Alpha Zulu OceanOS™

An AI-Native Maritime Intelligence Platform for Sustainable Island Development

Supporting the Alpha Zulu RoPAC ZeroFF Programme

A strategic vision for AI-native maritime transport, ocean stewardship, food security and sustainable development in Caribbean Small Island Developing States.

"Every Alpha Zulu voyage carries more than cargo. It carries knowledge, opportunity and measurable progress towards a more resilient Caribbean."

Prepared for discussion with Caribbean governments, universities, maritime and agricultural institutions, regional organisations, development partners and industry.

Revised 28 October 2026

1. Executive Summary

Marine decarbonisation offers Caribbean Small Island Developing States an opportunity that extends beyond replacing conventional propulsion. When zero-onboard-fossil-fuel vessels are combined with modern sensing, digital communications and artificial intelligence, scheduled inter-island transport can become intelligent regional infrastructure supporting commerce, food security, ocean stewardship, research, workforce development and public policy.

Alpha Zulu OceanOS™ is the proposed digital intelligence platform for that infrastructure. It complements the Alpha Zulu RoPAC ZeroFF Programme: RoPAC demonstrates reliable, scheduled, low- and zero-emission movement of passengers and palletised cargo; OceanOS enables each voyage to generate, interpret and responsibly share operational, logistical and environmental knowledge.

OceanOS is not conceived as a closed proprietary application. It is an open, modular and interoperable ecosystem connecting vessels, ports, producers, markets, universities, governments and development partners. Its specialised Agentic AI capabilities would analyse information, coordinate workflows and present evidence-based recommendations. Physical AI would connect that intelligence to sensors and vessel systems in the real world, always under the authority of qualified masters, engineers and public institutions.

The platform would initially be tested through practical Alpha Zulu RoPAC operations. A focused pilot could demonstrate value in four connected areas:

safe and energy-efficient vessel operations, maintenance and route planning;

reliable agricultural logistics, cold-chain integrity and cargo traceability;

routine ocean and weather observations from scheduled voyages; and

verified evidence of emissions, trade, food-security and development outcomes.

This Brief presents a direction for collaborative development, not a completed technical blueprint. Governance, data rights, cybersecurity, scientific standards, financing and institutional responsibilities must be designed with participating Caribbean institutions. The immediate objective is to identify partners and a limited pilot capable of producing credible operational evidence before regional expansion.

2. The Regional Opportunity

The Caribbean Sea is the region's natural highway, yet inter-island supply chains remain fragmented and heavily dependent on extra-regional services. Moving a pallet of fresh produce between neighbouring islands can be less reliable and more expensive than importing comparable goods from outside the region. The consequences extend to farm incomes, food prices, manufacturing, disaster resilience, employment and the practical implementation of regional integration.

The region simultaneously faces rising sea temperatures, severe weather, coastal erosion, coral degradation, Sargassum influxes and changing marine ecosystems. These pressures require more frequent observation, stronger coordination and faster evidence-based decisions. Dedicated research and monitoring programmes remain essential, but their coverage is constrained by cost and vessel availability.

Scheduled commercial vessels can help address both challenges. Their primary purpose remains safe, reliable transport. However, a digitally connected vessel repeatedly travelling established corridors can also collect consistent environmental observations, improve supply-chain visibility and create an operational record useful to researchers, regulators, investors and development partners. It becomes a ship of opportunity without ceasing to be a commercial ship.

Decarbonisation is therefore the point of departure rather than the final objective. Wind propulsion, electric drive, renewable energy, batteries, communications and onboard intelligence can reduce emissions and operating exposure while enabling a wider regional information network. The investment case can then recognise both commercial performance and measurable public value, without confusing the two.

3. The Alpha Zulu OceanOS™ Concept

Every voyage produces operational, cargo and environmental information. Much of it is currently isolated, inconsistently recorded or used only for a single purpose. OceanOS would provide the trusted digital framework through which appropriate information can be validated, analysed and converted into useful knowledge.

The platform would be built around five principles:

Interoperability: connect with existing navigation, port, customs, meteorological, agricultural and research systems through open standards rather than duplicate them.

Modularity: add vessels, sensors, analytical agents and institutional partners progressively without redesigning the whole platform.

Human authority: preserve the legal and professional responsibilities of masters, engineers, scientists, regulators and data owners.

Trust by design: incorporate cybersecurity, privacy, traceability, explainability and access controls from the outset.

Caribbean capability: develop regional skills in maritime AI, engineering, data governance and applied research rather than create permanent technological dependence.

Information would be separated according to purpose and sensitivity. Vessel operators may require real-time engineering and navigation dashboards; producers and buyers may need cargo status and delivery information; researchers may receive quality-controlled and appropriately anonymised datasets; governments and development partners may require aggregated indicators. Participation would not imply unrestricted access to commercial, personal or sovereign data.

OceanOS would also create a consistent evidence chain. Data provenance, time, location, sensor quality, authorised amendments and AI-generated conclusions should be traceable.

This is essential if information is to support safety decisions, scientific analysis, regulatory reporting, climate-finance verification or development evaluation.

4. Agentic and Physical AI

Agentic AI is the intelligence layer: specialised software agents analyse information, coordinate tasks and recommend actions within defined authority. Physical AI connects this intelligence to the physical world through sensors, machinery and control interfaces. On an Alpha Zulu vessel, Physical AI could observe vessel motion, weather, energy use, equipment condition and cargo environment, while Agentic AI interprets those observations and advises the crew or shore team.

Illustrative agents include:

a Voyage Agent combining forecasts, sea state, schedules and energy availability to recommend safe and efficient routing;

a Cargo Agent matching bookings, pallet allocation, cold-chain requirements, capacity and destination demand;

an Engineering Agent detecting anomalies, forecasting maintenance and optimising batteries, solar generation and electric propulsion;

an Environmental Agent validating sensor observations and flagging unusual ocean, weather, debris or Sargassum conditions; and

an Evidence Agent preparing traceable operational, emissions and development-performance reports for authorised users.

These agents would support rather than replace professional judgement. Navigation, safety, engineering, scientific interpretation and public policy remain the responsibility of qualified people and authorised institutions. Recommendations should show their evidence, assumptions and confidence level so users can question or reject them.

Learning across repeated voyages can improve forecasts, maintenance planning, cargo utilisation and route design. However, model performance must be monitored for error, bias and changing conditions. Caribbean universities and technical institutions should participate in testing, independent evaluation, workforce preparation and the development of rules appropriate to regional circumstances.

4.1 Bidirectional Human–AI Command Authority, Voice Authentication and Fail-Safe Control

OceanOS is proposed as an AI-native vessel operating environment integrating Agentic AI, Physical AI and nature-informed sailing intelligence. Authorised officers should be able to issue original instructions, interrogate observations, modify or reject AI recommendations, suspend operations and request their resumption. OceanOS should likewise initiate dialogue, explain its reasoning, flag hazards and request decisions. This collaborative human–AI seamanship remains subject to the master's legal authority and independent protective systems.

Authenticated identity and delegated authority

Enrolled speaker recognition may identify the Captain, First Mate, Chief Engineer and other designated crew. A separate command-authorisation service shall verify role, watchkeeping status, control mode and delegated permissions. Voice identity alone shall not authorise hazardous physical action: independent authentication or a secured local confirmation shall be required according to risk. The system must resist replay, synthetic voices, mistaken identification and unintended activation, including under wind and machinery noise.

Command functions

Initiate: issue a new informational, observational, analytical or approved physical instruction.

Modify: change a proposed or ongoing action within validated limits.

Override: reject or supersede an AI-generated recommendation, observation classification or command.

Suspend: interrupt AI activity through a defined safe-state or safe-abort sequence.

Resume: restore supervised operation only after status verification and authorised release.

Illustrative commands include “OceanOS, explain the proposed course alteration”; “disregard that wind forecast and show the alternatives”; “ease the jib ten centimetres”; “prepare the first reef”; “cancel the pending trim change”; and “suspend autonomous sail handling.” Ambiguous instructions shall be clarified rather than guessed. Commands to maintain course or sail configuration remain subordinate to collision-avoidance duties, rig limits and immediate protective action.

Independent fail-safe control

A safety-rated or otherwise appropriately assured control layer, independent of generative AI, shall enforce machinery limits, rig-load envelopes, interlocks, actuator travel and safe shutdown. Emergency stopping and essential manual control must remain usable without voice recognition, network access or AI services. Critical manoeuvres require explicit authorisation and verified execution feedback. Failure, disagreement or loss of sensor data must trigger a predefined degraded mode rather than unsupported autonomous action.

Example of bidirectional dialogue

OceanOS: “Captain, a gust increase is forecast. Recommend preparing the first reef.” Captain: “Maintain the present configuration; alert me at twenty-five knots apparent wind.” OceanOS: “Instruction acknowledged, subject to rig-load and safety limits. Monitoring continues.” A subsequent reefing command would require the prescribed independent execution approval.

Assurance and pilot pathway

Start with offline, read-only voice interaction and simulated decisions; then progress to a shore-based actuator test rig and supervised onboard trials after hazard analysis. Record identity, permissions, command interpretation, confirmation, actuation and measured result. Seek class and Barbados flag-state determination of applicable human-factors, machinery, functional-safety and cyber-assurance requirements. Neither voice authentication nor AI advice constitutes a substitute for bridge watchkeeping or professional responsibility.

4.2 OceanOS Loadmaster AI Agent — Dynamic Multi-Port Cargo Stowage

The proposed Loadmaster AI Agent would create and maintain a continuously updated digital cargo and stowage model for Alpha Zulu’s scheduled, multi-port palletised services. It would allocate cargo according to discharge sequence and through-shipment commitments, seeking to minimise unnecessary rehandling or restowage while preserving access for later port calls. Commercial efficiency is always subordinate to vessel stability, structural limitations, cargo securing and the approved loading envelope.

Digitally identified cargo units

Each consignment would carry a unique machine-readable identifier and a validated record including product and commodity description; quantity and volume; pallet and handling envelope; length, width and height; mass and centre-of-gravity information where required; packaging and stacking limitations; chilled, frozen or ambient temperature range; humidity or ventilation requirements; compatibility and dangerous-goods restrictions;

loading port, discharge port and through-shipment status. Data should be captured before loading where practicable and reconciled at the vessel interface.

Optimisation over the entire port rotation

Before departure from a hub, the agent would plan stowage against the confirmed itinerary, bookings, expected port calls, compartment characteristics, loading access, securing arrangements and possible downstream cargo. It would distinguish cargo for the next discharge from through-shipment cargo remaining aboard, and would avoid positioning the latter where it obstructs intermediate discharge. Forecast demand may inform provisional space reservation but must not be confused with confirmed bookings.

When previously unconfirmed or late cargo appears at an intermediate port, the agent would assess feasible positions, temperature compatibility, loading access, available capacity and subsequent discharge obligations. If restowage is unavoidable, it would propose the least disruptive compliant sequence, with expected handling movements, time and temperature exposure. Scanning, operator confirmation and appropriate sensors would reconcile planned and actual stowage after every move.

Stability and structural compliance are hard constraints

Every proposed cargo placement, loading sequence, relocation and discharge sequence must be checked against approved vessel stability information, loading conditions and relevant flag-state/class requirements. Checks must encompass intermediate and final conditions at each port, including displacement, trim, heel, longitudinal/transverse/vertical centres of gravity, free-surface effects, compartment and deck loads, hull-specific loading, securing and variable weights such as water, stores, ballast and energy-system consumables where relevant. The multihull arrangement demands particular attention to transverse asymmetry and hull-specific structural limits.

No recommendation shall be executed or approved solely because it reduces handling or increases cargo density if it breaches an approved stability, structural, securing or cargo-compatibility constraint. If no compliant arrangement exists, OceanOS must reject the loading proposal, identify the limiting condition and provide safe alternatives. The authorised officer retains responsibility for review and approval; a validated loading computer and approved stability data, rather than a language model, provide the authoritative calculation basis.

Human–AI loadmaster interaction

First Mate: “OceanOS, identify the best chilled-compartment position for this Dominica pallet without moving Antigua through-cargo.” OceanOS: “Cargo identity and dimensions verified. One candidate location satisfies temperature, access and preliminary weight-distribution constraints. Formal loading-condition check pending.” First Mate: “Run the stability and securing checks and show the revised discharge sequence.” OceanOS:

“Validated plan available for authorised review; no movement instructed.”

Operational integration and evidence

Subject to equipment design, Physical AI could guide handlers, confirm identity and placement, monitor cargo environment and update the manifest. Any automated movement requires independent machinery protection, personnel-exclusion arrangements and human supervision. The agent should retain traceable records of location, custody, loading/discharge events, restowage, temperature excursions and approvals. These records would support turnaround performance, cargo integrity, logistics forecasting and operational evidence.

Governing design principle: OceanOS shall optimise multi-port cargo placement and rehandling only within independently validated stability, structural, securing and environmental constraints, with the Captain and authorised cargo officers retaining operational authority.

5. Food Security and Sustainable Logistics

Caribbean food insecurity is not solely a production problem; it is also a logistics problem.

Seasonal surpluses may exist beside shortages, but unreliable sailings, weak cold chains, fragmented booking and limited market information prevent producers and buyers from coordinating confidently. Perishable goods then suffer delay, loss and reduced value.

OceanOS could link crop availability, harvest timing, packaging, cargo reservations, vessel capacity, sailing schedules, destination demand and delivery status. AI-assisted forecasting could identify likely cargo flows, consolidate small consignments, reduce empty capacity and help producers plan for dependable market access. The objective is not to centralise commercial decisions, but to give participants timely information with which to make them.

Onboard monitoring could record temperature, humidity, ventilation and handling conditions, alert crews to deviations and provide traceability from loading to delivery. These records may strengthen quality assurance and support sanitary, phytosanitary and market-access requirements. More reliable schedules and better handling can reduce post-harvest loss, raise producer confidence and make regional sourcing more attractive to retailers and consumers.

The same network could support emergency logistics following hurricanes, volcanic events or other disruptions. Vessels, ports and cargo systems used every week for commerce would already possess relationships, route knowledge and operating data valuable during a crisis. Disaster capability should therefore be designed as a resilient extension of normal service, not as an isolated system activated only after an emergency.

6. Ocean Observation, Stewardship, Education and Research

Scheduled vessels operating consistent routes can complement existing scientific programmes by providing frequent observations across under-sampled sea lanes. Appropriate instruments may record sea-surface temperature, atmospheric pressure, humidity, wind, rainfall, waves and sea state. Crew reports or machine vision may, where scientifically appropriate, document Sargassum, floating debris, harmful algal blooms, navigational hazards or unusual marine events.

An Alpha Zulu observation package could combine Rutter's sigma S6 processing of the vessel's existing X-band radar with FLIR thermal and visible-light imaging and conventional meteorological, navigation and machinery sensors. Rutter modules such as WaMoS® II, Oil Spill Detection, Current Monitor™ and Small Target Surveillance can derive sea state, wave and surface-current measurements, identify and track oil slicks, and detect small or floating targets. FLIR long-wave infrared and visible-light cameras can provide day-and-night visual confirmation of oil, debris, people, vessels and other anomalies. OceanOS would correlate these independent observations into a common time- and position-referenced record, issue alerts and preserve the source data needed for scientific review and Monitoring, Reporting and Verification (MRV). The systems remain complementary: radar supplies wide-area continuous observation; thermal and optical cameras support classification and confirmation; conventional sensors provide local measurements; and AI assists interpretation without replacing the master or qualified specialists.

The value lies in continuity and quality control. Repeated, geo-referenced measurements can reveal seasonal patterns and long-term change, but only if collection methods, calibration, metadata and validation meet agreed standards. OceanOS should therefore connect observations to established meteorological, oceanographic and research institutions rather than create a competing scientific authority.

A governed data environment would also support applied education and research. Maritime cadets, engineers, computer scientists, agricultural specialists and environmental researchers could work on real Caribbean problems involving vessel performance, renewable-energy integration, logistics, marine ecology, climate

adaptation and AI. Commercial confidentiality, personal privacy and sovereign interests must be protected through appropriate access and anonymisation.

This creates a practical innovation pathway: researchers and industry identify a problem; a sensor, analytical method or operating practice is tested on a working vessel; results are independently assessed; and successful approaches are refined for wider use. The Caribbean thereby becomes a producer of maritime knowledge and technology, not merely a recipient.

7. Development Value and the Blue Economy

OceanOS would help make the wider value of intelligent maritime infrastructure visible and measurable. Relevant outcomes may include avoided onboard fossil-fuel use, schedule reliability, cargo moved, cold-chain performance, reduced food loss, increased regional sourcing, workforce training, research outputs and verified environmental observations. Indicators should be limited to those that can be credibly measured and attributed.

These outcomes align with regional priorities and several Sustainable Development Goals, particularly food security, clean energy, decent work, resilient infrastructure, responsible production, climate action, life below water and partnerships. The platform should not claim that each voyage independently achieves those goals. Its value lies in producing evidence showing how a reliable transport system contributes to defined outcomes over time.

For climate-finance institutions and development banks, this evidence can complement conventional transport economics. It may support evaluation of concessional finance, grants, guarantees and technical assistance where wider benefits are real but not fully captured in freight revenue. Transparent measurement is also important for avoiding exaggerated environmental claims and maintaining investor and public confidence.

8. Partnerships, Governance and Pilot Pathway

OceanOS should be developed as a collaborative ecosystem rather than a centrally controlled regional programme. Governments provide policy, regulatory and public-accountability frameworks. Regional organisations convene and align initiatives. Universities and research institutions establish scientific integrity and independent evaluation. Vessel operators, producers, logistics providers and technology companies translate concepts into working systems. Development partners may contribute finance, capacity building and international knowledge exchange.

Governance must address data ownership, permitted use, cybersecurity, privacy, intellectual property, scientific standards, AI ethics, liability, procurement and long-term operating responsibility. National sovereignty and institutional mandates must be respected. Trust will depend less on declarations of openness than on clear rules showing who may access what information, for which purpose, under whose authority and with what accountability.

A phased pilot is the most credible path forward. The Alpha Zulu RoPAC ZeroFF Programme provides a real commercial environment in which a limited OceanOS capability can be tested. A first phase should select one corridor, one vessel, a defined group of cargo users, a small sensor package and a limited number of AI-supported workflows. Baseline measures should be agreed before service begins.

A practical pilot could proceed through four stages:

Co-design: agree the use cases, partners, data responsibilities, safety boundaries and measures of success.

Instrument and integrate: install validated sensors and connect only the operational systems required for the selected use cases.

Operate and evaluate: collect evidence during scheduled commercial voyages and subject results to independent technical and scientific review.

Scale selectively: retain capabilities that demonstrate value, correct those that do not, and expand by route, vessel or institutional partner only when justified.

Early discussion is therefore sought with UTT, MTCC-Caribbean, UWI and relevant agricultural, maritime, ocean-governance, CARICOM, private-sector, development-finance and international partners. The immediate questions are practical: which use cases create the greatest regional value; what existing systems should be connected; what minimum data and governance standards are required; and which institution is best placed to lead each element?

9. Conclusion: An Invitation to Collaborate

Alpha Zulu OceanOS advances a focused proposition: a zero-onboard-fossil-fuel vessel can be more than a cleaner transport asset. Properly governed and digitally connected, it can also strengthen food logistics, generate useful ocean observations, support research and training, and provide credible evidence of sustainable-development outcomes.

The concept does not depend on autonomous ships, unrestricted data sharing or a single technology provider. It depends on reliable commercial service, disciplined measurement, human authority, open standards and institutions willing to collaborate around clearly defined problems. Its architecture should evolve from operational evidence rather than ambition alone.

The Alpha Zulu RoPAC programme offers an opportunity to begin at practical scale. If the pilot demonstrates that routine voyages can move cargo reliably while producing trusted knowledge and wider public value, the model can be adapted across Caribbean corridors and shared with other island and coastal regions.

The invitation is to shape that pilot together: to define the questions worth answering, the safeguards required, the evidence that will be credible and the partnerships capable of turning an AI-native maritime vision into useful Caribbean infrastructure.

Closing Reflection

The Caribbean Sea has always connected our islands. OceanOS asks how every voyage might also connect our knowledge, strengthen our stewardship and create lasting public value.

Annex A — EU-Aligned Cybersecurity and Digital Trust

OceanOS should incorporate cybersecurity from initial design through operation and retirement. This section proposes a baseline for vessel equipment, shore systems, APIs, AI agents and shared datasets. It supplements the governance and pilot pathway in Section 8. These are proposed design commitments, to be validated through engineering and procurement; they do not represent implemented controls or certified compliance.

EU alignment means drawing on relevant European legal frameworks and security principles while confirming applicability to each product, organisation and data flow. It does not imply an EU endorsement of OceanOS or a separate EU standard bearing the OceanOS name. Caribbean flag-state law, applicable national data-protection law and agreed classification requirements remain part of the approval basis.

NIS2. Directive (EU) 2022/2555 addresses qualifying entities under EU Member State jurisdiction, including certain water-transport companies and ports. Its water-transport category excludes individual vessels. Applicability depends on jurisdiction, entity size and designation, not a 500 GT ship threshold. For Caribbean-only operations, use its risk-management principles as a voluntary benchmark unless a specific legal or contractual obligation is established. [1]

Cyber Resilience Act. Regulation (EU) 2024/2847 concerns in-scope products with digital elements made available on the EU market. It may therefore matter to OceanOS software or connected equipment supplied into

that market, subject to product scope and exclusions. Main obligations apply from 11 December 2027; specified reporting obligations apply from 11 September 2026. EU funding or an EU supplier alone does not make the Caribbean vessel subject to the Act. [2]

Personal data and AI. Assess GDPR territorial scope for each processing activity rather than assuming it applies to all Caribbean data. Identify lawful processing, access, retention and transfer arrangements under applicable law. Review each AI use case against the EU AI Act where it has an EU connection; classification and obligations depend on intended use and legal scope. No blanket high-risk or compliant designation is assumed. [3, 4]

Maritime assurance. Use IMO maritime cyber-risk guidance as the operational reference. Ask the selected class society to confirm the applicable scope of IACS UR E26 and E27, including exclusions and voluntary treatment for sub-500 GT cargo vessels. Confirm the statutory safety-management basis with the flag administration. [5, 6]

Proposed OceanOS security protocols

The following are project design requirements for discussion, rather than verbatim EU prescriptions. Implementation should be proportionate to the consequences of a failure and verified before operational use.

Separate safety and business networks. Isolate propulsion, steering, battery ESS, alarms and any future hydrogen safety systems from cargo, research, crew internet and cloud services. Use controlled gateways and default-deny rules. Begin with read-only monitoring; keep protective interlocks and local control independent of AI and internet availability.

Authenticate people and devices. Use unique identities, least-privilege roles and multifactor authentication for privileged and remote access. Apply device certificates where feasible, protect and rotate credentials, revoke departed users promptly and prohibit shared administrator accounts.

Secure APIs and communications. Use authenticated encrypted connections, preferably TLS 1.3 where supported, with mutual authentication for critical machine interfaces. Scope API permissions, validate inputs, rate-limit requests and reject replayed commands. Encrypt sensitive stored data and control keys separately. Provide a secured gateway for legacy sensors that cannot support these measures.

Control supplier access and updates. Require named, time-limited remote sessions approved by the operator, logged and capable of immediate termination onboard. Obtain software-component inventories, vulnerability contacts and support periods. Verify signed updates, test them away from live machinery and retain a safe recovery configuration.

Protect evidence and observation data. Record source, sensor identity, calibration, timestamp, location, processing and authorised changes. Use protected logs and integrity checks for MRV and cargo records. Detect missing or implausible observations and cross-check position and time sources. Integrity controls cannot establish that a faulty sensor reading is scientifically correct.

Constrain AI authority. Treat external documents, messages and sensor feeds as untrusted inputs. Restrict agent tools and data access; require human approval for safety-relevant or externally binding actions. Test prompt injection, data poisoning and misleading observations. Version models and record consequential recommendations, overrides and approvals.

Protect personal and commercial information. Separate customer, crew, scientific and public datasets. Minimise collection, set retention limits and document controller and processor responsibilities. If wearables are introduced, segregate health records, establish the necessary legal basis and restrict access; do not place identifiable medical data in ordinary voyage or research dashboards.

Operate safely through disruption. Retain essential onboard functions during loss of satellite or shore connectivity. Set recovery objectives and test offline backups, restoration and manual procedures. Assign incident responsibility, isolate compromised systems, preserve evidence and notify relevant parties under the applicable legal and contractual deadlines.

Class review and pilot assurance

Common class AiP question. Each bidding society should state whether its current rules and IACS UR E26/E27 apply to Alpha Zulu, identifying ship-type, tonnage and construction-date criteria, exclusions and any voluntary notation. Request the same review scope from each: network separation, supplier access, software updates, incident response and failure recovery. Require a list of documents, supplier evidence and tests, priced deliverables, exclusions and the work remaining after AiP. Confirm the statutory basis separately with the flag administration.

Minimum acceptance evidence should include an asset and software inventory; network and data-flow diagrams; a threat and consequence assessment; an applicability register; supplier support and vulnerability arrangements; and an incident and recovery plan. Test network isolation, access revocation, API permissions, loss of communications, unauthorised changes, backup restoration and compromised sensor inputs in a controlled environment. Intrusive testing must not endanger live vessel systems.

Recent implementation guidance. DNV advertised a 22 October 2026 webinar on lessons from implementing UR E26/E27 for designers, builders, integrators and suppliers. It is guidance, not a newly adopted rule or evidence of a blanket sub-500 GT obligation. The listing does not establish recording availability. Request materials as useful supporting input, without making the common AiP specification society-specific. [7]

Appoint an accountable cyber lead, budget ongoing support and training, and obtain operational release from the master and operator after required reviews. AiP is not final system certification. Keep a security action register and reassess material changes before deployment.

Authoritative references

NIS2 Directive (EU) 2022/2555, especially Articles 2, 21, 23 and 26 and Annex I.

Cyber Resilience Act, Regulation (EU) 2024/2847, especially scope, Annex I and application dates.

European Commission guidance on GDPR applicability.

European Commission overview of the EU AI Act.

IMO Guidelines on Maritime Cyber Risk Management, MSC-FAL.1/Circ.3/Rev.3, 4 April 2025.

IACS explanation of revised UR E26 and E27; consult current rules and class applicability.

DNV webinar listing, 22 October 2026, lessons from UR E26/E27 implementation.

Cybersecurity provisions updated 26 October 2026. Applicability remains subject to design and deployment review.

Annex B — Voice-Directed Physical AI for Sail Handling

Concept for technical discussion | 28 October 2026

This exploratory annex extends Section 4 (Agentic and Physical AI) and the existing cybersecurity and class-assurance annex. It is a proposed capability, not an installed, validated or class-approved vessel-control system.

Operational proposition

The master could address OceanOS in ordinary seamanship language, for example, “Harden the foresail” or “Ease the jib.” An onboard speech interface would recognise the instruction and request a bounded action from a separately engineered sail-control system. The system would identify the correct sail and actuator, resolve any ambiguity, check operating limits, obtain confirmation where appropriate, and report the measured result. Voice interpretation must never directly energise a winch.

Illustrative exchange

Master: “OceanOS, ease the jib.”

OceanOS: “Jib sheet easing requested. Specify distance or approved trim increment.”

Master: “Ease ten centimetres.”

OceanOS: “Jib sheet, ten centimetres. Conditions and interlocks checked. Confirm.”

Master: “Confirm.”

OceanOS: “Executing.”

OceanOS: “Adjustment completed; measured sheet movement ten centimetres.”

For “harden the foresail,” the system should request a defined tension, position or authorised trim increment where the command alone is insufficiently precise. The example assumes suitable sensors, calibrated actuators and confirmed safe limits; it does not imply that these are already specified for Alpha Zulu.

Functional architecture

Speech layer: local microphones, marine-noise suppression, wake/identity handling, speech recognition and a constrained maritime command vocabulary.

Command gateway: deterministic parsing of sail, direction, magnitude and operator authority; reject ambiguous, contradictory or unrecognised instructions.

Supervisory layer: verify apparent wind, vessel motion, sheet load, actuator status, crew location and operational mode; require explicit confirmation according to risk.

Actuation layer: independent certified or otherwise appropriately assured controller operating electric/hydraulic winches with load, travel and rate limits.

Feedback: independent position/load measurements, command logging, completion/failure annunciation and immediate manual override.

Development stages

Stage 1 — advisory: offline recognition and read-only sail-trim recommendations.

Stage 2 — supervised actuation: voice-requested, crew-confirmed, bounded adjustments with hardware interlocks.

Stage 3 — constrained optimisation: continuous recommendations or authorised adjustments to improve speed, heel, loads and battery consumption within the master’s operating envelope. No unrestricted autonomous control is proposed.

Safety, cybersecurity and class considerations

Separate voice/AI processing from machinery control by a controlled, authenticated gateway. No free-form language-model output should become an executable actuator command. Preserve local physical stops,

independent overload protection, manual operation and safe response to lost microphones, communications, sensors or AI services. Test misrecognition in wind and machinery noise, speaker impersonation, inadvertent activation, contradictory orders, latency, degraded sensors and cyber compromise. Record command, identity, confirmation, measured outcome and overrides. Bureau Veritas and the flag administration should be asked to determine the applicable machinery, automation, human-factors and cybersecurity assurance basis; AiP is not operational approval.

Potential technology partner — Synervoz

Synervoz (Canada) may warrant a technical discussion as a possible supplier of embedded speech/audio and voice-interface technology, including offline operation. No maritime deployment, sail-control integration, class certification or commitment by Synervoz is established here. Sail-control intelligence, machinery safety and integration would remain separate engineering work packages.

Proposed proof of concept and decision questions

Begin with an offline, read-only bridge demonstrator using realistic wind and winch noise. Progress to a shore-based winch test rig only after a formal hazard assessment. Define the command vocabulary, speaker-authorisation method, acceptable error/latency thresholds, fail-safe states, instrumentation and the evidence required for class and flag review. Confirm whether the eventual system is advisory only or may issue bounded control requests.

Relationship to the existing brief

This concept supports OceanOS's modularity, human authority, trust by design and Caribbean capability principles. It is additional to—not a replacement for—the existing environmental observation, cold-chain, MRV and cyber-risk workstreams. Any claims of improved sailing performance or reduced energy use would require measured trials and independently reviewable evidence.