Advanced Certificate in Marine Navigation and Nautical Science

Radio Communications and Electronic Navigation Aids

AIS (Automatic Identification System) – related terms: VDES, SAR, ship-to-shore communication. The AIS is a digital VHF radio system that automatically transmits a vessel's identity, position, course, speed and other data to nearby ships and shore stations. Example: A cargo ship in busy traffic uses AIS to broadcast its ETA, enabling traffic separation schemes to be managed safely. Practical application includes collision avoidance, search-and-rescue coordination and maritime domain awareness. Challenges involve signal congestion in dense traffic, spoofing attacks and the need for regular software updates.

Alpha-numeric Code – related terms: NATO phonetic alphabet, maritime signal flags. A standardized set of letters and numbers used in voice and written messages to convey clear information, especially under poor radio conditions. Example: "Bravo Charlie Delta" conveys the letters B-C-D. Practical application is in distress calls, identification of vessels and verification of coordinates. Challenges include mis-hearing due to interference and the necessity for crew training.

AM Radio – related terms: MF, carrier wave, sideband. Amplitude Modulation (AM) transmits voice and data by varying the amplitude of a carrier frequency, typically in the medium-frequency band (300 kHz–3 MHz). Example: Coastal stations broadcast weather forecasts on 2182 kHz using AM. Practical application is long-range communication when line-of-sight is limited. Challenges are susceptibility to static, limited bandwidth and interference from atmospheric noise.

Beacon – related terms: marine radio beacon, distress beacon, EPIRB. A fixed or floating transmitter that emits a continuous or periodic signal to aid navigation or signal distress. Example: A lighthouse equipped with a VHF beacon transmits its identifier every 10 seconds. Practical application includes vessel position fixing and aiding search-and-rescue teams. Challenges involve maintenance of power sources and signal overlapping in congested areas.

Berthing Radio – related terms: port operations, VHF channel 16, ship-to-shore. Dedicated VHF channels used by pilots and port authorities to coordinate docking maneuvers. Example: A tanker requests berth clearance on channel 16 before entering the harbor. Practical application is safe berthing in restricted waters. Challenges include channel congestion during peak traffic and the need for clear procedural language.

Channel 16 – related terms: distress, safety, VHF. The international VHF maritime distress, safety and calling frequency (156.8 MHz). All vessels must monitor this channel continuously. Example: A vessel in distress transmits a Mayday on channel 16, prompting nearby ships to respond. Practical application is initial contact

before switching to a working channel. Challenges are channel overload, especially near busy ports, and the necessity for disciplined radio discipline.

Coastal Radio Station – related terms: MF, HF, NAVTEX. Shore-based facilities that provide voice communication, weather information and navigational warnings to ships at sea. Example: A vessel contacts the coastal station "GMDSS A" for a weather update. Practical application includes routine reporting, safety traffic and coordination of rescue operations. Challenges are equipment aging, limited coverage in remote regions and language barriers.

Compass Deviation – related terms: magnetic variation, compass error, deviation card. The error introduced into a magnetic compass by local magnetic fields on the vessel, such as steel hulls or electrical equipment. Example: A vessel's deviation card shows a 2° east deviation when the heading is 090°. Practical application is correcting compass readings for accurate navigation. Challenges involve periodic re-calibration and the impact of new equipment installations.

Compass Variation – related terms: magnetic declination, true north, charted variation. The angle between magnetic north and true geographic north at a specific location, varying with latitude and longitude. Example: A chart indicates a variation of 12° west for a position off the coast of England. Practical application is converting magnetic bearings to true bearings for chart work. Challenges include annual changes and the need for up-to-date data.

Digital Selective Calling (DSC) – related terms: GMDSS, distress alert, VHF. An automated signaling system that uses digital codes to establish contact, transmit distress alerts and exchange routine messages over VHF, MF or HF bands. Example: A vessel sends a DSC distress alert on channel 70, automatically transmitting its MMSI and position. Practical application streamlines emergency communication and reduces voice traffic. Challenges are equipment compatibility, user training and ensuring proper configuration of ship-board equipment.

DSC Channel 70 – related terms: VHF, distress, GMDSS. The dedicated VHF channel (156.525 MHz) for DSC distress, safety and routine calls. All vessels equipped with DSC must monitor this channel. Example: A fishing vessel initiates a DSC distress call on channel 70 after a collision. Practical application is rapid alerting of nearby ships and shore stations. Challenges include false alerts, limited bandwidth and the need for a clear understanding of the call sequence.

Electronic Chart Display and Information System (ECDIS) – related terms: ENC, AIS integration, chart updating. A computer-based navigation system that integrates digital charts, position data, AIS targets and radar overlays to provide real-time situational awareness. Example: A cruise ship's ECDIS shows the vessel's track, nearby traffic and the planned route, automatically alerting when a deviation occurs. Practical application replaces paper charts, enhances route planning and supports compliance with SOLAS requirements. Challenges involve data integrity, system redundancy and crew proficiency.

Emergency Position Indicating Radio Beacon (EPIRB) – related terms: SAR, distress alert, COSPAS-SARSAT. A

self-activating transmitter that, when triggered, sends a distress signal containing the vessel's identification and GPS coordinates to satellite networks. Example: A crew manually activates the EPIRB after a hull breach, prompting a rescue sortie. Practical application is rapid global alerting for vessels in distress, especially when out of VHF range. Challenges include battery life, false activations and ensuring the beacon is registered with the appropriate authority.

Frequency Modulation (FM) – related terms: VHF, bandwidth, carrier frequency. A method of transmitting information by varying the frequency of the carrier wave, providing superior noise immunity compared with AM. Example: Most VHF marine communications use FM to convey voice and data. Practical application includes ship-to-ship, ship-to-shore and port operations. Challenges are limited range due to line-of-sight constraints and the need for stable oscillators.

Global Maritime Distress and Safety System (GMDSS) – related terms: DSC, EPIRB, NAVTEX. An internationally coordinated set of safety procedures, equipment and communication protocols designed to ensure that ships in distress can be reached quickly. Example: A vessel equipped with GMDSS automatically transmits its position and distress signal via DSC when a man-overboard event occurs. Practical application includes automated alerts, satellite messaging and continuous monitoring of distress frequencies. Challenges involve equipment maintenance, crew training and ensuring compliance with SOLAS thresholds.

GNSS (Global Navigation Satellite System) – related terms: GPS, GLONASS, Galileo. A constellation of satellites that provides positioning, navigation and timing (PNT) data to users worldwide. Example: A ship's chartplotter receives GNSS data to display its exact latitude and longitude on an electronic chart. Practical application is precise navigation, route planning and collision avoidance. Challenges include signal blockage in narrow channels, spoofing threats and multi-constellation integration.

HF Radio – related terms: long-wave, ionospheric propagation, SSB. High-frequency (3 MHz–30 MHz) communications that can travel beyond line-of-sight by reflecting off the ionosphere, enabling inter-continental contact. Example: A vessel on a trans-Atlantic passage uses HF to exchange weather reports with a coastal station. Practical application includes long-range distress alerts, ship-to-shore data exchange and satellite backup. Challenges are variable propagation conditions, complex antenna tuning and the need for skilled operators.

High-Frequency Direction Finding (HF-DF) – related terms: radio direction finder, bearings, SAR. A technique that determines the direction of a radio transmitter by measuring the angle of arrival of HF signals. Example: A rescue aircraft uses HF-DF to locate a vessel transmitting a distress call on 2182 kHz. Practical application is locating ships in distress when GPS is unavailable. Challenges include signal reflection, multipath interference and the necessity for calibrated equipment.

International Maritime Organization (IMO) – related terms: SOLAS, MARPOL, STCW. The United Nations specialized agency responsible for setting global standards for the safety, security and environmental performance of shipping. Example: IMO conventions mandate the carriage of AIS equipment on vessels

over 300 GT. Practical application includes rule-making, inspection guidelines and facilitating international cooperation. Challenges are ensuring uniform implementation across jurisdictions and adapting regulations to emerging technologies.

International Telecommunication Union (ITU) – related terms: frequency allocation, band plan, maritime mobile service. The UN agency that coordinates the global use of the radio-frequency spectrum and satellite orbits, including maritime communications. Example: The ITU assigns the VHF maritime band (156 MHz–174 MHz) and defines channel spacing. Practical application is preventing interference between services and harmonising standards. Challenges involve balancing commercial, military and safety needs and updating allocations as new services emerge.

Ka-band Radar – related terms: X-band, shipborne radar, target resolution. A radar operating in the 26.5 GHz–40 GHz frequency range, offering higher resolution and smaller antenna size compared with lower-frequency radars. Example: A modern patrol vessel uses Ka-band radar to detect small debris in congested waterways. Practical application includes precise navigation in tight channels and enhanced target discrimination. Challenges are susceptibility to rain attenuation and higher power consumption.

Marine VHF – related terms: FM, channel plan, GMDSS. The primary short-range radio service for ship-to-ship and ship-to-shore communication, operating between 156 MHz and 174 MHz with 25 kHz channel spacing. Example: A vessel calls “Mayday, Mayday, Mayday” on VHF channel 16 to announce a fire. Practical application includes distress signaling, routine traffic, port coordination and weather updates. Challenges are line-of-sight limitation, channel congestion and the need for disciplined call procedures.

Marine Satellite Services – related terms: Inmarsat, Iridium, VSAT. Communications platforms that provide voice, data and broadband connectivity via geostationary or low-earth-orbit satellites. Example: A container ship uses Inmarsat C to transmit its daily position report to the charterer. Practical application includes global email, real-time weather routing and emergency calling. Challenges involve subscription costs, latency, coverage gaps at high latitudes and equipment installation constraints.

Marine VHF Digital Voice (MVD) – related terms: digital modulation, GMS, voice over IP. An emerging technology that transmits voice digitally over VHF, improving clarity and allowing integration with data services. Example: A coastal authority pilots a trial of MVD to reduce background noise on channel 16. Practical application is enhanced speech intelligibility and potential for combined voice-data streams. Challenges include standardisation, retrofitting legacy radios and ensuring interoperability.

METAR – related terms: weather report, aviation, marine METAR. A routine aviation weather observation that includes wind, visibility, cloud cover and significant weather phenomena, often adapted for marine use. Example: A vessel receives a METAR from the nearest coastal airport detailing a 15-knot wind from 270° and moderate seas. Practical application is short-term weather planning and route adjustment. Challenges are interpreting aviation-specific codes and ensuring timely updates.

MF Radio – related terms: medium-frequency, 2182 kHz, NAVTEX. Maritime Medium Frequency band

(300 kHz–3 MHz) used for distress, safety and navigational information, especially the international distress frequency 2182 kHz. Example: A vessel monitors MF for NAVTEX broadcasts of local notices to mariners. Practical application includes long-range voice distress calls and automated text messaging. Challenges are limited bandwidth, interference from atmospheric noise and the gradual shift toward digital services.

Navtex – related terms: MF, broadcast, safety information. A global automated service that transmits navigational and meteorological warnings, weather forecasts and other safety information on a fixed MF frequency (518 kHz for English-language broadcasts). Example: A ship's Navtex receiver alerts the officer on watch to a newly issued coastal warning about reduced visibility. Practical application is continuous delivery of up-to-date safety messages without manual logging. Challenges include limited language coverage, signal blockage in high-latitudes and reliance on a single transmitter per region.

Navigation Light – related terms: AIS, COLREGs, beacon. Visual signals on a vessel's hull and superstructure that indicate its status, size, and operational intent during darkness or reduced visibility. Example: A fishing vessel displays a red-green navigation light system while underway at night. Practical application is compliance with COLREGs and aiding visual identification. Challenges involve power consumption, bulb failure and ensuring correct colour orientation.

Negative-Frequency Offset – related terms: frequency planning, channel spacing, interference. A deliberate shift of a transmitted frequency below the nominal centre frequency to reduce interference with adjacent channels. Example: A coastal station uses a –5 kHz offset on its MF distress channel to minimise overlap with nearby traffic. Practical application is improving channel separation in crowded bands. Challenges include ensuring receivers are calibrated to detect the offset and maintaining coordination with neighbouring administrations.

Noise Figure – related terms: receiver sensitivity, SNR, thermal noise. A measure of the degradation of the signal-to-noise ratio (SNR) caused by components in a radio receiver, expressed in decibels (dB). Example: A high-performance VHF receiver has a noise figure of 1.5 dB, allowing clear reception of weak distress signals. Practical application is selecting equipment that can reliably detect low-power transmissions. Challenges involve balancing cost, size and power consumption while achieving low noise figures.

Octave Band – related terms: frequency spectrum, bandwidth, spectral analysis. A frequency interval where the upper limit is twice the lower limit, used in acoustic and radio spectrum analysis. Example: An acoustic survey of a harbor measures noise levels in 1 kHz to 2 kHz octave bands. Practical application includes assessing interference, designing filters and complying with environmental noise regulations. Challenges are accurate measurement and interpreting results across multiple bands.

PDH (Pulsed-Doppler Radar) – related terms: target tracking, maritime radar, clutter suppression. A radar technique that transmits short pulses and measures the frequency shift caused by moving targets, providing both range and velocity information. Example: A coastal surveillance radar uses PDH to differentiate between a small boat and sea clutter. Practical application is enhanced detection of fast-moving vessels and

improved clutter rejection. Challenges include complex signal processing and higher power requirements.

Phased-Array Antenna – related terms: beam steering, radar, antenna aperture. An antenna consisting of multiple radiating elements whose relative phase can be controlled to steer the beam electronically without moving parts. Example: A modern patrol vessel's radar employs a phased-array antenna to scan 360° rapidly. Practical application includes faster target acquisition, multi-beam operation and reduced mechanical wear. Challenges are high cost, sophisticated control electronics and the need for precise calibration.

Radio Direction Finding (RDF) – related terms: bearing, HF-DF, SAR. The process of determining the direction from which a radio signal originates, typically using a rotating directional antenna or an array of fixed antennas. Example: A shore-based RDF station provides a bearing to a vessel transmitting a distress call on 2182 kHz. Practical application is locating ships in distress, aiding SAR missions and verifying the source of interference. Challenges include multipath propagation, signal fading and the requirement for skilled operators.

Radio Frequency Interference (RFI) – related terms: EMI, spurious emissions, band planning. Unwanted radio signals that disrupt the reception or transmission of intended communications. Example: A vessel's high-power radar creates RFI that degrades the performance of nearby VHF radios. Practical application is identifying and mitigating sources of interference to maintain reliable communications. Challenges are detecting intermittent sources, complying with emission limits and coordinating with other spectrum users.

Radio Teletype (RTTY) – related terms: digital mode, HF, remote logging. An early digital communication method that transmits typed characters over HF radio using frequency shift keying. Example: A coastal station sends weather forecasts via RTTY on 2182 kHz. Practical application includes automated dissemination of meteorological data and ship reports. Challenges are low data rates, susceptibility to noise and the need for dedicated decoding equipment.

Receiver Operating Characteristic (ROC) – related terms: detection probability, false alarm rate, signal detection theory. A graphical plot that illustrates the trade-off between detection sensitivity and false alarm probability for a given receiver. Example: An antenna manufacturer presents the ROC curve of its new VHF receiver, showing improved detection at low SNR. Practical application is evaluating equipment performance for distress monitoring. Challenges include interpreting the curve in operational contexts and balancing sensitivity with reliability.

Reed Switch – related terms: magnetic compass, compass swing, shipboard sensors. A simple magnetic sensor that changes state when exposed to a magnetic field, often used in compass swing testing to verify deviation tables. Example: During a compass calibration, a reed switch detects the presence of a known magnetic field to confirm the swing accuracy. Practical application includes low-cost verification of magnetic instruments. Challenges are limited precision and susceptibility to external magnetic disturbances.

Satellite-Based Augmentation System (SBAS) – related terms: GNSS, WAAS, EGNOS. Ground-based

reference stations that monitor GNSS signals and broadcast correction data via satellite to improve accuracy, integrity and availability. Example: A vessel's navigation system receives SBAS corrections from the European EGNOS service, achieving sub-meter positioning. Practical application is enhanced route planning in constrained waterways and compliance with precision-approach requirements. Challenges include coverage gaps, latency and dependence on the integrity of the correction broadcast.

Signal-to-Noise Ratio (SNR) – related terms: sensitivity, noise floor, modulation quality. The ratio of the power of a desired signal to the power of background noise, expressed in decibels. Example: A VHF receiver reports an SNR of 12 dB for a received distress call, indicating clear reception. Practical application is assessing communication quality and determining whether a message can be understood. Challenges involve maintaining adequate SNR in noisy environments, such as during thunderstorms or in congested ports.

Sidelobe – related terms: antenna pattern, main lobe, interference. Unwanted radiation emitted by an antenna outside its main beam, which can cause interference with other services or reduce system efficiency. Example: A high-gain VHF antenna on a ship exhibits low sidelobes to minimise interference with nearby vessels. Practical application includes designing antennas that meet regulatory emission limits and improve directional performance. Challenges are precise manufacturing and the need for accurate pattern testing.

Single-Sideband (SSB) Modulation – related terms: HF, voice communication, bandwidth efficiency. A form of amplitude modulation that transmits only one sideband (upper or lower) and suppresses the carrier, reducing bandwidth and power consumption. Example: Long-range HF voice communications between ships often use SSB on frequencies around 16 MHz. Practical application includes efficient use of spectrum for distant communication and clearer voice under weak signal conditions. Challenges are the requirement for precise tuning and the possibility of frequency drift.

Satellite Emergency Position-Indicating Radio Beacon (SEAB) – related terms: EPIRB, SAR, SAR-compatible. A satellite-linked beacon that transmits a distress alert and GPS position via geostationary satellites, providing near-instantaneous global coverage. Example: A small yacht carries a SEAB that automatically activates when the hull is breached, prompting an immediate SAR response. Practical application is rapid alerting for vessels operating beyond VHF range. Challenges include battery maintenance, registration accuracy and ensuring the beacon meets the latest IMO performance standards.

Sidelobe Suppression – related terms: antenna design, interference mitigation, beam shaping. Techniques used to reduce the strength of sidelobes in an antenna's radiation pattern, often through physical shaping, feed network adjustments or digital signal processing. Example: A phased-array radar incorporates sidelobe suppression algorithms to minimise clutter from land reflections. Practical application improves signal clarity, reduces interference with adjacent channels and enhances detection of weak targets. Challenges involve complex design, higher cost and the need for thorough testing.

Signal Propagation – related terms: ionospheric reflection, line-of-sight, ground wave. The behavior of radio waves as they travel through the atmosphere, over the sea surface and via ionospheric layers. Example: VHF signals propagate by line-of-sight, limiting range to the horizon, whereas MF signals can travel beyond the horizon via ground-wave propagation. Practical application includes choosing appropriate frequencies for the intended communication distance. Challenges are variability due to weather, solar activity and terrain.

Software-Defined Radio (SDR) – related terms: digital signal processing, flexible receiver, GMDSS. Radio communication hardware where functions such as tuning, filtering and demodulation are performed by software rather than fixed circuitry. Example: A modern shipboard SDR can switch between VHF, MF and HF bands with a single antenna and provide real-time spectrum analysis. Practical application includes multi-mode operation, rapid firmware updates and the ability to implement new protocols without hardware changes. Challenges are cybersecurity, processing power requirements and regulatory certification.

Standard Marine Communication Phraseology (SMCP) – related terms: voice protocol, distress calls, GMDSS. A set of prescribed phrases and formats used in maritime voice communication to ensure clarity and brevity, especially during emergencies. Example: The phrase “Mayday, Mayday, Mayday, vessel name, position, nature of distress” follows SMCP guidelines. Practical application reduces misunderstanding, speeds up call handling and aligns with international regulations. Challenges involve crew language proficiency and maintaining familiarity through regular drills.

Standard Marine VHF Channel List – related terms: channel 16, channel 70, GMDSS. The internationally agreed list of VHF channels, each assigned a specific purpose such as distress, safety, navigation or ship-to-shore traffic. Example: Channel 13 is designated for bridge-to-bridge communication between ships on the same route. Practical application ensures consistent use of frequencies worldwide and simplifies training. Challenges include channel congestion in busy ports and the need for disciplined monitoring.

Station Identifier (SI) – related terms: call sign, MMSI, beacon code. A unique alphanumeric code assigned to a radio transmitting station, used to identify the source of a broadcast. Example: A coastal MF station transmits its SI “GMDSS-A” at the start of each Navtex bulletin. Practical application enables receivers to filter and log transmissions from specific stations. Challenges are ensuring the identifier is correctly programmed and that it conforms to ITU conventions.

Statistical Multiplexing – related terms: bandwidth allocation, digital radio, satellite. A method of combining multiple data streams into a single transmission channel based on statistical analysis of traffic patterns, maximizing efficient use of bandwidth. Example: A satellite service provider uses statistical multiplexing to carry AIS, email and voice calls over the same transponder. Practical application reduces required satellite capacity and lowers operating costs. Challenges involve latency spikes when many users transmit simultaneously and ensuring quality-of-service for priority traffic.

Steering Mirror Antenna – related terms: directional antenna, beamwidth, antenna gain. A compact,

high-gain antenna that uses a reflective surface shaped like a mirror to focus radio energy into a narrow beam, often employed on vessels for long-range HF communication. Example: A research vessel installs a steering mirror antenna to maintain a stable link with a coastal HF station while sailing at 12 knots. Practical application includes improved signal strength, reduced power consumption and easier pointing. Challenges are mechanical robustness in harsh sea states and precise alignment.

Storm-Signal Transmission – related terms: NAVTEX, weather broadcast, distress. A specialized broadcast that conveys imminent severe weather warnings, often transmitted on MF or VHF frequencies with a distinctive tone to attract attention. Example: A coastal station issues a storm-signal on 156.8 MHz, prompting vessels to seek safe anchorage. Practical application is early warning for vessels to take protective action. Challenges include ensuring the signal is received despite heavy sea-state noise and avoiding false alarms.

Super-High Frequency (SHF) – related terms: radar, satellite communication, microwave. The portion of the radio spectrum from 3 GHz to 30 GHz, commonly used for radar, satellite links and high-capacity data transmission. Example: A ship's X-band radar operates at 9.4 GHz within the SHF band. Practical application includes high-resolution imaging, short-range target detection and robust satellite communications. Challenges are rain attenuation, line-of-sight constraints and the need for precise antenna pointing.

TCAS (Traffic Collision Avoidance System) – related terms: transponder, ADS-B, radar. An onboard system that monitors the airspace (and, in marine adaptations, the nearby sea surface) for other vessels equipped with transponders, providing alerts to prevent collisions. Example: A ferry's TCAS alerts the helmsman when a nearby cargo ship is on a converging course. Practical application enhances situational awareness in high-traffic corridors. Challenges include reliance on other vessels' transponder compliance and potential alarm fatigue.

Transmission Line – related terms: coaxial cable, waveguide, impedance matching. The physical medium that carries radio frequency energy from the transmitter to the antenna, requiring careful design to minimise loss and reflections. Example: A ship's HF transmitter uses a low-loss coaxial cable with a characteristic impedance of 50 Ω to feed the antenna. Practical application ensures efficient power delivery and maintains signal integrity. Challenges involve corrosion in marine environments, connector reliability and maintaining proper VSWR.

Transponder – related terms: AIS, TCAS, radar beacon. A device that receives an interrogation signal and automatically replies with a coded response, used for identification and tracking. Example: An AIS transponder continuously broadcasts a vessel's MMSI, position and course. Practical application supports collision avoidance and traffic monitoring. Challenges include power consumption, firmware updates and ensuring the transponder is not disabled inadvertently.

Universal Mobile Telecommunications System (UMTS) – related terms: cellular, broadband, maritime broadband. A third-generation (3G) mobile communication standard adapted for shipboard broadband

services, enabling high-speed internet and data transmission via shore-based cellular networks. Example: A cruise ship's passenger Wi-Fi uses UMTS shore-based base stations when docked. Practical application provides high-capacity data services for crew and passengers. Challenges are limited coverage offshore, handover complexity and the need for shipboard antennas with sufficient gain.

Vessel Monitoring System (VMS) – related terms: fisheries management, AIS, satellite tracking. A satellite-based system used primarily for monitoring fishing vessels, transmitting position, speed and activity data at regular intervals. Example: A trawler's VMS reports its location every two hours to the fisheries authority. Practical application supports sustainable fisheries, compliance verification and illegal-fishing detection. Challenges include ensuring data security, battery life and the integration of VMS data with other maritime surveillance systems.

VHF Data Exchange System (VDES) – related terms: AIS, maritime broadband, GMDSS. An advanced communication protocol extending AIS capabilities to include higher-capacity data exchange, such as weather forecasts, navigational warnings and ship-to-shore messaging. Example: A vessel receives a VDES broadcast of a detailed cyclone forecast, allowing the crew to adjust the route proactively. Practical application enhances situational awareness, supports e-navigation initiatives and reduces reliance on satellite links. Challenges involve phased implementation, equipment cost and ensuring backward compatibility with legacy AIS.

VHF Radio Beacon – related terms: distress beacon, AIS, maritime safety. A low-power transmitter operating in the VHF band that emits a continuous or periodic signal to aid in vessel location, often integrated with AIS to provide identification. Example: A small craft carries a VHF beacon that transmits "MOB" (Man Overboard) on 156.525 MHz when activated. Practical application includes rapid localisation of distressed vessels and supplementing AIS visibility. Challenges are limited range, battery maintenance and ensuring the beacon is audible amid other VHF traffic.

VHF Marine Band – related terms: FM, channel plan, GMDSS. The portion of the radio spectrum allocated for maritime use, ranging from 156 MHz to 174 MHz, divided into 25 kHz channels for voice and data communications. Example: Channel 22A (156.650 MHz) is used for ship-to-ship safety calls in many regions. Practical application provides reliable short-range communication for navigation, safety and operational coordination. Challenges include spectrum congestion, the need for regular channel monitoring and interference from non-maritime users.

VOR (VHF Omnidirectional Range) – related terms: radio navigation, beacon, bearing. A ground-based radio navigation system that transmits a VHF signal containing phase information, allowing aircraft and, in some coastal areas, ships to determine a radial bearing from the station. Example: A vessel uses a VOR receiver to verify its position relative to a coastal beacon. Practical application includes cross-checking GNSS data and providing a backup navigation aid. Challenges are limited coverage, signal blockage by terrain and the gradual phase-out in favour of satellite navigation.

Weather Fax (WEFAX) – related terms: NAVTEX, METAR, satellite imaging. An automated system that transmits weather charts and satellite imagery over HF or VHF frequencies, allowing ships to receive detailed meteorological data. Example: A vessel receives a WEFAX broadcast of a synoptic chart showing an approaching low-pressure system. Practical application provides high-resolution weather information for route planning. Challenges include the need for specialised decoding equipment and potential signal degradation during adverse conditions.

Wideband Frequency-Hopping (WFH) – related terms: spread spectrum, anti-jamming, secure communications. A method of transmitting data by rapidly switching among many frequencies within a wide band, reducing the likelihood of interception or interference. Example: A naval vessel employs WFH