



# Cyber insecure vessels at sea

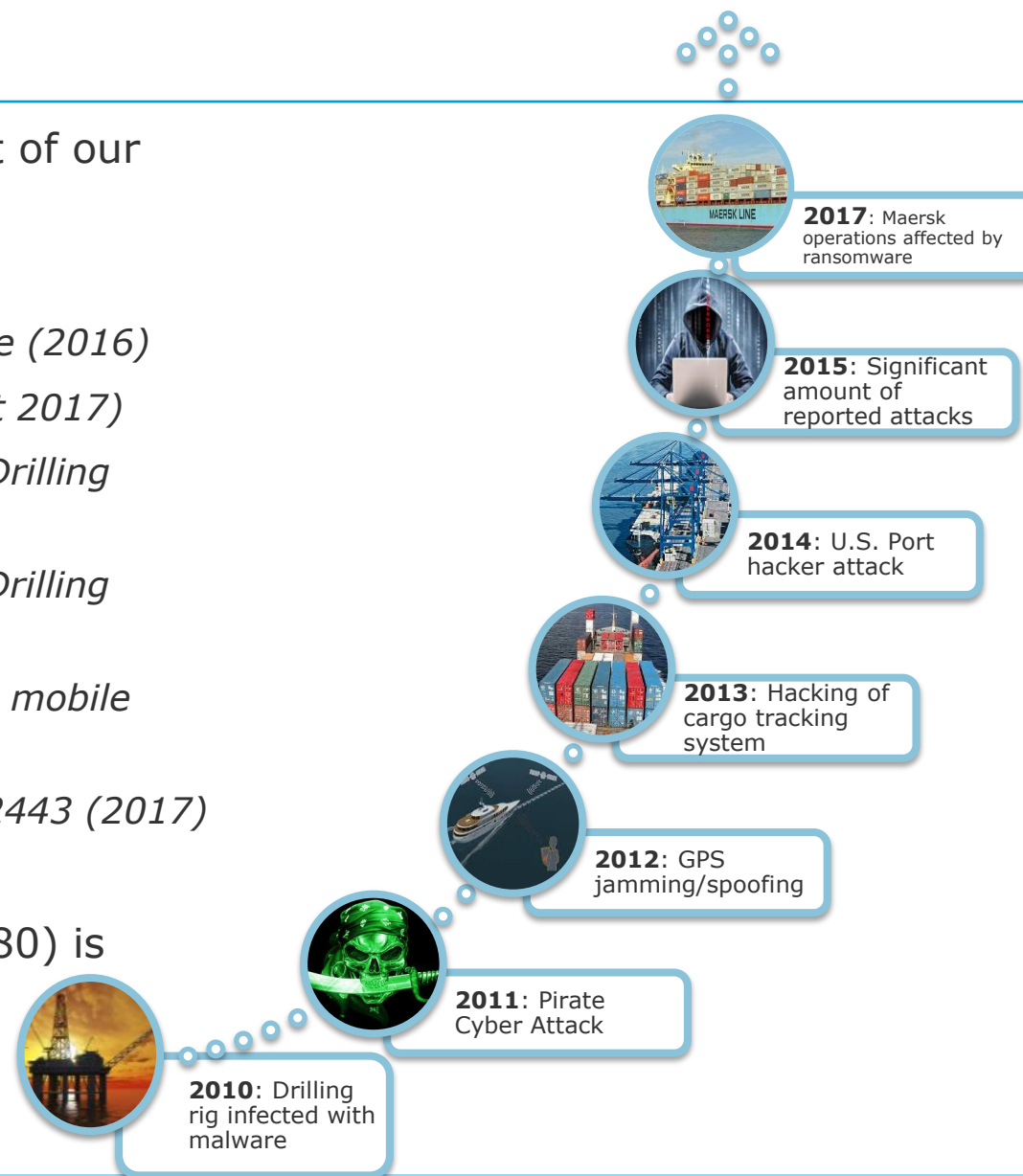
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Global Service Line Leader, Cyber Security

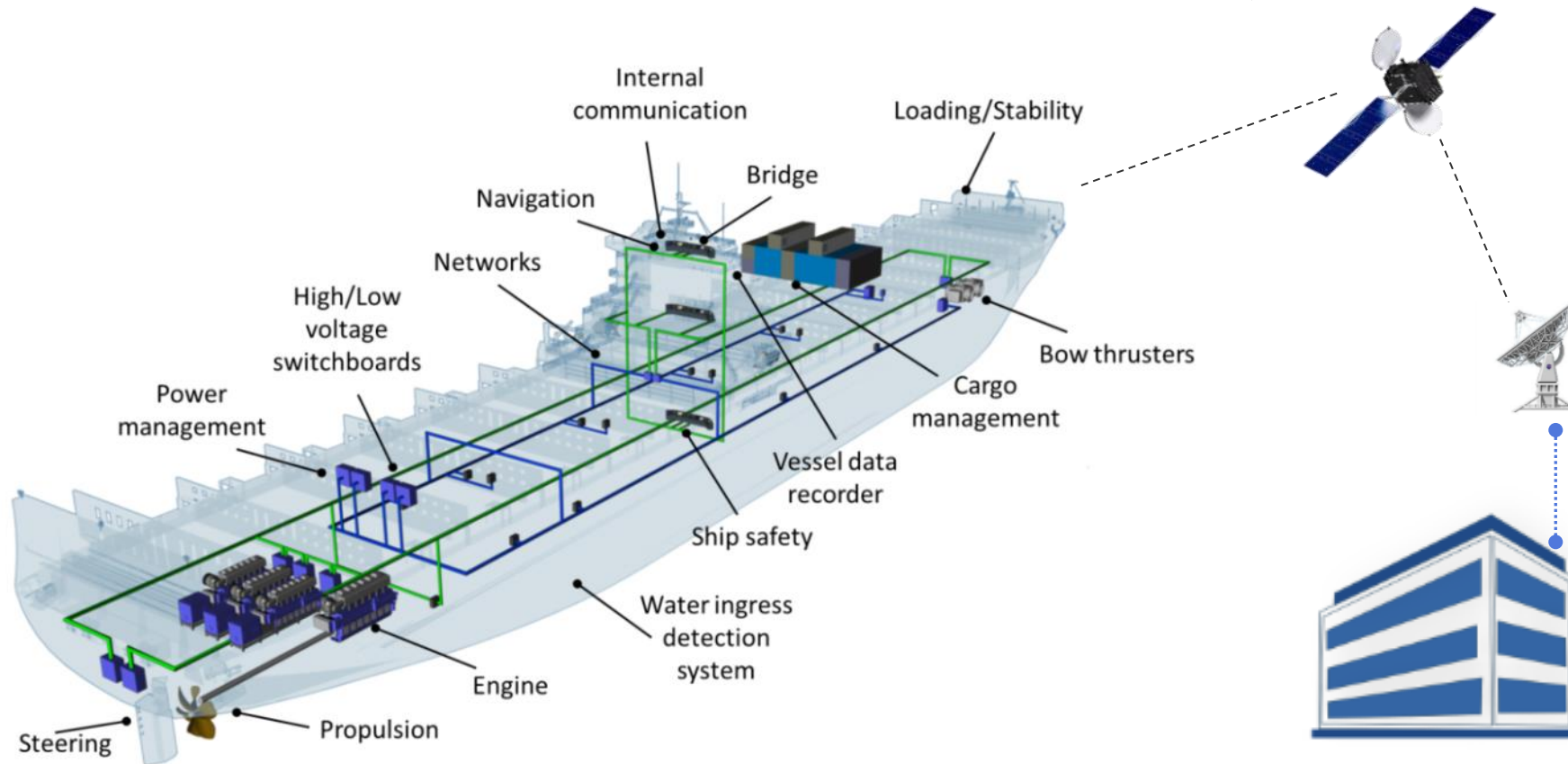
DNV GL – Digital Solutions

## Cyber security trends at sea

- Cyber security **threats are progressing** and becoming a part of our daily business
- **Evolving guidelines and regulations:**
  - USCG Maritime Bulk Liquids Transfer Cybersecurity Framework Profile (2016)
  - USCG Cybersecurity Framework Profile for Offshore Operations (draft 2017)
  - IADC Guidelines for Assessing and Managing Cybersecurity Risks to Drilling Assets (2015)
  - IADC Draft Guidelines for Minimum Cybersecurity Requirements for Drilling Assets (2017)
  - DNVGL-RP-0496 Cyber security resilience management for ships and mobile offshore units in operation (2016)
  - DNVGL-RP-G108 Cyber security in the O&G industry based on IEC 62443 (2017)
  - . . .
- The **cyber security exclusion clause** in insurance (Clause 380) is being **challenged**:
  - Owners expect complete insurance coverage
  - Underwriters need to properly manage their risks



## Maritime safety heavily depends on cyber systems



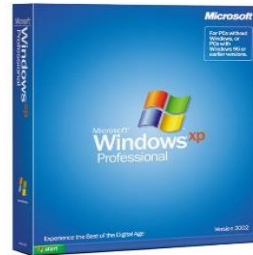


## The cyber-asymmetry

- Increasing levels of computer control and automation



US Navy pays USD 9.1M for contract extension



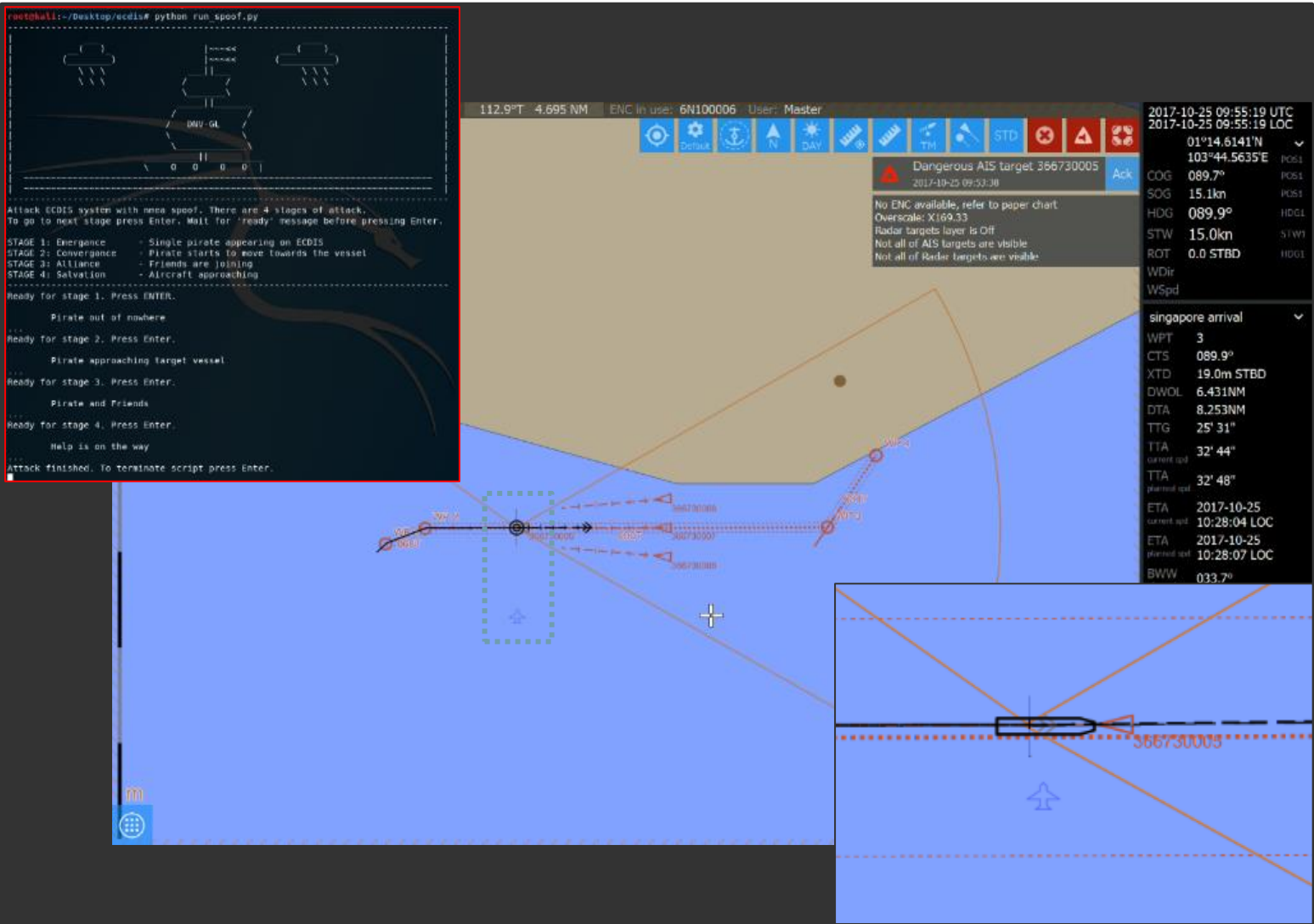
- Electronics and software could and will be upgraded over the ship's lifetime

- Cyber-attacks can be low-cost alternatives to physical attacks

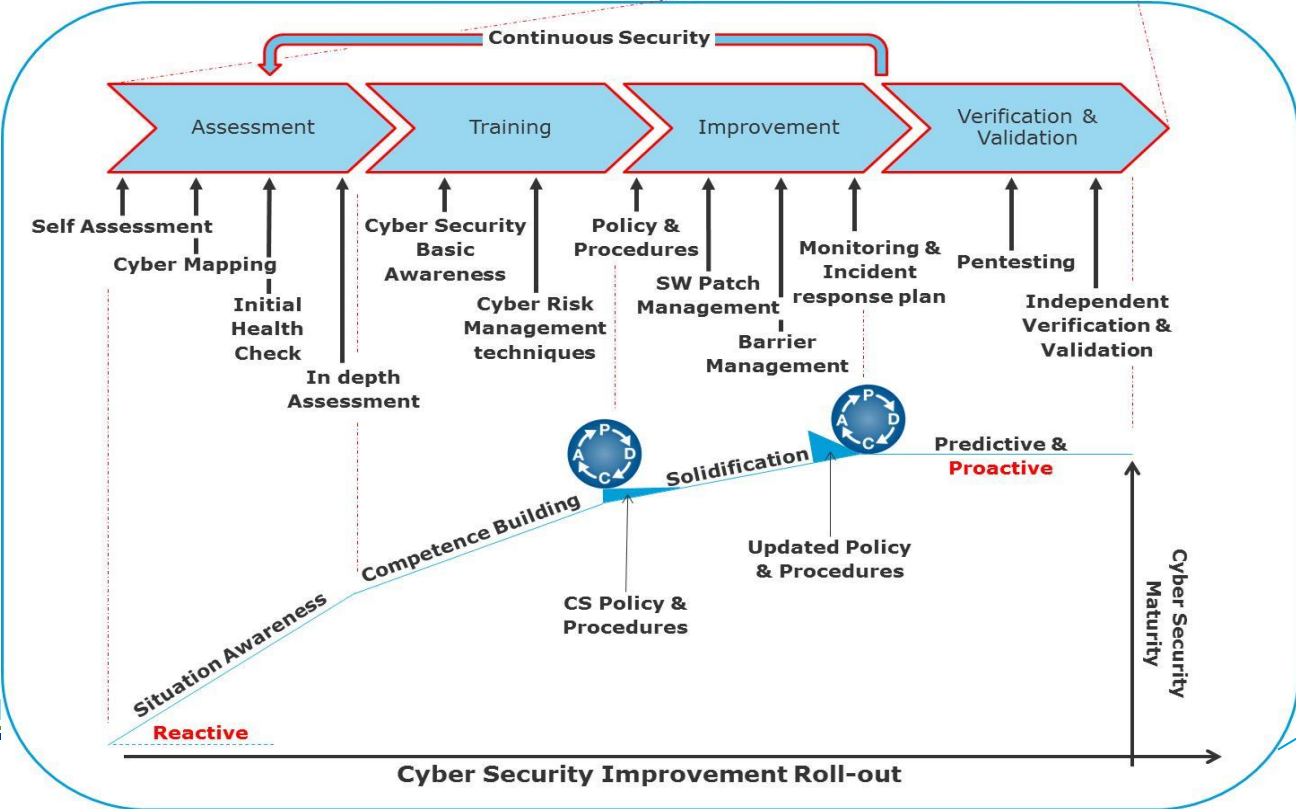
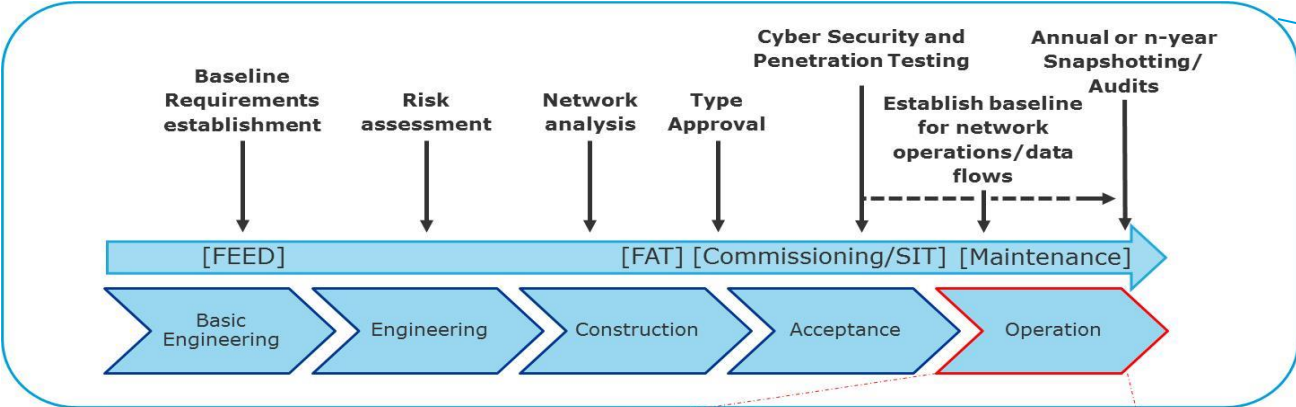


SDR + AIS ~ 100USD

# No need to spoof RF



# What to do during the lifecycle of a cyber-enabled vessel?



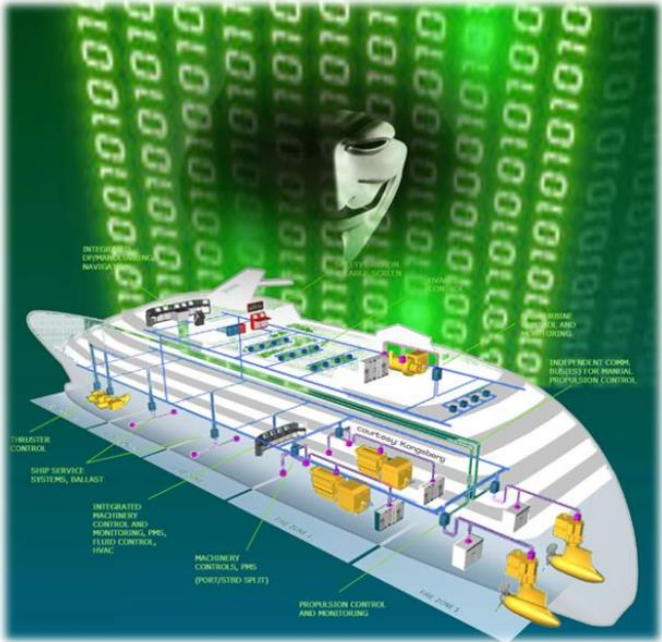
**DNV·GL**

**RECOMMENDED PRACTICE**  
**DNVGL-RP-0496**

**CYBER SECURITY RESILIENCE MANAGEMENT**  
**FOR SHIPS AND MOBILE OFFSHORE UNITS IN OPERATION**

DNV GL MARITIME

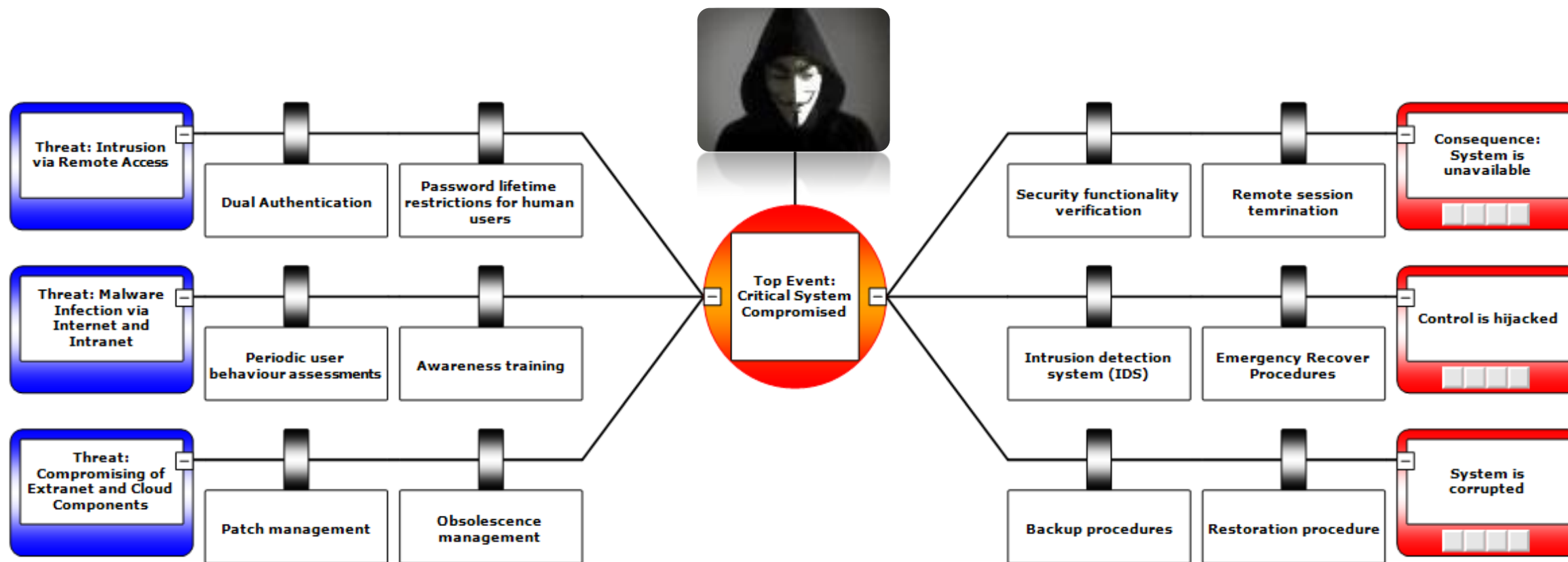
Doc Number: DNVGL-RP-0496 September 2016



<http://www.dnvgl.com/rpcs>

## DNVGL-RP-0496: Graphical understanding of protection barriers

- Leverages existing industry knowledge using Bow-Tie & Barrier management methodologies and transposes this intuitive method to help assess complex attack scenarios





# Autonomous LNG carrier #1

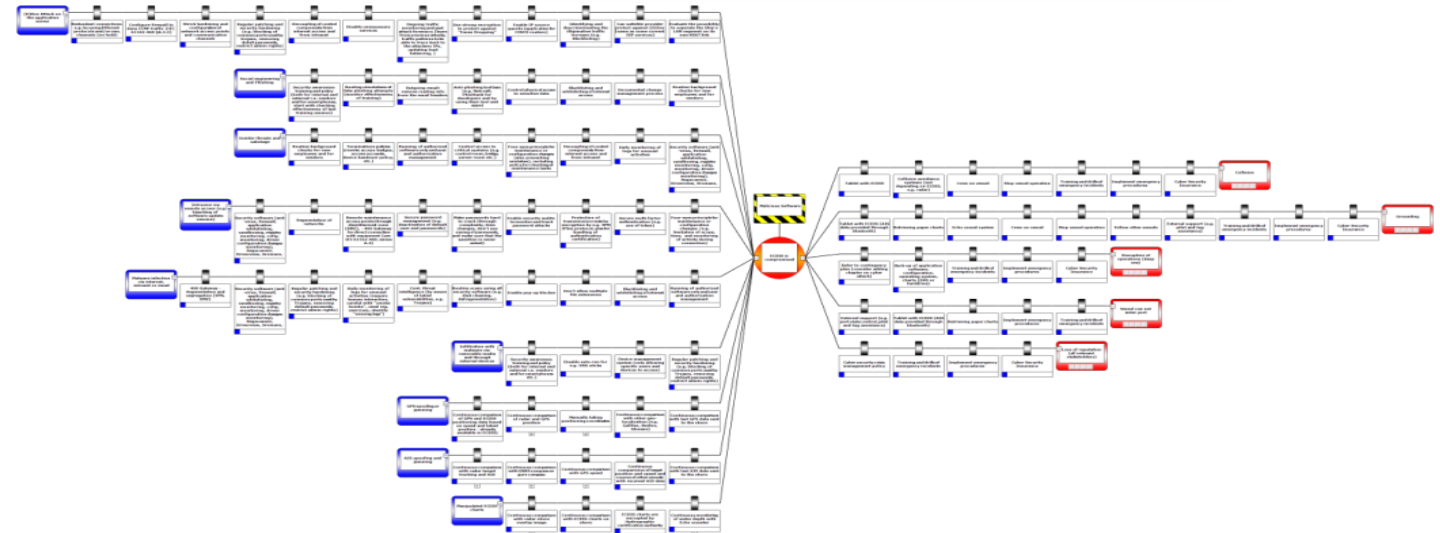


## ■ 75 Preventive barriers:

- Intrusion detection
- Encryption
- Disable unnecessary services
- Segregation of networks
- Multi-factor authentication
- Blacklisting and whitelisting of internet access
- Documented change management process
- Restricted access
- Daily monitoring of logs for unusual activities
- Strict hardening
- Disable auto-run for e.g. USB sticks

## ■ 31 Mitigating barriers, e.g. including:

- Collision avoidance systems
- Back-up procedures
- Emergency response (drills & training)
- External support (e.g. pilot and tug assistance)
- Cyber Security insurance



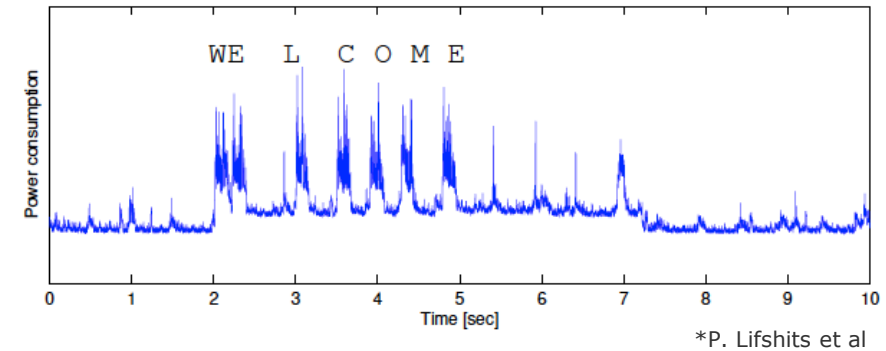


## Popular threat vectors

- Network segregation (a.k.a. air-gaps)
  - Portable storage devices;
  - Covert signaling channels (acoustic, light, RF, etc.)



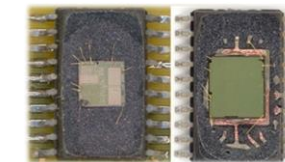
- Social engineering attacks
  - Policies & procedures
  - BYOD
  - Crew welfare



- Maintenance phase attacks
  - Update, upgrade, and patching



- Supply chain and construction phase
  - Protect all levels of the supply chain



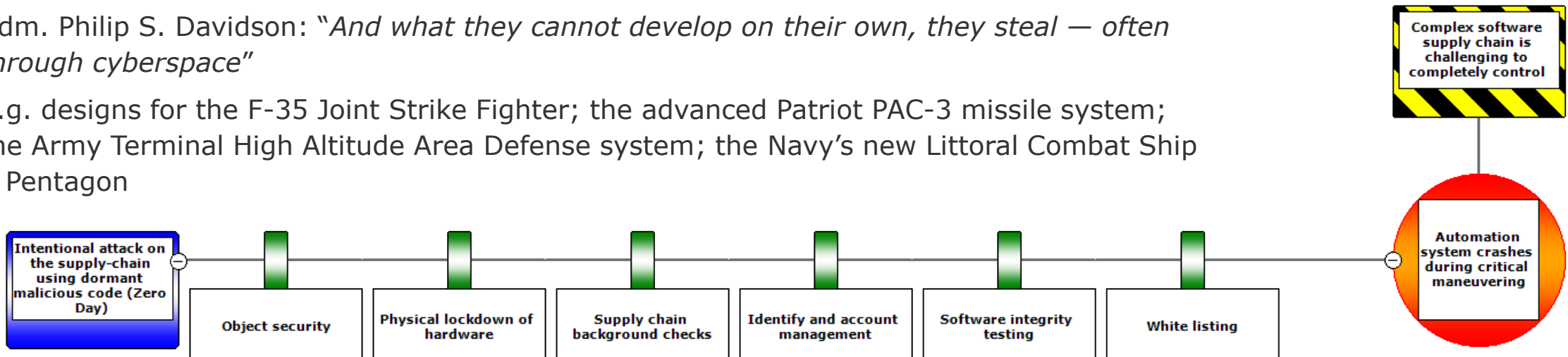
\*C. Tarnovsky

## Why the supply chain / contractors ?

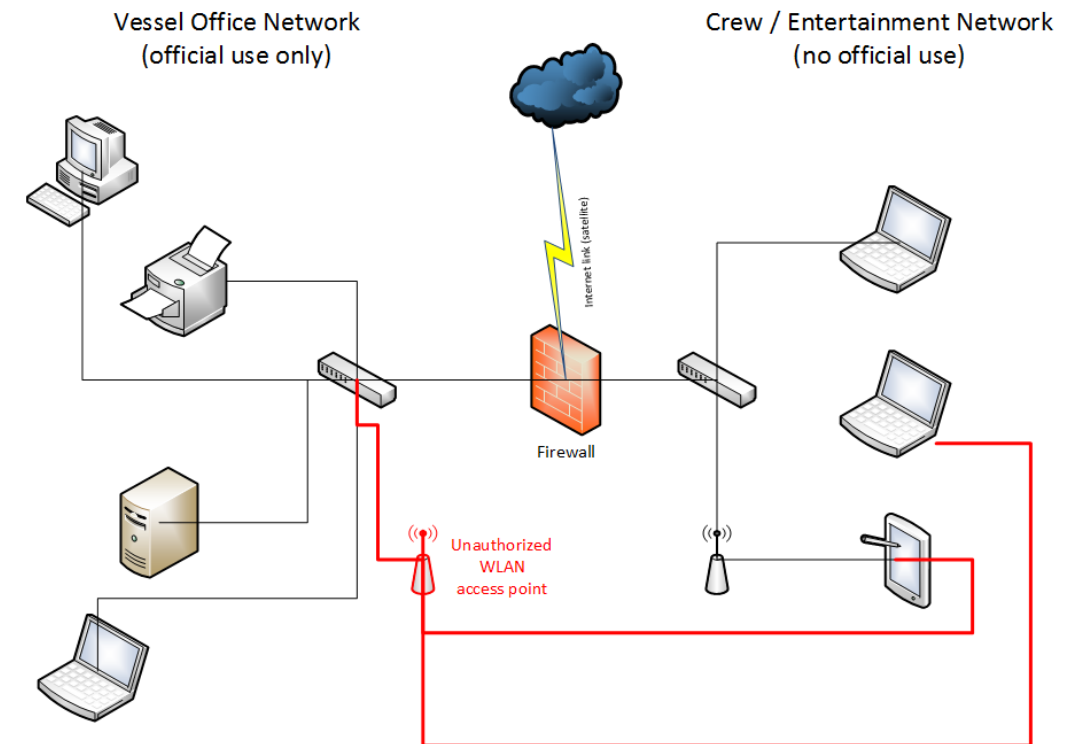
- 614 GB of: Sea Dragon material, signals and sensor data, submarine radio room cryptographic systems information, electronic warfare library
- Stolen data highly sensitive, housed on the contractor's unclassified network.. When aggregated, could be considered classified
- Navy spokesman: *"There are measures in place that require companies to notify the government when a 'cyber incident' has occurred that has actual or potential adverse effects on their networks that contain controlled unclassified information."*
- *"The Pentagon has requested or used more than \$300 million for the project since late 2015 and has said it plans to start underwater testing by September."*
- Adm. Philip S. Davidson: *"And what they cannot develop on their own, they steal — often through cyberspace"*
- E.g. designs for the F-35 Joint Strike Fighter; the advanced Patriot PAC-3 missile system; the Army Terminal High Altitude Area Defense system; the Navy's new Littoral Combat Ship – Pentagon



\*Illustration by Popular Mechanics, from Getty Images



# Crew training & awareness





## Crew training & awareness



## (Film)Crew training & awareness

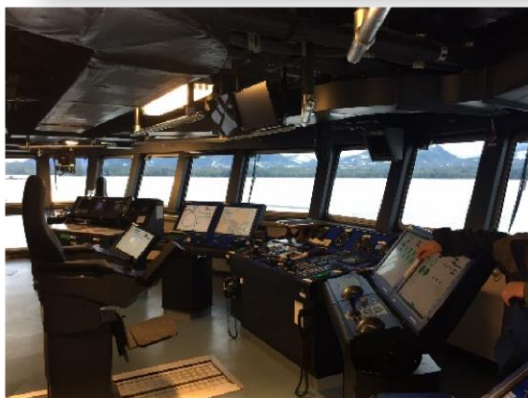


[www.President.ir](http://www.President.ir)





## Responsibilities – and how testing can help



**Vessel/Asset Owners**



**System Integrators**



**OEMs**

**Component/Type testing**

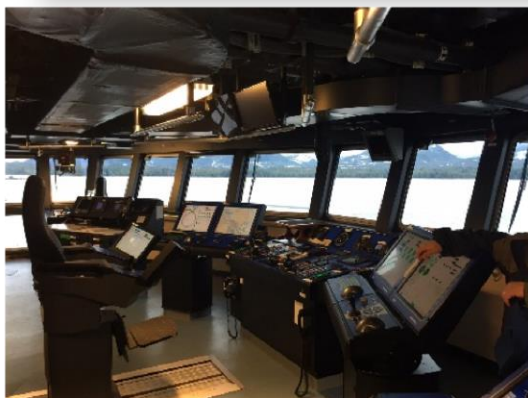


# Example for a vulnerability in a base component - SSA-818183: Denial-of-Service Vulnerability in S7-300 CPU



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1 # PoC_2016-12-04_140747_PoC_2ay [3]
2 # Autogenerated Zulu PoC File
3 # NGS Secure 2014
4 #!/usr/local/bin/python
5
6 import sys
7 from socket import *
8 import os
9
10 if (len(sys.argv) != 3):
11     print "\nUsage: PoC <target IP> <target port>"
12     print "-----\n"
13     exit(0)
14
15 host=sys.argv[1]
16 port=int(sys.argv[2])
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## Responsibilities – and how testing can help



**Vessel/Asset Owners**



**System Integrators**

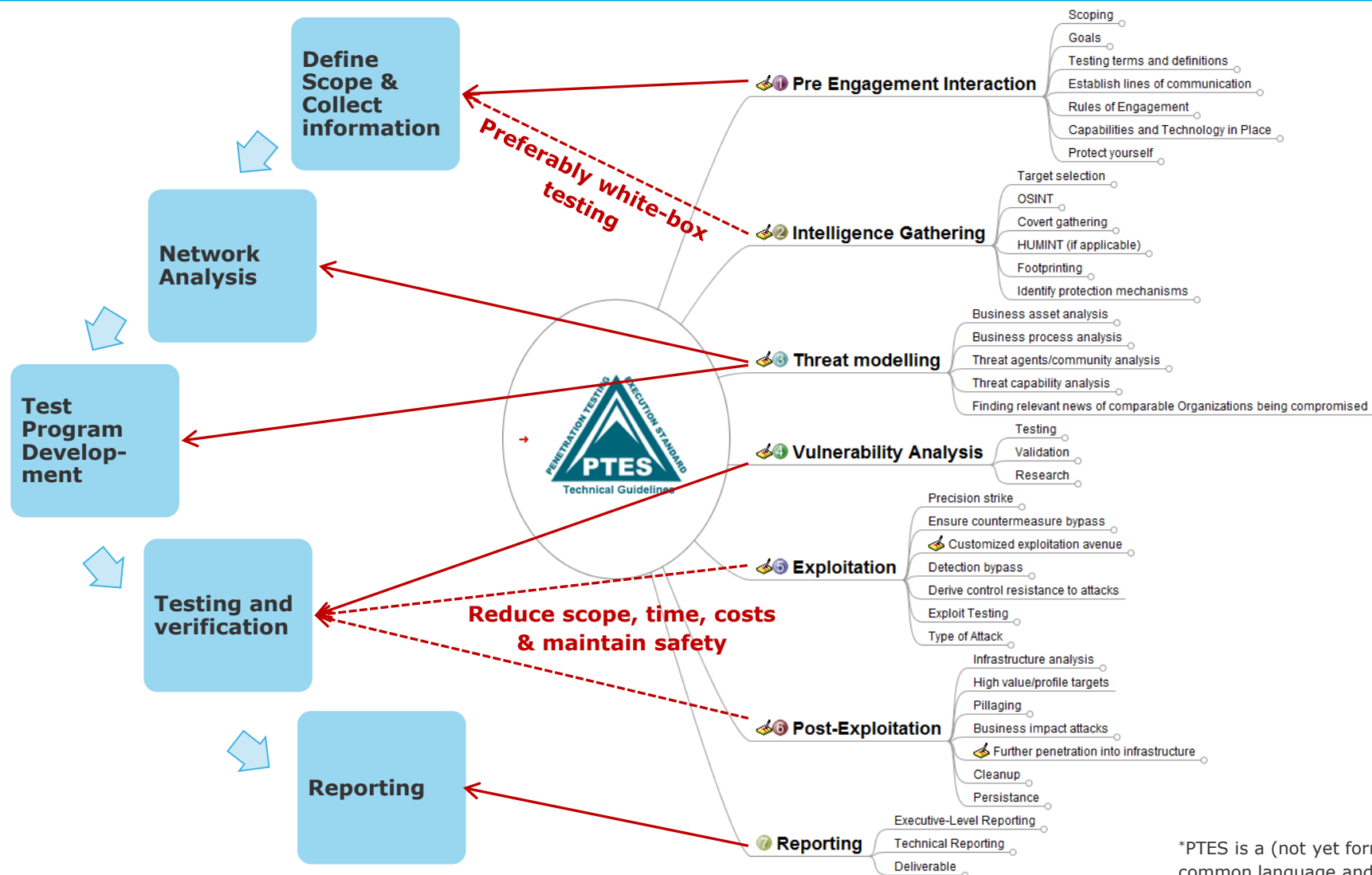


**OEMs**

**System testing**

**Component/Type testing**

# Cyber security testing & the Penetration Testing Execution Standard



\*PTES is a (not yet formal) standard designed to provide a common language and scope for performing a pentest.



## Example vulnerabilities in control systems at sea

### ■ Design, documentation, & implementation

- Re-use of IP address ranges across vessels: shortcut for easier overview, maintenance, and logging;
- Deployment of networking gear does not match topology drawings;
- Internal clocks in ballast water treatment control system showing 1994 as date, making forensics difficult;
- Large amount of default credentials, e.g. publicly known factory default passwords;

### ■ Patching & hardening

- Windows OS updated only during major upgrades, i.e. up to 3 years outdated; OS installations configured with standard settings;

### ■ Network segregation

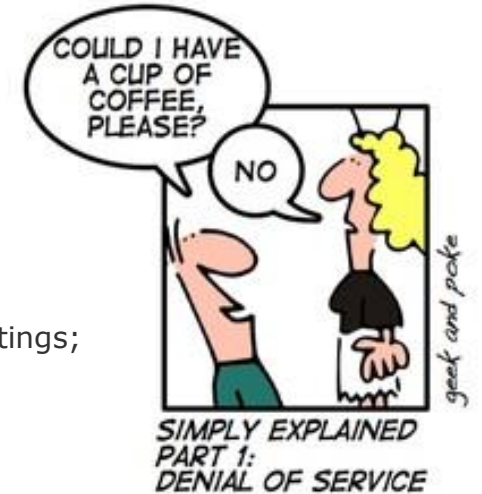
- OT device(s) connected to insecure on-board WiFi;
- No Anti-virus on “island-mode” workstations; Undetected infection of Loading computer; Skype installed on tank sounding computer;

### ■ Removable storage

- No defined policies to follow by associated vendors/service personnel: service provider technician uses own USB stick to print reports;
- Single USB stick policy. But, personal HDD used by crew member to backup “in case something gets lost”; SD card used between camera and workstations;

### ■ Network and software robustness

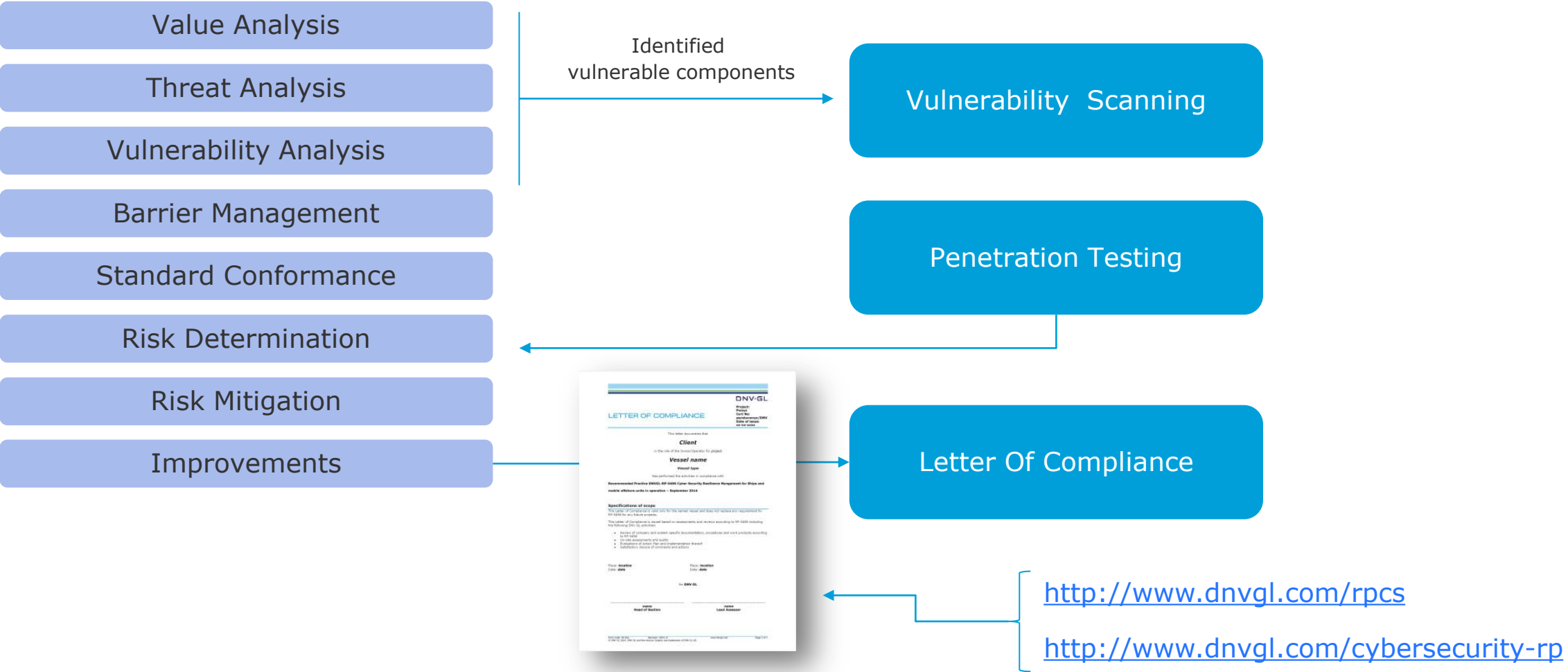
- Alarm monitoring system susceptible to loss of view (DoS); Alarm overflow: after a certain number, no further alarms can be received;
- Loss of positioning when overloading DP network. Loss of all posrefs, gyros and VRSs; Standby DP controller is shutdown when 1% traffic is introduced; Network storm on one DP operator station results in both redundant operation stations being “in command” at the same time;
- Emergency disconnect sequence of a BOP does not start when commanded from HMI when PLC subject to networks stress;



# Cyber readiness of vessels

## Risk assessment & penetration testing

Activities conducted to uncover vulnerabilities and find possible chains leading to compromise:



# The three pillars of cyber security

## People

- Training & Awareness
- Professional skills & qualifications
- Written procedures
- Authorizations
- Physical Security

## Process

- Management Systems
- Governance Frameworks
- Policies
- Procedures
- Vendor/Third party contracts-follow up
- Audit regimes

## Technology

- Design review
- Inspection/verification
- Test
  - Functional testing
  - Vulnerability Scanning
  - Penetration test



**Thank you for your attention!**

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**SAFER, SMARTER, GREENER**