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The smallest winning margin in F1 was the 2002 United States Grand Prix victory of Rubens Barichello over Michael Schumacher by 0.011seconds.[1]

Big Data in the Driver's Seat: Motorsports Winning with SSDs

Introduction

When 43 cars roar by you topping speeds in excess of 200mph, inches apart on a tightly coiled bend in a NASCAR race, you're in a world where milliseconds matter, where millimeters spell the difference between a narrow position-advancing turn, or a potentially violent spin out. But it's not just behind the wheel of a shuddering stock car where a thousandth of a second means winning or losing, it's also in the data center where data and analytics impact performance just as much as a driver's instincts and feel for the track. In today's Motorsports Technology, which includes NASCAR and F1 racing, Big Data, the Internet of Things (IOT) and Information Technology Innovation are big movers at the track and on a global stage.

[1] http://grandprixcentral.com/global/statistics/

Before a Fédération Internationale de l'Automobile (FIA) Formula One World Championship race even begins, team engineers and mechanics tap into tremendous amounts of real-time data to gain an edge against the competition. F1 cars are essentially big data factories on wheels. A myriad of sensors collect data on everything from fuel levels and engine performance, to oil temperature and tire pressure.[2]

No different than F1 is the innovation in the automotive races of NASCAR where Joe Gibbs Racing, home to 4 teams—most notably Kyle Busch in the number 18 Toyota Camry—measures each stock car's throttle position, steering wheel angle, brake pressure. According to Joe Foley, Chief Technology Officer at Joe Gibbs Racing, "we're collecting a large amount of data about car performance, as well as data to support driver race strategy, and improve car design, safety and fuel efficiency." By pushing the limits of sensors and data analytics, professional motorsports act as a showcase for the cutting-edge systems that find their way into automotive applications and into enterprise.

Given how important technology is for NASCAR and F1, it's no wonder why winning teams are using SSDs and NAND flash technology.

Motor Racing Size and Challenges

The professional motorsports market is estimated to reach $5 billion by 2018 at a healthy cumulative annual growth of 9.6%.[3] Automotive and consumer lifestyle brands like Red Bull and Budweiser adorn driver and car alike in hopes of forging a powerful, positive association when their driver takes the cup. Some famous F1 teams like McLaren, Mercedes and Ferrari are not just in the business of motorsports, but their success and reputation, nevertheless, are also critically tied to performance on the track.

Once thought to be a regional phenomenon, NASCAR is no longer confined to the Southern United States. From New Hampshire to California, with 18 states hosting, the NASCAR Sprint Cup Series is the sport's highest level of professional competition, also making it the most profitable NASCAR series. The NASCAR Sprint Cup consists of 36 races over 10 months, covering somewhere between 300-600 miles.

Likewise F1 teams are equally busy with 21 races, or to use the French nomenclature, Grand Prix. A particularly grueling circuit of races held on almost every continent, the season starts in Australia and ends in Abu Dhabi nine months later.

A key challenge for teams is the limited practice time on the track, so simulations offset this constraint, particularly in F1, where limited track time and cross-continent travel present logistical and organizational obstacles. Complicating matters further is the physical limit of how many team members (read engineers) are allowed on the track such that motorsports teams routinely run racing operations remotely from home, which can be sometimes thousands of miles away from the race. Infiniti Red Bull, for example, has 60 engineers on-site and 30 more in England.

[2] http://www.v3.co.uk/v3-uk/feature/2416146/big-data-analytics-accelerates-williams-formula-one-performance
[3] Future Trend in Motorsports Market, Ranjith R. https://www.linkedin.com/pulse/future-trend-motorsports-market-ranjith-rama?forceNoSplash=true

Joe Foley adds, "It's not like we are entering into arenas where there are millions of dollars of network infrastructure established for us to use. We are changing that but NASCAR racetracks are very large compared to most stadiums or arenas. That presents unique challenges physically and financially. We take a very proactive approach entering each week, relying on frequent replacement, constant monitoring and only the highest quality equipment."

Operational Efficiency

Shaving critical seconds through technical advantages and removing the guesswork is the highest priority for both F1 and NASCAR teams. "It's all probabilistic," says Mark Williams, McLaren's head of vehicle engineering. "Because the system is running races live in the background, you can say to it, 'How am I going to beat the guy in front?' It goes off and looks at all the options that he could do and you could do and comes up with the best solution based on probabilistic analysis. You may or may not beat him, but the closest you'll get to him is by doing this strategy."[4]

And in a world where the average NASCAR margin of victory in 2013 was 1.267 seconds those seconds are *critical*[5], sometimes providing the driver with an advantage that changes his odds on a track.

Automotive Racing has become an insight business that must avail itself of Cloud Computing, Big Data and the Internet of Things if teams are to remove the guesswork and produce calculated gambles through data analysis and simulations.

Wireless infrastructure and telemetry plays a large role. Remember Infiniti Red Bull whose team of 60 onsite engineers in Australia coordinated simulations with the other team in the U.K.? Well it currently takes less than 300 milliseconds for the data to reach Infiniti Red Bull's U.K. team, says Alan Peasland, head of technical partnerships.[6]

"Graeme Hackland, Williams' chief information officer, claims his F1 race team generates around 120GB of data from sensors, telemetry and video feeds over the course of a race.

The amounts of data can be staggering. For example, during a typical race weekend Mercedes's two racecars will generate approximately half a terabyte of data.[7]

At Joe Gibbs Racing, Joe Foley explains their unique networking setup, "During practice and post race, we plug into the car to download the all the data. It's just much faster that way. NASCAR has a wireless feed that distributes timing and scoring information that we also collect. At each track we deploy our own 2.4 GHz wireless mesh network. During practices the requirement is that all this happen and the data from the run that the driver just completed is downloaded, processed and delivered wirelessly in about one minute or less."

Data storage figures into the equation, especially the deployment of solid state drives (SSDs). Motorsports embraced SSD technology in 2008, according to Foley, citing a reputation for failures involving mechanical drives as a big problem. Remember that these race cars are whizzing at 220mph and whose vibrations

[4] http://www.bloomberg.com/bw/articles/2014-10-02/mclaren-uses-racing-expertise-in-data-driven-consulting
[5] http://www.nascar.com/en_us/news-media/articles/2013/11/29/by-the-numbers-gen-6-car-debut-season-sprint-cup-series.html
[6] http://fortune.com/2015/11/12/big-data-formula-1-championship-race/
[7] http://www.autoblog.com/2015/10/27/mercedes-wifi-tire-data/

throughout the car may displace components ultimately causing failure, mechanical or electrical.

"We depend on the reliability of SSDs," Foley adds. "Everything we do involves vibrations. The sound waves coming off the cars are an enormous source of vibration especially at the short tracks. If you're pitted in turn 2 or 4 at a short track like Bristol it's especially bad. You're very close to the track and as the drivers accelerate out of the turn it is common to see more than 140 decibels."

Racing Innovation Exploits Big Data and the Internet of Things

With affordable sensors and pervasive computing power making everything measurable, the challenge is to know what data is important to winning the race and what is merely track noise. "We measure whatever we need to manage during the race, and then we model to get the predictive intelligence on how the cars are going to perform," says Geoff McGrath, Chief Innovation Officer at McLaren Applied Technologies.[8]

To address the challenge of limited practice time at the track, McLaren has developed two machines: full-size car bodies mounted on hydraulics surrounded by curving video screens, with robotic arms that jerk the driver's helmet back and forth to imitate the violent G-forces of high-speed turns. An encyclopedic range of courses and conditions can be programmed into the simulators, but they're more than just training tools. They're able to calculate how different components affect a car's handling, even if those components exist only as a set of specs. That means the team can test parts on the simulator before it actually builds them, so only the promising ones would be fabricated and tried out at the track. Before McLaren started using a simulator, just 10 percent of the parts it made ended up being used in its race cars; now, 90 percent of them do.[9]

What's next at the race track? Video streaming is mentioned frequently by CTOs, but what's more, by using onboard thermal

Winning: There's a CTO for That

Every race team has some kind of lead engineer championing the data effort, whether they're known as a CTO or CIO. Given the minor margin of victory in a race, the chief technologist's role can be as important as the driver or crew chief for a racing team.

The CTO is responsible for assembling all fixed infrastructure at the main shop, as well as the pop-up data center created Friday morning at the track that operates through the end of the race on Sunday evening.

"We use SSDs because we want the win. I won't send anything to the race track that is not SSD," Joe Gibbs Racing's CTO Foley declared.

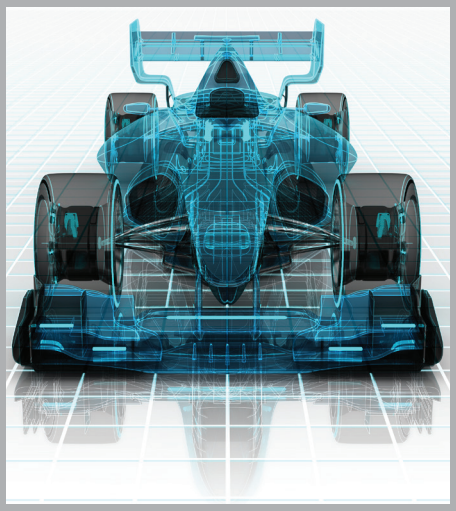
[8] http://fortune.com/2015/11/12/big-data-formula-1-championship-race/
[9] http://www.bloomberg.com/bw/articles/2014-10-02/mclaren-uses-racing-expertise-in-data-driven-consulting

cameras, engineers and mechanics will now be able to gauge tire temperatures during a lap to prevent them from overheating in corners and on the straights. Understanding temperature variations allows a team to set the cars up optimally for grip and tire life during a stint.[10]

Cars competing on the Formula E (electric car) racing circuit will be fitted with up to four on-board Vislink Gigawave HD cameras, which can be mounted in up to 10 different positions. These micro-sized units will be linked to a Gigawave H.264 on-board transmitter, which can also transmit on-board data and HD video and audio.[9]

Jim Foley of Joe Gibb Racing predicts, "We've seen a big boom related to pictures and video which presents its own challenges related to storage and data transfer. Cloud based technology is growing as well. There is only so much hardware we have space for on the trucks and in pit boxes, so as technology grows there is not room for our hardware footprint to grow. We have to manage that with cloud based services."

How Racecar Technologies Translate to Automotive Innovation



Mainstream auto manufacturers are now looking at how data is collected and used in the racing world and applying it to your standard sedan, SUV, or self-driving cars. Based on their smart phones, drivers are demanding an equivalent level of feature-rich dashboards and digital services, with digital business models dominating the automotive landscape.

Automotive and technological convergences, inevitably, find expression in the new digital lifestyle market. The street auto is evolving as quickly as the racecar. Research firm Gartner forecasts that by 2020, 70% of all auto-related customer interactions will be digital. Annual sales of cars with embedded telematics are expected to exceed 16 million units in 2015.[11]

Notably, McLaren is now in the consumer automotive business, designing and selling high-end cars. They're also consulting in the energy, healthcare and pharmaceutical sectors, leveraging everything they've learned supporting their core F1 teams.

For all the data generated by the car, the driver sees little of it. Data analytics haven't solved everything. There's still no way to get an accurate sense of where the cars are laterally on the track, and it's impossible to determine how well a tire is gripping the roadway. To put things in perspective, McLaren's Geoff McGrath, opines, " the driver is still the best sensor we have."[12]

[10] http://www.autoblog.com/2015/10/27/mercedes-wifi-tire-data/
[11] http://www.gsma.com/connectedliving/wp-content/uploads/2013/06/cl_ma_forecast_06_13.pdf
[12] http://fortune.com/2015/11/12/big-data-formula-1-championship-race/

NAND Flash Memory and SSDs

Speed matters in the data center as well. Jim Foley of Joe Gibbs Racing enjoys "the drive speed that comes with SSDs," adding, "Nobody waits on you in racing. We run 36 races back to back in a season … There might be tens of thousands of computational iterations we are running between those practice laps, so drive speed is very important."

In Conclusion: Winning with SSDs

When you want to win something as important as a NASCAR or F1 race, your operational efficiencies matter as much as the power of the car or the talents of the driver. When the margin of victory is less than two seconds, and there are still 30 cars running with you on the lead lap after 500 miles of racing, you need the best possible data analysis and simulations to keep you in contention.

Speed, reliability and data security from NAND flash SSDs provide that edge. The advantages of racing technologies covered in this paper can also apply to the quieter environs of fixed corporate data center, and across any industry applications where milliseconds matter, where millimeters matter.

The world of digital content grows exponentially every day and SanDisk® is designing flash storage solutions so that your valued data is readily available and reliable, even in the most challenging environments. SanDisk solid state drives offer energy-efficient, compact and durable alternatives to traditional hard disk drives for desktops, laptops and ultra-thin PCs.