Teams at the 35th America’s Cup competed on AC50 catamarans with 15m hulls.

Emirates Team New Zealand won the America’s Cup for the third time.
Emirates Team New Zealand relies on PC-based control and EtherCAT in America’s Cup contest

In June 2017, Emirates Team New Zealand pulled off an emphatic victory in the 35th America’s Cup in Bermuda with a 7-1 win over Oracle Team USA. The New Zealand team also won the Louis Vuitton Trophy during the qualifier event, beating contenders from Britain, France, Japan and Sweden. PC- and EtherCAT-based control technology on the New Zealand boat proved to be a crucial aid for fast, precise trimming – the process of tuning the hydrofoils and the wing sail’s position and profile to suit the wind, course and swell. Beckhoff, now on board as an official supplier for the team’s title defense bid, can report on the technology deployed in the oldest sailing race still held today.
Emirates Team New Zealand has a number of technical requirements that are less than typical in traditional industrial applications. The team needs compact, lightweight, high-performance controllers capable of withstanding high temperatures, moisture, saltwater, vibration and shock – requirements that most electronic components are not designed to meet.

**Outstanding performance in harsh conditions**

It was the compact design and low weight of Beckhoff control technology that caught Emirates Team New Zealand’s eye. “When racing sailboats made entirely of lightweight composite materials, installing heavy electronic components would be counterproductive,” says Dan Bernasconi, the team’s technical director. Despite their compact, lightweight construction, the Beckhoff components proved exceptionally reliable in an incredibly tough environment. “In spite of the conditions we operate in, not one of the Beckhoff components failed, and they required practically zero maintenance – even after we capsized spectacularly,” adds electronics engineer Stefano Morosin.

Emirates Team New Zealand’s boat was the only one in the race not fitted with winches. Instead, all the vessel’s trim surfaces, barring the rudder, were controlled over EtherCAT by a Beckhoff Embedded PC. This resulted in exceptional precision, repeatability and reliability that kept the boat stable, fast and efficient, allowing the crew to virtually fly across the water. “A system capable of responding instantaneously to my input was essential for steering the boat,” explains America’s Cup winner and Olympic gold medalist Blair Tuke, the team’s foil trimmer.

**Flexibility is the key**

Using PC-based control for the on-board systems opened up many possibilities for Emirates Team New Zealand. Says control engineer Ryan Thomas: “The fact that we could use any PC software, plus the ease of communication between TwinCAT ADS libraries and the real-time controller – locally and over a network – gave us maximum flexibility when managing the system architecture. This is particularly valuable in a fast-moving development environment with software and hardware changes happening on a daily basis.”

However, these were not the only benefits of the flexibility offered by TwinCAT 3-based control. Emirates Team New Zealand searched everywhere for controllers, sensors and other devices that would meet their exacting expectations. With the wide range of EtherCAT I/O modules, control system-integrated interfaces and gateway bus terminals and box modules from Beckhoff, they achieved all connectivity and communication requirements. With Beckhoff technology, choosing the best option for a given application was never a problem, as Ryan Thomas explains: “Using EtherCAT as our central bus system on board, we got extremely fast response times and could integrate any number of other devices via gateways. When you’re not limited by communication protocols, your options expand enormously, particularly when you’re looking for solutions to highly specialized problems.”

The large quantities of data to be processed from position and pressure sensors, anemometers and other sources, plus the navigation calculations and the racing software all called for an exceptionally fast computer. The CX5140 Embedded PC with an Intel® Atom™ quad-core processor delivers the requisite computing power by making optimum use of all four of its CPU cores. The compact, lightweight design also made the PC ideal for this particular use case.

**Advanced diagnostics on board**

Plenty of time spent on the water is essential to any successful America’s Cup bid, so fast, accurate diagnostics and troubleshooting were crucial to maximize the amount of live training and testing on the actual boat. The diagnostic capabilities of EtherCAT and corresponding tools in TwinCAT 3 detected potential problems quickly – sometimes even before the boat’s crew...
spotted them. "In the harsh, wet conditions involved in sailing, connectors will usually develop faults over time due to water ingress and gradual corrosion. The ability to identify early on where this will happen allows us to maximize productive time on the water and avoid situations that could harm the boat," Stefano Morosin says.

Shore crew and support engineers needed a portable solution with an intuitive user interface to maintain the mechanical and hydraulic systems. Through the web-based HMI options provided by TwinCAT, every function implemented on the race boat could be controlled through a web interface on a tablet device – the ideal portable control unit for maintenance tasks, as hydraulics engineer Vito Vattuone explains: "The ability to actuate any valve from anywhere on the boat, even from the very front of the hull, was exceptionally important for maintenance and trouble-shooting."

Looking ahead to the 36th America’s Cup
After winning the 35th America’s Cup, the pressure is on for the NZ team to successfully defend its title, especially since it will host the race’s 36th staging in Auckland, New Zealand, in 2021. Each race team will use a Beckhoff PLC to control its hydrofoil cant system via EtherCAT. Emirates Team New Zealand welcomes Beckhoff as an official supplier and looks forward to using the company’s PC-based control architecture to redefine the performance boundaries of high-speed boat racing once again.