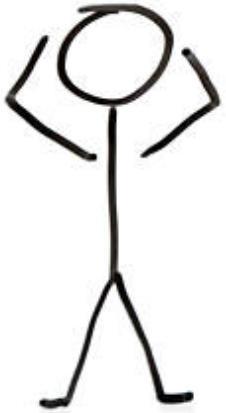
From E-Navigation to Resilience Engineering

Session: Use of Technology for Maritime Safety

Dr. D. Göge
Dr. E. Engler
C. P. Wrede

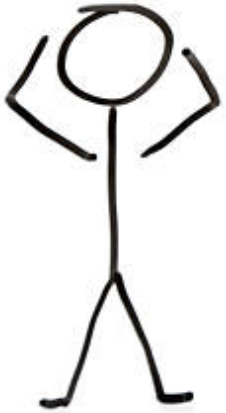
From E-Navigation to the Design of Resilient Systems



Safety I:

to avoid, that things go wrong

From E-Navigation to the Design of Resilient Systems



Safety I:
to avoid, that things go wrong

Safety II:
make sure, that things go right

International Framework

IMO's E-Navigation Strategy

Vision

Safe, secure and efficient realization of all processes inside the global Maritime Traffic System.

Mission

E-Navigation is the harmonized collection, integration, exchange, presentation and analysis of marine information on board and ashore by electronic means to enhance berth to berth navigation and related services for safety and security at sea and protection of the marine environment.

E-Navigation is intended to meet present and future user needs through harmonization of marine navigation systems and supporting shore services.

Challenge

- ✓ enhancement based on gaps identified in relation to user needs
- ✓ safety of shipping with modern, proven tools that are optimized for good decision making in order to make maritime ICN technologies more reliable and user friendly

E-Navigation: Strategic Implementation Plan

5 Prioritized Solutions

Efficient transfer of maritime information

(ship-ship, ship-shore, shore-ship and shore-shore)

- S2 – means for standardized and automatic reporting
- S4 – integration and presentation of available information in graphical displays received via communication equipment
- S9 – **improved communication** of VTS Service Portfolio (not limited to VTS stations)

Workable and practical use of the information and data on board

- S1 – improved , harmonized and user-friendly bridge design
- S3 – **improved reliability, resilience, and integrity of** bridge equipment and **navigation information**

New tasks in R&D and standardization e.g.

1. **Reliable and resilient on-board provision of PNT data and associated integrity information (RCO 5 of S3)**
2. Robust communication
3. Comprehensive and reliable situation pictures (regarding used systems/services, traffic, environment,….)
4. Standardization of integrity information

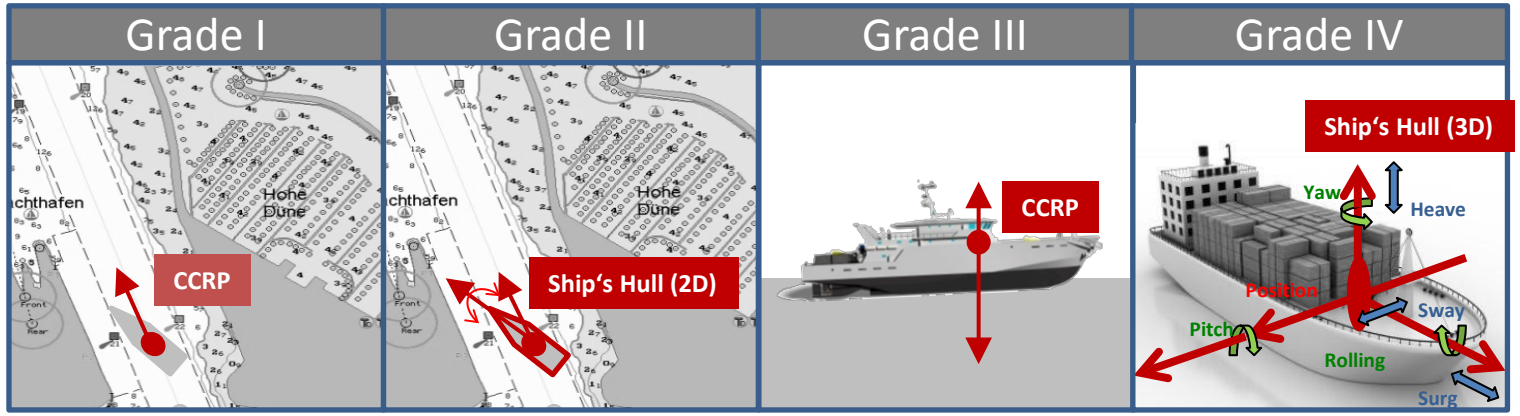
Reliable and Resilient On-Board Provision of PNT Data

RCO 5 of S3 (E-Navigation SIP)

Challenge

Efficient use of space-based and terrestrial services as well as on-board sensors for **reliable** and **resilient** provision of **PNT data and associated integrity information** with respect to diversity of navigational phases, nautical applications, …..

single GNSS sensor ↓ 2D ship navigation ↓ comprehensive ship navigation



PVT data:
- Lat and Long
- SOG and COG
- Time

Horizontal PNT data:
PVT data +
- Heading and ROT
- STW and CTW

Extended PNT data:
Horizontal PNT data +
- Altitude
- Depth

Full PNT data:
Extended PNT data +
- Heave, sway*, and surge*
- Yaw*, pitch, and roll

DLR's contribution

- ✓ standardization of on-board PNT-DP (within IMO CG) e.g. MSC1./Circ.1575
- ✓ demonstration of resilient on-board PNT data processing
- ✓ standardization of GNSS augmentations services as IALA member
- ✓ development of R-Mode as maritime backup option of GNSS

DLR

Resilience

Definitions

International Maritime Organisation (IMO MSC1./Circ.1575)

Resilience is the ability of a system to detect and compensate external and internal disturbances, malfunction and breakdowns in parts of the system. This should be achieved ***without loss of functionalities and preferably without degradation of their performance***.

European Commission

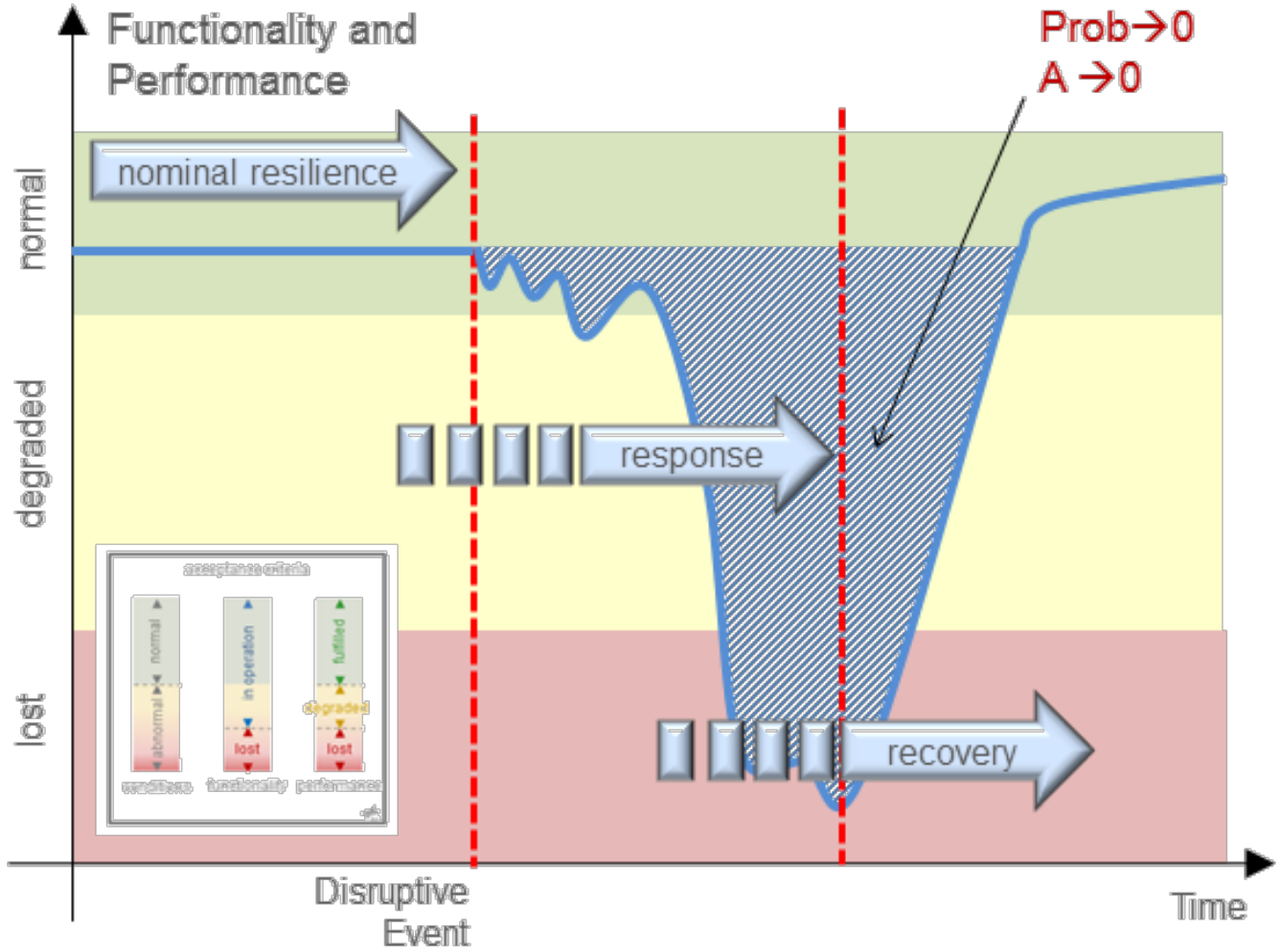
Resilience is the “ability of an individual, a household, a community, a country or a region to withstand, to adapt, and to quickly recover from stresses and shocks”

United Nations Office for Disaster Risk Reduction

Resilience is “the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, ***including through the preservation and restoration of its essential basic structures and functions”***

Resilient System of Systems

Safeguarding of functionality and performance:

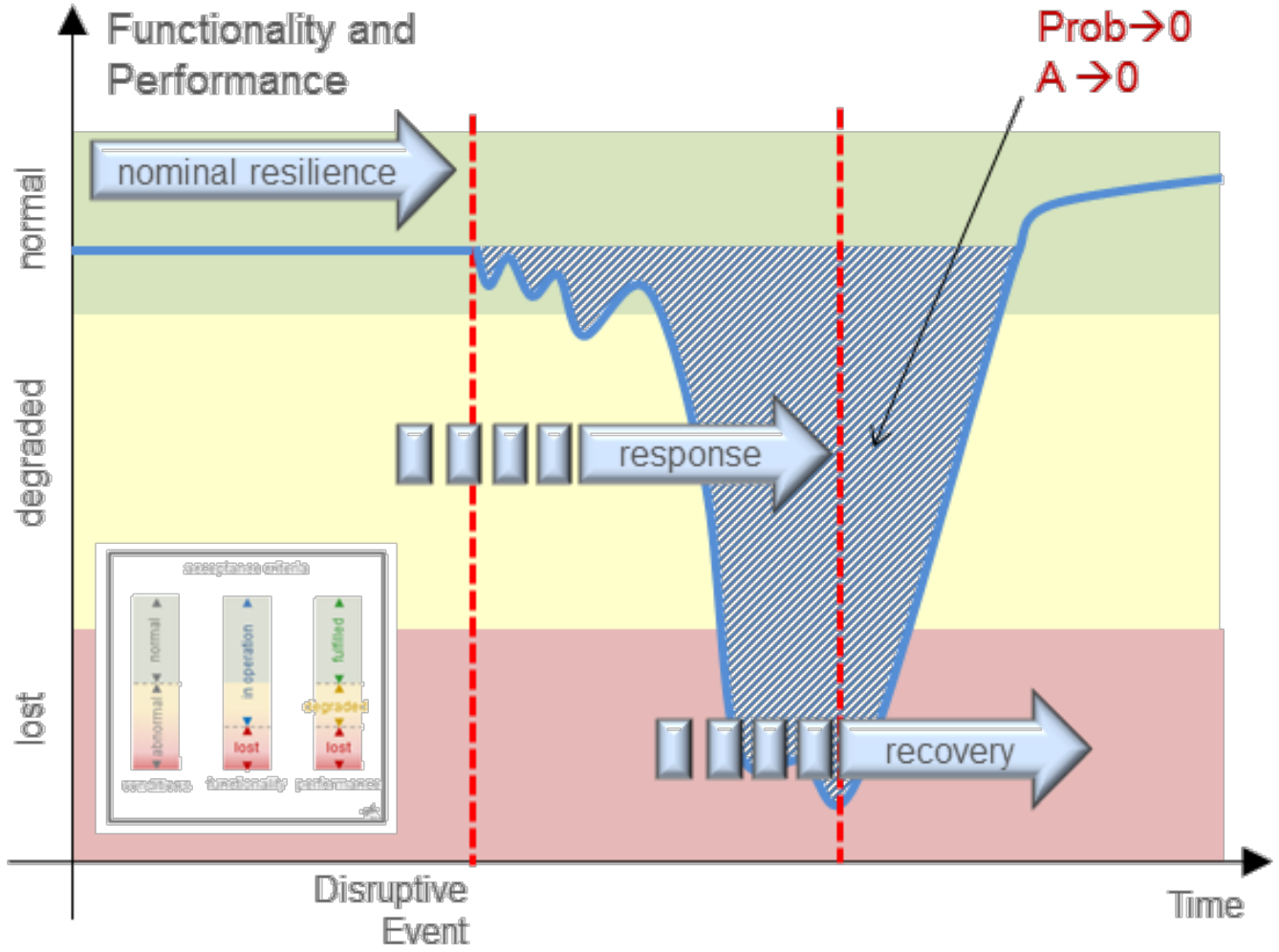


Operational safety (24/7) under normal conditions

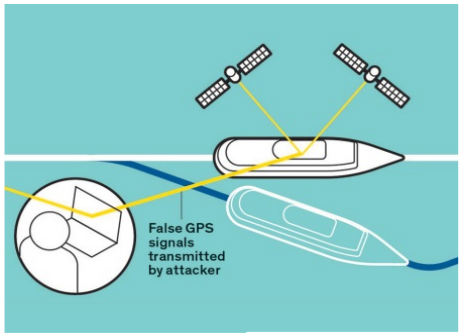
including occupational safety

Resilient System of Systems

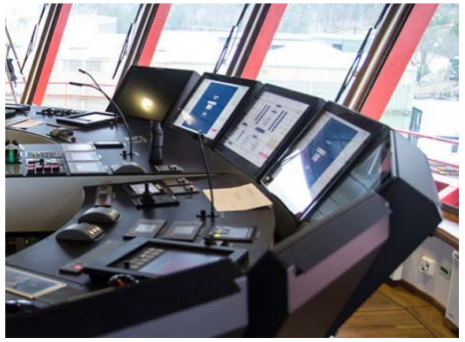
Safeguarding of functionality and performance



Increased robustness by protection of ICN cyberspace

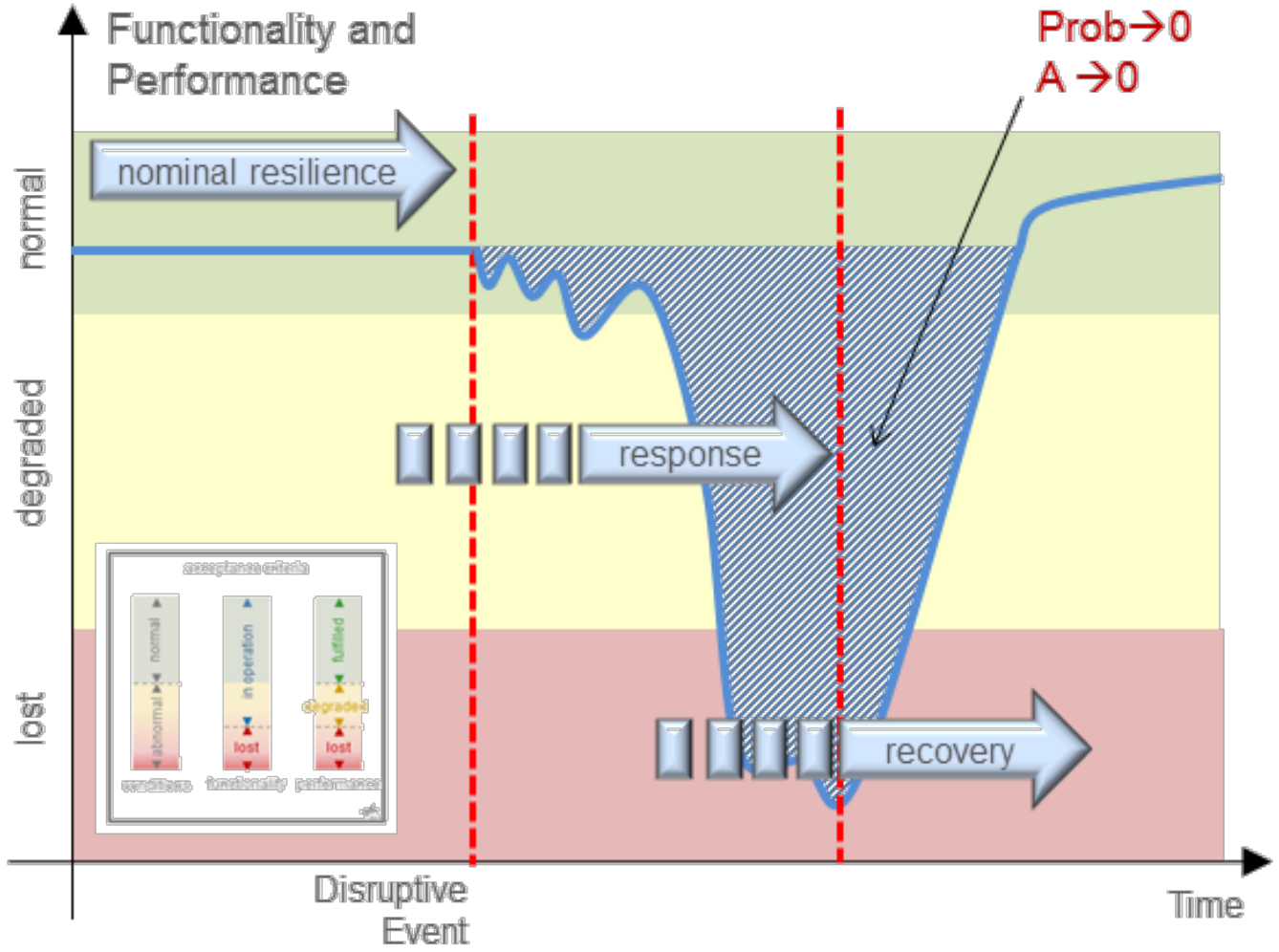


and monitoring of data and system integrity



Resilient System of Systems

Safeguarding of functionality and performance

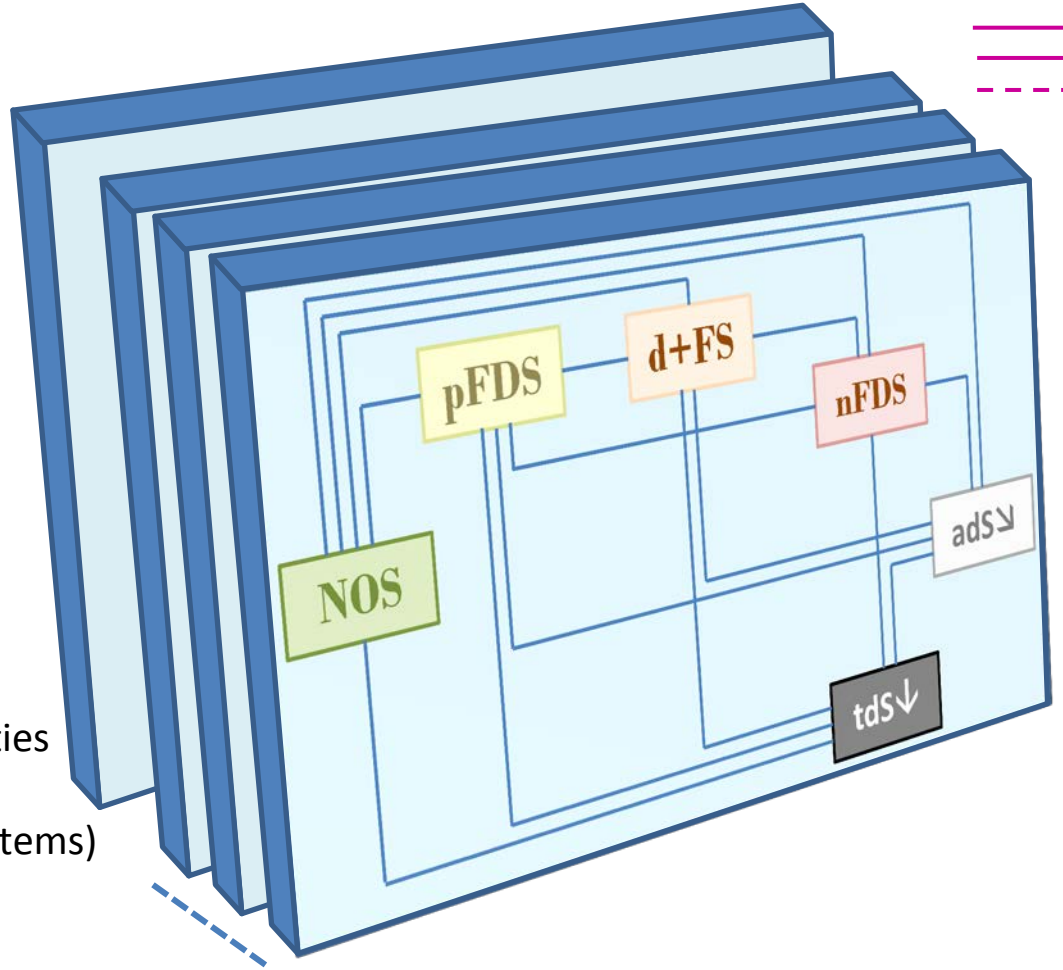


Protection of maritime infrastructures and systems

and just-in-time damage containment

Integrity Monitoring and Situation Pictures

Prerequisite to facilitate both: Safety I and Safety II (proactive/reactive adjustment)



Core functionalities
of system
(or system of systems)

Operational Self-Monitoring

Integrity of subsystems
- to indicate usability (situation awareness)
- to create alerts, if necessary
- for adaptive controlling of redundant systems
- for reporting e.g. to adapt maintanance/repair

Situation Surveying

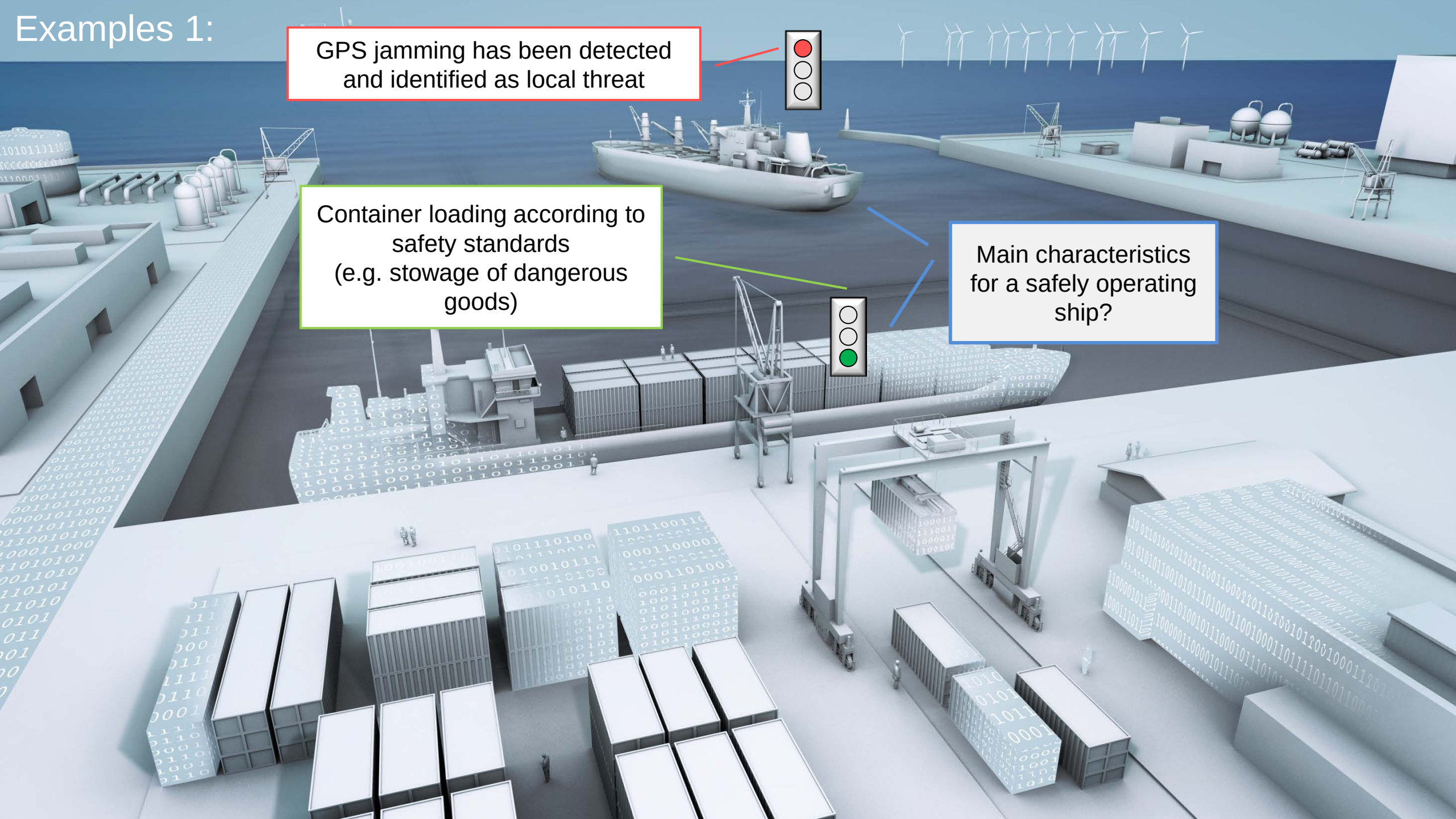
Monitoring of conditions and events
- to detect current threats
- to adjust the system operation
- for proactive damage containment
- to forecast emerging threats
- for proactive risk prevention

*may be cooperative or supported by services

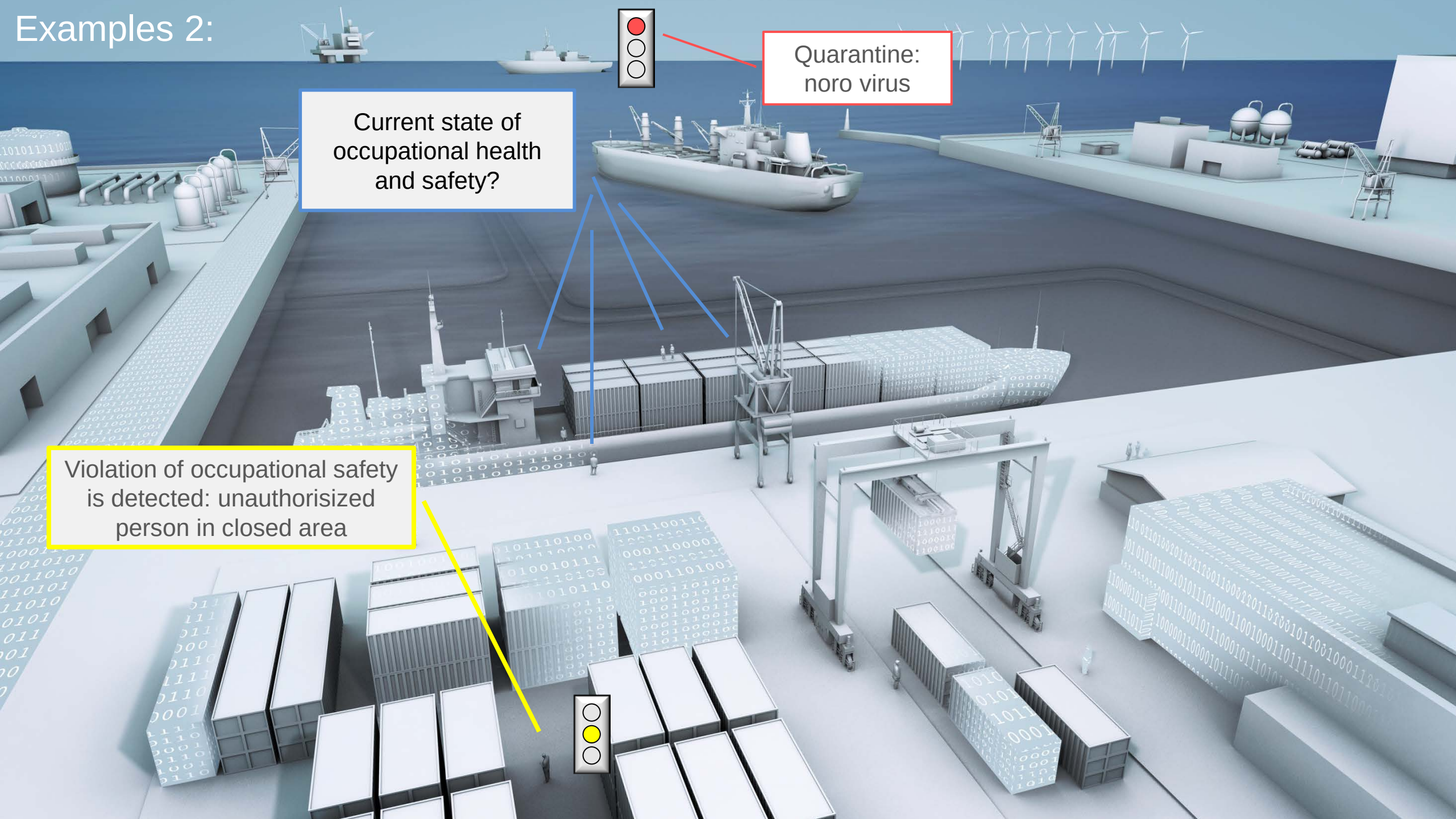
Adaptive Decision Making

Adjustments to manage system-of-systems in their variability

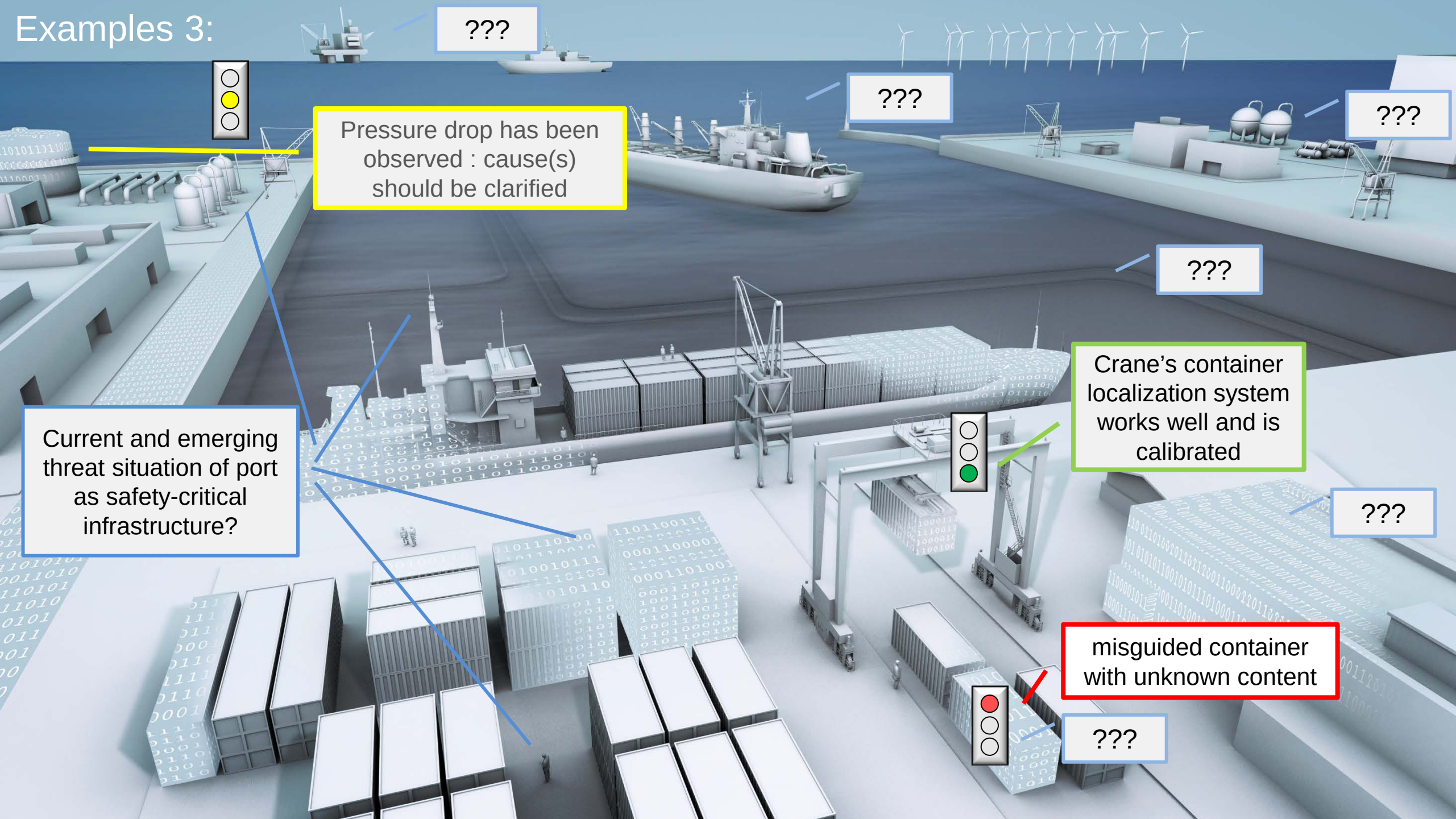
Examples 1:


GPS jamming has been detected and identified as local threat
Container loading according to safety standards (e.g. stowage of dangerous goods)
Main characteristics for a safely operating ship?

Examples 2:


Quarantine:
noro virus
Current state of occupational health and safety?
Violation of occupational safety is detected: unauthorisized person in closed area

Examples 3:


???
???
???
???
Pressure drop has been observed : cause(s) should be clarified
Current and emerging threat situation of port as safety-critical infrastructure?
Crane’s container localization system works well and is calibrated
???
misguided container with unknown content
???

Conclusions

- In the last decade the DLR, as a technologically focused research establishment, became an active contributor to the development and implementation of the IMO's e-navigation strategy. For this purpose DLR developed technological concepts (VDES, PNT) and supports the standardization in communication and navigation at IMO and IALA.

- Scope of DLR's R&D activities in this sector is the qualification of space-based and terrestrial technologies for safety-critical application e.g. by implementation of data and system integrity (monitoring & evaluation) or by decreasing the vulnerability of technologies (technological resilience).

- The complexity of maritime transport system and continuous change of conditions, threats and scenarios are the main reasons for the combined consideration of safety and security aspects as well as for the extension of safety I research activities to safety II.

- For this purpose the DLR has established a new **R&D Institute for the Protection of Maritime Infrastructures.**

Thanks for your attention!

Merci de votre attention!

Gracias por su atención!

Terima kasih atas perhatiannya!

ਤੁਹਾਡੇ ਧਿਆਨ ਲਈ ਧੰਨਵਾਦ

感謝您的關注

관심을 가져 주셔서 감사합니다.

Hvala na pozornosti!

Salamat sa iyong pansin!