Digital Ships

Autonomy and Remote Access

September 2019

Lloyd's Register

Introduction – Digital Ship

Digital Ship Product Structure at LR

Digital Ship Assurance

LR Digital Ship Deliveries Examples

Digital has Created a New World Order

Fast forward to Today

- **Apple** becomes the first trillion dollar company in August 2018

- **Amazon** reaches the trillion dollar mark after 4 weeks.

-**Google and Microsoft** are not far behind at roughly $900 billion each.

Image source: Visual Capitalist

Technology is transforming the marine world

=

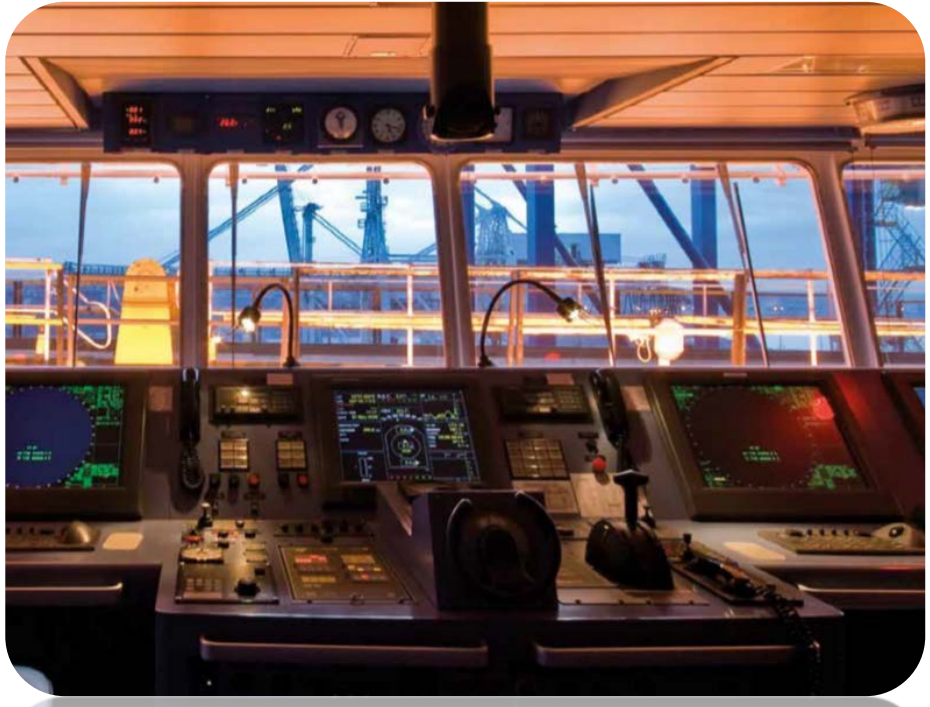
- Reduce costs
- Increase operational efficiencies
- Enhance safety
- Become more sustainable
- Reduce environmental impacts

Digital Ships

Today's leading suppliers and operators want to innovate, using the latest technologies for **autonomous** or **remote operation.**

This new era in the marine sector is often referred to as the 'digital ship'.

Autonomous does not necessarily mean ***Unmanned***



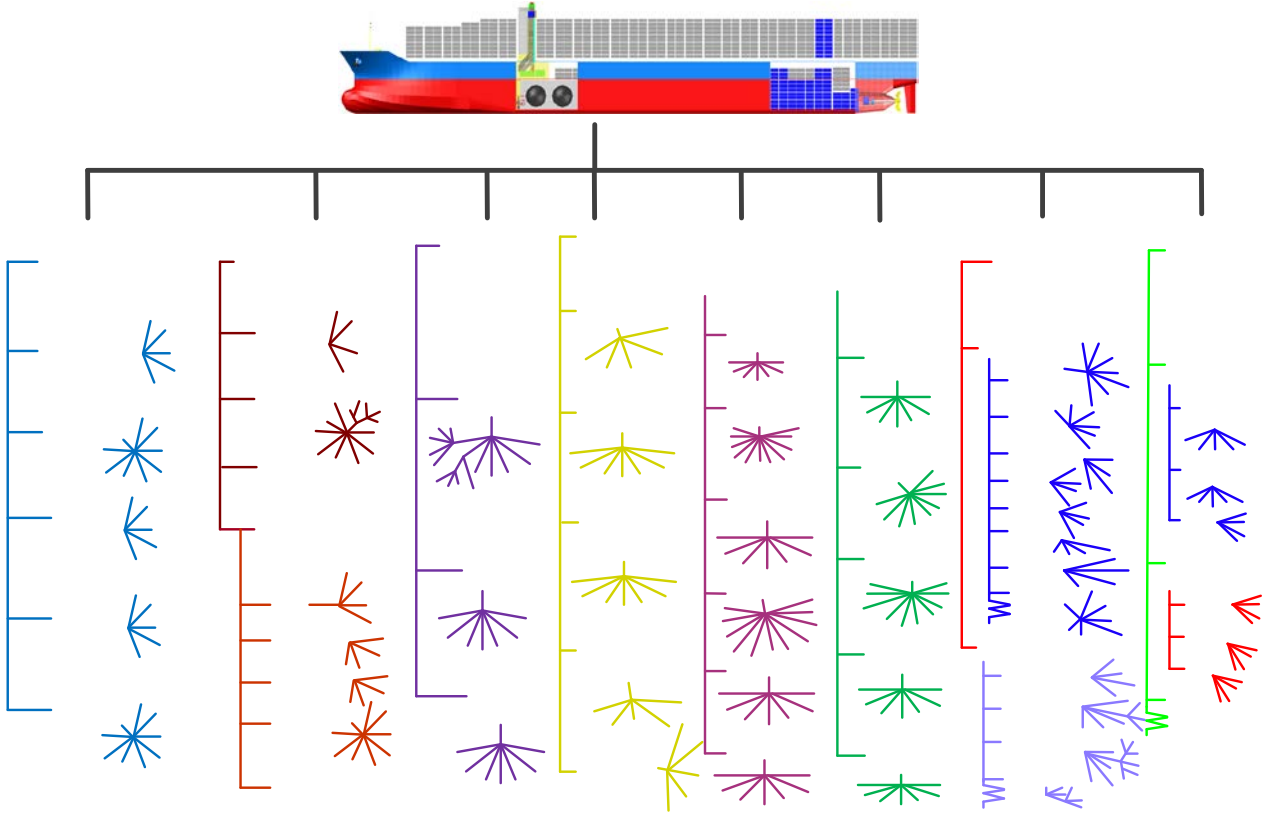
Opportunities in Digital Ships

- The ability to capture and analyse a wide range of data, including operational, service and monitoring.
- Operational support and guidance
- Performance and maintenance optimisation
- Addressing shortfall in crew competence (particularly for engineering roles, as complexity and demand for performance increase)
- Ability to easily update products based on software (cyber implementation techniques provide an easy path to product evolution)
- The ability to future proof ships (having system components designed to be adapted and extended in function, for example, through software changes)

Note: Automated ≠ Autonomous

Automated (design based on established nominal and abnormal conditions) **≠**
Autonomous (**Automated** + capacity to learn and adapt improving the performance)

There are over 30 unique communications, electrical, mechanical, navigation and safety systems in a typical ship.

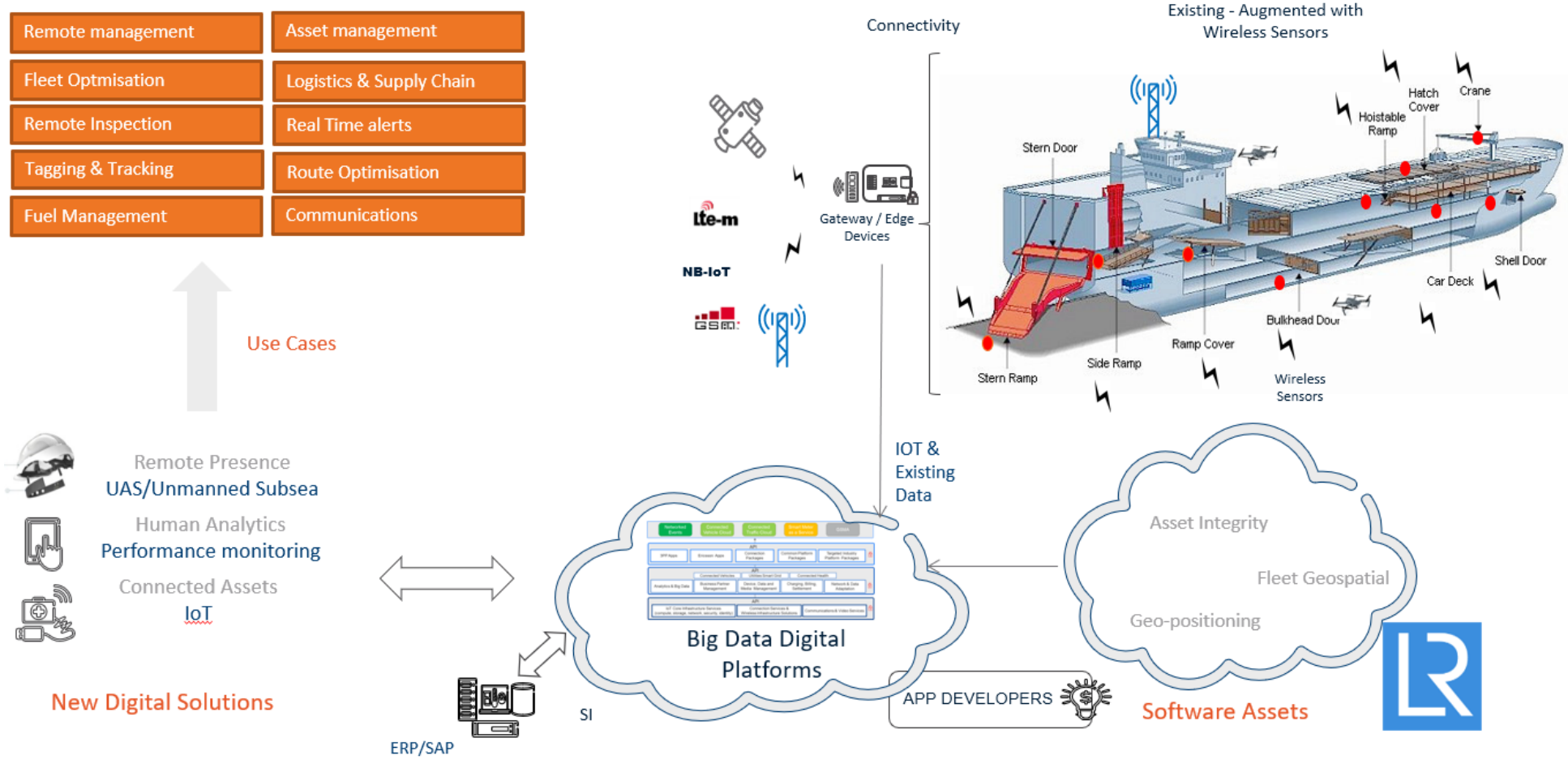


What can be connected in a Digital Ship?

- Navigation (ECDIS, AIS, GPS,…)
- Communication
- Propulsion and Steering
- Power Generation, Management, and distribution
- Ventilation & chilled water
- Fuel, lubrication & other ancillaries
- Fire Fighting and Emergency Systems
- Flood / Stability
- Cargo Systems
- Accommodation Systems
- Dynamic Positioning

… nearly any system…

The Digital Ship



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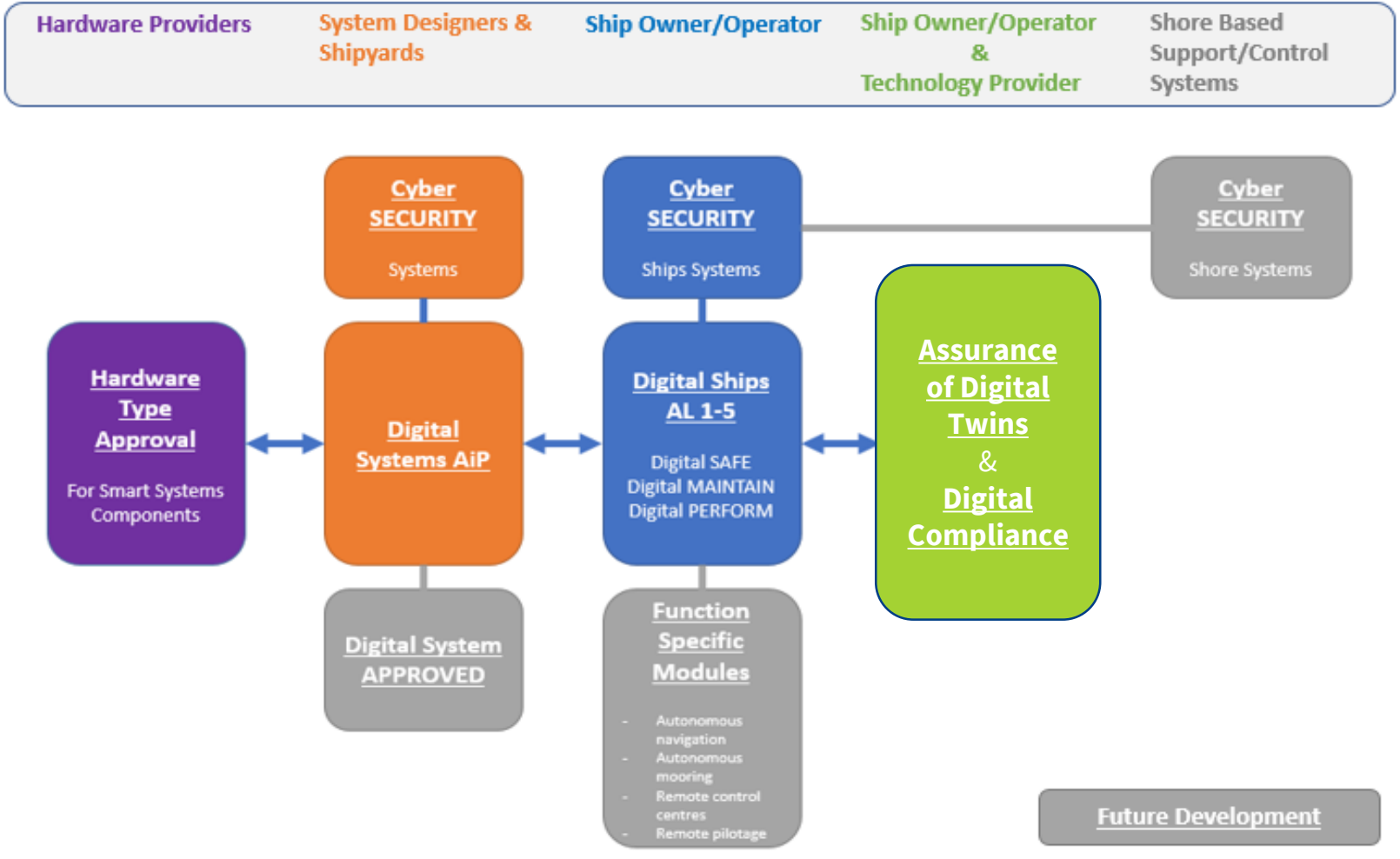
Digital Ships: The Story So Far...

Lloyd's Register

Value Proposition Design

Customer	Hardware/Technology Providers	System Integrators/Shipyards	Ship Owner/Operator
Challenges	- Need to give confidence in product to customers - Need to access new markets - Grow market share - Establish substantiated use cases	- Need to give confidence in product to customers - Need to access new markets - Grow market share - Brand projection	- Demonstrate safe system to regulators (enable use) - Brand projection - Need confidence in safety of technology - Digital Systems claim they provide benefits, but are not always understood by this group, or trusted to deliver operationally
	↓	↓	↓
LR Products & Services	- Smart Component Type Approval - Assurance of Digital Twins: 'READY' & 'APPROVED'	- Systems AiP - Systems Cyber Security - Assurance of Digital Twins: 'READY' & 'APPROVED'	- Digital Ships Descriptive Notes and Cyber Security - Digital Compliance and Assurance of Digital Twins: 'COMMISSIONED' & 'LIVE'
	↓	↓	↓
Gains	- Confidence in technology in new markets - Confidence in technology in existing markets - Brand projection	- Confidence in technology in new markets - Confidence in technology to existing markets - Brand projection	- Confidence in technology being used - 3rd party backing to regulator cases - Brand projection - Class benefit of using digital technology through Digital Compliance

Modular Product Structure



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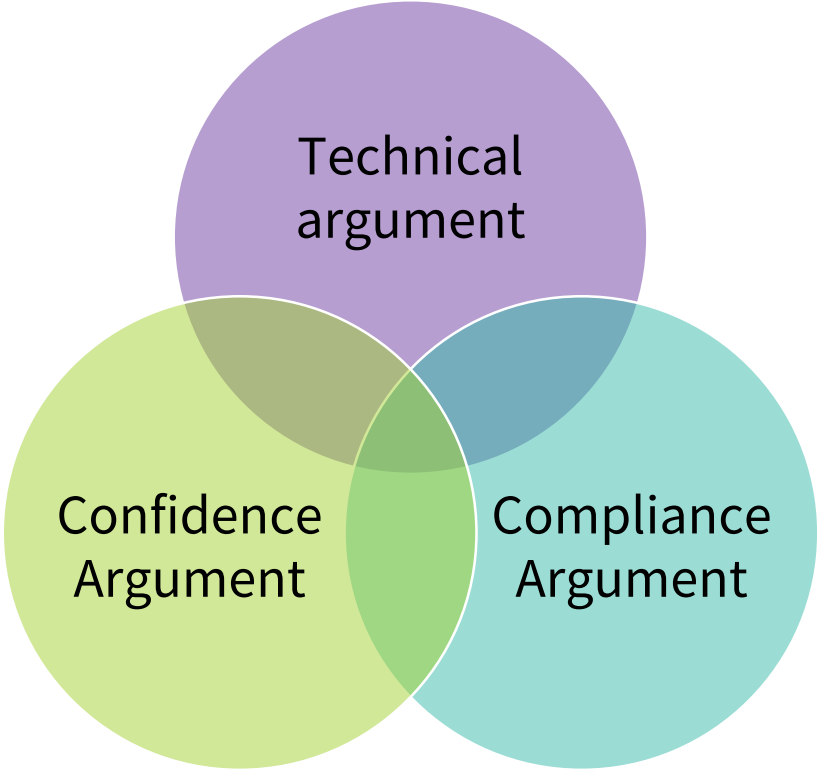
System Assurance

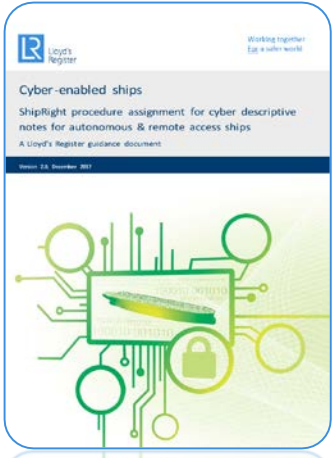


An argument explains why something can be deduced as true from supporting evidence.

Digital Ships

ShipRight Procedure

- The functionality provided by digital systems can range from simple remote monitoring with a crew on board through to a fully autonomous vessel without a crew on board.
- Consequently, as the risks can vary considerably, the assessment of digital ship systems requires a risk-based approach to identify the hazards introduced by digital enablement and to mitigate the associated risks.



Digital Ships - ShipRight

LR has classified digital enabled technology in five defined accessibility levels for autonomy/remote access:

AL0

- **No access** – no assessment – no descriptive note – for information only

AL1

- **Manual access** – no assessment – no descriptive note – for information only

AL2

- Cyber access for autonomous / remote monitoring

AL3

- Cyber access for autonomous/remote monitoring and control (onboard permission is required, onboard override is possible)

AL4

- Cyber access for autonomous/remote monitoring and control (onboard permission is not required, onboard override is possible)

AL5

- Cyber access for autonomous/remote monitoring and control (onboard permission is not required, onboard override is not possible)

Digital Ships – Descriptive Notes

and four descriptive notes for digital ships:

Digital-SAFE
Ship can be operated safely at defined Autonomy/Remote Access Level

Digital-MAINTAIN (Conditioned Based Maintenance)
Data driven CBM, also supported by LR Digital Compliance

Digital-PERFORM
Ship can safely achieve performance targets through digital-enablement to a defined Autonomy/Remote Access Level.

Cyber-SECURE
Cyber-security assured at a level beyond that required for safe operation at a defined Autonomy/Remote Access Level

Digital Ships – Descriptive Notes

Examples:

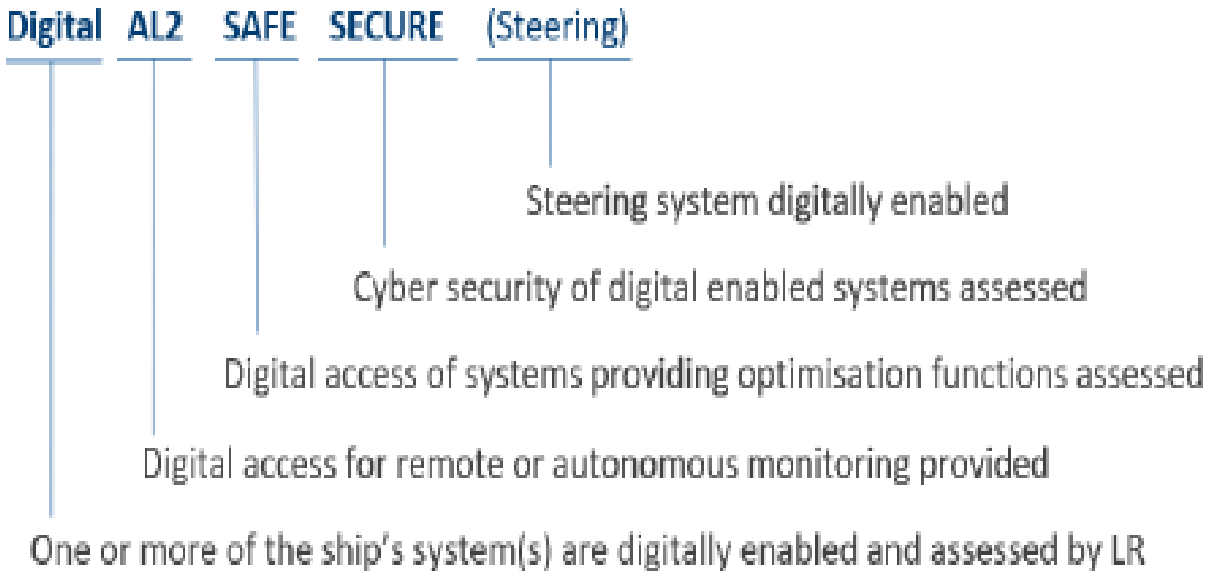


Figure 2.5.5 Combined digital descriptive note example

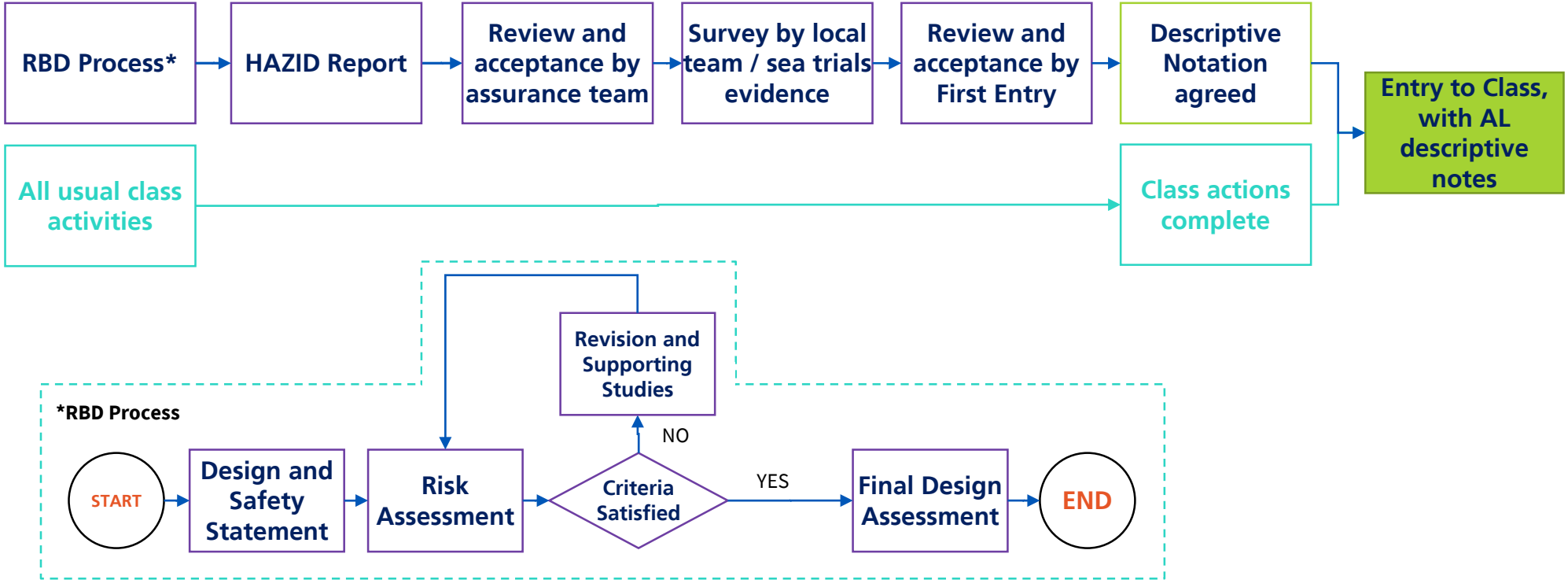
Understanding the risks of being connected…

9 Key Risk Areas for a Digital Enabled Ship:

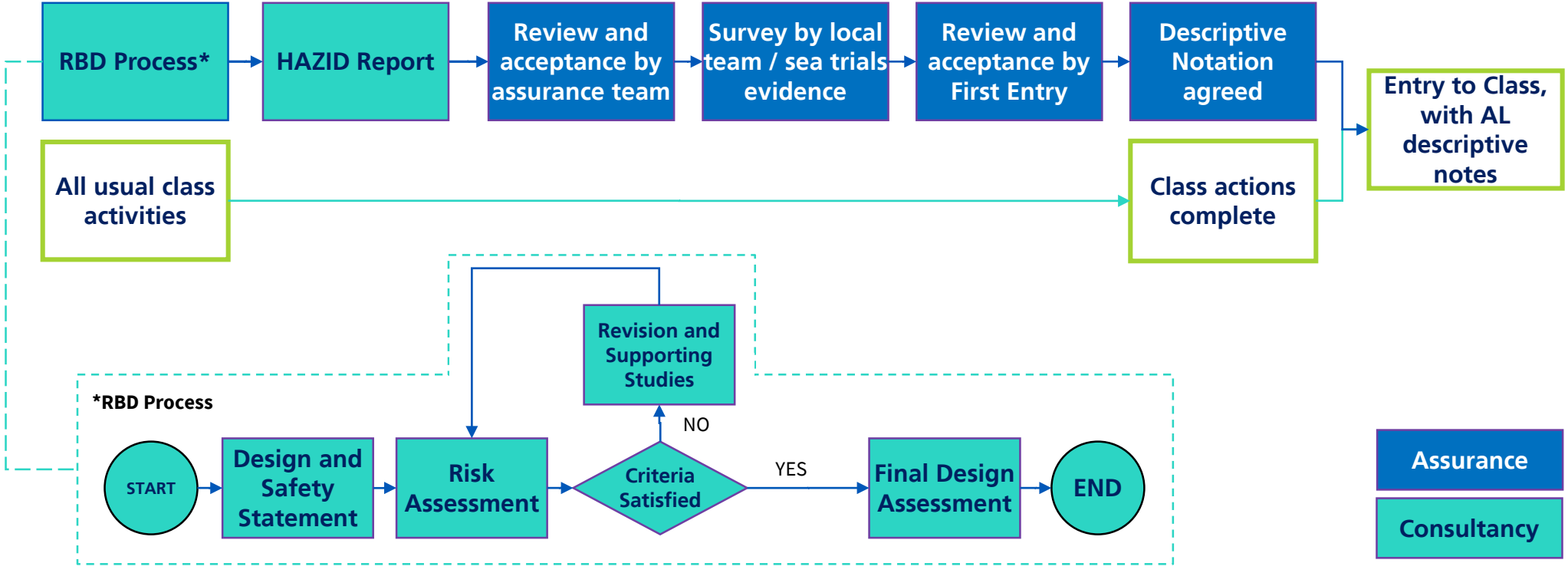
- **Human Interaction**
- **Data Quality**
- **System Architecture**
- **Hardware**
- **Software**
- **Communications and Network**
- **System Integration**
- **Configuration Management**
- **Cyber Security**

Digital Ships - Process

ShipRight - Risk Based Design (RBD) review process:



Digital Ships - Process



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First digital 20000TEU container ship achieving AL3 Level

COSCO Shipping Aries is the first ever container ship to receive LR's Digital ship descriptive note 'Cyber AL3 SECURE PERFORM' for its energy management system. The ship was built by Nantong COSCOS KHI Ship Engineering Co., Ltd (NACKS).

LR's Digital Ship descriptive notes –

Cyber SECURE
Digital AL3 PERFORM (Energy Management)

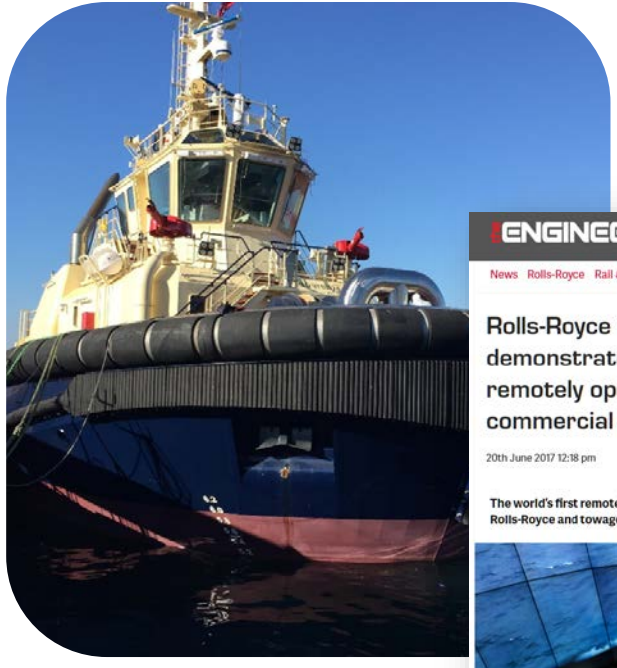
First digital ship in China

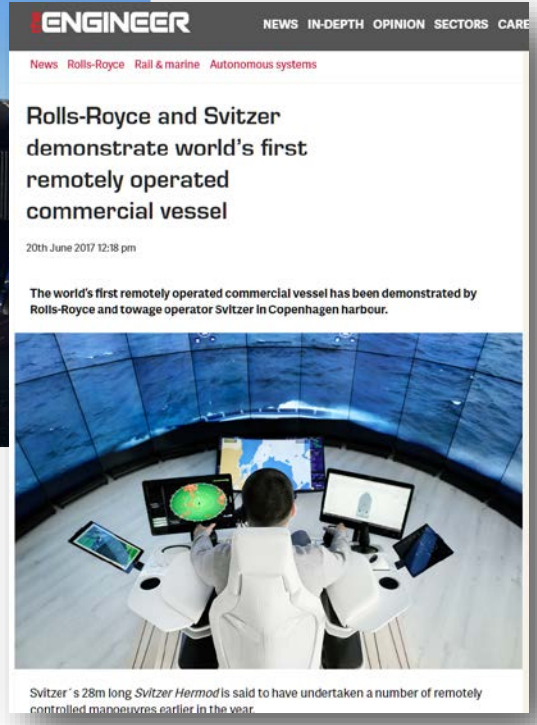
LR's CES descriptive notes –
Cyber AL2 Safe (Navigation, Propulsion, Steering),
Cyber AL2 Maintain (M/E, A/E, Boiler, Shaft) and
Cyber AL2 Perform (Energy Management)

China's first cyber-enabled ship was built at Guangzhou Wenchong Shipyard, with LR working in collaboration with SERI (the System Engineering Research Institute).

The *Great Intelligence*, a 38,800 dwt modified version of the *Green Dolphin* fuel-efficient Bulk Carrier concept, is the pilot smart ship project within China. LR's latest cyber enabled ships descriptive notes were assigned to the project and the latest requirements are applied to this ship.

First remote control tug





ENGINEER NEWS IN-DEPTH OPINION SECTORS CARE

News Rolls-Royce Rail & marine Autonomous systems

Rolls-Royce and Svitzer demonstrate world's first remotely operated commercial vessel

20th June 2017 12:18 pm

The world's first remotely operated commercial vessel has been demonstrated by Rolls-Royce and towage operator Svitzer in Copenhagen harbour.

Svitzer´s 28m long *Svitzer Hermod* is said to have undertaken a number of remotely controlled manoeuvres earlier in the year.

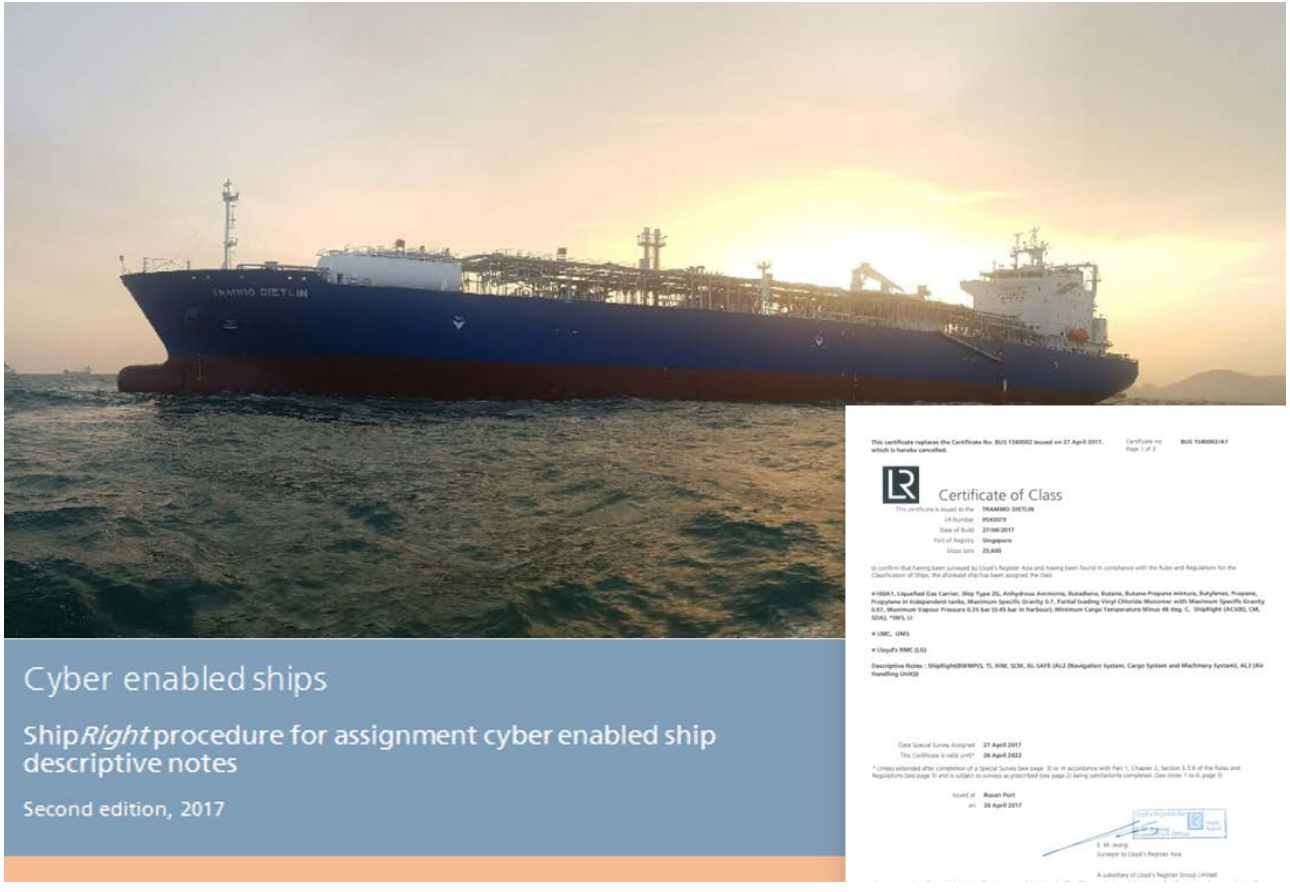
Lloyd's Register worked in collaboration with Maersk, Rolls-Royce and Svitzer to deliver the first approval to Version 1.0 of the cyber enabled ships ShipRight.

A key learning of this project was that our autonomy levels should consider remote access/control operations, and this led to the levels being redefined as 1-5, from the previous 1-6. Autonomy Levels were refined to Accessibility Levels for Autonomy and Remote Access.

The Svitzer tug was awarded an Approval in Principle to V1.0 of the ShipRight

SVITZER Rolls-Royce

First digital ship classification



Built in Korea, the first ship to receive LR's cyber descriptive notes was the Trammo Deitlin, working in collaboration with Synergy Marine and Alpha-Ori.

The Trammo Dietlin (and three sister ships) were awarded:

AL2 SAFE
AL3 SAFE

for different systems on board the ship

Other projects/cooperation

- COSCOS 13500 TEU project (SSSRI smart system provider)
- COSCOS 21000TEU projects (SSSRI smart system provider)
- NACKS VLCC projects (SSSRI smart system provider)
- DSIC Aframax Oil Tanker projects (JIP project)
- SERI Digital system development consultancy service projects (Health Management System, Digital Twin, etc)
- HHI-HE (INTEGRICT) for Digital SAFE, PERFORM and SECURE, Type Approval for components
- DSME(DIPS) for Digital SAFE
- HMM (Vessel Insight) Digital PERFORM
- SHI(INTELLIMAN) Digital SAFE PERFORM SECURE
- SEANET – Cyber SECURITY

Thank you

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Digital Components, Systems and Ships

Component Manufacturers

System Designers
System Integrators
Shipyards

Ship Owners/ Operators

Smart Hardware Type Approval

Hardware Type Approved
For Smart Systems

Smart Systems

Cyber SECURITY
Systems

Digital AiP
-
System Approved

Digital Ships & Cyber Security

Cyber SECURITY
Ships Systems

Digital SAFE AL 1-5
Digital MAINTAIN AL 1-5
Digital PERFORM AL 1-5