Machine-learning via Thuraya satellite helps University of Michigan take runners-up spot at world solar event

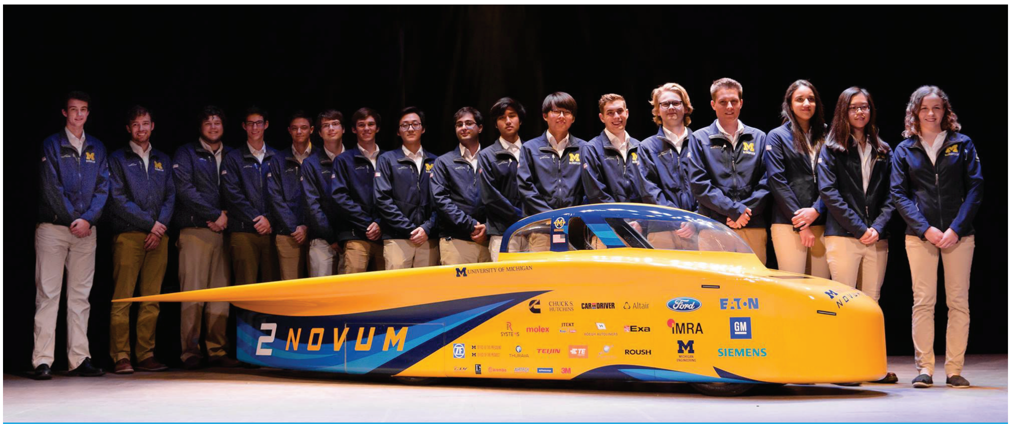
Case Study:
University of Michigan Solar Car Team World Solar Challenge

Products:
Thuraya IP Voyager
Thuraya XT
Thuraya Vehicle Docking Stations

Location:
Australia

"The World Solar Challenge continues to showcase the development of advanced automotive technology and promote alternatives to conventional vehicle engines."

- Janice Lau



Pushing the boundaries of solar cell research at UoM

The University of Michigan is home to world-leading photovoltaic research within the Optoelectronic Components and Materials Group under Professor Stephen Forrest. Advanced research conducted by the Group includes applying new techniques to produce more efficient solar arrays and investigating the potential of organic photovoltaic cells.

Solar car racing is all about keeping things moving forward. For the University of Michigan Solar Car Team, that means achieving their best-ever finish at the Bridgestone World Solar Challenge in Australia, in October 2017.

It also means pushing the boundaries of solar car design, introducing new technologies and features to make their race vehicle, Novum, ultra competitive. That included relying on Thuraya satphones for mission-critical data acquisition, machine learning and team communications – and fitting Novum with a similar type of solar cells used on the panels of satellites.

The World Solar Challenge was set up to "showcase the development of advanced automotive technology and promote alternatives to conventional vehicle engines". In keeping with that ethos," Novum was the smallest, fastest and most aerodynamic vehicle entered by the student-run team since it began racing the event in 1990.

Team business director Lynne Bekdash says: "In the lead up to the 2017 race, our engineers did some hard thinking about what worked in previous races and what we could do differently this time to achieve what we wanted. They decided they wanted to take a risk and try something really different."

The team adopted a new monocoque design, moving away from the larger catamaran build of previous UoM cars. However, they also needed a new approach to energy management because the smaller, bullet-shaped vehicle would have less surface area on which to mount a solar array.

Having used silicon solar cells on previous cars, for Novum UoM invested in a more expensive but much more efficient multi-junction gallium arsenide array, similar to those mounted on modern satellites and on the NASA Mars rover vehicles. "This was crucial to the design," says operations engineer Janice Lau. "It meant we could race with a small, lightweight car and still draw the

Machine-learning via Thuraya satellite helps University of Michigan take runners-up spot at world solar event

"The Thuraya equipment allowed us to stay in constant communication with the main caravan surrounding Novum."

"Using the Thuraya XT-PRO satphones we were able to have detailed phone conversations about race strategy and how to best optimize the available sunlight."

- Peter Rohrer

"IBM agreed we could use its PAIRS application-programming interface to develop our own machine-learning model. "

- Alan Li

power needed to race competitively." Due to the unfamiliarity and complexity of the multi-junction array, the team's engineers undertook extensive quantitative modelling to establish how to get optimum performance from the cells during racing. All design, build and testing work was undertaken by the student team. In addition to extensive research online, they sought initial advice from UoM faculty members Professor Pei-Cheng Ku (on the basic performance of multi-junction solar cells and on potential damage risks) and Professor Neil Dasgupta (on the importance of quantitative modelling).

Thuraya enables machine learning

As a long-term UoM team sponsor, Thuraya was delighted to supply six IP Voyager data terminals, six Thuraya XT-PRO satphones and unlimited airtime for the race. The broadband links were vital to a critical aspect of the UoM race strategy – the M2M acquisition and synthesis of real-time weather data.

Since 2015, UoM had downloaded machine-learned weather data directly from the servers of sponsor IBM. However, for the 2017 event, head strategist Alan Li decided to create a bespoke machine-learning model to handle weather data. This would allow the UoM team to acquire and synthesise data from a wider range of weather forecasters during the race and give the team a better control of parameters.

Alan says: "IBM agreed we could use its PAIRS application-programming interface to develop our own machine-learning model. We wrote the code from scratch and it took about six months to build, train and validate the model."

Machine learning is a basic form of artificial intelligence. It uses advanced algorithms to enable a computer programme to become progressively more accurate at a task – in this case weather prediction – without extensive reprogramming at each stage of the learning process.

Alan and his team used historic weather data during development and testing at UoM, but relied on the Thuraya Voyager IP terminals to download real-time weather data into the model once in Australia for pre-race testing and racing. The connections worked extremely well and the compact and lightweight terminals fitted easily into the confined space of the UoM support vehicles.

Thuraya was also key to another 2017 innovation, after race strategist Andrew Dickinson developed an application for tracking the race vehicles in real time. Using Thuraya IP Voyager to connect to a central server in Michigan, the app enabled 20-40 UoM alumni to see the exact position of Novum at all times. It also helped the team in the weather truck to keep tabs on Novum.

To further enhance the experience for people following the race, the team used the Thuraya IP Voyager to stream basic resolution video live over the internet. Operations director Peter Rohrer

THURAYA

Machine-learning via Thuraya satellite helps University of Michigan take runners-up spot at world solar event

"This was exciting, because it proves to us that Thuraya's network can handle anything we can imagine using it for."

- Peter Rohrer

Follow the Sun

"Sun chasing" is a key element of solar car racing. The longer a vehicle spends in the sunshine the more power it can draw, which equates to faster race times. The 2017 Bridgestone World Solar Challenge was marked by cloudy and unsettled weather, which was difficult to predict, so the ability to download the latest forecasts via Thuraya was crucial to Novum's taking its first-ever second place in the Challenger Class.

comments: "This was exciting, because it proves to us that Thuraya's network can handle anything we can imagine using it for."

Essential comms when radio and cellphones fail

Thuraya was a vital channel for communications across the race caravan. With the weather truck travelling far ahead of Novum, sometimes up to 200km, UHF and VHF radio communications were either impossible or impractical, while the remoteness of the Stuart Highway meant that cellular networks were rarely available.

"The Thuraya equipment allowed us to stay in constant communication with the main caravan surrounding Novum," says Peter. "Using the Thuraya XT-PRO satellite phones we were able to have detailed phone conversations about race strategy and how to best optimize the available sunlight."

Each day the weather team co-ordinated with the rest of the race caravan about the planned stopping location for the night. On the first night of the race, a misunderstanding occurred and there was a danger that Novum would stop in the wrong place and incur time penalties. However, the weather team used the XT-PRO to warn the chase vehicle as soon as the error was noticed, so no time was lost.

During pre-race testing, an unseasonal rain storm hit the Australian outback and it was important to get Novum under cover without delay. The team used the Thuraya XT-PRO to call up its semi-trailer from miles down the road, and Novum was stowed away quickly before the rain could damage the car and its electrical systems.
Peter concludes: "Thuraya's continued support of the team has been phenomenally helpful for us as a team. An interesting observation is that the team's performance at the World Solar Challenge has improved every year since we began receiving support from Thuraya!"

To learn more about Thuraya's vehicular products, visit:
www.thuraya.com/ip-voyager
To learn more about the University of Michigan Solar Car Team, visit:
www.solarcar.engin.umich.edu/novum