

ABB PA OGP A&ES & Politecnico di Milano DEI – November 28th, 2012

mcT 2012 - Tecnologie per il petrolchimico

Safety, Performance & Innovation in Oil&Gas Rotating Machines



POLITECNICO
DI MILANO

Power and productivity
for a better world™



Market Analysis

Compressors and Pumps



- About 2000 new compressor and 5000 new pumps installed every year for Oil, Gas & Petrochemical market (from 2010 data)
- 30% of the market are motor & VSD driven
- New LNG plants & new pipelines (Asia, Brazil, Russia and North America)
- Compressing and pumping are expensive processes
- Main source of inefficiency:
 - Old machinery
 - Sub-optimal control schemes
 - Bad tuning & maintenance

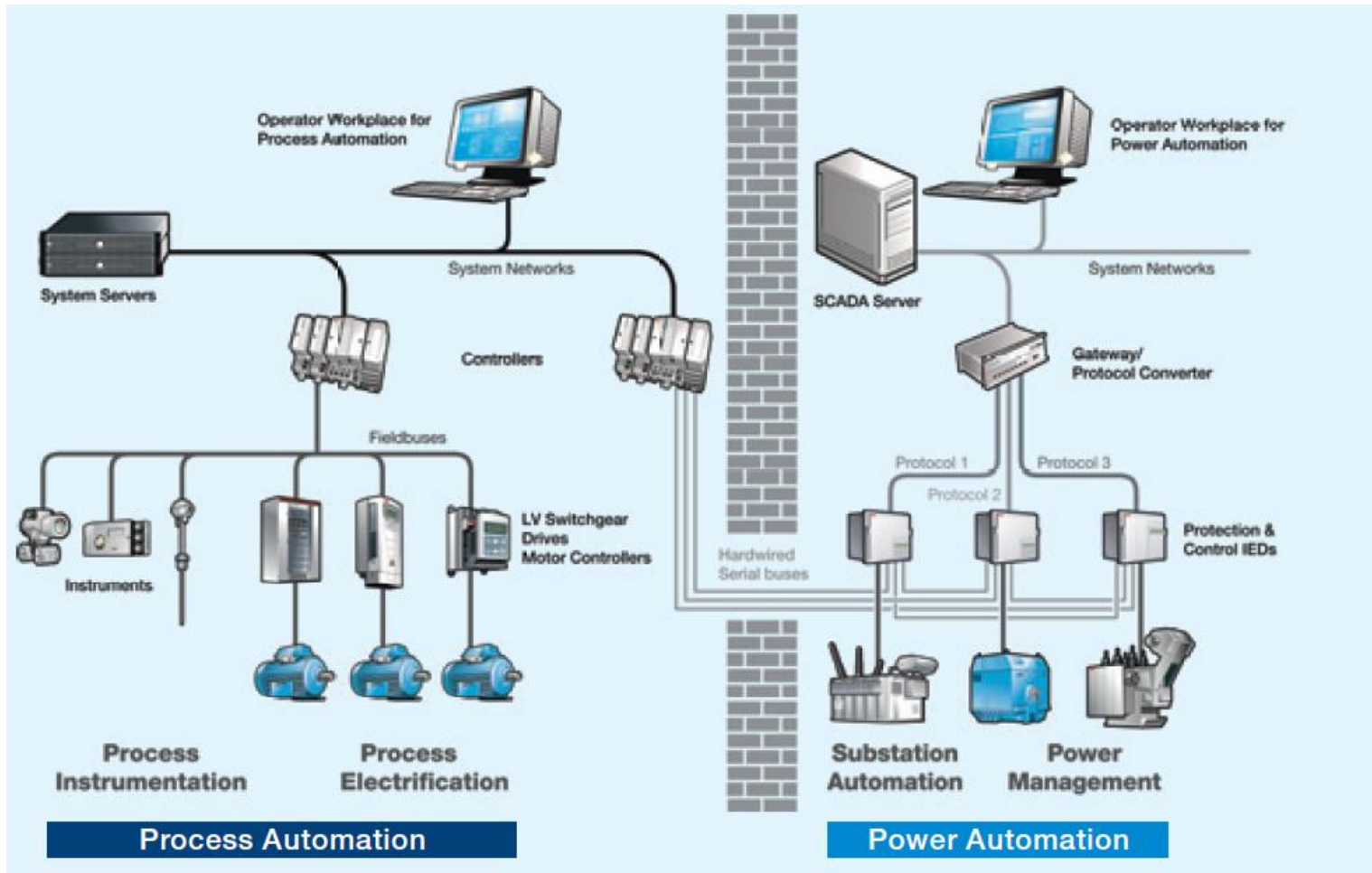
The Power of Integration

Process and Power Automation together



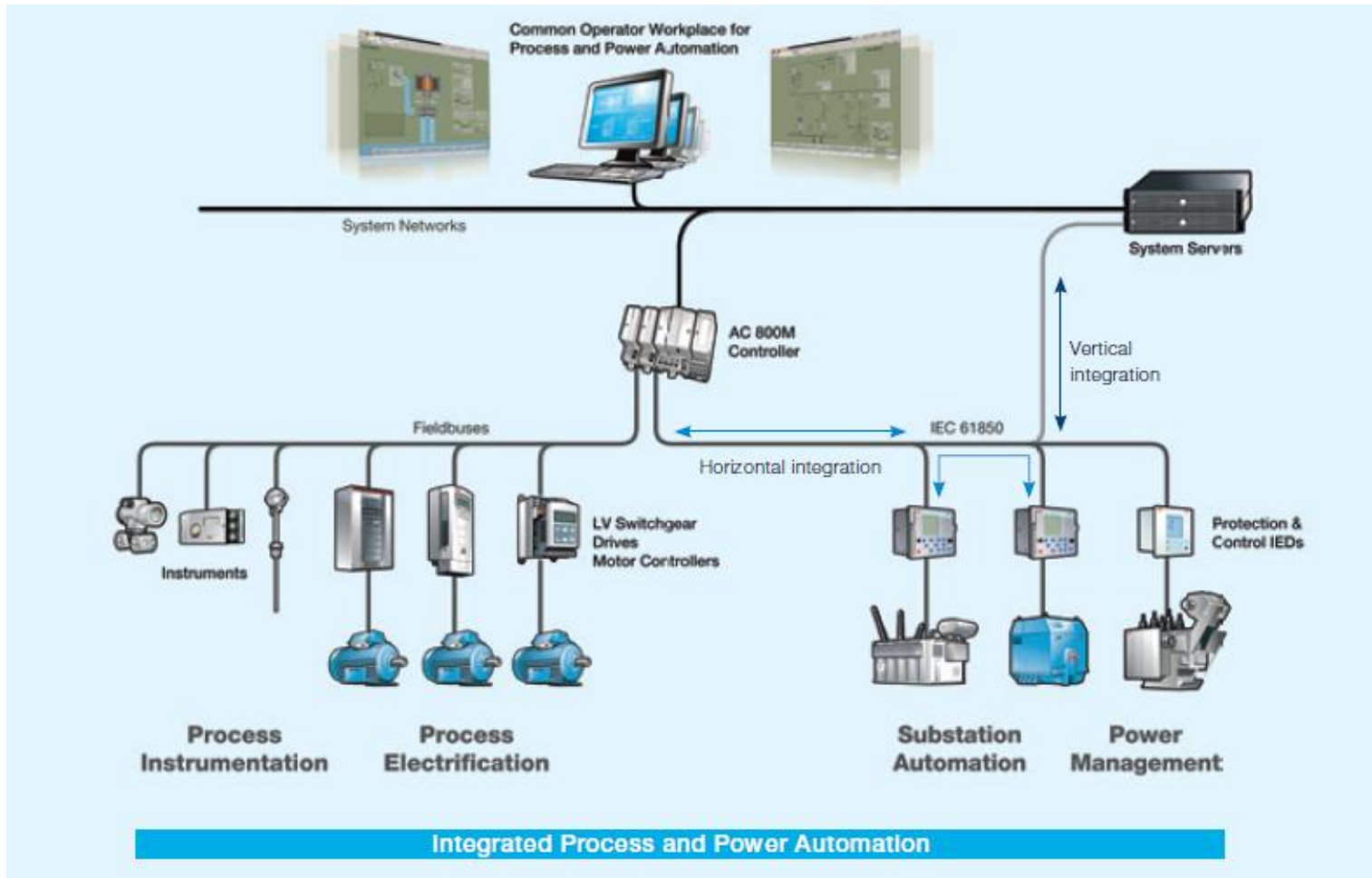
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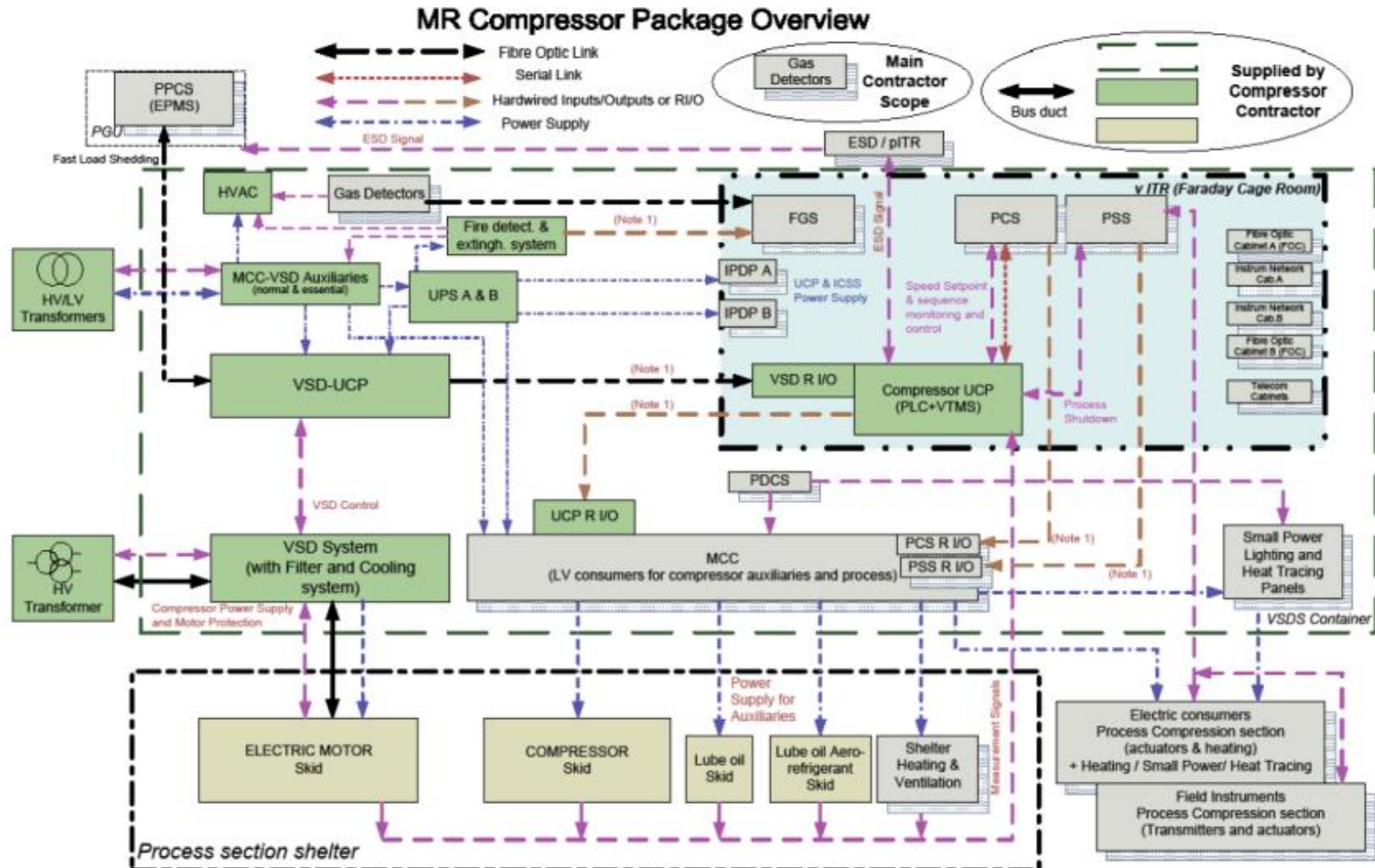
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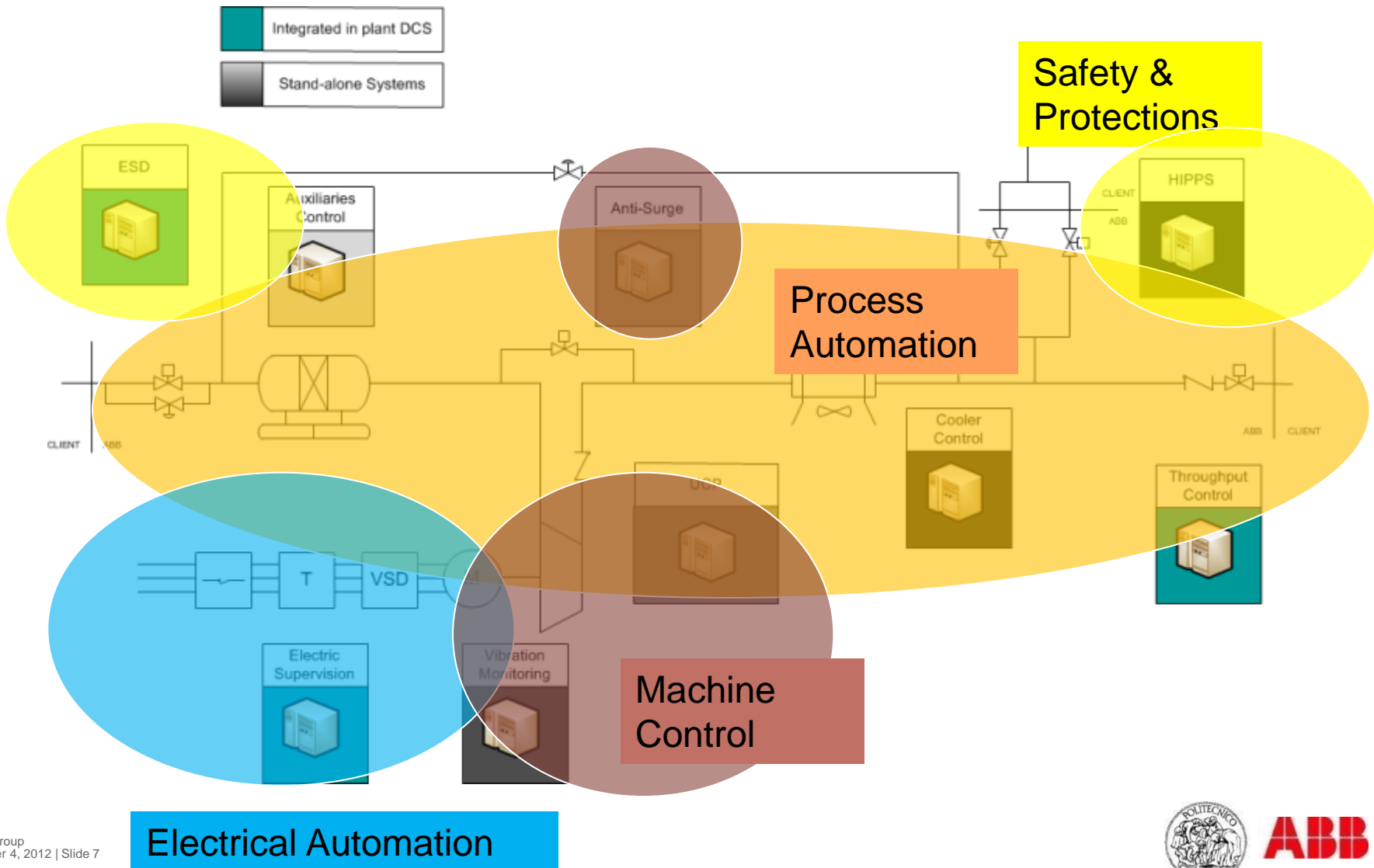


Traditional control solution for rotating equipments

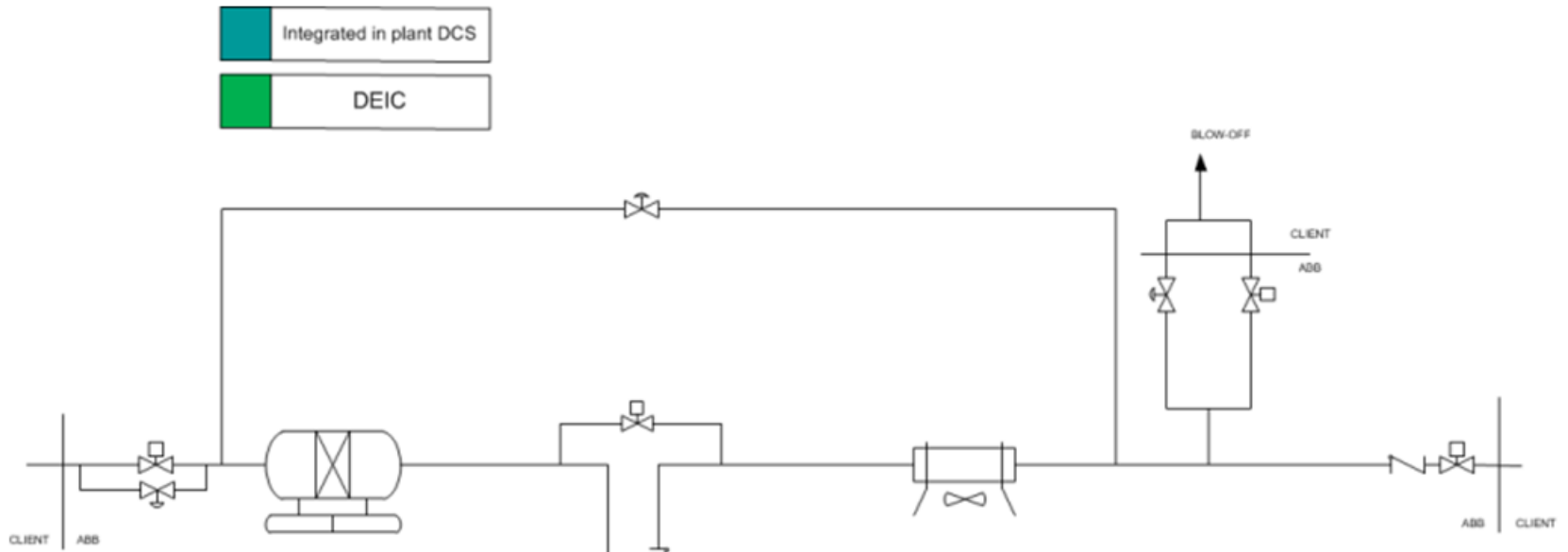
A fragmented architecture



Lesson Learnt From Traditional Solution....



Lesson Learnt ...to an Integrated Solution



Drive and driven Equipment Integrated Control

ESD	UCP	Anti-Surge	Throughput Control	HIPPS
Electric Supervision	M			Many Others Functions

DEIC

DEIC

Drive & driven equipment integrated control system



- The integrated solution providing all the functionalities required for the driving and driven rotating machine
- Features
 - Complete libraries of control and protection functions
 - Supervision & monitoring on the assets
 - Open & modular structure
 - Easy integration with other ABB or third party systems
 - Small footprint
 - Reliable and safe hardware certified by TÜV Rheinland
 - Software designed according to IEC61131 standard

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DEIC

Drive & driven equipment integrated control system



DEIC-700

Compact version, fully functional, no PC required



DEIC-800

Complete DCS solution, granting best performance and high safety level



DEIC-900

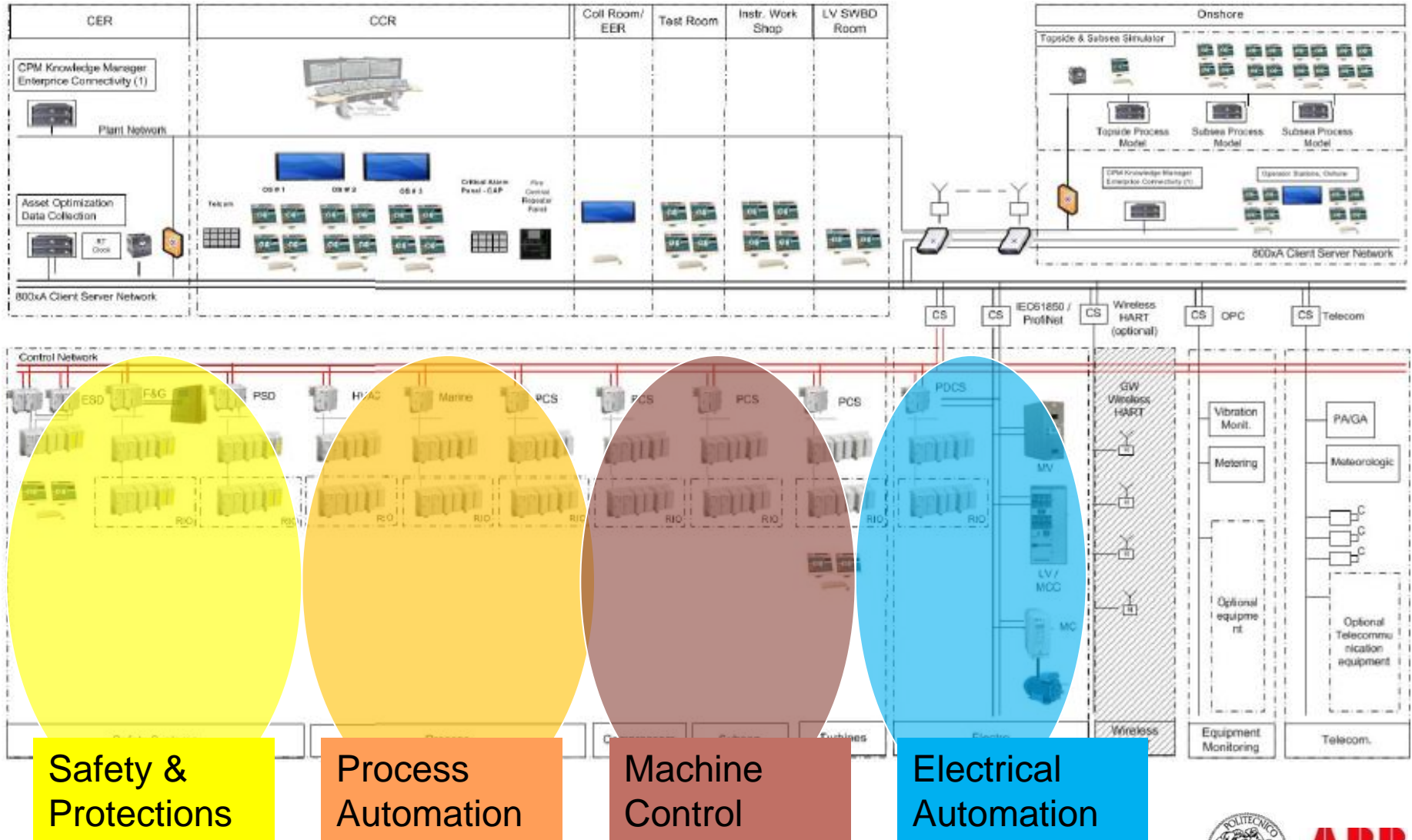
Designed to respond to highest and strictest safety requirements, up to SIL3 level

ENI Norge Goliat FPSO



- Reservoir: Oil & Gas
- Start production: late 2013
- Production: more than 100 000 oil-drums per day, 3.9 million cubic meter gas per day and store 950 000 oil drums
- Client / Country: ENI Norge
- Duration: 2010 - 2014
- Scope of Work: Feed, Electrification, Instrumentation, Control, Advanced Solution, Telecommunication
- ENI Norge requirement:
 - Minimize the number of interfaces for Electrical, Instrumentation, Control and Telecommunication systems
 - Support during FEED
 - Service Support

GOLIAT Automation Architecture



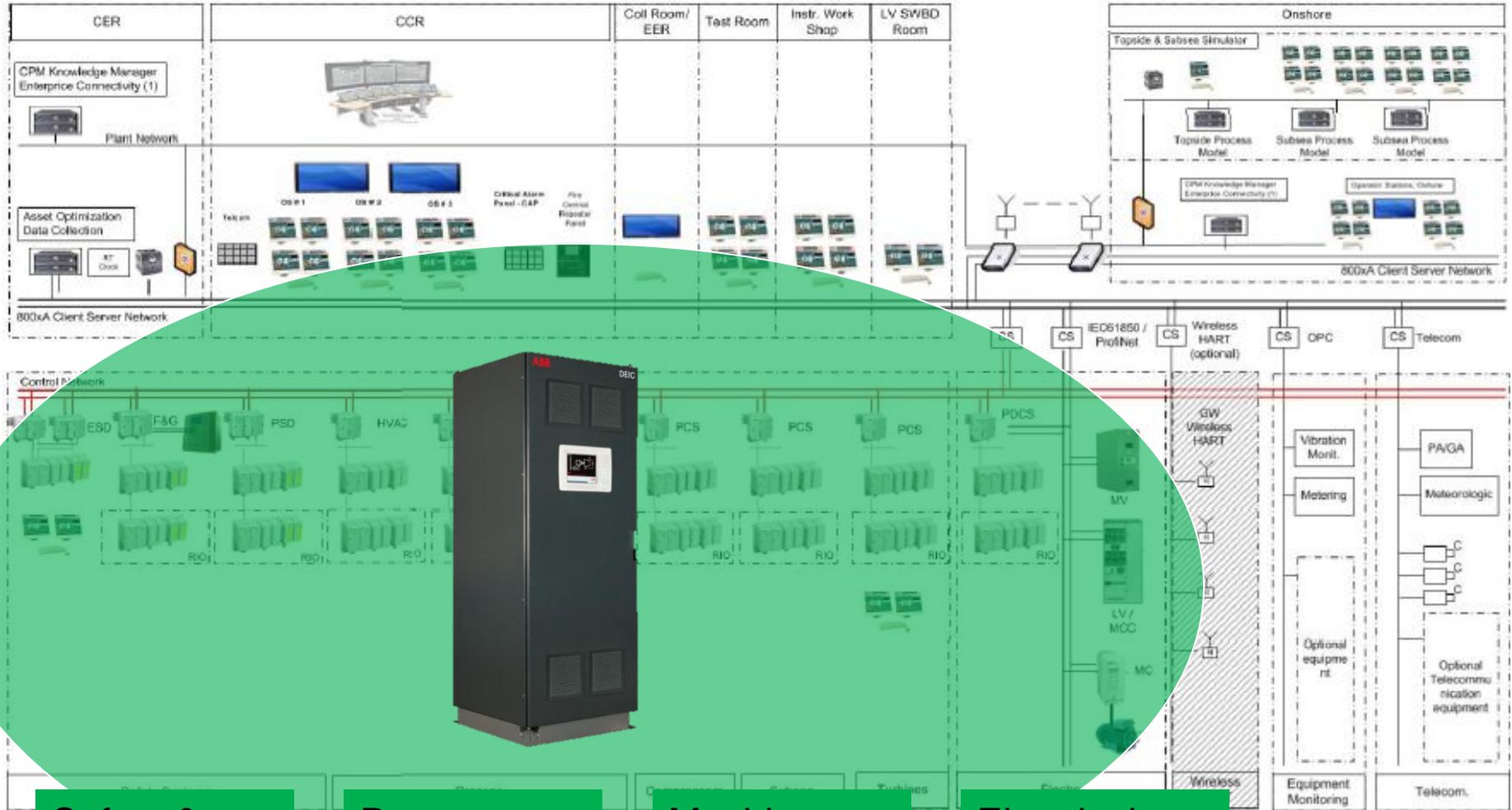
Safety & Protections

Process Automation

Machine Control

Electrical Automation

GOLIAT Automation Architecture



Safety & Protections

Process Automation

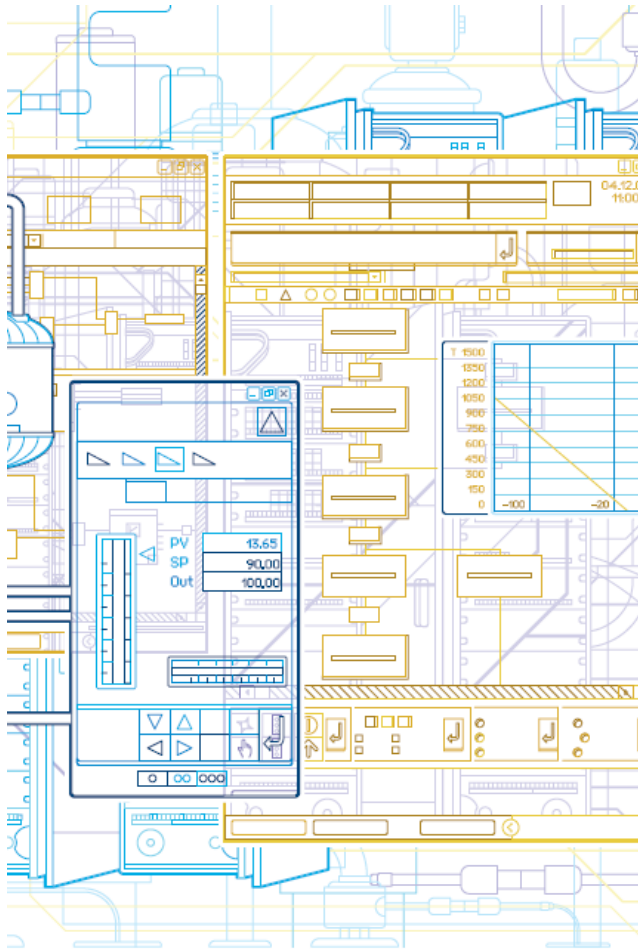
Machine Control

Electrical Automation



Not just Integration

The other areas of Innovation

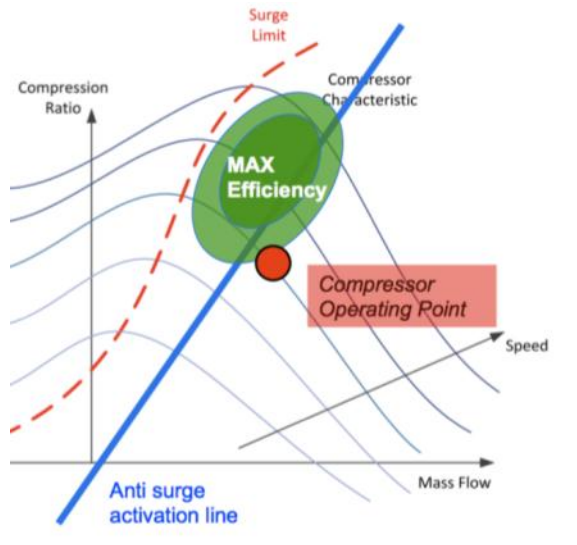


Main areas of innovation:

- Anti-Surge & Drive-assisted Anti-Surge Control
- Advanced Load Sharing
- Performance Monitoring System

Compressor instabilities

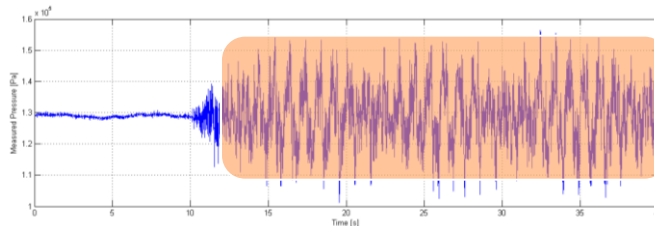
Surge



- Gas compressors are unstable in certain operating conditions
- Unstable operation can be easily depicted in
- “Surge” is the most dangerous instability, related to low flow, high discharge and/or low suction pressures

- Surge’s pressure and flow oscillations cause high compressor’s blades thermal and mechanical stress
- The stress can be intense and cause blades breaking
- Maximum efficiency stands very close to surge limit

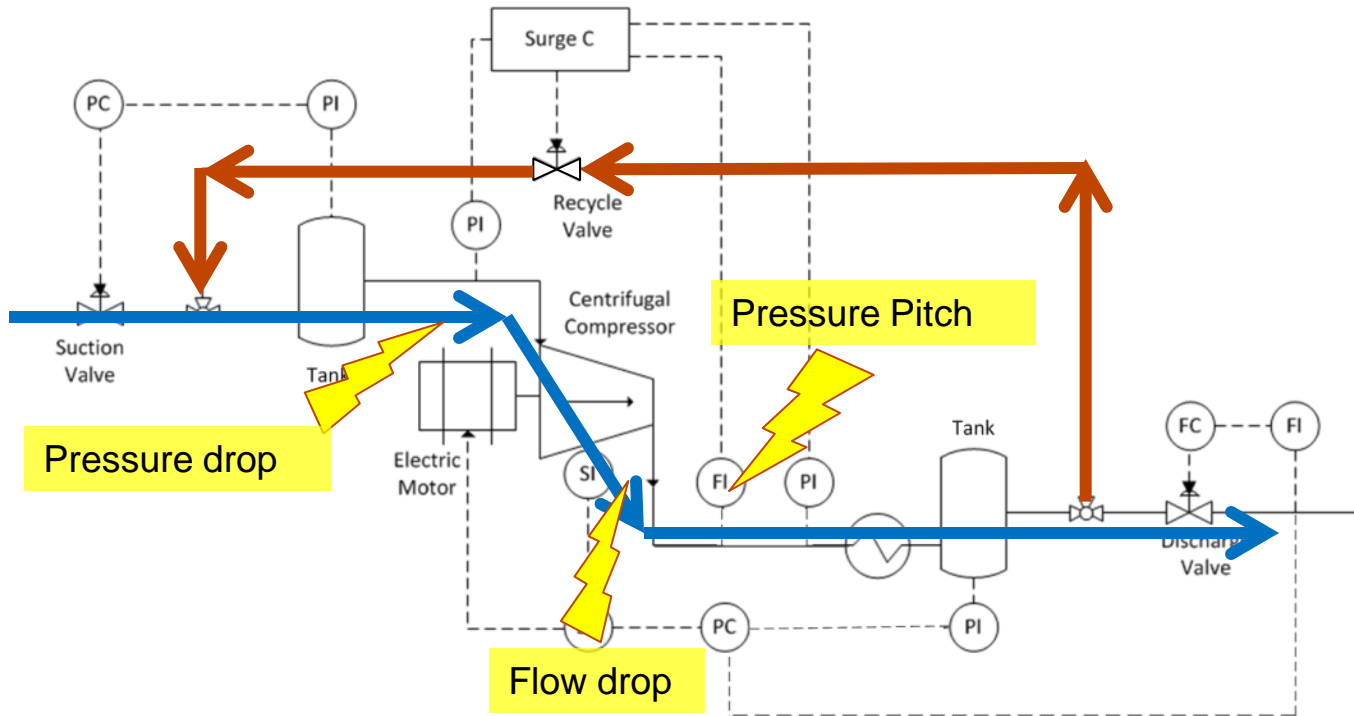
Volumetric flow [m³/h]



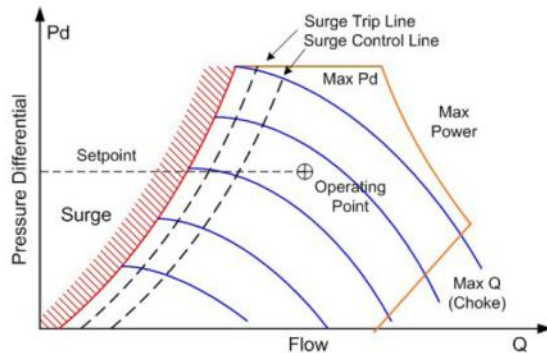
Time [s]

Compressor instabilities

Anti Surge Control



Antisurge control

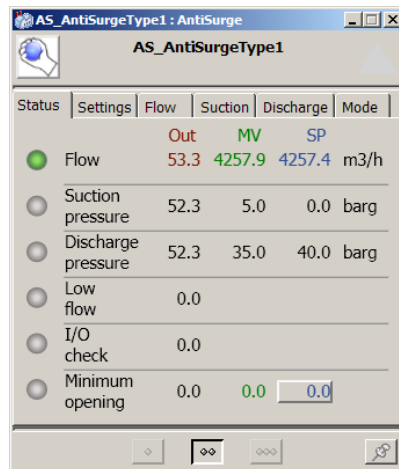


Includes all “standard” anti-surge control functionality:

- Control-line control
- Surge protection by ensuring 100% valve signal before reaching the surge line
- Suction/discharge pressure control
- Gain-scheduling and valve linearization functionality
- Fast control cycle time (10ms)

Provides a fully open and integrated anti-surge control system:

- Reduces installation, commissioning, training, and maintenance costs
- Providing the operators with the same look and feel of the other control blocks

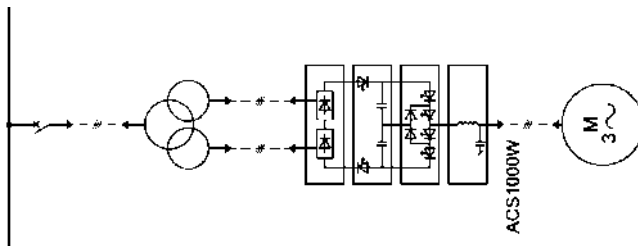


Anti surge control

The contribute of VSD



- Variable Speed Drives (VSD) as driver of compressors and pumps is the new growing trend
- This solution enhances availability and energy efficiency of the system
- The only solution for subsea applications



- VSD have a response time of few milliseconds to a step speed reference change
- Gas turbines have a response time of several seconds
- This rapidity can pave the way to new surge protection schemes

Anti surge control

The contribute of VSD

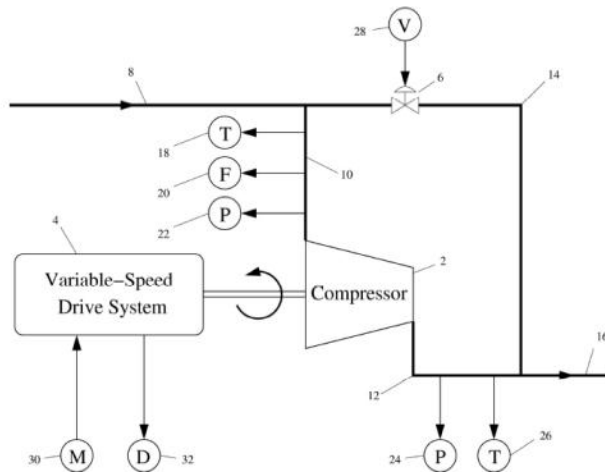
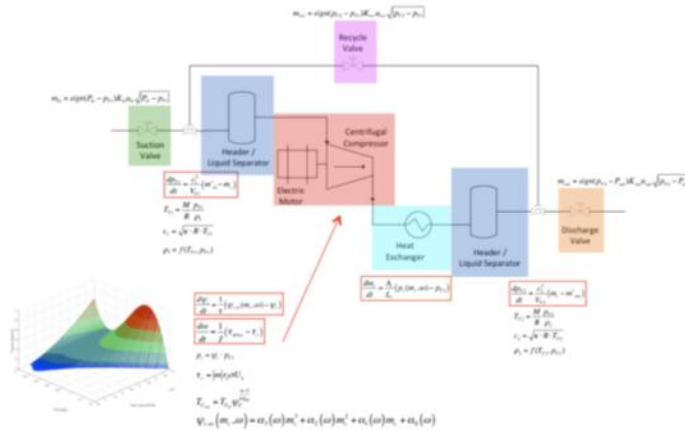


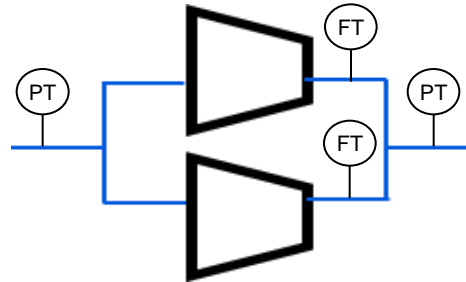
FIG. 1

- Standard Anti-Surge Control suffers the “slow” speed of the anti-surge valve
- Surge can take few fractions of seconds to appear.
- VSD are significantly faster than the ASV and can help the compressor to stay safe while the ASV opens.
- Coordinated control between VSD and ASV is a challenge in compressor protection systems

Advanced Load Sharing

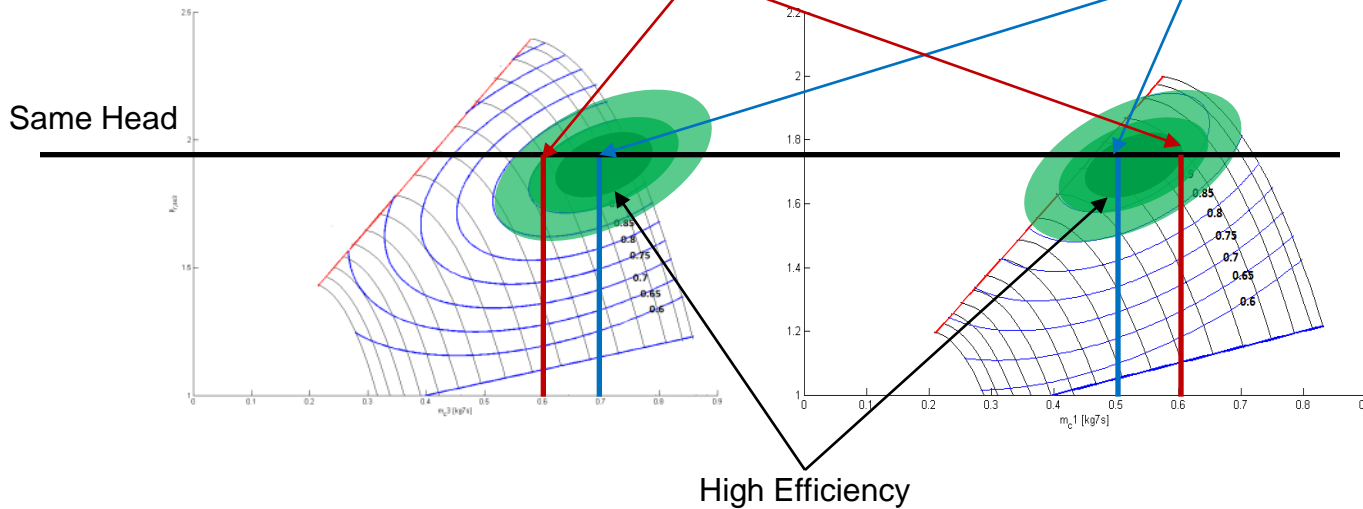
What is Load Sharing Optimization

Case Study: Two Similar Compressors operating in parallel



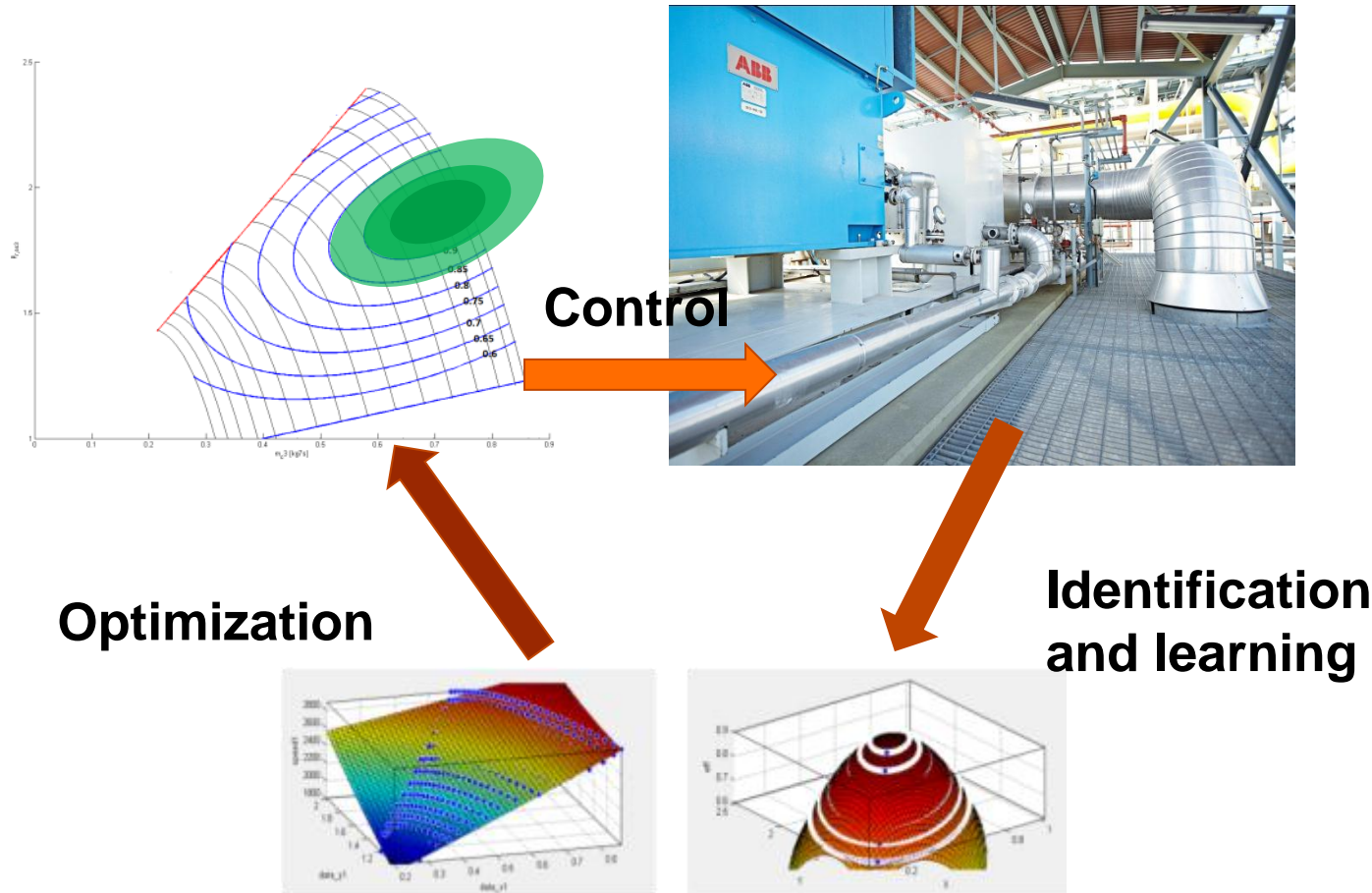
Initial operating point
Less efficient
(Same Speed / Flow)

Optimized operating point
Energy Saving
(Different Speed / Flow)



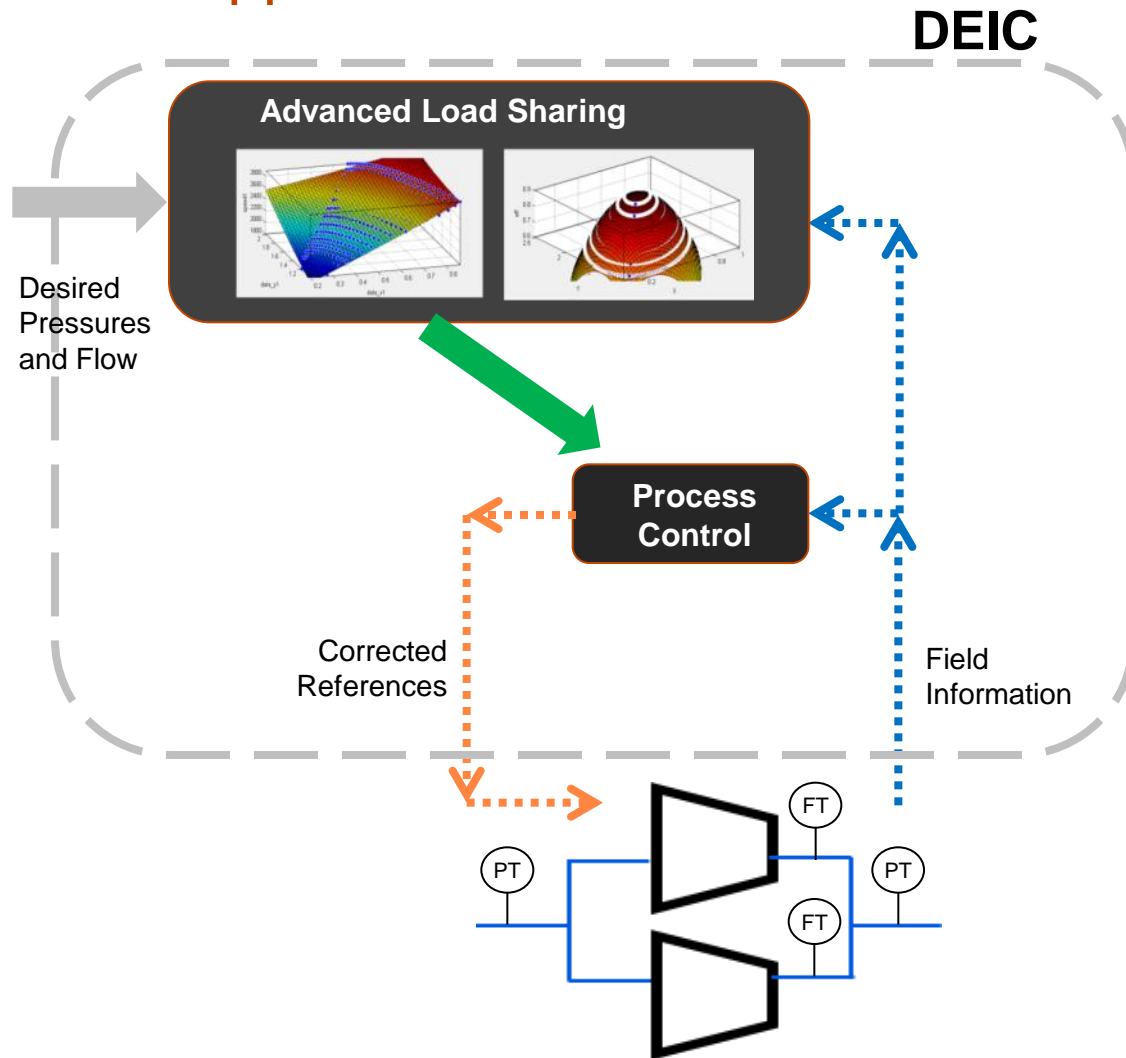
Advanced Load Sharing

What is Load Sharing Optimization



Advanced Load Sharing

A new approach



Currently the load balance between parallel compressors is computed by:

- Same flow
- Same distance from surge

Advanced load sharing is based on optimization of machines performance taking into account:

- Performance maps
- Compressors aging
- Field information

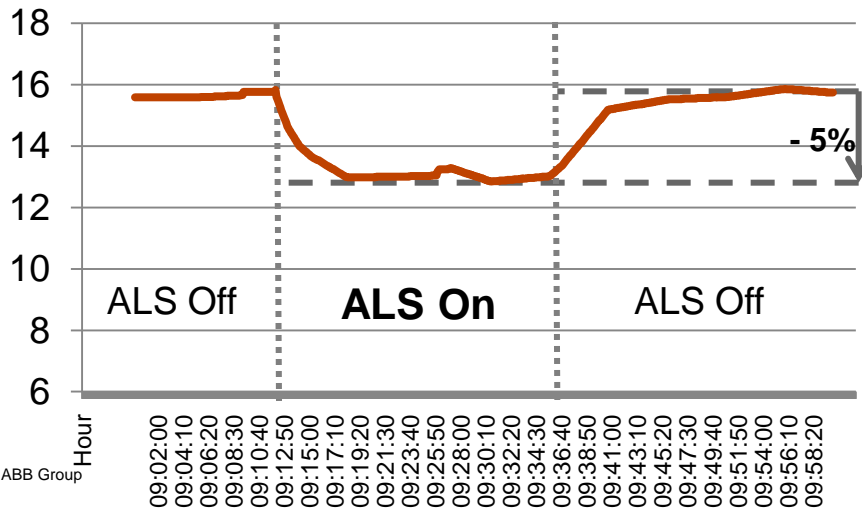
The optimization parameters are adapted as the system changes by using learning algorithms.

Advanced Load Sharing Pilot project



- The advanced load sharing is being tested in a pilot site in a gas pumping station of the TransMed pipeline network
- The commissioning of the system has started in October 2012
- After the commissioning of the system, the fuel gas consumption of **the compression station has reduced by 3%**
- The estimated fuel gas saving is of 1,5 million cubic meters per year
- ...and the best has yet to come !!!

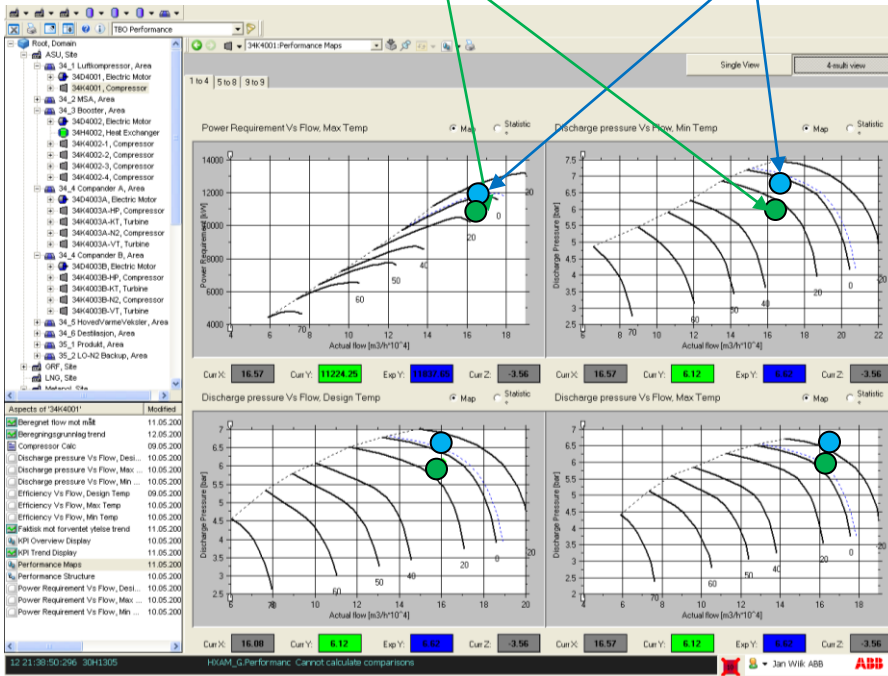
TOTAL TURBOCOMPRESSOR SHAFT POWER [MW]



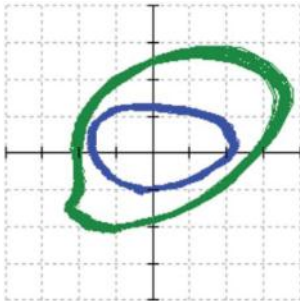
Performance monitoring

Expected
Performance

Actual
Performance



- The Performance Monitoring System provides continuous monitoring of the status of rotating equipment (Compressors, Pumps, Turbines, ..)
- The actual status, measured from the field and the expected status, defined by a model of the rotating machine
- A vibration analyzer (Analyst) monitors the status of the bearings and of the shaft supported by
- This tool provides a powerful help for:
 - Machine online status monitoring
 - Predictive maintenance
 - Fault diagnosis



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