the figure illustrates the gap between safety and security with respect to the media, i.e., no security measures in the wired segments and no safety measures in the wireless segments. It is of vital importance to achieve “seamless integration” of wired and wireless communication, to increase design, engineering, and maintenance efficiency. In industrial settings, different technologies will most probably be deployed even in the future, as it is extremely difficult to solve all industrial requirements with one standard/protocol. Therefore, we present a framework to deal with safety and security in heterogeneous networks, that hides the technical underlying differences, and provides a unified approach for safety and security.

In order to address the issues with respect to safety and security, regardless of the type of media, i.e., wired or wireless, we propose a framework based on the principle of the black channel. The proposed framework uses the principle of the black channel, where each layer comprises all measures necessary to fulfill the safety or security requirements, without where a security layer is added between the communication layer and the application layer, using the communication layer as the black channel. The security layer is not added within the scope of the Open Systems Interconnection model (OSI model), but rather between the OSI model and the application to avoid conflicts with standards and to allow end-to-end security. In the same manner the safety layer is used between the communication layer, or security layer depending of the usage of the security layer. For safety certification reasons, the security layer is part of the safety layer’s black channel. Within the proposed framework, safety and security layers can be utilized independent of each other and are deployed based on the current requirements. This approach enables end-to-end security as well as safety, without adding any safety or security requirements on the transmission media. Furthermore, our approach suits both modular field devices such as distributed I/O’s and compact devices such as field instrumentation. Within a modular device, the safety/security