

The Importance of Smart Airflow Optimization Solutions in Data Center Equipment

Enterprise data center facilities can be tens of thousands of square feet filled with servers, routers, cables, and other equipment. Compute density and power in this hardware generates waste heat that has traditionally been managed with air cooling technology. Efficient and effective thermal management is critical to maintain optimal system performance, prevent damage to sensitive components, and achieve target energy efficiency standards.

To help data centers get the most out of their air cooling technology, smart airflow optimization technologies are designed to maximize the utilization of air in the system. [Fans](#) move air across printed circuit boards, processors, and other heat sources within the server. [Heat sinks](#) with thermal interface pads are attached to high heat sources, like processors, to optimize the transfer of heat from the

heat source to the air cooling system. Air cooled systems are generally high energy demand, so incremental improvements to existing designs that make air cooled systems more efficient and effective improve data center sustainability, decrease operating cost, and enhance compute performance. Air baffles are a design enhancing technology that helps data centers get the most out of their air cooled systems. They are lightweight, low profile, durable, electrically insulating custom components designed to redirect airflow in the server racks and cabinets to the most efficient and useful path through the system. They essentially direct airflow where it is needed and contain it from areas where it would be detrimental versus allowing active air to find its own path through the system. [Airflow optimization solutions](#) maximize thermal efficiency of air cooled technologies for data center systems.



Boyd has decades of extensive experience developing smart airflow optimization solutions for [enterprise data center applications](#). From air baffles and filters to air blockers, insulation, and custom gasket and sealing solutions, this whitepaper explores the various solutions Boyd develops to optimize airflow and how we enhance data center efficiency, sustainability, and performance.

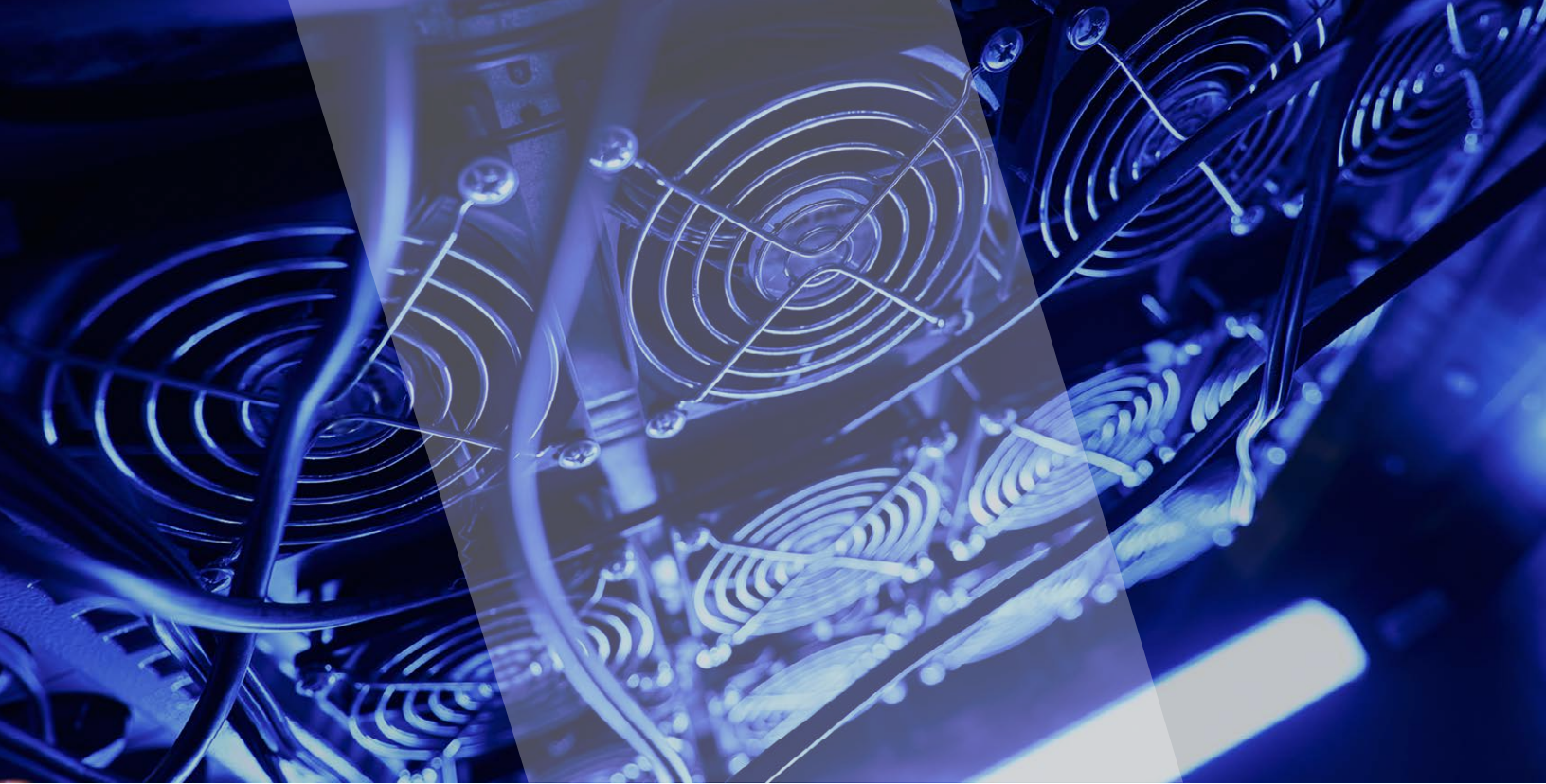
Air baffles

Circuit boards feature sensitive heat-generating components packed together in a small area. Air baffles not only redirect air within the system in the most efficient path possible to maximum use areas, but also protect or block sensitive components from detrimental system heat. Many data center servers feature electrically insulating materials, like polypropylene or polycarbonate, fabricated into baffles that are installed to facilitate airflow and also act as a dielectric barrier between internal electronics and the chassis. Air baffles both efficiently direct air to maximize thermal performance and also protect against electrical shorts.

One of the most common materials Boyd uses to create custom air baffles is FR (flame rated) V-0 or UL 94 V-0 grade polypropylene because of its inherent performance characteristics that make it flame resistant, durable, lightweight, and efficient to manufacture or fabricate. FR V-0 grade polypropylene is a plastic with a high dielectric constant so that it acts as an electrical insulator or blocker and can be in contact with electrical components without causing them to short out. Due to its flame resistant characteristics, it is also helpful as a heat barrier. This is advantageous in server racks where space is limited and components are packed tightly together. Metal partitions are electrically conductive and can spark if they come into contact with electrical components, so polypropylene is a high performance alternative to sheet metal baffles. FR V-0 grade polypropylene will melt if conditions are over 200 degrees Fahrenheit.

Boyd designs and fabricates custom polypropylene air baffle solutions in a variety of thicknesses depending on the rigidity that's required for a particular application. Baffles can be pre-formed to a desired shape using compression molding or supplied flat and scored or perforated for easy 3D assembly to create a custom geometry including tabs and Pressure Sensitive Adhesive (PSA) if required. Flat configurations optimize logistics and storage expenses as they pack efficiently and the solutions can then be quickly folded and formed into the custom designed 3D form during assembly. If tooling, product design, or other manufacturing conditions change, it's also very easy to redesign flat materials to a different configuration.

Higher temperature resistance materials, like FR V-0 grade polycarbonate, are also available as thermoformed air baffle insulators. This material's inherent characteristics require the air baffle to be heat formed to final application configuration and shape as it is less flexible than polypropylene. Pre-formed polycarbonate air baffles are ideal for higher temperature applications and optimized to accelerate assembly times.



Air blockers

Air blockers mitigate excessive air current in a certain area within a server rack or cabinet. They separate different areas within or between a server or rack. Server rack designers desire to block air for different reasons, including shielding sensitive components from hot exhaust air or blocking areas in a server design where hot or cool air may be trapped or become stagnant with no exit path, like an eddy. Sheet metal was traditionally used as an air blocker to control airflow between servers within a chassis, and in some cases is still used. But Boyd's air blockers are made from lightweight, low profile, durable, and rugged alternative materials that provide a wide variety of additional benefits for data center equipment OEMs.

FR V-0 grade polypropylene can be a lower cost component than sheet metal in most cases, provide a significant weight reduction, and function as an electric insulator. Reducing mass within a server helps improve energy efficiency and create additional available design space for more compute functionality. Being an electrical insulator,

polypropylene air blockers improve server safety and reliability, reducing the opportunity for spark voltage shorting.

Air blockers are also made from a variety of foam materials. Foam technologies provide additional value-add performance features like vibration absorption, acoustic damping, and thermal insulation. Lightweight, durable, high temperature and flame-resistant open cell foam air blockers, like Boyd's SOLIMIDE® polyimide foam, optimize air flow and prevent air eddies, reduce server noise, heat shield sensitive components, and act as flame barriers. Boyd's foam air blockers are fabricated using compression molding, thermoforming, and machining techniques.

Gaskets and sealing solutions

[Gaskets and seals](#) play a significant role in the effectiveness of smart airflow optimization systems. Enclosure seals, housing gaskets, port seals, environmental seals, and other bonding solutions designed for ingress protection are critical to protect sensitive internal components from contaminants, particles, and dust build-up associated with

air cooled technology that hinders system performance and may cause failures. Air cooled servers, by design, feature more enclosure ports and housing openings to accommodate intake and exhaust air. This creates additional opportunity for electromagnetic interference (EMI), making EMI shield gasket technologies critical to protect signal integrity and reliable performance. Reliably bonding components within server and rack assemblies is also vital to ensure baffles, blockers, gaskets, EMI shields, and other components remain securely in place for optimal performance and overall system durability. Precision gaskets manufactured with tight tolerance contain cool air within the server and rack assembly, reducing cool air system loss, maximizing energy efficiency, and protecting system performance.

Most gaskets and seals feature pressure-sensitive adhesive (PSA) to maximize assembly efficiency and boost sealing performance.

Boyd regularly evaluates, specifies, and converts PSAs like VHB tape, adhesive transfer tape and other double-sided PSA tapes. These flexible adhesives save space, are easier to work with than liquid adhesive, are lighter than mechanical fasteners, and aid in assembly efficiency. Replacing mechanical fasteners with PSA provides more flexibility when changing overall system design because it's easier to remove and redesign gaskets without having to modify the chassis. Our materials experts will recommend adhesives that can withstand data center environment temperatures and maintain adequate bond strength for the intended life of the product.

We laminate plastic, foam, adhesive, and other materials together to create complex, multifunctional solutions that offer the optimal performance characteristics from a variety of materials. Where foam or other elastomer or polymeric materials are used to create a seal on components that may be removed and reattached, such as access panels,



our experts will suggest materials that provide optimal compression set and reusable or permanent adhesives based on project requirements.

Common gasket materials include polyethylene, polystyrene, polypropylene, polyurethane, silicone rubber, natural rubber, neoprene rubber and other plastics and foams. Boyd experts guide material selection and gasket design based on environmental conditions, compressive force requirements, mating surface finishes, material compatibility, and ambient temperature to give you the best performing technology for your operating environment. Many data center applications specify silicone foam gaskets due to their conformability, high material compatibility, temperature and flame resistance, and versatility for a broad range of usage parameters.



Filters

Air cooled technologies require air intake, and the air is pulled from the ambient environment of the data center. Intake air needs to be filtered to remove contaminants. The primary purpose of an air filter is to prevent dust, dirt, and other debris from contaminating data center equipment.

An important consideration to smart, optimized air filter design is how fine the filter is and how aperture size balances effective filtering functionality and appropriate intake airflow volume. More porous filters allow more air to pass through to the air cooled system, but also pass through more contaminants, while finer filters catch more particulate matter but significantly restrict airflow. For example, using HEPA filter-type materials will reduce air flow significantly compared to filters made from less dense reticulated foam or similar materials.

A good balance between ingress protection needs and airflow volume is crucial to prevent data center systems from overheating and protecting their cleanliness for stable, reliable operation. Product developers need to consider fan size, optimal air intake volume, and other factors to determine final air filter design and material selection.

Boyd designs and manufactures custom air filters from a variety of materials optimized for filter functionality and air flow volume. Open-cell reticulated foams and mesh materials offer filtration performance from coarse (10 pores per inch (PPI)) foam filters to fine (100 PPI foams and beyond). Custom mesh air filters also double as a noise reduction solution to mitigate the sound of internal fans and improve the audible safety in the data center environment.

Working with the trusted experts

There are many strategies to cool components in enterprise data center applications. Many data center server and rack designers are looking to extend the performance of traditional air cooled systems. Heat sinks, [thermal interface materials](#), and fans certainly play a central role in managing heat, but to improve the efficiency and extend the performance of air cooled systems, engineers use smart technologies to optimize airflow technologies. The most efficient way to do that is to work with a partner that has the technology and expertise to deliver turnkey solutions that solve complex airflow challenges and streamline manufacturing operations.

Boyd is that partner.

Our team has a wealth of experience developing smart airflow optimization solutions for data center server and rack designers. From custom air baffles and blockers that optimize airflow direction and current to dual purpose shielding and insulating components to custom gaskets and seals, we develop solutions that solve airflow challenges to enhance air cooling technologies and improve energy efficiency. Our [converting capabilities](#), subassembly services, and other value-added

offerings boost manufacturing efficiency and shorten lead times to improve project success rates. Being a global [3M Preferred Converter](#) means we have priority access to premium 3M adhesives and other innovative materials.

By working with Boyd, manufacturers of data center equipment create innovative airflow optimization solutions that enhance server performance and improve environmental sustainability.

Ready to start your next project?

Contact Boyd today to leverage our technologies, data center heritage, and materials science expertise to help you improve airflow management in data center applications.

BOYD

Boyd is the trusted global innovator of sustainable solutions that make our customers' products better, safer, faster, and more reliable. Our innovative engineered materials and thermal solutions advance our customers' technology to maximize performance in 5G infrastructure and the world's most advanced data centers; enhance reliability and extend range for electric and autonomous vehicles; advance the accuracy of cutting-edge personal healthcare and diagnostic systems; enable performance-critical aircraft and defense technologies; and accelerate innovation in next-generation electronics and human-machine-interface. Core to Boyd's global manufacturing is a deep commitment to protect the environment with sustainable, scalable, lean, strategically located regional operations that reduce waste and minimize carbon footprint. We empower our employees, develop their potential, and inspire them to do the right things with integrity and accountability to champion our customers' success.

