Technology Innovation at Sea

From the Experts at Scale Computing

Technical White Paper

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The shipping industry is known to have many challenges. From CO2 emission rules to the fast-growing number of cyberattacks, ships and crews are vulnerable and must stay safe at all times. Onboard computer technology must become simpler, more secure, and resilient.

We can see how digital technology helps transform the way we live our lives and disrupt business models. It's hard to say just one technology will transform the maritime industry. The interplay and overlap between the technology areas are crucial, but this transformation has yet to make a significant impact on shipping.

Scale Computing provides this white paper to explain the increased dependence on the combination of onboard IT infrastructure, the cloud and central, shore-based data centers.

This paper is intended for shipowners, fleet managers, and IT staff implementing and managing maritime information technology.

Challenges

The maritime industry could be seen as one of the most volatile environments. Potentially harsh climates, distance to onshore facilities, and different international stakeholders all create complex and uncertain conditions that affect the success and survival of maritime organizations.

Keeping a ship up and running 24/7/365 is a major challenge. Management of vessels, while lowering TCO, must be agile. For centuries, the shipping administration has collected huge amounts of manual scripts and reports to keep OpEx and CapEx under control. Technology has brought ships closer to shore-based operations in the last few decades.

Complexity

More technology means more IT systems and added complexity. Onboard IT knowledge is limited - a growing concern for most shipowners and ship management companies. Human failure is still on top of the agenda when it comes to reducing accidents at sea, according to Benedikte Wentworth, CEO of Propel. Human error accounted for "an estimated 75% to 96% of marine accidents and approximately $1.65bn in losses in almost 15,000 marine liability insurance claims analyzed," according to Allianz.

Traditional onboard infrastructures with several servers, separate server visualization, a separate storage unit and/or backup devices are too complex and difficult to manage. Complexity causes mistakes, endangers operations, and gives rise to frustration among the crew. Complexity also increases system downtime, leading to voyage deviation, increased loading/unloading time, or even worse, more accidents.

Reducing crew turnover and improving training has become more important than ever. Nowadays, crews need to become "digital natives." The systems they work with are increasingly sophisticated, and complex regulatory expectations make it even harder for them to do their jobs.

Increasing automation, self-healing processes, and simplicity help to overcome the challenges described above.

Safety and Security

Today, ship security is one of the most important aspects of ship and crew safety. The maritime industry faces many threats, including cyberattacks, piracy, and hijacking. Technology plays an important role to overcome this challenge, as the advanced security systems and software available today can efficiently identify and help negate potential threats to ships.

The number of computer systems, software applications, and IoT (Internet of Things) devices like sensors and beacons aboard ships have increased and will continue to do so in the future. This is driven by the need to secure overall ship performance improvement, regulatory compliance, and security requirements.

Using IoT devices across the fleet helps to gain a competitive edge and supports decision-making. More and more devices are implemented to streamline fleet-wide operations at sea, from tank and draft sensors to load/unload sensors, from vessel tracking, crew safety, voyage planning optimization to predictive maintenance. Sensors, monitoring, and analytics guide the ship crew in planning the most efficient route. Using IoT devices across the fleet helps to gain a competitive edge and support decision-making.

At the same time, more IT systems and more IoT devices make ships more vulnerable. Security represents the most significant problem in implementing IoT devices on ships. Severe storms can disrupt connections with shore-based systems. Hijackers and bad actors often gain access due to less secure, open systems like IoT devices to jam systems.

Cybersecurity firm Naval Dome reports, "Cyberattacks on the maritime industry's operational systems have increased by 900% over the last three years, with the number of reported incidents to reach record volumes by year-end." Is there a solution? It isn't easy, since ships are 'connected' most of the time.

Growing regulations around cybersecurity increase the need for continuous availability and a tested business continuity and disaster recovery strategy for every shipowner and operator.

Video surveillance has become an important tool in overall ship security programs used to protect the crew, the ships, and related assets. While not effective as standalone security features, cameras can and have been used effectively as part of an integrated security program to reduce the potential for crime, enhance physical controls, assist in investigations, and enhance public/life safety. Surveillance cameras should be deployed as part of an overall security program with consistent monitoring and the ability to provide prompt emergency response.

VMS (Video Management System) use is most common to track activities. To guarantee uptime, VMS applications typically run on one or more dedicated servers. These environments are complex to manage.

Shipowners and ship management organizations can benefit from this technology and get a better handle on their deployments across many ships.

(Unplanned) Downtime

The maritime industry needs real-time IT support to help reduce the cost of downtime. The maritime industry demands accuracy and reliability for staff, crew, and customers during a network outage, but it's tough to create a plan or have someone available 24/7/365.

When a network goes down, data loss must be minimized. By setting up a schedule with frequent backups or replications, data can be kept safe. The cloud does not provide the guarantees most organizations look for to secure operations and minimize downtime. The top unplanned downtime causes are IT equipment failure and network outage, human error, problems at a service provider, and cyberattacks.

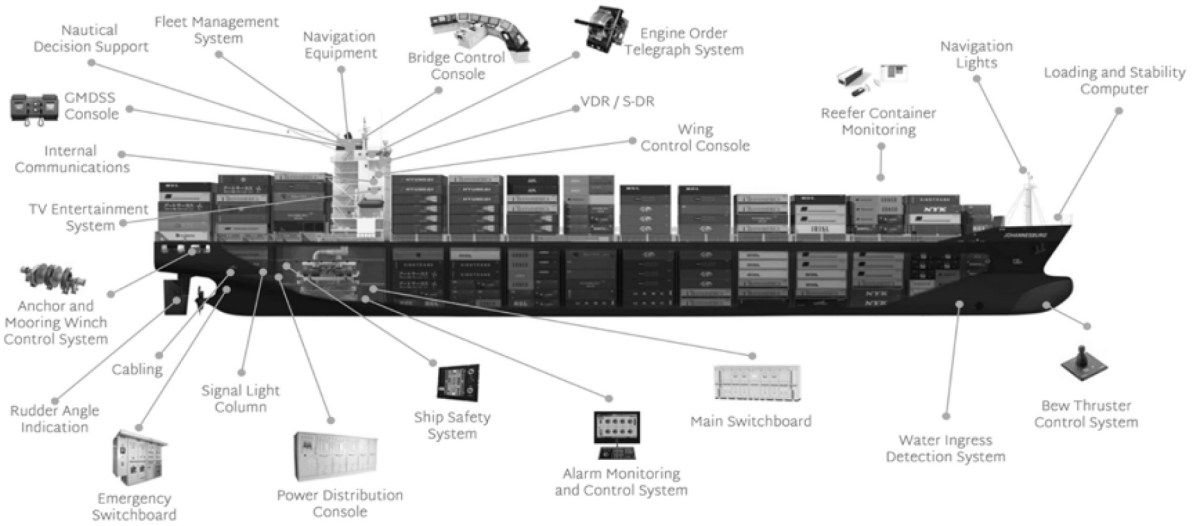
When IT systems experience downtime, there can be short-term and long-term damage to the business. Direct loss of revenue is the number one impact, followed by loss of productivity, data loss, and loss of customer trust and company reputation.

Downtime might cause voyage deviation, leading to higher fuel consumption and the inability to always stay secure. IT infrastructure on ships must become resilient and always "on". If the PMS system isn't live, a ship is not allowed to depart the harbor.

IOT Explosion

The Internet of Things (IoT) is the single biggest change in maritime technology. It revolutionizes the industry with devices such as alarm monitoring and control systems, ship safety systems, temperature control, propulsion optimization sensors, and much more. But, the explosion of IoT devices creates a tremendous challenge for every ship manager.

IoT and operational technology systems create vulnerabilities open to cyberattacks.



Energy Regulations

The shipping industry faces various energy regulatory challenges as well—many implement Ship Energy Efficiency Management Plans (SEEMP). More (likely IoT) devices and new applications are installed to improve the overall ship's performance and efficiency while reducing CO2 emissions simultaneously. We see the number of software applications growing, driving the need for better systems.

Bandwidth and Connection

Historically, once a ship anchored at sea, it became isolated from communication with the shore. While ship-to-shore communications have gradually evolved, the significant increase in digital signals creates massive amounts of data. Ship operators want to see more transparency to understand how much data is used and how much is needed. Crews demand more connectivity. They want to chat with their families and friends onshore, use social media, and stay connected. It is vital to a crew's welfare.

A modern onboard IT infrastructure bridges two worlds: traditional onboard IT and the cloud. There is, however, no guarantee that a connection with "the cloud" or the shore is always available. Although greater bandwidth became available and shore-based connections dramatically improved over the last few decades, connectivity cannot always be guaranteed. Ships can face communication problems during a storm, satellite switch, cyberattack, or worse.

The need for a modern, more secure, robust and reliable IT infrastructure is, therefore, more important than ever - but that creates an immediate problem. As the importance of ship computers increases by the day, how do you manage these systems? There is seldom in-depth IT knowledge available on a ship, and communications with shore-based support staff is not always available.

Digitalization and Data Analytics

To improve ship performance, data analytics is key. To make informed decisions, collecting data and being able to analyze data in real-time becomes a requirement. Data analytics can support shipowners with technical management functions in applications and decision-making processes for regulatory compliance, safety operations, planned maintenance, fuel reduction, and more. Most of these analytics can be performed at any time. For the crew, better insight related to vessel performance, onboard safety and risk exposure, real-time analysis helps make that one informed decision when needed. They simply cannot wait a few hours until the data is analyzed.

Automation and technology advancements mean the shipowner, fleet manager, and crew must deal with the exponential growth of data. Understanding this "big data" means an investment in solutions and systems, both onshore and aboard ships. Continuous data analytics is possible only when applications and systems can support these activities.

> "By embracing analytics and turning data into actionable insights, shipping players have an opportunity to drive improved efficiency and quality."
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> Source: Trelleborg

System Support

Supporting IT systems in the shipping industry, on an oil platform or even on a windmill at sea is not as easy as you might expect. Compare it to a shore-based operation. When your server goes down, you call support, and they analyze the problem. If repair of a component or server is required, an engineer is sent to your location. At sea, contacting shore-based support staff isn't always possible, and they certainly cannot send someone to the ship for repairs.

That means traditional IT solutions are not capable of providing the required continuous operation of a modern, "smart" ship. If a component or a complete server fails, resulting in the halt of operations, this might become a tremendous liability and endanger the safety of the crew and vessel.

Downtime might cause voyage deviation, leading to higher fuel consumption and an inability to stay secure at all times. IT infrastructure on ships must become resilient and always "on."

Integration

With the growing number of applications, the maritime industry faces the challenge of integrating all the software efficiently and ensuring the integrated software accurately communicates with each other, ideally in real-time. Unfortunately, there is still a high cost to achieve this integration, and that is a barrier for most ship managers.

The use of APIs in the maritime industry is not that common but can help to overcome these integration challenges. APIs add efficiency to ship technology by integrating the technology stack, helping tools communicate better with one another.

Backup and Resiliency

Although modern solutions optimize available bandwidth and minimize data volume, they don't eliminate all risks. Automatic, real-time data transfer from ship to shore might be in place, but not always sufficient. If the vessel gets jammed or a cyberattack takes place, you might need to roll back quickly to a state as it was an hour or a day ago.

Onboard replication of data and the ability to roll back to a prior state is costly and, in many cases, impossible without shore-based support or retrieving complete backups from a shore-based data store. Some processes can wait; others cannot. The need for instant local rollback is a requirement for smart ships.

Performance Optimization, Improved TCO

Managing the total cost of ownership/operation is fundamental to any successful shipowner or operator. There are tens, if not hundreds, of situations you can think of that impact your TCO. To name a few:

- Regulations, like the new CO2 emission rules, might require higher investments
- Course deviation resulting in higher fuel consumption
- Low crew morale might result in higher sickness levels
- Maintenance and repair timing and execution
- Hull fatigue conditions
- Procurement conditions
- Cyberattacks: this alone might cost millions

Why Not Cloud?

Cloud computing changed our idea of digital agility. Companies augmented or replaced traditional data centers with cloud environments. In turn, they enjoyed better access to the right amount of compute resources when needed, while saving time and money. The benefits were huge, and a cloud-fixes-all mentality quickly emerged.

Cloud computing significantly accelerated the ability to support digital business, providing better availability and scalability without the burden of managing IT infrastructure. But...not all applications can or should run in the cloud - especially in the maritime industry.

Why?

Accessibility. Internet connectivity cannot always be guaranteed. Disruptions to communications might occur for any number of reasons.

Security. According to IDC, 80% of companies experienced a cloud breach in the last 18 months. Transporting data increases risk. The risk is much higher versus on-premises edge computing, where you can simply disconnect. That means less data at risk.

Legacy requirements. Legacy applications and systems are based on outdated technologies, but are critical to day-to-day operations and may not make sense to put in the cloud.

Innovation restrictions. Innovation requires speed. Low latency is not an option for many applications. Artificial intelligence (AI), augmented reality (AR), and smart IoT make inroads, demanding local compute power at the edge.

Regulatory compliance. Complying with data security and privacy regulations is both serious and non-trivial. The more data collected and processed on-site, the simpler maintaining compliance becomes. The risk of interception and regulatory non-compliance increases every time data is moved. By definition, the cloud is a fuzzy place, making it difficult to know exactly where data is and where it has been.

Understanding Edge Requirements

Edge computing involves placing compute resources closer to where data is generated and used rather than sending all data back to centralized servers or the public cloud. Though edge environments are supported by centralized processing, running applications locally, on-premises solves many of the inherent challenges of data center and cloud computing.

Today, distributed infrastructure is a critical enabler of innovation and immersive experiences. However, this proliferation of computing at the edge of the network threatens the cloud-enabled digital agility we expect. The threat is not on-premises computing itself, but the way it's been done.

Most of the infrastructure used for local computing was never designed for the unique needs of edge computing. Done right, edge computing infrastructure extends the best elements of the cloud and the data center to on-premises local computing.

In placing compute services at the edge, organizations can implement strategies for content caching, IoT management, improving response time, and faster data transfer rates. This also represents capabilities that can't be matched by cloud technologies while delivering those capabilities at a very competitive price point. Furthermore, there are no concerns about vendor lock-in or trouble moving or reclaiming future data.

Future-Ready Edge Technology

The good news is there is an answer to many challenges the maritime industry faces. An edge infrastructure technology strategy is based on manageability and flexibility. After all, new applications, devices, data sources, and needs continuously emerge.

Some applications may be resource and data storage-heavy. Others may only need to run a few very lightweight applications. For example, a new deployment that needs to run a few small applications collectively consumes just a few gigabytes of memory. Does it make sense to deploy an infrastructure that consumes ten times those resources to function? Of course not. The additional cost of such an infrastructure due to excessive overhead is a significant barrier, especially if multiplied across tens, hundreds, or thousands of edge sites.

Instead, a scalable solution that delivers the core functions of a data center is needed.

Scale Computing Platform

SC//Platform is the basis for a complete "data center in a box" with servers, storage, and virtualization integrated into a single appliance to deliver simplicity, availability, and scalability to make IT infrastructure easier for maritime organizations. The integrated hypervisor offers proven technology that guarantees easy migration from any physical or virtual environment. Virtualizing applications reduces application deployment costs, management time, and capabilities.

Manageability. The centralized management platform provides an easy-to-use interface to manage and monitor distributed deployments from a single location. From initial deployment and routine system maintenance to capacity expansion and hardware replacement, administrative tasks are easily automated and remotely executed. Combining centralized management with cloud automation allows infrastructure and applications to achieve and maintain the desired state throughout the entire life of the environment.

Scalability. SC//Platform is incredibly simple to scale out. Nodes can be mixed and matched, allowing scale-out focused on the increasing RAM, CPU, or storage. New nodes can be added seamlessly into a running cluster without disrupting running VMs. New resources become immediately available, including storage, which is automatically added to the cluster-wide storage pool.

Rapid, Easy Deployment. The centralized management portal provides automated, error-free provisioning and configuring of new infrastructure without skilled IT staff aboard ships. To deploy or replace infrastructure, simply ship equipment to the destination and leave the keyboard behind—no on-site configuration will be required. Just have someone plug it in and connect it to the network. The management portal will take over from there.

Right-Size Configurations. Plan the perfect future by not predicting it. Capacity, performance requirements, and hardware specs will forever change. Legacy applications will remain mission-critical, while modern applications will require new architectures. Simply mix and match the old and the new on the same infrastructure for a future-proof environment.

Cloud-init Customization. SC//HyperCore includes cloud-init customization via REST-APIs to enable infrastructure-as-code so developers and administrators can automate otherwise very manual processes. With this you can:

- Mass provision customized VMs
- Save time automating manual steps in site and application setup
- Manage application updates
- Reduce human error from manual setup
- Ensure deployment consistency across sites
- Enable consistent change control and more reliable updates through standardization

Self-Healing Automation. Self-healing intelligence automatically takes corrective action when error conditions are detected, without manual intervention, ensuring applications are always available and no data is lost.

Reduced Management Costs. SC//Platform reduces costs by reducing downtime and operational management costs dramatically. Both planned and unplanned downtime are nearly eliminated with built-in redundancy, high availability, disaster recovery and backup. Management is reduced from days or hours a week to just minutes with a combination of automation and simplicity by design.

Improved performance. Eliminate inefficiencies common in virtualization, such as virtual storage appliances (VSAs) or multiple storage protocols like NFS and iSCSI used for legacy hardware architectures—not required in SC//Platform. The built-in storage architecture with cluster-wide striping and automated hybrid-flash tiering give SC//Platform improved performance over traditional infrastructure.

Unique architecture. Right-sized, edge-ready infrastructure combines compute, storage, virtualization and disaster recovery into a single solution with a smaller attack surface. The unique architecture and tight integration of system components allow the infrastructure to monitor itself. A standard three-node cluster provides built-in redundancy and fault tolerance at a lower price than fully-redundant, over-provisioned, duplicate systems and uses a fraction of the resources of alternatives. Get far more computing power and run more applications with a single platform.

High Availability. Failover, redundancy, and resiliency are fundamentally designed into every aspect of the solution, creating the most highly-available infrastructure solution possible.

Zero-Touch Provisioning (ZTP). The ZTP feature of Scale Computing Fleet Manager provides cloud-like simplicity for administrators, allowing them to centrally configure clusters prior to nodes arriving on-premises, decreasing the time of installation by 90% or more.

Modernizing With Low-Code And Containers

In their effort to modernize operational technologies, the maritime industry has started to adopt low-code and container technologies to boost their application efficiency.

We often hear customers ask if it is possible to run containers and Kubernetes on SC//Platform. The answer is yes! Many of our customers have containerized workloads running on SC//Platform today, and we expect the adoption to increase over the coming years as more and more application vendors take advantage of the portability provided by containers. The more complex these container-based applications become, the more likely they will be deployed with an orchestration tool such as Kubernetes.

Containers. Containers are wonderful in their ability to provide consistency from one environment to another (e.g., from the developer's test environment to a VM running on SC//Platform). A container bundles together the entire runtime environment that includes the application, its dependencies, libraries/binaries, and the configuration files needed to run it.

Kubernetes. Kubernetes is a widely adopted, open-source orchestration tool used for managing and running containers in production environments. It provides a framework for providing your containers' resiliency, networking, load-balancing, and scaling. It is common to see these tools as a part of a larger CI/CD (continuous integration and continuous delivery) pipeline.

Containers and Kubernetes will continue to see adoption, and SC//Platform makes it ridiculously easy to run those workloads alongside legacy VM applications.

Conclusion

Small changes could result in significant outcomes when non-linear maritime IT environments and climates intertwine. IT infrastructure in the maritime industry is more critical than ever. It must become a true data center at the edge: easy to use and manage, resilient, always available, and secure.

Scale Computing combines highly available and extremely easy to manage clusters with a low TCO, for any size implementation. From a lifecycle perspective, SC//Platform easily adapts to continually changing requirements.

SCALE COMPUTING

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