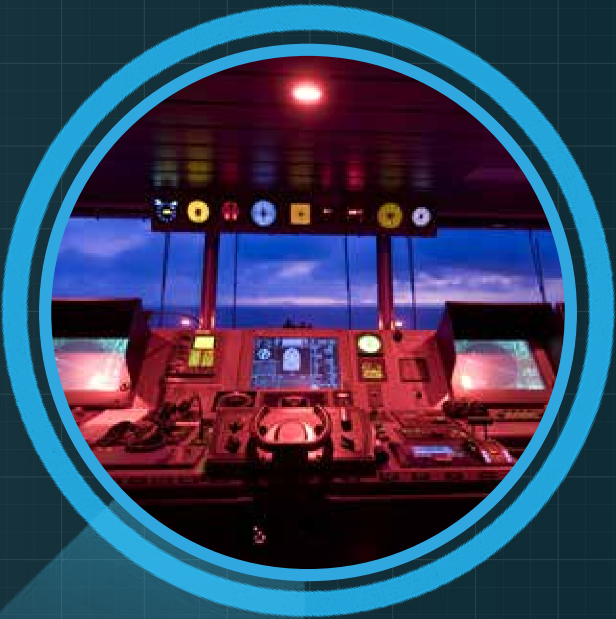
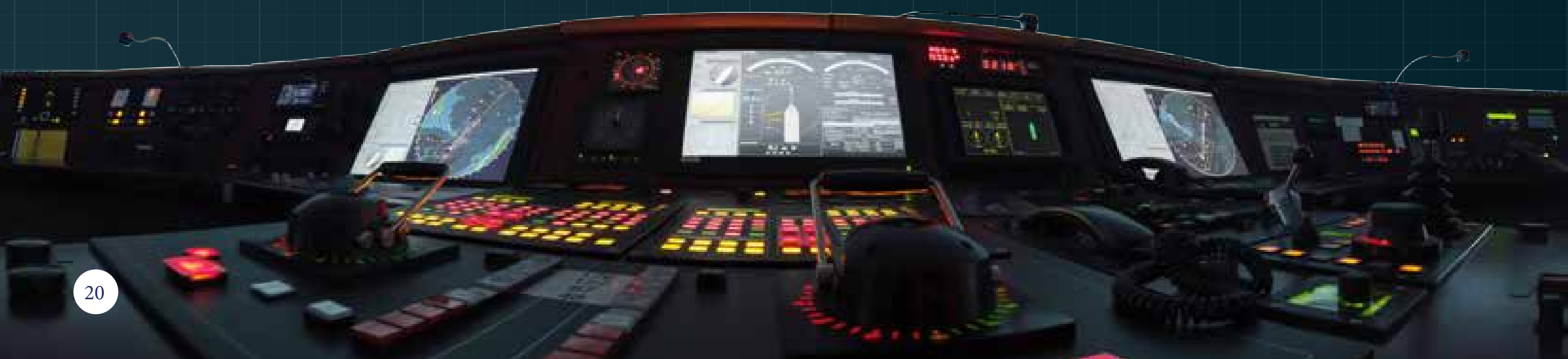


Sound the alarm! How many alerts are too many on a ship's bridge?

Lovro Maglić from the Faculty of Maritime Studies in the University of Rijeka takes us through his recent paper from The Journal of Navigation (Maglić and Zec, 2020).



What is an alert?

The International Maritime Organization (IMO) defines an alert as information indicating a circumstance or condition on a ship that requires the attention and possibly a specific task carried out by the Officer of the Watch (OOW). The alerts are classified as emergency alarms, alarms, warnings, and cautions. Emergency alarms indicate an immediate danger to human lives, the ship, or machinery, requiring immediate actions from the crew. Alarms indicate conditions, on or around the ship, requiring immediate attention and action from an OOW. Warnings indicate potentially hazardous conditions requiring attention and, possibly, actions, while cautions indicate low-priority non-ordinary conditions, requiring only the attention of an OOW.

Depending on the ship's bridge design and integration, alerts can be generated on devices and systems installed on a bridge (a so-called decentralized or "old" approach) or through the Central Alert Management Human-Machine Interface (CAM-HMI) as a part of the Bridge Alert Management (BAM) System (a "new" approach on integrated bridge systems). BAM is designed to improve alert management by listing alerts sorted by their priority, by grouping alerts triggered by the same cause and by providing a systematic record. One of BAM's main disadvantages is the fact that many alerts are duplicated, i.e. sounded on the CAM-HMI unit and the source system or device.

Generally, in integrated bridge systems, engine and cargo related alerts are displayed and sounded almost identically as in the engine and cargo control room. Nevertheless, the OOW's actions are very limited, often restricted to acknowledging and verifying the information. Further actions are the responsibility of the duty engineer or cargo officer.

How many alerts may be sounded on a bridge?

According to IMO altogether there are 69 mandatory navigation-related alerts and other essential ship systems' alerts defined for a bridge for all ships in international trade. However, on a modern bridge the total number of alerts exceeds this number significantly. An attempt to count all of a ship's alerts for research purposes took place on the Faculty of Maritime Study in Rijeka, Croatia. There the Transas Marine Navi-Trainer Professional 5000 bridge simulator has 202 different navigational equipment alerts. Additionally, the Kongsberg MC 90-IV engine simulator (MAN B&W MC 90 slow motion diesel engine) generates 482 different alerts. Finally, 164 alerts can be generated by the cargo simulator CHT 2000-VLCC-II for a Very Large Crude Carrier with 16 cargo tanks and four discharging pumps. It can be estimated that on some ships that have engine and cargo systems integrated on a bridge with unrestricted access through computer systems, approximately 850 different alerts may be sounded on a bridge.

Alerts in reality

According to recent research and based on the questionnaire survey with 104 participants considering different ship types during coastal navigation, on average 4 alerts are sounded per hour (Maglić and Zec, 2020). This frequency of alerts is significantly higher on faster, more complex, and modern ships (mainly container ships, different oil tankers and liquid gas carriers), counting even up to 10 alerts per hour or one every 5 to 6 minutes. Considering the breakdown of different alert types, alarms occur in approximately 27% of the cases, warnings in 38% and cautions in 35%. Engine-related alerts are sounded on a bridge in 90% of the ships, whereas cargo-related alerts (of any kind) in 56% of the ships. What is very interesting, according to the judgement of the participants, is that 45% of all alarm level alerts are over-prioritised and actually act as distractions in the moment of notification.

How an alert influences an OOW

As part of the same research (Maglić and Zec, 2020) an extensive experiment on OOW workload conducted on a navigational bridge simulator was carried out. The goal of the experiment was to observe the behaviour of the OOW during a navigational watch in high traffic coastal waters. One of the specific, and very interesting, aims was to analyse each action in the officer's procedure triggered by an alert. The results of the analysis, which included 220 alert procedures, showed that the reactions of the OOW vary between one and nine distinctive actions (or four actions on average) per alert. In most cases, low priority alerts (warnings and cautions) trigger only a visual observation and alert acknowledgement. On the other hand, uncommon and high priority alarms trigger more responsive and numerous actions. For example, almost all participants acted similarly in the case of a steering gear pump failure simulation: acknowledgement, turning off the autopilot, starting the second pump, rectifying heading, turning on the autopilot, setting the autopilot, calling the master, instructing the helmsman, calling the duty engineer.

A single action can last from less than 0.1 minutes (just a few seconds, usually for the first action including a visual check with acknowledgement) to more than 1 minute (for example, rectifying the ship's heading by manual steering). Considering all alert types and actions, the average time to conduct a single action is 0.35 minutes. According to the study it is estimated that after each alert an

OOW spends 1.4 minutes conducting four actions on average. The longest total time spent by the OOW recorded during an experiment, triggered by one alert, was 8.3 minutes. This included nine actions upon a gyro compass failure alarm.

Based on the study, it may be estimated that in one standard navigational watch of four hours, on average 16 different alerts are sounded, generating in total 64 actions that an OOW conducts in 22.4 minutes or 9.3% of the watch time.

There was one important observation. Nearly all the participants showed an idle time - time spent doing nothing between certain important actions, usually for a few seconds. The participants explained that these short periods were used for reflection and the planning of the next actions. Such reflection time is not included in the results. However, it is estimated that in many cases the reflection time can prolong the whole procedure time even up to 50%.

How many alerts are too many?

The following question arises: is it acceptable that approximately 10% of the OOW's time is spent on managing different alerts? If looking purely from a statistical point of view, the answer could be "yes". However, if superfluous and non-essential alerts dominate, and if they occur during a demanding navigational situation (such as collision avoidance, during waypoint course changes, distress or urgency message receipt, another high priority alert state, etc.) then the answer would be "no". Some of these demanding situations, like collision avoidance, can last for several minutes, and in such situations low priority alerts that require a few minutes of the OOW's attention may significantly reduce the situational awareness of the OOW. In other words, alerts do not "choose" a suitable moment for notification. Even the low priority alerts, not requiring "real actions", sometimes require walking, reading, acknowledgement, information collection from a source and related equipment, event record, forwarding information to other crew members, etc. When observing all the actions that an OOW conducts following each alert, it is not surprising that 45% of all the alerts are experienced as distracters, i.e. events that unnecessarily interrupt the processing of a previously started procedure.

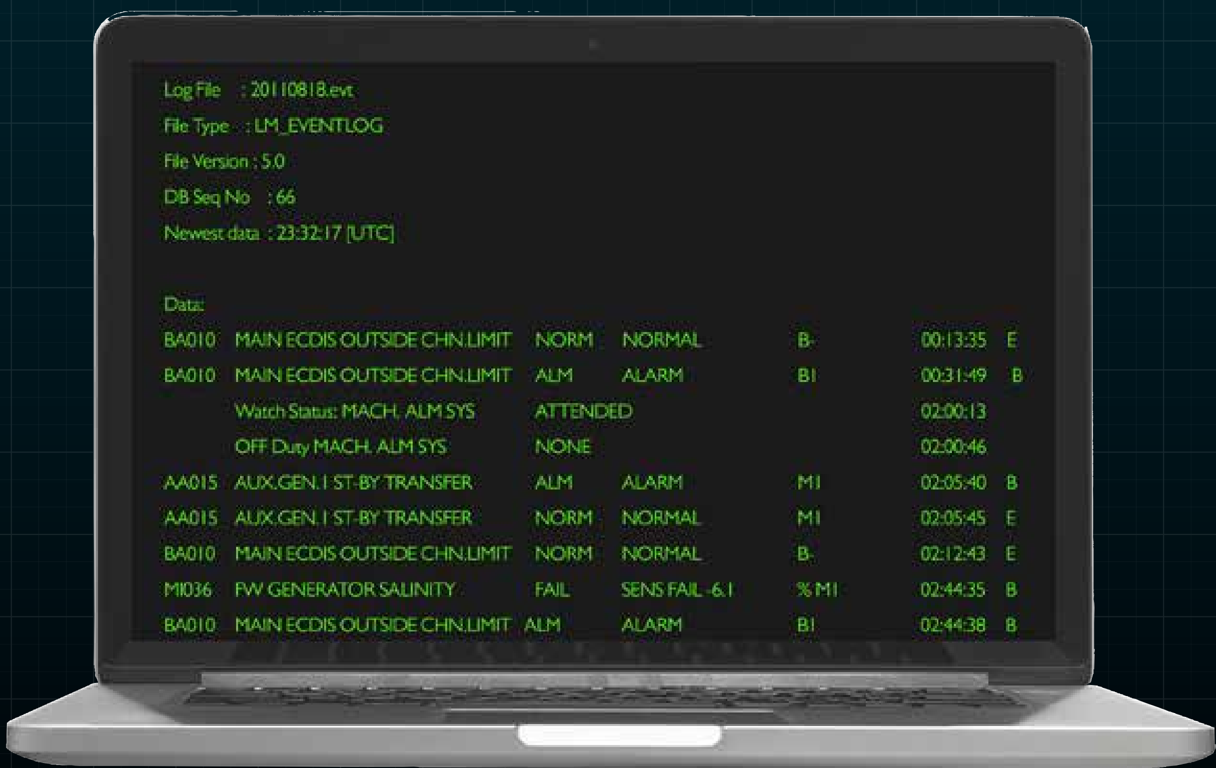
There are several possible approaches to cope with the issue of the ever-growing number of alerts. One method would be a careful selection of permissible cargo and engine-related alerts, limiting the notifications only to alerts essential for the ship's safety or pollution prevention. The second approach could be developing an intelligent adaptive information system. Such a system could intercept low-priority alerts and postpone their notification for a short period during recognized demanding situations (Maglić et al., 2016). Finally, the third approach includes further development of automated systems and making them capable of carrying out remedial actions without the involvement of the OOW. In this case, the interaction with the officer should be limited to information about the situation after remedial actions.

So, how many alerts are too many? The answer lies in whether or not the alerts were worth distracting the OOW.

References:

Maglić, L., Zec, D. (2020). The Impact of Bridge Alerts on Navigating Officers. The Journal of Navigation, 73(2), 421-432.

Maglić, L., Zec, D. and Frančić, V. (2016). Model of the Adaptive Information System on a Navigational Bridge. The Journal of Navigation, 69(6), 1247-1260.



Example of a bridge alarm log