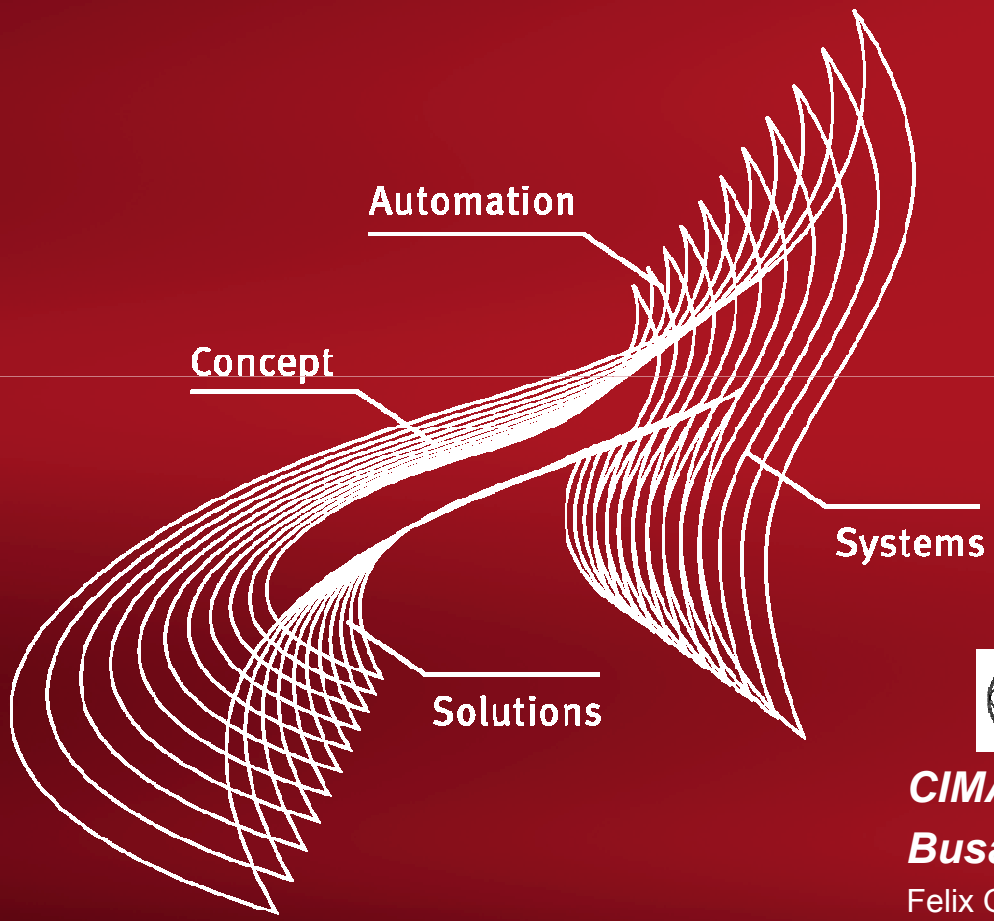
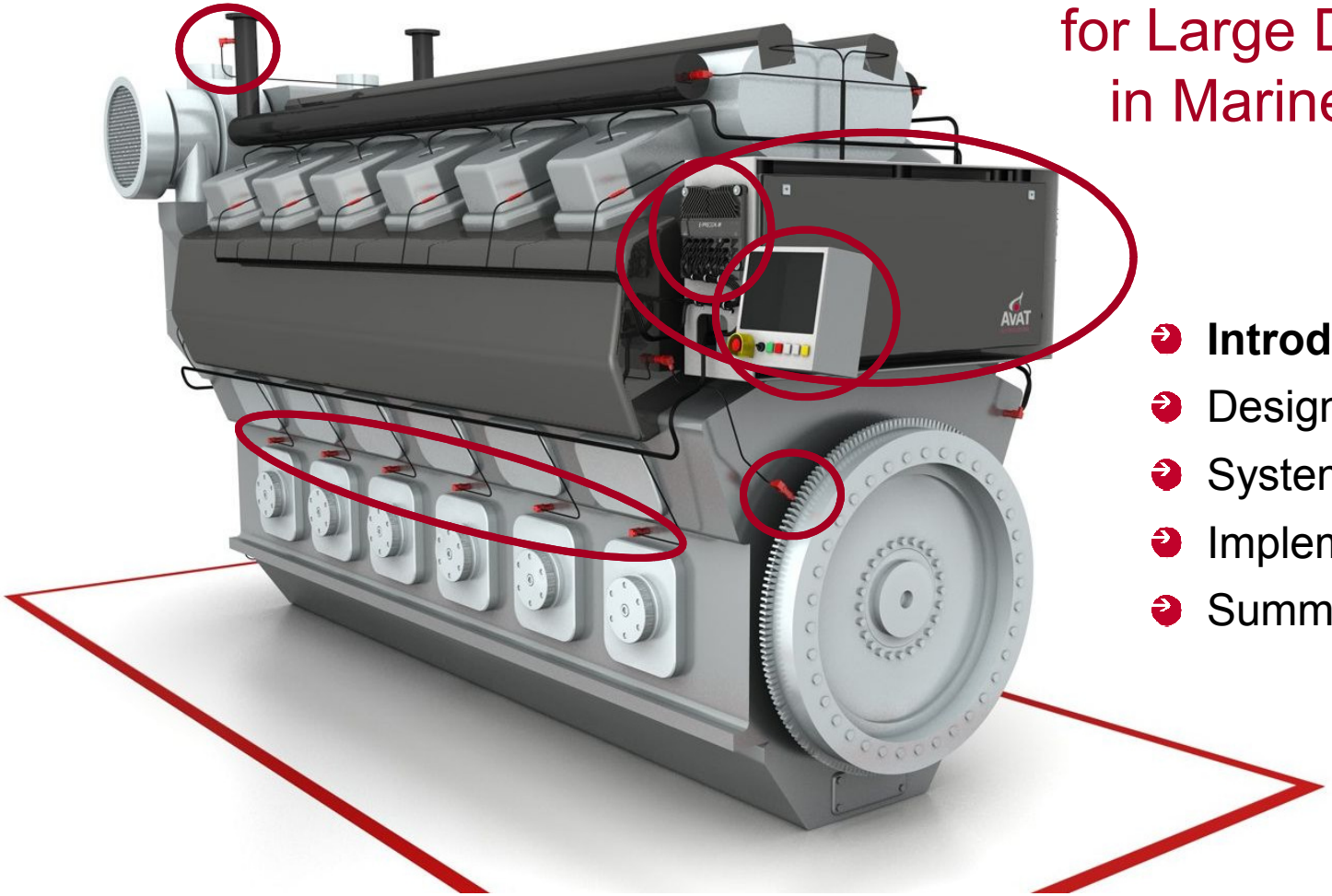
AVAT AUTOMATION



CIMAC CASCADES 2014*, *Busan

Felix Grüninger, AVAT Automation GmbH, Germany

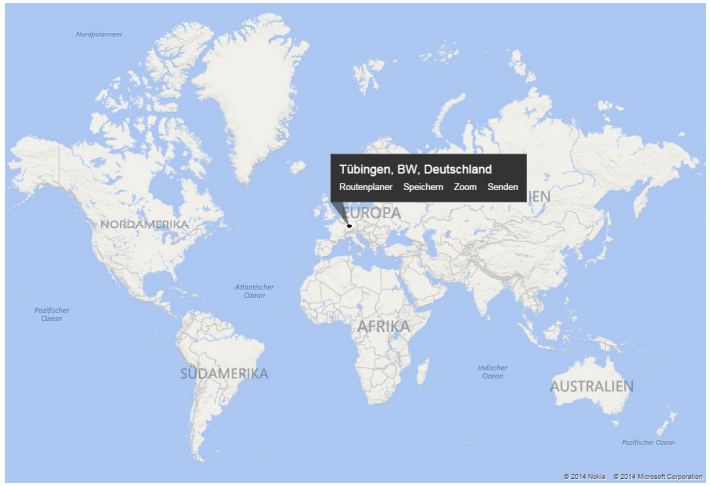
Advanced Engine Control System for Large DF Engines in Marine Applications



- **Introduction**
- Design Features
- System Layout
- Implementation Details
- Summary

AVAT Automation GmbH

- More than 8000 gas engine control systems in service worldwide
- Over 25 years of experience in control, hardware design and engine optimization
- Marine certified products for engine control, combustion monitoring and engine protection
- Close cooperation with renowned engine manufacturers all over the world



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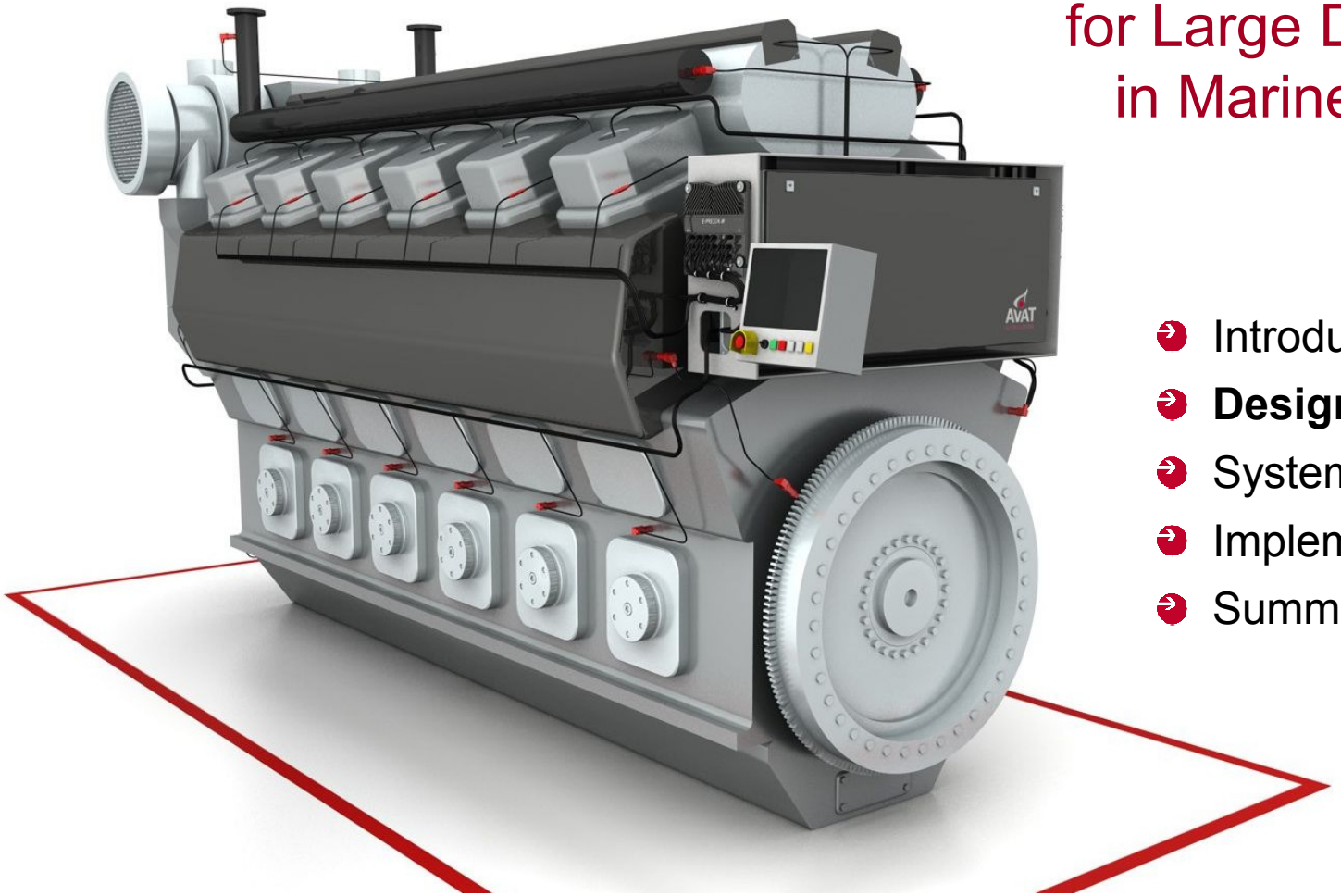

- Introduction
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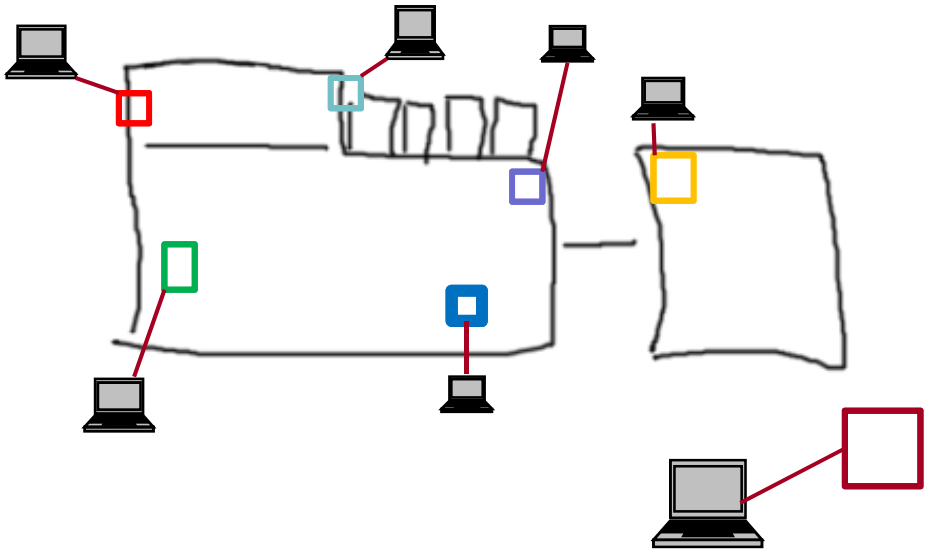
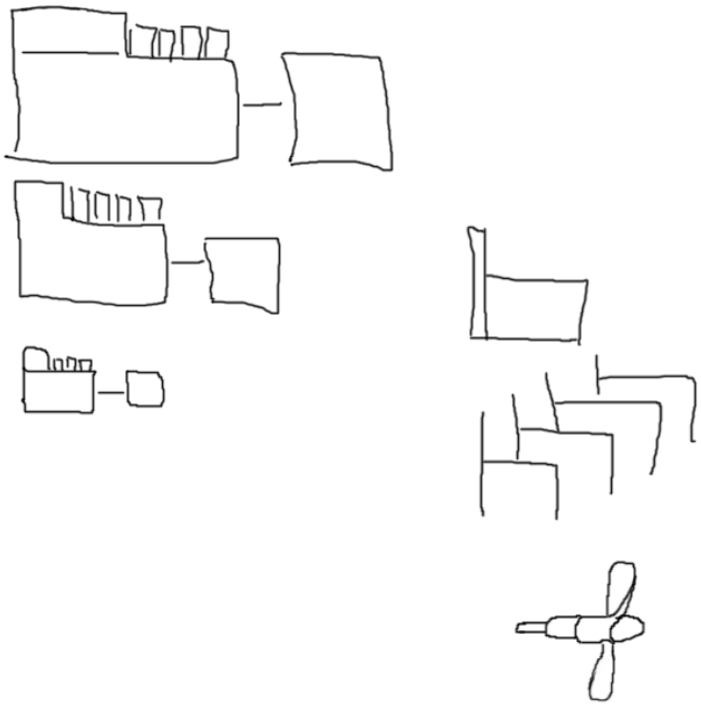
Initial Situation

- Many sub-systems



- Very different engine types



- Very different applications

In principle the user wants the engine running…

Key Features: Collection

What jobs do our customers have to accomplish with our product? What are they expecting from us?

system integration

safe operation

versatility

reliability

easy integration

meeting strict emission limits

custom system layout

product family

longevity

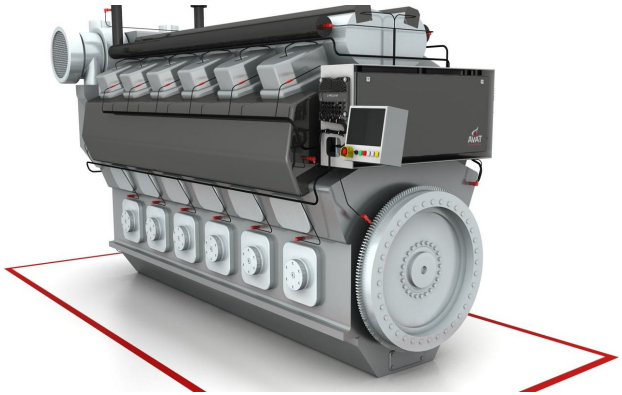
optimal control

MCS support

ease of use

reduced complexity

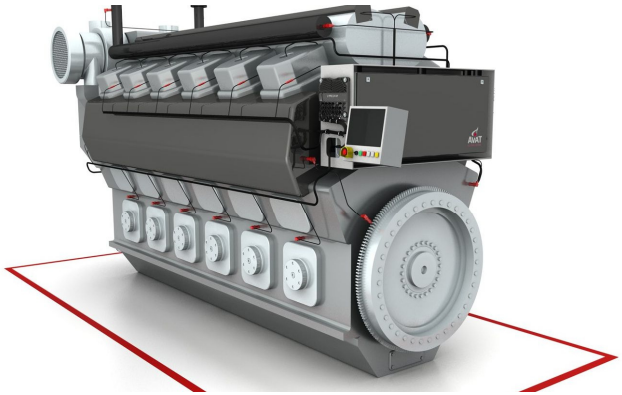
modularity



Which is the most important to you?

Key Features: Structured

- System Design
  - modularity
  - product family
  - system integration
  - reduced complexity
  - easy integration
  - custom system layout
- Essentials
  - meeting strict emission limits
- Operation
  - safe operation
  - optimal control
  - longevity
  - ease of use
  - reliability
  - versatility
- Services
  - MCS support



Modularity: How to handle functionality

In functionality

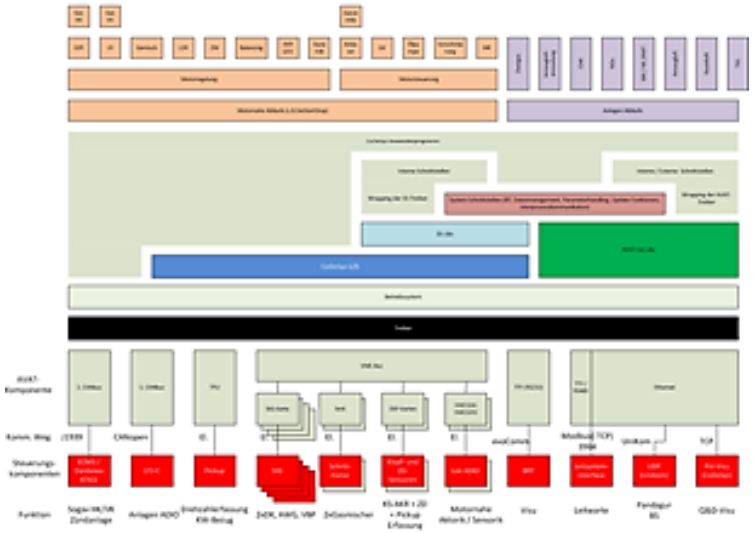
- adding new when necessary
- change existing (maybe just for this one installation)
- deactivate not needed functions

In space

- place IOs where they are needed
- reliable, fast and secure connections
- and yet still flexible!

In time

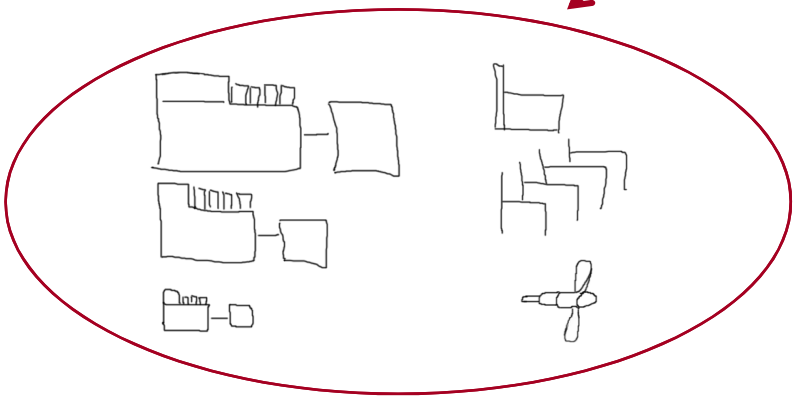
- extend functionality even after years of service
- provide retrofit capabilities

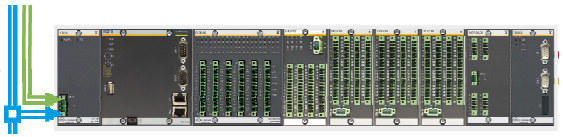


Product Family: How to handle system diversification

The user wants to find the same

- user interface/concept, scalable HMI
- software
- hardware



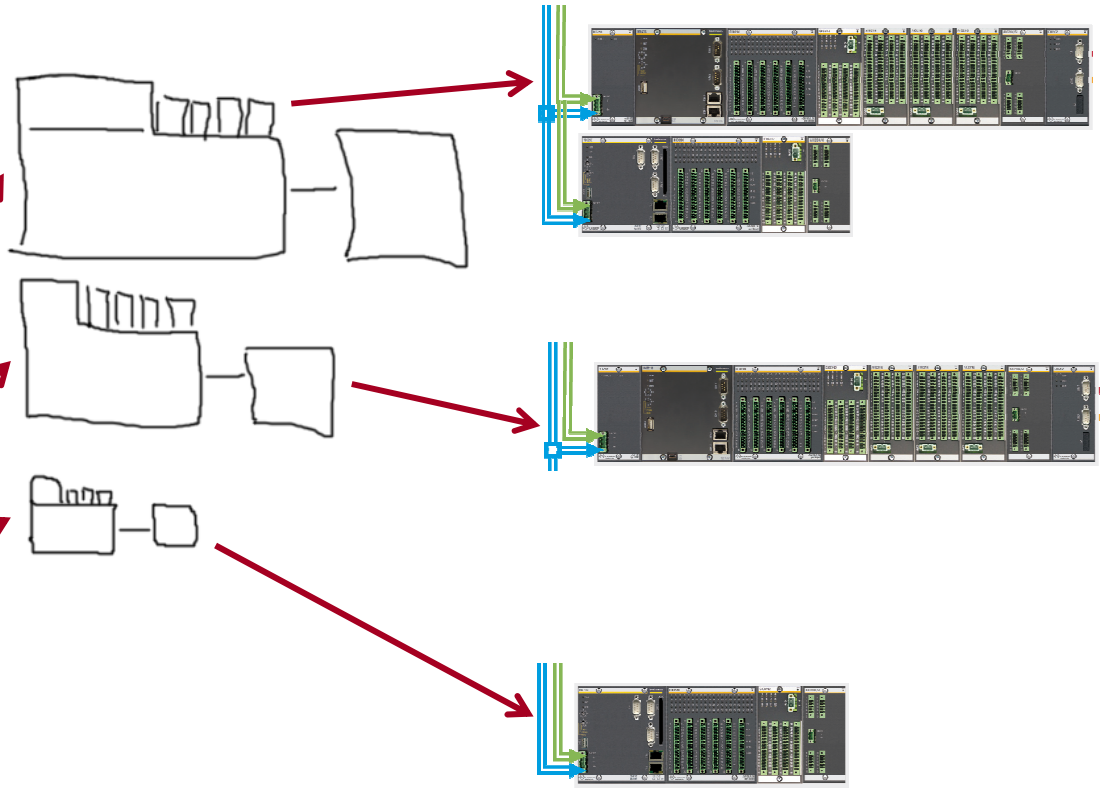


Product Family: How to handle system diversification

The engine

- large
- medium
- small

Only eight different system modules

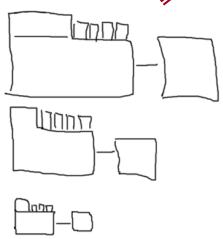


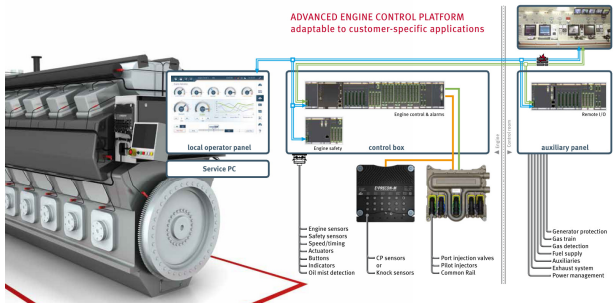
Same user interface everywhere

Product Family: How to handle system diversification

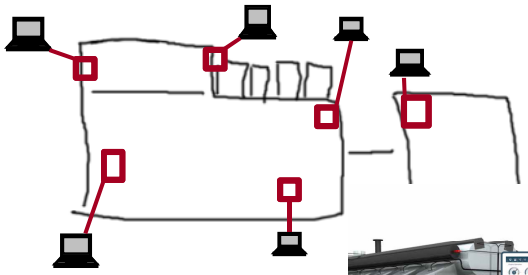
The application

- single engine
- multi-engine power generation
- marine environment





System Integration: How to handle system complexity



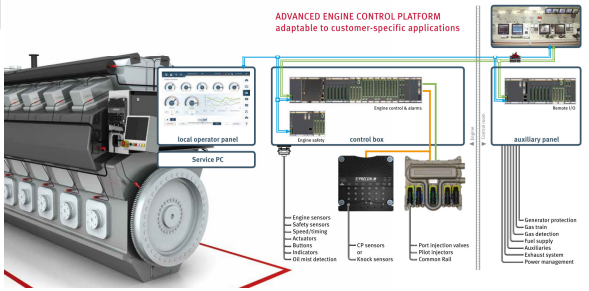
Access to all connected components

- single interface
- process values
- configuration

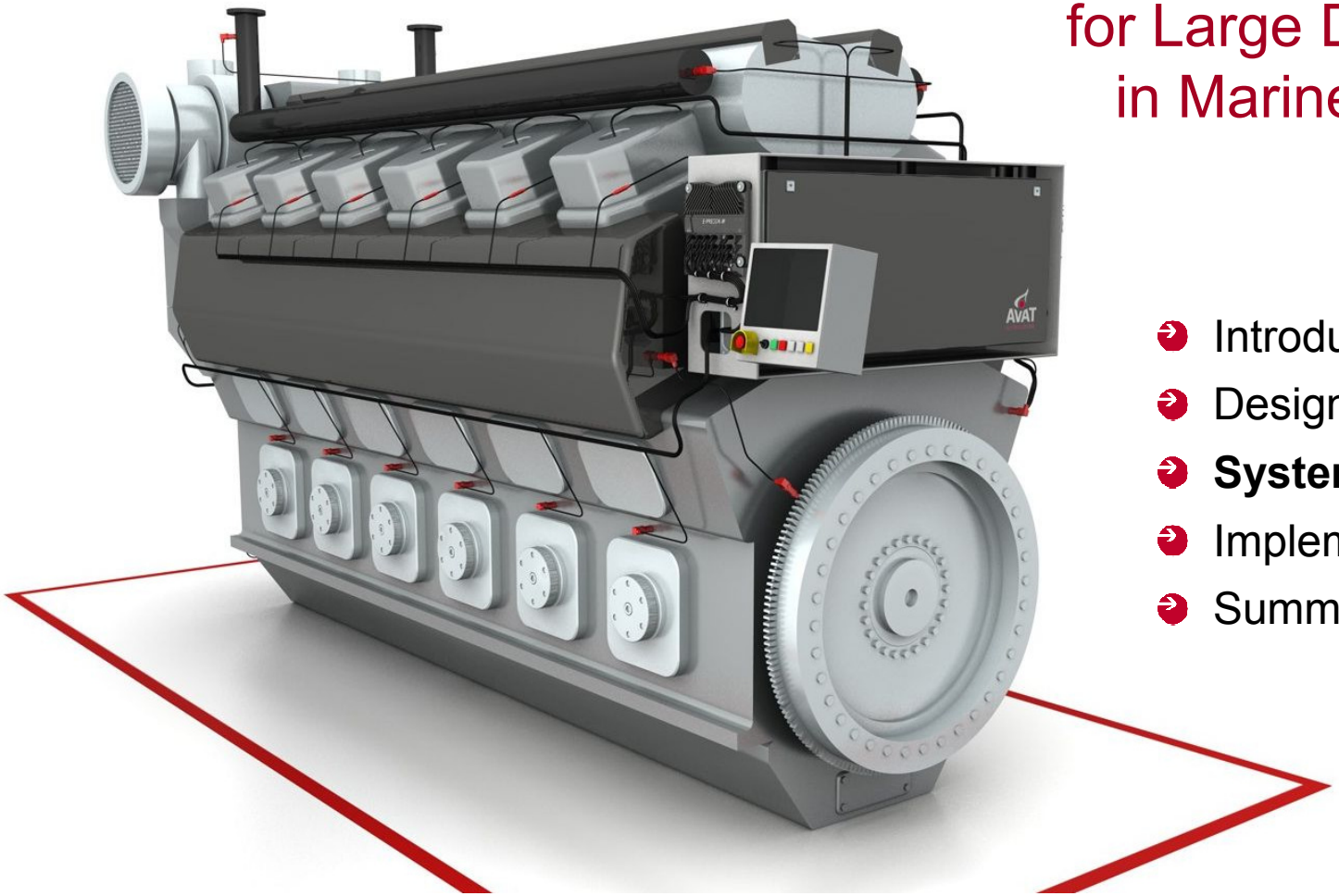
Design “in one block” and system integration

- facilitates/enables system operation
- clear responsibilities and interfaces

Only one contact person/company for support



Advanced Engine Control System for Large DF Engines in Marine Applications



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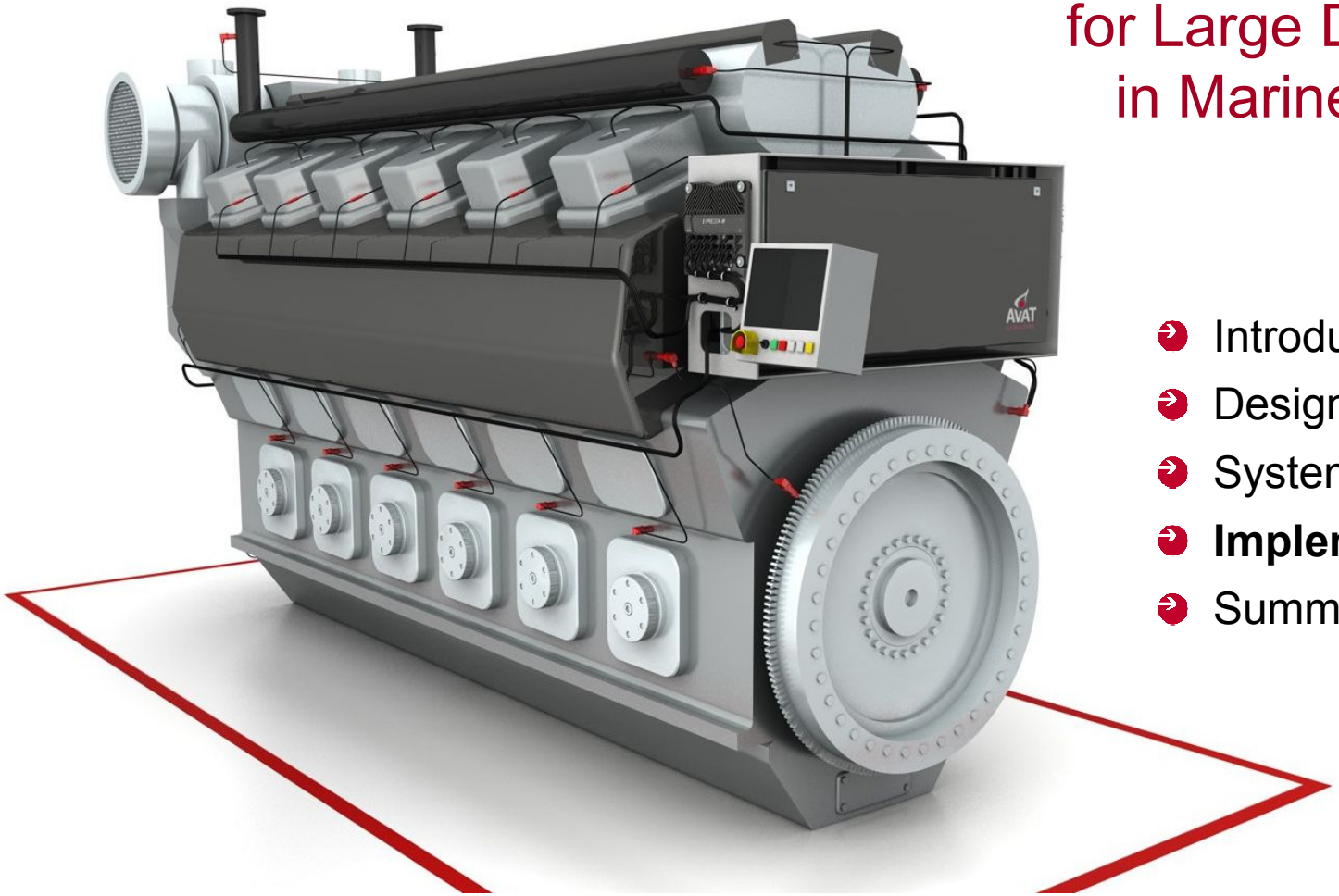
System Layout

ECS System

Engine

Control room

Advanced Engine Control System for Large DF Engines in Marine Applications



- Introduction
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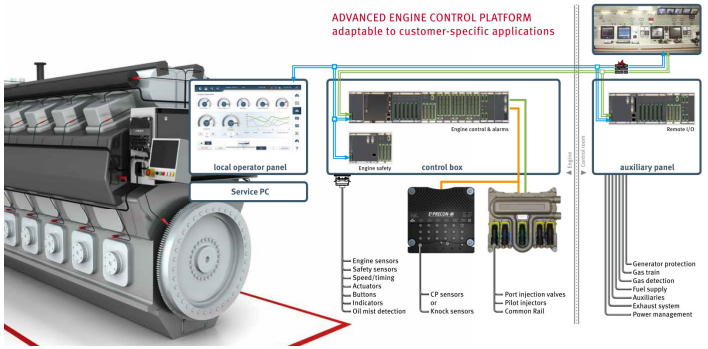
Modularity and Family Concept

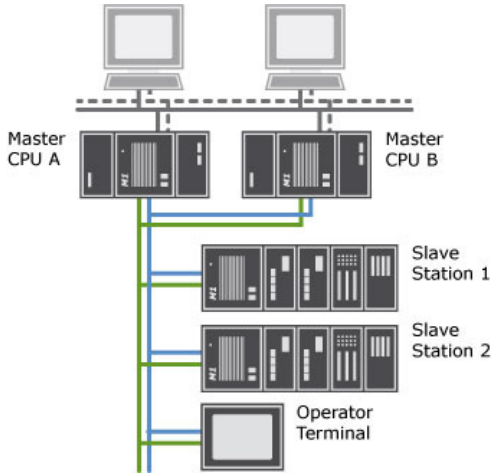
Application diversity

- easily adaptable system design
- small, lightweight, extendable modules
- using standard components
- meet even diverging requirements

Redundancy

- Ethernet and field bus where necessary
- all critical components/functionalities are doubled
- hot standby redundancy is possible
- multiple IO slave stations provided





Implementation Details

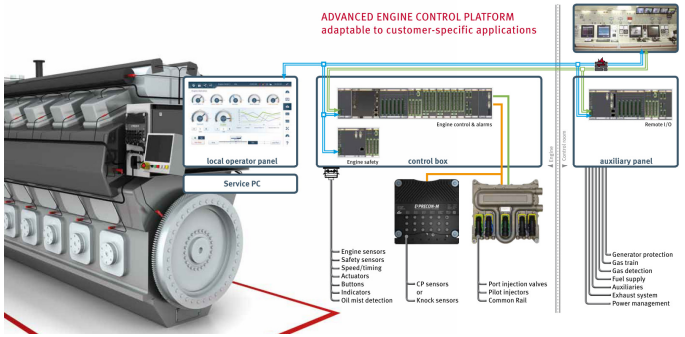
System Integration

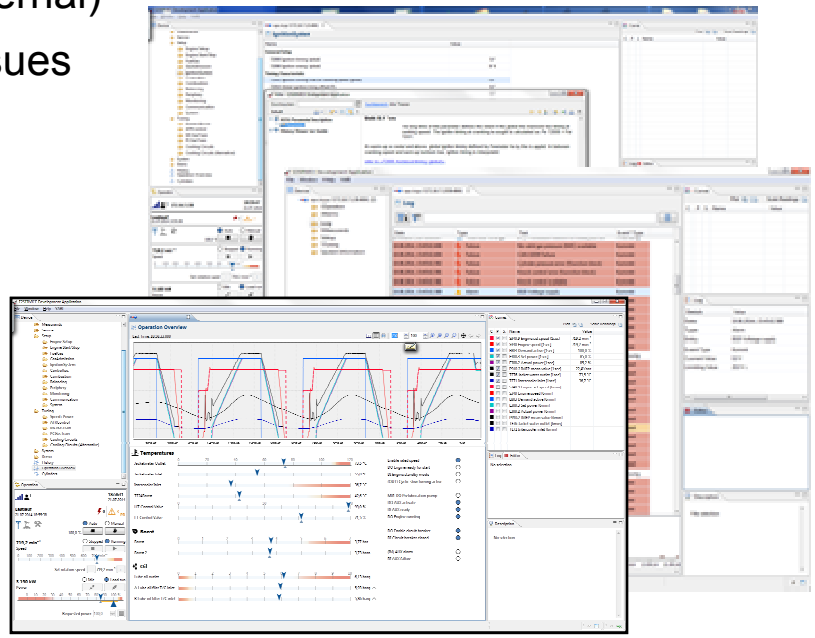
Comprehensive matching of all involved components

- signal ranges and wiring concept
- communication concept (internal/external)
- grounding concept (e.g. crosstalk issues for Structure Borne Sound signals)

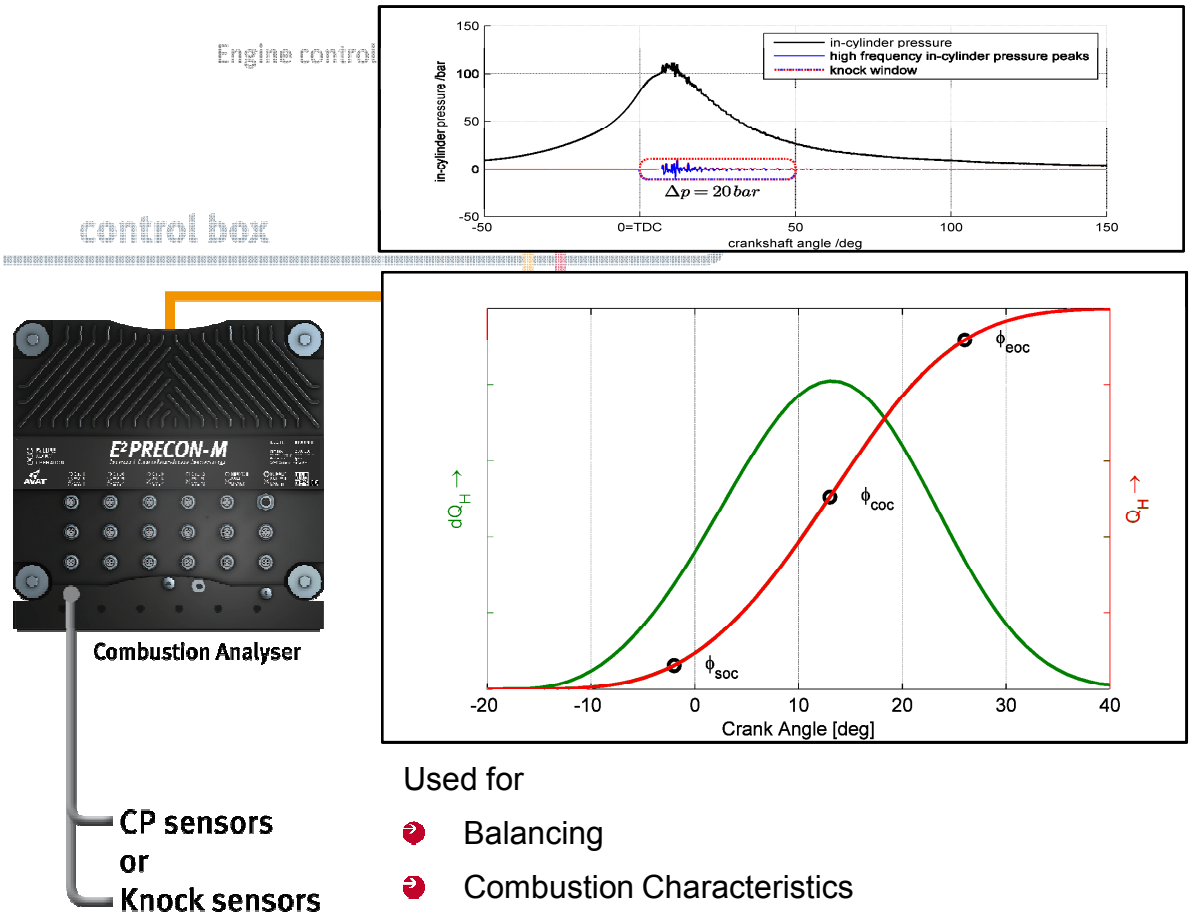
One service tool for

- sub systems
- visualization of process values
- configuration
- fault diagnosis
- help desk
- long term data acquisition



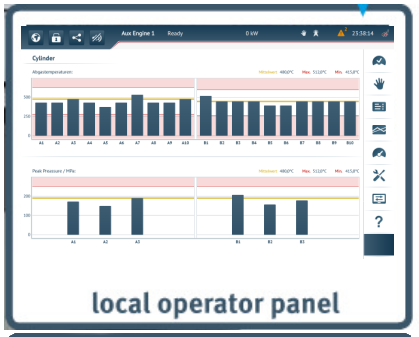


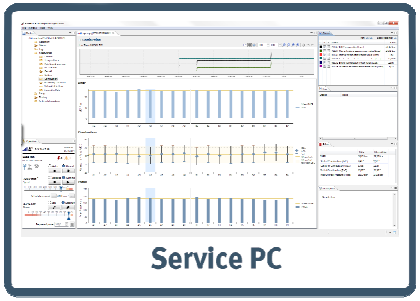
ECS System: Combustion Monitoring and Engine Protection

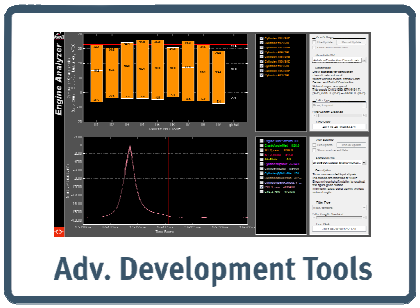


Used for

- Balancing
- Combustion Characteristics
- Alarm Monitoring
- Cylinder Comparisons

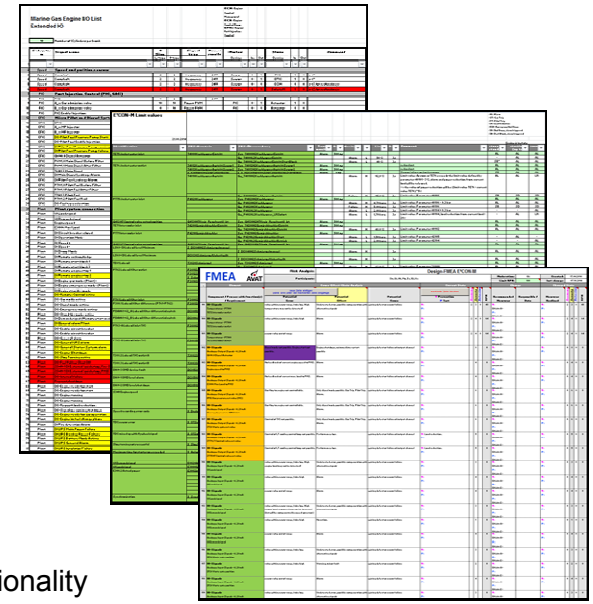






Implementation Details

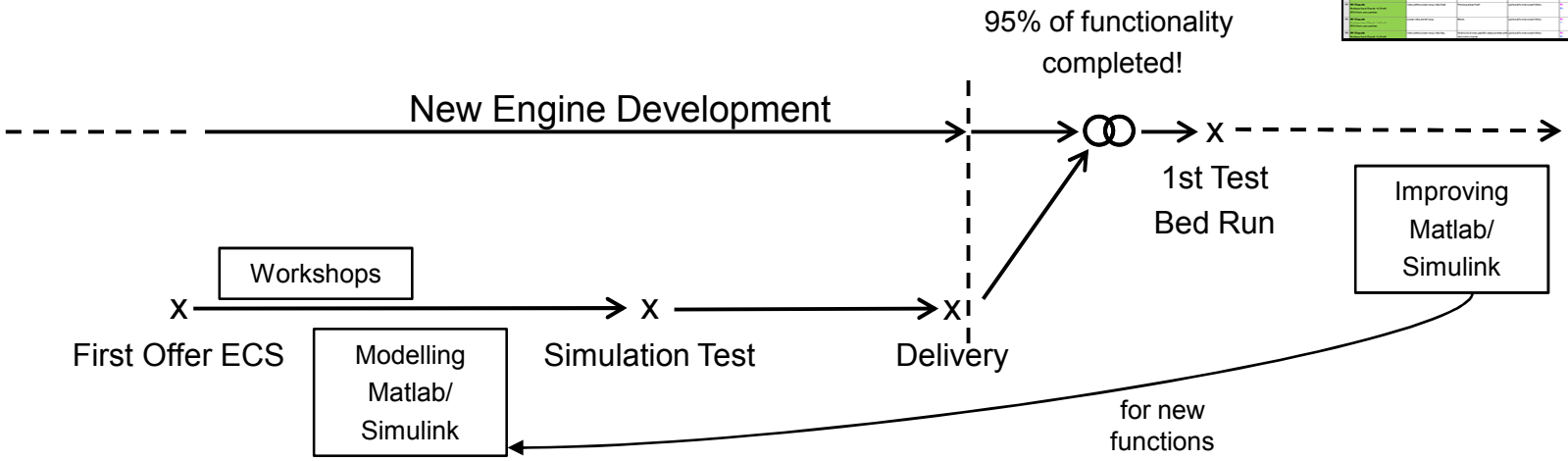
Development Process



Fast Time-to-Application

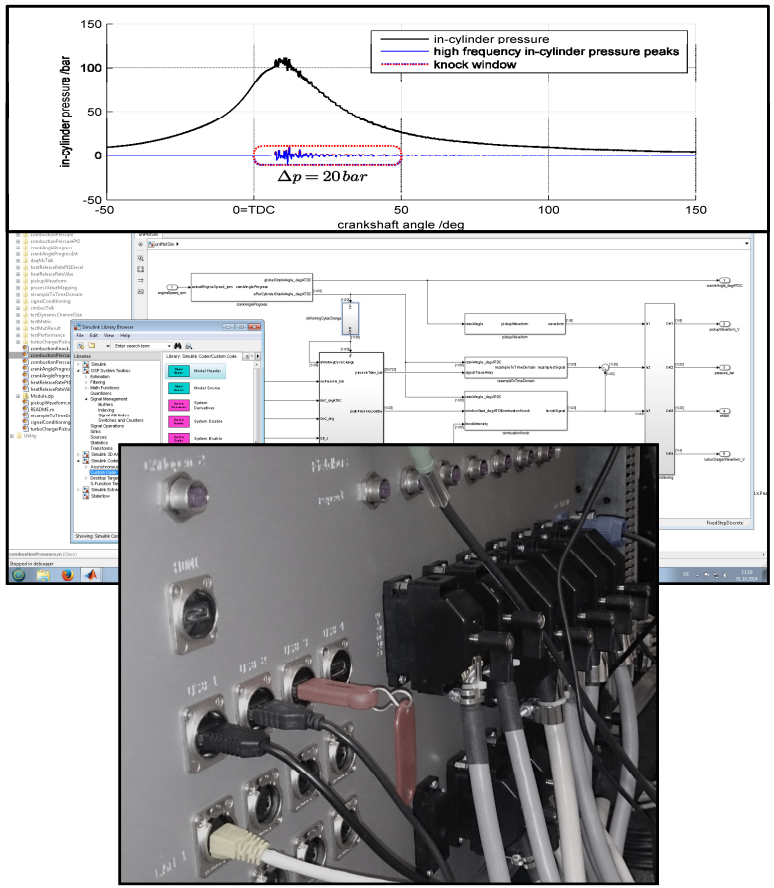
- checklists for requirements identification
- generic IO lists as starting point
- Design-FMEA

“Fully tested system” before first test bed run!



Verification: Advanced Testing Framework

- Complete Hardware-in-the-Loop testing
- Dynamic engine simulation
- Rapid control prototyping
- Fast signal generation for
  - structure borne sound
  - in cylinder pressure transducers
  - simulation of realtime, cylinder individual effects
  - replay of real world recordings
- Automated test framework
  - regression testing
  - reliable testing against requirements
  - automatic report generation



Summary

Advanced Engine Control System

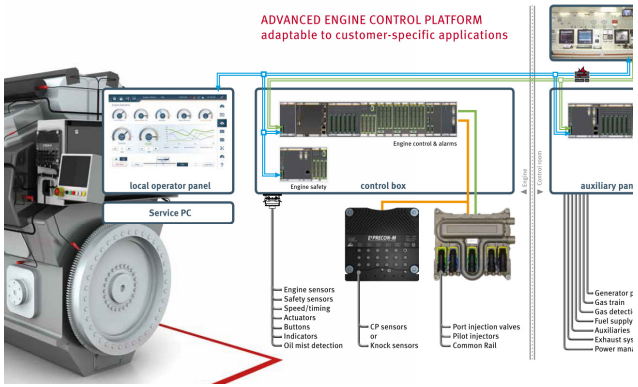
- modularity concept
- family concept
- system integration
- combustion monitoring
- constant testing

for **Large DF Engines**

- optimal control and protection for two to ten MW engines
- DF functions “inside”

in **Marine** Applications

- compliant with major MCS



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Thank you very much for your attention.