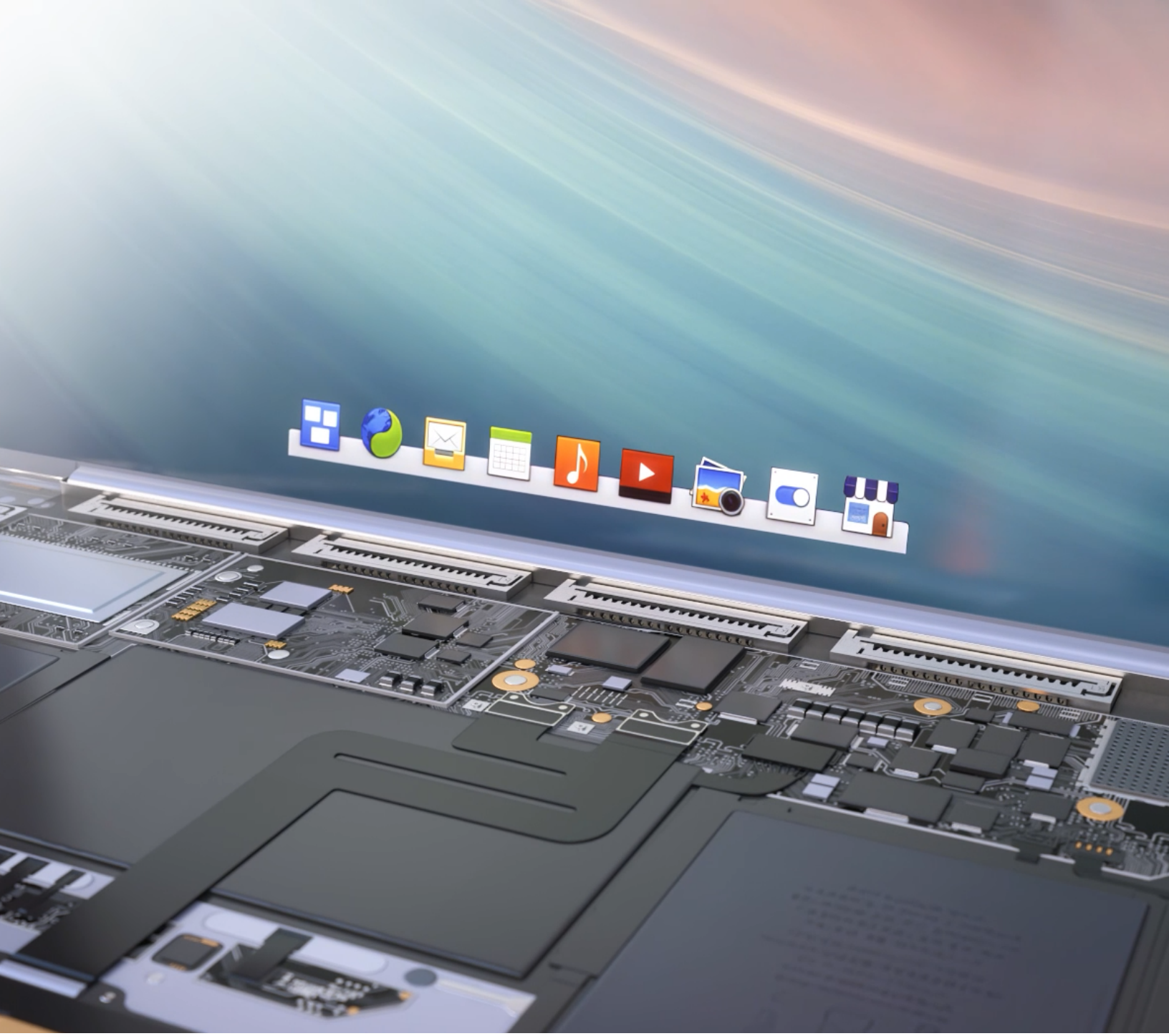

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Silent Performance for AI and Gaming Laptops:

A Breakthrough in 100W-Class Thermal Management

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Executive Summary

AI and gaming laptops push the boundaries of thermal performance, combining high-powered CPUs, GPUs, and NPUs in compact, portable chassis. These systems can exceed 100W of combined system power under load—typically requiring bulky cooling systems that generate significant fan noise.

This paper introduces how the ICE9™ silent thermal management system—powered by Ventiva's Ionic Cooling Engine (ICE®) technology—enables breakthrough acoustic and thermal performance for gaming laptops. By making use of modular, silent ionic air movers rather than conventional fans, the ICE9 system offers a compact, high-efficiency solution that maintains whisper-quiet acoustics even under full load—without sacrificing performance or portability.

Introduction

Modern high-performance laptops deliver desktop-class performance in thin, mobile form factors. However, this leap in performance brings significant challenges in thermal management. Gamers and professionals often cite fan noise, heat buildup, and system throttling as key frustrations. Traditional fan-based systems, while effective in raw airflow, generate a disproportionate amount of acoustic noise which becomes even more pronounced under sustained CPU and GPU loads.

These high-performance laptops commonly reach or exceed 100W of system TDP during gameplay or AI workloads. Managing such sustained heat in a portable chassis without noise has been an unthinkable feat until now.

Enter the ICE9 thermal management system, a silent, compact, and modular cooling solution that replaces fans with cutting-edge ionic air propulsion.

In gaming, sound is a critical part of gameplay. The roar of a cooling fan can mask important in-game audio cues like footsteps, environmental sounds, or enemy actions. This makes fan noise not only an annoyance but a real distraction that can impact gaming performance. Moreover, no professional user wants the constant roar of a fan in the background each time they try to leverage a tool like Microsoft Copilot, loudly chipping away at their productivity gains. Silent cooling, therefore, goes far beyond comfort and is a real competitive advantage.

Silent Cooling for High-Power Laptops

Ventiva's patented ICE technology uses electrohydrodynamic (EHD) flow to silently move air. It creates a high-voltage electric field between electrodes to generate ionized airflow, eliminating the need for mechanical fans. These solid-state devices produce consistent, directional airflow without moving parts during operation, resulting in zero noise and vibration.
For AI and gaming laptops, Ventiva has developed an enhanced ICE9 configuration

capable of cooling systems up to 100W or more, addressing both CPU, GPU, and NPU hotspots. The solution includes:

- Multiple ICE9 units arranged to cool discrete thermal zones
- Software-controlled power management using existing PWM fan signals
- Modular integration into existing laptop form factors
- Compact footprint, freeing up internal space for larger batteries or GPU cooling pipes

This approach enables cooler surfaces, longer sustained performance, and drastically reduced fan noise – often the loudest component during gameplay.

Key Benefits for Gaming Laptop OEMs and Users

- **Silent Operation:** Even under full GPU, CPU, and NPU load, the ICE9 system emits no noise.
- **Compact and Modular:** ICE9 devices are up to 80% smaller than fans, allowing more space for a battery or higher functionality designs.
- **Thermal Zoning:** Modular cooling allows for independent CPU and GPU heat path optimization.
- **PWM-Compatibility:** Seamlessly integrates into existing thermal control systems.
- **User Comfort:** Reduced system vibration, cooler touch temperatures, and lower acoustic fatigue during long gaming sessions.

Integration of Heat Pipe-Based Thermal Modules

Gaming and professional laptops demand cooling solutions capable of handling high thermal loads from any combination of CPU, GPU, and NPU activity. A core part of Ventiva's solution involves using heat pipe or vapor chamber-based thermal modules in conjunction with ICE9 devices. These heat transfer elements rapidly transport heat from hotspots to fin stacks designed for optimizing air flow while minimizing pressure drop. The ICE9 devices silently direct airflow through these fins, enhancing heat exchange.

The improved modular setup enables efficient thermal zoning, allowing the ICE9 system to respond to gaming load dynamics with precision, maintaining silence and performance even during intense gameplay.

Direct Air Inlet Design

To optimize ICE9 performance, the laptop cover incorporates a dedicated air inlet at the bottom of the chassis. This inlet allows ambient air to enter directly into the cooling zone, bypassing preheated internal air and improving thermal performance. Careful engineering ensures unimpeded laminar flow while maintaining the mechanical strength of the chassis. In high-performance systems where heat spikes are expected, this direct inlet design plays a crucial role in sustaining cooling capacity during peak gaming conditions.

Thermal Modeling

Thermal modeling was performed on a 16-inch gaming laptop with exemplar high-power CPU and GPU modules. The modeled system simulated a 70W TDP across CPU and GPU zones with convection from multiple ICE9 devices. Heat transport was facilitated by heat pipes and fin stacks designed for high flow-through efficiency. Simulations were conducted with an ambient temperature of 25°C to evaluate worst-case scenarios during gaming or demanding AI sessions. Flow patterns and thermal module temperatures are shown in Figure 1. The thermal stack included:

- Two heat pipes for the GPU and one heat pipe for the CPU
- Optimized copper fin stacks with separate flow paths
- Four independently controlled zones of ICE9 devices
- Direct air inlet at the bottom panel
- High-performance TIM (5 W/m·K)

Results demonstrate that the junction temperatures of both CPU and GPU remained below 75°C under sustained gaming loads with total airflow exceeding 4 CFM.

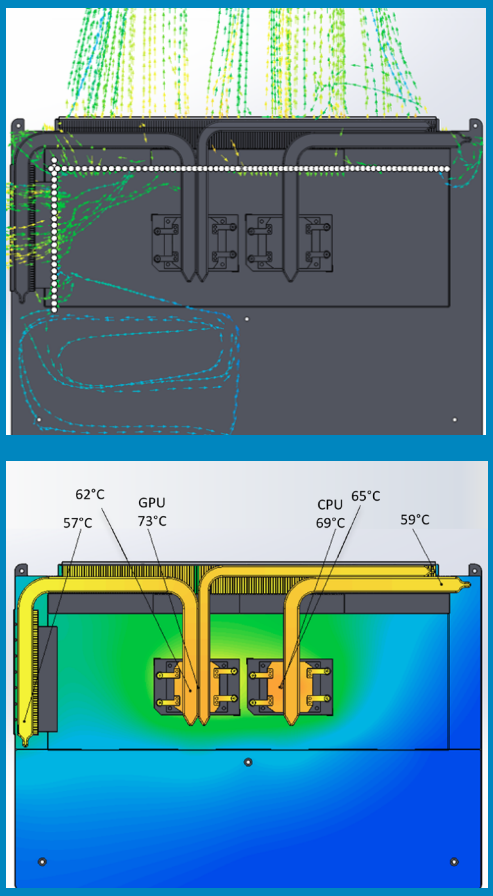

Figure 1. Thermal modeling results at 70W total system power

Experimental Validation

To validate the simulation, Ventiva assembled a physical thermal test vehicle using a 3D-printed gaming laptop shell and integrated ICE9 cooling system. The CPU and GPU heat sources were emulated using thin-film heaters. Two additional peripheral heaters were used to simulate other power sources (e.g., memory, radios, voltage regulators, and SSD). The layout of the system is shown in Figure 2. Different colors highlight the ICE9 and power supply units that comprise the four individually controlled cooling zones.

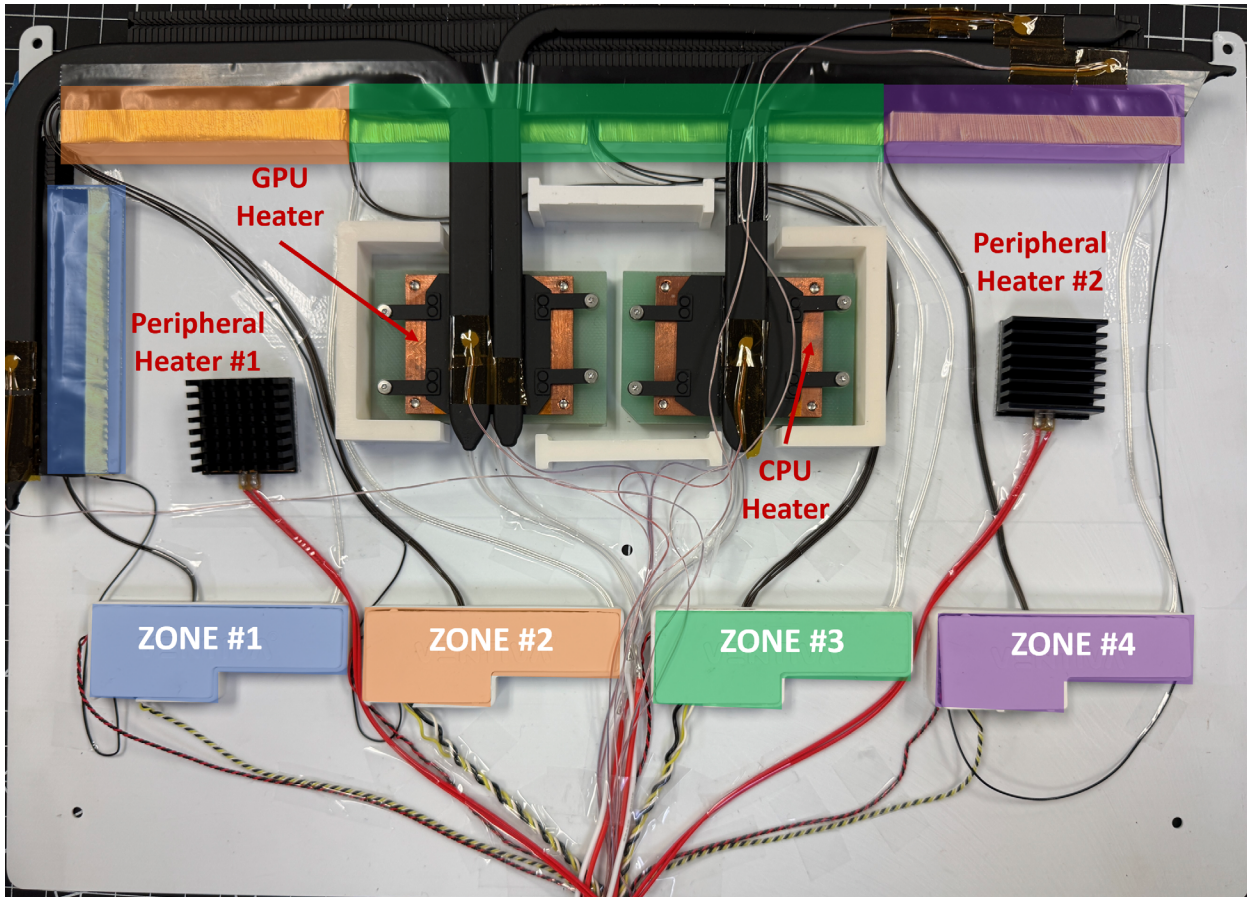

Figure 2. Layout of physical thermal test vehicle

The pressure and flow characteristics for the thermal test vehicle are shown in Figure 3. Q_{max} and P_{max} are 8.6 CFM and 10 Pa, respectively. The operating point flow was measured at 6.1 CFM.

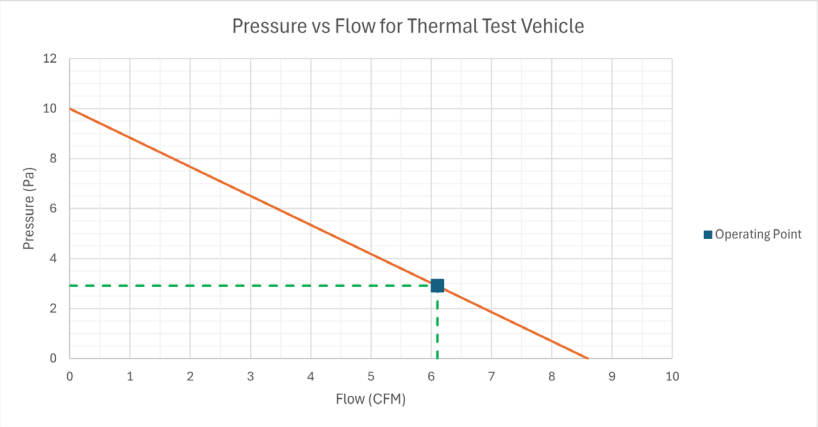

Figure 3. Pressure and flow characteristics for the thermal test vehicle

Temperatures were measured using thermocouples in a natural convection chamber set to 25°C.

Powers of the GPU, CPU, and peripheral heaters were varied according to Table 1.

Total System Power (W)	GPU Heater Power (W)	CPU Heater Power (W)	Peripheral Heaters Power (W)
70	45	25	0
80	50	30	0
90	55	35	0
100	55	35	10

Table 1. Thermal test vehicle power settings

The curves in Figure 4 show the CPU, GPU, and skin temperatures of the thermal test vehicle at each of the listed power conditions.

Under 70W system power test conditions, measured GPU and CPU temperatures were within 5°C of the thermal modeling results. **At a 100W system power load, the ICE9 system maintained CPU and GPU temperatures under 90°C, proving the effectiveness of the silent cooling design**.

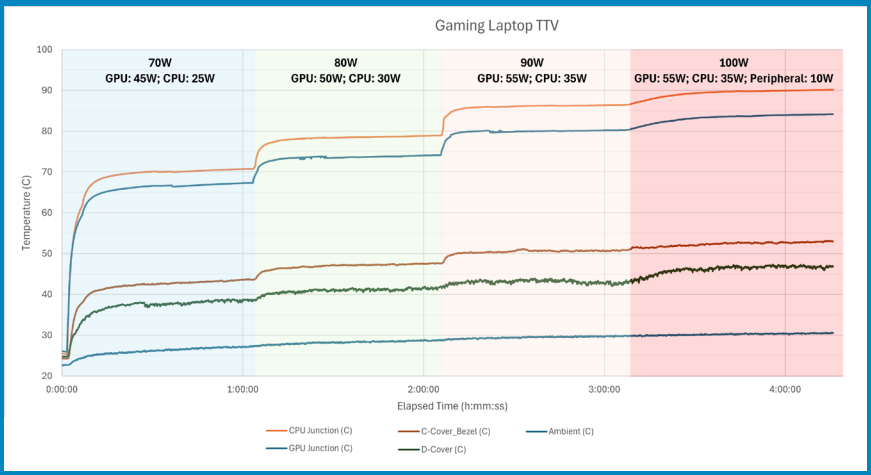

Figure 4. Measured temperatures on the thermal test vehicle at various system powers

Conclusion

The Ventiva ICE9 thermal management system offers a transformative solution for high-performance AI-enabled and gaming laptops. By integrating silent air movers with traditional heat pipes and a direct air path, the solution enables powerful yet quiet systems that meet the demands of both serious gamers and serious professionals using the latest laptop-native AI tools. This design reduces reliance on bulky fans, eliminates acoustic noise, and creates opportunities for thinner chassis or larger batteries—all while preserving critical thermal headroom.

The modular approach ensures the ICE9 solution can scale with next-generation GPUs and CPUs, setting a new benchmark in silent gaming performance. With this advancement, Ventiva is proud to deliver silence that speaks volumes—from commanding victory on the gaming battlefield to commanding the room in the boardroom.

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