# Rugged Small Form Factor Fan Cooled Computer

Intel Xeon E3-1515M "Skylake"

Nvidia Quadro P5000

210W Peak Power Draw

**275%** increase in available CPU power

**100%** increase in available GPU power

**ZERO** Frame Rate Drops

## About Our Partner

Our customer is a hardware design and manufacturing company that specialises in rugged, small form factor solutions. They have a nimble engineering team ready to engage in Custom Design when "off-the-shelf" is not the solution.

Our customer were identified as a leading candidate to develop a custom complete development environment for a unique rugged ground vehicle. With their extensive experience in GPU system development, and their capability to respond to custom challenges, they were considered ideal for this application.

Their task, directed by their customers' unique requirements, was to pack an extensive selection of processing functionality into a small robust frame, where **weight, noise and agility were considered key metrics**. To achieve these goals, our customer chose to create a product architecture around two powerful SOMs (System on Modules); the Intel Skylake Xeon E3-1515M, and the Nvidia P5000.

## Accepting Internal Challenges

Our customer knew they had a challenge on their hands to ensure they could achieve reliable performance for that power consumption in the environment necessary. While they have outstanding expertise developing functional solutions for commercial environments, they **identified quickly that this challenge had more unique thermal specialities and acted quickly** to ensure they could deliver on time.

Our customer identified that this dual processor system would push performance outside their current experience set, and that **testing by trial-and-error would severely impede their customers' delivery schedule**. A high accuracy simulation option would be the only method to advance development fast enough to keep up, combined with experienced thermal design handlers to ensure that the system design was to be reflective of the final product.

**Finding a partner who would be open throughout the design process,** and could confidently handle the task at hand, was essential for our customer. This would **allow them to prioritise their internal team to do what they do best** – develop world class industrial systems – and also **retain trust with their customer** as regular design meetings progressed.

entropy

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## Opening the Throttle (/Upping the Frequency)

Entropy were quickly identified as a partner who could provide high-end expertise and a communicative engineering team.

We were able to take on the existing design architecture and using our extensive component dataset, quickly complete **an initial evaluation of the current unit**.

The scale of the challenge was immediately clear as the final **solution needed to improve the theoretical thermal margin by almost 70°C,** whilst remaining quiet and reliable.

Entropy broke the issue down into six simple steps:

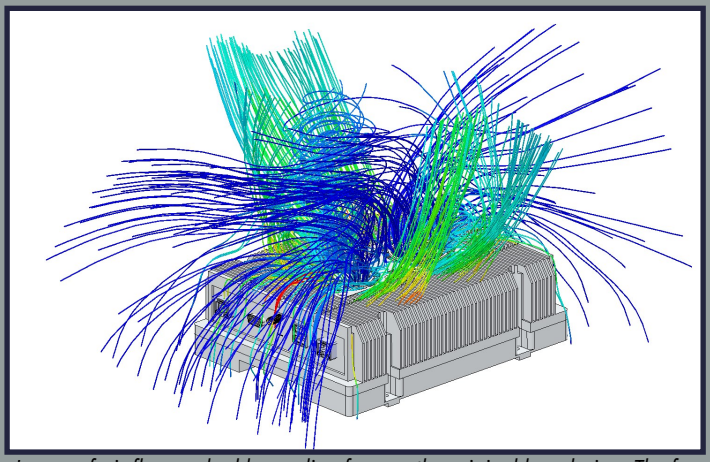


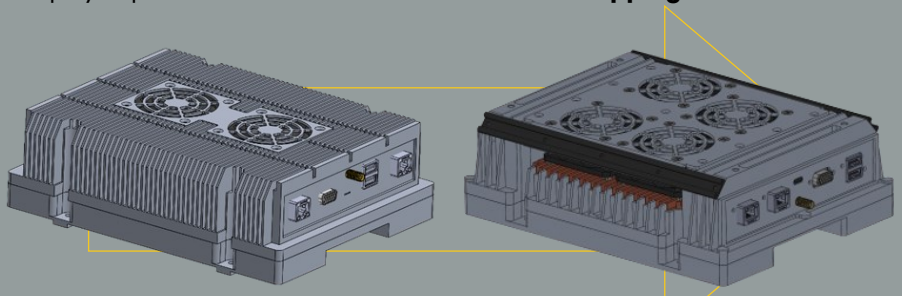
*Image of air flow pushed by cooling fans on the original box design. The fan position and fin design meant back pressure was extremely high. Most of the air did not contact the fins at all and was lost as a cooling resource.*

- **Target the Source** – improving thermal inefficiencies closer to the source of heat, where power densities are typically higher, can drastically reduce the cooling complexity downstream. Entropy addressed this by correct application of Thermal Interface Materials, Assembly Tolerance Stack-Ups, and Contact Pressure.
- **Establish a Physical Maximum** – identifying the maximum possible cooling potential of the existing system using a high accuracy simulation model gives a clear indication whether the design should be *evolution* or *revolution*.
- **Quantify the Customer Levers** – understanding the relative importance of each thermal design parameter allows any design decision to be *project driven*. Entropy held open conversations with both our customer and the end client to ensure critical factors were always held clearly in mind.
- **Fan Selection** – understanding the resistance of the system to passing airflow in detail allows optimal fan selection. The fan must operate within its stable region for the given system while also remaining quiet, protected against ingress (IPXX), low power & rugged.
- **Material Selection** – material selection is essential to ensuring heat is conducted to the largest surface area possible. The **Customer Levers** now advise whether mass, cost or assembly complexity – such as heat pipes – are driving factors.
- **Fin Optimisation** – getting fin geometry correct is essential to maximising the efficiency of a system. Too narrow can choke air flow, too wide will reduce surface area, while the wrong shape may prevent air entering or escaping the system entirely. Entropy designed the correct fin geometry considering individually which surfaces were exposed to moving air.

## A More Powerful System

Applying excellent engineering fundamentals with experienced design of rugged thermal solutions resulted in a **275% increase in available power from the Intel CPU** and a **100% increase in available power from the GPU**. This allowed our customer to **deliver some of the highest performing components ever integrated** in an environmentally hardened system. Operating at full frequency ensured our customer's client could deploy a product which had **zero frame rate dropping** even at +45°C ambient temperatures.

Entropy's professional and open communication promise allowed our customer the comfort of **relinquishing the stress of design anxiety**, allowing them to **focus their available resource** on high quality packaging design while we prepared and hosted thermal design reviews with the end client.



*The development of the unit as a result of thermal design enhancements shows greater overall ruggedness, improved fan cooling, optimal fin spacing for both ambient surfaces and fan blown, and appropriate material consideration.*

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