

Trendsetter Vulcan Offshore - Janus Monitoring System

detect and predict risk of a vessel entering parametric or resonant roll instability that could result in capsize or container loss

the challenge

Protecting the marine environment is a priority for the maritime industry. However, spills and incidents continue to occur. These events can not only have a devastating impact on the aquatic ecosystem, they can also jeopardize mariner safety. Incidents at sea also can be costly, disrupting the global supply chain and requiring enormous capital to repair/replace damaged assets.

In 2022, 38 vessels were lost; 10 were cargo ships. The data show container ships are particularly at risk. The Allianz “Safety and Shipping Review 2023” states: “Container losses at sea have spiked in recent years. More than 3,100 containers were lost on average annually during 2020 and 2021—four times the total reported in the previous period—and incidents have continued.”

To reduce the likelihood of incidents that can lead to container or vessel loss or injury to the crew, TVO developed a system to monitor container stack and vessel stability, predict and detect unsafe conditions, and provide the vessel captain with advance notice that enables evasive action to be taken.

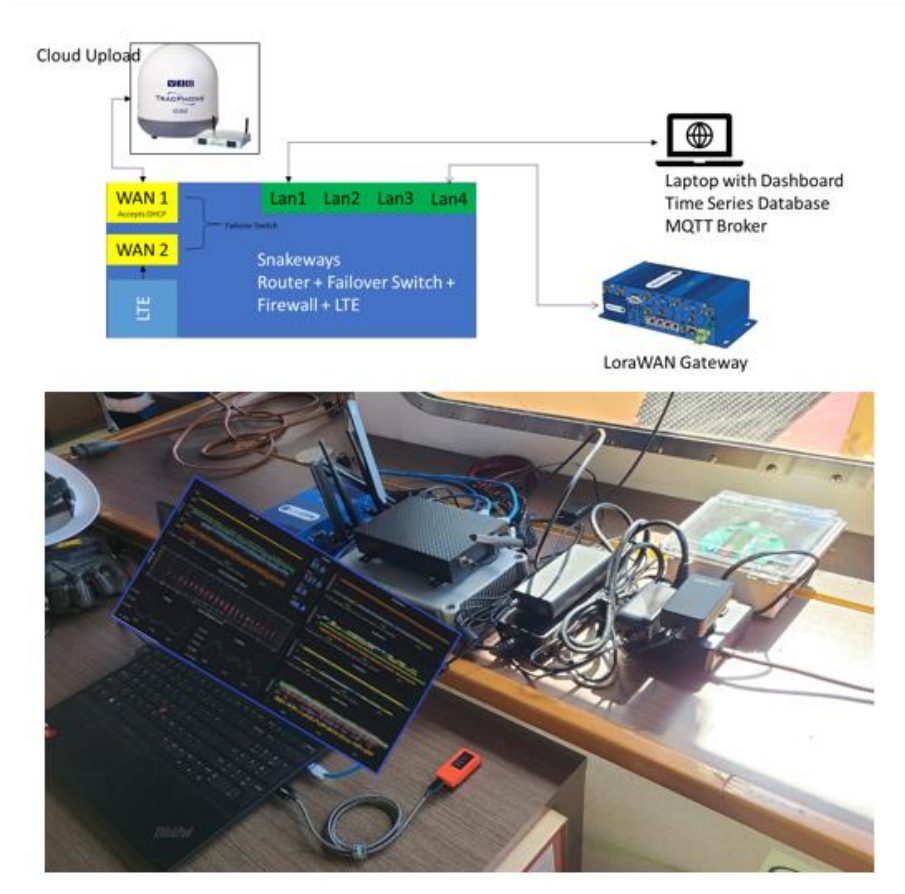
This system utilizes its own sensors installed on container stacks and the bridge, its own communication network for data collection and transmission, and provides a user-friendly dashboard for displaying results.

TVO applied existing technologies in a novel way to address multiple challenges, including:

- Vessel instrumentation
- Contending with signal Interference
- Preventing signal loss
- Overcoming bandwidth limitations
- Inputting collected data to an algorithm developed by TT
- Detecting risk of parametric roll
- Detecting excessive stack vibrations
- Developing a simple graphical user interface with real-time alarms.

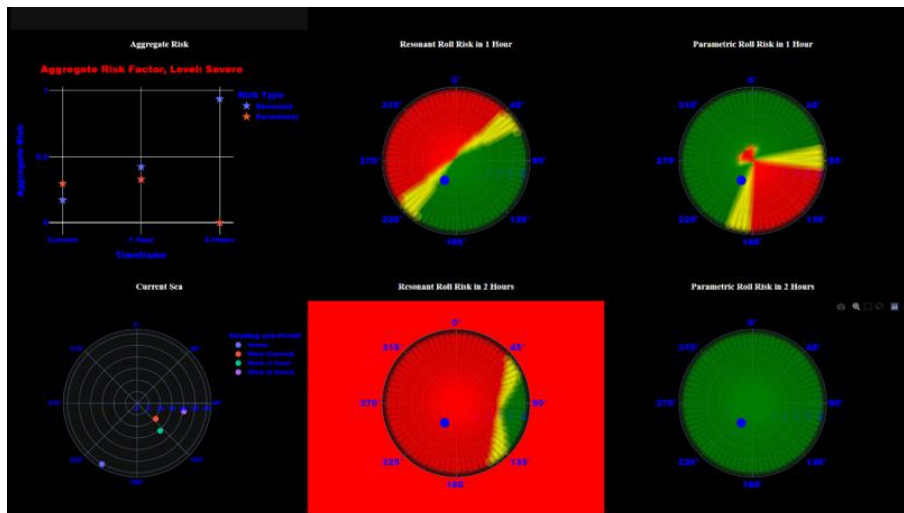
the innovation

TVO’s Janus monitoring system works to detect and predict a vessel’s risk of entering into either parametric or resonant roll—a condition where a confluence of factors push the vessel into instability, causing extremely high roll angles, potentially resulting in capsizing.



The system uses the vessel’s heading and speed, its measured roll period from TVO’s sensors, and the sea state (gathered from a third party) as input parameters to Top Tier’s prediction algorithm.

The wireless monitoring system uses Long-Range Wide Area Network (LoRaWAN) technology to communicate information gathered by onboard sensors to the vessel’s bridge. The continuous data feed allows potentially dangerous conditions to be detected and alerts the captain up to 200 seconds before an event occurs, allowing sufficient time for evasive action



to be taken to avoid a situation that could compromise vessel stability. Every 5 minutes, essential statistics are transmitted to the cloud for display on a web-based dashboard

The Janus system, which can be monitored onboard or remotely, can be integrated with TVO's proprietary Next Generation Lashing system—which uses technology adapted from a system used for oil and gas applications in subsea environments to arrest blowout preventor motions—to monitor tether tensions and stack dynamics, delivering an additional level of confidence to container retention.

Until now, no solution has addressed this challenge, leaving vessels, millions of tons of cargo, and maritime crews at risk.

Connected to IMU for motion measurement



Connected to Load Cell for force measurement



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how it was implemented

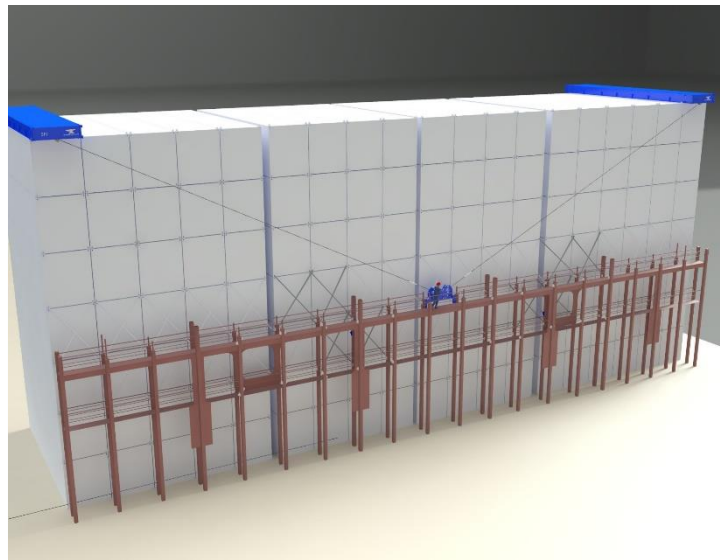
The first onboard evaluation of the Janus system was a communications test in June 2022, which proved a long-range (LoRa) communication network could consistently transmit data onboard a vessel. A second communications test using the same system was carried out on a vessel instrumented with sensors to test that the LoRa system could transmit data in real time.

In September 2022, the monitoring system was installed on a vessel making a Pacific crossing, during which data from load cells and accelerometers were communicated via LoRa to the

bridge. In March 2023, a similar test was performed using a LoRaWAN communication system to determine its ability to consistently transmit sensor data in real time.

A final sea trial, in June/July 2023, integrated the Janus system with TVO's Next Generation Lashing (NGL) system on a 13,700 TEU vessel traveling from Oman to Malaysia. The NGL test bay and the adjacent bay were instrumented to measure tension loads through the conventional lashings to compare NGL performance to a conventional lashing system and accelerations via the stack top accelerometers.

Load cell sensors measured the tension in the ship's lashings and tracked load changes and tension variations. Motion sensors on the deck plate and container stack tops tracked the vessel's motion and container stack dynamics. A sensor measuring accelerations, angular velocities, roll and pitch was installed on the bridge as a reference for vessel motions. The system uses inertial measurement units, pivotal devices that integrate multiple sensors to track and measure motion, to monitor container stack dynamics and movements and track vessel motions (such as roll and pitch³).



Next Generation Lashing System - NGL 1.0

result

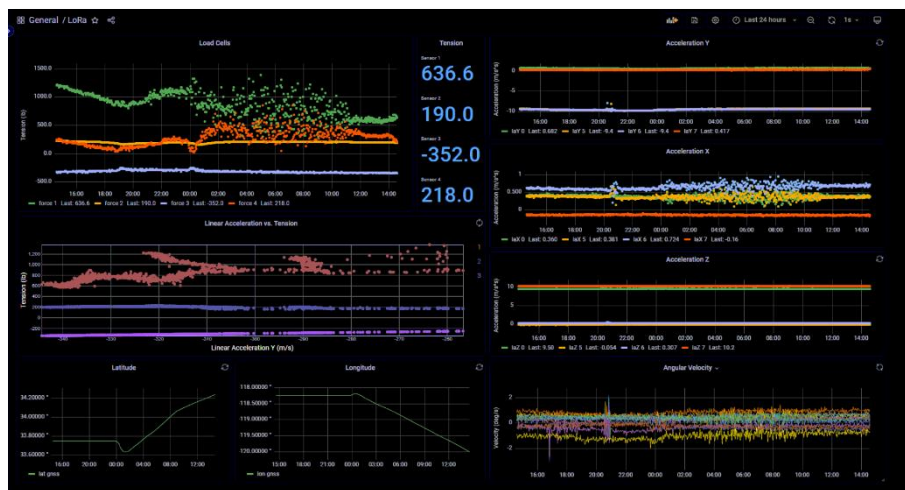
The initial LoRa communication system trial results demonstrated its appropriateness for use on a large vessel with long distances between sensors and receivers as well as those with large obstructions in the communication path. The following test showed its ability to consistently transmit data from the sensors to the onboard PC. The first sea trial in 2022 using a fully instrumented vessel proved the Janus system works as designed and allowed the web-based dashboard to be evaluated and enhanced, while the second successful sea trial enabled additional monitoring data to be gathered.

³ Roll and pitch are derived from accelerations and angular velocities using advanced Kalman filtering.

The June/July 2023 trial, in which the Janus system was integrated with the NGL, yielded useful results. The data transmitted and analysed by the Janus monitoring system indicate TVO's NGL system is a practical solution for reducing instances of container overboarding and has the potential to enable higher container stacks without compromising vessel or crew safety.

Because of the mild sea conditions, it was not possible for the Janus system to gather and assess the influence of stack dynamic changes and reductions. Although the system was not tested in these exacting conditions, the Janus system functioned as anticipated, and the data gathered provide indications of the NGL system's potential efficacy, with evidence suggesting it can both absorb and dissipate energy originating from ship motions and external forces.

The data gathered from sea trials can be fed into the finite element analysis (FEA) model to better visualize the responses of the vessel and container stack to understand the stresses on the system and where failures would be most likely.



conclusion

The Janus monitoring system uses LoRaWAN communication to consistently transmit critical data from strategically placed devices to help identify changes in the vessel's state that could impact its stability. The system is designed to detect potential risks with the vessel's roll and alert users of those potential risks. The system comes with a user-friendly dashboard that can be accessed at any time either onboard or via a web portal.

Real-world tests have been carried out to display the viability of this system. The goal is to take this novel system to the next level, increasing reliability and expanding the operational window to help the maritime industry improve safety and reduce the risk of accidents and injuries.

Using the Janus system with the NGL expands the value of the monitoring system. The International Maritime Organization estimates 20% of 1,500 maritime accidents resulting in injuries each year involve containerships. More than 3,100 containers were lost on average annually in 2020 and 2021—four times the total reported in the previous period.

Containerships are particularly at risk; so improving the ability to secure tall container stacks and monitor the tethering system has the potential to save both money and lives.

As the Janus Monitoring System is installed on more vessels, performance data will be compiled and analysed to generate useful correlations among the sea state, and vessel motions, to allow the system to forecast potentially adverse events more rapidly and precisely.

LINK: <https://www.trendsettervulcanoffshore.com/>