Business challenge
To create competitive F1 cars and winning race strategies, Red Bull Racing must maximize performance of the IT infrastructure running its data-intensive simulation, design and analytics solutions.

Transformation
Staying competitive in F1 requires Red Bull Racing to analyze and store huge amounts of data. With IBM® software-defined solutions underpinning its computational fluid dynamics (CFD), analytics and storage environments, the F1 team can design and refine race-winning components faster than ever before, and drive smarter real-time decisions around strategy.

“Working with IBM enables us to make better decisions by unlocking the full potential of our data, ultimately translating into success on the track.”
—Nathan Sykes, Head of Numerical Tools and Technology, Red Bull Racing

Red Bull Racing
Transforming data into faster insight and more competitive F1 race cars

After just twelve seasons in Formula One, Red Bull Racing has already racked up 58 pole positions, 128 podium finishes, 49 fastest laps, 51 race wins and four double World Championships. Combining exceptional on-track performance and a radically different approach to racing, the Red Bull Racing team has redefined what the sport means to fans the world over. In its factory in Milton Keynes, UK, the team designs, manufactures, tests and refines practically every component of its highly sophisticated cars, preparing them to compete in 21 global Grands Prix races. On the racetrack, the team analyzes data from more than a hundred sensors to make real-time decisions about race strategy.
**Speed is everything**

Formula One™ (F1™) is the world’s most popular and most technically advanced motor racing series, encompassing 21 races each year across five continents. Although the sport’s FIA governing body maintains complex regulations that restrict maximum performance—both to ensure driver safety and to keep costs sustainable for smaller teams—F1 cars remain exceptionally powerful, light and fast.

Zoe Chilton, Senior Technical Partnership Manager at Red Bull Racing, says: “Our success and failure is measured by milliseconds on the track. That means when we’re making decisions, whether it’s here in the factory or on the circuit, we have to be incredibly precise and data-driven to make the best call.”

To stay among the front-runners in F1, Red Bull Racing maintains deep internal technical expertise and works with innovation partners to design an almost entirely new car each year and then continually develops it throughout the racing season. Since 2014, FIA regulations have required the use of small V6 engines, so teams use a combination of advanced turbochargers, energy recovery units and auxiliary electric motors to boost performance. They also have extremely complex aerodynamic features that balance downforce and drag to permit high speeds on both corners and straights.

Matt Cadieux, CIO at Red Bull Racing, comments: “Within Red Bull Racing everything is about speed. We need to be fast on the track but also our business processes need to be fast. The car has about 7,500 unique part numbers on it, and evolves so we actually design about 100,000 parts over the course of a season. The speed of the company requires us to have very aggressive product development processes.”

Computer-aided design and simulation are hugely important in F1, where regulations strictly limit the amount of real-world wind-tunnel and track testing the teams can undertake. In fact, the FIA even limits the number of teraflops that can be used for virtual testing within an eight-week period, so Red Bull Racing must squeeze the greatest possible efficiency and performance out of its IT resources in order to keep evolving its cars throughout the season.

Of course, optimization of the cars does not stop during racing; Red Bull Racing gathers and analyzes huge quantities of data from hundreds of on-board sensors which is analyzed in real time to help the drivers and pit crew make decisions on how to adjust the cars during a race. This data is also used for the all-important race strategy and tactics, both in simulations at headquarters and to respond to emerging challenges and competitive threats trackside during race weekends. Given that races take place all over the world, significant challenges emerge when transferring these vast data sets for Red Bull Racing at the speed and reliability needed to effectively collect, store, retrieve and analyze to produce key insights.

“On Friday and Saturday, we run simulations to help optimize the setup of the car prior to qualifying, and during the race we run simulations to optimize the performance,” says Matt Cadieux. “We get multiple data inputs, and use advanced analysis tools in order to have a data-driven approach to making optimal decisions.”
Gaining a competitive edge

In a high-pressure sport featuring extremely complex equipment, manufactured to micron tolerances, and with equally complex race strategies based on both deterministic and stochastic modeling, Red Bull Racing naturally requires exceptional IT resources. To make the most of the FIA regulations, the team must keep CAD/CAE systems running optimally at all times, ensure the constant availability of world-class analytics solutions, and maintain fast, dependable access to huge amounts of data from all over the world, both current and historical.

For all three requirements, Red Bull Racing has chosen to base its infrastructure on IBM software-defined solutions, including IBM® Spectrum LSF to handle the scheduling and management of jobs on its HPC cluster, and IBM Spectrum Elastic Storage Server with IBM Spectrum Scale™ as the hub for data storage and retrieval. The IBM solutions also work seamlessly with IBM Aspera® to optimize big data file transfers between race tracks and the factory in the UK.

Matt Cadieux comments: “IBM software-defined solutions are used to automate our workflows and provision and schedule our supercomputers; without them, we would significantly slow down car development processes. Equally, we use IBM Spectrum Scale to manage our most critical simulation data. IBM has great products and great engineers that help us get the most out of the products. We have key analytical applications, all of which run on IBM solutions.”

Success for Red Bull Racing naturally starts with designing and constructing a competitive car each year. Computational fluid dynamics (CFD) plays a major role in both the initial design and the constant optimization throughout the course of the racing season.

CFD software enables Red Bull Racing to test virtual models of new components, assemblies or even the entire car to see how the all-important aerodynamics will work. By analyzing the results of CFD computations executed on its IBM Spectrum LSF cluster, Red Bull Racing can refine components much faster and more flexibly than if it were to physically prototype them. In particular, IBM Spectrum LSF makes it easy for Red Bull Racing to use its wide range of CFD tools within a standardized workflow, enabling the team to work rapidly and efficiently to get the best results. Using the latest version of IBM Spectrum LSF has also enabled Red Bull Racing to create an extremely intuitive working environment for high performance computing (HPC), allowing the engineering team to onboard new members in a matter of hours versus the six months it previously took.

Nathan Sykes, Head of Numerical Tools and Technology at Red Bull Racing, comments: “As generally there’s no silver bullet in F1, you have to iterate to get to a better component. IBM software-defined solutions allow us to move new applications in and out of the workflow very efficiently, even when workflows span global distances. We can run them side-by-side so we can understand what the differences are, and then provide ourselves with a workflow which is a step forward. This means that our components get better and better for every iteration that we run.”
Zoe Chilton adds: “When we’re designing cars that have to carry a driver at around 200 mph around a racetrack just millimeters from the tarmac, we really have to be confident the designs we’re producing are going to be robust. The value to Red Bull Racing of having IBM as an innovation partner is that it allows us to make the very most of the computing power we have here on site. The ability to run more simulations of how the car will behave on track allows us to know more about how the driver will be experiencing the vehicle, and it allows us to be more confident about safety and performance.”

In addition to the huge amount of data produced from both physical and virtual testing, the streamed data from in-car sensors and trackside monitoring equipment at every race weekend represents another critical element in refining the design of the Red Bull Racing cars. The same data is also analyzed in the operations room in Milton Keynes and used to support on-track decision making, helping trackside team members to make quick decisions about the setup of the car prior to qualifying and real-time adjustments to race strategy in response to changing conditions and competitive pressures. To ensure the fast and reliable transmission of large files between global race locations and the UK headquarters, Red Bull Racing relies on a highly capable wide area network and IBM Aspera high-speed file transfer software with the patented Aspera FASP® technology.

Nathan Sykes says: “IBM Spectrum LSF helps us to get the information from track into the format we need to compare it to CFD and wind tunnel really quickly, almost in real time. As we move data around the world we have huge distances between the racetrack and our HPC. Aspera allows us to move this data much faster and more reliably by optimally using our bandwidth.”

CFD, physical testing and racing telemetry together generate enormous quantities of data for processing, analysis and storage by Red Bull Racing. Both for CFD and analytics applications, the team must have fast, dependable access to these huge volumes of data. And while the value of this data tends to peak at the moment it is produced, the team may also need to refer back to it days, weeks, months or even years later.

With IBM Spectrum Scale acting as the gateway to the storage and archive landscape at Red Bull Racing, the team is able to provide extremely fast retrieval of the most current data while simultaneously reducing the cost of long-term storage for historical data using IBM Spectrum Protect™.

“Over time, once data has been consumed, we’re not going to need it as much, so it can move from our fast disk to our slower disk,” says Nathan Sykes. “This is something which is done automatically so we don’t need to worry about it. And if something is a year old and it needs to come back from tape, the system looks after it itself, pulling it straight back up, with the user completely unaware of where it’s come from. IBM Spectrum Scale allows us to automatically tier data from the fastest, most expensive disk, to the least expensive disk over time so that we can maximize our investment.”

Chris Middleton, IT Infrastructure Manager at Red Bull Racing, adds: “Data backup and recovery is immensely important to Red Bull Racing. IBM Elastic Storage Server sits at the center of Red Bull Racing’s backup environment. It provides the volumes that are provided to IBM Spectrum Protect, to provide the storage pools where all of Red Bull Racing’s backed-up data resides. In the event that we have an environmental or data center disaster, we can recover our data, take it anywhere in the world, and then use that data to reproduce any single part of the car without any issues.”
The combination of IBM Elastic Storage Server, IBM Spectrum Scale and IBM Spectrum Protect along with IBM Aspera high-speed transfer solutions enables Red Bull Racing to access, store, and recover large volumes of valuable data over time—efficiently, at low cost and with low administration requirements.

Chris Middleton comments: “One of our greatest challenges is capacity management: in our CFD environment, we can produce terabytes per day, in comparison to our mainstream environment where we’re looking at terabytes per year. Using IBM Spectrum Protect allows us to take a backup of the data we need. Shortly after that data has become a little older, we can delete it, safe in the knowledge that it’s backed up, and readily available to be recovered at any point. This allows us to store data that’s of more interest to us in our production environment without the need to worry so much about capacity.”

**Race-winning performance**

IBM software-defined solutions are a cornerstone of the data-driven design and analytics processes at Red Bull Racing, helping the team to gather and access data rapidly and reliably, process and analyze it at high speed, and protect it cost-effectively.

Using IBM Spectrum LSF to manage its HPC resources enables Red Bull Racing to get the maximum useful work done per hour of CPU time, which is critically important given the resource restrictions imposed by the FIA.

Nathan Sykes comments: “IBM Spectrum Storage solutions have allowed us to understand where the bottlenecks are and use the best hardware for that application. We’ve seen in the past that this has led to over 30 percent improvements in our workflow throughput. Sometimes we can get runs onto the cluster in half the time. So utilizing much more of the available hardware resource will allow us to get it onto the cluster quicker, and that means we can make decisions faster. Ultimately, this means that we can take better components to the track that help reduce our lap times.”

Supporting both CFD and analytical requirements, IBM Spectrum Scale has helped to cut data access times by up to 30 percent, enabling faster results and more timely insight into challenges. Chris Middleton comments: “IBM Elastic Storage Server gives us huge performance benefits. We’re able to run large backups overnight without running into next day operating, which ensures that design and research are not affected by any backup windows. It is very easy to implement, and after that it can be pretty much left to itself. This allows administrators to get on with tasks that are more directly related to car performance, ensuring the success of the team.”

Data is also delivered faster and more efficiently from the race cars: Red Bull Racing uses a highly capable wide area network and IBM Aspera complements this by optimizing file transfers between track locations and the Red Bull Racing headquarters.

In combination, the IBM software-defined solutions help Red Bull Racing to take full advantage of its data to drive competitive advantage both in the factory and on the track. Matt Cadieux concludes: “We’re very knowledge-led here. We tend to be early adopters, and we try to engage with the best companies in the world. Working with IBM as an innovation partner enables us to make better decisions by unlocking the potential of our data, and those decisions ultimately translate into success on the track.”
Solution components

- IBM® Spectrum LSF
- IBM Spectrum Symphony™
- IBM Spectrum Protect™
- IBM Spectrum Scale™
- IBM Spectrum Elastic Storage Server
- IBM Aspera® Point to Point Clients

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