IBM FlashSystem 9200R Rack Solution Product Guide

Matt Smith
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The FlashSystem 9200 combines the performance of flash and end-to-end Non-Volatile Memory Express (NVMe) with the reliability and innovation of IBM® FlashCore technology, the ultra-low latency of Storage Class Memory (SCM), the rich features of IBM Spectrum® Virtualize and AI predictive storage management and proactive support by Storage Insights— all in a powerful 2U enterprise-class, blazing fast storage all-flash array.

The FlashSystem 9200 is adequately documented in many places including the IBM FlashSystem 9200 Product Guide and IBM Spectrum Virtualize FAQ. It is suggested that you familiarise yourself with the FlashSystem 9200 before reading this document.

Scale Up and Scale Out

IBM Spectrum Virtualize technology allows the FlashSystem 9200 to both scale up (add more capacity) and scale out (linearly scale performance, connectivity and capacity) to create a much larger system for customers who want to grow big or consolidate their workloads.

For the FlashSystem 9200, scale up is achieved by adding FlashSystem 9000 expansion enclosures to the controller enclosures. Two models are offered - a AFF which is a 2U 24 drive system, and a A9F which is a 5U 92 drive system. Both enclosure models support SSD drives up to 15.36 TB in size.

Scale out is achieved through clustering. This is taking two, three or four model AG8 controller enclosures and clustering them together to operate as a single system with a single point of control. Each controller enclosure is effectively operating in an active-active node pair, (known as an IO group) where write cache is mirrored across both nodes for redundancy. These node pairs come together to operate as a single system with the ability to move workloads between IO groups to manage performance and balance workloads.

Each model AG8 controller enclosure supports 24 NVMe drives, up to 38.4 TB in size, with further capacity possible via hardware compression. Each controller enclosure has dedicated CPU, ports and cache to serve that storage. Therefore, if you cluster controller enclosures together you can scale the performance, connectivity and capacity linearly, and expect 2, 3 and 4 times the capability of a single model AG8.
FlashSystem 9200R Overview

The FlashSystem 9200R provides a way of ordering a clustered FlashSystem 9200 with a dedicated Fibre Channel network and optional expansion enclosures, delivered ready-assembled in a rack.

The FlashSystem 9200R can be ordered with 2, 3 or 4 FlashSystem 9200 model AG8 controller enclosures. These different configurations are referred to as IBM FlashSystem® 9202R, IBM FlashSystem 9203R and IBM Flashsystem 9204R, with the last number denoting the number of AG8 controller enclosures in the rack.

Each rack will feature a pair of 32Gb Fibre Channel switches with all ports enabled. This allows a dedicated, redundant Fibre Channel network to be created to allow inter-cluster traffic to flow between the canisters in the AG8 controller enclosures. By having this dedicated network, cluster traffic will be prevented from interfering with either host or copy service traffic and will provide reliable, consistent communications.

For customers wanting extra storage, a single 2U 24 drive model AFF or 5U 92 drive model A9F expansion enclosure can be added to each model AG8. To allow the expansion to be attached to the model AG8, a 12Gb SAS card is required in one of the IO card slots, reducing the number of slots available for host and clustering connectivity.

Compatibility

Although the FlashSystem 9200R is a separately orderable product, it remains equivalent to a clustered FlashSystem 9200.

This means that all the functionality available through Spectrum Virtualize (such as data reduction, copy services, DRAID, etc) is available in the FlashSystem 9200R. Indeed, the GUI will show the system as a clustered FlashSystem 9200.

The FlashSystem 9200R has the same licensing scheme as the FlashSystem 9200. This means all-inclusive licensing for all functions except encryption - which is a country limited feature code, and external virtualization.

The configuration rules and best practices associated with the FlashSystem 9200 are also the same. There are obviously some additional considerations when using clustered FlashSystem products, but these don't differ when the FlashSystem 9200 is supplied in FlashSystem 9200R rack form. Any limitations (such as number of volumes, number of RC partnerships, etc) also match the limitations stated for the FlashSystem 9200.

Interoperability is the same as the FlashSystem 9200, and should be referenced as a FlashSystem 9200 in the IBM System Storage Interoperability Center.

Capabilities

When purchasing any FlashSystem product, it's important to understand the workload requirements and the suitability of the product to meet those requirements. The FlashSystem Family Overview FAQ discusses how you might do this.

However, to illustrate the difference between a single FlashSystem 9200, and clustered (or racked) FlashSystem 9200s, Figure 1 shows some high level comparisons. The capacity
shows just the NVMe capacity in the controller enclosure, with further capacity possible via expansion enclosures.

<table>
<thead>
<tr>
<th>Controller Enclosures</th>
<th>Physical Capacity</th>
<th>Effective Capacity</th>
<th>IOPS (4k read miss)</th>
<th>Bandwidth</th>
</tr>
</thead>
<tbody>
<tr>
<td>FlashSystem 9200</td>
<td>1</td>
<td>921TB</td>
<td>1.6PB</td>
<td>4PB</td>
</tr>
<tr>
<td>FlashSystem 9202R</td>
<td>2</td>
<td>1.8PB</td>
<td>3.2PB</td>
<td>8PB</td>
</tr>
<tr>
<td>FlashSystem 9203R</td>
<td>3</td>
<td>2.7PB</td>
<td>4.8PB</td>
<td>12PB</td>
</tr>
<tr>
<td>FlashSystem 9204R</td>
<td>4</td>
<td>3.6PB</td>
<td>7.3PB</td>
<td>18.4PB</td>
</tr>
</tbody>
</table>

*Figure 1  High level comparisons between single and clustered systems*

**Rack Configurations**

For the initial offering, the FlashSystem 9200R has a limited set of configurations as shown in Figure 2.

<table>
<thead>
<tr>
<th>9848-AG8</th>
<th>9848-AFF*</th>
<th>9848-A9F*</th>
<th>FC Switches**</th>
</tr>
</thead>
<tbody>
<tr>
<td>FlashSystem 9202R</td>
<td>2</td>
<td>0 to 2</td>
<td>0 to 2</td>
</tr>
<tr>
<td>FlashSystem 9203R</td>
<td>3</td>
<td>0 to 3</td>
<td>0 to 2</td>
</tr>
<tr>
<td>FlashSystem 9204R</td>
<td>4</td>
<td>0 to 4</td>
<td>0 to 2</td>
</tr>
</tbody>
</table>

* For each 9848-AG8, just one expansion enclosure can be ordered. You cannot mix AFF and A9Fs in the same system in the initial order.
** Exactly 2 32Gb switches will be supplied with each rack. These should only be used for internal fabric connections. There’s a choice between an identical pair of 8960-F24 switches or a pair of 8977-T32 switches.

*Figure 2  FlashSystem 9200R configurations*

Whilst this set of configurations falls well short of the total number of configurations possible when clustering the FlashSystem 9200 with expansion enclosures, they represent the most popular configurations.

If an alternative configuration is required, then there are two paths to achieving this. The first is to order one of the FlashSystem 9200R products for delivery fully assembled, and then order further expansion enclosures for installing into the rack at the customer site (the expansion enclosure will be racked and cabled by an IBM engineer). The second approach is to order the rack, switches, enclosures and controllers separately and then use an IBM Lab Service or Business Partner engagement to assemble the rack entirely onsite.

**Component Options**

The FlashSystem 9200R makes ordering all of the components and feature codes needed much easier. To achieve this, some options within the ordering system are restricted.

The model AG8 is the most configurable component and where possible retains all the options available on the FlashSystem 9200 model AG8. 32Gb Fibre Channel connectivity is mandated as is SAS connectivity if expansion enclosures are specified, but other IO card
options can be freely specified. Cache is defaulted to 1.5TB maximum but can be reduced to 768GB per controller enclosure.

Models AG8, AFF and A9F can all have different amounts of storage added to them, but it's recommended you try and balance the storage across the components in order to make most of the performance available.

The switch configuration is largely fixed, with all ports populated and enabled for future expansion.

The rack configuration is similarly fixed, with the PDU and power cords to each of the components automatically selected by the ordering system. The user is responsible for selecting a rack power cord from the rack to their data centre power supply.

Models AG8, AFF and A9F can have features added post initial order using MES. Where available more cache, different IO cards and of course more storage can be added.

### Ordering

Ordering a FlashSystem 9200R is something that you'll need to work with your IBM representative (or Business Partner) to achieve.

The FlashSystem 9200R is an infinitely larger unit than a single 2U FlashSystem 9200 and requires a little more up-front planning. There is a Planning section in the [IBM FlashSystem 9200 Documentation](#) in the Knowledge Center. A FlashSystem 9200R specific Pre-sales Technical and Delivery Assessment (TDA) should also be reviewed with your IBM representative (or Business Partner) to understand the environmental considerations before ordering.

To order the FlashSystem 9200R, your IBM representative (or Business Partner) will be using the e-config tool. Within the Storage product family, under FlashSystem, there are three options - a FlashSystem 9202R, a 9203R and a 9204R as shown in Figure 3.

*Figure 3  FlashSystem 9200R options*
Selecting one of these products will result in the minimum required components being selected. Expansion enclosures can then also optionally be added. Figure 4 on page 7 shows a FlashSystem 9202R with expansion enclosures available to add.

![Figure 4: FlashSystem 9200R with expansion enclosures available to add](image)

Editing one of the selected products results in the same experience as ordering a non-rack FlashSystem 9200, with some of the options removed or defaulted as discussed previously in this document. If you try and remove or add component that are required, then this will be prevented or result in an error.

Once the components have been selected and configured, a diagram of the rack is displayed in e-config with the components displayed in their intended position. Figure 5 on page 8 shows the FlashSystem 9202R with two model AFF expansion enclosures.
Once you have finalized the configuration, you can progress through e-config to complete the order.

The order will be assembled in a rack by IBM and then shipped to the customer site, where an IBM representative will complete the configuration, making the rack ready for use.

**Rack installation**

In order to keep the configuration simple and predictable, the components in the rack are always installed in the same location. Figure 6 on page 9 shows the position of each of these components.
The two Fibre Channel switches (shown in Figure 6 in orange) are located at the top of the rack with a 1U gap between them.

Two or four PDUs will be included in the side of the rack (shown in blue). If additional PDUs are required, they will be horizontally located above the model AG8 controller enclosures.

The model AG8 controller enclosures (shown in yellow) are installed at U12 upwards, ordered upward starting with the largest capacity at the bottom to the smallest capacity at the top. The feature codes AL01 to AL04 denote the rack position and are assigned automatically.

The IO group ordering of the model AG8 controllers matches the rack position with the first IO group being located at U12 and indicated by AL01.

The model AFF and A9F expansion enclosures (shown in purple) are installed with a 1U gap at the bottom of the rack. Similar to the model AG8, they’re ordered upward starting with the largest capacity. The feature codes AL01 through to AL04 are also used with the expansion enclosure to denote rack position.

The free rack space can be used for other components, but an assessment must be made to ensure that appropriate power and cooling is available for everything that’s installed in the rack.
Fibre Channel cabling

Figure 7 shows the rear of a model AG8 controller. It shows two PSUs on the left and right, with a pair of canisters between them. Although both canisters are identical, the top canister is inverted. The shaded yellow boxes indicate the location of the first IO card slot. These two IO card slots have 4 32Gb Fibre Channel ports each and are dedicated to clustering.

![Figure 7 Rear of model AG8 controller](image)

In order to ensure redundancy, ports 1 and 3 from each card are connected to the first Fibre Channel switch, and ports 2 and 4 are connected to the second Fibre Channel switch. The model AG8 controllers are cabled to the switches from left to right. A full description of the Fibre Channel cabling can be found in the IBM FlashSystem 9x00 Knowledge Center.

The outlined yellow boxes indicate the location of the other available IO card slots. You can either install 25Gb Ethernet cards in these slots, or additional 32Gb Fibre Channel cards. These can be used for both host connectivity and remote copy to other clusters.

Fibre Channel Configuration

The switches will be configured to create a zone that will be used just for inter-cluster traffic. This creates a separation from host and remote copy Fibre Channel traffic. Maintaining this separation will ensure that the inter-cluster traffic, and ultimately the operation of the cluster will not be impacted by Fibre Channel congestion.

The remaining host ports available on each of the model AG8 controllers should be connected to a SAN network. Port masking and/or switch zoning can be used to determine what traffic flows on each port. For more information on this refer to IBM FlashSystem 9200 and 9100 Best Practices and Performance Guidelines, SG24-8448.

SAS cabling

Figure 8 shows the rear of a model AG8 controller again. Although the picture shows a Fibre Channel card, the purple boxes indicate the location of the SAS cards if model AFF or A9F expansion enclosures are used.

![Figure 8 Rear of AG8 controller showing location of SAS cards](image)
Figure 9 on page 11 shows the rear of the model AFF. It has two canisters with two SAS ports each. The left-hand side SAS port on each canister, indicated with a purple box, is connected to a SAS port in each of the model AG8 canisters. The connectivity of the A9F is similar, but because the canisters are installed inverted, the two right-hand side SAS ports of each canister are used.

![Figure 9 Rear of model AFF](image)

Because of the restricted configurations where you can only have 0 or 1 expansion enclosure per controller enclosure, by default a pair of SAS cards are only included in a model AG8 if there's an associated model AFF or A9F included in the rack. Where a SAS card is not installed, a 32Gb Fibre Channel or 25Gb Ethernet card can optionally be installed.

**Power Cabling**

Generally, the components in the rack use a C13 to C14 power cord to connect to the Power Distribution Units (PDU) outlets. The model A9F expansion enclosure requires C19 to C20 power cords. A pair of redundant PDUs will be included in the rack with the right set of outlets to support the selected components. Where a model A9F is included, a PDU will be included that includes outlets for both types of power cords.

Where a component has dual power supply units (PSUs), such as the model AG8 controller, one of the PSUs will be connected to one PDU, with the other PSU connected to the other PDU. The switches only have a single PSU though, so one switch will be connected to one PDU and the other switch will be connected to the other PDU.

As mentioned previously, all the power cords required to connect the components to the rack PDUs will be automatically specified during ordering and cabled to the PDUs prior to the delivery of the rack. The exception is the power cords required by the rack itself. These need to be selected and ordered based on the power requirements of the environment in which the rack will ultimately be installed.

**Rack Management**

All FlashSystem 9200 clusters present themselves as a single system. This means a single GUI, with a single command line. All resources can be managed from within the GUI, with each of the model AG8 controller enclosures in the cluster shown as an IO group. Workloads can be moved between IO groups in order to balance the performance across all the available resources in the cluster.

The switches have their own separate GUI, which will be used to set up the zoning, etc. Once the switches have been set up there should be little need to access either switch GUI. Any issues with ports or connections to the model AG8 controllers will be detected and reported from within the FlashSystem 9200 event log.
Using SNMP or email error reporting, along with enabling call home will improve the support experience, as will taking advantage of Storage Insights to give you an overview of your entire storage estate. Storage Insights will alert you to any device (or cluster) that needs attention, as well as highlight any performance issues. You can also give IBM service representatives access to your Storage Insights data to improve problem resolution and aid in remote debug.

Conclusion

The FlashSystem 9200R products offer a convenient way of ordering a pre-packaged cluster with a dedicated Fibre Channel SAN for the clustering. The assembly, cabling and pre-configuration of the cluster will suit customers who want to get to first IO as quickly as possible.

For customers wanting to scale out an existing FlashSystem 9200 installation, or customers who want to use their own data center infrastructure, then clustering may still be the right answer - and is fully supported outside of the FlashSystem 9200R environment. The components needed can be ordered separately, but consideration should be given to rack space, SAN infrastructure, power, cooling and cabling.

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