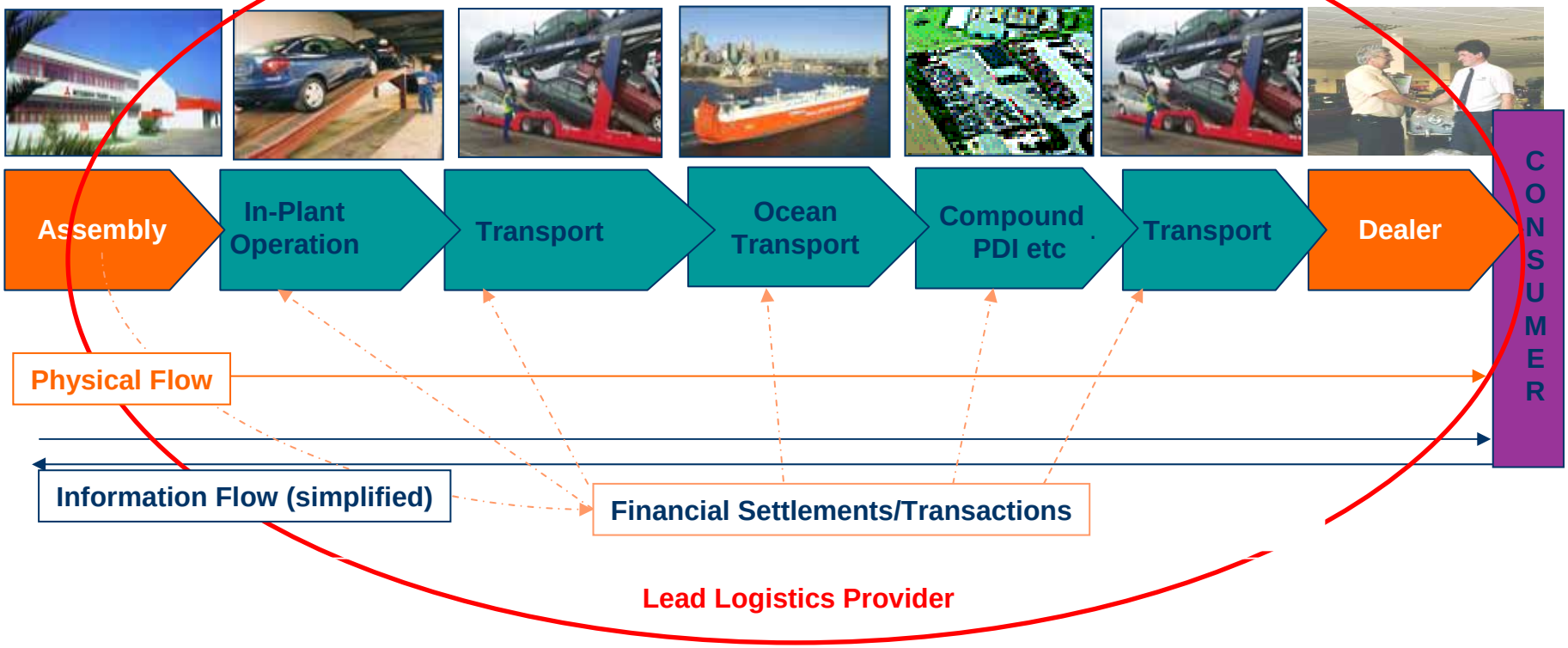
Door to Door operations in new car distribution chain is an extended service compared to traditional RoRo shipping

"Traditional RoRo shipping"

"Door-to-door new car distribution"

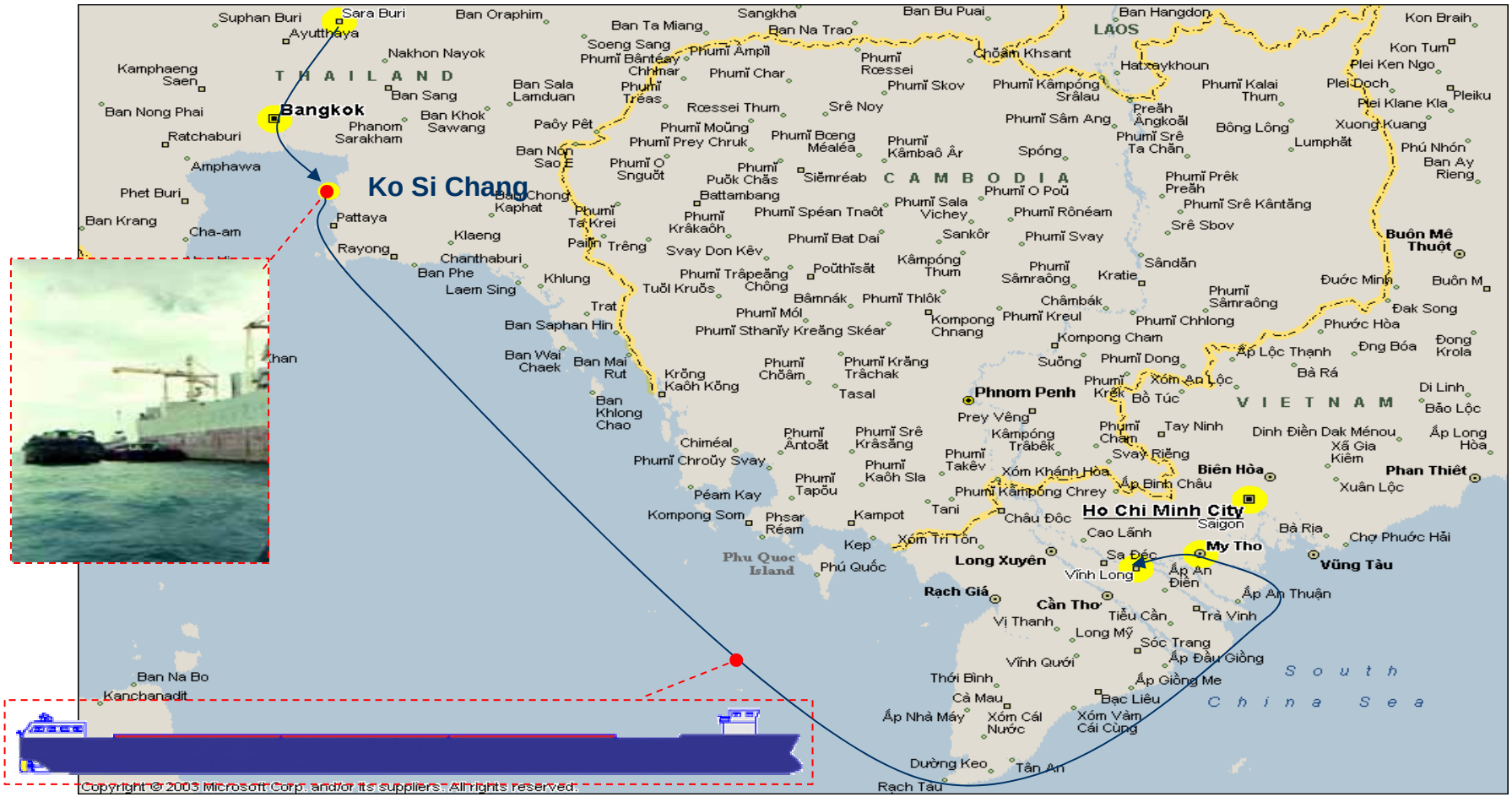


Lead Logistics Provider service – Total Responsibility for Integrated Logistics



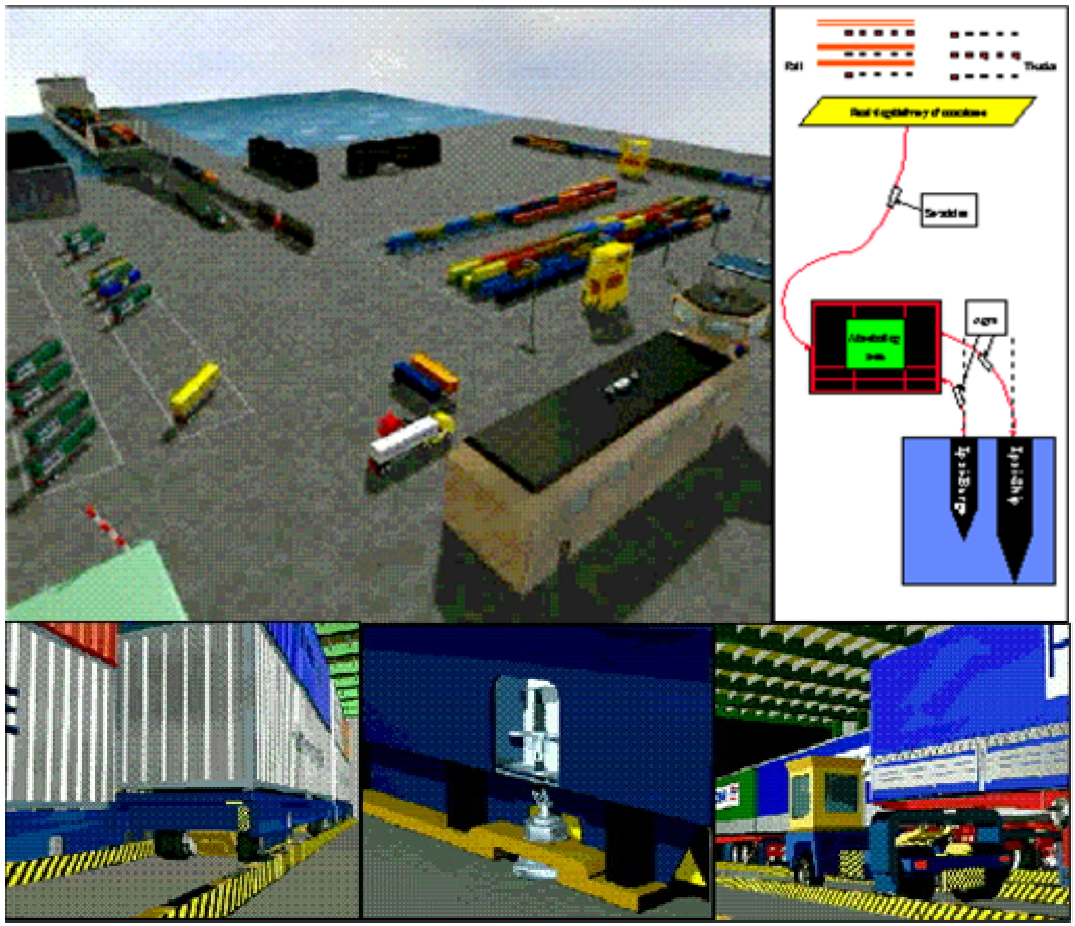
Local bulk transport solution using using Handysize vessels and barge transshipment

Local bulk transport solution using using Handysize vessels and barge transshipment



IPSI - Technology for the cargo handling

- State-of-the terminal lay-out
- Fast cargo handling
- High capacity
- Reduced area requirements
- State-of-the-art multi modal solution
- Automatic guided vehicles, (AGV) operations
- 2400 TEU per day
- 400 TEU per hour



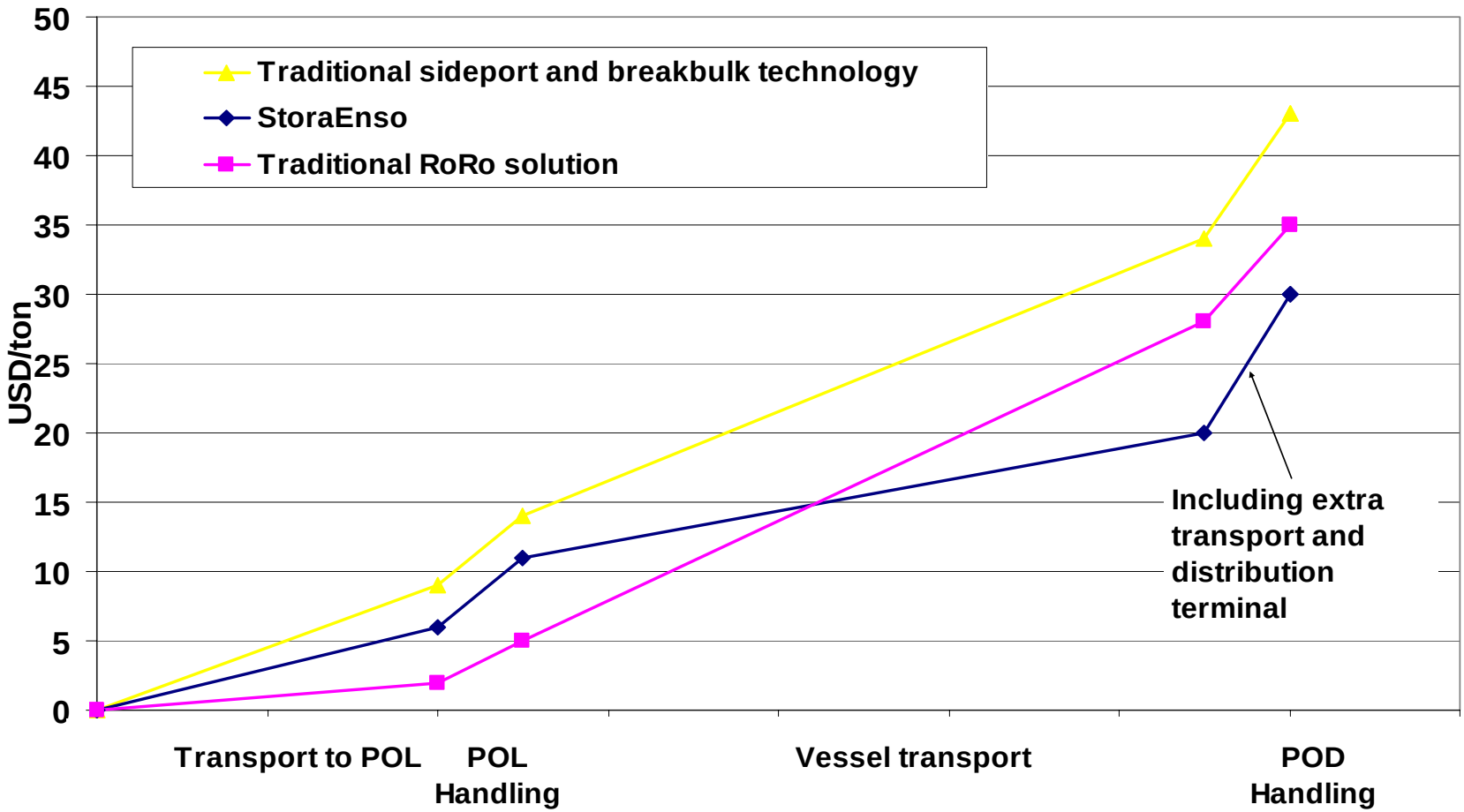
Source: HamworthyKSE, IPSI – A Revolutionary Concept for Intermodal Transport

IPSI - Concept terminal

IPSI – vessel is purpose built to accommodate specialised container boxes (SECU) carrying up to 80 tons each on RoRo cassettes

SECU = Store Enso container unit

Distribution cost comparison from plant to continental terminal

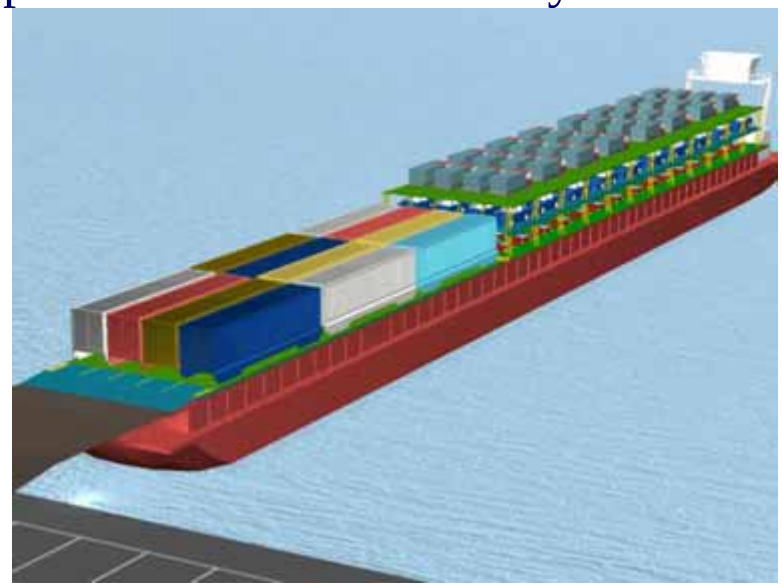


The Interbarge concept

- The Interbarge transport concept focus on combining transport of paper and other commodities suitable for unitizing with transport of new cars, heavy machinery and other road units
- Targets :
  - To improve the cost position of RoRo based transport solutions by utilising the European waterways.

  - Reduce emissions and fuel consumption facilitated by reduced light ship weight, low resistance due to optimized hull shapes and state-of-the-art propulsion systems.

Localisation of production sites in Europe / Main inland waterways:



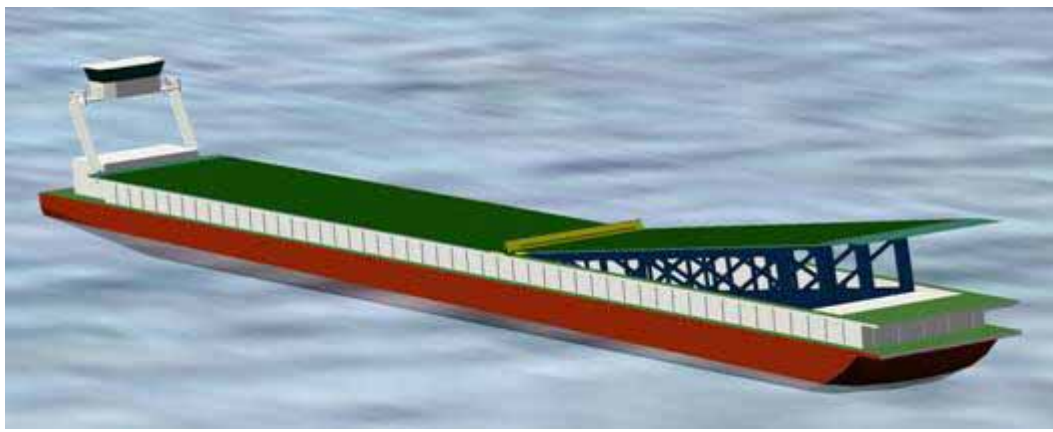
The Interbarge concept – basic design; Comparing the new design with a conventional RoRo vessel design

Main data MS"VERA":

- **LOA: 108.5 m**
- **Breadth moulded 11.4 m**
- **Draught light ship 1.2 m**
- **Draught loaded 2.5 m**
- **Payload 1450 tons**
- **Displacement light ship 1200 tons**

Main data NEW DESIGN:

- **LOA: 110 m**
- **Breadth moulded 11.4 m**
- **Draught light ship 0.95 m**
- **Draught loaded 2.63 m (design)**
- **Payload 2050 tons(design)**
- **Displacement light ship 950 tons**




LOGISHIP

This new design is designed for transporting cement in dedicated tanks and mainly empty containers to USA and containers with cargo to Caribbean.

Increased capacity on High Speed Crafts
(Multi-hull)

Let’s imagine that we move 10-15 years in the future…

Cruise and Leisure

Deep Sea Shipping

Short Sea Shipping

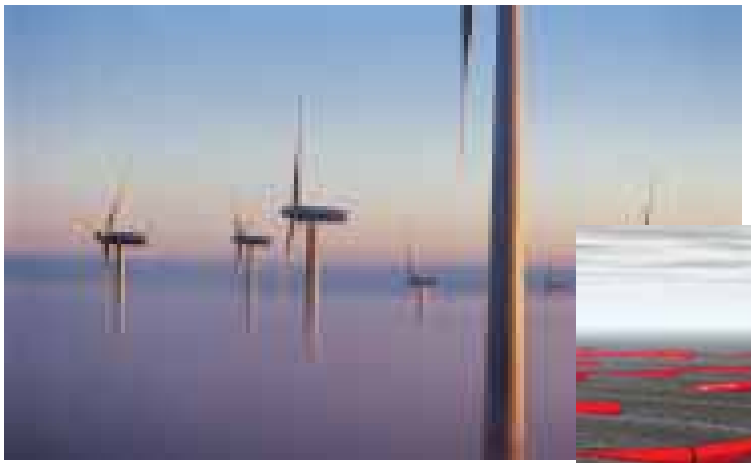
Inland Shipping

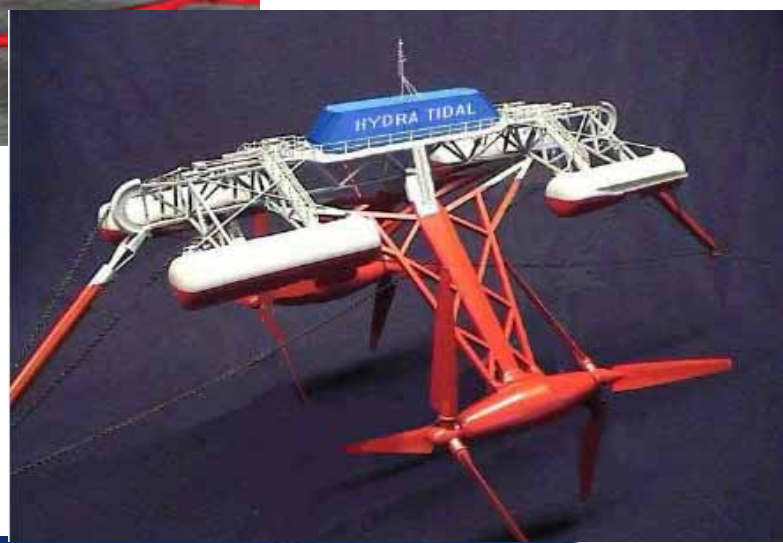
Floating Infrastructures

Be prepared to handle critical situations

Operations in hard weather conditions is challenging for people and constructions

Energy production from wind, waves and current need in dept knowledge in marine technology





http://www.tocc.no

TOCC
Technical Operation
Competence Centre

Technical Operation Competence Centre

Presentation 8. June 2006, Brage Mo, MARINTEK

Objective

TOCC improves competence by employing tools for performance analysis and decision support suited to the maritime industry.

TOCC tools are beneficial and easy to use. They are also transparent and consistent for better understanding and easier implementation.

The concept of TOCC

Current situation vs. Best practice

- Not optimised reporting & performance assessment method
- Limited performance assessment support

- Limited time to evaluate vessel data
- Reporting sub optimal
- Limited tools / support / authority for operation optimisation
- Operation/performance indicators not optimal
  - -Technical condition vs. company strategy?
  - -Over-all fleet performance?

- Little co-operations
- Lack of standards
- Lack of best practice

- Simple and smart reporting
- Quality feedback
- Focus on critical systems
- Clear procedures
- Customised training

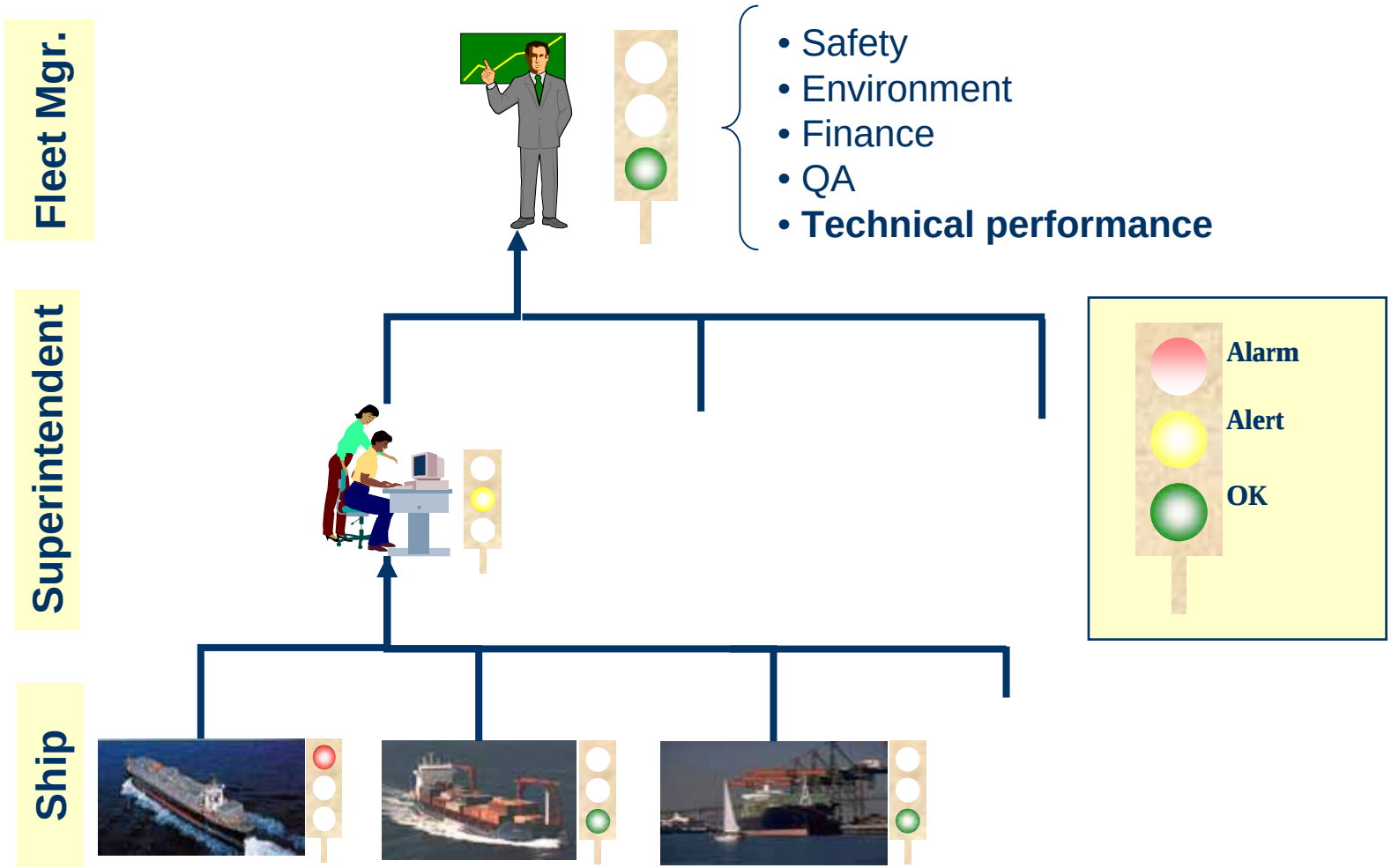
- Monitoring of indicators
- Standardised reporting & monitoring
- Cross-fleet comparison
- Proactive planning
- Customised training

- Cross-company comparison
- Common performance standards
- Competence sharing

Benefits for TOCC participants

- TOCC offers new methods and tools for efficient technical operation
- TOCC addresses common challenges, but individual solutions are possible
- TOCC will ensure the development of an active competence network.
  - research and university sector
  - classification, authorities
  - ship owners
  - system and equipment suppliers
  - offshore industry
- TOCC gives the direction for R&D within shipping technical operations.

Indexing fleet performance



TOCC cases

- **Performance for critical systems**
  - **Index for main engine performance data**
  - **Index, other systems**
    - **Auxiliary engines**
    - Other critical systems
- **Hull and propeller analysis**

General status:

- M.E. performance model specified and tested in SW tool with data received from ships.
- Findings improved by ship owners.
- New reporting form for performance tests validates info and sends xml messages.
- Guidelines testing and collection of measurements under development.
- Onboard implementation started May 2006.

- Hull and propeller model not finished for testing.

- AE performance model development has started.

Existing standards

- The project have reviewed some “standards” describing engines. One initiative is SFI, often used by Norwegian shipowners and yards (A Functional classification of the ship) :
  1. Generals ship arrangement
  2. Hull
  3. Loading equipment
  4. Ship equipment
  5. Equipment for crew and passengers
  6. **Machinery main components**
  7. Systems for machinery main components
  8. Ship common systems

6 - Machinery main components

- **601 - DIESEL ENGINES**
- 625 - EL. GENERATOR/EL. MOTOR PLANTS
- 628 - SPECIAL PROPULSION AGGREGATES
- 631 - FIXED PROPELLER PLANTS INCL. NOZZLES
- 634 - CONTROLLABLE PITCH PROPELLER PLANTS INCL. NOZZLES
- 636 - SPARE PROPELLERS
- 637 - MAIN REDUCTION GEARS W/THRUST BEARINGS & COUPLINGS
- 638 - CENTRAL GEARS (JOINT AUXILIARY GEAR, NOT FOR PROPULSION)
- 641 - MAIN BOILERS
- 644 - AUXILIARY BOILERS
- 646 - EXHAUST GAS BOILERS
- 647 - STEAM CONVERTERS
- 648 - CENTRAL HEATING & THERMAL OIL BOILERS
- 651 - MOTOR AGGREGATES
- 665 - HARBOUR & EMERGENCY AGGREGATES W/EQUIPMENT
- 667 - SHAFT GENERATORS

TOCC Procedures

- Develop forms
- Input ship static data
- Send forms to ship

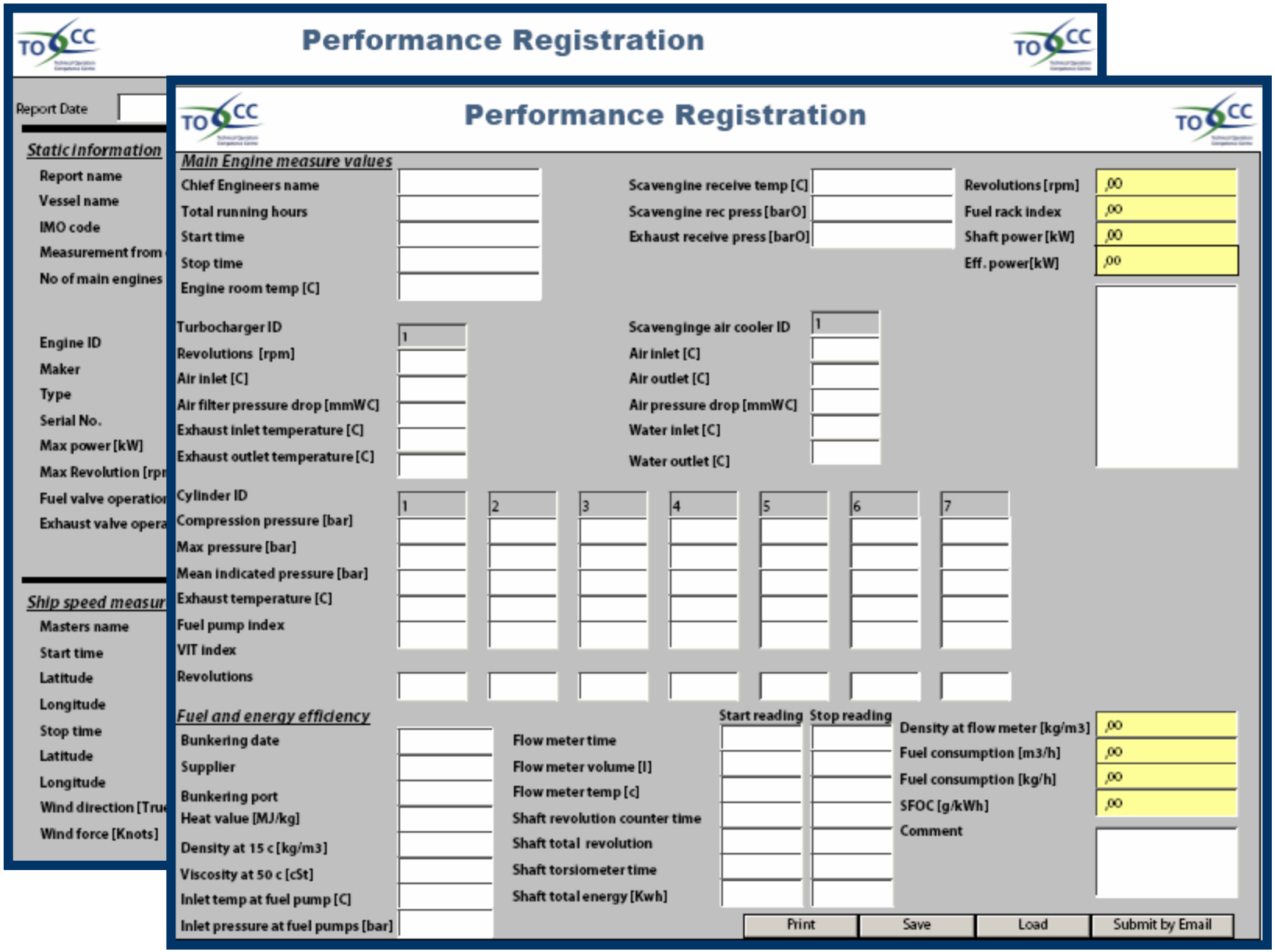
- Install forms
- Input measure data
- Validate
- Send data to TOCC
- Use email as prot.

- Receive xml/email
- Validate
- Store data
- Analyze
- Develop report
- Send report to ship

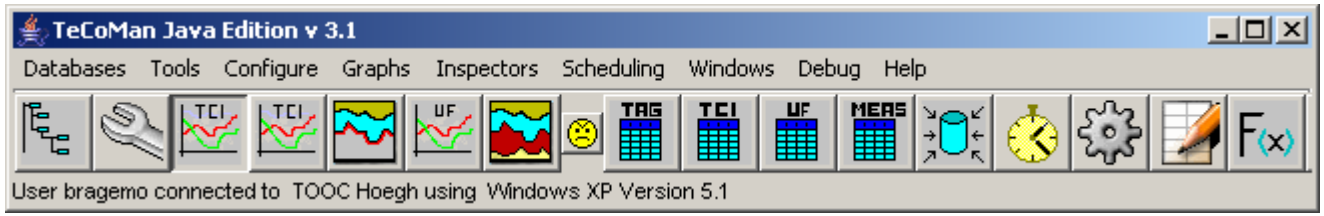
- Receive report
- Do maintenance

TOCC Technical Operation Competence Centre

TOCC Technical Operation Competence Centre


Performance Registration
Report Date
Static information
Report name
Vessel name
IMO code
Measurement from
No of main engines
Engine ID
Maker
Type
Serial No.
Max power [kW]
Max Revolution [rpm]
Fuel valve operation
Exhaust valve opera
Ship speed measur
Masters name
Start time
Latitude
Longitude
Stop time
Latitude
Longitude
Wind direction [True]
Wind force [Knots]
Performance Registration
Main Engine measure values
Chief Engineers name
Total running hours
Start time
Stop time
Engine room temp [C]
Scavengine receive temp [C]
Scavengine rec press [barO]
Exhaust receive press [barO]
Revolutions [rpm]
Fuel rack index
Shaft power [kW]
Eff. power[kW]
Turbocharger ID
Revolutions [rpm]
Air inlet [C]
Air filter pressure drop [mmWC]
Exhaust inlet temperature [C]
Exhaust outlet temperature [C]
Scavenginge air cooler ID
Air inlet [C]
Air outlet [C]
Air pressure drop [mmWC]
Water inlet [C]
Water outlet [C]
Cylinder ID
Compression pressure [bar]
Max pressure [bar]
Mean indicated pressure [bar]
Exhaust temperature [C]
Fuel pump index
VIT index
Revolutions
Fuel and energy efficiency
Bunkering date
Supplier
Bunkering port
Heat value [MJ/kg]
Density at 15 c [kg/m3]
Viscosity at 50 c [cSt]
Inlet temp at fuel pump [C]
Inlet pressure at fuel pumps [bar]
Flow meter time
Flow meter volume [l]
Flow meter temp [c]
Shaft revolution counter time
Shaft total revolution
Shaft torsiometer time
Shaft total energy [Kwh]
Start reading
Stop reading
Density at flow meter [kg/m3]
Fuel consumption [m3/h]
Fuel consumption [kg/h]
SFOC [g/kWh]
Comment
Print
Save
Load
Submit by Email

ME performance specification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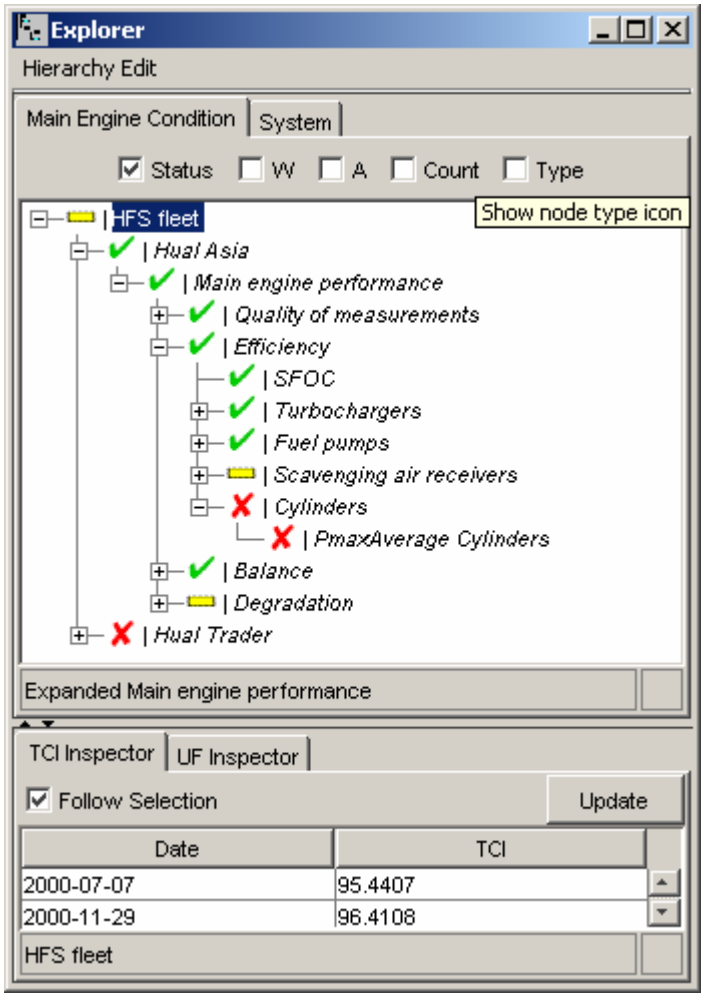
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Show node type icon
HFS fleet
Hual Asia
Main engine performance
Quality of measurements
Efficiency
SFOC
Turbochargers
Fuel pumps
Scavenging air receivers
Cylinders
PmaxAverage Cylinders
Balance
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Expanded Main engine performance
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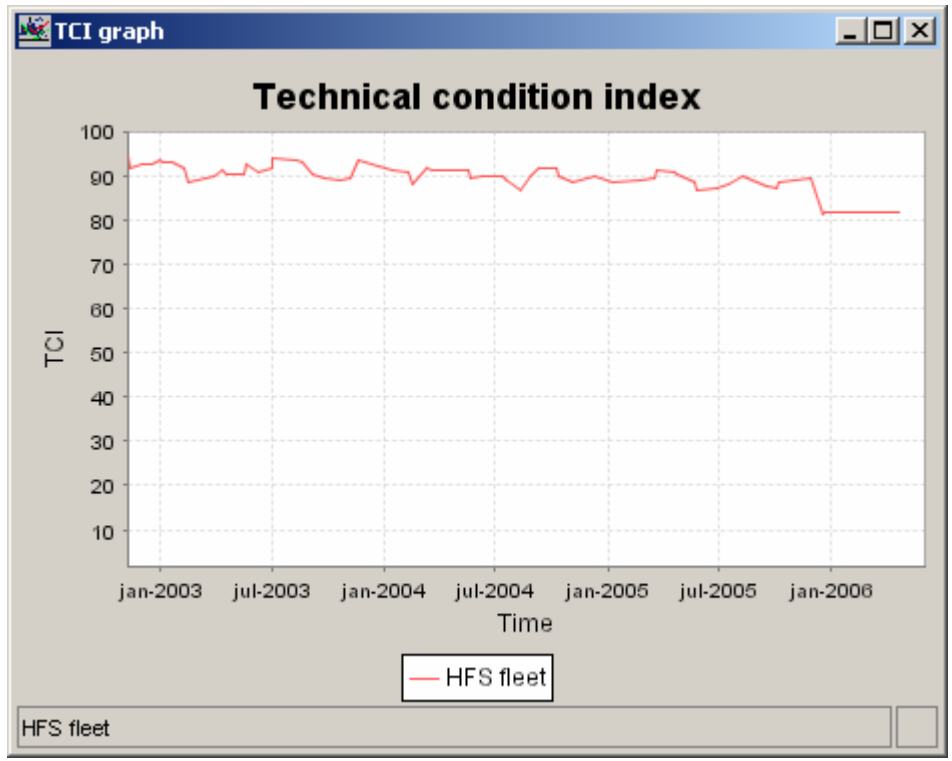
96.4108
HFS fleet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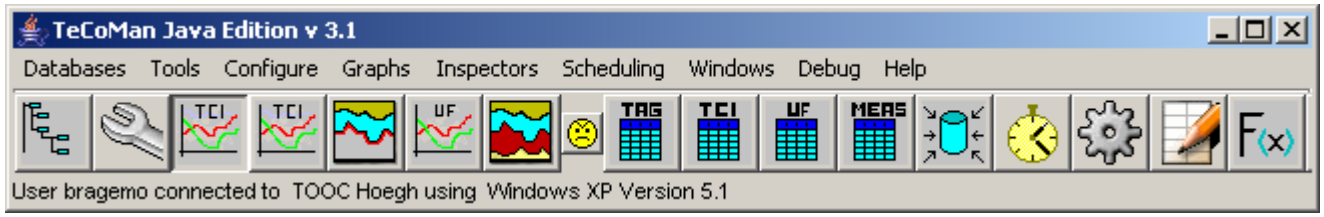
Time
HFS fleet
HFS fleet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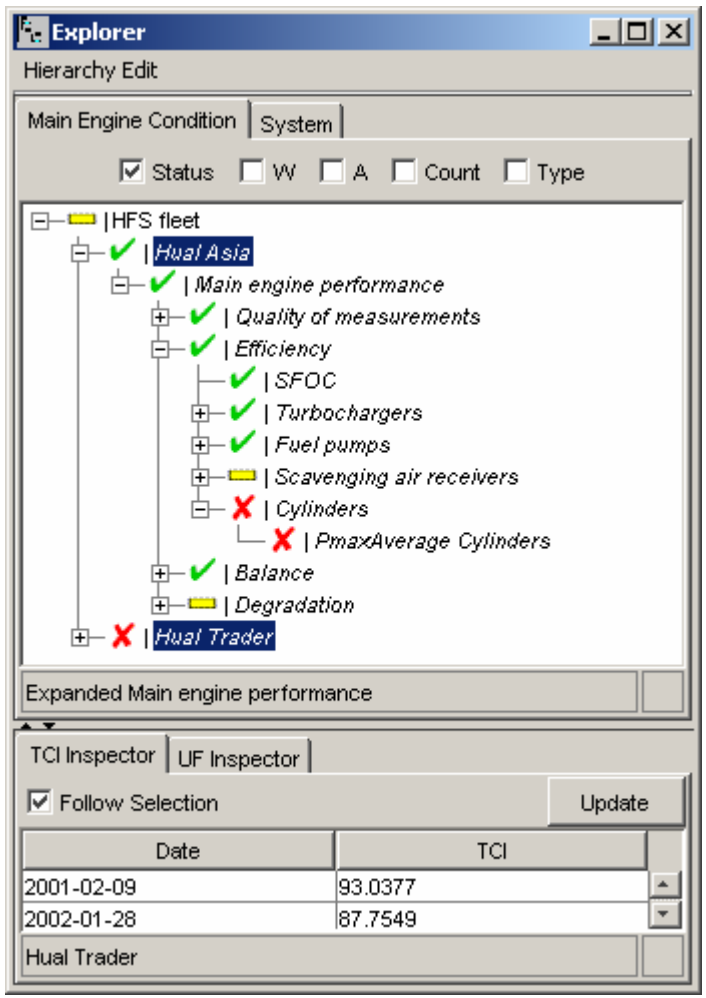
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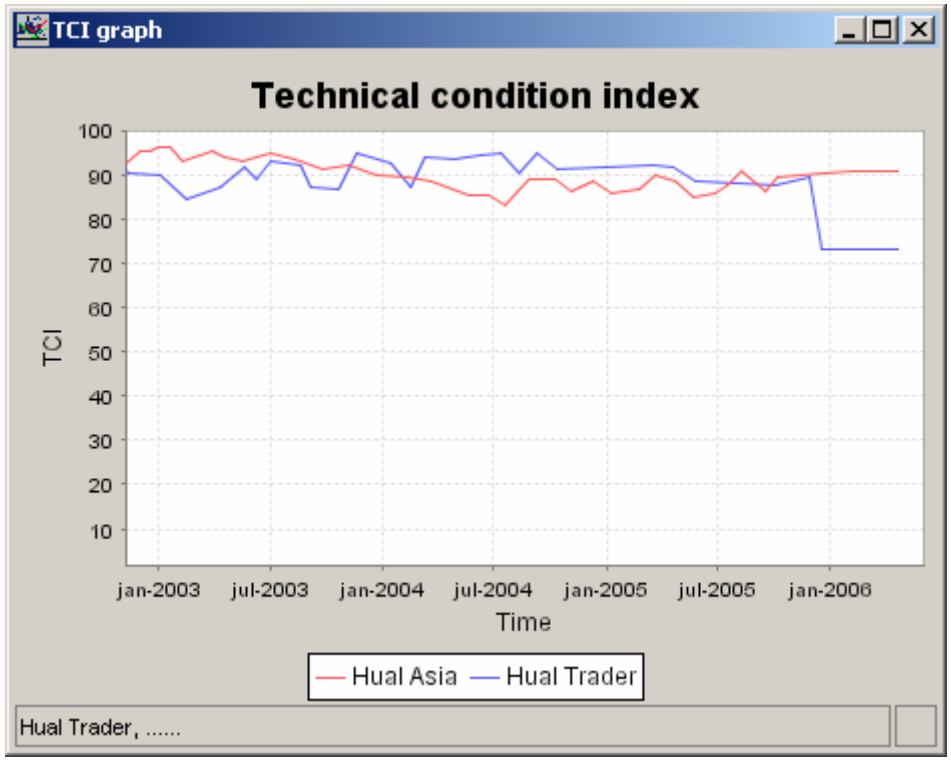
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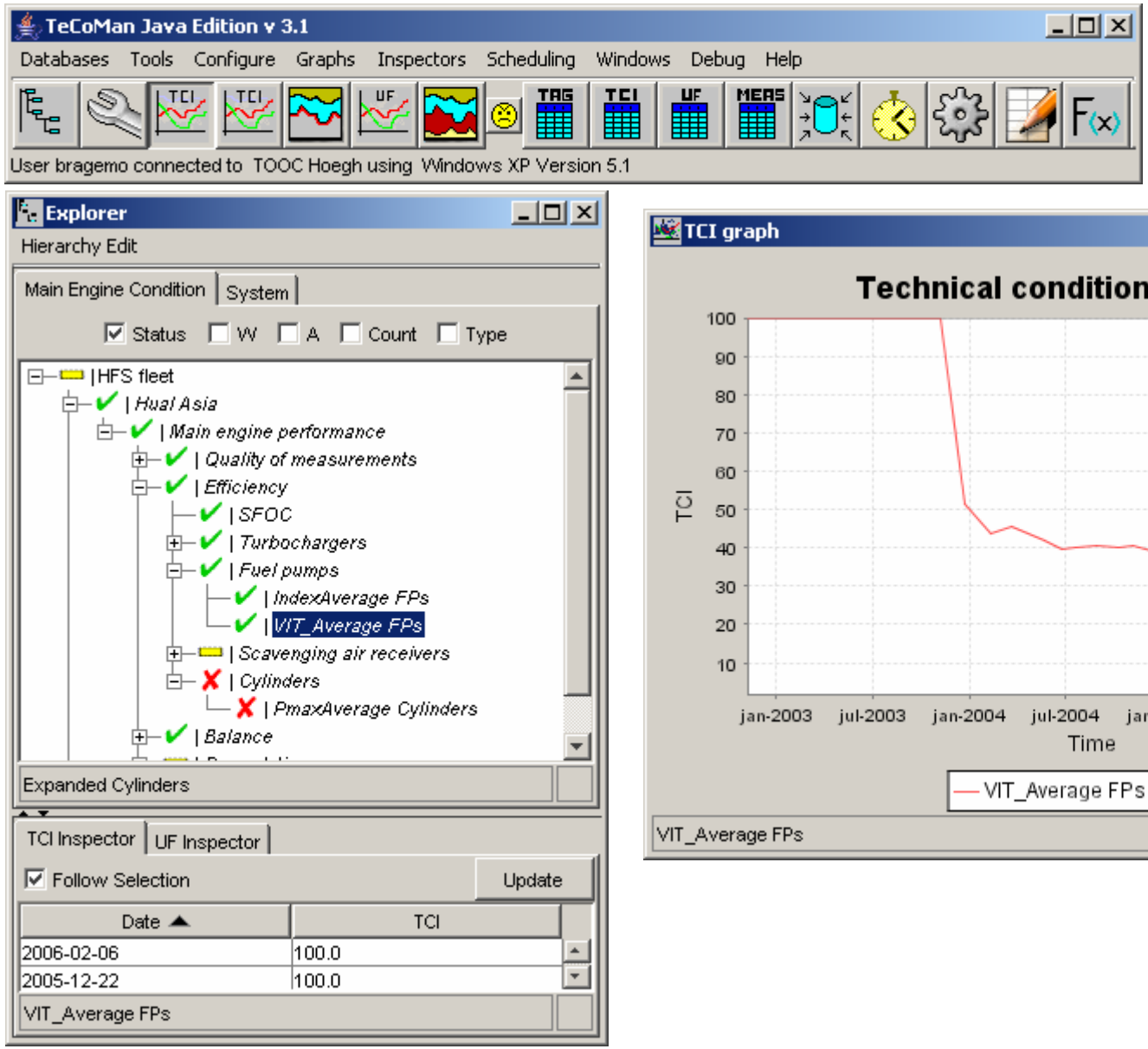
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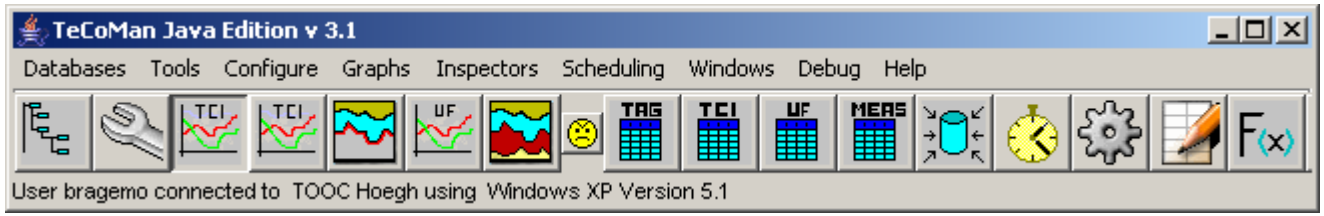
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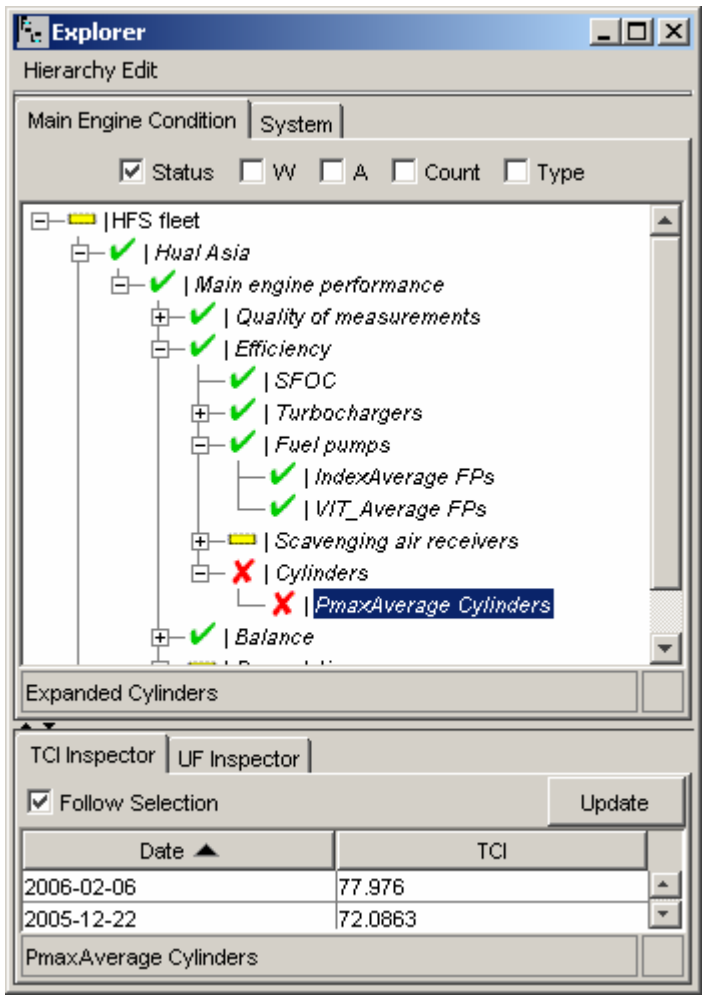
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Scavenging air receivers
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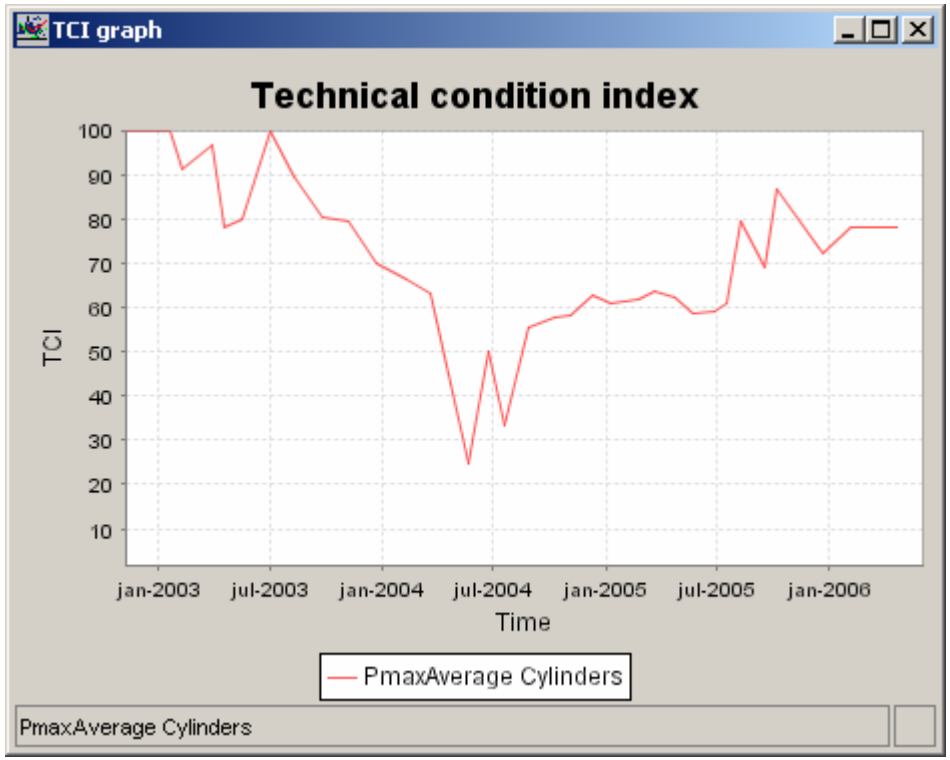
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Time
PmaxAverage Cylinders
PmaxAverage Cylinders

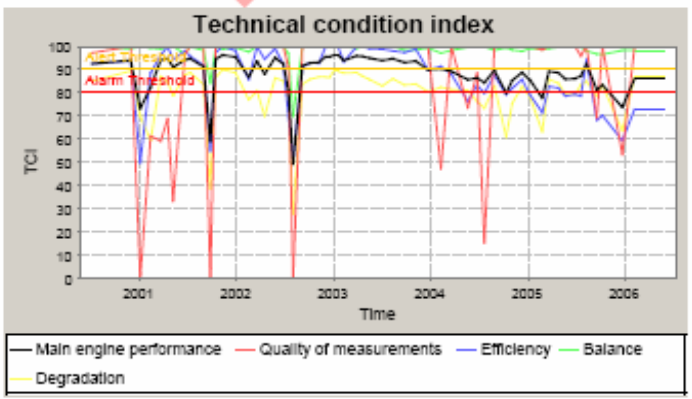
TOCC ME Report
Main engine performance
Tue May 30 12:04:08 CEST 2006

✓ *ok*
– *Keep attention*
✗ *Follow up required, see enclosed comments below respective analyses*

Top level conditions

	Name	TCI	1/2 year Trend
–	--Main engine performance	86.0	decreasing
✓	--Quality of measurements	100.0	decreasing
✗	--Efficiency	72.9	decreasing
✓	--Balance	98.2	improving
–	--Degradation	86.9	decreasing

Comments: Here the chief's eventual comments on current machinery report will appear.



TOCC ME Report
Main engine performance
Tue May 30 12:04:08 CEST 2006

Analyses are based on following calculated values. Only values which need further attention (alarm and alert state) are shown

Analysis of 'Efficiency' is based on

Status	Name	TCI	1/2 year Trend	Val	Ref	Unit
✗	Pscav Receiver	0.0	decreasing	1.0	2.04	[bar]

Possible reasons to unsatisfactory result:
- Too low pressure in scavenging air receiver.
- Too high pressure in scavenging air receiver.

Possible causes:
- Too low pressure in scavenging air receiver.
  - Too low air flow reducing efficiency of engine.
    - Check turbocharger
    - Check air cooler
    - Check air filter
  - Erroneous measurements wrongly imply result.
  - Erroneous reporting wrongly implies result.

- Too high pressure in scavenging air receiver.
  - Too late combustion process.
    - Too early injection timing, check VIT adjustment if installed.
    - Poor combustion quality of fuel.
  - Erroneous measurements wrongly imply result.
  - Erroneous reporting wrongly implies result.

Analysis of 'Balance' is based on

Status	Name	TCI	1/2 year Trend	Val	Ref	Unit
✗	VIT Dev FP5	41.2	decreasing	-0.6	0.00	Index

Possible reasons to unsatisfactory result:
- Fuel pump VIT index too low relative average VIT index for fuel pumps.
- Fuel pump VIT index too high relative average VIT index for fuel pumps.

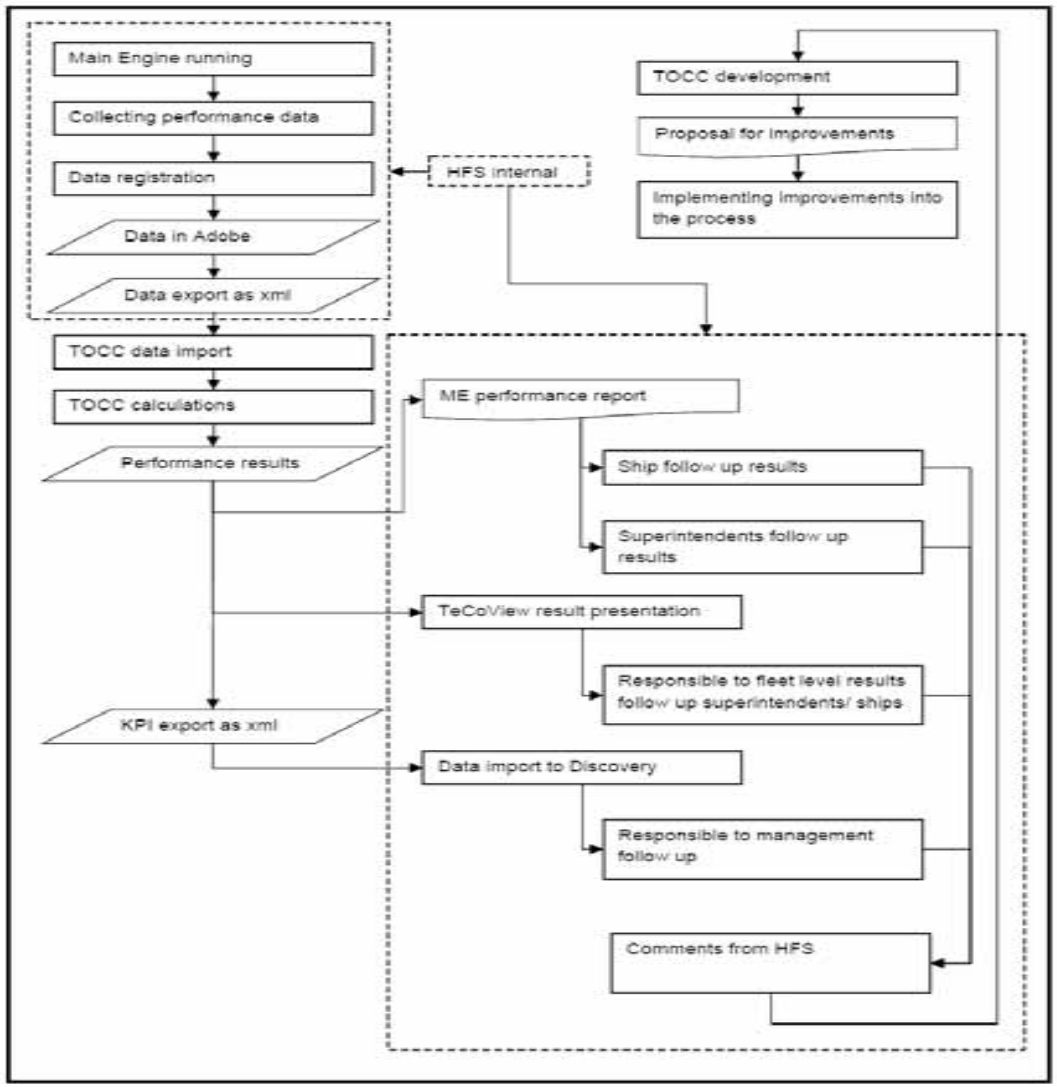
Possible causes:
- Fuel pump VIT index too low relative average VIT index for fuel pumps.
  - Too low maximum pressure in this cylinder relative other cylinders.
  - Erroneous reporting wrongly implies result.

- Fuel pump VIT index too high relative average VIT index for fuel pumps.
  - Too high maximum pressure in this cylinder relative other cylinders.
  - Erroneous reporting wrongly implies result.

–	VIT Dev FP6	84.7	decreasing	-0.4	0.00	Index

Draft

HFS process connected to ME performance model process.



General

- Situation
  - Need for better input
  - Need experience to conclude
    - Realistic improvement in data quality to stabilize TCI results
    - Measurements accuracy influence on indicators
- Improvements
  - Ships get insight in TCI ME model
    - Specifications
    - Results
  - Ships focus on procedures for measurement collection
  - A template that give feedback (hint) about illogical readings

Conclusion

Systematic analysis of operation data will improve the ship operation and quality.

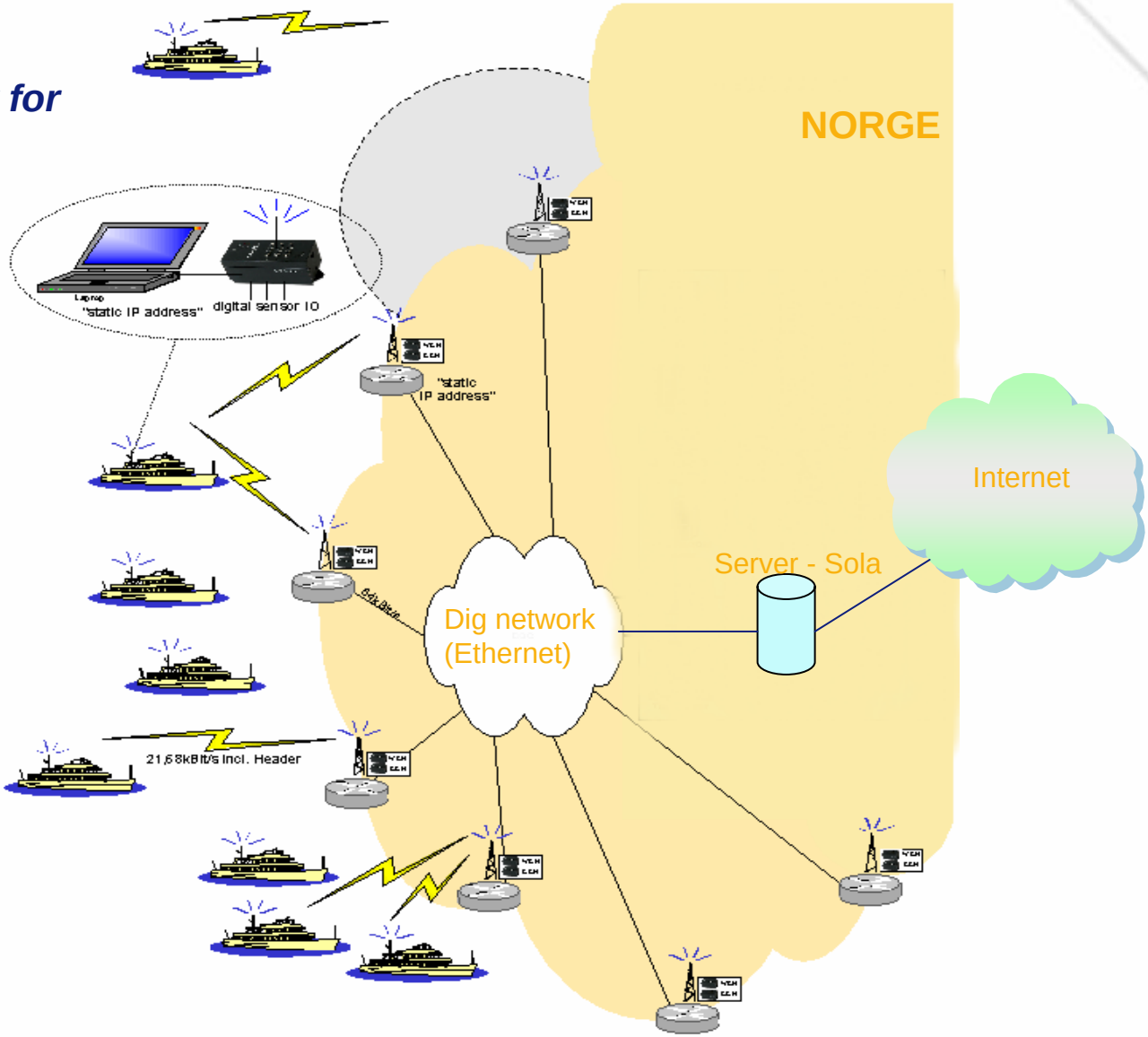
TOCC analysis will focus from ship managers viewpoint to expose performance that should initiate corrective action.

TOCC will provide ship managers with tools and competence to improve operation and quality through collaboration between relevant parties.


TOCC
Technical Operation
Competence Centre

VHF Data

Communication carrier for the maritime market



telenor

VHF Data – What is done?

- A pilot project was performed on a limited network with 6 VHF base stations, each with two radios. Various types of ships participated in the test for a period of two years
  - *We have favourable experiences regarding stability, range and functionality. It was easy to set up local networks on ship LAN and to adapt various software applications to the system*

VHF Data – What is done?

- *In the test period, we have had close cooperation with the Norwegian fishery authorities. We have developed a new positioning database and a tracking system in accordance with international standards for tracking of fishing vessels.*
- *We have also developed a fishery catch reporting system in accordance with the SHEEL project (Secure and Harmonised European Electronic Logbook)*
- *The system has been approved by the Norwegian Interbank Payment Centre (BBS) as a carrier for credit card and online payment terminals on board passenger ships*

VHF Data – Main project

- Based on the experience from the pilot project, and feedback from customers, a feasibility study for improvement of the system was performed in cooperation with the manufacturer.
- The suggested improvements are included in the main project

- Telenor has now decided to build a VHF Data radio system on 50 base stations, covering the coastline from Oslo to Kirkenes (near the Russian border in northern Norway).
- The system will be in full commercial operation by 1st quarter 2007.
- The project includes a new customer service platform as well as other system improvements:
  - *IP speed up on 25 kHz channel*
  - *Crypto*
  - *Automatic Web and e-mail compression*
  - *Web broadcast*
  - *New VHF Data radio using 225 kHz bandwidth*

VHF Data – functionality (1)

- IP protocol with Ethernet interface
  - *Enables simple interface with other equipment and applications*
- Fixed IP-address on board the vessel
  - *May be addressed from shore to ship without active action onboard*
- Always connected
  - *Well suited for " real time applications".*

VHF Data – functionality (2)

- The system continues data transfer automatically after a break in communication, e.g. when going outside coverage
  - *There is no need for the operator to intervene, the system detects when the connection is resumed and continues the data transfer from the position where the break took place*
- Several in and out interfaces, both analogue and digital, direct from the radio equipment
  - *Simple connection to instruments, GPS and local networks (LAN)*

VHF Data – funcionality (3)

- Extensive internal memory in the radio equipment
  - *May be operated without any external PC connected*
  - *For instance is the complete protocol for tracking of fishing vessels based upon the internal memory of the radio*

VHF Data – funcionality (4)

- Data parcels from different users and services may be transmitted on the same channel, and various IP packets may be given different priority.
  - *For example, it is possible to connect at the same time several active payment terminals to one radio that allready is in use for e-mail. IP packets that contain transaction data from a bank terminal may be given priority and are transmitted immediately, even if the radio is engaged with e-mail og web-surfing.*

VHF Data – funcionality (5)

- The system will automatically choose the next available channel if there is no capacity left on the primary channel.
  - *Under heavy trafic, larger volumes of data are moved to the next available channel.*
  - *In areas of constantly heavy trafic, it is of course possible to equip the base stations with more channels.*

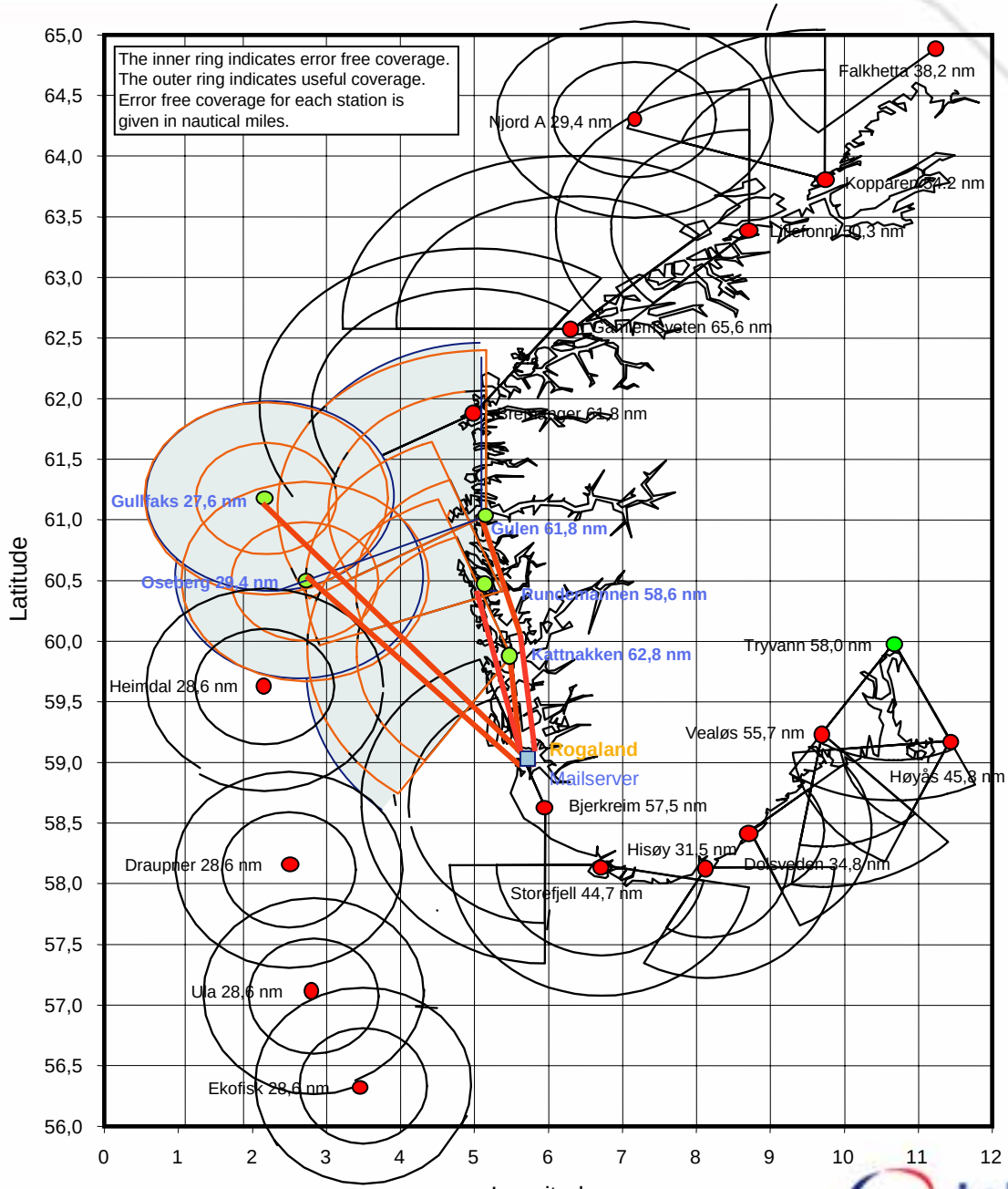
VHF Data

Located on existing VHF base stations

- Under piloting
- Ready for construction

- Basic coverage of the Norwegian coast, the North Sea and Haltenbanken requires construction of VHF Data on about 50 base stations

- We have about 130 existing VHF base stations which may be used if needed, enabling better local coverage and increased transmission capacity,



telenor

Typical services provided by VHF Data.

Telenor Maritime Radio

- System owner
- Frequency license
- Owner of infrastructure
- Operator

Service providers (examples)

- Fishery Authorities
- Storm Weather Centre
- Interbank payment services
- Coastal Authorities
- Fishery sales organisations
- Machinery control systems

Supplier of ship equipment

- Delivery
- Installation
- Stocks

- IP-address
- Configuration

Service platform

E-mail	Tracking Electronic logbook	Payment services	Web	Weather forecast

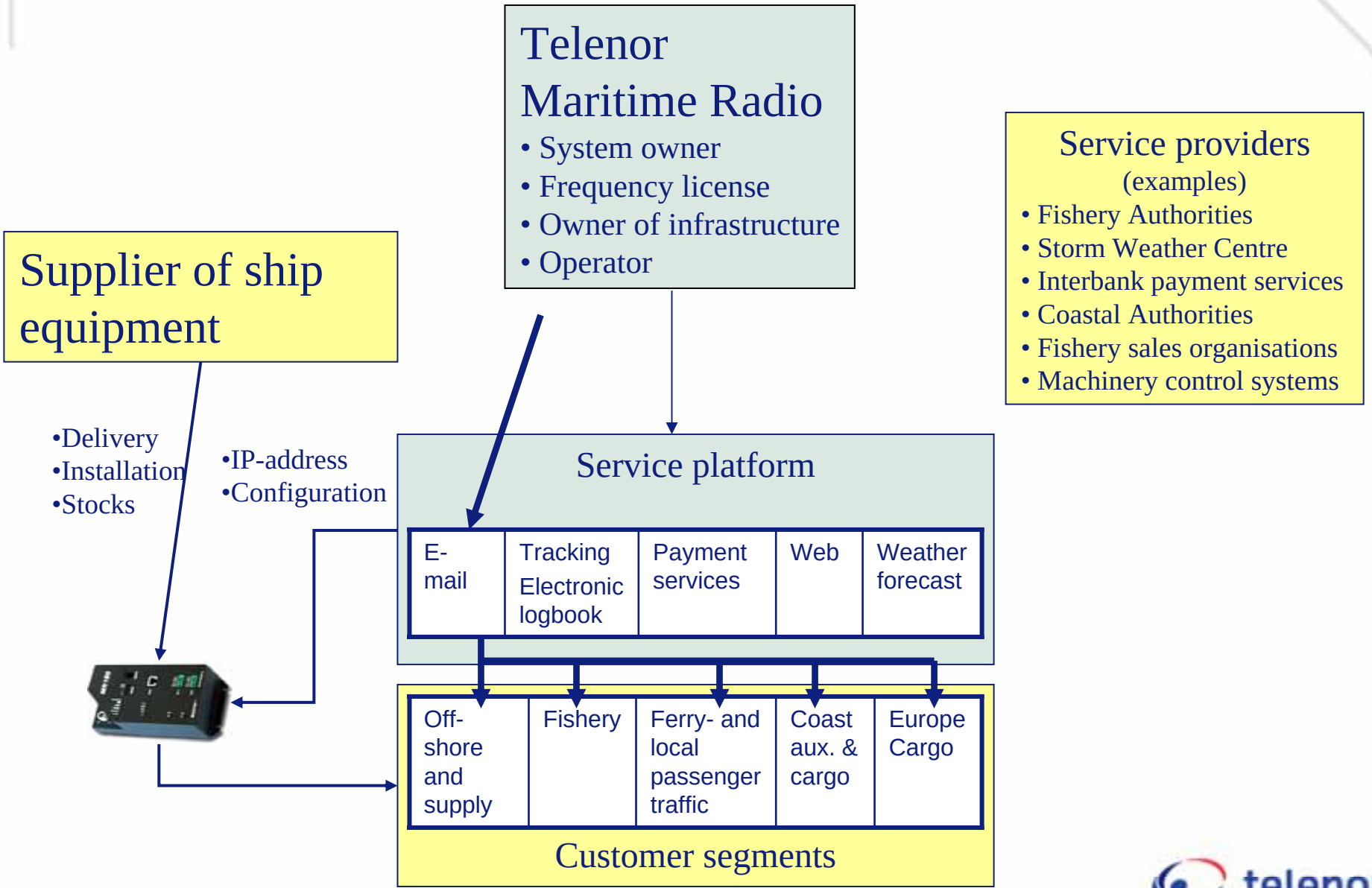
Customer segments

Off-shore and supply	Fishery	Ferry- and local passenger traffic	Coast aux. & cargo	Europe Cargo

VHF Data

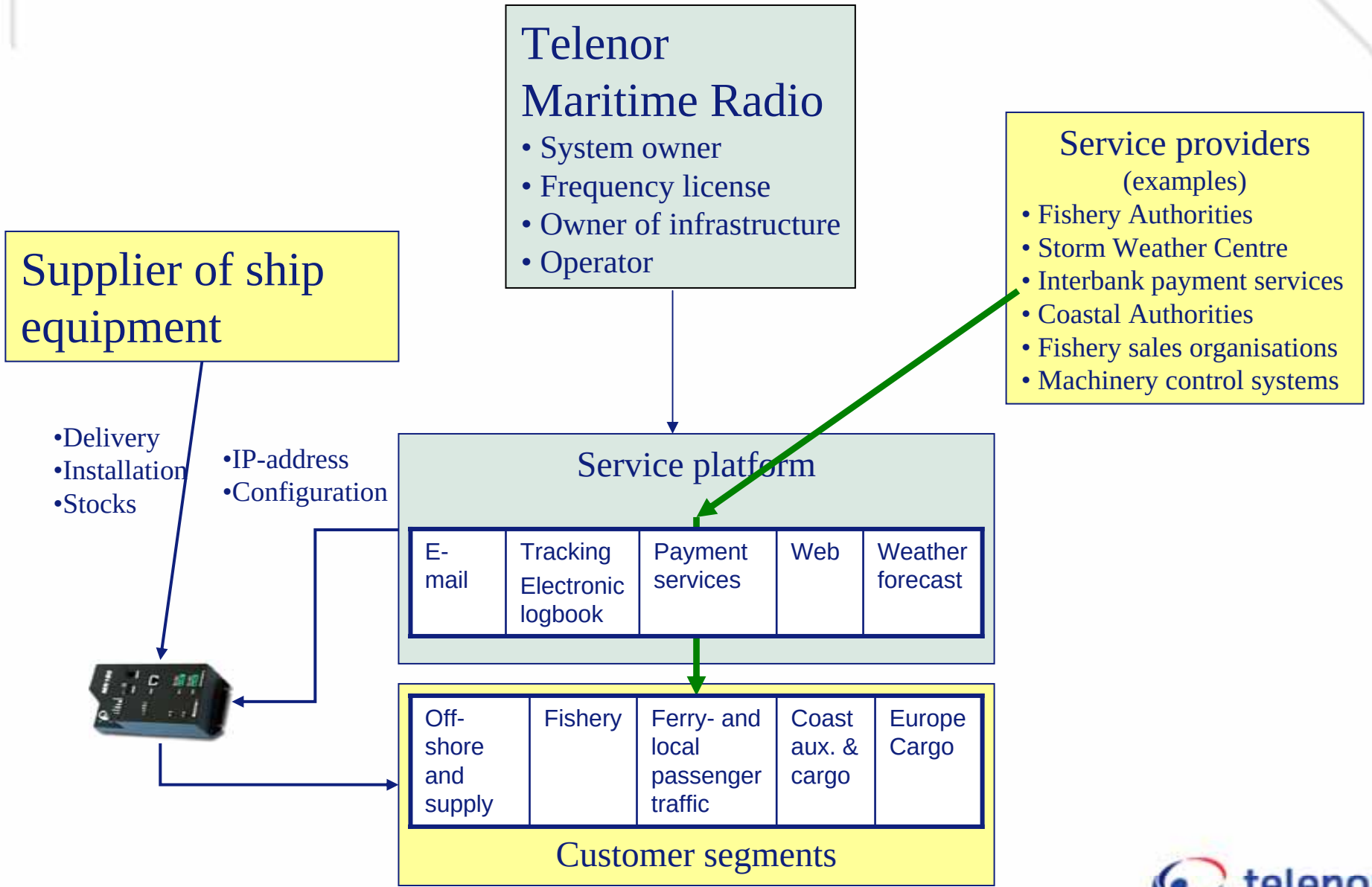
telenor

Typical services provided by VHF Data.



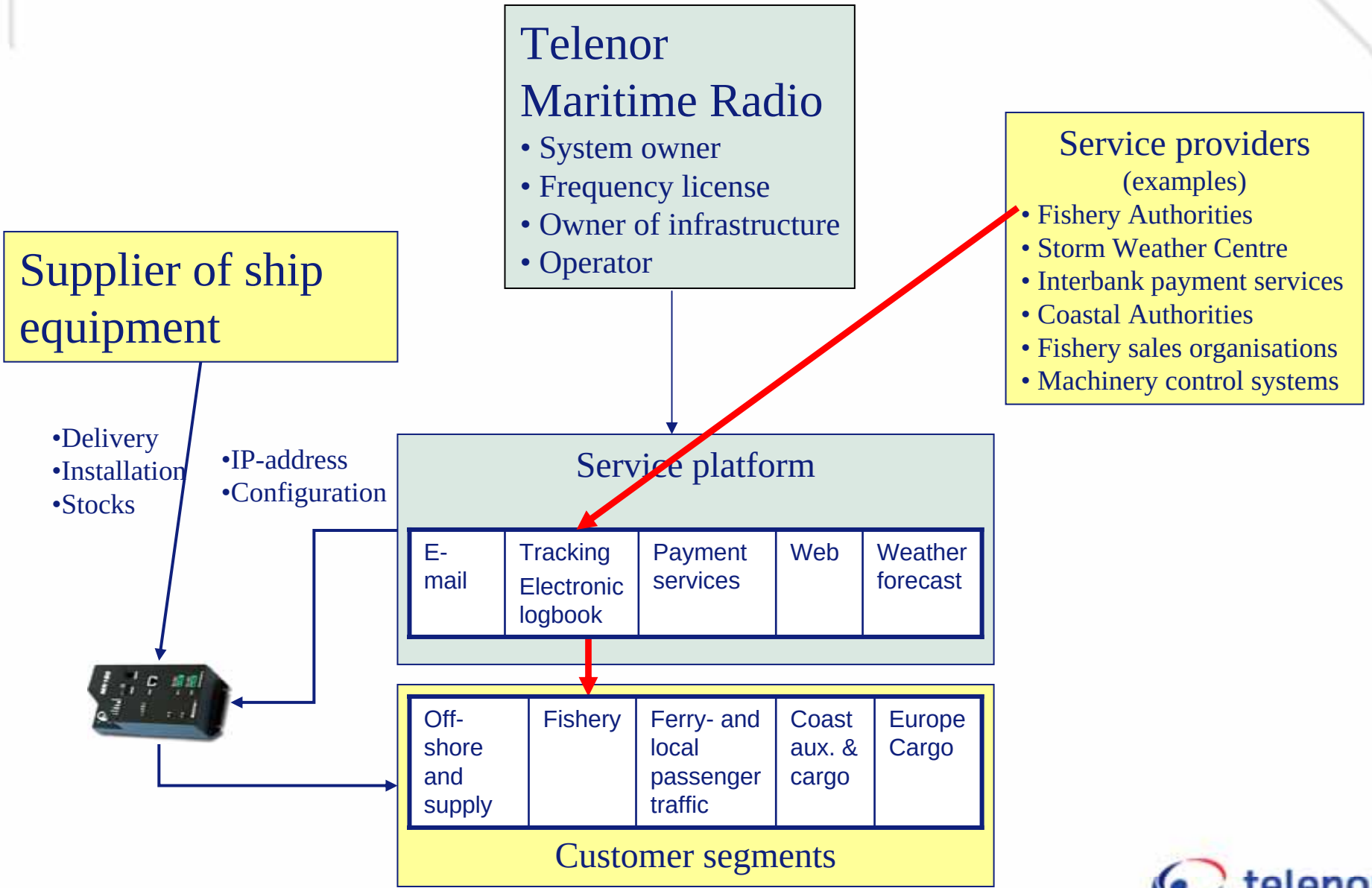
telenor

Typical services provided by VHF Data.



telenor

Typical services provided by VHF Data.



telenor

Typical services provided by VHF Data.

Telenor Maritime Radio

- System owner
- Frequency license
- Owner of infrastructure
- Operator

Service providers (examples)

- Fishery Authorities
- Storm Weather Centre
- Interbank payment services
- Coastal Authorities
- Fishery sales organisations
- Machinery control systems

Supplier of ship equipment

- Delivery
- Installation
- Stocks

- IP-address
- Configuration

Service platform

E-mail	Tracking Electronic logbook	Payment services	Web	Weather forecast

Customer segments

Off-shore and supply	Fishery	Ferry- and local passenger traffic	Coast aux. & cargo	Europe Cargo

KYSTVERKET

SafeSeaNet

VHF Data

telenor

Typical services provided by VHF Data.

Telenor Maritime Radio

- System owner
- Frequency license
- Owner of infrastructure
- Operator

Service providers (examples)

- Fishery Authorities
- Storm Weather Centre
- Interbank payment services
- Coastal Authorities
- Fishery sales organisations
- Machinery control systems

Supplier of ship equipment

- Delivery
- Installation
- Stocks

- IP-address
- Configuration

Service platform

E-mail	Tracking Electronic logbook	Payment services	Web	Weather forecast

Customer segments

Off-shore and supply	Fishery	Ferry- and local passenger traffic	Coast aux. & cargo	Europe Cargo

Storm WEATHER CENTER

Dynamic weather forecast based on GPS position

VHF Data

telenor

Typical services provided by VHF Data.

Telenor Maritime Radio

- System owner
- Frequency license
- Owner of infrastructure
- Operator

Service providers (examples)

- Fishery Authorities
- Storm Weather Centre
- Interbank payment services
- Coastal Authorities
- Fishery sales organisations
- **Machinery control systems**

Supplier of ship equipment

- Delivery
- Installation
- Stocks

- IP-address
- Configuration

Service platform

E-mail	Tracking Electronic logbook	Payment services	Web	Weather forecast

Open to third party application providers.

Off-shore and supply	Fishery	Ferry- and local passenger traffic	Coast aux. & cargo	Europe Cargo

Customer segments

VHF Data

telenor

VHF Data – Contracts as per 2. February 2005

Fosen trafikklag:

- Bastøferga (3 ferries)
- 9 payment terminals with automatic cashier accounts
- (e-mail)
- The company owns 18 vessels.

3 X

HSD:

- 1 ferry + 1 fast passenger craft
- (e-mail)
- The company owns 40 vessels

Rødne ship owners:

- 1 fast passenger craft
- 1 payment terminal
- e-mail
- maintenance system
- The company owns 16 vessels

telenor

VHF Data – competing / complementary systems: VHF data versus some satellite systems

Typical equipment cost

Monthly cost

Payment willingness / needs

Norsat (fixed)

Voice + e-mail + internet
128 kbit/s)

Inmarsat Fleet

Voice + e-mail + et
128 kbit/s)

Inmarsat Fleet 33

Voice + e-mail + interne
t/s up – 28 kbit/s d

Inmarsat C

Tracking + SMS

0,6 kbit/s

Irridium

Voice + e-mail (2,4 kbit/s)

Equipment: € 40.000
Monthly cost: € 3.000

Equipment: € 20.000
Monthly cost: € 3.000

Equipment: € 7.500
Monthly cost: € 1.200

Equipment: € 4.500
Monthly cost: € 400

Equipment: € 3.000
Monthly cost: € 400

Equipment: € 2.500
Monthly cost: € 400

VHF Data may also penetrate the satellite market:
- For long periods the ships are within VHF coverage
- Special applications made for VHF Data
- Lower costs
- Complementary to satellite

Functionality and data speed

VHF Data – competing / complementary systems: VHF data versus cell phone

The customer will make his choice based on:

- coverage / distance to shore
- stability
- functionality
- maritime applications

Data speed and functionality

UMTS

Voice + e-mail + internet 386 kbit/s down)

Will not have sufficient coverage for the maritime market.

Edge

Voice + e-mail + internet 128 kbit/s

GPRS

Voice + e-mail + internet 64 kbit/s)

VHF Data

Tracking + e-mail + internet 21 kbit/s - 64 kbit/s)

VHF Data for tracking.

GSM

Voice + e-mail + internet– 14,4 kbit/s)

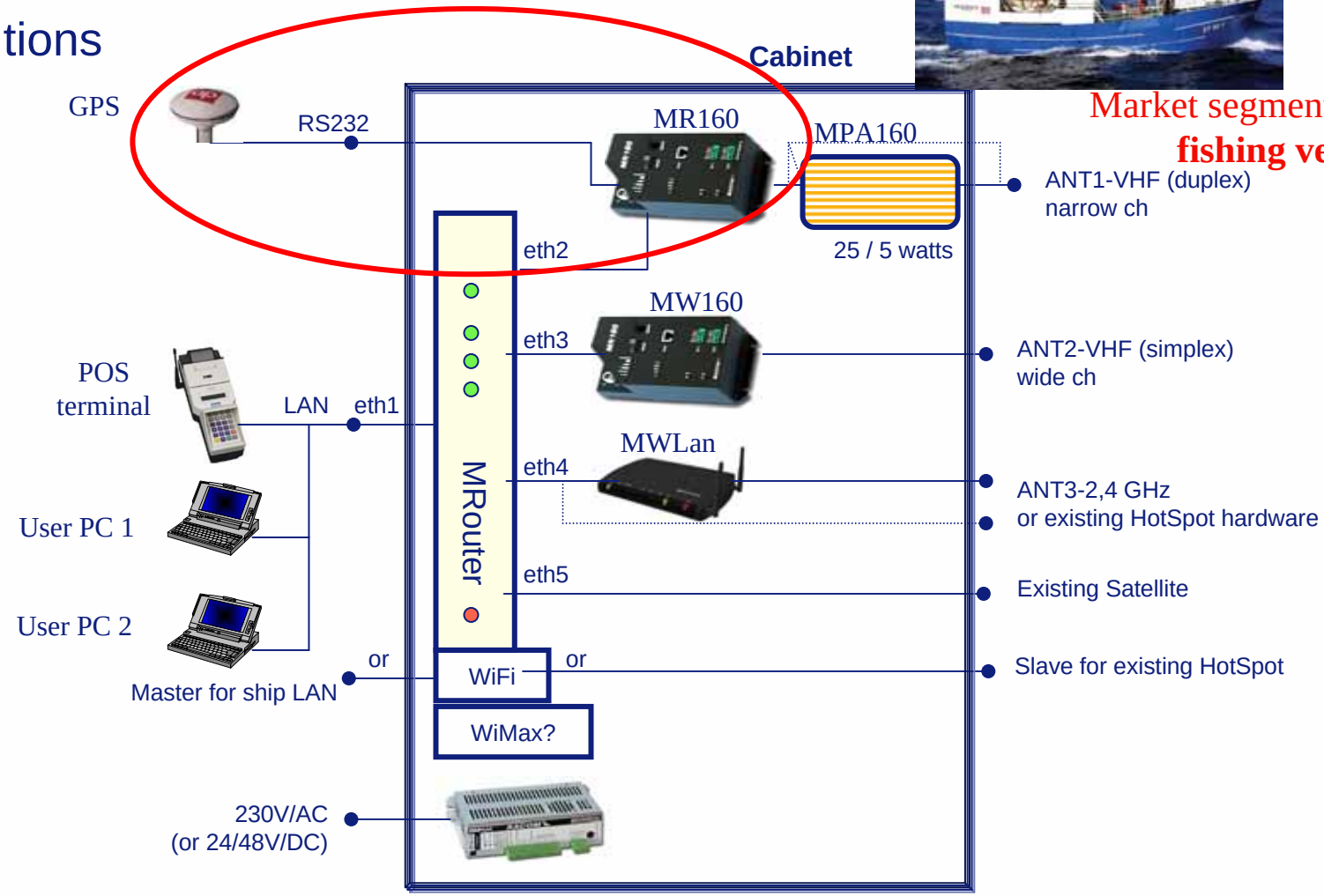
GSM for voice and SMS

Stability and coverage

Ship

Modular solutions

Market segment: **Coastal fishing vessel**

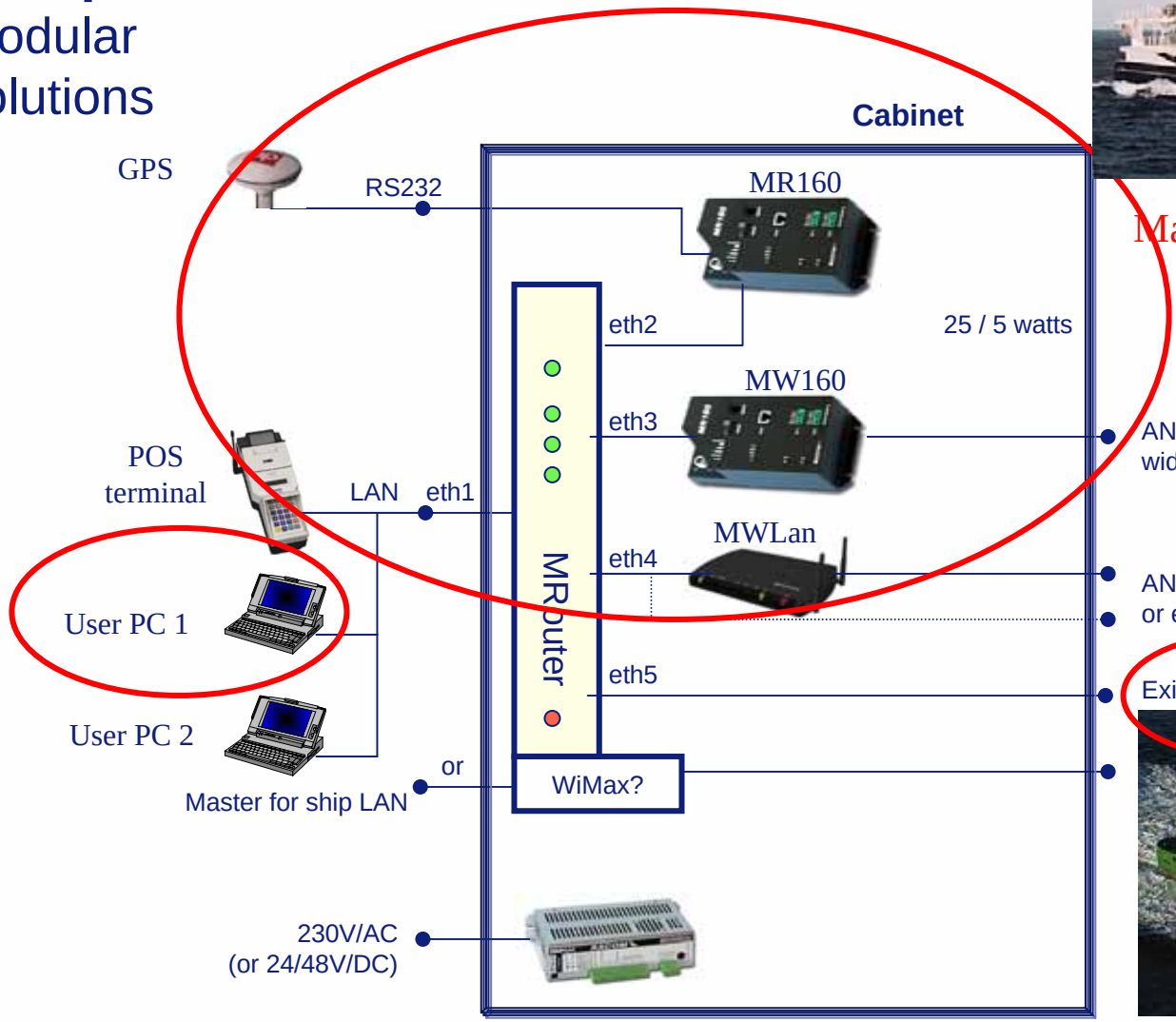


telenor

Ship

Modular solutions

Market segment: **Ocean Fishing vessels**



Market segment: **Offshore / supply**

telenor

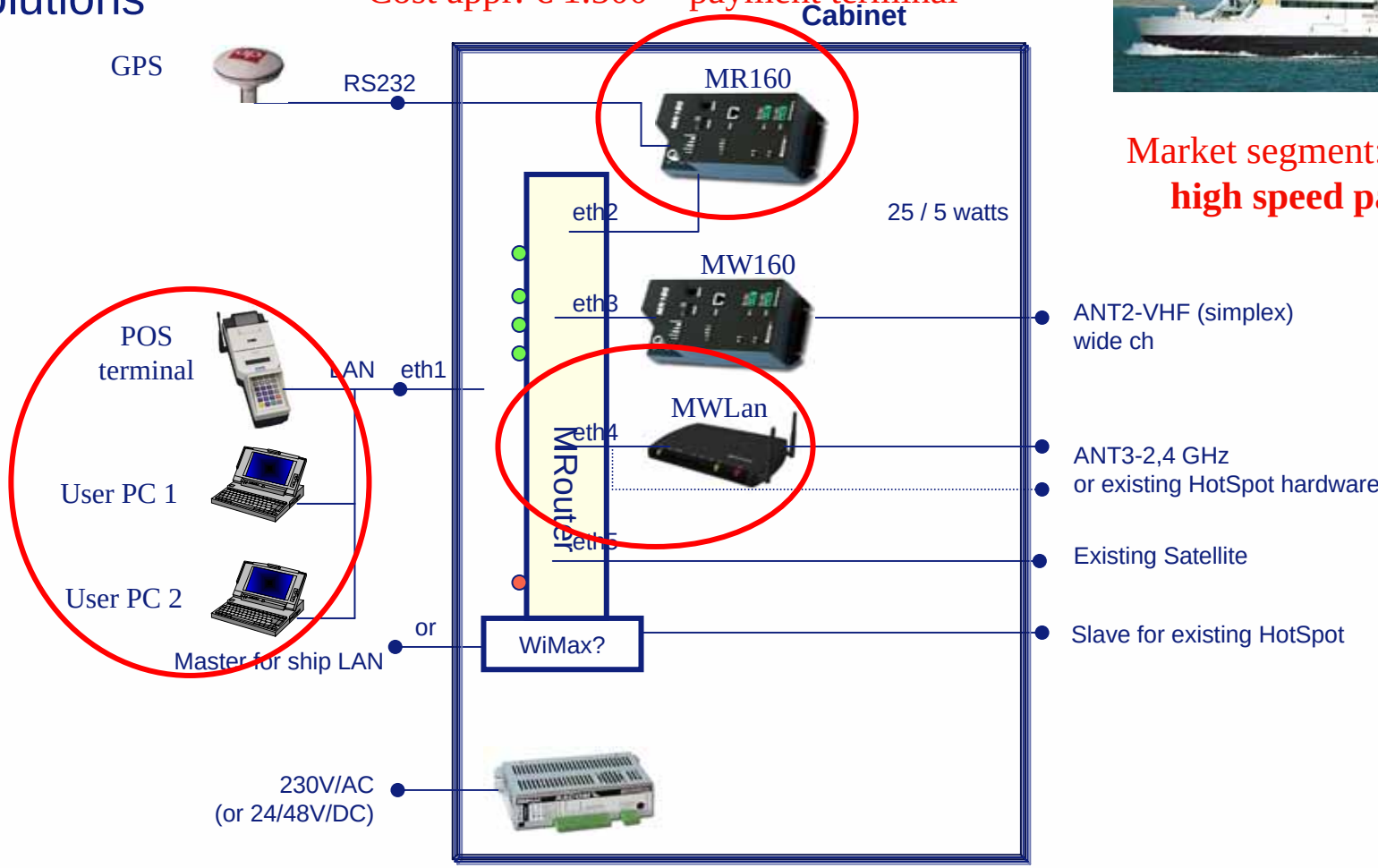
Ship
Modular solutions

”Narrowband”/ Wlan

e-post / web / maintenance system / payment services

Cost appr. € 1.500 + payment terminal

Market segment: **Ferry and high speed passenger**



Specification

Main Engine

Performance model

Hual Asia and Hual Trader

Revision: 0.i.2
Date: 5th of May 2006

Indexing

This specification describes calculations used to decide main engine performance. The performance is a sum of index values calculated from measurements.

The index values range from 0 to 100 where 0 is extreme unacceptable performance and 100 is design performance.

The measurements and calculated index values are kept in a database. The index values make it easier to interpret and compare performance over time and between similar units as ships, engines, turbochargers, etc. Values and corresponding time are presented in tables and graphs.

It is advantageous to run the performance tests collecting measurements at steady state at the same service condition each time for better quality in measurements and index model results. The model is more correct near the recommended power of 85% of MCR.

Summation of indexes

An index tree is used to structure the main engine performance and to sum up measurements from performance tests. Summation of indices into higher level indices in the index tree is done by functions like weighted sum, mean, worst case, etc. Refer index tree in this specification.

Converting measurements to index values

The example in figure 1 illustrates how measurements are converted into index values. Ideal relation between cylinder maximum pressure (Pmax) and mean effective pressure (MEP) from project guide is shown as the blue line. The slope of this curve is used to correct Pmax measured at (1) to Pmax at standard MEP (15.14 bar) at (2). Correction of Pmax to a standard MEP is essential if measurements shall be comparable through time.

The index function (red, yellow and green lines) convert the corrected value (2-3-4) to an index value [0,100] and a status; red, yellow or green.

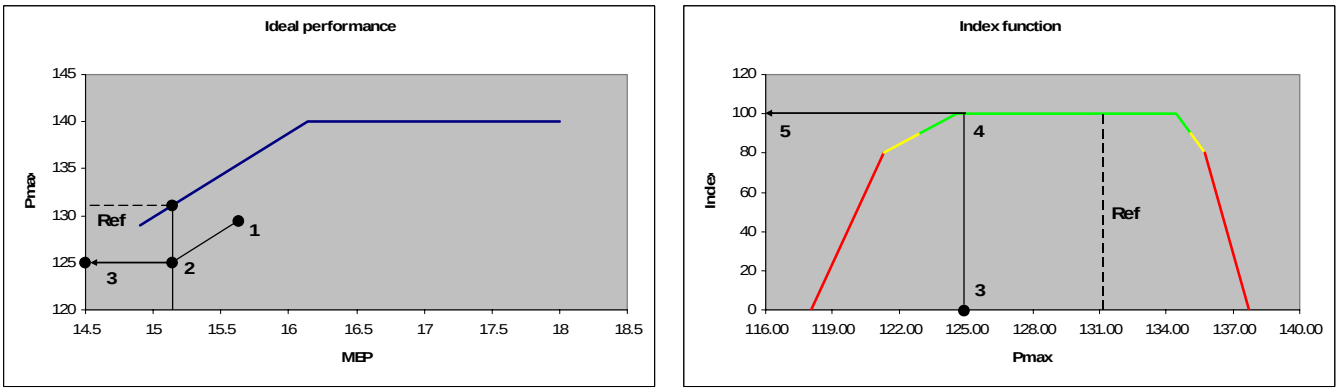


Figure1: Conversion of cylinder maximum pressure measured (1) to corrected value (2-3-4) to index value (5).

Results

Example of result presentation in the software TeCoView is shown in figure 2 below. At left the corrected measurements are presented as points interconnected with straight lines. At right the corresponding index values are presented as points interconnected with a step curve to indicate that index values are valid until new values are obtained.

The results below show that engine performance with respect to Pmax has improved and is acceptable after 2003.

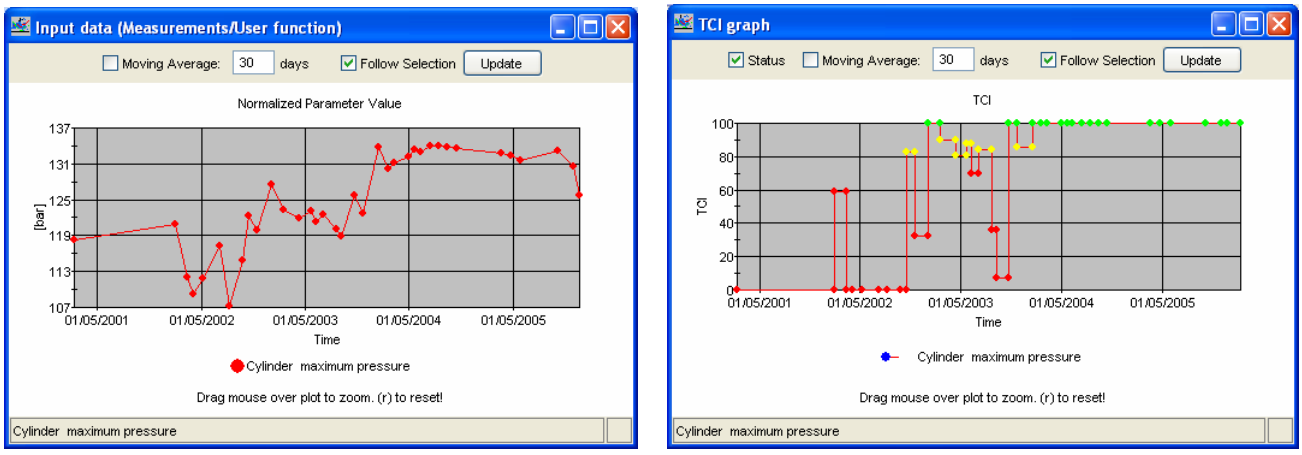


Figure 2: Example of how results are presented in the Technical Condition Viewer.

It is important to have in mind that low index values can be caused by:

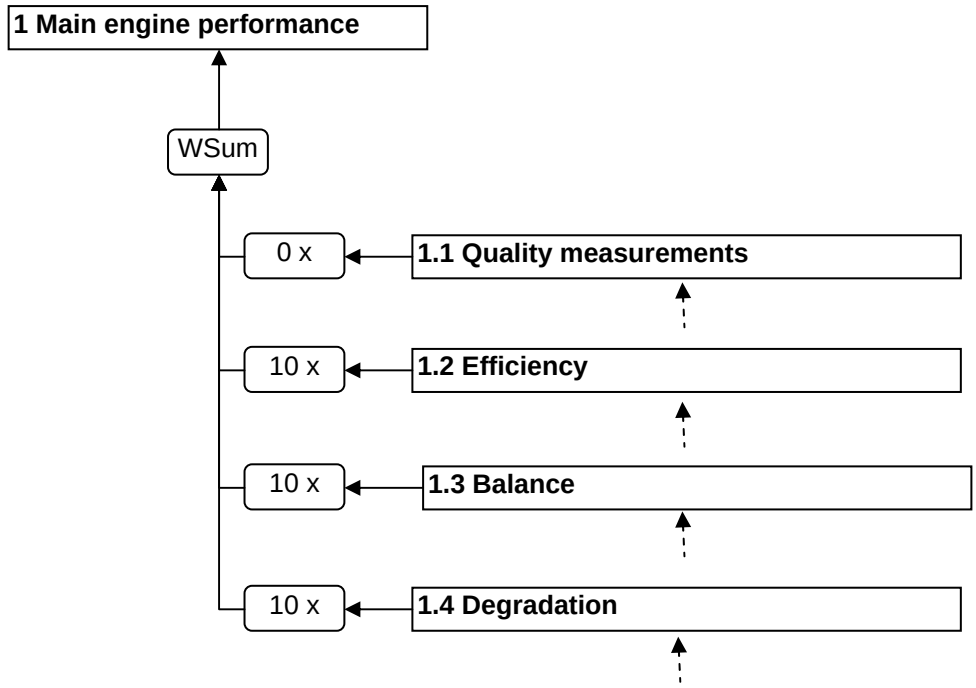
- Bad performance.
- Bad instrumentation.
- Bad registration.

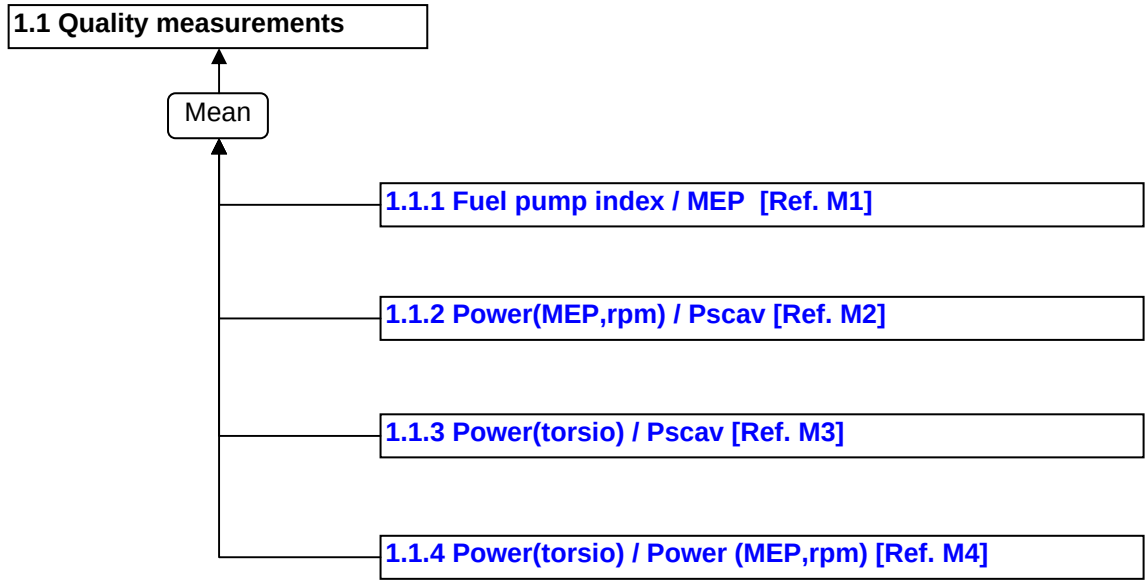
Instrumentation and registration quality should be checked before erroneous conclusions to poor performance.

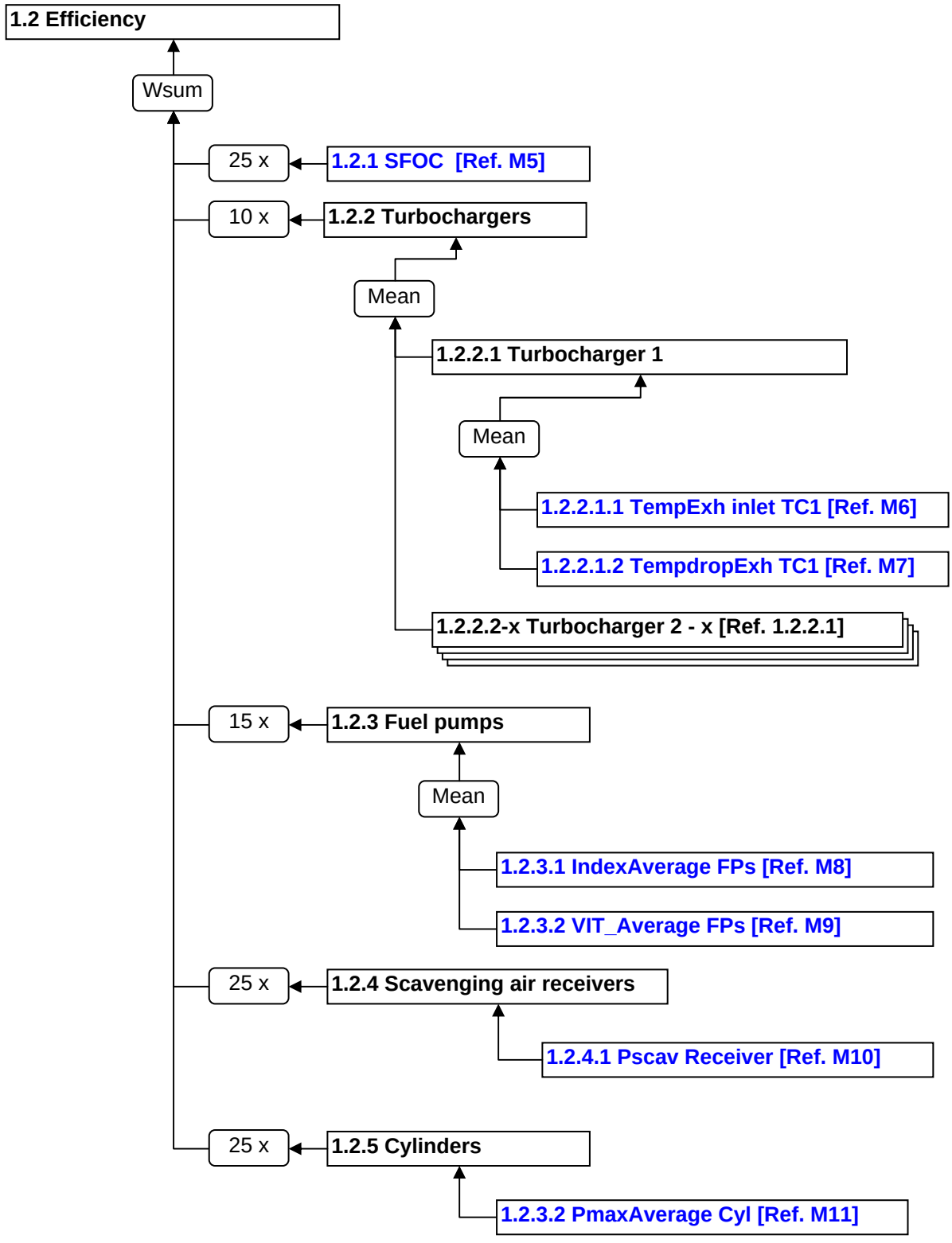
Results are also presented in reports that easier can be submitted to the ships. These reports are also in use at office. The reports focus on the performance at a high level and at measurement level where follow-up and attention are required, respectively red or yellow status.

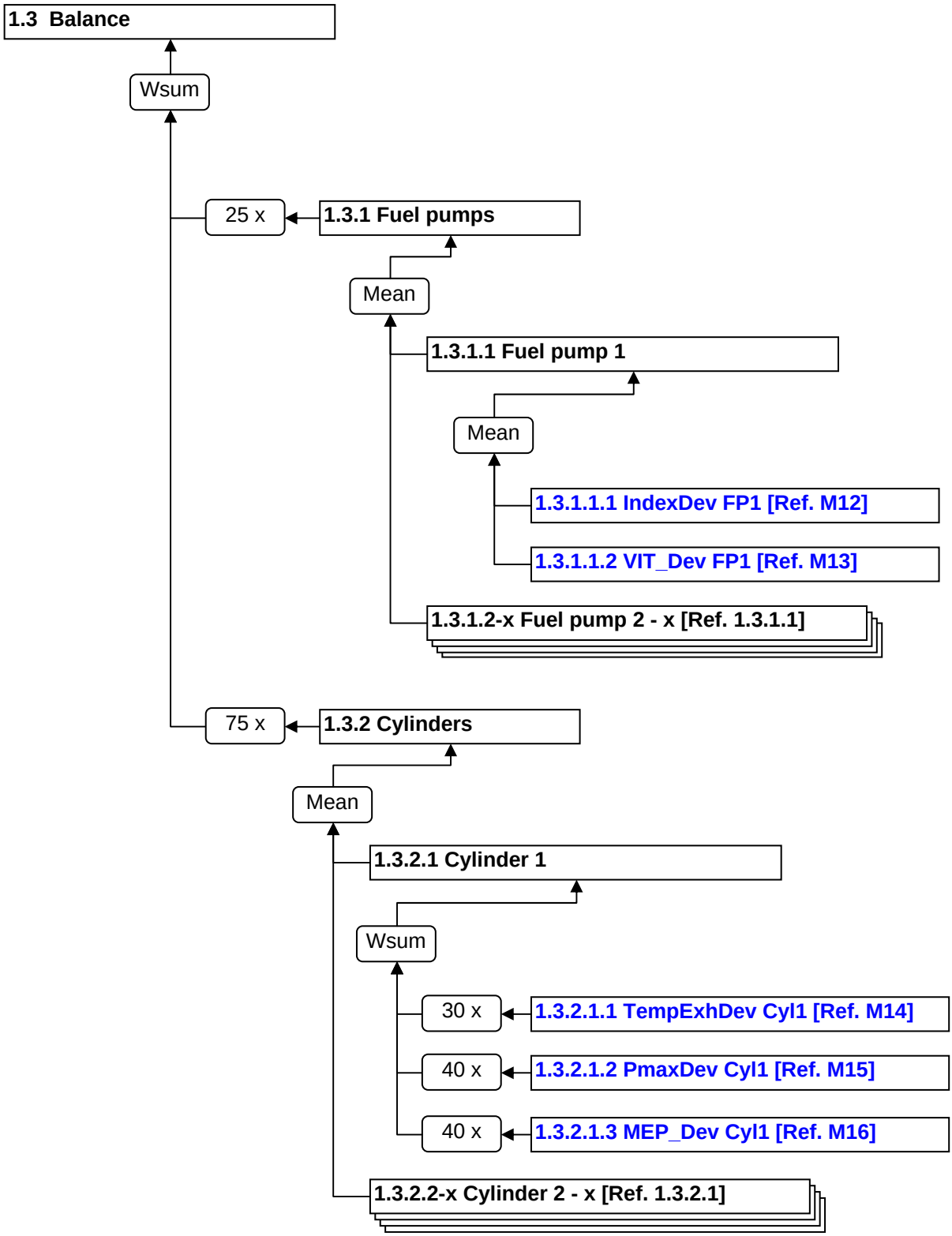
Reference documentation

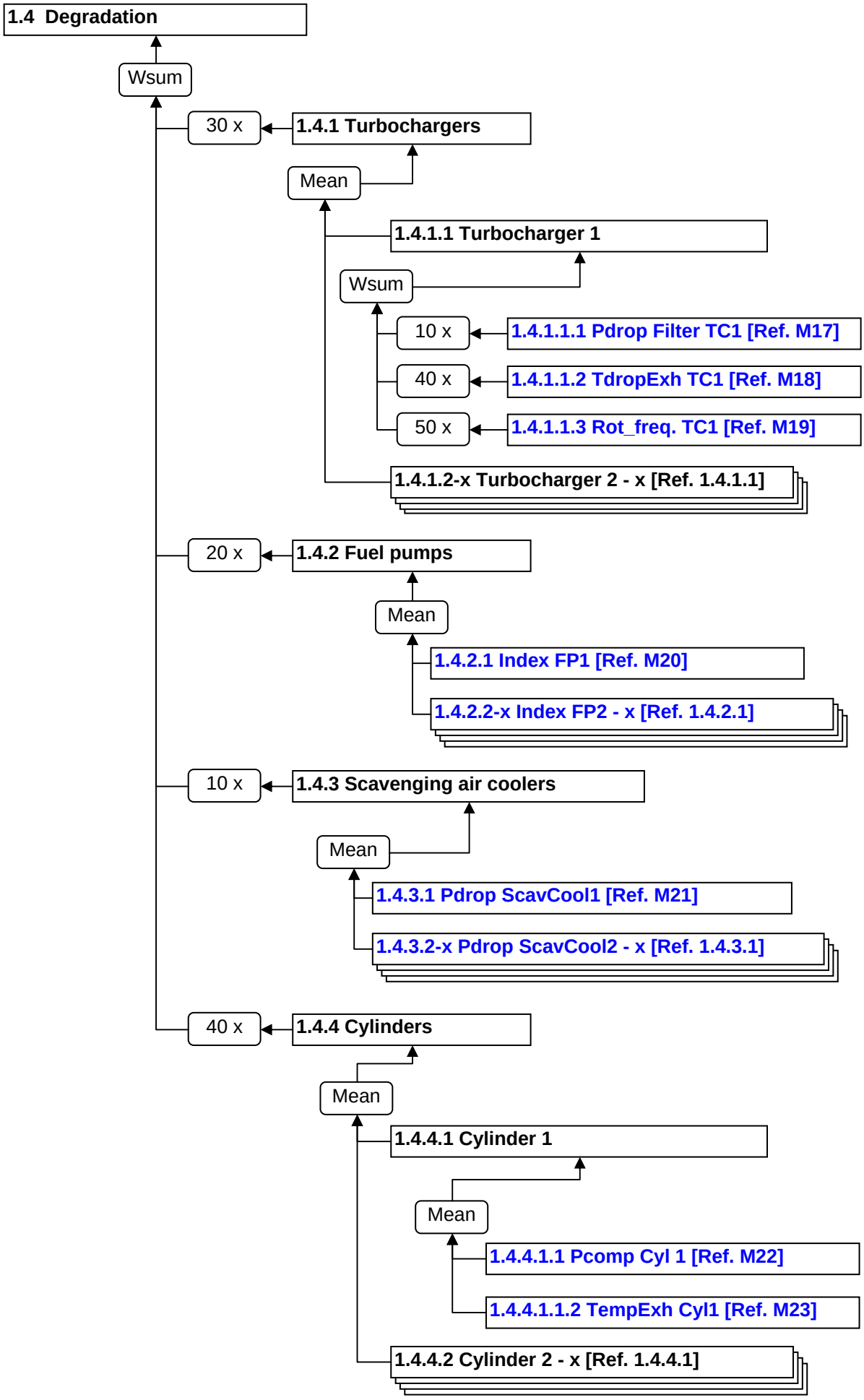
Reference documents used to develop indexes are performance tests, sea-trials, shop tests, project guides, experience and statistics.


1 Main engine performance
WSum
0 x
1.1 Quality measurements
10 x
1.2 Efficiency
10 x
1.3 Balance
10 x
1.4 Degradation


1.1 Quality measurements
Mean
1.1.1 Fuel pump index / MEP [Ref. M1]
1.1.2 Power(MEP,rpm) / Pscav [Ref. M2]
1.1.3 Power(torsio) / Pscav [Ref. M3]
1.1.4 Power(torsio) / Power (MEP,rpm) [Ref. M4]


1.2 Efficiency
Wsum
25 x
1.2.1 SFOC [Ref. M5]
10 x
1.2.2 Turbochargers
Mean
1.2.2.1 Turbocharger 1
Mean
1.2.2.1.1 TempExh inlet TC1 [Ref. M6]
1.2.2.1.2 TempdropExh TC1 [Ref. M7]
1.2.2.2-x Turbocharger 2 - x [Ref. 1.2.2.1]
15 x
1.2.3 Fuel pumps
Mean
1.2.3.1 IndexAverage FPs [Ref. M8]
1.2.3.2 VIT_Average FPs [Ref. M9]
25 x
1.2.4 Scavenging air receivers
1.2.4.1 Pscav Receiver [Ref. M10]
25 x
1.2.5 Cylinders
1.2.3.2 PmaxAverage Cyl [Ref. M11]


1.3 Balance
Wsum
25 x
1.3.1 Fuel pumps
Mean
1.3.1.1 Fuel pump 1
Mean
1.3.1.1.1 IndexDev FP1 [Ref. M12]
1.3.1.1.2 VIT_Dev FP1 [Ref. M13]
1.3.1.2-x Fuel pump 2 - x [Ref. 1.3.1.1]
75 x
1.3.2 Cylinders
Mean
1.3.2.1 Cylinder 1
Wsum
30 x
1.3.2.1.1 TempExhDev Cyl1 [Ref. M14]
40 x
1.3.2.1.2 PmaxDev Cyl1 [Ref. M15]
40 x
1.3.2.1.3 MEP_Dev Cyl1 [Ref. M16]
1.3.2.2-x Cylinder 2 - x [Ref. 1.3.2.1]


1.4 Degradation
Wsum
30 x
1.4.1 Turbochargers
Mean
1.4.1.1 Turbocharger 1
Wsum
10 x
1.4.1.1.1 Pdrop Filter TC1 [Ref. M17]
40 x
1.4.1.1.2 TdropExh TC1 [Ref. M18]
50 x
1.4.1.1.3 Rot_freq. TC1 [Ref. M19]
1.4.1.2-x Turbocharger 2 - x [Ref. 1.4.1.1]
20 x
1.4.2 Fuel pumps
Mean
1.4.2.1 Index FP1 [Ref. M20]
1.4.2.2-x Index FP2 - x [Ref. 1.4.2.1]
10 x
1.4.3 Scavenging air coolers
Mean
1.4.3.1 Pdrop ScavCool1 [Ref. M21]
1.4.3.2-x Pdrop ScavCool2 - x [Ref. 1.4.3.1]
40 x
1.4.4 Cylinders
Mean
1.4.4.1 Cylinder 1
Mean
1.4.4.1.1 Pcomp Cyl 1 [Ref. M22]
1.4.4.1.1.2 TempExh Cyl1 [Ref. M23]
1.4.4.2 Cylinder 2 - x [Ref. 1.4.4.1]

M1. Fuel pump index / MEP {to be defined}

M2. Power(MEP,rpm) / Pscav {to be defined}

M3. Power(torsio) / Pscav {to be defined}

M4. Power(torsio) / Power (MEP,rpm)

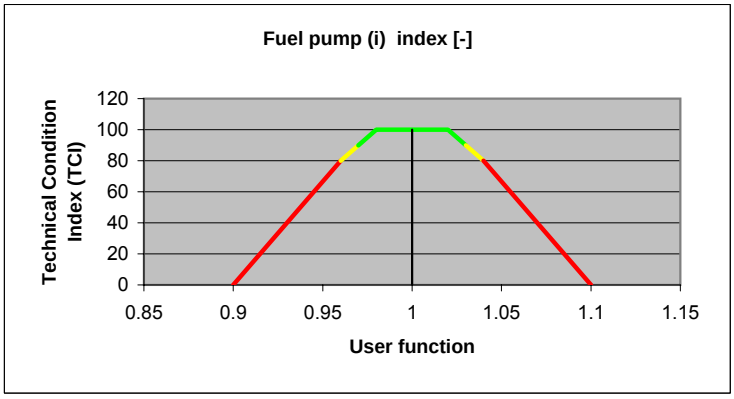
Acceptable deviation between power from torsiometer and power calculated from MEP and rpm given in index function.

Reference value:

1.00

Index function

SFOC	Index	From reference
0.90	0	-10.0 %
0.96	80	-4.0 %
0.97	90	-3.0 %
0.98	100	-2.0 %
1.02	100	2.0 %
1.03	90	3.0 %
1.04	80	4.0 %
1.10	0	10.0 %

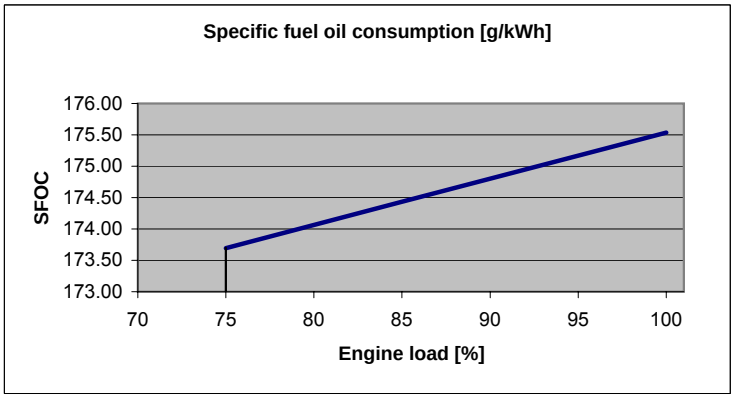


M5. SFOC

Ideal performance	75	85	100 [%]
$SFOC_{BHP}$	129.58	130.13	130.95 [g/BHP]
$SFOC_{kWh}$	173.69	174.43	175.54 [g/kWh]

Reference value:

173.70

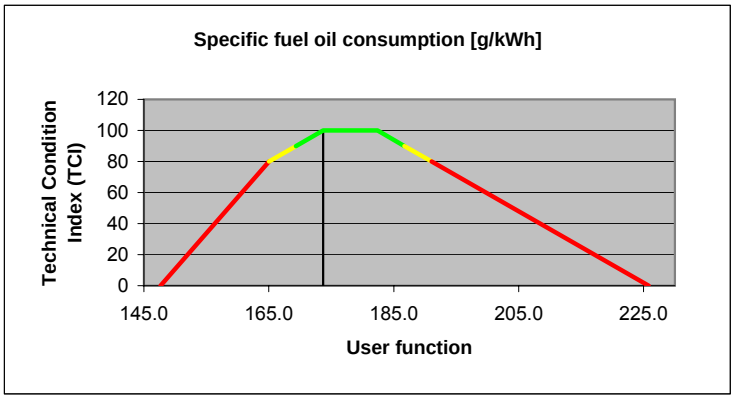


Calculated value:

$$SFOC = \left(\frac{FOC_{meas}}{SHP[kW]_{meas}} \cdot \frac{LCHV_{meas}}{42700} \right) \cdot \left[1 - 0{,}0002(T\_air_{meas} - 25) - 0{,}0006(T\_scav_{meas} - 25) \right] \cdot 1000$$

Index function

Value	Index	From reference
147.6	0	-15.0 %
165.0	80	-5.0 %
169.4	90	-2.5 %
173.7	100	0.0 %
182.4	100	5.0 %
186.7	90	7.5 %
191.1	80	10.0 %
225.8	0	30.0 %



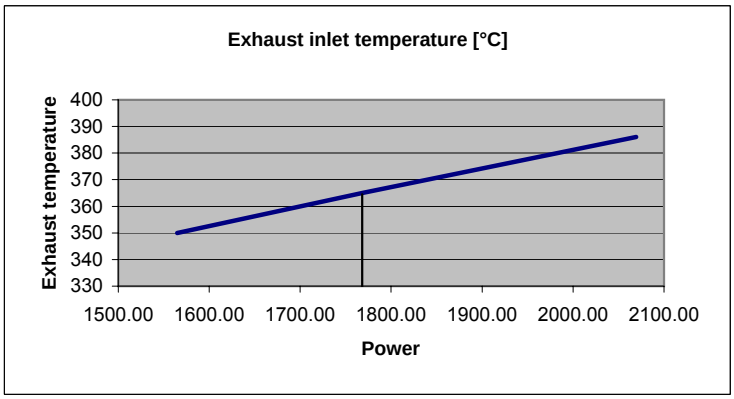
M6. TempExh inlet TC1

Ideal performance

$$BHP_{M\_meas} = \frac{\sum_{i=1}^{n} BHP(i)_{meas}}{n}$$

Engine power	75	85	100	[%]
Texh_T/C_inlet	350	365	386	[˚C]
BHP_{M_meas}	2097.66	2370.35	2773.94	[BHP]
Power	1564.85	1768.28	2069.36	[kW]

Reference value:
364.52



Calculated value:

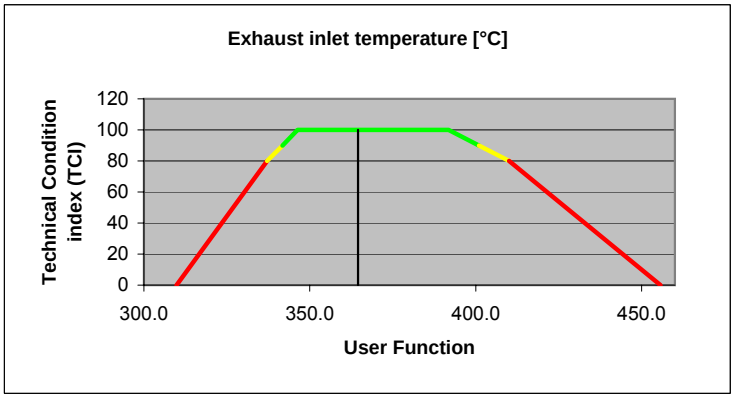
$$K\_exh\_temp = \frac{T\_exh\_inlet_2 - T\_exh\_inlet_1}{Power_2 - Power_1}$$

K_{exh_temp} = 0.0714

$$T_{exh\_corr} = T_{exh\_meas} + K_{exh\_temp} \cdot \left(power_{ref} - Power_{meas} \right) + \left(\left(T_{eng\_room} - 25 \right) \cdot \left(-2.466 \cdot 10^{-3} \right) \cdot \left(273 + T_{exh\_meas} \right) \right)$$
$$+ \left(\left(T_{cool\_water} - 25 \right) \cdot \left(-0.59 \cdot 10^{-3} \right) \cdot \left(273 + T_{exh\_meas} \right) \right)$$

Index function

Value	Index	From reference
309.8	0	-15.0 %
337.2	80	-7.5 %
341.7	90	-6.3 %
346.3	100	-5.0 %
391.9	100	7.5 %
401.0	90	10.0 %
410.1	80	12.5 %
455.6	0	25.0 %



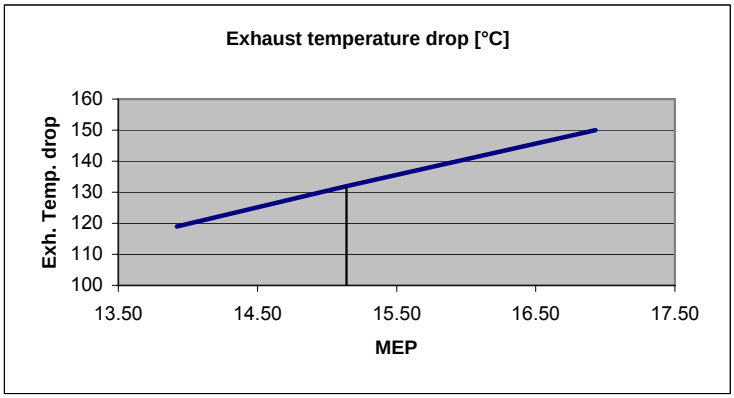
M7. TempdropExh inlet TC1

Ideal performance
$MEP(i)_{meas}$= $MIP(i)_{meas}$ - 0,94 [Bar]

$$MEP(i)_{meas} = \frac{BHP}{n \cdot K}$$

Engine power	75	85	100	[%]
Texh_T/C_inlet	350	365	386	[˚C]
Texh_T/C_outlet	231	233	236	[˚C]
ΔT T/C_exh (ΔTi)	119	132	150	[˚C]
MEP_{meas}	13.92	15.14	16.93	[bar]

Reference value:
131.56



Calculated reference:

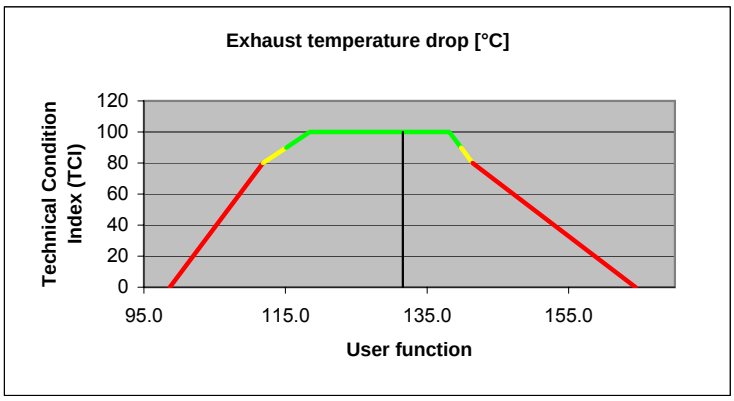
$$K_{\Delta T\_T/C\_exh} = \frac{\Delta T_2 - \Delta T_1}{MEP_2 - MEP_1}$$

$K_{\Delta T\_T/C\_exh}$ = 10.2990

$$\Delta T\_T/C\_exh_{corr} = \Delta T\_T/C\_exh_{meas} + K_{\Delta T\_T/C\_exh}\left(MEP_{ref} - MEP_{M\_meas}\right)$$

Index function

Value	Index	From reference
98.7	0	-25.0 %
111.8	80	-15.0 %
115.1	90	-12.5 %
118.4	100	-10.0 %
138.1	100	5.0 %
139.8	90	6.3 %
141.4	80	7.5 %
164.5	0	25.0 %



M8. IndexAverage FPs

Ideal performance

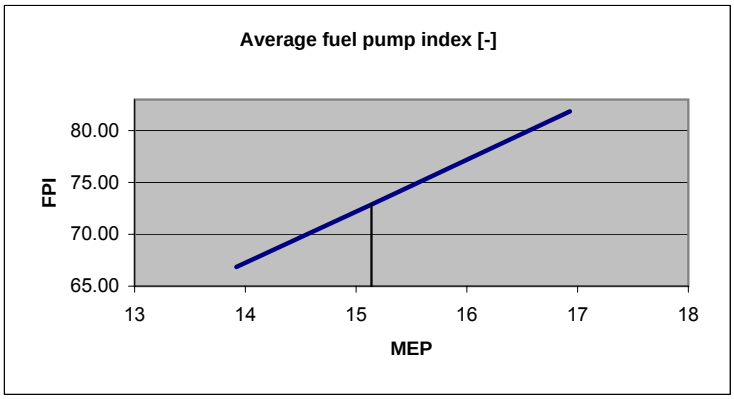
Spec. fuel grav. 15˚C	Spec_ grav_ 15˚C$_{ST}$	LCHV	LCHV$_{ST}$
0.966 [kg/l]	966 [kg/m³]	9690 [kcal/kg]	40570 [kJ/kg]

$$FPI_{M\_meas} = \frac{\sum_{i=1}^{n} FPI(i)_{meas}}{n}$$

Engine load	0	75	85	100	[%]
FPI$_{meas}$	-8.833	66.86	72.86	81.86	[-]
MEP$_{meas}$	0	13.92	15.14	16.93	[bar]

Reference value:

72.86



Calculated value:

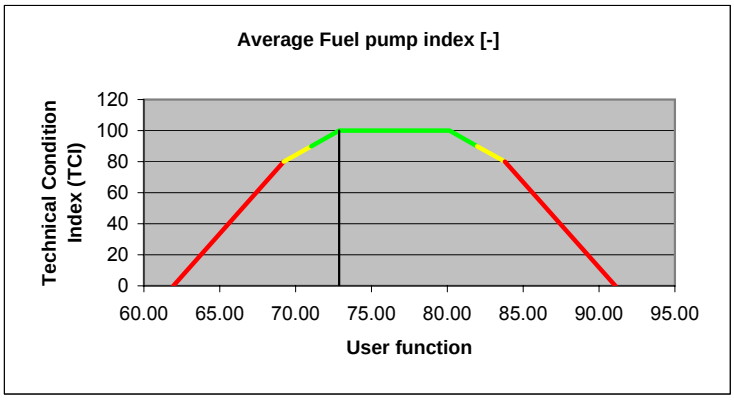
$$K_{mep} = \frac{FPI_2 - FPI_1}{MEP_2 - MEP_1}$$

K$_{mep}$ = 5.3958

$$Fuel\_pump\_index_{M\_corr} = \left(Fuel\_pump\_index_{M\_meas} + K_{mep}\left(MEP_{ref} - MEP_{M\_meas}\right)\right) \cdot \left(\frac{Spec\_grav\_15°C_{meas}}{Spec\_grav\_15°C_{ST}} \cdot \frac{LCHV_{meas}}{LCHV_{ST}}\right)$$

Index function

Value	Index	From reference
61.93	0	-15.0 %
69.22	80	-5.0 %
71.04	90	-2.5 %
72.86	100	0.0 %
80.15	100	10.0 %
81.97	90	12.5 %
83.79	80	15.0 %
91.08	0	25.0 %



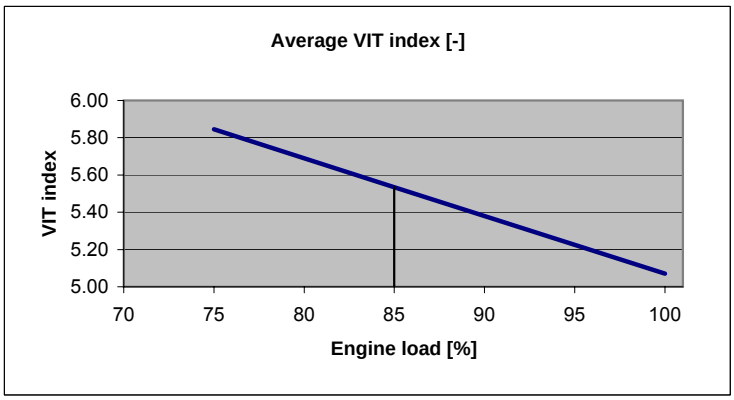
M9. VIT_Average FPs

Ideal performance

Engine load	75	85	100	[%]
VIT_{meas}	5.85	5.54	5.07	[-]

Reference value:

5.54

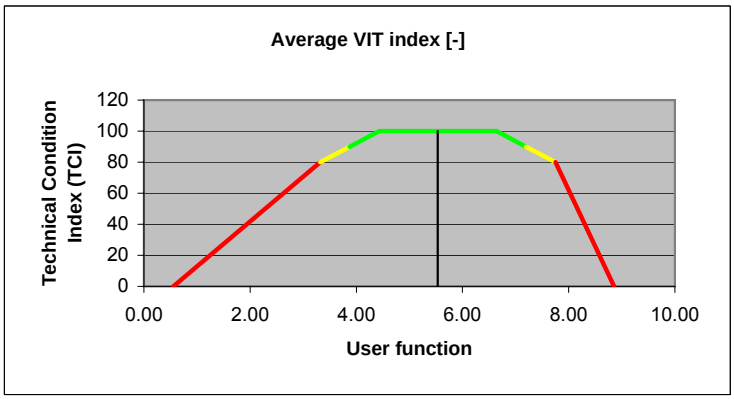


Calculated value:

$$VIT_{ind\_M} = \frac{\sum_{i=1}^{n} VIT(i)_{ind\_meas}}{n}$$

Index function

Value	Index	From reference
0.55	0	-90.0 %
3.32	80	-40.0 %
3.87	90	-30.0 %
4.43	100	-20.0 %
6.64	100	20.0 %
7.20	90	30.0 %
7.75	80	40.0 %
8.86	0	60.0 %



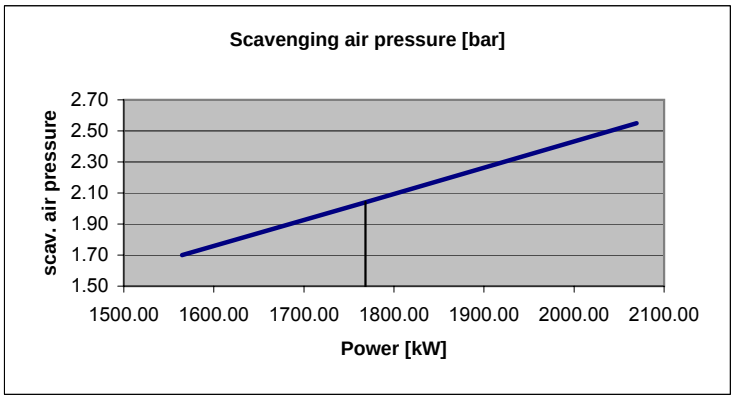
M10. Pscav Receiver

Ideal performance

$$BHP_{M\_meas} = \frac{\sum_{i=1}^{n} BHP(i)_{meas}}{n}$$

Engine load	75	85	100	[%]
Scav_air_press	1.70	2.04	2.55	[bar]
BHP	2097.66	2370.35	2773.94	[BHP]
Power	1564.85	1768.28	2069.36	[kW]

Reference value:
2.04



Calculated value:

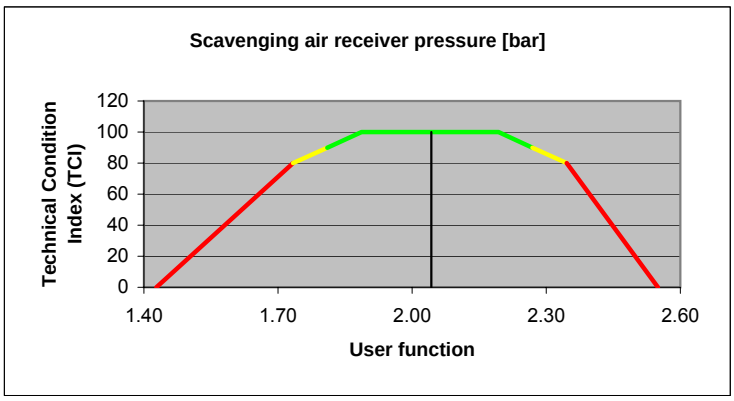
$$K_{Pscav} = \frac{Pscav_2 - Pscav_1}{Power_2 - Power_1}$$

K_scav = 0.0017

$$Pscav_{corr} = Pscav_{meas} + K_{Pscav}\left(Power_{ref} - Power_{M\_meas}\right) + (T_{Eng\_room\_meas} - 25) \cdot 0,002856 \cdot Pscav_{meas}$$

Index function

Value	Index	From reference
1.43	0	-30.0 %
1.73	80	-15.0 %
1.81	90	-11.3 %
1.89	100	-7.5 %
2.19	100	7.5 %
2.27	90	11.3 %
2.35	80	15.0 %
2.55	0	25.0 %



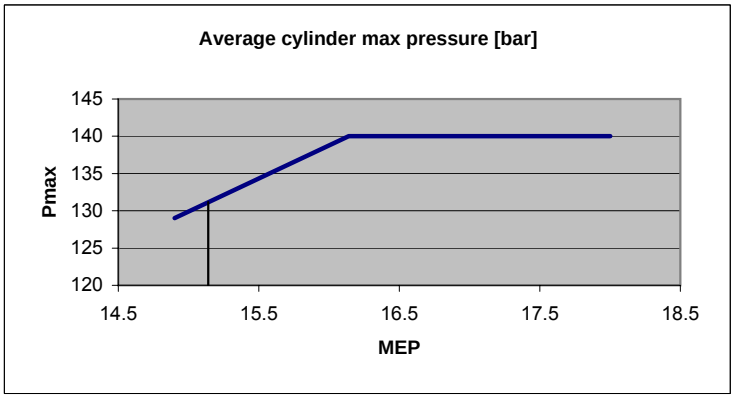
M11. PmaxAverage Cyl

Ideal performance

$$P\max_{M\_meas} = \frac{\sum_{i=1}^{n} P\max(i)_{meas}}{n} \qquad MEP_{M\_meas} = \frac{\sum_{i=1}^{n} MEP(i)_{meas}}{n}$$

Engine load	75	85	100	[%]
P_{max}	129	140	140	[bar]
MEP	14.9	16.1	18.0	[bar]
MEP_{meas}	13.92	15.14	16.93	[bar]

Reference value:
131.16



Calculated value:

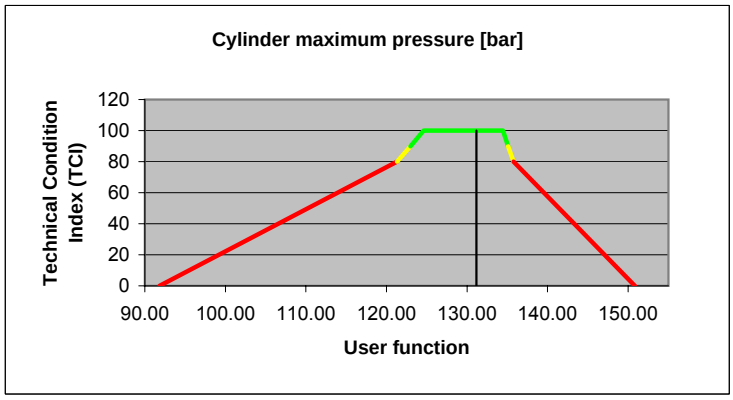
$$K_{P\max} = \frac{P\max_2 - P\max_1}{MEP_2 - MEP_1}$$

K_{Pmax} = 9.0164

$$P\max_{M\_corr} = P\max_{meas} + K_{P\max}\left(MEP_{ref} - MEP_{M\_meas}\right) + (T_{eng\_room} - 25)\cdot 2{,}198\cdot 10^{-3}\cdot(1 + P\max_{meas})$$

Index function

Value	Index	From reference
91.81	0	-30.0 %
121.33	80	-7.5 %
122.97	90	-6.3 %
124.61	100	-5.0 %
134.44	100	2.5 %
135.10	90	3.0 %
135.75	80	3.5 %
150.84	0	15.0 %



M12. IndexDev FP1

Deviation from reference calculated on basis of fuel pump index absolute condition.
Indicator referance: M8.

Reference value:

0.00

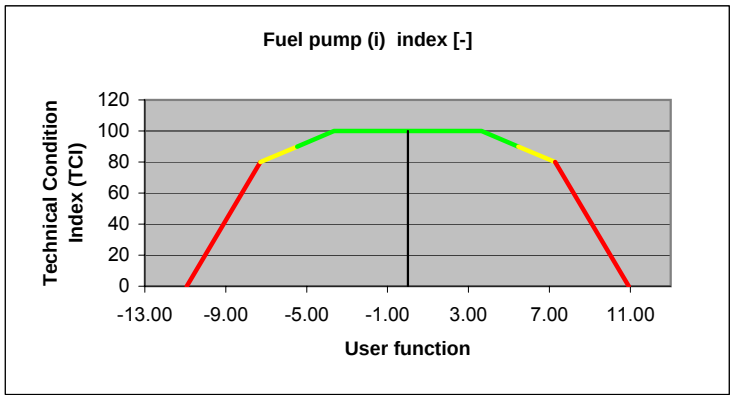
Calculated value:

$$FPI_{M\_meas} = \frac{\sum_{i=1}^{n} FPI(i)_{meas}}{n}$$

$$FPI(i)_{dev} = FPI(i)_{meas} - FPI_{M\_meas}$$

Index function

Value	Index	From reference
-10.93	0	-15.0 %
-7.29	80	-10.0 %
-5.46	90	-7.5 %
-3.64	100	-5.0 %
3.64	100	5.0 %
5.46	90	7.5 %
7.29	80	10.0 %
10.93	0	15.0 %



M13. VIT_Average FPs

Deviation from reference calculated on basis of fuel pump average VIT index absolute condition.
Indicator referance: M9.

Reference value:

0.00

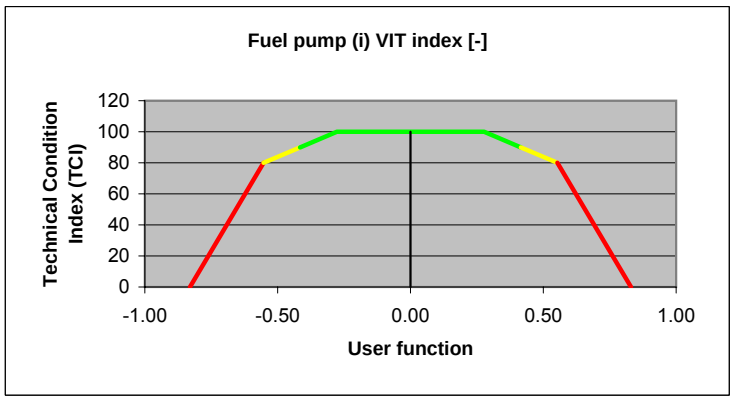
Calculated value:

$$VIT_{M\_meas} = \frac{\sum_{i=1}^{n} VIT(i)_{ind\_meas}}{n}$$

$$VIT(i)_{dev} = VIT(i)_{ind\_meas} - VIT_{M\_meas}$$

Index function

Value	Index	From reference
-0.83	0	-15.0 %
-0.55	80	-10.0 %
-0.42	90	-7.5 %
-0.28	100	-5.0 %
0.28	100	5.0 %
0.42	90	7.5 %
0.55	80	10.0 %
0.83	0	15.0 %



M14. TempExhDev Cyl1

Deviation from reference calculated on basis of exhaust inlet temperature absolute condition.
Indicator referance: M6.

Reference value:

0.00

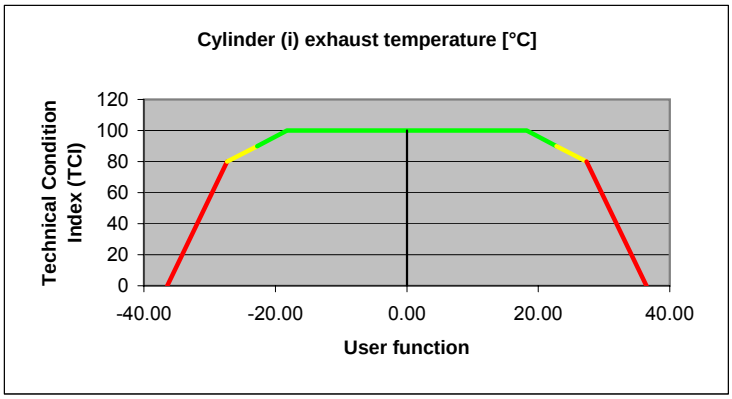
Calculated value:

$$Texh\_T/C\_inlet_{M\_meas} = \frac{\sum_{i=1}^{n} Texh\_T/C\_inlet}{n}$$

$$Texh\_T/C\_inlet_{dev} = Texh\_T/C\_inlet_{meas} - Texh\_T/C\_inlet_{M\_meas}$$

Index function

Value	Index	From reference
-36.45	0	-10.0 %
-27.34	80	-7.5 %
-22.78	90	-6.3 %
-18.23	100	-5.0 %
18.23	100	5.0 %
22.78	90	6.3 %
27.34	80	7.5 %
36.45	0	10.0 %



M15. PmaxDev Cyl1

Deviation from reference calculated on basis of cylinder maximum pressure absolute condition.
Indicator referance: M11.

Reference value:
0.00

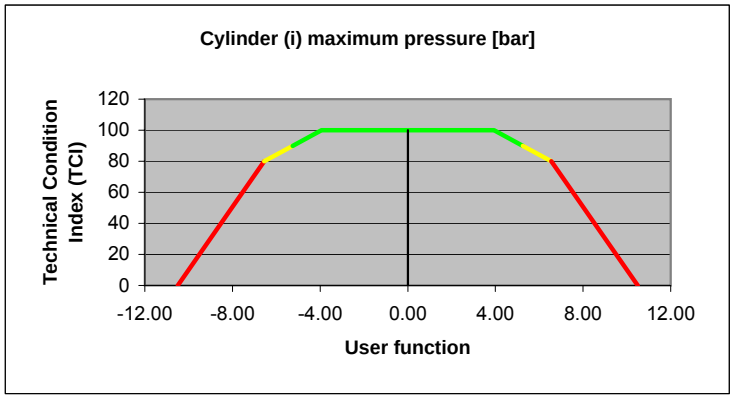
Calculated value:

$$P\max_{M\_meas} = \frac{\sum_{i=1}^{n} P\max(i)_{meas}}{n}$$

$$P\max_{dev} = P\max(i)_{meas} - P\max_{M\_meas}$$

Index function

Value	Index	From reference
-10.49	0	-8.0 %
-6.56	80	-5.0 %
-5.25	90	-4.0 %
-3.93	100	-3.0 %
3.93	100	3.0 %
5.25	90	4.0 %
6.56	80	5.0 %
10.49	0	8.0 %



M16. MEP_Dev Cyl1

Deviation from reference calculated on basis of MEP_ref.

Reference value:
0.00

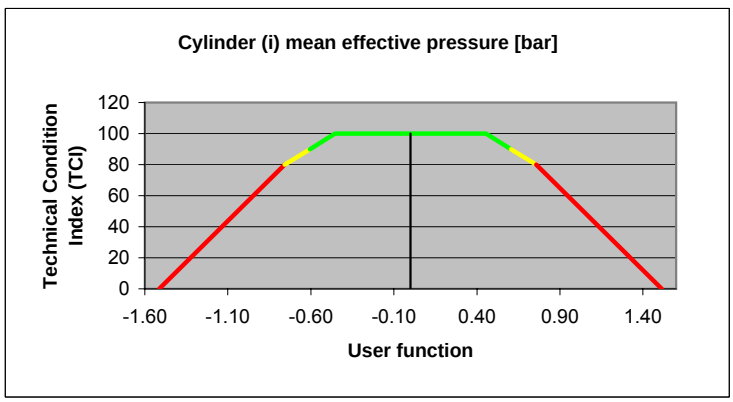
Calculated value:

$$MEP_{M\_meas} = \frac{\sum_{i=1}^{n} MEP(i)_{meas}}{n}$$

$$MEP_{dev} = MEP(i)_{meas} - MEP_{M\_meas}$$

Index function

Value	Index	From reference
-1.51	0	-10.0 %
-0.76	80	-5.0 %
-0.61	90	-4.0 %
-0.45	100	-3.0 %
0.45	100	3.0 %
0.61	90	4.0 %
0.76	80	5.0 %
1.51	0	10.0 %



M17. Pdrop Filter TC1

Scavenging air pressure from "Introduction for 46 - 98 MC type engines operation" Edition 40E page 196.

Model performance

	1	2	
$Scav\_air\_press_{meas}$	2.00	3.00	[bar]
Air_filterΔp(i)	27.0	43.0	[mmWc]

Calculated model value:

$K_{scav\_air\_press}$ = 16.00

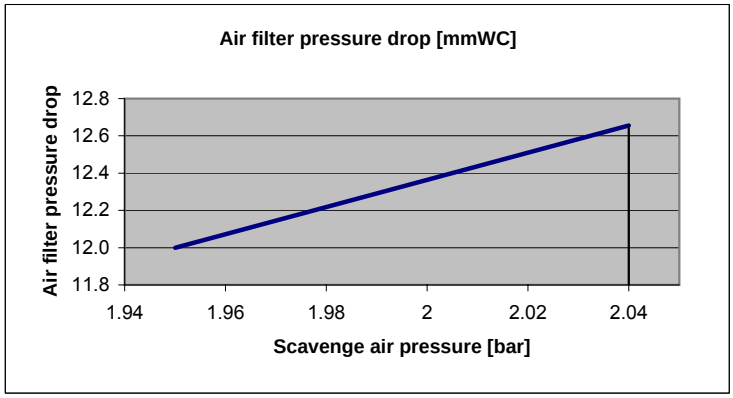
$$K_{scav\_air\_press} = \frac{\Delta p_2 - \Delta p_1}{Pscav_2 - Pscav_1}$$

Air filter pressure drop are not given in "Report of Sea Trial".
Estimated from "Hual Asia Engine performance data sheet"
from 0501 dated 2004-11-21, lowest value at T/C pressure drop.
$Scav\_air\_press_0$ from "Hual Asia Engine Performance data sheet" from 0501.

Ideal performance

	0501	ref	
$Air\_filter\Delta p_0$	12.0	12.66	[mmWc]
$Scav\_air\_press_0$	1.95	2.04	[bar]

Reference value:
12.66



Calculated value:

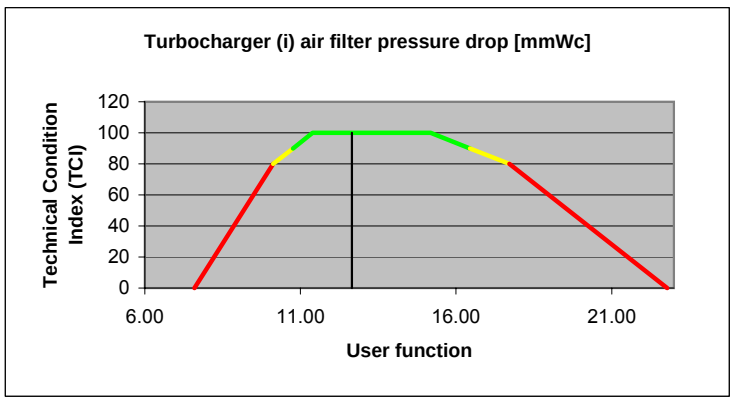
$$K_{Pscav\_calibrated} = K_{Pscav} \cdot \frac{\Delta p_0 \cdot Pscav_1}{\Delta p_1 \cdot Pscav_0}$$

$K_{Pscav\_cailbrated}$ = 7.2934

$$\Delta p_{filter\_corr} = \Delta p_{filter\_meas} + K_{Pscav\_calibrated}\left(Pscav_{ref} - Pscav_{meas}\right)$$

Index function

Value	Index	From reference
7.59	0	-40.0 %
10.13	80	-20.0 %
10.76	90	-15.0 %
11.39	100	-10.0 %
15.19	100	20.0 %
16.45	90	30.0 %
17.72	80	40.0 %
22.78	0	80.0 %



M18. TdropExh TC1

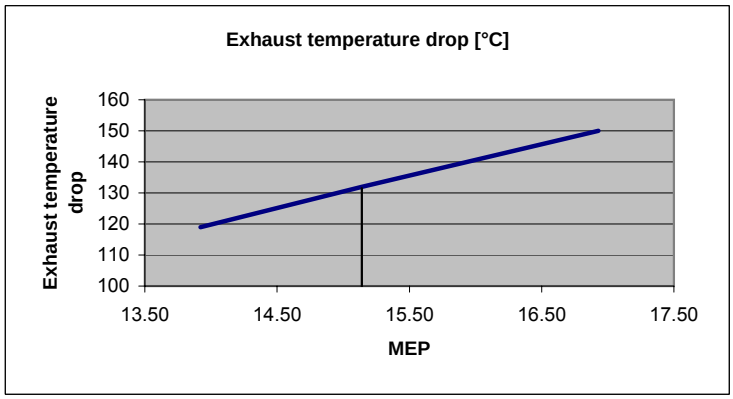
Ideal performance

Engine load	75	85	100	[%]
Texh_T/C_inlet	350	365	386	[˚C]
Texh_T/C_outlet	231	233	236	[˚C]
ΔT T/C_exh (ΔT_i)	119	132	150	[˚C]
MEP_{meas}	13.92	15.14	16.93	[bar]

$$MEP_{M\_meas} = \frac{\sum_{i=1}^{n} MEP(i)_{meas}}{n}$$

Reference value:

131.56



Calculated value:

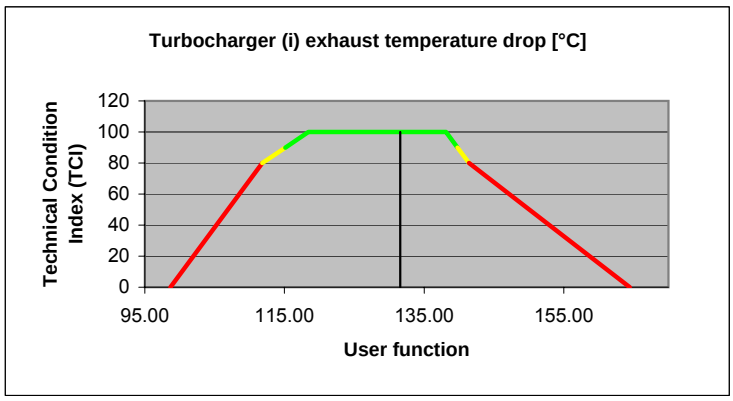
$$K_{\Delta T\_T/C\_exh} = \frac{\Delta T_2 - \Delta T_1}{MEP_2 - MEP_1}$$

$K_{\Delta T\_T/C\_exh}$ = 10.2990

$$\Delta T\_T/C\_exh_{corr} = \Delta T\_T/C\_exh_{meas} + K_{\Delta T\_T/C\_exh}\left(MEP_{ref} - MEP_{M\_meas}\right)$$

Index function

Value	Index	From reference
98.67	0	-25.0 %
111.83	80	-15.0 %
115.12	90	-12.5 %
118.41	100	-10.0 %
138.14	100	5.0 %
139.79	90	6.3 %
141.43	80	7.5 %
164.46	0	25.0 %

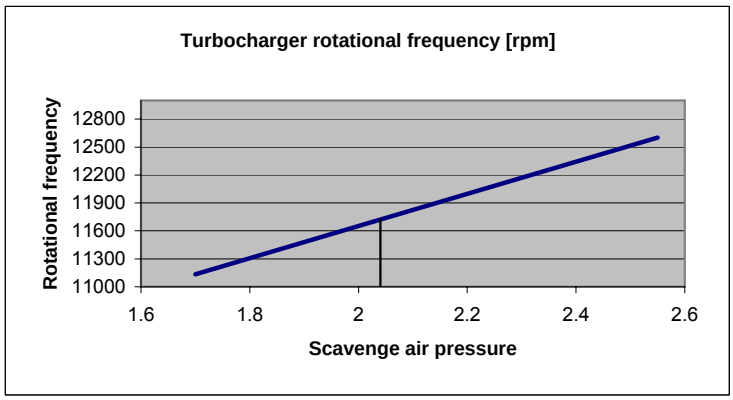


M19. Rot_freq. TC1

Ideal performance

Engine load	75	85	100	[%]
T/C_RPM$_{meas}$	11133	11720	12600	[rpm]
Scav_air_press	1.7	2.04	2.55	[bar]

Reference value:
11720.00



Calculated value:

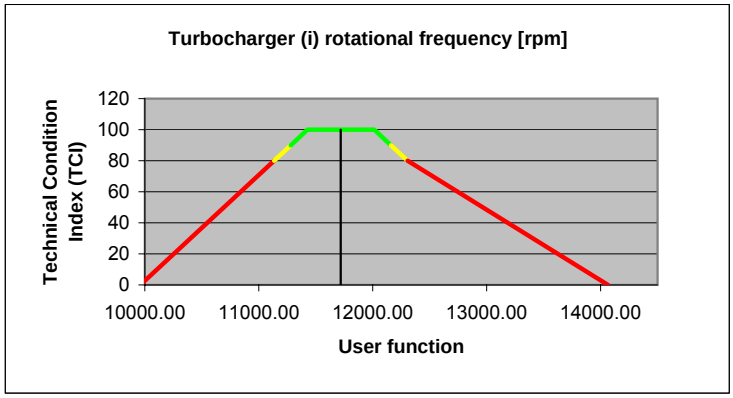
$$K_{T/C\_RPM} = \frac{T/C\_RPM_2 - T/C\_RPM_1}{Pscav_2 - Pscav_1}$$

K_{T/C_RPM} = 1725.88

$$T/C\_RPM_{corr} = T/C\_RPM_{meas} + K_{T/C\_RPM}\left(Pscav_{ref} - Pscav_{meas}\right)$$

Index function

Value	Index	From reference
9962.00	0	-15.0 %
11134.00	80	-5.0 %
11280.50	90	-3.8 %
11427.00	100	-2.5 %
12013.00	100	2.5 %
12159.50	90	3.8 %
12306.00	80	5.0 %
14064.00	0	20.0 %



M20. Index FP1

Ideal performance

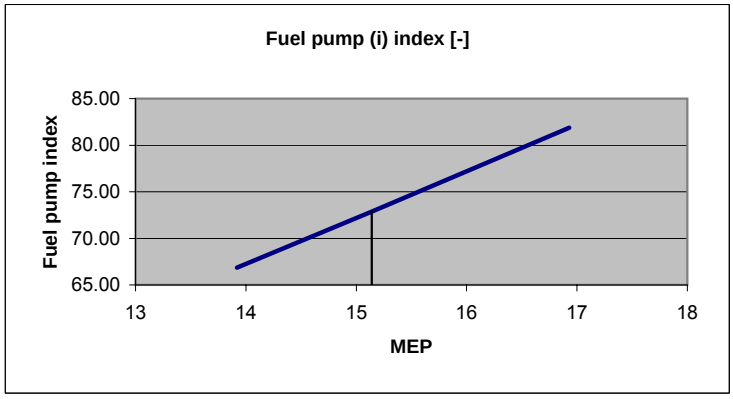
Spec. fuel grav. 15˚C	Spec_ grav_ 15˚C$_{ST}$	LCHV	LCHV$_{ST}$
0.966 [kg/l]	966 [kg/m³]	9690 [kcal/kg]	40570.09 [kJ/kg]

$$FPI_{M\_meas} = \frac{\sum_{i=1}^{n} FPI(i)_{meas}}{n}$$

Engine load	0	75	85	100	[%]
FPI$_{meas}$	-8.833	66.86	72.86	81.86	[-]
MEP(i)$_{meas}$	0	13.92	15.14	16.93	[bar]

Reference value:

72.86



Calculated reference:

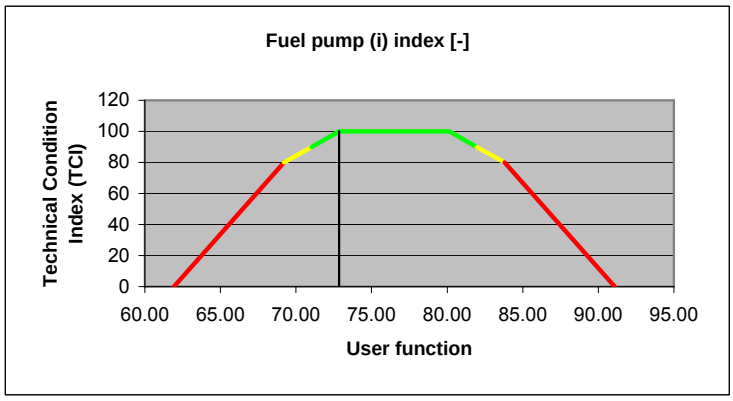
$$K_{FPI} = \frac{FPI_2 - FPI_1}{MEP_2 - MEP_1}$$

$K_{Fuel\_pump\_index}$= 5.3958

$$FPI(i)_{corr} = \left(FPI(i)_{meas} + K_{FPI} \cdot \left(MEP_{ref} - MEP_{meas}\right)\right) \cdot \left(\frac{Spec\_grav\_15°C_{meas} \cdot LCHV_{meas}}{Spec\_grav\_15°C_{ST} \cdot LCHV_{ST}}\right)$$

Index function

Value	Index	From reference
61.93	0	-15.0 %
69.22	80	-5.0 %
71.04	90	-2.5 %
72.86	100	0.0 %
80.15	100	10.0 %
81.97	90	12.5 %
83.79	80	15.0 %
91.08	0	25.0 %

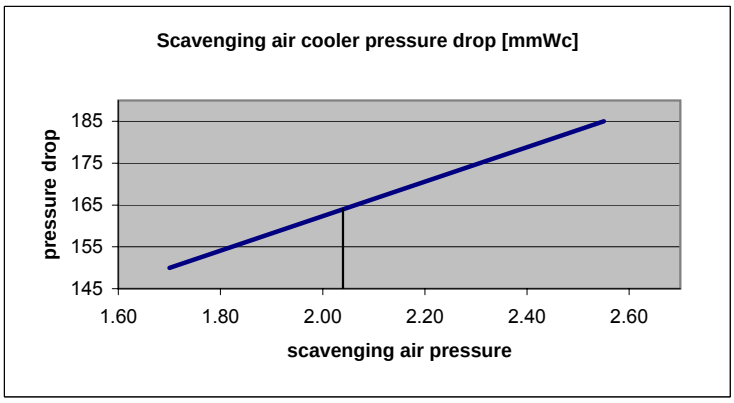


M21. Pdrop ScavCool1

Ideal performance

Engine load	75	85	100	[%]
Scav_coolΔp_{meas}	150	164	185	[mmWc]
Scav_air_press	1.70	2.04	2.55	[bar]

Reference value:
164.00



Calculatd value:

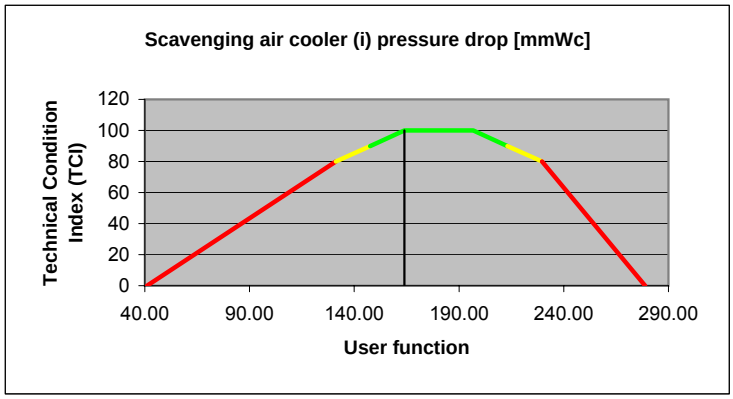
$$K_{cooler\Delta p} = \frac{\Delta p_2 - \Delta p_1}{Pscav_2 - Pscav_1}$$

$K_{cool\Delta p}$ = 41.1765

$$\Delta p_{cool\_corr} = \Delta p_{cool\_meas} + K_{\Delta pcool\_calibrated}\left(Pscav_{ref} - Pscav_{meas}\right)$$

Index function

Value	Index	From reference
41.00	0	-75.0 %
131.20	80	-20.0 %
147.60	90	-10.0 %
164.00	100	0.0 %
196.80	100	20.0 %
213.20	90	30.0 %
229.60	80	40.0 %
278.80	0	70.0 %



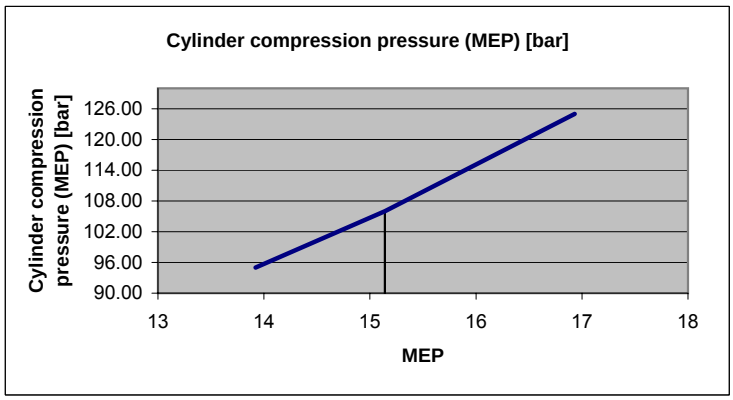
M22. Pcomp Cyl 1

Ideal performance

Engine load	75	85	100	[%]
Cyl(i)_comp_press	95.0	106.0	125.0	[bar]
MEP_{meas}	13.92	15.14	16.93	[bar]

$$MEP_{M\_meas} = \frac{\sum_{i=1}^{n} MEP(i)_{meas}}{n}$$

reference value:
106.00



Calculated value:

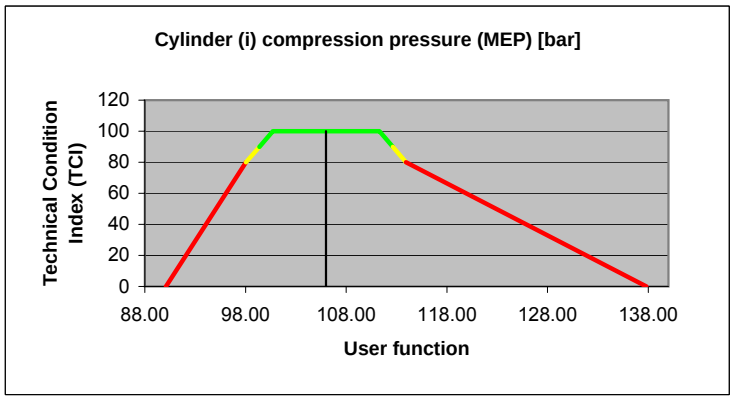
$$K_{Pcomp} = \frac{Pcomp_2 - Pcomp_1}{MEP_2 - MEP_1}$$

$K_{cyl\_comp\_press\_(MEP)}$ 9.9668

$$Pcomp(i)_{corr} = Pcomp(i)_{meas} + K_{Pcomp} \cdot \left(MEP_{ref} - MEP_{M\_meas}\right) + \left(T_{eng\_room} - 25\right) \cdot 2.954 \cdot 10^{-3} \cdot \left(1 + Pcomp(i)_{meas}\right)$$

Index function

Value	Index	From reference
90.10	0	-15.0 %
98.05	80	-7.5 %
99.38	90	-6.3 %
100.70	100	-5.0 %
111.30	100	5.0 %
112.63	90	6.3 %
113.95	80	7.5 %
137.80	0	30.0 %

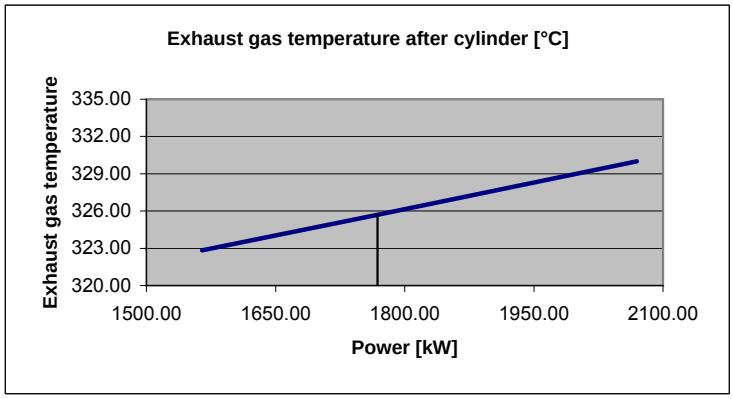


M23. TempExh Cyl1

Ideal performance

Engine load	75	85	100	[%]
Exh temp after cyl	322.83	325.70	330.00	[°C]
BHP	2097.66	2370.35	2773.94	[BHP]
Power	1564.85	1768.28	2069.36	[kW]

Reference value:
325.73



Calculated value:

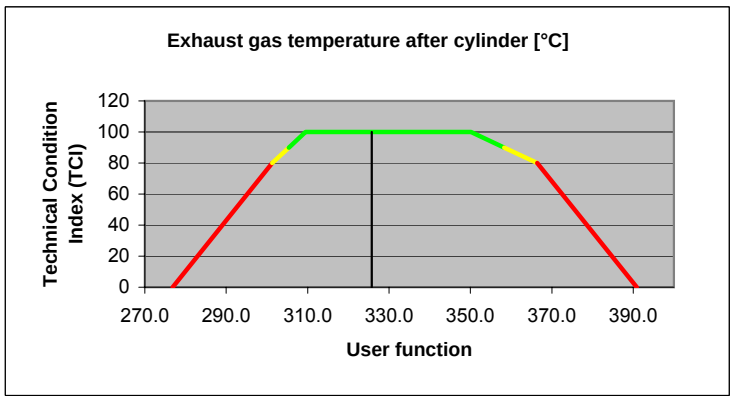
$$K\_exh\_temp = \frac{T\_exh\_outlet_2 - T\_exh\_outlet_1}{Power_2 - Power_1}$$

$K_{\_exh\_temp}$ 0.0143

$$T_{exh\_corr} = T_{exh\_meas} + K_{exh\_temp} \cdot \left(Power_{ref} - Power_{meas}\right) + \left(\left(T_{eng\_room} - 25\right) \cdot \left(-2.466 \cdot 10^{-3}\right) \cdot \left(273 + T_{exh\_meas}\right)\right) + \left(\left(T_{cool\_water} - 25\right) \cdot \left(-0.59 \cdot 10^{-3}\right) \cdot \left(273 + T_{exh\_meas}\right)\right)$$

Index function

Value	Index	From reference
276.9	0	-15.0 %
301.3	80	-7.5 %
305.4	90	-6.3 %
309.4	100	-5.0 %
350.2	100	7.5 %
358.3	90	10.0 %
366.5	80	12.5 %
390.9	0	20.0 %



Index-tree	2006-03-21	Index tree changed
Specific fuel oil consumption (SFOC)	2006-01-03	Operational reference load changed to 80 % for easy comparence to other ships.
Specific fuel oil consumption (SFOC)	2006-01-18	Operational reference load changed to 85 %, Limits set by absolute deviation removed.
Specific fuel oil consumption (SFOC)	2006-02-23	Acceptable limits for lowest value changed to include possible variations
Specific fuel oil consumption (SFOC)	2006-03-21	Layout changed
Exhaust inlet temperature	2006-01-18	New indicator added to the specification.
Exhaust inlet temperature	2006-02-23	Acceptable limits for lowest value changed to include possible variations
Exhaust inlet temperature	2006-03-21	Layout changed
Exhaust temperature drop	2006-01-03	Operational reference load changed to 80 %.
Exhaust temperature drop	2006-01-18	Operational reference load changed to 85 %, Limits set by absolute deviation removed.
Exhaust temperature drop	2006-02-23	Acceptable limits for lowest value changed to include possible variations
Exhaust temperature drop	2006-03-21	Layout changed
Average VIT index	2006-01-03	Operational reference load changed. Limits set by percentage deviation changed.
Average VIT index	2006-01-18	Operational reference load changed to 85 %, Limits set by absolute deviation removed.
Average VIT index	2006-02-23	Acceptable limits for lowest value changed to include possible variations
Average VIT index	2006-03-21	Layout changed
Average Fuel pump index	2006-01-03	Operational reference load changed to 80 %.
Average Fuel pump index	2006-01-18	Operational reference load changed to 85 %, Limits set by absolute deviation removed.
Average Fuel pump index	2006-02-23	Acceptable limits for lowest value changed to include possible variations
Average Fuel pump index	2006-03-21	Layout changed
Scavenging air pressure	2006-01-03	Operational reference load changed to 80 %.
Scavenging air pressure	2006-01-18	Operational reference load changed to 85 %, Limits set by absolute deviation removed.
Scavenging air pressure	2006-02-23	Acceptable limits for lowest value changed to include possible variations
Scavenging air pressure	2006-03-21	Layout changed
Average Cylinder max pressure	2006-01-03	Operational reference load changed. Limits set by percentage deviation changed.
Average Cylinder max pressure	2006-01-18	Operational reference load changed to 85 %, Limits set by absolute deviation removed.
Average Cylinder max pressure	2006-03-21	Layout changed
VIT index balance	2006-01-03	Limits changed. Now set by percentage deviation of reference load.
VIT index balance	2006-01-18	Operational reference load changed to 85 %, Limits set by absolute deviation removed.
VIT index balance	2006-03-21	Layout changed
Fuel pump index balance	2006-01-03	Limits changed. Now set by percentage deviation of reference load.
Fuel pump index balance	2006-01-18	Operational reference load changed to 85 %, Limits set by absolute deviation removed.
Fuel pump index balance	2006-03-21	Layout changed
Exhaust temperature balance	2006-01-18	Limits changed. Now set by percentage deviation of reference load.
Exhaust temperature balance	2006-03-21	Layout changed
Cylinder max pressure balance	2006-01-03	Limits changed. Now set by percentage deviation of reference load.
Cylinder max pressure balance	2006-01-18	Operational reference load changed to 85 %, Limits set by absolute deviation removed.
Cylinder max pressure balance	2006-03-21	Layout changed
Mean effective pressure balance	2006-01-03	Limits changed. Now set by percentage deviation of reference load.
Mean effective pressure balance	2006-01-18	Operational reference load changed to 85 %, Limits set by absolute deviation removed.
Mean effective pressure balance	2006-03-21	Layout changed
Air filter pressure drop	2006-01-03	Operational reference load changed. Limits set by percentage deviation changed.
Air filter pressure drop	2006-01-18	Operational reference load changed to 85 %, Limits set by absolute deviation removed.
Air filter pressure drop	2006-03-21	Layout changed
Exhaust temperature drop	2006-01-03	Operational reference load changed to 80 %.
Exhaust temperature drop	2006-01-18	Operational reference load changed to 85 %, Limits set by absolute deviation removed.
Exhaust temperature drop	2006-02-23	Acceptable limits for lowest value changed to include possible variations
Exhaust temperature drop	2006-03-21	Layout changed
Rotational frequency	2006-01-03	Operational reference load changed. Measured values changed.
Rotational frequency	2006-01-18	Operational reference load changed to 85 %, Limits set by absolute deviation removed.
Rotational frequency	2006-02-23	Acceptable limits for lowest value changed to include possible variations
Rotational frequency	2006-03-21	Layout changed

Air filter pressure drop relative condition	2006-01-03	Limits changed. Now set by percentage deviation of reference load.
Air filter pressure drop relative condition	2006-01-18	Operational reference load changed to 85 %, Limits set by absolute deviation removed.
Air filter pressure drop relative condition	2006-03-21	Indicator removed from specification
Exhaust inlet temperature relative condition	2006-01-18	Limits changed. Now set by percentage deviation of reference load.
Exhaust inlet temperature relative condition	2006-01-18	Limits changed. Now set by percentage deviation of reference load.
Exhaust inlet temperature relative condition	2006-03-21	Indicator removed from specification
Rotational frequency relative codition	2006-01-03	Limits changed. Now set by percentage deviation of reference load.
Rotational frequency relative codition	2006-01-18	Operational reference load changed to 85 %, Limits set by absolute deviation removed.
Rotational frequency relative codition	2006-02-23	Acceptable limits for lowest value changed to include possible variations
Rotational frequency relative codition	2006-03-21	Indicator removed from specification
Fuel pump index deviation	2006-01-03	Limits changed. Now set by percentage deviation of reference load.
Fuel pump index deviation	2006-01-18	Operational reference load changed to 85 %, Limits set by absolute deviation removed.
Fuel pump index deviation	2006-02-23	Acceptable limits for lowest value changed to include possible variations
Fuel pump index	2006-02-23	FPI changed from deviation to absolute value
Fuel pump index	2006-03-21	Layout changed
Scavenging air cooler (i) pressure drop	2006-01-03	Operational reference load changed to 80 %.
Scavenging air cooler (i) pressure drop	2006-01-18	Operational reference load changed to 85 %, Limits set by absolute deviation removed.
Scavenging air cooler (i) pressure drop	2006-02-23	Acceptable limits for lowest value changed to include possible variations
Scavenging air cooler (i) pressure drop	2006-03-21	Layout changed
Scav air cooler pressure drop relative condition	2006-01-03	Limits changed. Now set by percentage deviation of reference load.
Scav air cooler pressure drop relative condition	2006-01-18	Operational reference load changed to 85 %, Limits set by absolute deviation removed.
Scav air cooler pressure drop relative condition	2006-03-21	Indicator removed from specification
Compression pressure (MEP)	2006-01-03	Operational reference load changed. Limits set by percentage deviation changed.
Compression pressure (MEP)	2006-01-18	Operational reference load changed to 85 %, Limits set by absolute deviation removed.
Compression pressure (MEP)	2006-02-23	Acceptable limits for lowest value changed to include possible variations
Compression pressure (MEP)	2006-03-21	Layout changed
Compression pressure (Scav)	2006-01-03	Operational reference load changed. Limits set by percentage deviation changed.
Compression pressure (Scav)	2006-01-18	Operational reference load changed to 85 %, Limits set by absolute deviation removed.
Compression pressure (Scav)	2006-02-23	Acceptable limits for lowest value changed to include possible variations
Compression pressure (Scav)	2006-03-21	Indicator removed from specification
Compression pressure deviation	2006-01-03	Limits changed. Now set by percentage deviation of reference load.
Compression pressure deviation	2006-01-18	Operational reference load changed to 85 %, Limits set by absolute deviation removed.
Compression pressure deviation	2006-02-23	Acceptable limits for lowest value changed to include possible variations
Compression pressure deviation	2006-03-21	Indicator removed from specification
Exhaust outlet temperature	2006-01-18	New indicator added to the specification.
Exhaust outlet temperature	2006-02-23	Acceptable limits for lowest value changed to include possible variations
Exhaust outlet temperature	2006-03-21	Layout changed

Variable in u.f.	TOCC tag name	Höegh tag name
SFOC	L.Hoegh_Asia_Engine specific fuel oil consumption	
FOC_{meas}	L.Hoegh_Asia_Engine fuel oil consumption	FO_KG_HR
$SHP[kW]_{meas}$	L.Hoegh_Asia_Shaft torsion meter power indicator	SHP
$LCHV_{meas}$	L.Hoegh_Asia_Engine fuel heat value	FO_HEAT_VAL
$T\_eng\_room_{meas}$	L.Hoegh_Asia_Ship engine room temperature	AIR_TEMP_ENG_R
T_scav_{meas}	L.Hoegh_Asia_Scavenging air receiver 1 temperature	REC_TEMP
$Texh\_T/C\_inlet_{meas}$	L.Hoegh_Asia_Turbocharger 1 exhaust gas inlet temperature	EXH_TEMP1
$Texh\_T/C\_inlet_{meas}$	L.Hoegh_Asia_Turbocharger 2 exhaust gas inlet temperature	EXH_TEMP2
$Texh\_T/C\_outlet_{meas}$	L.Hoegh_Asia_Turbocharger 1 exhaust gas outlet temperature	OUTLET1
$Texh\_T/C\_outlet_{meas}$	L.Hoegh_Asia_Turbocharger 2 exhaust gas outlet temperature	OUTLET2
$MIP(i)_{meas}$	L.Hoegh_Asia_Cylinder 1 mean indicated pressure	CYLINDER_PMI1
$MIP(i)_{meas}$	L.Hoegh_Asia_Cylinder 2 mean indicated pressure	CYLINDER_PMI2
$MIP(i)_{meas}$	L.Hoegh_Asia_Cylinder 3 mean indicated pressure	CYLINDER_PMI3
$MIP(i)_{meas}$	L.Hoegh_Asia_Cylinder 4 mean indicated pressure	CYLINDER_PMI4
$MIP(i)_{meas}$	L.Hoegh_Asia_Cylinder 5 mean indicated pressure	CYLINDER_PMI5
$MIP(i)_{meas}$	L.Hoegh_Asia_Cylinder 6 mean indicated pressure	CYLINDER_PMI6
$MIP(i)_{meas}$	L.Hoegh_Asia_Cylinder 7 mean indicated pressure	CYLINDER_PMI7
$VIT(i)_{ind\_meas}$	L.Hoegh_Asia_Cylinder 1 fuel pump VIT index	CYLINDER_VIT1
$VIT(i)_{ind\_meas}$	L.Hoegh_Asia_Cylinder 2 fuel pump VIT index	CYLINDER_VIT2
$VIT(i)_{ind\_meas}$	L.Hoegh_Asia_Cylinder 3 fuel pump VIT index	CYLINDER_VIT3
$VIT(i)_{ind\_meas}$	L.Hoegh_Asia_Cylinder 4 fuel pump VIT index	CYLINDER_VIT4
$VIT(i)_{ind\_meas}$	L.Hoegh_Asia_Cylinder 5 fuel pump VIT index	CYLINDER_VIT5
$VIT(i)_{ind\_meas}$	L.Hoegh_Asia_Cylinder 6 fuel pump VIT index	CYLINDER_VIT6
$VIT(i)_{ind\_meas}$	L.Hoegh_Asia_Cylinder 7 fuel pump VIT index	CYLINDER_VIT7
$Fuel\_pump\_index(i)_{meas}$	L.Hoegh_Asia_Cylinder 1 fuel pump index	CYLINDER_FUEL1
$Fuel\_pump\_index(i)_{meas}$	L.Hoegh_Asia_Cylinder 2 fuel pump index	CYLINDER_FUEL2
$Fuel\_pump\_index(i)_{meas}$	L.Hoegh_Asia_Cylinder 3 fuel pump index	CYLINDER_FUEL3
$Fuel\_pump\_index(i)_{meas}$	L.Hoegh_Asia_Cylinder 4 fuel pump index	CYLINDER_FUEL4
$Fuel\_pump\_index(i)_{meas}$	L.Hoegh_Asia_Cylinder 5 fuel pump index	CYLINDER_FUEL5
$Fuel\_pump\_index(i)_{meas}$	L.Hoegh_Asia_Cylinder 6 fuel pump index	CYLINDER_FUEL6
$Fuel\_pump\_index(i)_{meas}$	L.Hoegh_Asia_Cylinder 7 fuel pump index	CYLINDER_FUEL7
$Spec\_grav\_15°C_{meas}$	L.Hoegh_Asia_Engine fuel specific gravity at 15oC	FUEL_DENSITY
$Scav\_air\_press_{meas}$	L.Hoegh_Asia_Scavenging air receiver 1 pressure	REC_PRESS_BAR
$Pmax(i)_{meas}$	L.Hoegh_Asia_Cylinder 1 maximum pressure	CYLINDER_PMAX1
$Pmax(i)_{meas}$	L.Hoegh_Asia_Cylinder 2 maximum pressure	CYLINDER_PMAX2
$Pmax(i)_{meas}$	L.Hoegh_Asia_Cylinder 3 maximum pressure	CYLINDER_PMAX3
$Pmax(i)_{meas}$	L.Hoegh_Asia_Cylinder 4 maximum pressure	CYLINDER_PMAX4
$Pmax(i)_{meas}$	L.Hoegh_Asia_Cylinder 5 maximum pressure	CYLINDER_PMAX5
$Pmax(i)_{meas}$	L.Hoegh_Asia_Cylinder 6 maximum pressure	CYLINDER_PMAX6
$Pmax(i)_{meas}$	L.Hoegh_Asia_Cylinder 7 maximum pressure	CYLINDER_PMAX7
$Air\_filter\Delta p_{meas}$	L.Hoegh_Asia_Turbocharger 1 air filter pressure drop	TC_DP1
$Air\_filter\Delta p_{meas}$	L.Hoegh_Asia_Turbocharger 2 air filter pressure drop	TC_DP2
T/C_RPM_{meas}	L.Hoegh_Asia_Turbocharger 1 rotational frequency	TC1
T/C_RPM_{meas}	L.Hoegh_Asia_Turbocharger 2 rotational frequency	TC2
$Scav\_cool\Delta p_{meas}$	L.Hoegh_Asia_Scavenging air cooler 1 air pressure drop	COOLER_DP1
$Scav\_cool\Delta p_{meas}$	L.Hoegh_Asia_Scavenging air cooler 2 air pressure drop	COOLER_DP2
$Cyl(i)\_comp\_press_{meas}$	L.Hoegh_Asia_Cylinder 1 compression pressure	CYLINDER_PCOMP1
$Cyl(i)\_comp\_press_{meas}$	L.Hoegh_Asia_Cylinder 2 compression pressure	CYLINDER_PCOMP2
$Cyl(i)\_comp\_press_{meas}$	L.Hoegh_Asia_Cylinder 3 compression pressure	CYLINDER_PCOMP3
$Cyl(i)\_comp\_press_{meas}$	L.Hoegh_Asia_Cylinder 4 compression pressure	CYLINDER_PCOMP4
$Cyl(i)\_comp\_press_{meas}$	L.Hoegh_Asia_Cylinder 5 compression pressure	CYLINDER_PCOMP5
$Cyl(i)\_comp\_press_{meas}$	L.Hoegh_Asia_Cylinder 6 compression pressure	CYLINDER_PCOMP6
$Cyl(i)\_comp\_press_{meas}$	L.Hoegh_Asia_Cylinder 7 compression pressure	CYLINDER_PCOMP7

ARKTRANS
System Framework Architecture for Multimodal Freight and Passenger Transport

Hans Westerheim

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ARKTRANS Background

- Need for harmonisation
  - Between transport modes (road, railway, sea, air)
  - Between freight and passenger transport
- The same information is requested by authorities, service users, service providers, transport users, etc.
  - Information is registered manually many times
  - Faulty and insufficient information, e.g for dangerous cargo
  - Multimodal transport chains are not managed properly
  - Lack of status information, estimated time of arrival, etc.
- Lack of information, or available information is not utilised when transport is planned and carried out.
  - Dynamic information (e.g. traffic conditions, meteorological conditions)
  - Route and traffic information across transport modes
  - Available capacity across transport modes

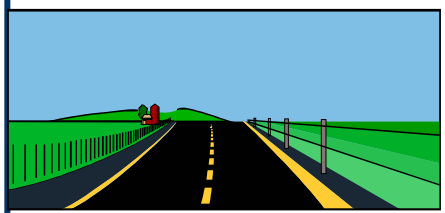
The ARKTRANS project

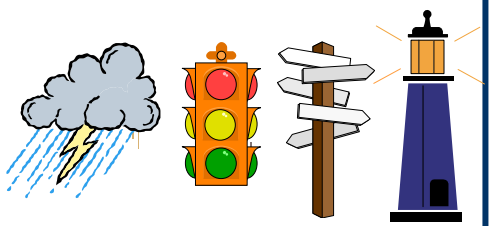
- Phase1: September 2000 – September 2001
- Phase 2 →: January 2002 – December 2004
- Participants
  - The Norwegian Public Road Administration (contractor)
  - The Norwegian Coast Administration
  - The Norwegian Civil Aviation Administration
  - The Norwegian National Rail Administration
  - The Norwegian State Railways
  - Telenor R&D
  - Ergo Solution
  - Transportbedriftenes Landsforening (TL) – Federation of Norwegian Transport Companies
  - The SINTEF Group (technical manager/project leader)
- User reference groups
- ARKTRANS is now managed by ITS Norway

The Transport Domain

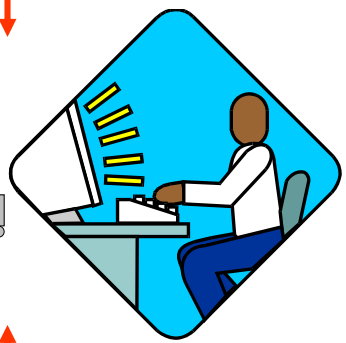
Transport Network

- Authorities
- Service providers
- Traffic control center

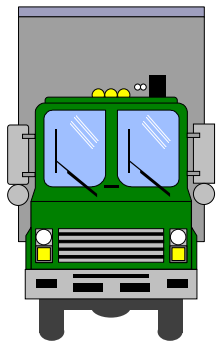




Transport User / Logistics Provider



Fleet Operator

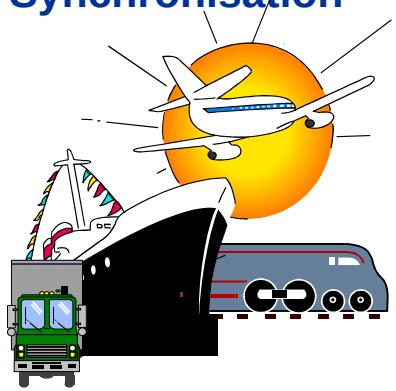


Transport Means / Crew

Terminal

- Authorities
- Terminal operator

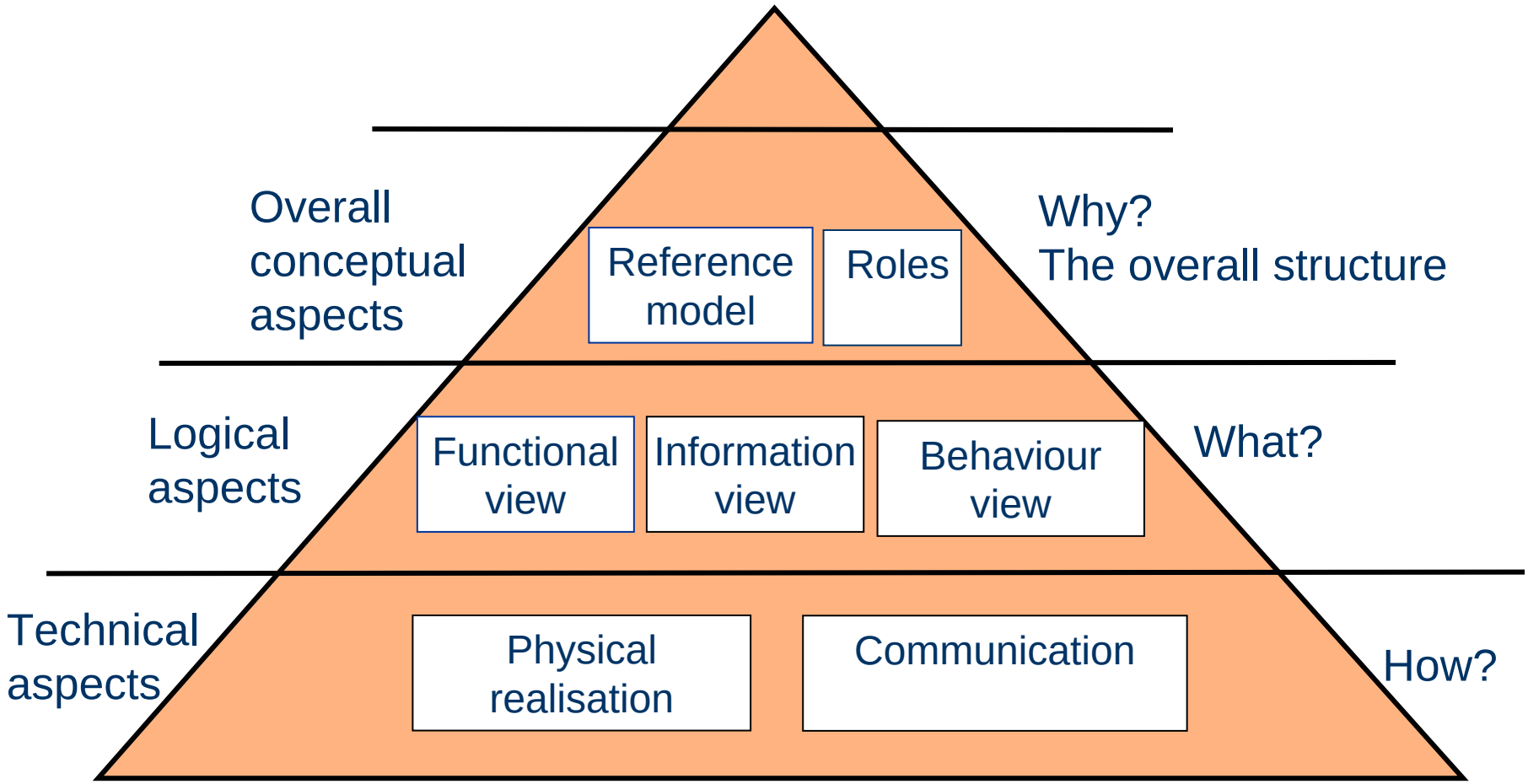
- Intermodality
- Synchronisation



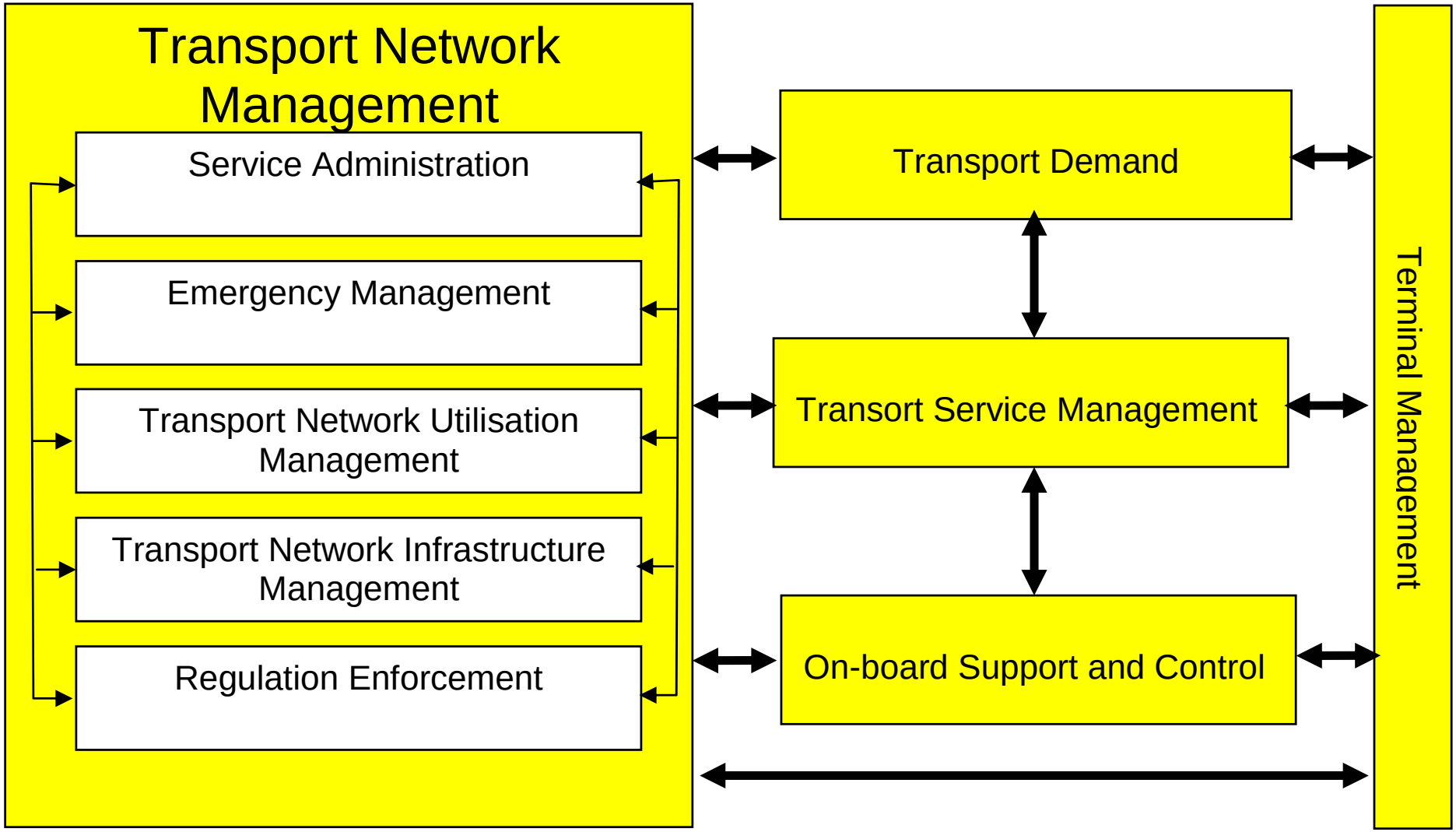
ARKTRANS
What we want to achieve

- Establish a common view on the transport domain
  - Transport domain organisation and structure
  - Multimodal terminology for roles (representing the actors involved)
  - Multimodal terminology for services and functionality
  - Specifications of roles, services and functionality
- Interoperable ICT solutions
  - Defined functionality
  - Can interact with other actors and other systems
  - ”Standardised” information exchange
- Better basis for specification of ICT solutions
  - ARKTRANS shall be a template
  - Requirements and solutions can be based on ARKTRANS
  - Solutions can be evaluated towards ARKTRANS

ARKTRANS - Content



The ARKTRANS Reference Model

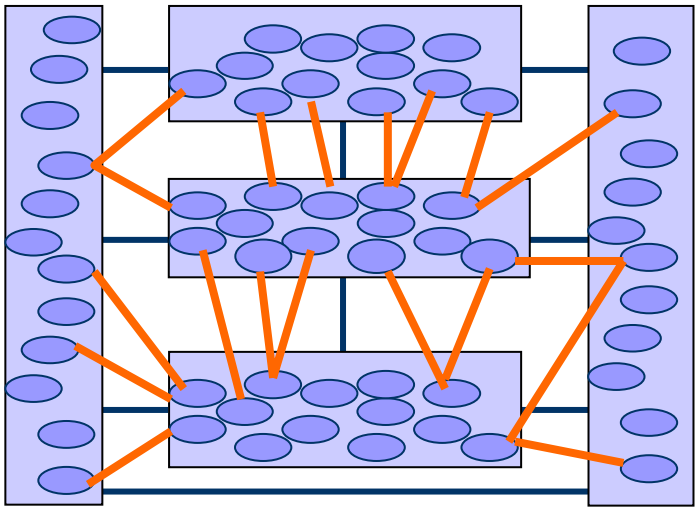


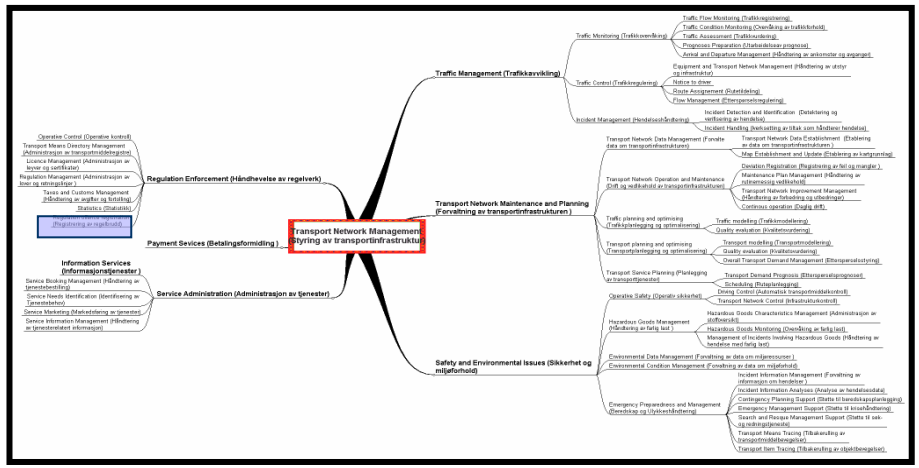
Roles – Some examples

Multimodal terms		Modal terms			
Superior roles	**Detailed roles**	**Road**	**Sea**	**Rail**	**Air**
Transport Network	Transport Corridor	Road	Fairway	Railroad	Corridor
Transport Means		Car, buss, etc.	Vessel, bark, etc.	Train	Aircraft, helicopter
Terminal		Stop, station	Terminal	Station	Airport
Crew	Captain	Driver	Captain	Engine driver	Captain
	Driver	Driver	Helmsman	Engine driver	Pilot
Transport Item	Traveller				
	Cargo				

- Referring to stakeholders and systems that may interact with ITS
- Common *multimodal* terminology – simplifies the architecture specification
- Mapping between multimodal and modal terms

Functional view: Decomposition, scenarios, interactions





- Functional decomposition of the reference model sub-domains
- Scenarios showing how the functionality can be used
  - Based on needs of different roles
  - Verifies the functionality
  - Identifies required interactions – interoperability

Behavior view - Scenarios

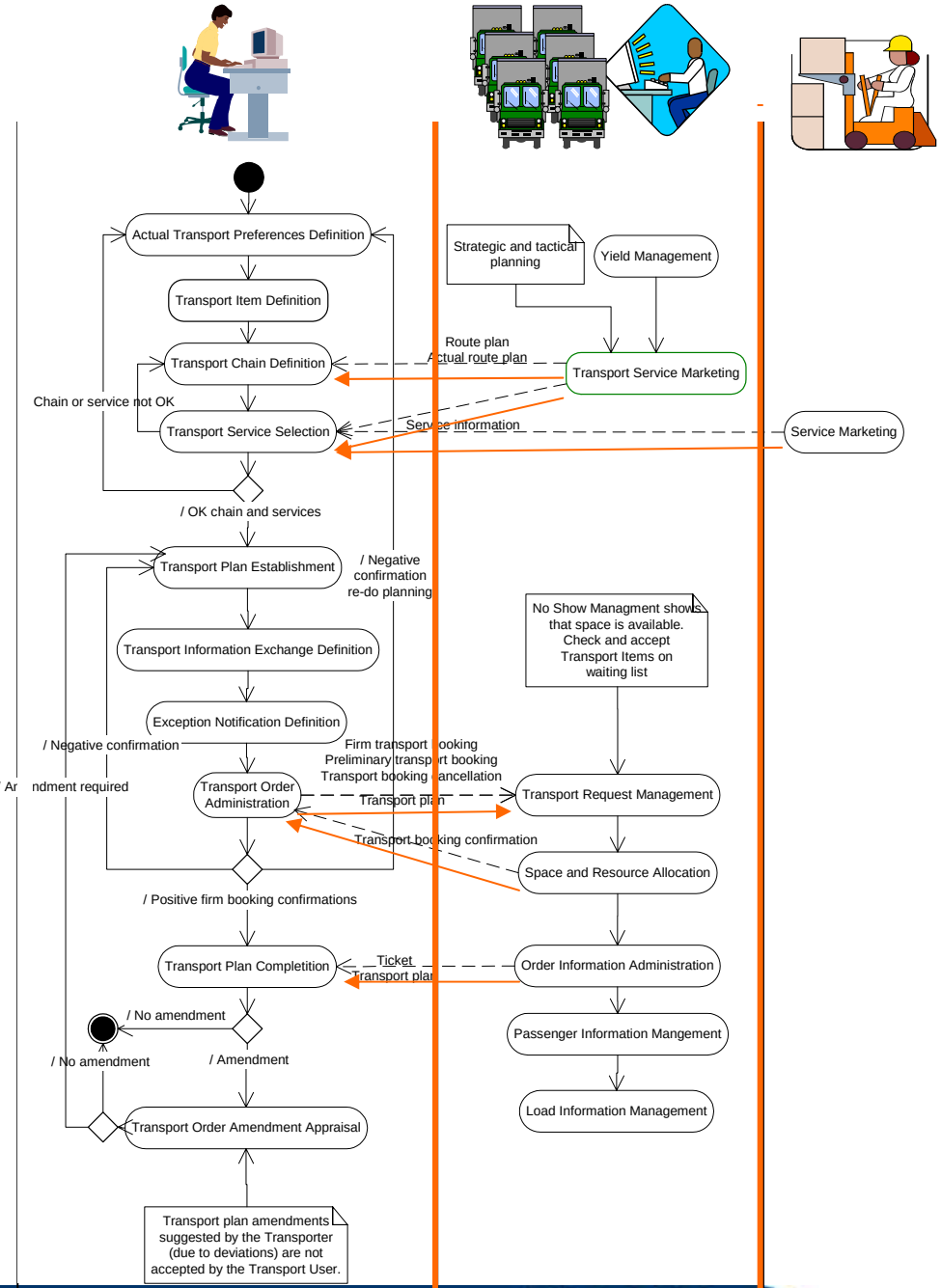
- Terminal Scenarier
  - Strategic and Tactical Planning
  - Operational Planning
    - Operational Inbound Planning
    - Operational Transhipment Planning
    - Operational Outbound Planning
  - Terminal Operation Management
    - Terminal Operation Monitoring
    - Inbound Control
    - Transhipment and Storage
    - Outbound Control
    - Incident and Deviation Management
- Transport Network Management Scenarier
  - TIC/TCC/Traffic and transport planner
    - Strategic and Tactical Planning
    - Transport Operation Planning
    - Traffic Monitoring
    - Traffic Control
    - Incident Handling
  - Service provider
    - Travel Information Provider
    - ….
  - Transport Network Manager
    - Strategic and Tactical Planning
    - …..
- Transport User Scenarier
  - Transport Preparation
  - Chain Management
- Transporter/Fleet Manager Scenarios
  - Strategic and Tactical Planning
  - Operational Planning
  - Transport Operation Management
    - Start-up and administration
    - Transport Operation Monitoring
    - Schedule Management
    - Deviation Management
    - Incident Management
    - Exceptional Transport Need Management
- On-board Scenarier
  - Driving support
  - Navigation support
  - Automated operations
  - Transport operation

The scenarios are important for the identification and harmonisation of the information flow

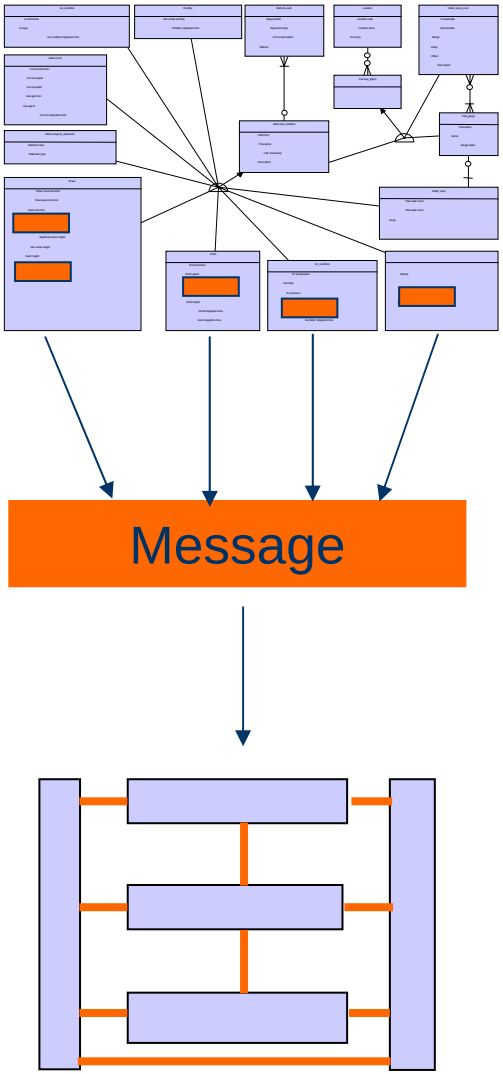
Scenarios

- UML swim lanes
- Show the use of functionality
- Verify functionality

- Identify interactions



Information focus: Information models and messages



- Conceptual information models defines common information
- Messages are composed by means of information elements from the information models
- Message specifications are generated from the models
- Interactions are message exchange sequences

The use of ARKTRANS

- ARKTRANS has been used in several research and development projects as an architectural basis
  - MarNIS
  - MultiRIT
  - VIKING Ferry Data Pool

- ARKTRANS may be used to set the **context** for the information flow realised by e.g. XML

www.arktrans.no