



Design

Innovations in Integrated Control Systems

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Kongsberg Maritime AS

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Innovations in
Integrated Control Systems

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Kongsberg Maritime AS

WORLD CLASS – through people, technology and dedication



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Innovations In Integrated Control System

Topics:

- The IVMS concept
 - Navigation and Manoeuvring
 - Marine and process automation
 - Safety
 - Data logging and analysis
- Common technology
- Operational advantages
- Network integrity



Integrated Vessel Management System

Introduction



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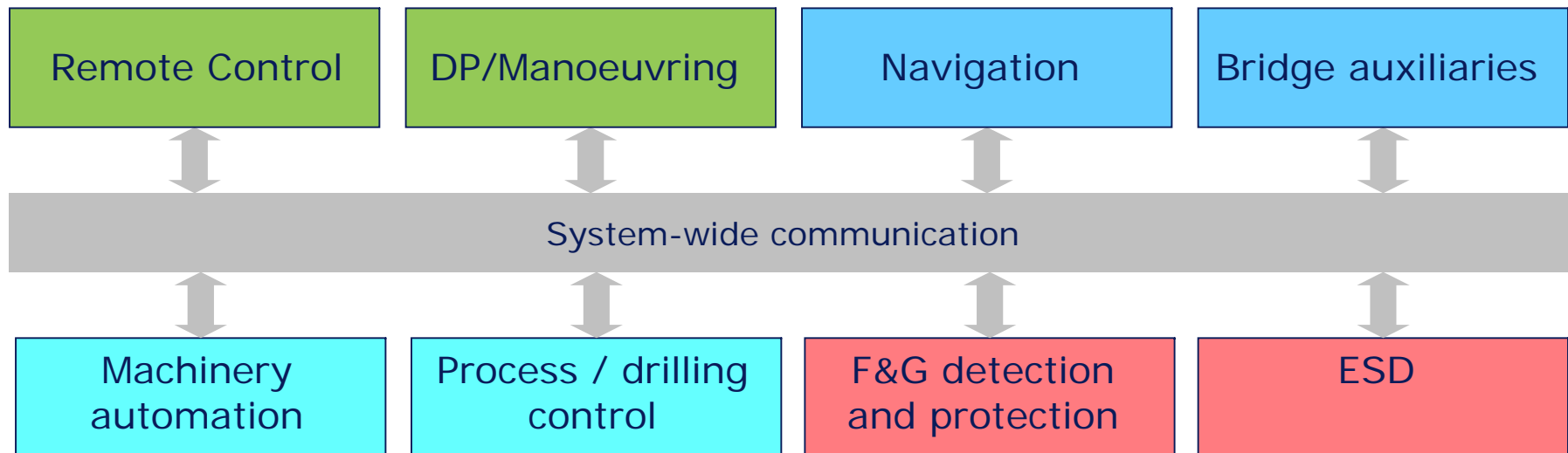
- Since the 80's there has been a move from tailor-made control systems towards integration of functions into one overall multi-functional control system. Typically:
 - Machinery alarms
 - Power management incl. engine controls
 - Engine room auxiliaries (pumps, fans, PID-controllers)
 - Ballast and cargo controls incl. level gauging
- Trend towards further integration, also including:
 - DP / joystick systems
 - Propulsion and thruster controls
 - Safety systems (fire and gas detection & protection , ESD)
- The offshore segment has been a forerunner in this development, especially oil & gas production units and drilling vessels.
- The integrated concept is now widely recognised also in other segments such as LNG transportation, offshore support vessels and cruise vessels.

Integrated Vessel Management System

The Concept



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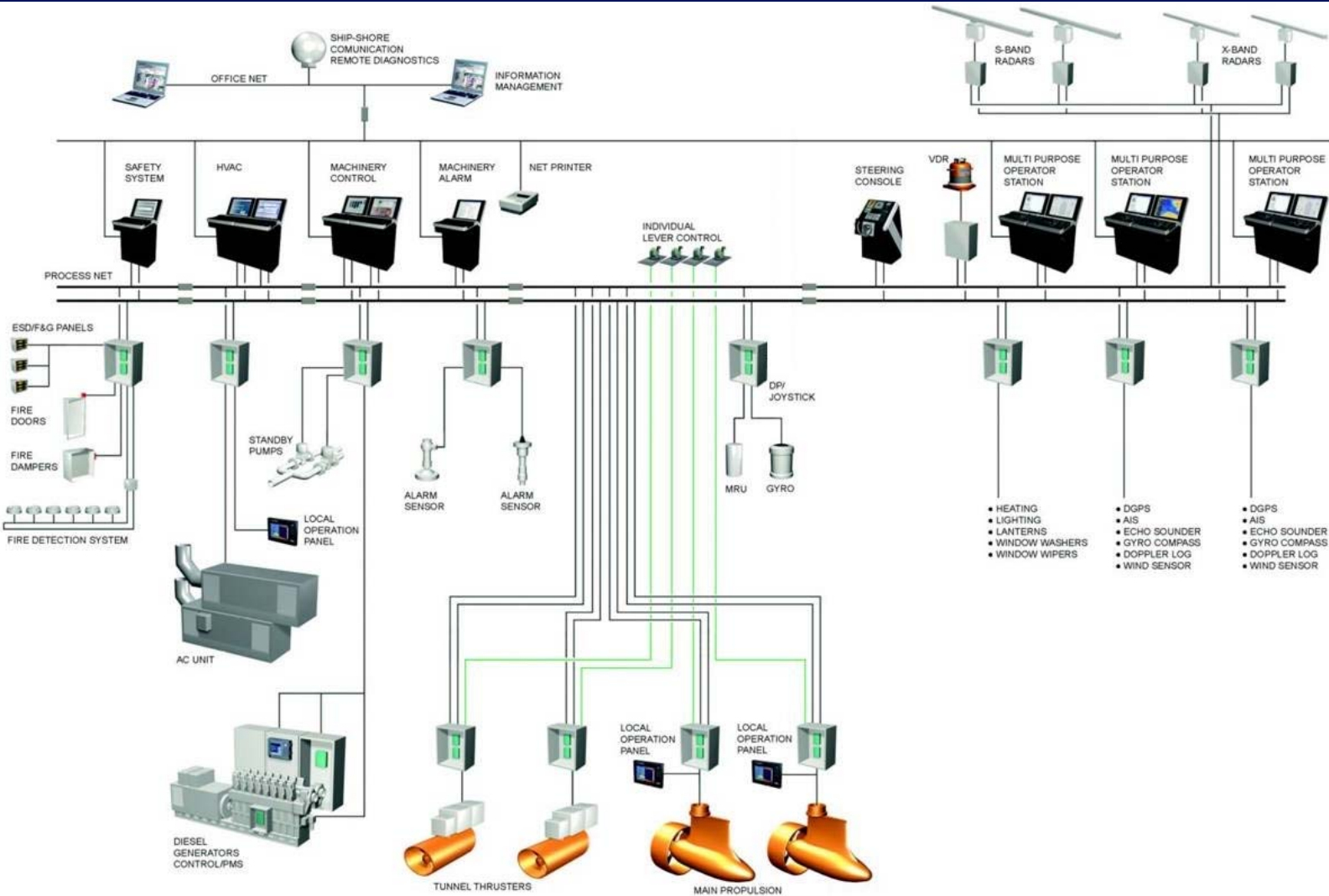


- Integration of vessel control systems by means of system-wide communication
- Autonomous network segments and controllers ensure integrity of each sub-system – no common failure modes
- Based on common technology platform – hardware and software



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Total Integration

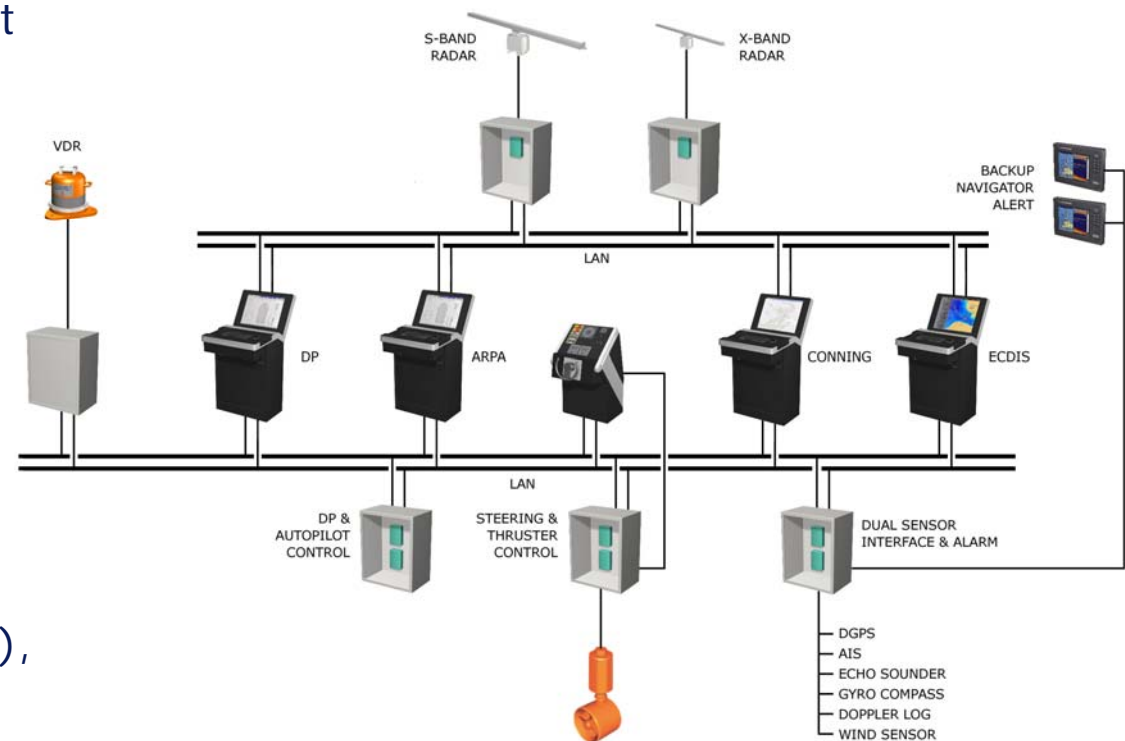




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Integrated Manoeuvring & Navigation

- Multifunctional Operator Stations
 - Radar, ECDIS, Conning, DP
- Integrated manoeuvring concept
 - Manual control
 - Autopilot
 - Track steering at any speed
 - Joystick
 - Station keeping
- Redundant navigation sensor interfacing, via dual LAN
- Autonomous controllers for DP/joystick
- Autonomous control system for each thruster (single/redundant), independent of DP and LAN

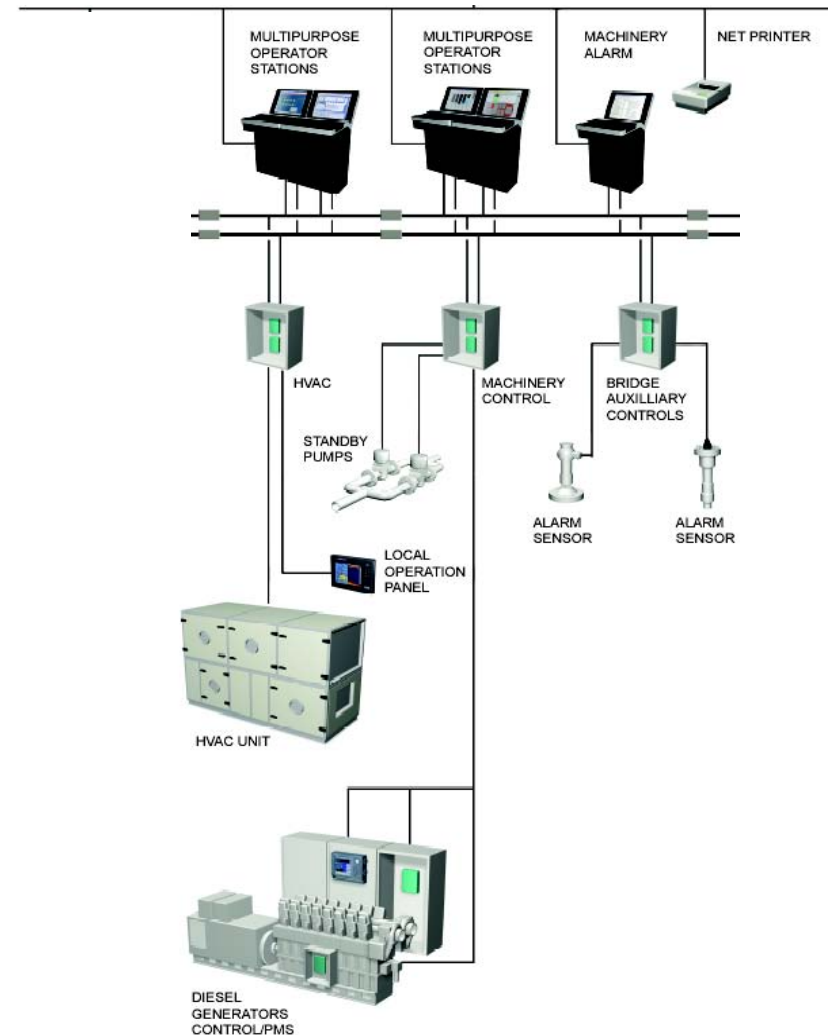




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Integrated Automation

- Marine automation
 - Machinery alarms and controls
 - Power management
 - Ballast controls
 - Cargo controls
- Process automation
 - Oil and gas separation
 - Gas export/re-injection
 - Drilling control
- Multifunctional Operator Stations
- Distributed control and monitoring
 - Segregation of processes to autonomous process controllers
 - Redundancy according to class and owner requirements
 - Remote I/O and field bus technology

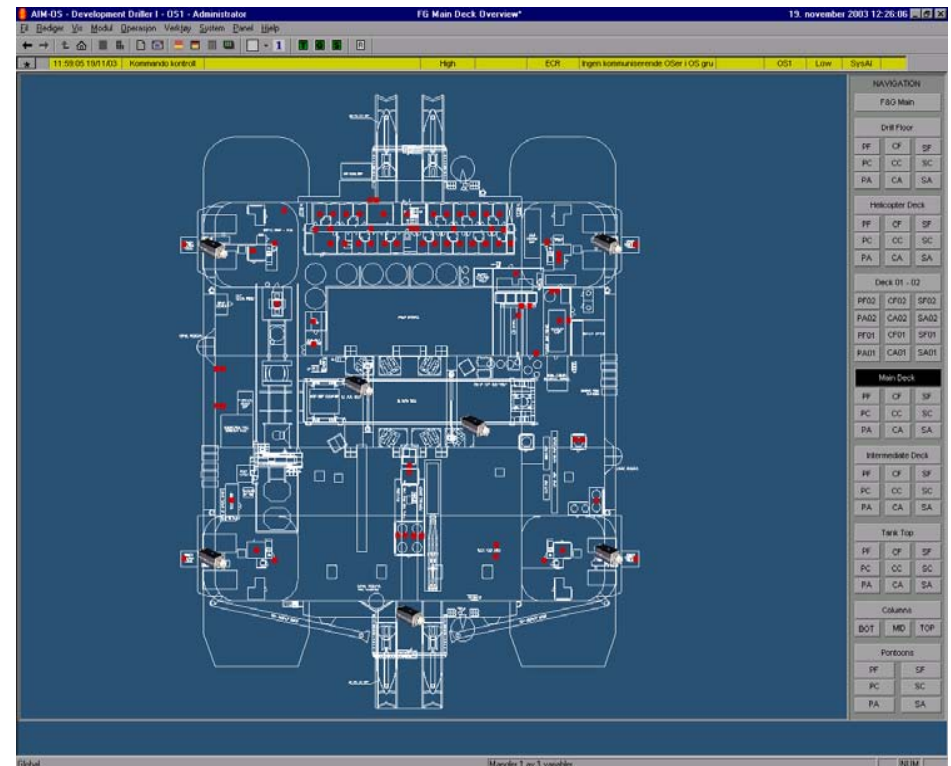




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Integrated Safety Management

- Integration of safety functions:
 - Fire detection and protection
 - Gas detection and protection
 - Fire extinguishing systems
 - Water integrity, stability computation
 - Emergency stop of ventilation and machinery
 - CCTV integration
 - Computerised safety plan with plotting table functionality
 - Interactive emergency procedures
- Multifunctional Operator Stations
- High integrity safety system – Safety Integrity Levels SIL1 - 3



Control Room Arrangement

Integration means new possibilities



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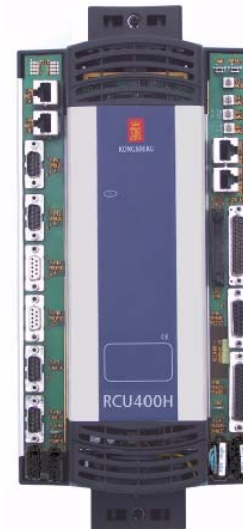


Common Technology

- Common basic software platform
- Identical HW components used throughout
 - Computers, controllers, I/O units, power supply units
 - Multifunctional I/O
- Multi functional operator stations
 - All information available on any operator station
 - Uniform user interfaces: Colour usage, alarm system, symbols, menus
- System wide network – free flow of information



- *working environments*
- *n operational of sub-systems*
- *interfaces between*
- *contr*
- *larr*
- *anc recording, ana*
- *Reduction of a and spare pari*
- *Software lifec (ref. ISO 17894)*
- *Remote Diagnostics*



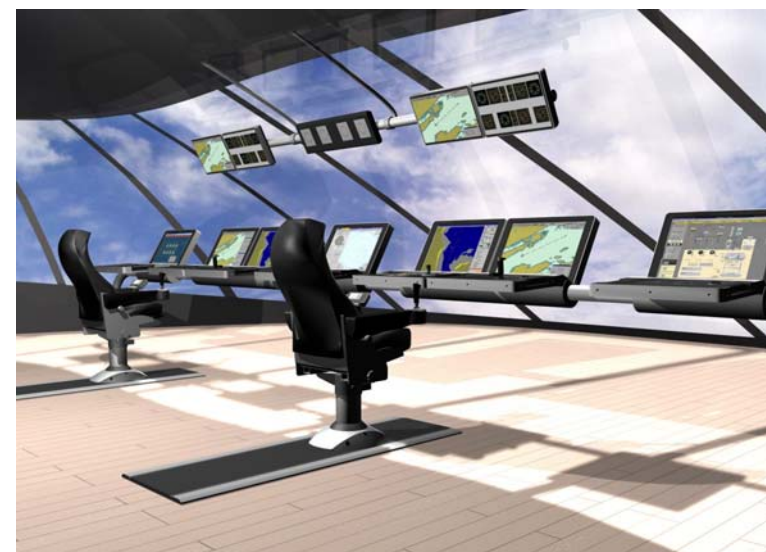
Operational Advantages

Integrated navigation & manoeuvring



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- 3 systems become 1
- True multifunctional operator stations
- Consistent user interface
- Safe transitions between operational modes and command locations
- Embedded DP functionality
- Fully integrated propulsion control system
- Integrated bridge alarm system
- Auxiliary bridge controls (lights, wipers, etc.) embedded on screens rather than hard panels



Operational Advantages

Power generation and consumer control



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- Fast acting load reduction
 - Blackout prevention
 - DP/PMS interactions
 - Optimal thruster power usage
- Improved speed control
 - Analogue speed order from PMS to fuel governor
 - Faster frequency/load control – “semi isochronous”
 - Improved safety by monitoring of order signal
- Monitoring of active and reactive load sharing systems
 - Alarms in case of unbalance in kW or kVAr load (deviation from setpoints)
 - Trip of busties and/or generator breakers if situation exceeds beyond safe operational limits

Operational Advantages

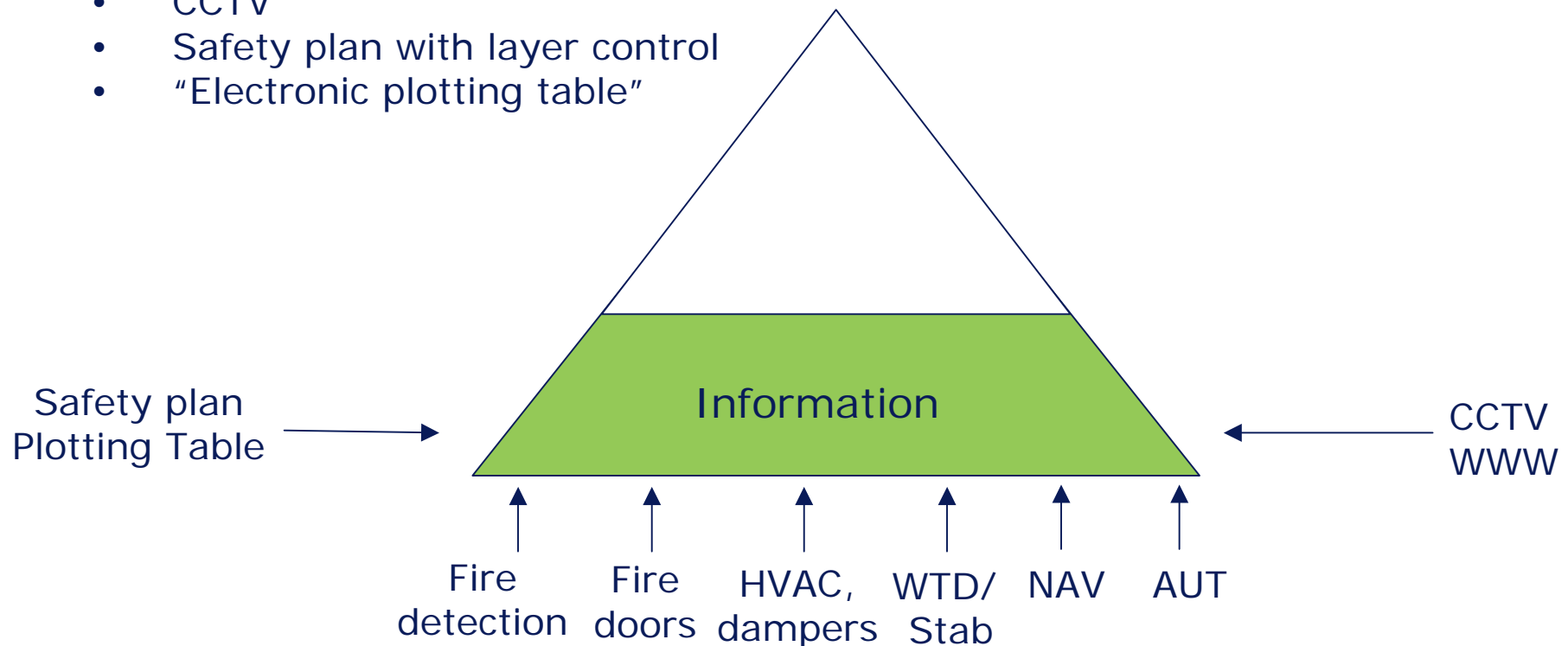
Integrated Safety Management



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Level 1: Information gathering, monitoring and presentation

- Fire detection, fire doors, fire dampers
- HVAC
- Water ingress, water tight doors, stability
- CCTV
- Safety plan with layer control
- "Electronic plotting table"



Operational Advantages

Integrated Safety Management



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Operational Advantages

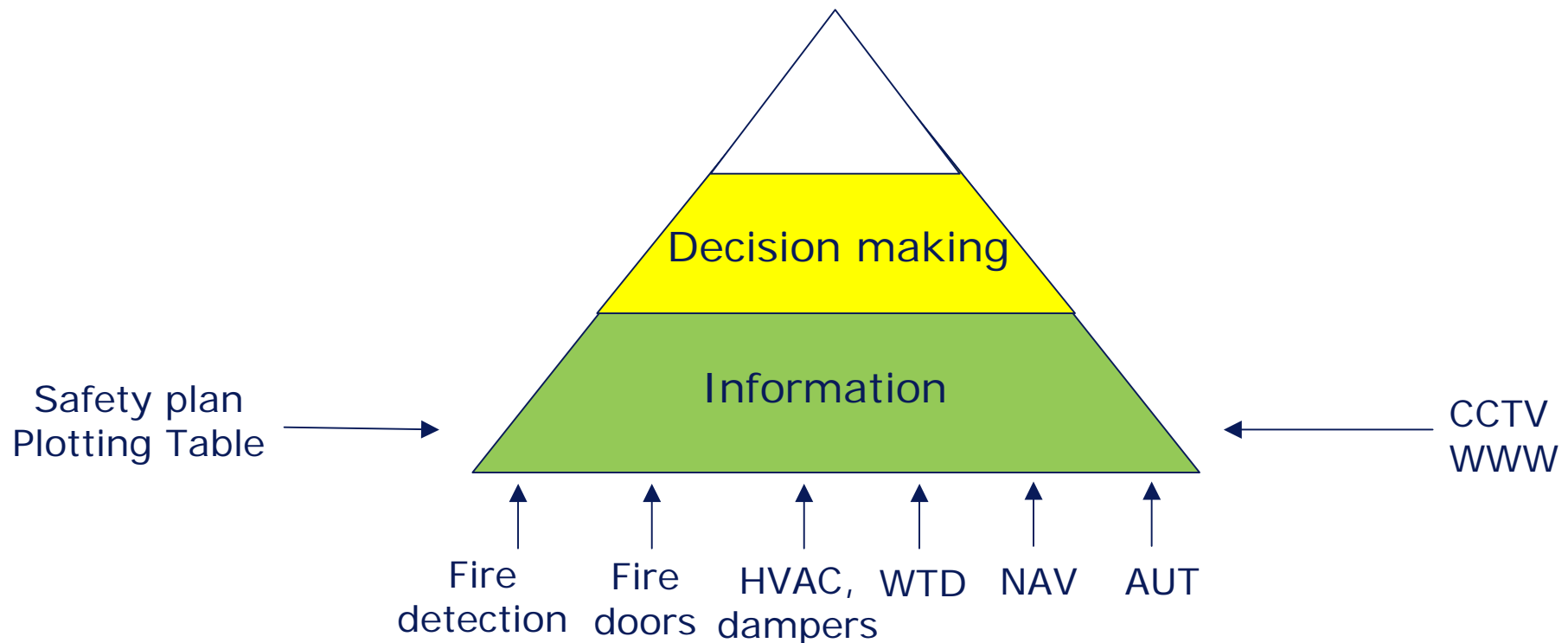
Integrated Safety Management



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Level 2: Decision making

- Interactive emergency procedures
- Decision support modules
- Manual decisions / override of automatic actions



Operational Advantages

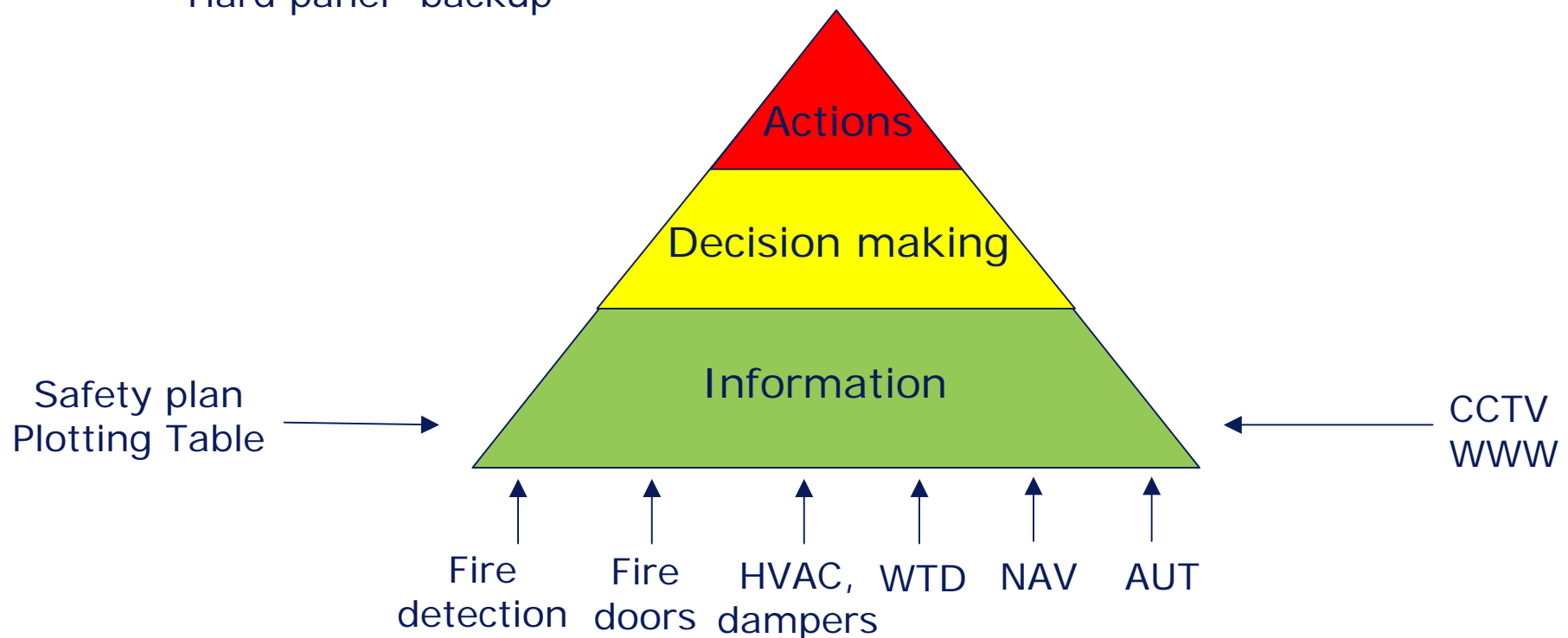
Integrated Safety Management



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Level 3: Actions

- Automatic actions (Cause & Effect programming)
- Via interactive check lists
- Manually from safety operator stations
- "Hard panel" backup

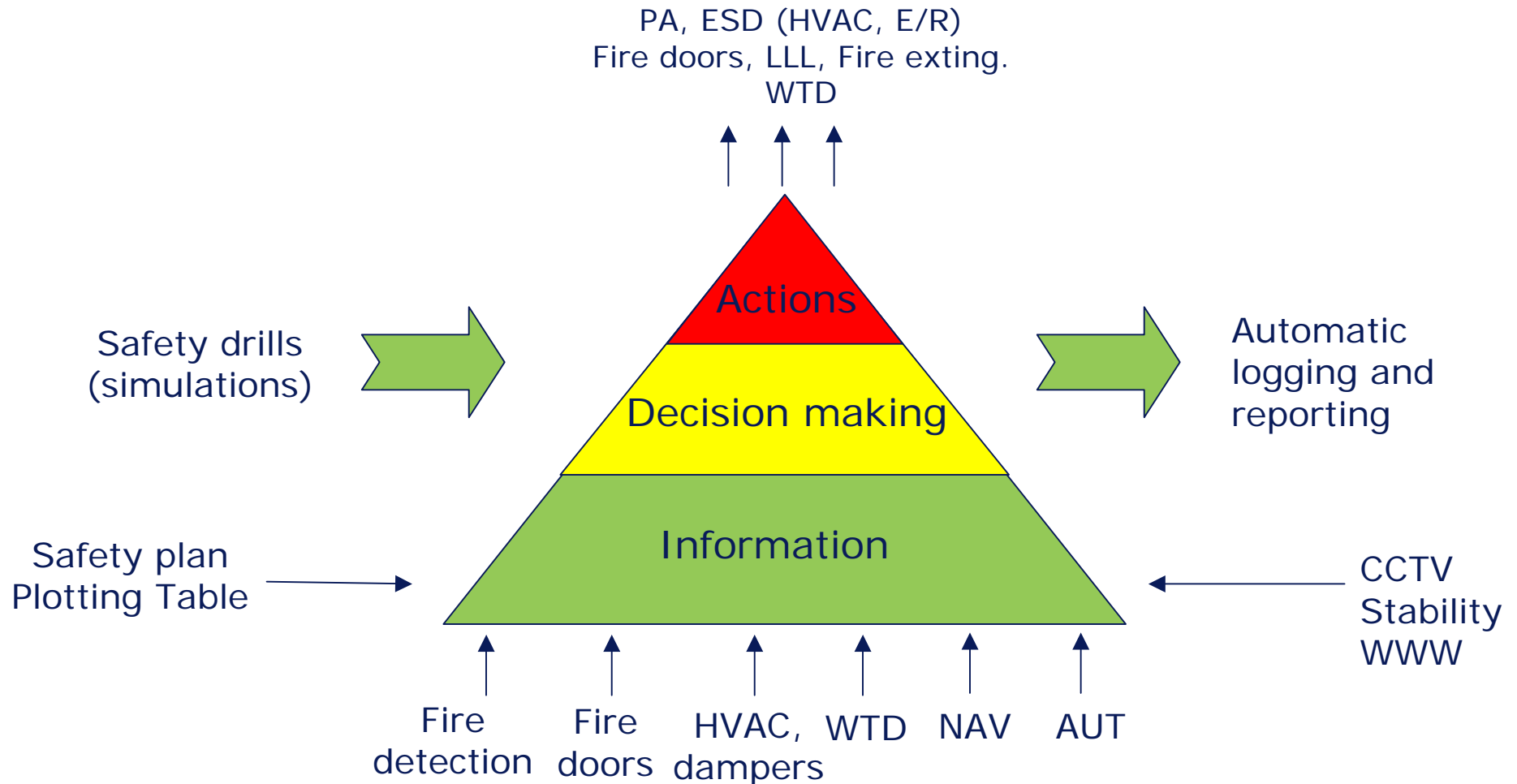


Operational Advantages

Integrated Safety Management



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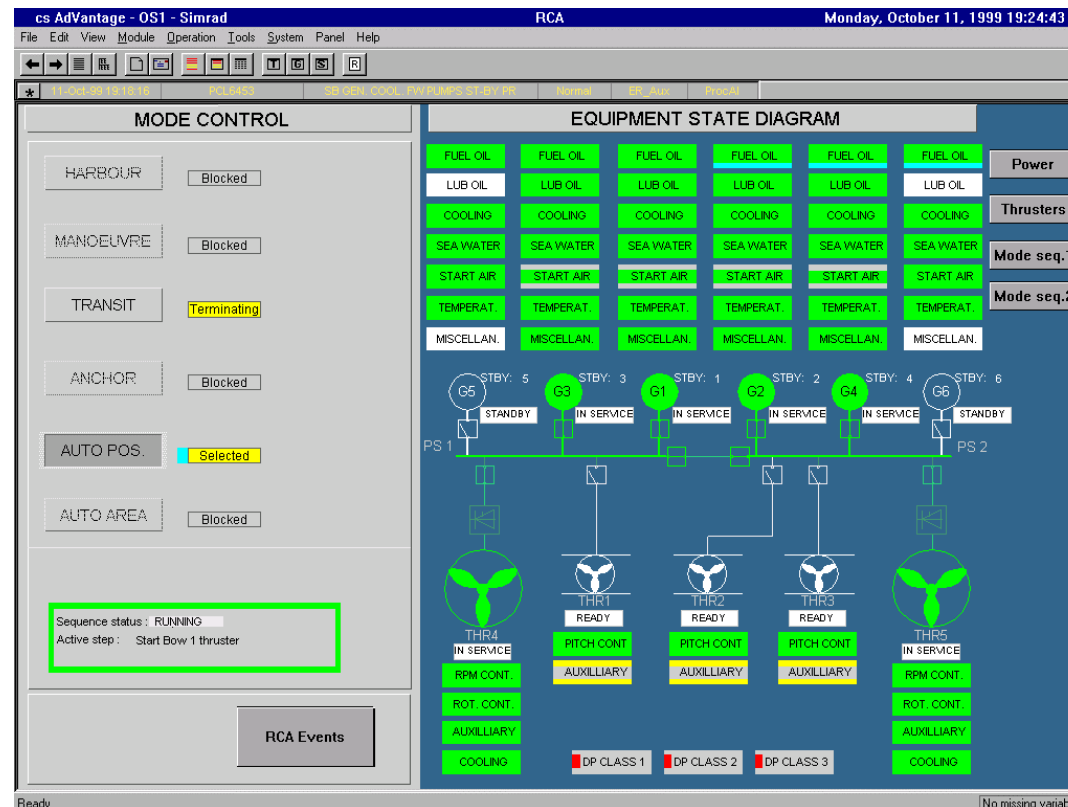
Operational Advantages

Operational mode control



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Propulsion and power plant set-up by a single touch
- and total status assessment by a single look



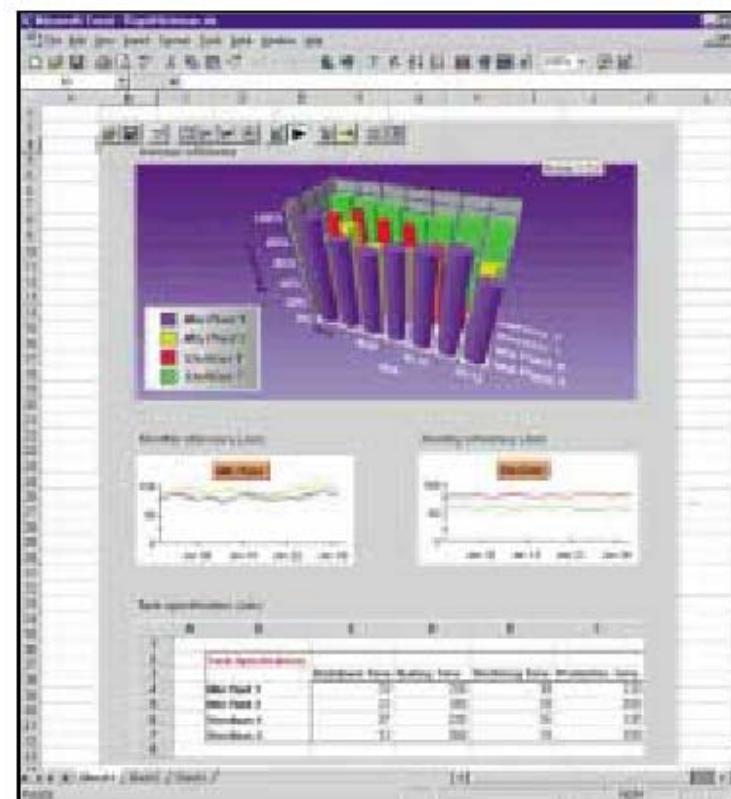
Operational Advantages

Information Management



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- Common data logging and analysis tools
 - Process variables, alarms and events from the various sub-systems are collected in the same database structure
 - All recorded data are using the same clock and are synchronised with milliseconds accuracy
 - Embedded tools for reporting and analyses, combining analogue time series and alarm/event log.
 - Electronic signature feature on reports
 - Fault tolerant solutions
 - Data backup/restore
 - Data export (MS Excel)
 - Replication function e.g. to shore office

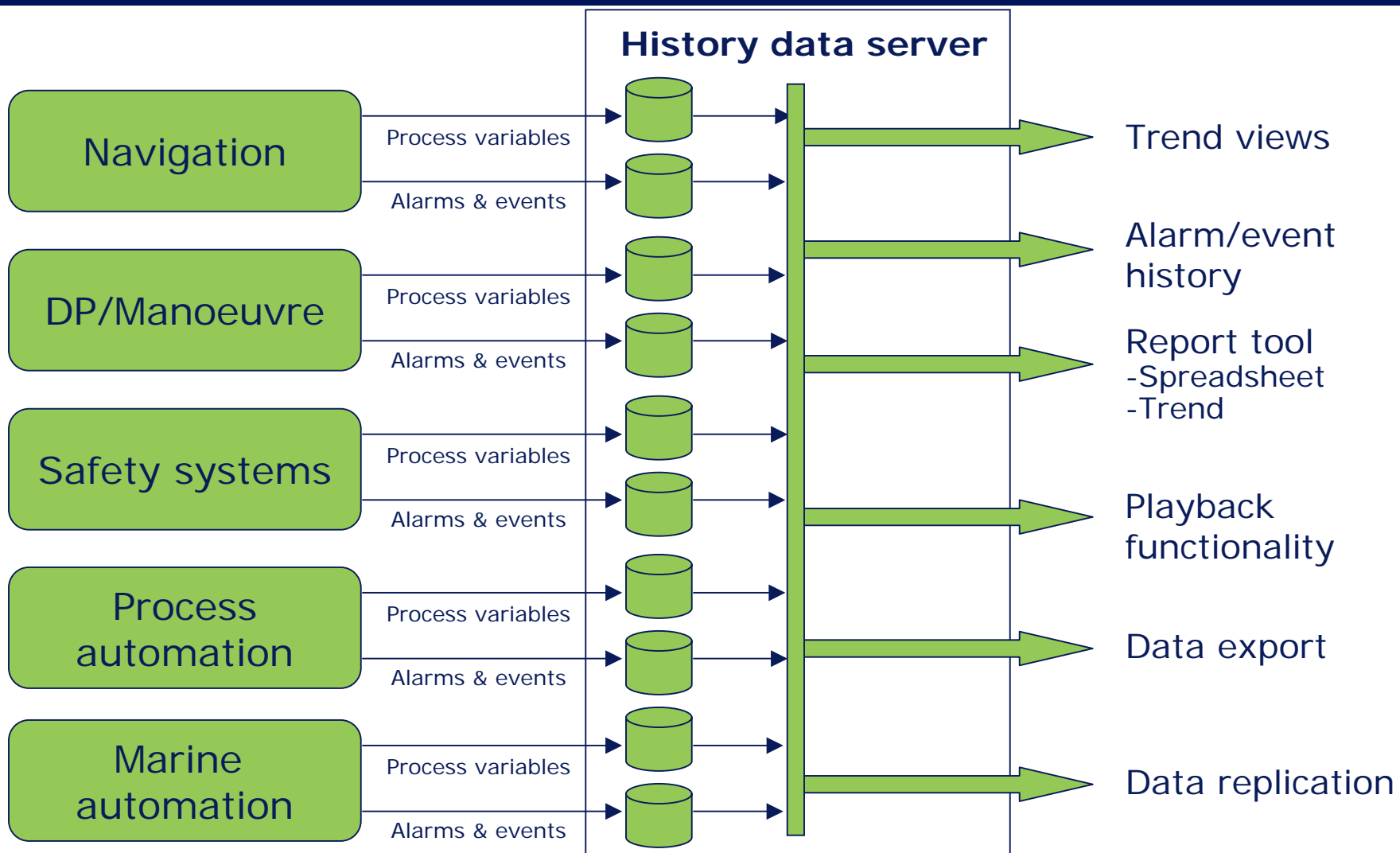


Operational Advantages

Data logging and analysis



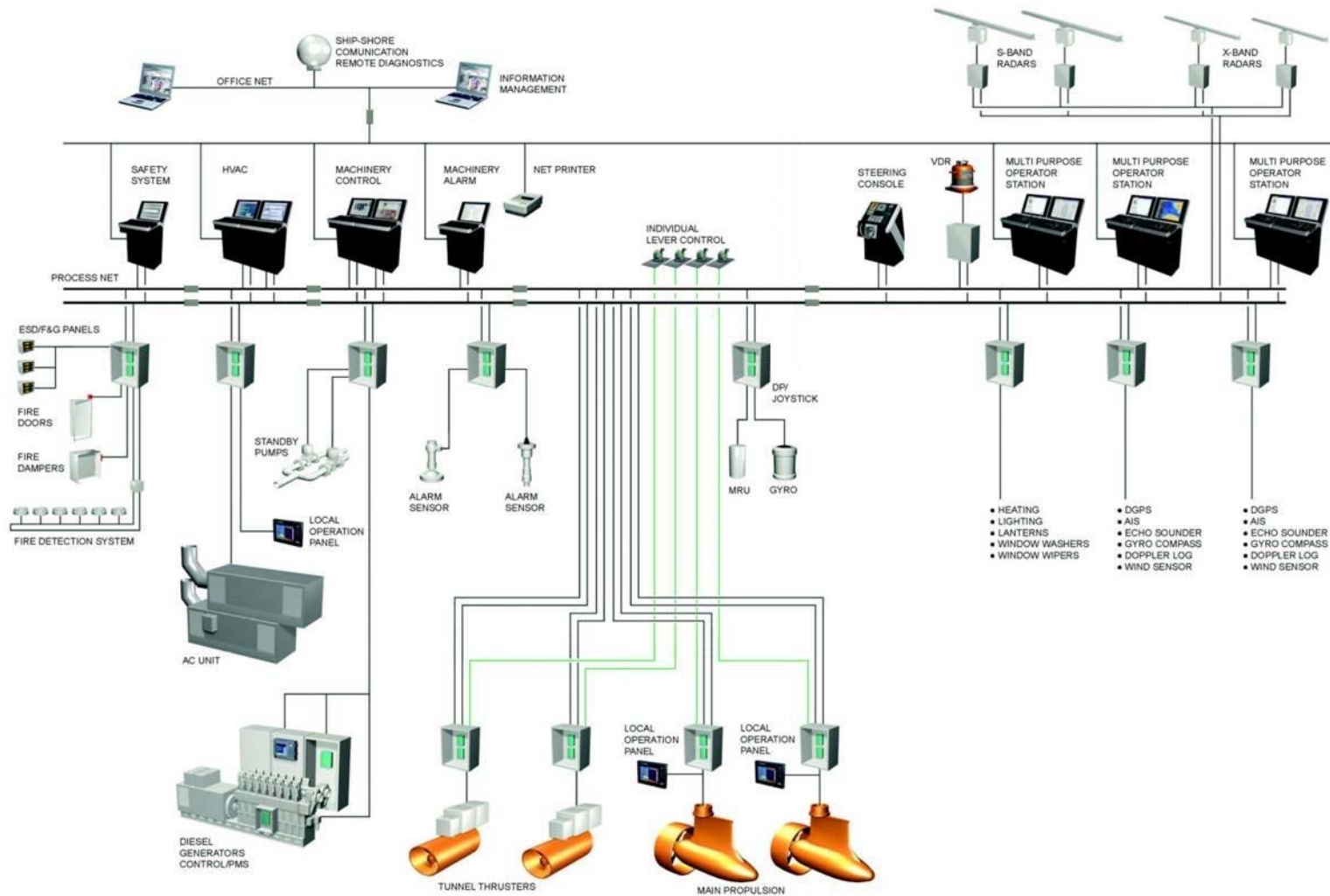
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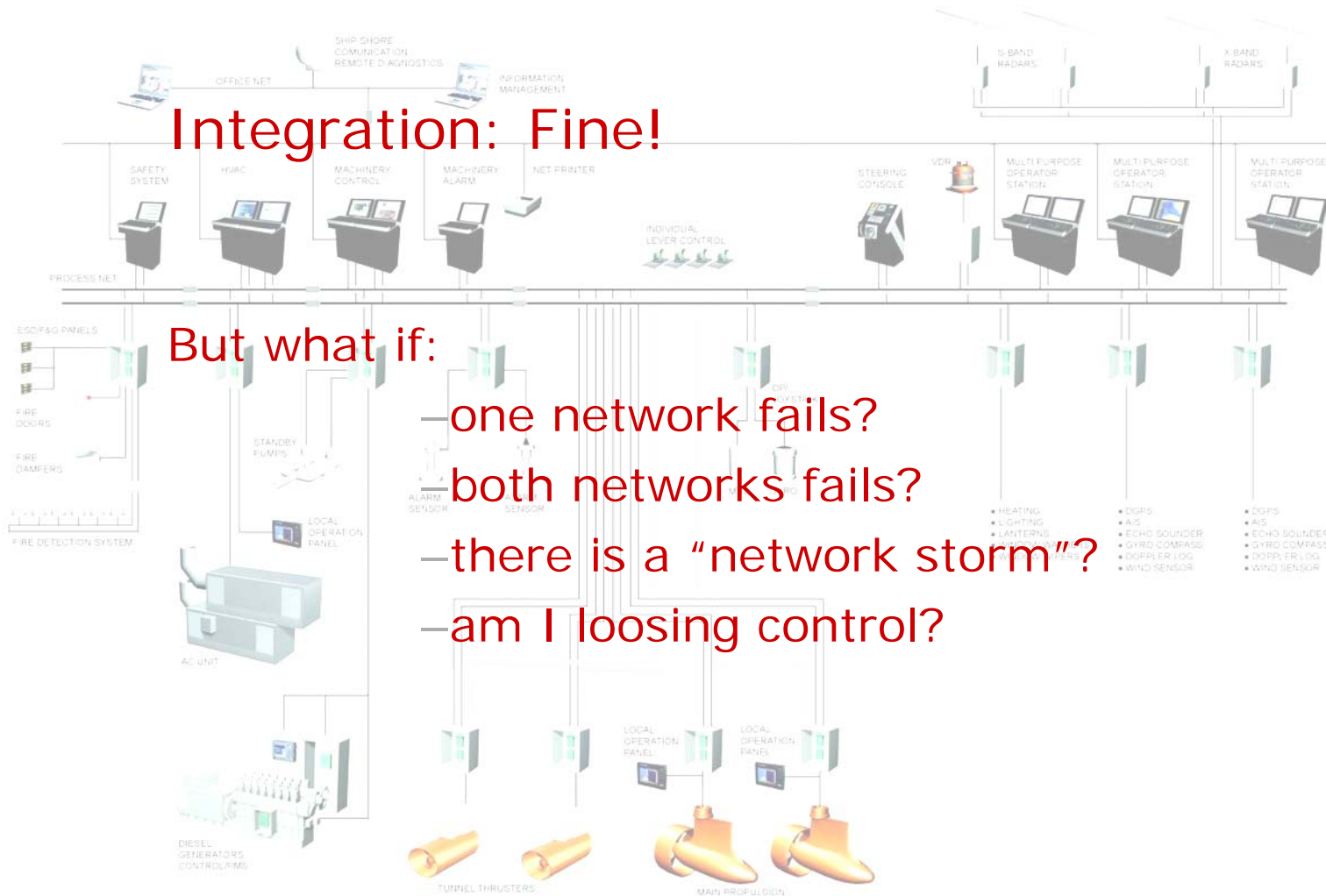
Network Integrity





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Network Integrity

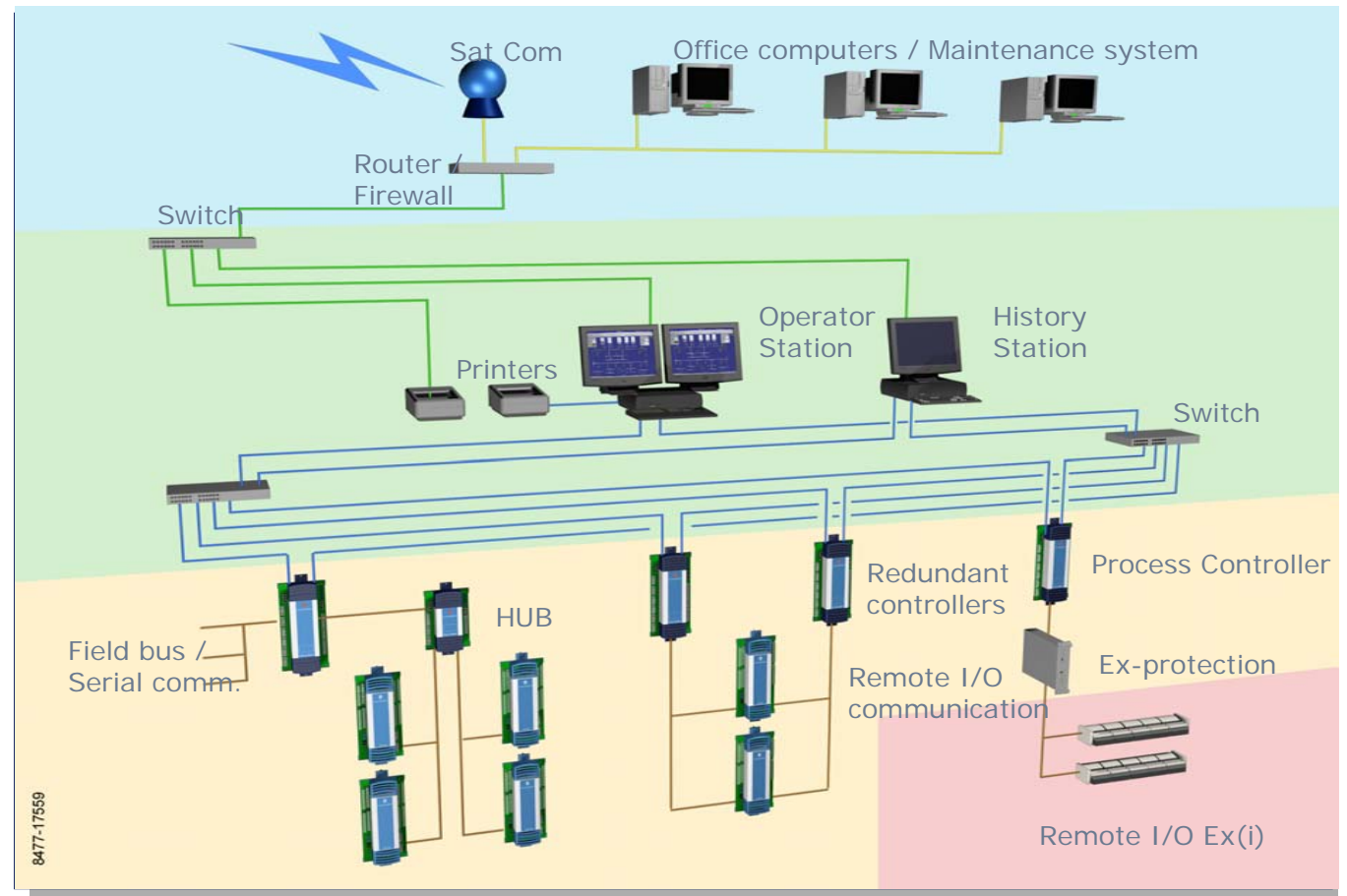




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Network Integrity

- Each main sub-system forms an autonomous network segment
- Principle architecture of a single sub-system:
- Redundant network communication with dedicated switches for each segment - "dual star"
- System wide communication enabled by "inter-connection switches"
- Only relevant information passes between sub-systems
- No common failures





Network Integrity

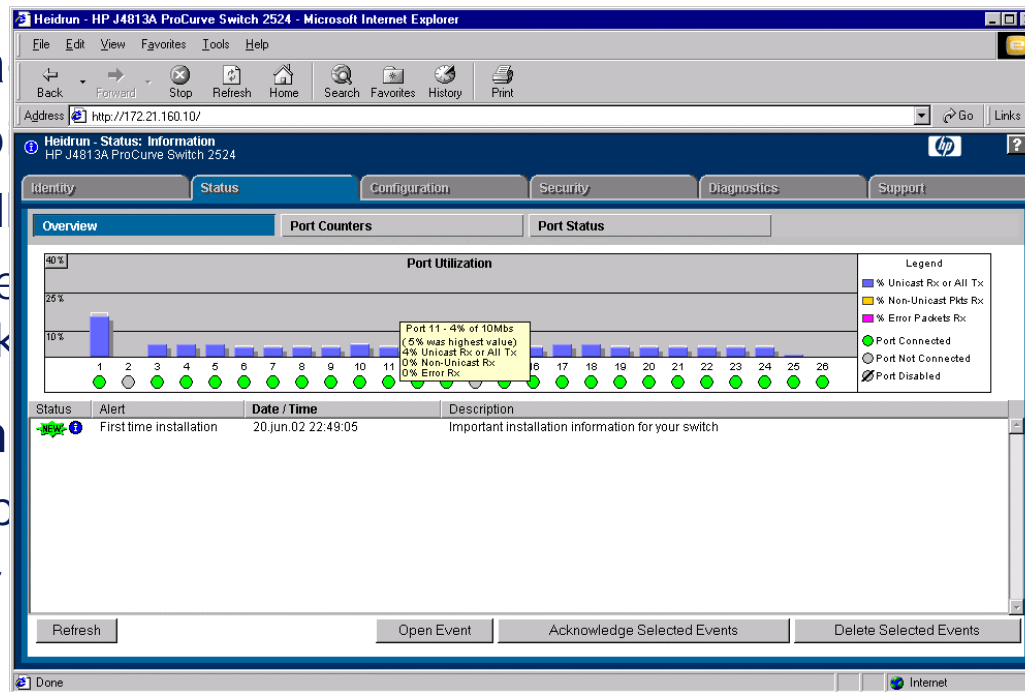
- Managed "intelligent" switches
 - Each switch automatically detects which computer is connected to each port - "self-learning" feature
 - Significant reduction of network traffic compared with old "hubs"
 - Web interface for easy switch/network inspection

- High capacity

- 100 Mb
 - 1000 Mb
 - Total network capacity

- Net storm

- Limits bandwidth
 - Further



of capacity in

limits)

and Controllers



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Network Integrity

- Backup
 - In case of total network loss (dual failure condition!)
 - Backup facilities for essential systems must be available
 - Navigation
 - Propulsion control
 - DP
 - Fire detection
 - ESD
 - Local control facilities for machinery
- Experience
 - Since introduction of switch technology, Kongsberg has not registered critical network failures (total loss of one or both networks) This is based on observations from more than 150 integrated systems over more than 4 years



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Summary

- Integrated Vessel Management:
 - Information sharing
 - Consistent user interface with multifunctional operator stations
 - Integration of DP, RCS and navigation systems
 - Enhanced functional integration of DP and PMS
 - Integrated safety management incl. decision support
 - Common synchronized data logging, reporting and analysis tools
 - Based on well proven, fault tolerant technology
- Reduced project risk:
 - Reduced number of suppliers – single point of contact
 - Larger engineering responsibility on IVMS supplier
 - Usage of “pre-engineered” solutions and standardized field interfaces
 - Total system test before delivery
 - Extensive distribution by using remote I/O and field buses
 - Reduced number of interfaces between sub-systems
 - HW and SW lifecycle control



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Thank you for your attention !

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