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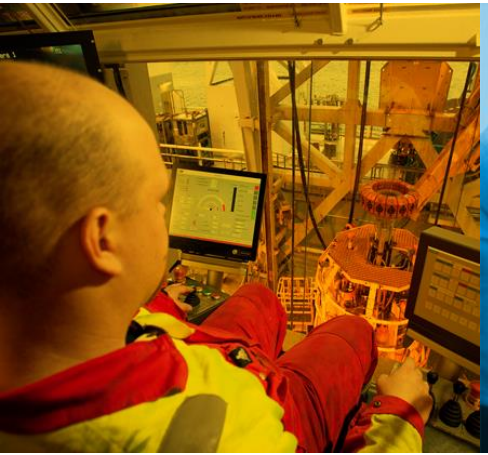
And keep you ahead.

Generations of Subsea Control System - Challenges and Solutions

Subsea Controls Down Under, Perth, WA- Oct 2016, John S Løvås & Guna Settiyannan




Contents

Generation of Control Systems

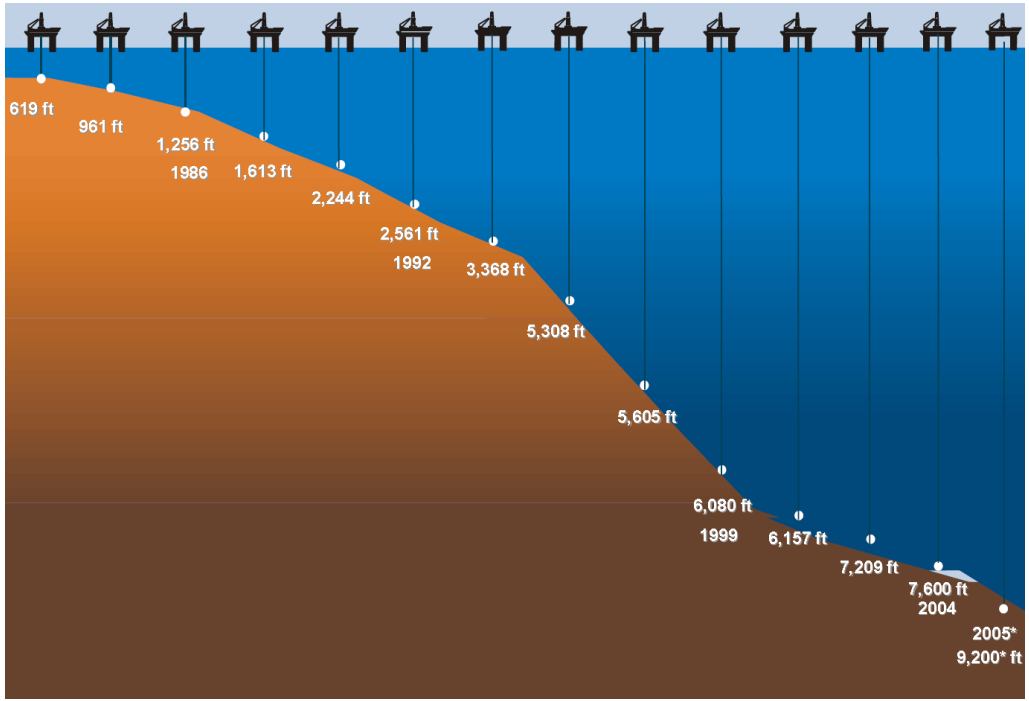
- Challenges
- Generations of Control Systems
  - Background and Key Futures of generations
  - Technology developments and advances utilized
  - Process improvements for a low volume market
  - Solutions and benefits and experiences gained
  - Upgrade solutions/ Lessons Learned
  - Obsolescence
  - New Solutions

Challenges


Depth
Technology
Govt Regulations
High Well Pressure & Temperature
Challenges
High Speed and Data
Water Temperature
Long Tieback
Cost

Challenges- Developments

- Deeper developments
  - In 1947 the first offshore wells were drilled in 21 feet water depth
  - In 2016, 3,400 meters (11,156 feet) is recorded as world deepest well
  - Reserves are identified even below 14000 feet
- Artic developments
- Challenges
  - New Design
  - New qualifications
  - Higher cost
  - Longer lead time



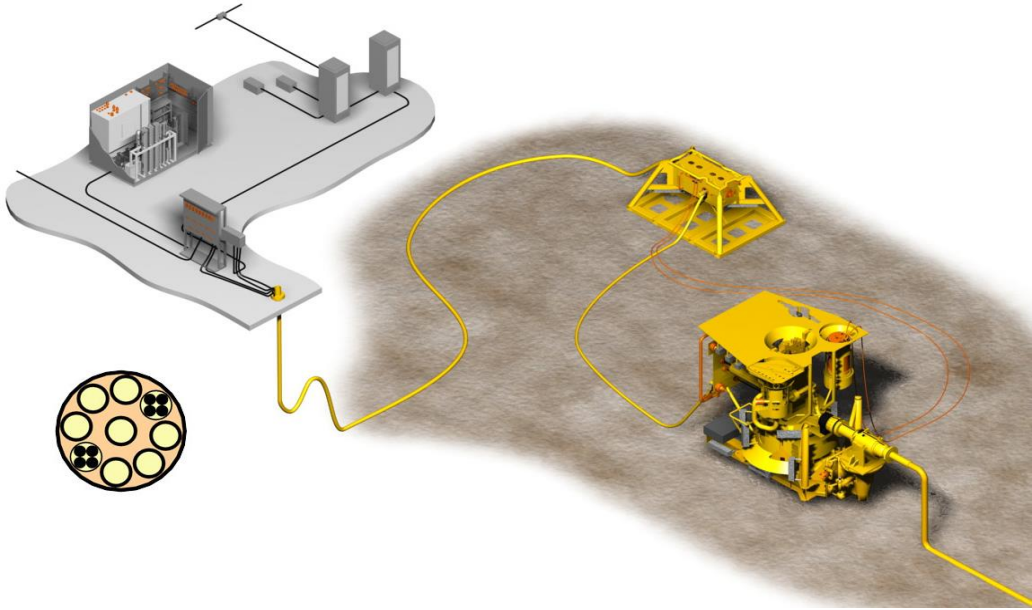
Challenges - Government Regulations

- Seismic Requirements
- Environmental Requirements
- Country Specific Standards
- Certifications
- Local Contents

Challenges - Higher Speed and More Data

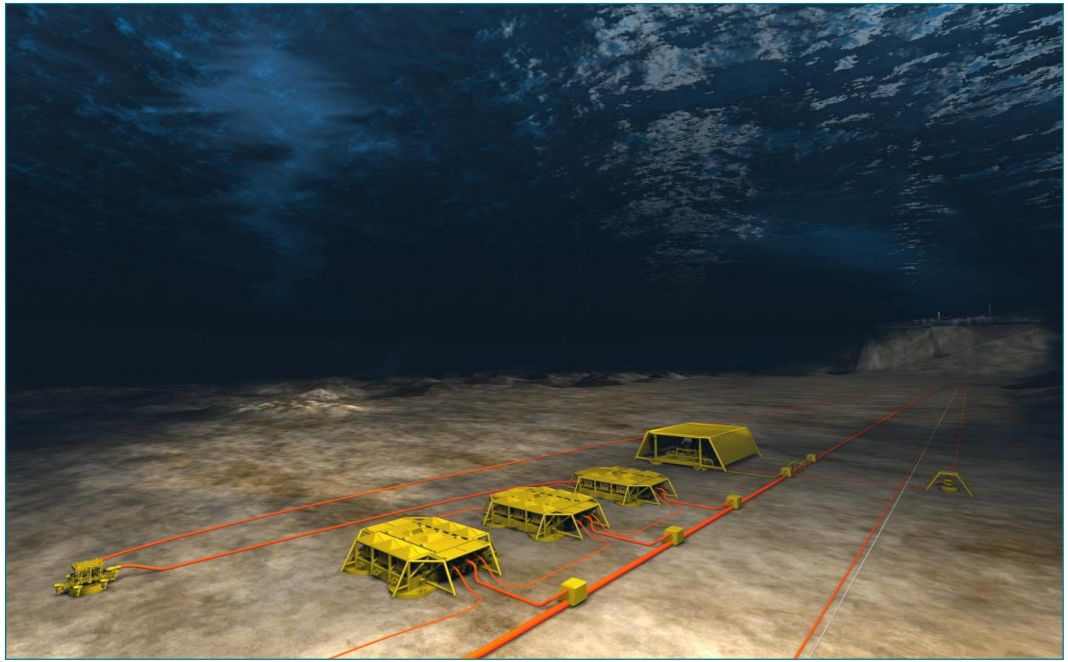
Higher Communication Speed and data rate needs increases

- More Sensors in XT and Manifold
- High accuracy Multiphase meters
- Higher/faster data for diagnostics/ Analysis
- Remote monitoring/Remote Diagnostics
- New Technologies
- Subsea processing
- Increased Safety functions



Challenges - Longer Tiebacks and Step Outs

- Longer Umbilical
- Long Step Out Wells
- Higher Power (EPU, Topside/Subsea Transformers, Connectors etc)
- Communication Technology (Fibre Optic, SRM, various flying leads)
- More Subsea Distribution Equipment's (UTH, SDU etc)
- Higher chemical injection rates (Bigger Couplers, MQC, Hoses etc)
- Bigger HPU (Pump size, Reservoir size, bleed timing, charging timing)
- Challenging Topology



Challenges - Technology Developments

New technology and equipment's are required for

- High Pressure and High Temperature
- Subsea Processing
- All Electric Solutions
- Interface Standardization
- Additional Functional Lines
- New Fluids
- Obsolescence
- Cost reduction
- Reliability
- Market Demand

Solutions- Generation of Control System

- Developed 4 Generations of Controls System together with
  - MCS
  - SPCU
  - SCM (SEM)
  - SRM
  - Communication Modems
  - DCV's
  - Software
  - Instruments

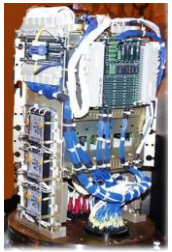
100 System

150 System

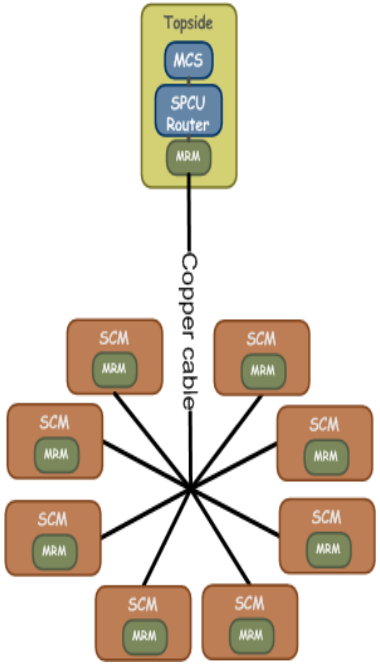
200 System

200e System

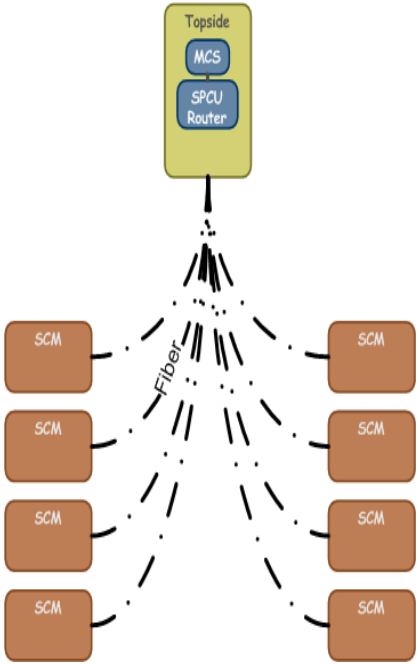
Solutions – SEM Generations

	100 – System	150 – System	200 – System	200e – System SEM600
				
Year of production	1985-1995	1995-2009	2001-2006	2007 →
ISO 13628-6 compliance.	No	No	No	Yes
Communication	Signal on power 1.2kb/s	Signal on power 2.4kb/s	Signal on Power 33.6kb/s. Fiber 4Mbit/s	Signal on Power 234 -1.500 kb/s. Fiber 1Gbit/s
Protocol	Proprietary	Proprietary	Proprietary	Open architecture TCP/IP
Industry Standard Interface	4-20 mA only	4-20 mA only	4-20 mA, IWIS	IWIS & SIIS compatible MDIS Emerging
SIL rated solutions	1	1	1	1 – 3

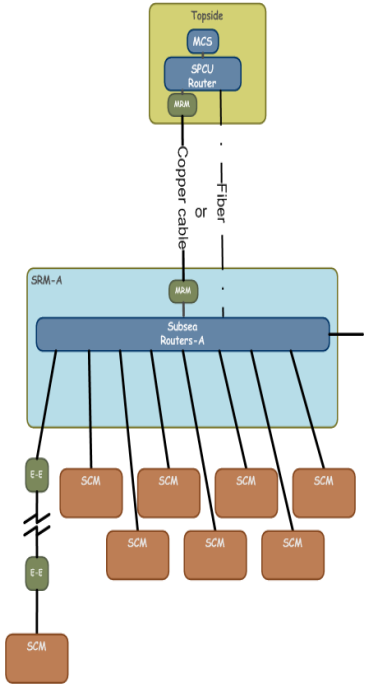
Solutions - Subsea Communication



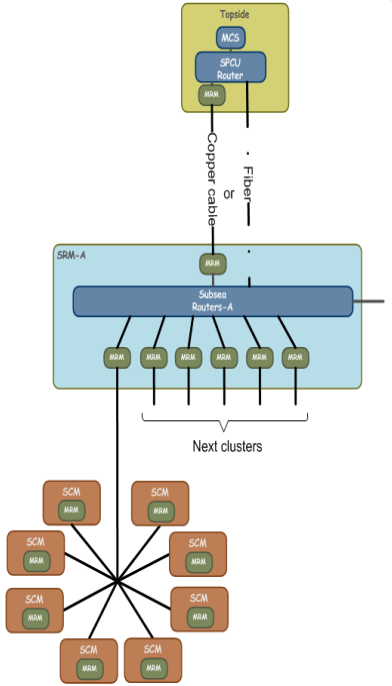
Multidrop communication on power cable



Point to point fiber optical communication



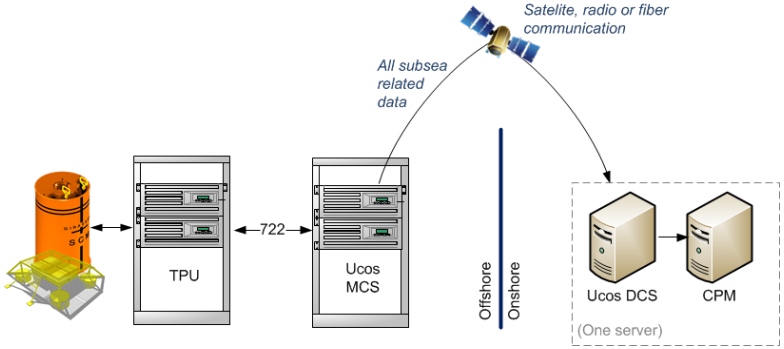
Subsea Router Module (SRM) with point to point Ethernet

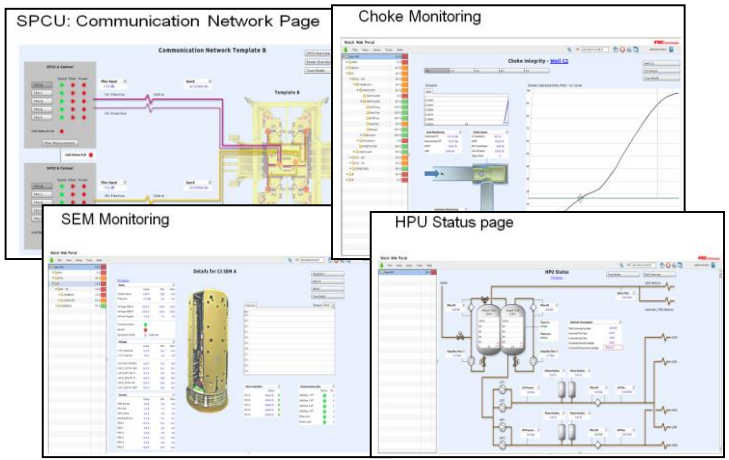


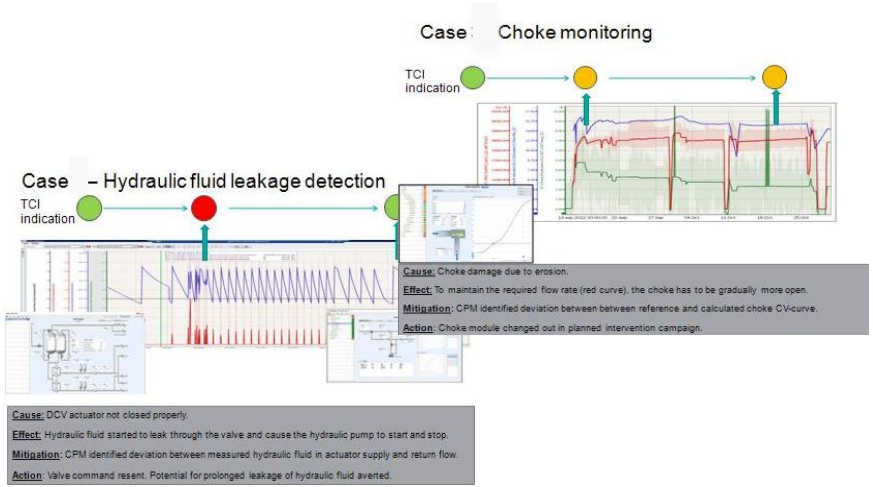
Subsea Router Module (SRM) "Topside repeated subsea"

Solution - Increasing Reliability

- Collection of Product Performance data, SCM Internal/ External/House Keeping Data and Valve Signature,
- Real time condition monitoring of subsea equipment's
- Early warning based on real time performance indicators







Challenges and Solution– Low Volume Market & Process Improvement

- Challenges
  - Low volume
  - Custom built products

- Solution
  - Flexible Standard designs
  - Configurable Products and system building blocks
  - Extensive product /component qualification

Generations of controls System – Upgrade Solution Subsea Electronic Module Upgrade

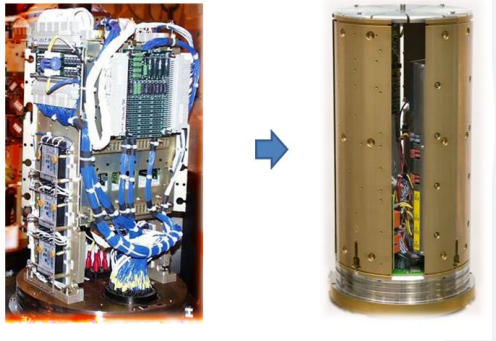
SEM is an improved SEM solution designed to extend the life of fields with SEM150 based SCM's.

SEM is a drop-in solution for SEM150 that supports new sensor interfaces such as CAN bus and IWIS.

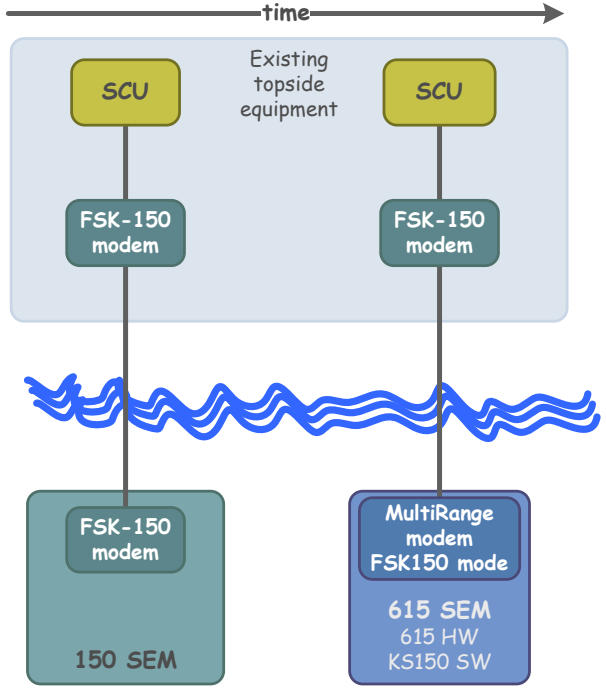
Topside changes are only needed if customer wants to enable additional functionality.

Upgrade open up for installation of a 200e system topside by activating the 200e functionality in the SEM615 for even further 'life of fields'- extensions.

SEM615 is a part of the field proven SEM600 series with significant improved reliability.



Generations of controls System – Upgrade Solutions Examples



Topside

Upgrade of a FMC 100/150 system

Subsea

Original system

Obsolescence challenges solved

Original functionality

No topside changes needed

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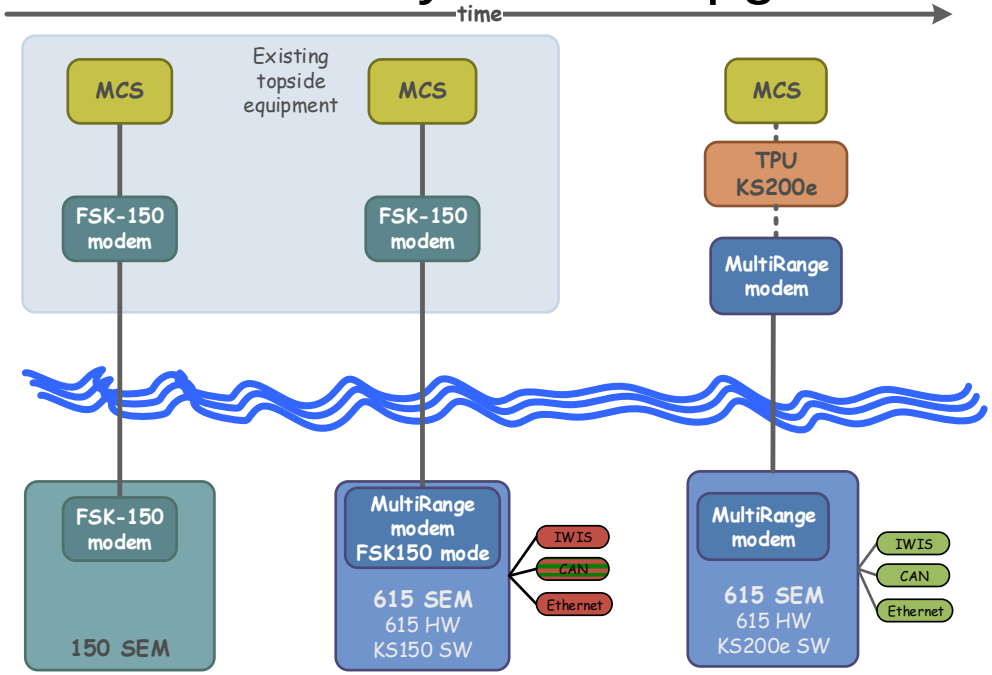
Generations of controls System – Upgrade Solutions Examples



Topside

Subsea

Original system

Obsolescence challenges solved

Original functionality

No topside changes needed

Obsolescence challenges solved

Improved bandwith.

IWIS and SIIS (CAN, Ethernet)

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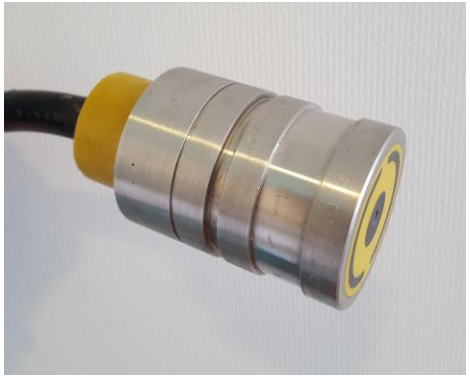
Challenges and Solution – Electrical connectors

Initial Subsea Control system used Inductive electrical couplers, which was a theoretically good solution for electrical connections for many reasons.

- Challenges
  - Loss because of tolerances
  - Not contamination tolerant
  - Sensitive form a operation point of view-

- Solution
  - Moved to conductive electrical couplers when mature for Deepwater system.
  - Achieved more electrical circuits i.e. function



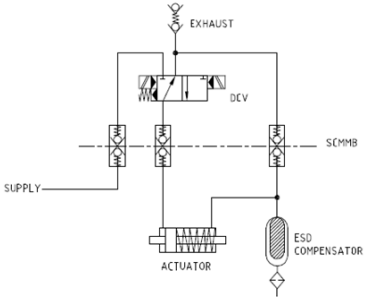
Challenges and Solution– Compensation System

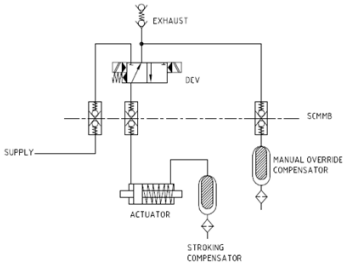
Challenges :

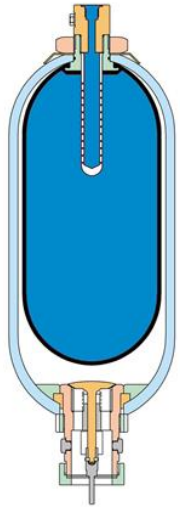
- Hydraulic lock connector/valve
- Compensation system sizing/design.

Solution

- Improved Design of hydraulic connector and system
- Compensation system designed and sized to handle storage , intervention operational and life of field operation.



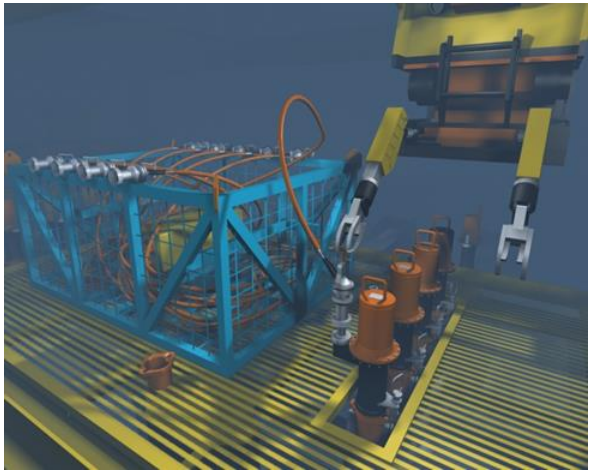


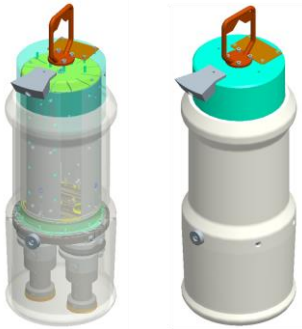


Challenges and Solution– Electric System

- Challenges
  - Electrical system actuator needs more power than a traditional subsea system.

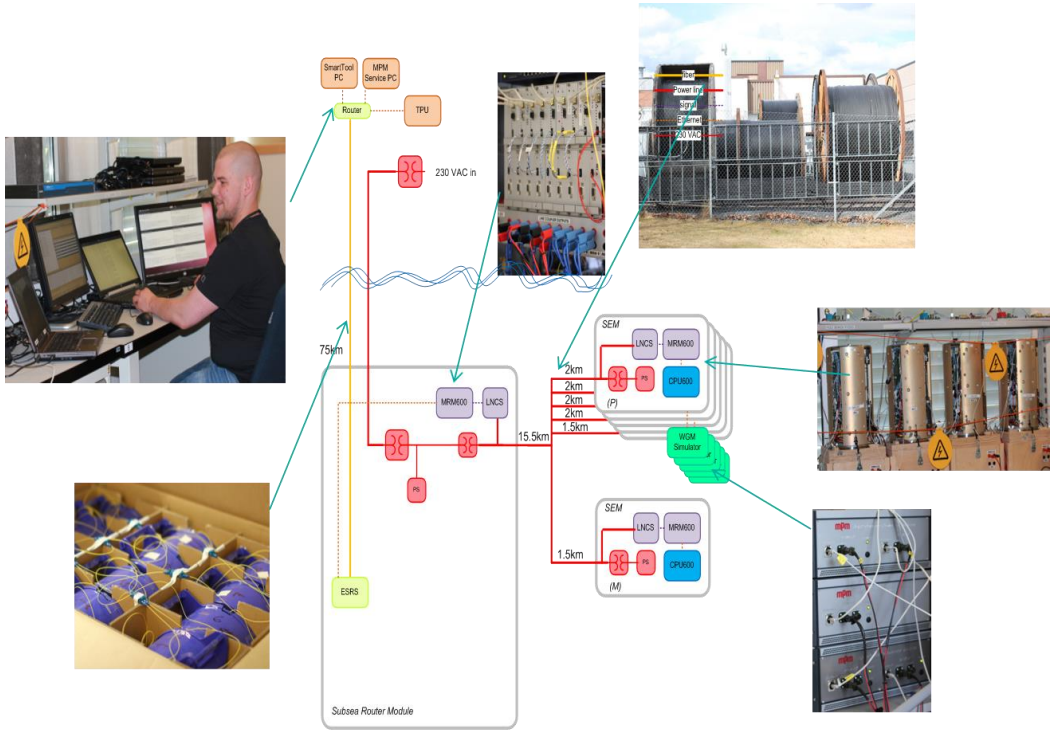
- Solution
  - Battery used to integrate electrical actuator system in legacy system for retrofit functionality.(choke /manifold)
  - Subsea Uninterrupted Power Supply for SIL safety systems





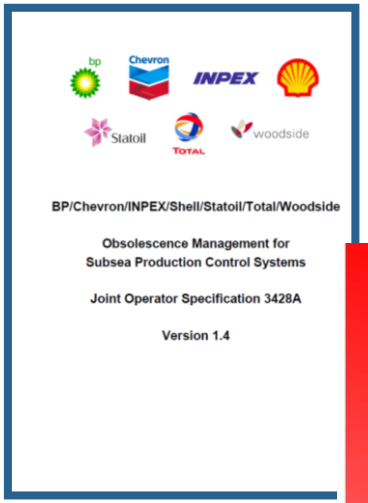
Challenges and Solution– System Performance Analysis

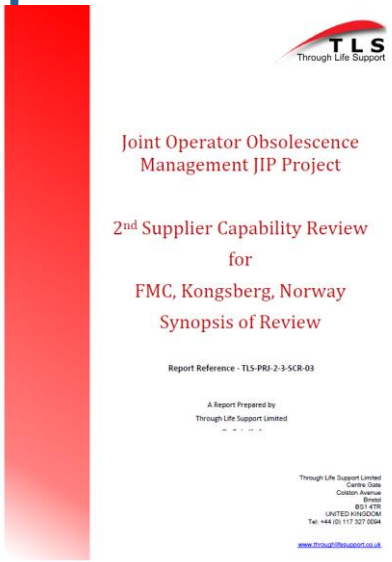
- Challenges
  - Complex subsea architecture
- Solution
  - Full scale Topology Test to verify complex configuration.
  - Up to 200 km electrical cable and 300 km fibre optical line for test available.



Obsolescence challenges and solution

- Form a historic point of view focus has not been Obsolecence managment /planning
- The Joint Obsolescence Management Specification is a joint effort between several clients
- FMC has developed OM plans, global Work instruction and specification and master documents





Conclusions

FMC have firmly addressed the requirements of Specification and used sound Project Management principles to set in place a plan to achieve full compliance across all activities by 2015.

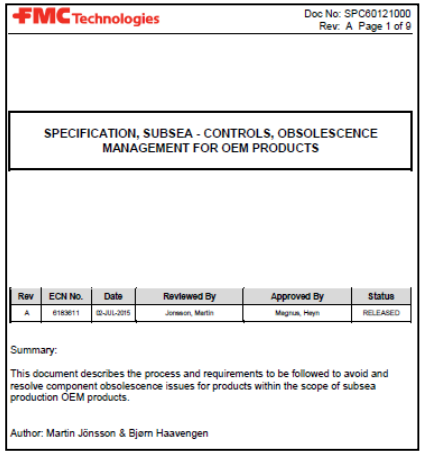
Generation of a GAP analysis and then auctioning and measuring success against this analysis is a good practice and will enable FMC control over implementing the RS.

This second SCR was a bit of “surprise” and FMC are to be congratulated on the actions taken and the obvious commitment to providing their customers (Operators) with a FMC capability to achieve the contractual requirements for Obsolescence Management.

Whilst it may be seen that there has been no noticeable improved delivery to the customer since the original SCR the organisation and processes that have been implemented and planned to be implemented will achieve compliance faster and more effectively than was evident from the first SCR.

FMC should be congratulated on their progress and commitment.

OM Specifications, various levels in value chain



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Doc No: SPC60121000
Rev: A Page 1 of 9

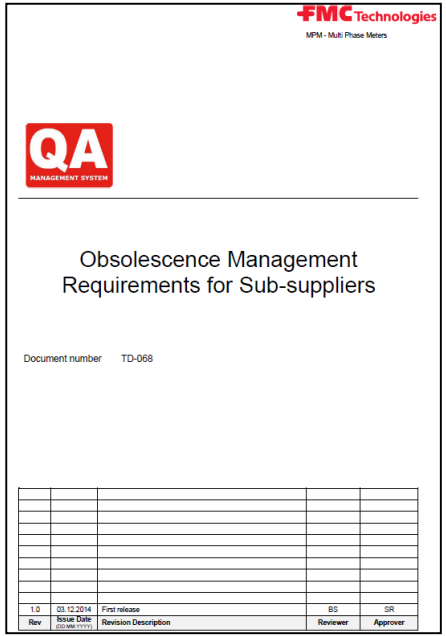
SPECIFICATION, SUBSEA - CONTROLS, OBSOLESCENCE MANAGEMENT FOR OEM PRODUCTS

Rev	ECN No.	Date	Reviewed By	Approved By	Status
A	6183611	02-JUL-2015	Jonsson, Martin	Magnus, Heyn	RELEASED

Summary:

This document describes the process and requirements to be followed to avoid and resolve component obsolesceonce issues for products within the scope of subsea production OEM products.

Author: Martin Jönsson & Bjørn Haavengen



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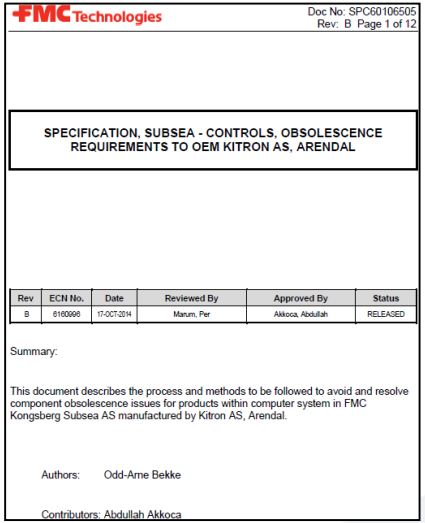
MPM - Multi Phase Meters

QA MANAGEMENT SYSTEM

Obsolescence Management Requirements for Sub-suppliers

Document number TD-068

1.0	03.12.2014	First release	BS	SR
Rev	Issue Date (DD.MM.YYYY)	Revision Description	Reviewer	Approver



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Doc No: SPC60106505
Rev: B Page 1 of 12

SPECIFICATION, SUBSEA - CONTROLS, OBSOLESCENCE REQUIREMENTS TO OEM KITRON AS, ARENDAL

Rev	ECN No.	Date	Reviewed By	Approved By	Status
B	6160998	17-OCT-2014	Marum, Per	Akkoca, Abdullah	RELEASED

Summary:

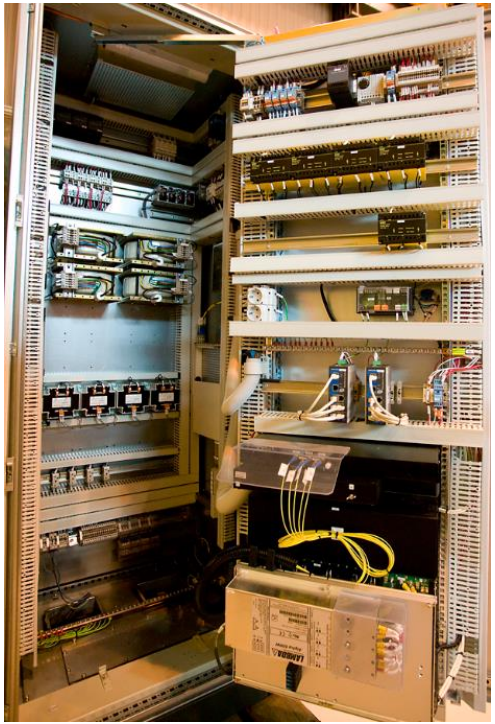
This document describes the process and methods to be followed to avoid and resolve component obsolescence issues for products within computer system in FMC Kongsberg Subsea AS manufactured by Kitron AS, Arendal.

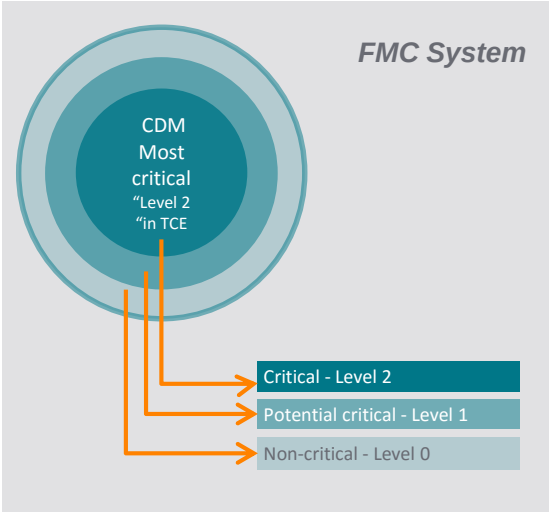
Authors: Odd-Arne Bekke

Contributors: Abdullah Akkoca

Several levels of managing obsolescence -

Highest focus to most critical components





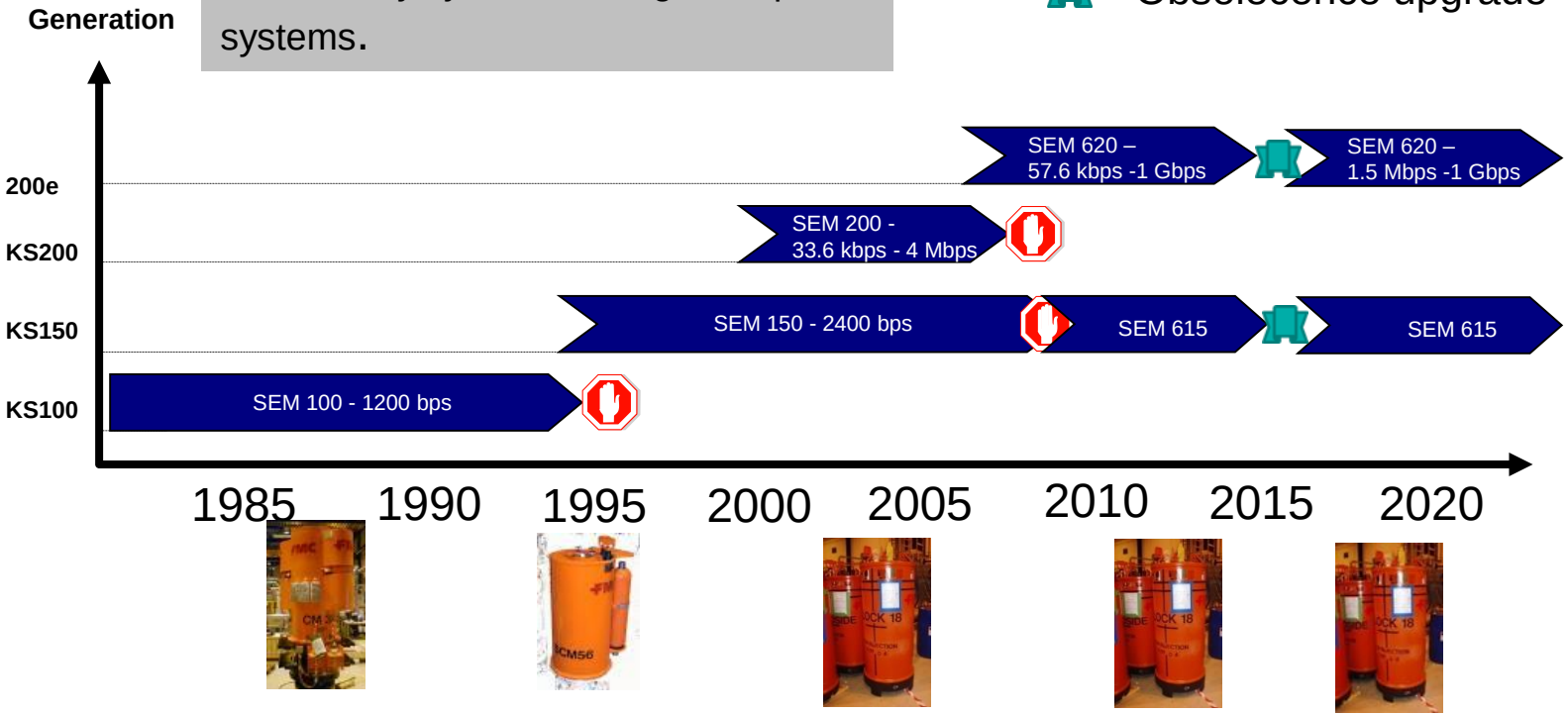
Generations FMC Subsea Electronics

MKII and III SCMs

200e includes scalable standard building blocks suitable for low functionality systems to large complex systems.

Obsolete

Obsolecence upgrade



FMC Future – build on experience but..

- Change focus
- Simplify
- Eliminate waste
- Reduce size
- Reduce part count
- Remove scope
- Challenge requirements
- Question some truths
- Automate

- Listen
- Collaborate
- Innovate
- Be bold

Questions?

Thank You