WHITE PAPER

Futureproofing Ships: Secure Data Communication With IEC 61162 Standards

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1. Executive Summary

The maritime sector, which carries approximately 80% of global trade according to the United Nations Conference on Trade and Development,[1] is undergoing a pivotal transformation characterized by digitalization and an increasing emphasis on cybersecurity. New international regulations such as ISO 16425:2024, IMO MSC.428(98), and the International Association of Classification Societies (IACS) Unified Requirements E26 and E27 are being introduced to ensure vessel network resilience, operational safety, and the secure integration of onboard systems.

In this evolving context, the IEC 61162 family of standards—especially IEC 61162-450 and IEC 61162-460—have emerged as crucial frameworks for facilitating secure and interoperable data communication on ships. These standards provide a structured method for upgrading legacy systems and ensuring compliance with cybersecurity and safety mandates.

This whitepaper discusses the evolution of maritime communication standards, analyzes the technical composition of the IEC 61162 standard family, and examines their relevance to modern shipbuilding and retrofitting. It also outlines the role of IEC 61162-460 in enabling compliance with IACS UR E27 and highlights how Moxa's portfolio of marine-certified networking solutions addresses the demands of these standards.

[1] UNCTAD: https://unctad.org/news/shipping-data-unctad-releases-new-seaborne-trade-statistics

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Moxa is a leading provider of edge connectivity, industrial computing, and network infrastructure solutions for enabling connectivity for the Industrial Internet of Things. With 35 years of industry experience, Moxa has connected more than 111 million devices worldwide and has a distribution and service network that reaches customers in more than 90 countries. Moxa delivers lasting business value by empowering industry with reliable networks and sincere service for industrial communications infrastructures. Information about Moxa's solutions is available at www.moxa.com.

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2. Evolution of Maritime Data Communication Standards

Modern onboard operations require reliable and secure data exchange between a wide array of navigational, monitoring, and control systems. As vessel functions become increasingly interconnected, standardized communication protocols have become essential.

The IEC 61162 family of standards has evolved to meet the growing complexity of onboard systems. Initially based on the National Marine Electronics Association (NMEA) serial protocols, the standards have progressed to support Ethernet-based communication and incorporate advanced cybersecurity mechanisms.[2]

2.1 From NMEA to IEC 61162

- **NMEA 0183/IEC 61162-1 and 61162-2:**[3] Developed in the 1980s, this standard defines a point-to-multipoint serial communication protocol widely used in early navigation systems. It was adopted by the IEC in 1995.
- **NMEA 2000/IEC 61162-3:**[4] A Controller Area Network (CAN)-based protocol designed to handle more devices and higher data throughput.
- **IEC 61162-450:**[5] Introduced Ethernet-based communication via the Lightweight Ethernet (LWE) protocol, using UDP multicast for real-time data transmission.
- **IEC 61162-460:**[6] The latest extension, offering enhanced data security, redundancy, network segmentation, and secure gateway functionality to address cybersecurity concerns.

[2] Maritime Cybersecurity: https://www.nmea.org/cybersecurity.html
[3] IEC 61162-1: https://webstore.iec.ch/en/publication/72729
[4] IEC 61162-3: https://webstore.iec.ch/en/publication/4714
[5] IEC 61162-450: https://webstore.iec.ch/en/publication/72731
[6] IEC 61162-460: https://webstore.iec.ch/en/publication/72732

2.2 Relevance to Fleet Modernization

UNCTAD's 2024 report[7] states that the global fleet comprises approximately 109,000 ships over 100 gross tons (GT), with an average age of 22.4 years. As a result of aging infrastructure, tightening regulations, and increasing shipbuilding costs, retrofitting existing ships has become a more economically viable and practical approach than constructing new builds.

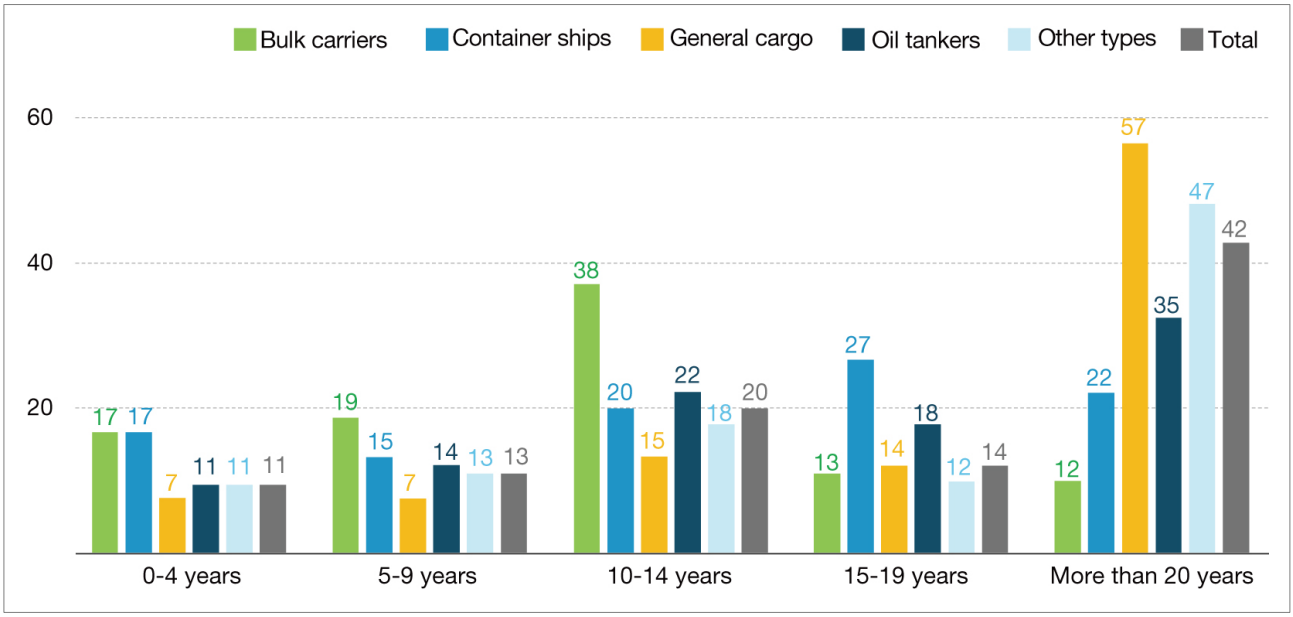

Figure 1: Average age of world fleet, percentage number of vessels, 2024

(Source: UNCTAD calculations, based on data provided by Clarksons Research Services.)

[7] UNCTAD Handbook of Statistics 2024: https://unctad.org/publication/handbook-statistics-2024

Digital retrofits enable compliance with the International Maritime Organization's (IMO) Data Collection System (DCS),[8] which mandates fuel consumption reporting for ships over 5,000 GT. Fuel consumption data is crucial for calculating a ship's operational carbon intensity (CII) and informing further measures to reduce greenhouse gas emissions from ships. In this context, the IEC 61162-450 and -460 standards provide critical communication frameworks that support seamless integration of navigational and monitoring systems across bridge and engine rooms.

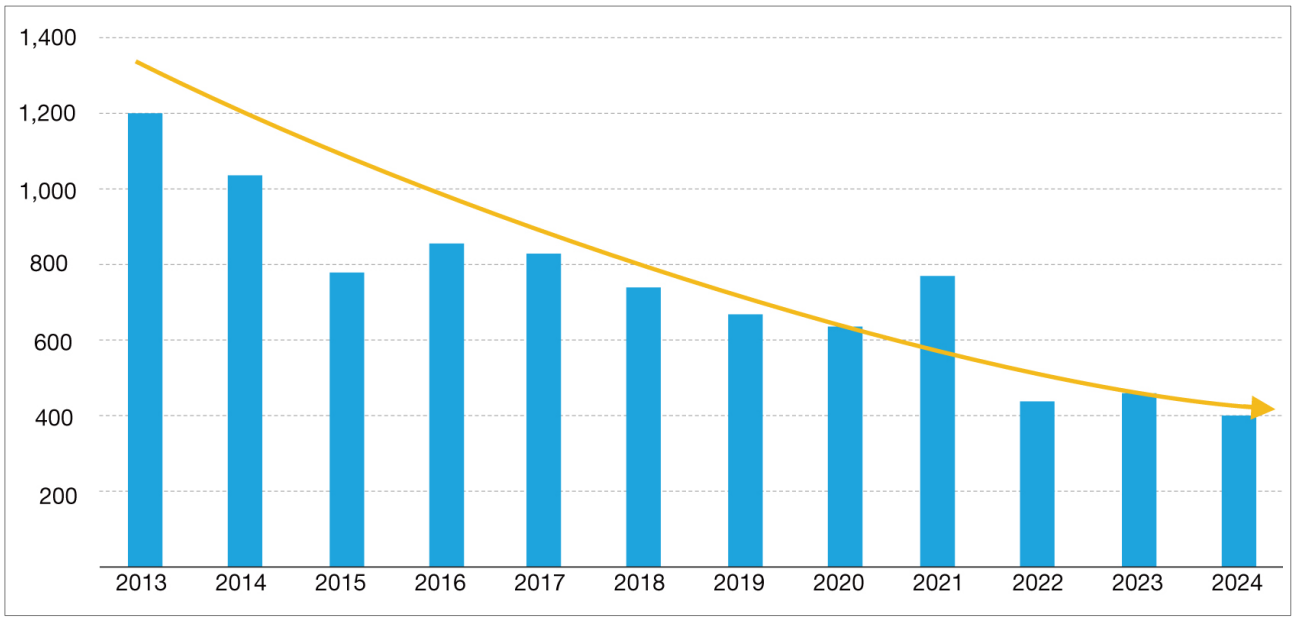

Figure 2: Scrapped Ship Quantity[9] (table compiled by the author)

[8] IMO Data Collection System (DCS): https://www.imo.org/en/ourwork/environment/pages/data-collection-system.aspx
[9] Annual Lists of Scrapped Ships: https://shipbreakingplatform.org/annual-lists/

3. Overview of the IEC 61162 Standard Family

The IEC 61162 family[10] is derived from NMEA[11] protocols and enables interoperability between onboard devices by standardizing the transport of navigation and operational data.

IEC Standard	Description	Known as	Key Requirements
IEC 61162-1:2024	Maritime navigation and radiocommunication equipment and systems - Digital interfaces - Part 1: Single talker and multiple listeners	NMEA 0183	1. Optical isolation designs should be considered. 2. Tested data rates must exceed 4,800 bits/s.
IEC 61162-2:2024	Maritime navigation and radiocommunication equipment and systems - Digital interfaces - Part 2: Single talker and multiple listeners, high-speed transmission	NMEA 0183-HS	The data rate requirement is more demanding (38,400 bits/s) compared to IEC 61162-1.
IEC 61162-3:2014	Maritime navigation and radiocommunication equipment and systems - Digital interfaces - Part 3: Serial data instrument network	NMEA 2000	1. Standard connector design. 2. Compatible with the Controller Area Network ("CAN Bus"). Higher-level protocol format: SAE J1939. 3. Could be considered a successor to NMEA 0183 with a higher data rate requirement (250,000 bits/s).
IEC 61162-450:2024	Maritime navigation and radiocommunication equipment and systems - Digital interfaces - Part 450: Multiple talkers and multiple listeners - Ethernet interconnection	Lightweight Ethernet (LWE)	1. The specification describes the transport of NMEA sentences as defined in 61162-1 over IPv4. 2. Due to the low amount of protocol complexity, it has been nicknamed LWE. 3. Communication between talkers and listeners is often achieved using UDP multicast.
IEC 61162-460:2024	Maritime navigation and radiocommunication equipment and systems - Digital interfaces - Part 460: Multiple talkers and multiple listeners - Ethernet interconnection - Safety and security	Extension of IEC 61162-450	1. Includes redundancy, authentication, and firewall rules to enhance cybersecurity. 2. It defines various roles such as 460-switch, 460-forwarder, 460-gateway, 460-wireless gateway, 460-node, and 450-node in the 460-network.

[10] IEC Webstore: https://webstore.iec.ch/en/
[11] NMEA: https://www.nmea.org/

4. Onboard System Architecture and ISO 16425

ISO 16425 establishes design principles for IP-based onboard systems, distinguishing between controlled and uncontrolled network environments. The ISO 16425 standard was first released in 2013, with the latest version published in 2024.[12]

When designing ship communication networks, this standard recommends segmenting the network into at least two types:

- **Controlled Networks:** Internally managed with defined access controls and monitoring mechanisms.
- **Uncontrolled Networks:** Include third-party or external systems and require strict security boundaries.

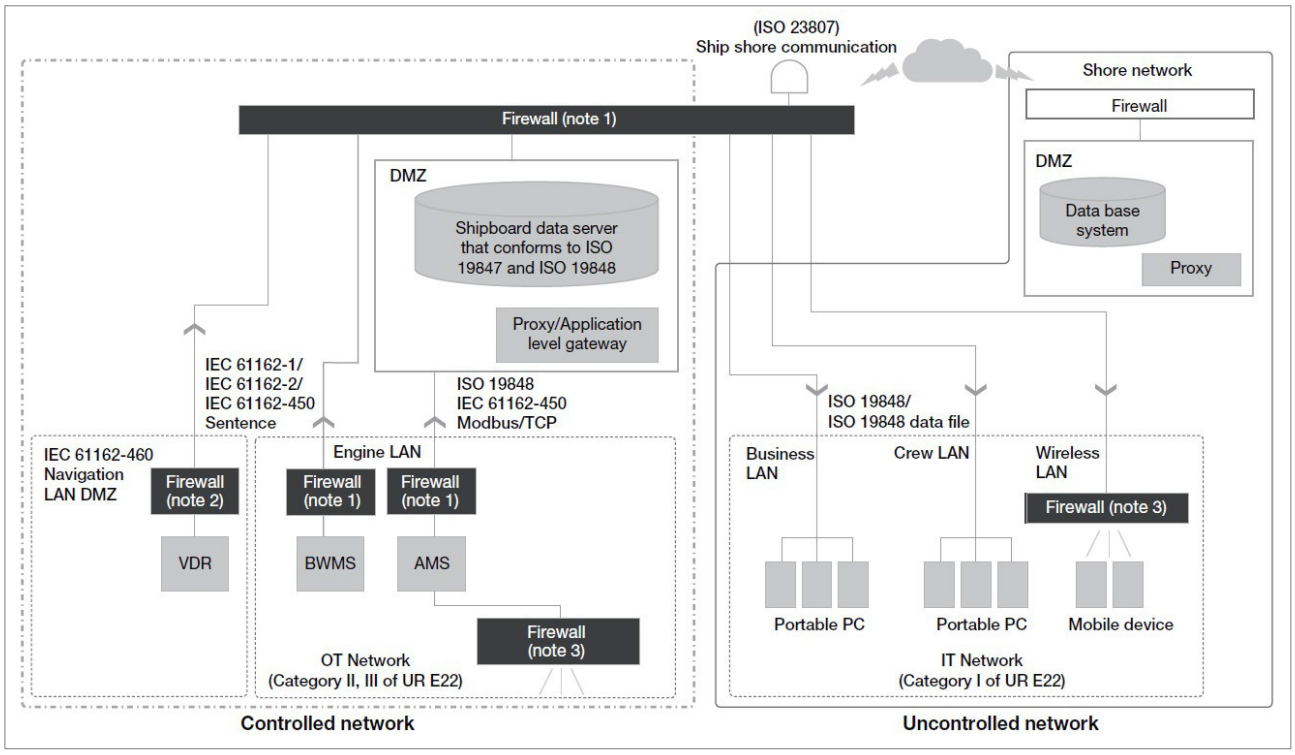

Figure 3: Revision of ISO/DIS 16425[13]

[12] ISO 16425:2024: https://www.iso.org/standard/78264.html
[13] SSAP: https://www.monohakobi.com/ja/wp-content/uploads/2022/09/SI01_02_20220715-Activities-of-SSAP-by-Hideyuki-Ando.pdf

Compared with the requirements in Navigation Network VDR in 2013 as shown in Figure 4, the importance of IEC 61162 in 2024 stands out—as shown in Figure 3—to ensure data integrity and security.

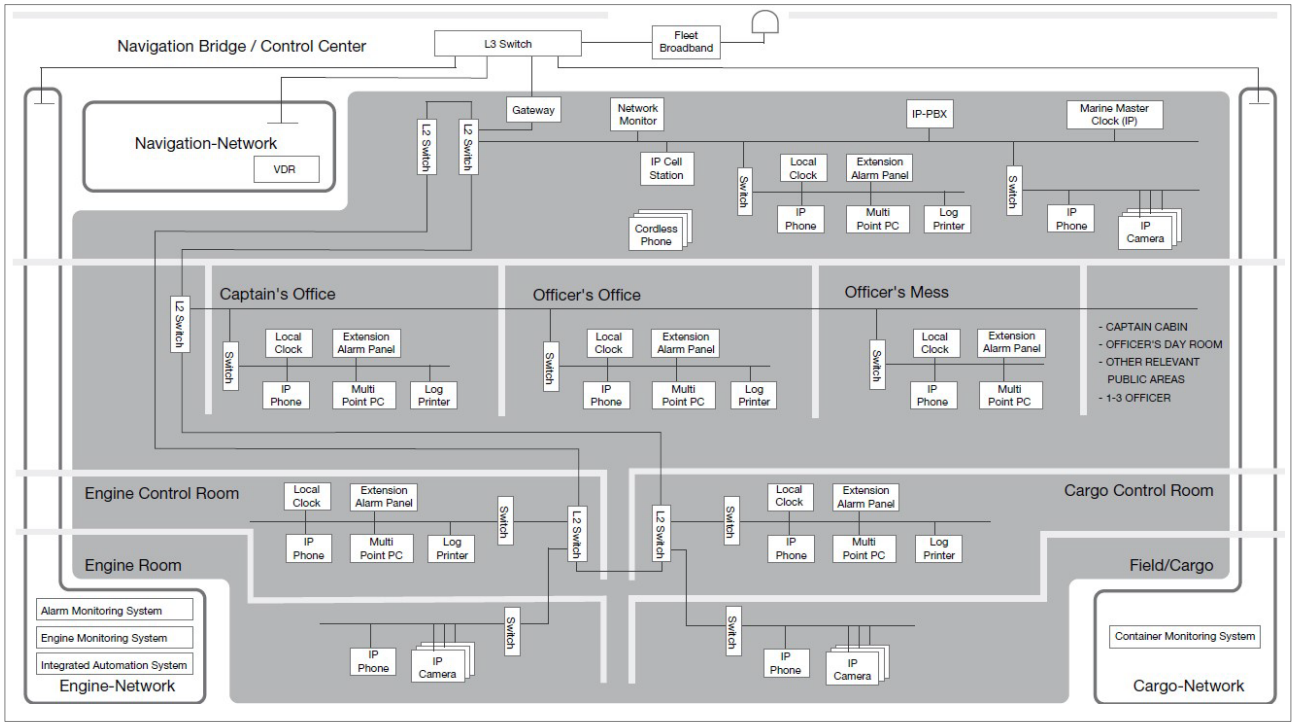

Figure 4: Sample network architecture scope in 2013

IEC 61162-450 provides a foundation for Ethernet-based communication using UDP broadcasts, enabling multiple bridge systems and navigation components to share data efficiently. It supports not only real-time updates essential for ECDIS, RADAR, and bridge alert management (BAM) integration, but also in other OT networks on vessels, such as Voyage Data Recorders (VDR) and alarm and monitoring systems (AMS), as shown in Figure 3. IEC 61162-460, on the other hand, introduces mechanisms for securely interfacing with external systems and segmented zones onboard.

Taking the Purdue Model as a reference framework as in Figure 5, onboard networks are typically structured in hierarchical layers:

- Instrument Layer: NMEA 0183/NMEA 2000
- Integration Layer: IEC 61162-450 for bridge system interconnection
- Security Layer: IEC 61162-460 for secure segmentation and external communication

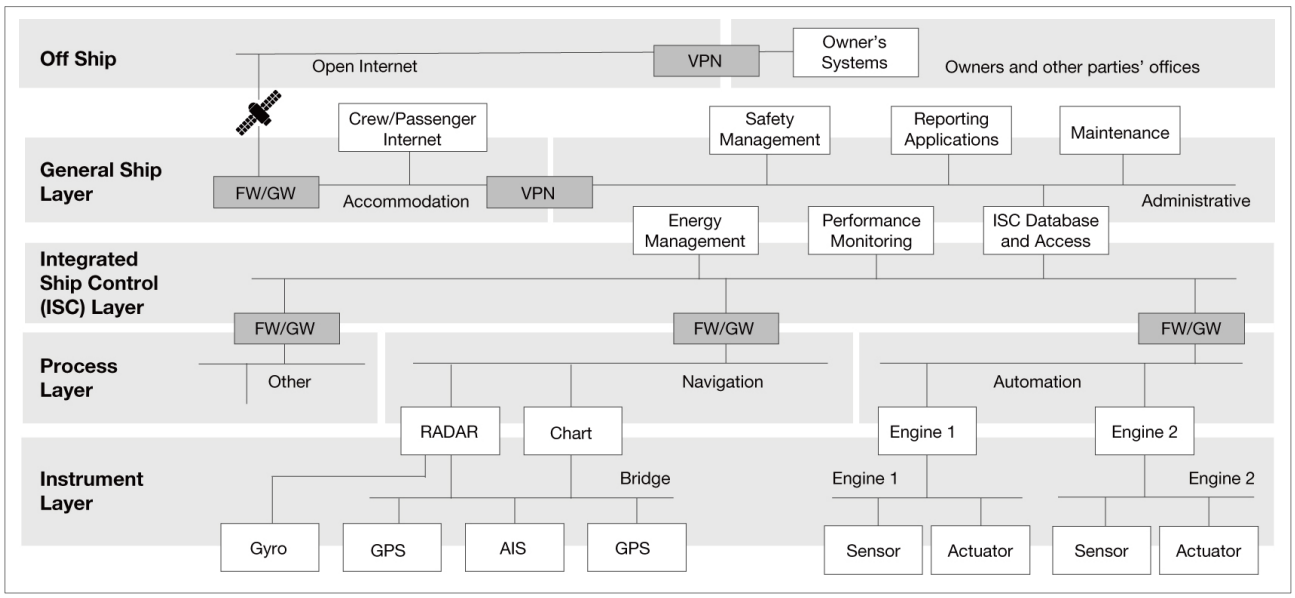

Figure 5: Schematic for ship network architecture[14]

[14] MiTS: https://mits-forum.org/network.html

5. Compatibility and Deployment Considerations

With many devices now supporting multiple standards (e.g., IEC 61162-1, -2, and -450), hybrid deployments are common. Retrofitted vessels often require protocol converters or gateways to bridge legacy systems with modern Ethernet-based networks.

IEC 61162-450 devices can be categorized based on OSI model roles:[15]

- **T-Profile:** Data transport
- **Profile:** Application data interface

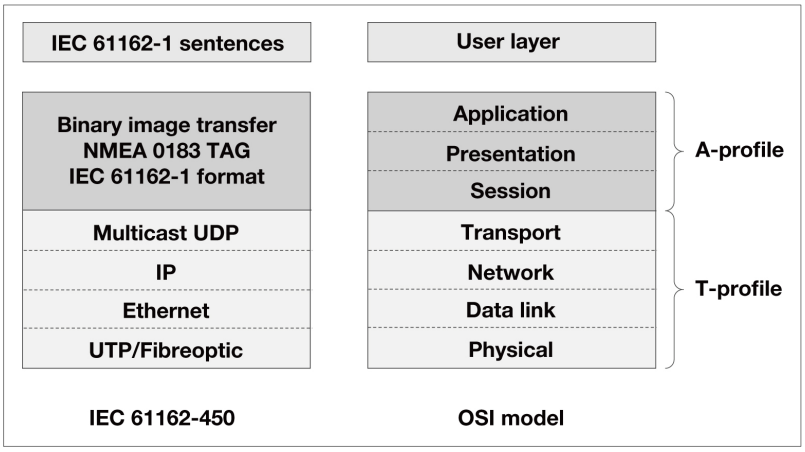

Figure 6: T- and A-profiles with corresponding OSI protocol layers

The transition to -450 networks can accommodate legacy protocols by utilizing gateways that interpret Talker IDs and System Function IDs (SFIs).

OEMs such as Wärtsilä, Furuno, JRC, and Sperry Marine have incorporated IEC 61162-450/460 compatibility into their latest product lines, accelerating the adoption of Ethernet-based maritime systems, which are higher level systems.

[15] Design challenges and decisions for a new ship data network: https://www.mits-forum.org/resources/lwe-paper-isis-v9.pdf

6. IEC 61162-460: Advancing Maritime Cybersecurity

IEC 61162-460[16] is designed to address growing cybersecurity risks by introducing specific architectural elements:

- **460-Nodes:** Devices within the secure Ethernet network
- **460-Switches:** Managed switches supporting segmentation
- **460-Gateways:** Boundary devices for interfacing with external networks
- **460-Forwarders:** Data routers that filter and route IEC 61162-450 traffic

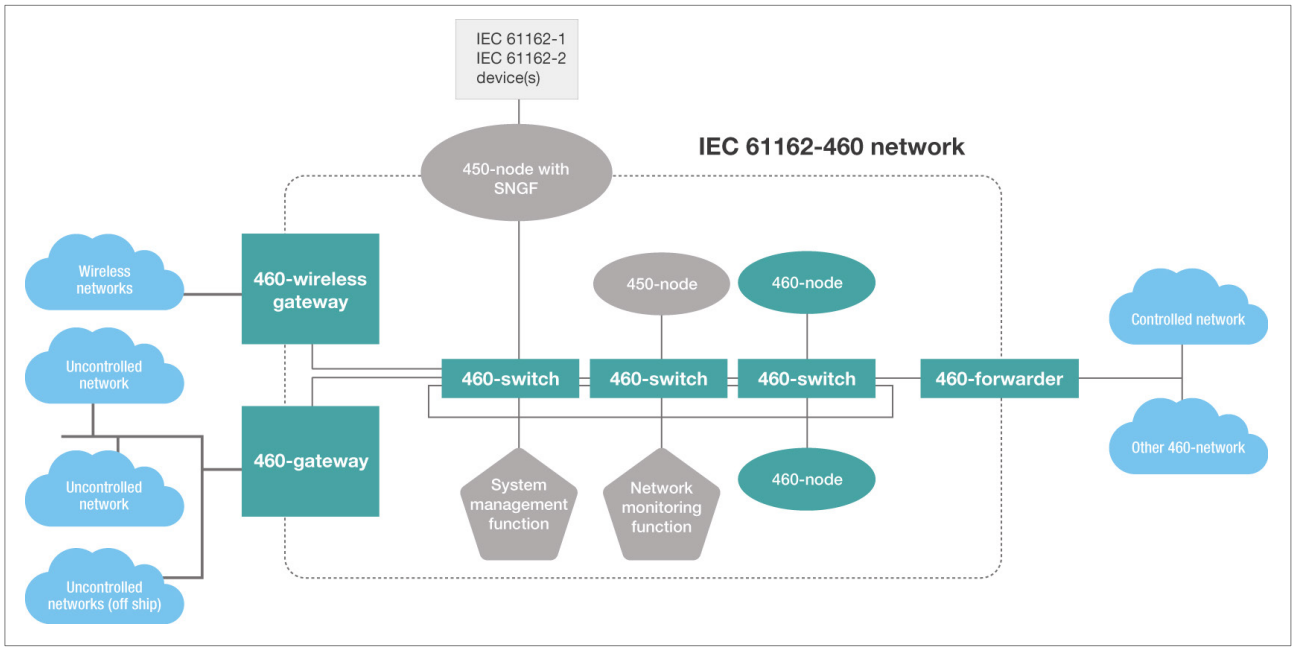

Figure 7: Functional overview of IEC 61162-460 applications

These components support essential cybersecurity features:

- Role-based access control
- Firewall enforcement
- Connection logging and timeout enforcement
- Traffic filtering by source, protocol, or destination

IEC 61162-460 aligns with IMO MSC.302(87) and can serve as a basic compliance path for IACS UR E27 when UR E26 cybersecurity measures are already fulfilled. It enables shipbuilders and operators to adopt a unified and pre-structured framework for addressing maritime cybersecurity requirements.

[16] IEC 61162-460:2024: https://webstore.iec.ch/en/publication/72732

For example, a key feature is the **460-gateway**, which governs communication between controlled and uncontrolled networks.

460-gateways provide:

- Demilitarized zone (DMZ) for application or file access
- IP, protocol, and port-level firewall rules
- Session control, including auto-termination after 4 hours or 10 minutes of inactivity

These mechanisms reduce the risk of unauthorized access and maintain secure data flows between onboard and external systems.

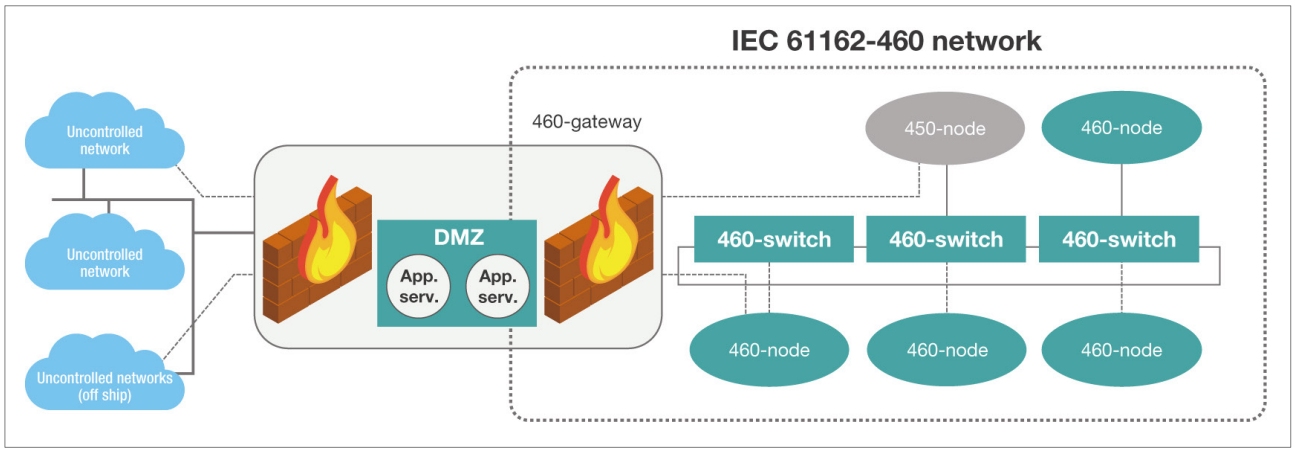

Figure 8: 460-network with a 460-gateway

7. Moxa's Role in Maritime Digitalization

Moxa offers marine-certified portfolio of networking and cybersecurity solutions that comply with marine standards such as IEC 60945 and DNV GL requirements.

Key offerings include:

- **Managed Ethernet Switches:** Supporting redundancy, multicast filtering, and IEC 61162-450/460 compliance
- **Protocol Gateways:** Enabling legacy device integration within modern networks
- **Cybersecurity Appliances:** Including firewalls and secure remote access solutions aligned with IEC 62443 and IMO guidelines

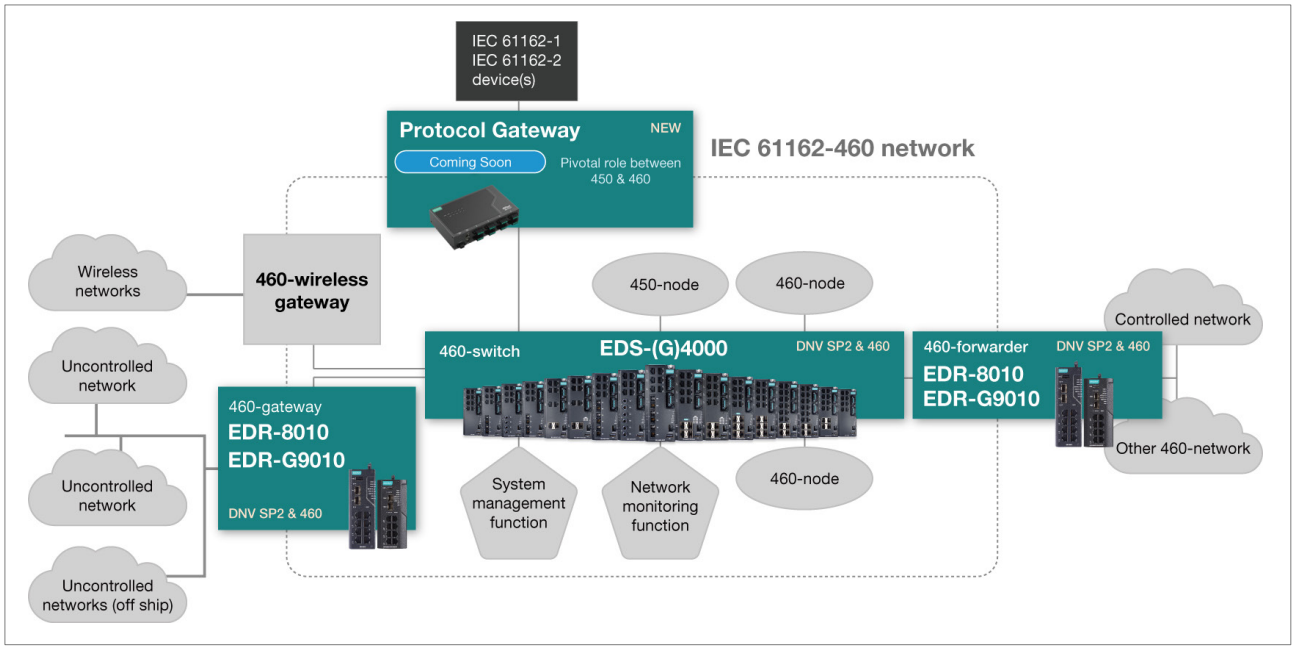

Figure 9: Moxa IEC 61162-460 portfolio

Moxa collaborates with shipbuilders and system integrators to develop future-ready maritime communication infrastructures that align with evolving regulatory demands.

8. Conclusion

As digital transformation accelerates in the maritime sector, secure, standardized communication frameworks are critical for ensuring safe and efficient operations. The IEC 61162 family of standards—particularly IEC 61162-450 and -460—offers practical, compliant solutions for both new builds and retrofitted vessels.

By embedding cybersecurity into the core of onboard network design, IEC 61162-460 enables vessel owners to meet regulatory demands while supporting interoperability, resilience, and operational visibility. Moxa's marine-grade solutions further simplify implementation and pave the way for future-ready maritime systems.

9. Additional Resources

For further information on maritime communication standards and Moxa's solution offerings, please visit: Moxa's Maritime Microsite.