MODULAR AND HIGH DENSITY COOLING

PREDICTABLE COOLING SOLUTIONS for an Unpredictable Environment

APC
Legendary Reliability®
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InfraStruXure™ from APC is an on demand architecture that allows the selection of standardized components to create a solution through modular and mobile configurations. This architecture fully integrates power, cooling, rack, management and services.

By utilizing APC Solutions and Resources, this award-winning, patent-pending approach provides increased availability, improved adaptability, and speed of deployment, as well as lower total cost of ownership (TCO) for all IT environments.

APC’s modular and high density cooling products are designed and tested to work as part of an InfraStruXure system. The modularity of these solutions enable scalability, simplified installation, and provide cost effective cooling to further increase the value of the InfraStruXure system.

A proper environment is extremely important for the underlying, physical foundation of an IT system that ensures business continuity. Also known as Network-Critical Physical Infrastructure (NCPI), this physical layer consists of power, cooling, racks, and physical structure, security and fire protection, cabling, as well as the management and servicing of these elements.

The cooling component of this physical layer must provide a predictable cooling architecture that increases the system availability and improves agility while lowering the TCO. APC’s InfraStruXure InRow cooling technology is the foundation for predictable cooling which provides an architecture that will enable existing and new data centers to evolve.
More Heat, Smaller Package

While the size of servers is shrinking, the amount of heat they generate is rising. The introduction of smaller servers and blade server technology is driving up the amount of heat removal required. The demand for blade servers is being driven by many factors such as space constraints, cable management requirements, quick deployment, scalability, and flexibility.

With space for data center deployment at a premium, more compact server solutions provides maximum utilization of available space. The ability to deploy more servers into an environment that could house far fewer traditional servers is a huge advantage to companies with limited space such as leased space or existing data centers.

Utilizing a shared chassis for many servers allows sharing of resources such as power supplies, network cables, floppy drives, and cooling fans. This simplifies both the deployment and management of server resources in a rack enclosure.

Since the need for computing power can change over time, the ability to deploy only the servers required with available slots for future deployment allows users the flexibility to scale computing power with ease as the demand increases.

Computing When You Need It

Power consumed by older server technologies varied only slightly with the demand on the processor. New technology allows for servers to consume less power when processing functions are not required to operate more efficiently with the demand.

Industries with a transactional based computing requirement can utilize this technology to handle the massive amounts of processing that is required in batch computing environments such as health care and banking.

All the power consumed by computing equipment in the data center is dissipated as heat. When the power consumption of computing equipment varies due to computational load, the heat output also varies. If equipment in one part of the data center suddenly increases its power consumption, this can create hot spots in the data center.

New Computers, Old Infrastructure

Most data center space is designed to have a useful life of 10-15 years depending on the business requirement. This lifespan can vary for redundant and backup sites, but the lifespan of the data center for most primary sites falls within this design parameter.

The useful life of most IT equipment that is deployed into these spaces is 2-4 years. This places a strain on the cooling infrastructure of the data center that must be able to accommodate the heat load profiles of the newer IT equipment as it is deployed. The cooling system must be able to scale and handle changes in heat densities with the deployment of more compact, dynamic computing and high power density IT equipment.
The Closets Are Heating Up

Advances in voice technologies and a movement to server based telephony are increasing the heat load and cooling requirements in wiring closets and small computer rooms. Voice Over IP (VOIP) and Power Over Ethernet (POE) are driving up the electrical demands, resulting in increased cooling requirements for these rooms that were not originally designed as IT spaces.

Legacy wiring closets, used to only house passive devices like patch panels and hubs, now need to accommodate these high power switches. To support IP phones and other powered devices, Power Source Equipment (PSE) capable LAN switches, that provide the ability to supply power over the data lines, are often used. PSE capable ethernet switches have larger cooling and airflow requirements. Today, it is not uncommon to see total power requirement in a typical wiring closet exceed 6 kW.

Comfort cooling for building systems is designed using a rule of thumb heat load calculation of approximately 4 to 5 watts/ft². This calculation is used to determine the total capacity requirement for a centralized or rooftop air conditioning system. This amount of cooling for telecom or networking equipment was sufficient to provide critical cooling. The advanced technology has driven the cooling requirement to loads up an order of magnitude of 40 watts/ft² and greater. Building air conditioning systems are not designed to handle heat loads of this density.

To compound the issue, wiring closets are typically very small rooms hidden in a remote location of the building with little or no ventilation. Even in situations where comfort cooling could provide some benefit, there is often no easy way to leverage it.
Raised Floor Cooling

There are many approaches used to cool today's data centers. The most common and widely used architecture is to deploy down flow computer room air conditioners (CRAC’s) around the perimeter of the data center. The CRAC units blow air into the raised floor, which serves as a common supply air plenum for the space. Perforated tiles are located on the raised floor to distribute air where needed.

While this approach has proven to be reliable in the past, today's IT trends are increasing heat densities far beyond the practical limits of raised floor cooling. High density servers are driving the need for new solutions and specialized data center designs. Even when following industry best practices for equipment layout, air distribution, and an oversized cooling system with extra capacity for redundancy, it is difficult to deal with the heat created by the latest IT technologies.

Equipment Layout

Arranging IT equipment to create a hot and cold aisle helps ensure that cold air from the raised floor is captured by IT equipment. This is called a hot/cold aisle arrangement. Perforated tiles are located in the common cold aisles to deliver cold air to the IT equipment. This enables IT equipment to ingest cold air from the raised floor while keeping the hot exhaust air away from IT equipment inlets.

Using the hot/cold aisle approach improved overall performance of the raised floor. However, as heat densities increase beyond 3 and 5 kW, mixing becomes an issue as the heat from the hot aisle is drawn into the inlet of the IT equipment. Also, the free return path of the hot air to the CRAC allows mixing to occur, creating unpredictable performance.
Typical perforated floor tiles used on a raised floor have 25% open area and provide between 300 and 500 CFM of air. This amount of air is acceptable when dealing with rack power of 2 to 3 kW per rack for standard IT equipment, and 4 to 5 kW per rack for Blade Server technology (shown in the above chart). To address hot spots in data centers many IT and facilities managers have turned to grate type floor tiles that will distribute between 700 and 900 CFM. These tiles will enable the rack operating in front of the tile to run as high as 5.75 kW per rack for standard IT equipment and 8 kW for Blade servers. However, the issue is that with today’s blade server technology, 8 kW per rack allows for the rack to be a third full. The rest of the space in the rack can not be utilized simply because there is not enough cooling available. Today’s blade server technology is driving densities up to 30 kW per rack when fully populated. This is far beyond the practical limits of what raised floor cooling can provide. Transitioning from 8 to 30 kW per rack would require a minimum of 3 grate type floor tiles to cool a single rack. Taking this approach would incur a significant increase in white space and total cost of ownership for the data center.

Oversizing and Redundancy

Because of air leakage and other inefficiencies of the raised floor, the cooling equipment is typically oversized by as much as three times as the heat generated by the IT equipment. Oversizing the cooling capacity typically gives IT and facilities managers a false sense of security.

While the equipment may be oversized, getting the extra capacity distributed evenly throughout the data center is difficult because of mixing and air distribution issues. Unit failures can upset the overall air distribution within the data center causing hot spots to occur. Even though the cooling load is oversized, redundancy has not been achieved due to the limitations of air distribution in the room. This makes it difficult, if not impossible, to effectively achieve redundancy.
APC’s In-Row Architecture

APC’s in-row architecture is the newest innovation in data center cooling technology. With this approach, cooling can be deployed in a predictable manner in any data center environment. Placing the unit in the row of racks moves the source of cooling closer to the heat load. This minimizes air mixing and provides a predictable cooling solution.

Failure Is Not An Option

As heat densities rise, predictable cooling becomes more critical. In today’s data centers, traditional cooling approaches involve complex air distribution systems that are unpredictable and leave many IT and facilities managers struggling to find solutions to cool new IT technologies being deployed. The capabilities of the latest IT technologies are being used in industries like medical and financial markets where failure is not an option. To ensure maximum uptime, industries like these are looking at in-row cooling to predictably cool the data center.

APC’s in-row architecture moves the source of cooling closer to the IT rack where heat is generated. This enables the unit to capture the hot air before it mixes with the room creating a predictable cooling solution.
Scalable for High Density

The predictable performance of the in-row architecture makes it well suited for high density applications. The focus on heat removal instead of cold air delivery is the key to making this approach scalable. Cooling units are added in the row of IT equipment as the demand for cooling arises.

The additional benefit of the in-row architecture is the ability to add either rack or aisle based containment systems. Containment further reduces any chance of hot and cold air streams mixing allowing the in-row cooling to be matched to the IT heat load. This enables the system to completely remove the heat before it ever has a chance to mix with the room.

With APC’s InfraStruXure InRow technology, data center cooling is no longer limited by the short comings of distributing cold air. By focusing on heat removal in-row architecture is limitless in its ability to meet the demands of growing heat densities.

Innovation Drives Evolution

Just as yesterday’s data centers were designed using down flow CRAC units on a raised floor, tomorrow’s data centers will be looking for new solutions to address the problems they face. APC’s InfraStruXure InRow technology is an innovative solution that will set new standards for data center cooling.

As new IT technologies are deployed in today’s data centers an evolution to in-row cooling can occur. The predictable nature of in-row cooling eliminates a lot of the one time engineering that happens with specialized air distribution systems. In-row cooling takes the guess work out of data center cooling making it easy to deploy in both new and existing data centers.
**InfraStruXure InRow SC**  
R-407C up to 7 kW  
**In-row predictable air conditioning for wiring closets and server rooms**
- Plug-and-Play installation to minimize deployment time and costs
- Network Manageable via Web, SNMP, and Telenet
- Automatic Restart in the event of a power outage
- Freeze up protection maximizes availability
- Dual ducted design increases cooling efficiency
- Condensate Pump and Duct Kit included

**InfraStruXure InRow RP**  
R-407C up to 40 kW  
Chilled water up to 60 kW  
**In-row precision air conditioning for medium to large data centers including high density applications**
- Humidity is managed through a self contained steam canister humidifier for maximum efficiency and ease of maintenance
- Modular design provides scalable solutions to add cooling as demand increases
- Variable speed fans reduce energy consumption during off-peak cooling periods
- Rack inlet control guarantees inlet temperature to IT equipment

**InfraStruXure InRow RC**  
Chilled water up to 30 kW  
**In-row air conditioning for medium to large data centers including high density applications**
- Draws power from UPS for power protection with dual feeds for redundancy
- Hot swappable fans allow unit to remain operational if a fan replacement is required
- Modular design provides scalable solutions to add cooling as demand increases
- Variable speed fans reduce energy consumption during off-peak cooling periods
- Rack inlet control guarantees inlet temperature to IT equipment
InfraStruXure Cooling Distribution Unit (CDU)

Chilled water up to 360 kW
Scalable to 12 InRow RC’s

Flexible chilled water distribution system for the InfraStruXure InRow RC

- Flexible piping allows quick deployment and startup
- Seamless piping minimizes the risk of fluid leaks in the data centers
- Allows isolation of cooling circuits for servicing
- Provides a central point for fluid balancing.

Rack Air Containment System (RACS)

Rack based containment system for high density designed to maximize in-row cooling predictability, capacity, and efficiency

- Increases InfraStruXure InRow cooling efficiency
- Allows for higher InfraStruXure InRow cooling capacity
- Increases cooling predictability within the IT environment
- Retrofittable to existing in-row and NetShelter SX rack installations
- Full containment version provides isolation for installed IT equipment from installation environment
- Full containment version reduces audible noise

Hot-Aisle Containment System (HACS)

Row based containment system for high density designed to maximize in-row cooling predictability, capacity, and efficiency

- Hot air containment eliminates hot spots by preventing hot air recirculation into sensitive IT equipment
- Scalable densities allows for higher density cooling to be achieved by integrating the Hot-Aisle Containment System with in-row architecture
- Scalable design allows for quick deployment of high density clusters and addresses changing needs and future expansion with pay-as-you grow architecture
Existing Data Center
Low Density
Initial buildout designed for 2-4 kW per rack. Raised floor architecture with perimeter cooling units.

Traditional Cooling
Room cooling units for low density applications utilizing a raised floor for air delivery.

Rack Air Containment System
Hot spot isolation for high and ultra high density racks. Allows for predictable cooling without impact to the room or row cooling system.

InfraStruXure Cooling Distribution Unit
Distributes chilled water to the InRow RC units using a flexible and jointless piping system. Piping can be added at any time for a scalable deployment.
Existing Data Center Expansion
Moderate to High Density
Rack deployment to an existing space utilizing in-row architecture for higher density requirement.

New Infrastructure Expansion
High to Ultra High Density
Space expansion separated from previous infrastructure. Use of in-row architecture and zone deployment of a hot aisle containment system for ultra high density.

InfraStruXure InRow RC
Provides predictable cooling in an in-row architecture. Can be deployed in existing or new data center space for medium to high density applications.

Hot Aisle Containment System
Zone deployment for ultra high density to eliminate mixing and increase predictability of the cooling system.

The Hybrid Environment
In both new or existing data center applications, APC provides a wide range of cooling products to address the heat load requirements. While the in-row cooling systems provide a highly predictable architecture, use of spot and zone cooling products allow for successful deployment into existing and new space including data center expansion.
Cooling Wiring Closets and Small Server Rooms

The InfrastruXure InRow SC provides dedicated cooling to IT loads in office environments. The cooling supplied by building air conditioning is not adequate to address the increased heat load requirements for critical equipment deployed into these areas. The focused cooling capacity provided in wiring closets and small computer rooms allows for continuous operation.

While office environmental controls fluctuate by season and off business hours, the InfraStruXure InRow SC maintains a constant temperature for sensitive electronic equipment vital to your business processes.

InfraStruXure InRow Capacities

InfraStruXure InRow cooling products come in a variety of sizes and are available for both chilled water and refrigerant based applications. The chart below represents the performance range for each of the products based on the application. The chart also shows how the unit capacity increases as a result of warmer return air temperatures that are achieved with hot aisle containment (HACS) and rack air containment systems (RACS). (See technical data manuals for performance criteria)
**Value Is The Key**

In today’s rapidly changing business world, companies must update the way they view the value of their investment in Network-Critical Physical Infrastructure (NCPI). NCPI is the foundation upon which IT and telecommunication networks reside.

To assess NCPI business value, three core considerations should be taken into account: Availability, Agility, and Total cost of ownership. The three considerations relate to value as follows:

\[ \text{Value} = \frac{\text{Availability} \times \text{Agility}}{\text{Total cost of ownership}} \]

Availability is dependent upon the reliability of the system and the time it takes to recover from a failure. Agility is the capability of the system to change or reconfigure, as well as the ability to reduce the speed of deployment and to be able to scale in size as needed for the business.

The in-row architecture increases the value of the NCPI by increasing availability and agility while reducing the total cost of ownership.

**Increased Availability**

In-row architecture increases reliability by predictably cooling the data center, eliminating hot spots and failures that can be caused by thermal stresses on sensitive IT hardware.

The reliability of the architecture also depends on the redundancy built into the system. The predictable behavior of the in-row architecture allows to effectively have N+1 cooling redundancy in the system.

Mean Time To Recover (MTTR) after a failure also plays an important role in the systems availability. APC’s InfraStruXure InRow cooling products can be easily rolled-out from the row without disturbing any cabling or racks. This reduces data center down time when repairs are required. The average time it takes to completely replace an InfraStruXure InRow cooling unit is 60 minutes with proper chilled water and refrigerant piping installation.

Failed unit on in-row architecture with N+1 redundancy. Hot spots are not created at the rack inlet.
Increased Agility

Speed of deployment is significantly increased with in-row cooling. The units do not require floorstands or specialized structures to be installed, and in-row units can be easily deployed in any data center environment. The InfraStruXure InRow cooling units do not require any special rigging or hoisting equipment to move them into the data center. The units can be simply off loaded and rolled into place like any other IT rack.

Speed of Deployment Savings With In-Row

In-row cooling cuts the amount of time it takes to deploy cooling to a 200 kW data center by as much as 50%. This is achieved because of the overall improvement in space utilization and ease of installation of the in-row architecture as shown in the table below.

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<th>In-Row Architecture</th>
<th>Traditional Cooling Solution</th>
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<tr>
<td>Power Installed</td>
<td>200 kW</td>
<td>200 kW</td>
</tr>
<tr>
<td>Total of Racks</td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>Capacity per Rack</td>
<td>16 kW</td>
<td>10 kW</td>
</tr>
<tr>
<td>Watts/square foot</td>
<td>289</td>
<td>110</td>
</tr>
<tr>
<td>Total construction and Installation Time (weeks)</td>
<td>10</td>
<td>19</td>
</tr>
<tr>
<td>Increased Speed of deployment</td>
<td><strong>47%</strong></td>
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Ease of Installation
Since a raised floor is not required for in-row cooling to work properly, the time required for the installation of the raised floor and equipment floor stands is saved. This also eliminates the time required for rigging and handling of large CRAC units. InfraStruXure InRow cooling units are easily installed in the row.

Improved Space Utilization
The high density capability of in-row architecture allows more high density IT equipment to be loaded into each rack. This reduces the total number of racks that would need to be deployed, and decreases the time it takes to complete the buildout of the data center.

The system modularity and the capabilities to be reconfigured allow the creation of a standardized approach with different density zones depending on the data center requirements. If a zone increases density, the system can be scaled by adding cooling units or a hot aisle containment into the rows without the need to add raised floor, tiles, floorstands or special accessories.
Reduced Total cost of ownership

The Total Cost of Ownership is not simply the initial investment of Network Critical Physical Infrastructure but includes all other costs associated with operating and maintaining that investment for its life. In a traditional system approach the initial investment is higher due to the larger area required and the raised floor cost. Also, in a traditional system, cooling represents about 40% of the electrical operating expense for the data center.

In-row architecture reduces the initial investment by rightsizing to the actual load, not having a one-time-engineered expense, no raised-floor requirement, and due to the system efficiency, the electrical operating costs are significantly reduced.

An in-row solution represents an initial cost savings from 15 to 45%. As the density of the data center increases, the initial cost savings increase too.

In-row architecture reduces at least 25% of the data center space that would be required for a traditional system. Space savings are achieved with in-row cooling by increasing the heat density in each IT rack. This reduces the overall number of racks needed in the data center.

The major impact on the Total Cost of Ownership savings is reflected with the electrical operational savings, where the larger the load, the greater the savings.
The focus of creating and maintaining highly valuable networks has shifted to the physical infrastructure, the foundation upon which critical processes and applications depend. In order to optimize the performance of this physical layer, proper management is imperative. If you do not have visibility and control over Network-Critical Physical Infrastructure (NCPI), you are blind to the layer upon which your network depends.

Management and environmental monitoring serve as the critical first line of defense against downtime. Intelligent network managed devices and software drastically reduce Mean Time To Recovery (MTTR) by providing notification, visualization, and management. MTTR includes the time it takes to understand where a problem lies within the NCPI and to quickly correct it.

Key concerns of a new management solution include the cost of deployment and training as well as maintenance, service, support, and consulting fees. An efficient management solution should also support industry standards, provide flexibility and ease of modification, and adapt to the changing management needs. In addition, such a solution should improve the current system by increasing resource efficiency and overall system functionality.

Whether managing a single device, multiple devices, or a mixture of device types, APC management solutions are easy to use and deploy. The solutions work together and independently, allowing you to monitor devices locally over existing IT networks or the Web, and to be notified of problems within the system via email or pager gateway notifications. They provide information on issues affecting system availability, reduce the burden of system management and adapt to changing business needs.

**Recommended Actions**
Reduces training, eases deployment, and speeds troubleshooting

**Notification Groups**
Ensure the right people receive warnings

**Browser Accessible**
Quick access from anywhere on the network

**Incident Management Module**
Notification and event analysis for managing network-critical physical infrastructure

**Device Status Summary**
Red: Urgent
Yellow: Attention
Green: Normal
SERVICES

In the complex world of today’s data center, APC’s service philosophy remains simple: by maximizing system availability, we ensure maximum customer satisfaction. In fact, APC Global Service (AGS) exceeds the industry standards for efficiency, adaptability, and speed of response.

Building upon APC’s advanced product engineering and predictive management software, AGS prevents problems throughout the life cycle of the data center, with services such as planning and installation, remote monitoring, and preventative maintenance. Staying a step ahead of industry trends and requirements, AGS supports your investment from the time of product purchase throughout the life of the hardware.

Our adherence to a rapid escalation of response policy and a defect correction and avoidance process ensures both customer satisfaction and continual system improvement. When you purchase from APC, you benefit from APC’s active research and development program, as well as from a group of highly trained experts committed to maximizing and maintaining your system availability.

Installation
A set of service options designed to deliver the vital resources, expertise, and tools needed to quickly and efficiently implement your APC solution

- Logistics coordination
- Equipment positioning
- Physical assembly
- Installation verification
- 7 x 24 upgrade option

Preventative Maintenance
An examination of your system ensures optimal performance

- System cleaning
- Environmental inspection
- Functional verification
- Consumables replacement
- Corrective maintenance
- Free firmware upgrades
- Logistics coordination
- 7 x 24 upgrade option

Start Up
An APC Certified Field Service Engineer will verify all connections within the system have been made according to factory specification, and that it is functioning correctly in all modes of operation, ensuring optimal performance and extending the life of the product

- Functional and installation verification
- APC solution operational training

Extended Warranty
An extension of coverage beyond the original factory warranty

- Free overnight shipping
- 7 x 24 telephone technical support
- Parts included

Remote Monitoring
Expert outsourced monitoring via APC’s InfraStruXure Manager

- On-demand trending reports
- Online alarms/events reports
- Environmental monitor and alarm notification

Project Management
A service designed to help you complete your projects on time and within budget

- Industry experienced project professionals
- Single point of contact
- Written summary report

Needs Assessment
A site survey that supplies you with the information necessary to design your facilities for optimal performance

- Industry experienced project professionals
- Customized report
- Environmental inspection

Network Integration
The assistance you need to transition from your existing solution to your new APC solution

- APC certified software engineer
- 7 x 24 off-hours service scheduling