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Thermal Focus: IT

Thermal challenges and trends in IT equipment

Introduction

In recent years, Future Facilities has commissioned industry-wide research reports exploring the specific processes of thermal analysis being used by design engineers and their experiences in delivering safe, powerful and reliable products and devices.

In our 2017 report, **The Heat is On**, we canvassed the opinions of design engineers to find out their views on the need for thermal simulation in design. The following year, our **The State of Thermal** report offered a deep-dive into the views of thermal professionals and the evolution of computational fluid dynamics (CFD) and simulation tools.

Now in 2019, our Thermal Focus report series will bring together design engineers and thermal professionals across all sectors, discussing their top trends and challenges for the year ahead. In this first report, we explore the views of nine leading thermal professionals, academics and engineers currently working in the IT equipment space.

Who should read this report?

- **Electronics and design engineers** working in the IT space
- **IT and data center** professionals
- **Thermal engineers** working on IT hardware and devices
- **Thermal engineering** experts

The Experts

To inform this report, 6SigmaET hosted a roundtable event, bringing together thermal engineering experts from some of the world's most prestigious companies, universities and industry publications.

ECN Magazine
Jennifer DeLaOsa
Associate Editor

6SigmaET
Chris Aldham
Product Manager

Facebook
Saket Karaiqikar
Senior Thermal Engineer

HP Enterprise
Ernesto Ferrer
Senior Thermal Engineer

Binghamton University
Prof. Baghat Sammakia
Prof Mechanical Engineering

Engineered Fluids
Gary Testa
President & CEO

QuantaCool
Steve Schon
Chief Technology Officer

CommScope
Tom Craft
Director of Engineering

Vertiv
Jason Matteson
Senior Solutions Architect

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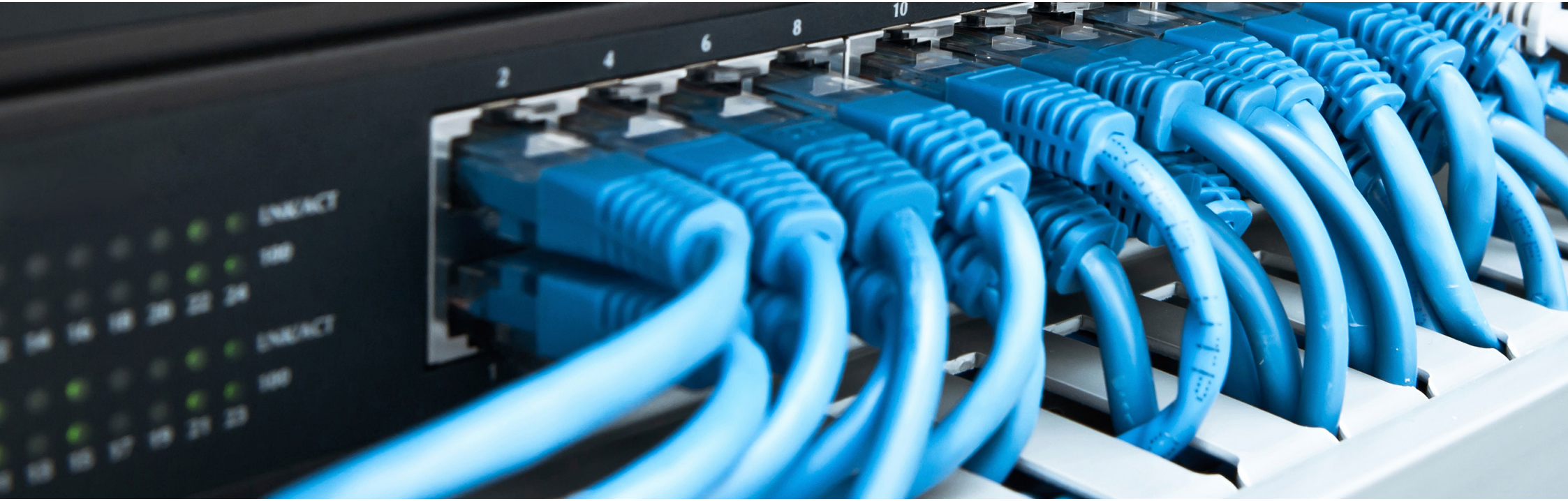
Industry Trends for 2019

Our experts recognize that the electronics space is evolving at an unprecedented pace, with the IT and datacenter sector proving no exception. As a whole host of new technologies and trends has redefined consumer and enterprise-level expectations, the potential for thermal complications has never been higher. Finding themselves on the frontline of these changes, our experts identified their top technology trends and challenges that they expect to face for the year ahead.



The Changing Nature of Electronics

Over the last decade, changing expectations in the enterprise have driven unprecedented developments in electronics and IT equipment. From the rise of cloud computing to the demand for remote and flexible working, new technologies and working practices mean that electronics must be more compact, more robust, and ultimately, more powerful than ever before.

According to our expert panel, the result of this trend is that optimum power, temperature and performance have become even more difficult to attain. The challenge for design engineers is to place powerful components into compact chassis without compromising reliability, usability or longevity. With more power, however, comes more heat. Given this fact, the key focus for engineers in 2019 will be figuring out how best to keep their designs cool.

Those in our panel also commented that many manufacturers are not able to predict, with any degree of certainty, the actual power consumption and operating environment, including temperature limits of a final product. As a result, engineers have to consider the history of the device, or similar devices, and ensure that the cooling is suitable for multiple configurations.

This means that engineers have to design as far beyond a product's launch date as possible, with thermal management and simulation playing an increasingly important role in reliable device operation and end of life aspects of the design.

What **our experts** say:

> "**Right now, the industry is very quickly trying to catch up** and figure out what's going to be the leading technology. Is it one solution or one technology, or multiple technologies?"
>
> **Jason Matteson**
> Vertiv

> "**Given how the electronics industry is changing,** we now have to start modeling simulations at least three or four years in advance."
>
> **Saket Karaiqikar**
> Facebook

Artificial Intelligence

Artificial Intelligence (AI) is set to shape a variety of future industry trends, from chip design to software. At chip level, AI is driving a race for new hardware, with manufacturers competing to develop products that can meet the evolving demands of the market. But in this fast-paced environment, there's a greater risk for thermal complexities to be overlooked.

From our panel, those working in the data center space are already seeing AI drive major changes in terms of data and storage. As both the amount and the complexity of data being analyzed and processed increases, data centers are being forced to adopt increasingly powerful servers and ever more complex cooling systems, such as liquid and immersion-cooled servers.

This change is also being driven by new processing hardware, with Nvidia DGX and Google's Tensor Processing Unit (TPU) being some of the first of their kind to demand liquid cooling in order to function within the data center.

What **our experts** say:

> "**AI is going to change things all the way from chip level to software.** It will cause a tremendous rise in the amount of data being processed and will drive tremendous storage demand."
>
> **Dr Baghat Sammakia**
> University of Binghamton

> "**Artificial intelligence caught the industry off guard.** Everybody was hedging their bets when it came to liquid cooling. They didn't invest. Now, where people were deploying 5kw on the data center floor, they're deploying 40kw. That's a huge change with a lot of thermal complications."
>
> **Jason Matteson**
> Vertiv

> "**AI is incredibly interesting,** because it's driving a tremendous amount of heat, primarily in the GPU space. That said, this only really applies to the machine learning phase. Once machine learning models are built, the actual deployment doesn't need nearly as powerful hardware."
>
> **Gary Testa**
> Engineered Fluids

The Internet of Things

Providing much of the data needed to inform artificial intelligence, the internet of things (IoT) will bring its own unique set of thermal challenges. IoT electronics will need to be incorporated into industrial environments, outdoor workspaces and even people's clothes. As such, they'll need to be powerful, light, portable and compact — a complex combination from a thermal perspective.

The key thermal challenge for the IoT identified by our panel was that of new and unexpected environments. Rather than being kept in fixed or managed settings, IoT devices will be out in the physical world, exposed to the elements. This development will mean exposure to an ever-growing range of temperature fluctuations and harsh environments, rendering many traditional cooling solutions obsolete.

To overcome this challenge, our experts proposed a combination of more advanced thermal modeling and simulation tools (capable of emulating atmospheric fluctuations), combined with newer thermal management techniques, such as full immersion cooling for devices in rugged conditions.

What **our experts** say:

> "**The IoT demands robust devices** that operate in harsh environments. This will drive thermal designs that have to operate under very high ambient temperature, high humidity, mixed temperature cycling, all of which will cause reliability issues. To achieve this, game-changing developments will be needed across the thermal industry."
>
> **Dr Baghat Sammakia**
> University of Binghamton

> "**What we're starting to see in the IoT space, particularly for outdoor deployed devices,** is the need not just for thermal management, but to physically protect devices. It's in these settings that immersion cooling will be essential, removing much of the need for 'active' components."
>
> **Gary Testa**
> Engineered Fluids

> "**Both AI and the IoT will drive innovative cooling solutions** in the future in order to meet changing thermal demands. Components and systems that were air-cooled will need to use ever more innovative cooling techniques – increasingly liquid cooling, hybrid cooling and full immersion cooling."
>
> **Ernesto Ferrer**
> HP Enterprise

Edge Computing

As the growth of the IoT and IoT devices gathers pace, edge computing will become critical to information management and the wider infrastructure of the new, interconnected world. The reason for this: edge computing allows data to be processed closer to the end user source of creation. When data is processed at the network's edge, as opposed to in the cloud or at an enterprise data center, it can be processed, analyzed and actioned faster to improve response times and the user experience.

The emergence and expansion of edge computing, however, raises the minimum requirements for operation, maintenance and uptime, which has led to a rethink on data center operations at the edge of the network. As with the IoT, moving data to the edge of the network means sophisticated IT equipment usually housed in expensive data centers is now out in the 'real world', bringing a host of environmental thermal considerations.

While our panel doesn't believe that edge computing will replace data centers, what is likely to happen is that we will see the creation of micro-data centers to support the IoT and other new technologies such as 5G.

What **our experts** say:

"**Edge computing** is definitely something that's driving our designs at Facebook. The question is, what thermal compromises need to be made in order to make it feasible? That's the discussion that needs to take place."

Saket Karaiqikar
Facebook

"**I do see the need for liquid cooling,** but I also see the extension of air. Edge computing will mean taking data centers in a telecom-centric direction; this will require a cross-over period between these two industries that tend to cool their systems in completely different ways."

Tom Craft
CommScope

"**We've talked about AI, IoT and Edge Computing today as if they're all different applications,** but in fact, what you've really got is a kind of mesh of all these things coming together."

Gary Testa
Engineered Fluids

Design Priorities for 2019

Driven by innovations in AI, the IoT, 5G and edge computing, there are a number of design priorities for thermal engineers to consider in 2019. With the industry rapidly looking to adopt these new technologies, thermal engineers must decide what tools and design techniques to prioritize in order to ensure the most reliable products and to stay one step ahead of the competition. Here are the top priorities from our panel of experts in 2019.

Our Experts' Priorities

Saket Karaiqikar
Senior Thermal Engineer
Facebook

"**Our key challenge in 2019** is to work out what's coming and to get a better understanding of where the industry is going in terms of storage, computing and networking. Once we know this, we can start to prepare our thermal management approach from both a hardware and a facilities perspective."

Steven Schon
Chief Technology Officer
QuantaCool

"**In 2019, we're focusing on hybrid cooling** as a top priority, bringing non-traditional cooling into an air-cooled environment. The idea would be to transition one rack at a time, and then transition into replumbing entire data centers with hybrid cooling in preparation for future processing and storage demands."

Gary Testa
CEO
Engineered Fluids

"**As a provider of immersive cooling technology,** for us it's really about going after the new 5G, edge computing and IoT markets – this is where we see real demand as a result of increasingly rugged environments. In the second half of 2019, we expect to see a growing focus on electric and battery cooling, but for now, the obvious demand will be in the edge and 5G space."

Our Experts' Priorities

Jason Matteson
Senior Solutions Architect
Vertiv

"**A lot of work is being done** within the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) right now around getting access to data from servers for remote monitoring and management – specifically around power cooling and other sensor technologies. As we witness this shift away from centralized data centers and towards edge computing, monitoring will be hugely important to ensure equipment is running reliably."

Baghat Sammakia
Professor of Mechanical Engineering
University of Binghamton

"**We're working very closely with 6SigmaET** in the aid of developing unique compact models for specific parts of the data centers. These will really just enhance the tool and make it more physics based. This would help us be more predictive and more accurate in looking at solutions from an energy perspective at the data center level."

Tom Craft
Director of Engineering
CommScope

"**5G will be key in 2019.** In earnest, we think there's a little way to go yet until 5G is ready for deployment at scale, but we are going to continue to work towards technology enablers for 5G. Currently, we are preparing for some trials of 5G deployments in early 2019."

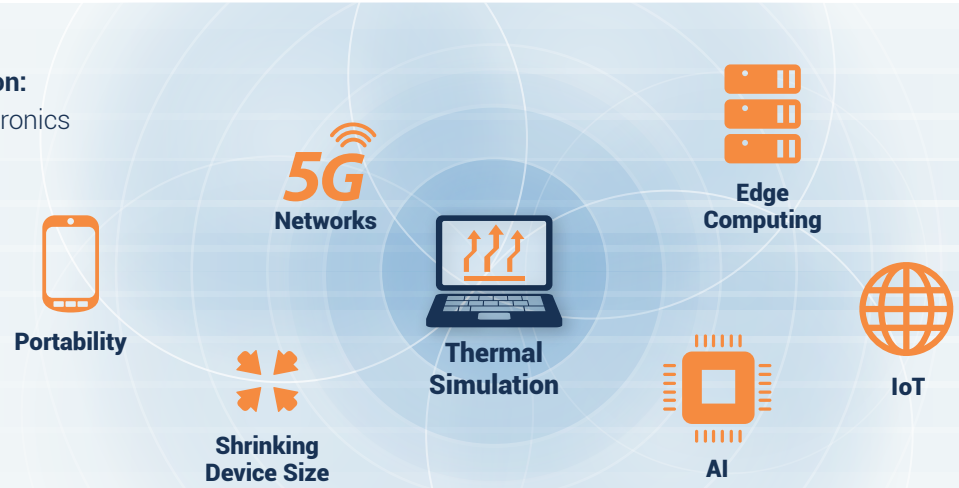
The Need for Thermal Simulation in IT

Our focus group revealed a wide variety of new technologies and trends currently facing those in the electronics IT industry. While these developments represent exciting new opportunities for designers and engineers, **they also pose major challenges – particularly when it comes to thermal design.**

With shrinking device sizes, greater portability and ever more powerful artificial intelligence, also comes increasingly difficult cooling conditions. Likewise, 5G, edge computing and the internet of things also bring ever more complex operating environments and fluctuating temperatures.

Faced with these new demands, design engineers need increasingly advanced thermal simulation tools that deliver accurate results on complicated design models in limited timeframes. Whether it's the simulation of heat within an electronic device or tackling the thermal properties of a data center, the onus is on design engineers to find solutions that can turn today's design trends into tomorrow's device realities. Thermal simulation tools that provide accurate, reliable insights into how products can be streamlined and improved will lie at the heart of this process. Whether it's developing the latest high-powered AI hardware, a 5G edge-base station or the next high-performance cloud computing solution, those that perfect and optimize their designs will be best placed to claim the market lead.

Thermal simulation:
The future of electronics



> "Everybody wants things at a lower cost with higher reliability. This puts more burden upon design engineers to find good solutions. Being able to find those solutions early on is going to be key in the future. And that's where simulation tools come in."
>
> **Saket Karaiqikar**
> Facebook

About 6SigmaET

This expert panel was commissioned by 6SigmaET, a leading provider of innovative thermal simulation solutions. The 6SigmaET platform has been identified as one of the fastest thermal simulation software suites in the electronics sector, using a combination of cloud solving, unstructured gridding and intelligent automation to generate thermal simulations in a fraction of the time of older, legacy platforms.

To find out more about how 6SigmaET can benefit your business, visit **http://www.6sigmaet.info**