bionano™

Saphyr® Networking and Setup Guide

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Revision History

REVISION	NOTES
A	Initial release.
B	Added Saphyr Instrument Controller configuration information.
C	Addition of Compute Option B Steps, Access.txt, and Legacy image.
D	Added port 3002 for Compute On Demand connectivity Added firewall configuration for ICS v5.2
E	Clarified that the Instrument controller cannot be connected to the Access server if a proxy server is being used.in the *Instrument Controller Network Connectivity Requirements* section.
F	Added clarity to Compute Configuration Steps. Added IT Requirements. Workflow improvements for customer and internal ease.
G	Updated tables and removed irrelevant verbiage.
H	Transferred to new template.
I	Updated references of CentOS and SGE to RHEL 9 and SLURM.
J	Added repo URLs for RHEL licensing. Removed section "External Firewall Requirements: Server Update".
K	Added Azure endpoints for Compute On Demand service
L	Added Dell 5860 Instrument Controller instructions

Introduction

This document is intended to allow customer IT personnel to understand the architecture of the Saphyr® System and its requirements for integration within their organization. Guidelines and specifications for integrating the Bionano Saphyr System into a customer's IT environment are provided. The Saphyr System is composed of a Saphyr instrument, instrument controller, Bionano Access™ Server and either an on premises Bionano Compute Server cluster or the cloud based Bionano Compute On Demand service. Please contact support@bionano.com prior to implementing the steps herein.

Saphyr System Overview

Figure 1 depicts the Saphyr system connectivity path. The Saphyr Instrument captures images of labeled DNA molecules from the Saphyr Chip. The Instrument Controller (which controls the function of the Saphyr Instrument) converts the images into molecule data files (.bnx) and computes real-time throughput, molecule N50, and label density values. The .bnx files are transferred to the Bionano Access Server, where mapping metrics are calculated and displayed in the Instrument Control Software (ICS) and Bionano Access dashboards. Once the chip run is complete, the completed molecule data files are automatically imported into the Bionano Access web application (hosted at the Bionano Access Server). The molecule data files can then be used to perform various bioinformatics operations such as generating a *de novo* assembly, rare variant analysis, or targeted FSHD analysis. The Customer Switch isolates traffic for the Compute Servers which are designed to work together as a cluster to process bioinformatics jobs submitted from the Bionano Access web application. Bionano also offers cloud-based computing (Bionano Compute On Demand) which can be used in place of local compute servers or to augment local compute resources during computational peak periods. The Bionano Access web application monitors the progress of each computation job, captures the output, notifies the user of completion, and allows them to inspect the results in their browser on the Customer Workstation. Bionano Compute On Demand, a pay-per-use computing service, is accessible through the Bionano Access Server, for computation needs.
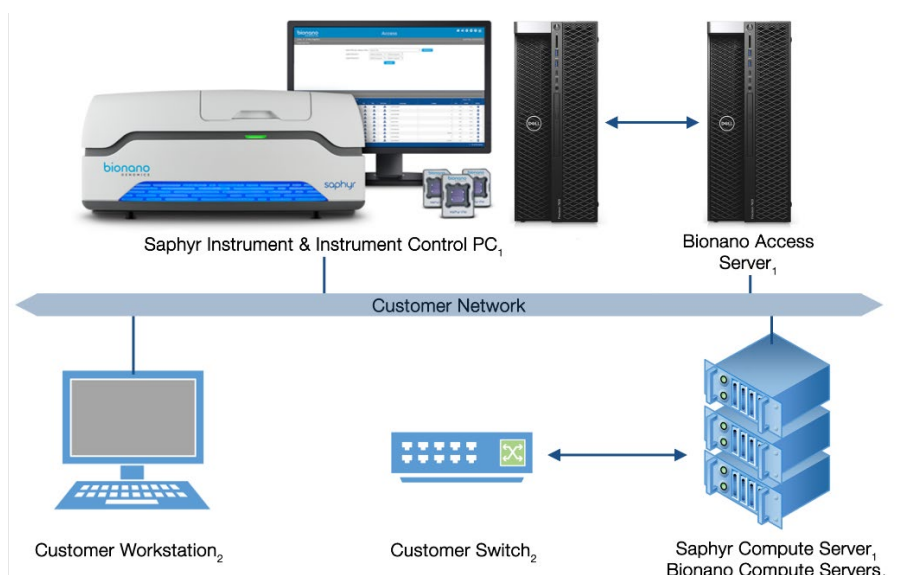

Figure 1. Saphyr System Connectivity Diagram
[1] Bionano Purchase   [2] User-Provided

References

- See *Data Security Guidelines* (CG-30292) for detailed information on Bionano's Saphyr System architecture and data handling and security policies.
- See *Saphyr Site Preparation Guide* (CG- 30145) for physical space requirements.

Hardware and Firewall Requirements

Laboratory

- Two (2) 1Gbps Data Ports in proximity of the Saphyr system (1m)
- Internet connectivity for:
    - ICS Controller: DHCP
        - Windows Defender and Widows updates
        - Bionano Assure - Instrument Health/Run Support
        - Saphyr Instrument Control Software Updates
        - Remote Support
    - Bionano Access Server: 1 Static IP assigned
        - Compute on Demand, if applicable.
            - Software Upgrades

Data Center for Compute Solution

- Available rack space for 2U Server/s
    - Saphyr Compute
    - Bionano Compute/s
- Network Switch.
- Networking Cabling
- Static IP assignments (configuration dependent)

Firewall Requirements

The Saphyr system requires access to the ports and URLs seen in **Table 1, Table 2,** and **Table 3,** which enable Bionano Assure, TeamViewer, Windows Update Services and connectivity between the ICS Controller, BAS, and Compute Server/s if applicable.

Table 1. Internal Firewall Requirements

From System	To Service	Ports (outbound)	URL (outbound)
Bionano Access Server	Compute Servers	TCP: 3005	http://<ipaddress Compute Servers> [1]
		SSH: 22	https://<ipaddress Compute Servers> [1]
Bionano Compute Servers	Bionano Access Server	TCP: 3005	http://<ipaddress BAS> [1]
		SSH: 22	https://<ipaddress BAS> [1]
Users Workstations	Bionano Access Server	TCP: 3005	http://<ipaddress BAS> [1]
			https://<ipaddress BAS> [1]
	VIA (Client to be installed)	TCP: 8443 (default)	https://<ipaddress BAS> [1]

[1] *Bionano Access Server and Bionano Compute Servers Static IP addresses to be provided by local IT administrators*

EXTERNAL FIREWALL REQUIREMENTS: SERVER INSTALLATION AND UPDATE

Table 2: External Firewall Requirements: Server Installation and Update

From System	To Service	Ports (outbound)	URL (outbound)
Bionano Access Server	internet	temporary opening allowing planned update to be rolled out	

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EXTERNAL FIREWALL REQUIREMENTS: SERVICES

Table 3: External Firewall Requirements: Services

From System	To Service	Ports (outbound)	URL (outbound)
Instrument Controller	Bionano Assure	TCP: 80, 443 (SSL)	https://api.saphyrassure.com
			https://saphyrassure01.blob.core.windows.net
	Windows Update [2]	TCP: 80, 443	http://windowsupdate.microsoft.com
			http://*.windowsupdate.microsoft.com
			https://*.windowsupdate.microsoft.com
			http://*.update.microsoft.com
			https://*.update.microsoft.com
			http://*.windowsupdate.com
			http://download.windowsupdate.com
			https://download.microsoft.com
			http://*.download.windowsupdate.com
			http://wustat.windows.com
			http://ntservicepack.microsoft.com
			http://go.microsoft.com
			http://dl.delivery.mp.microsoft.com
			https://dl.delivery.mp.microsoft.com
	TeamViewer	TCP/UDP: 5938	http://*.teamviewer.com
		TCP: 443, 80	https://*.teamviewer.com
Bionano Access Server	Users emailing [3]	SMTP: 587	email-smtp.us-west-2.amazonaws.com
	Bionano Assure	TCP: 3000	https://us.bionanostratus.com
	Compute On Demand	TCP: 3000	https://*.bionanostratus.com
		TCP: 3001	http://*.bionanostratus.com
		TCP: 443	https://platform.rescale.com
			https://*.blob.core.windows.net
			https://*.storage.azure.com
			https://*.storage.azure.net
			https://*.amazonaws.com
	TeamViewer	TCP/UDP: 5938	http://*.teamviewer.com
		TCP: 443, 80	https://*.teamviewer.com
	RHEL Licensing	TCP: 443	https://repo-us.bionano.com https://repo-eu@bionano.com
Compute server (nodes)	RHEL Licensing	TCP: 443	https://repo-us.bionano.com https://repo-eu@bionano.com

[2] *Windows Server Update Services (Configure WSUS)*
[3] *Users notification emailing service.*

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Saphyr Instrument Controller

Saphyr Instrument Controller Specification

The instrument controller is designed to be located adjacent to the Saphyr Instrument. The two systems are directly tethered for controlling the instrument and direct data transfer of image files. See **Table 4**.

NOTE: The Saphyr Instrument Controller Software is a Windows operating system designed to contain a series of embedded accounts, including SaphUser, which is the default account for User Instrument Operation. Do not modify the SaphUser windows account credentials.

Table 4. Saphyr Instrument Controller Specification

Type	Requirements/Specifications	
Provided By	Bionano	
Accessories	• Monitor	• Mouse
	• Keyboard	
Operating System	• Windows 10 IoT Enterprise LTSC 2019 1809 x64	
Software	• Saphyr Instrument Controller Software (ICS)	
	• TeamViewer (remote assistance, optional)	
	• Microsoft Edge (not user accessible, service only)	
Memory	• 32 GB RAM	
Data Storage	• 8 TB in RAID 1 (D drive)	• 256 GB (C drive)
Space	• Height: 46 cm (18 in)	• Depth: 47 cm (18.5 in)
	• Width: 18 cm (7 in)	
Power	• 100-240 VAC at 50-60 Hertz	
	• Power Consumption ≤ 300 Watts	
	• The Controller is shipped with a United States power cord. Users outside of the United States are required to supply a 2m long, country specific IEC 60320-C13 power cord (in some cases, the FSE may be able to provide the suitable power cord).	
Network	• 2 – 1 gigabit ethernets ports	
	• Port 1 (required): connected to the Bionano Access Server	
	• Port 2 (recommended): connected to customer network to provide connectivity support tools as described in 30292	

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Instrument Controller Network Connectivity Requirements

The Instrument Controller connectivity requirements are broken into two parts, as seen in **Figure 2**. The first is the required connection to the Bionano Access Server. The recommended connection is via a direct tether connection to eliminate the possibility of instrument downtime due to network issues. The system can optionally be connected via the customer's network though this is not preferred.

To maintain optimal performance, security, and reliability, it is strongly recommended that the Instrument Controller be connected to the customer network to provide access to the Bionano Assure, TeamViewer and Windows update services. See the "References" section for links to more information about these services and their benefits.
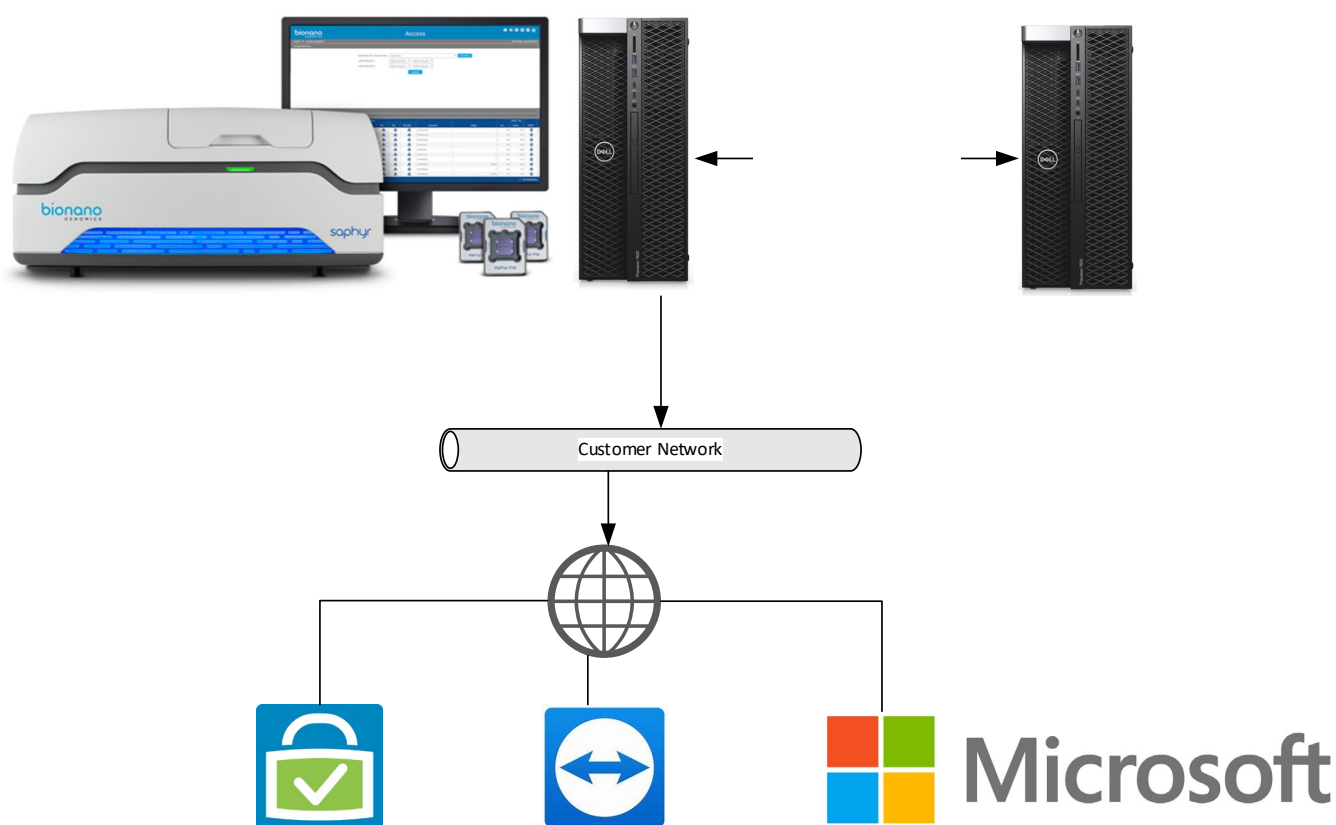

Figure 2. Instrument Controller Network Connectivity Requirements

Bionano Access Server

The Bionano Access Server (BAS) requires one customer-provided static IP address and will come with two pre-configured static IP addresses (`111.111.111.1`, `222.222.222.2`) for connection to Instrument Controller(s).

Bionano Support personnel will configure the network for all Bionano systems during installation.

The Bionano Access Server is designed to be located adjacent to the Saphyr Instrument Controller. The two systems are tethered for direct data transfer.

Bionano Access Server Specifications

NOTE: The Bionano Access Server is supplied with the Saphyr system. **Table 5** describes the specifications needed for the Access Server.

Table 5. Bionano Access Server Specifications

Type	Requirements/Specifications		
Provided By	Bionano		
Software	• RedHat Enterprise Linux 9.x • Bionano Access • Bionano Solve • VIA • PostgresSQL • Java	• Nodejs • Perl • Python • R • Singularity • slurm	
Memory	• 128 GB RAM		
Data Storage	• 40 TB with RAID Controller (4x 16TB RAID 5)		
Space	• Height: 46 cm (18 in) • Width: 18 cm (7 in) • Depth: 47 cm (18.5 in)		
Power	• 100-240 VAC at 50-60 Hertz • Power Consumption ≤ 300 Watts • The server is shipped with a United States power cord. Users outside of the United States are required to supply a 2m long, country specific IEC 60320-C13 power cord (in some cases, the FSE may be able to provide the suitable power cord).		
Network	• One port is connected to the Saphyr Instrument controller at 1Gbps • LAN connection can be done at 1 or 10Gbps		

BIONANO ACCESS PROXY SERVER COMPATIBILITY

Bionano Access is not compatible with proxy servers and should be excluded on all user workstations from proxy requirements. Proxy servers will often cache results and prevent dynamic pages such as the dashboard from updating properly.

ICS Controller + BAS Setup

Saphyr Instrument Controller and Bionano Access Server Cabling

NOTE: Bionano Support Personnel will perform cabling of the ICS Controller and BAS.

SINGLE SYSTEM

The Single System Configuration, seen in **Figure 3**, is comprised of one Saphyr instrument (left), Saphyr Instrument Controller (middle) and a Bionano Access Server (right). Actual physical placement may be modified to meet site specific needs; however, the units must be in proximity of each other. Network cables are connected according to the diagrams below.
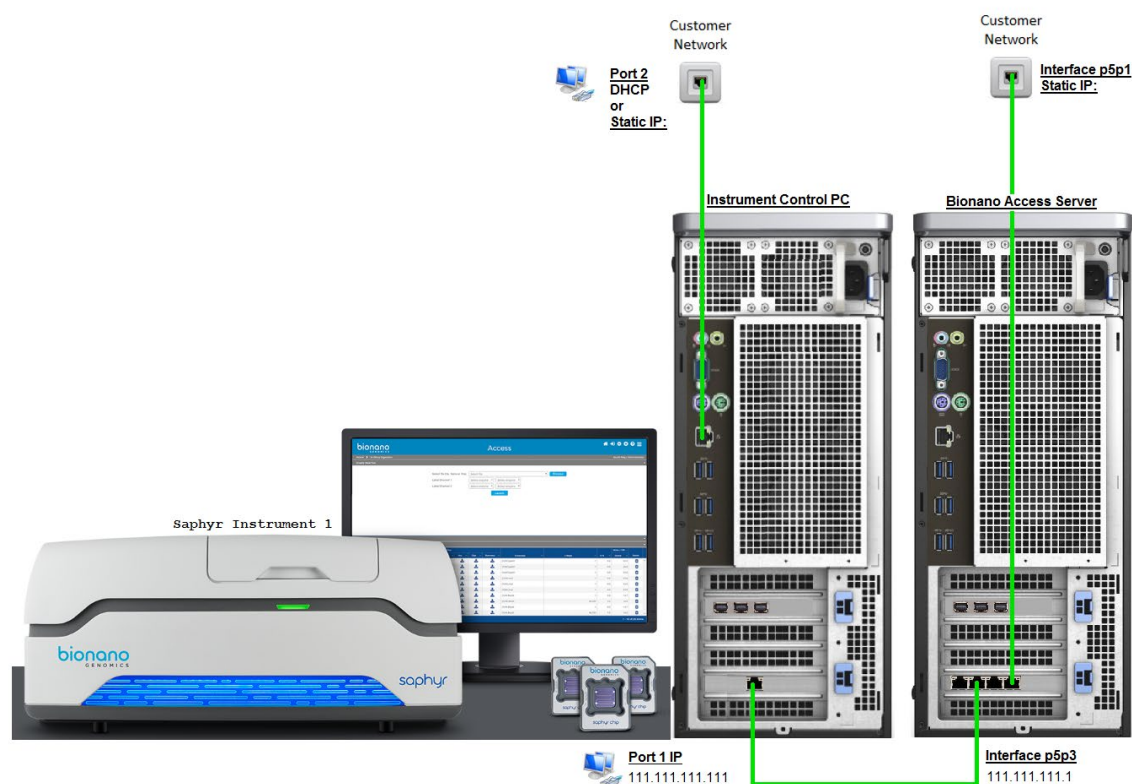

Figure 3. Single System Cabling

- Saphyr Instrument Controller NIC Card: Two ports, Adaptor 1, and Adaptor 2 (bottom and top)
- Ethernet Adaptor 1 (bottom): Tether to Bionano Access Server NIC Card p5p3
- Ethernet Adaptor 2 (top): Tether to Customer Network
- If there is a third port (as with the Dell 5860 PC), ignore it.

BIONANO ACCESS SERVER NIC CARD: Four ports, p5p4 to p5p1 (descending order, left to right)

- P5p3: Tether to Saphyr Instrument Controller (60368) NIC Card Adaptor 1

- P5p1: To Customer Network

DUAL SYSTEM

The Dual System Configuration, seen in **Figure 4**, is an example of connecting two Saphyr Systems to a single Bionano Access Server. This Dual System Configuration illustration includes two Saphyrs, two Saphyr Instrument Controllers (60368) and one Bionano Access Server (middle).
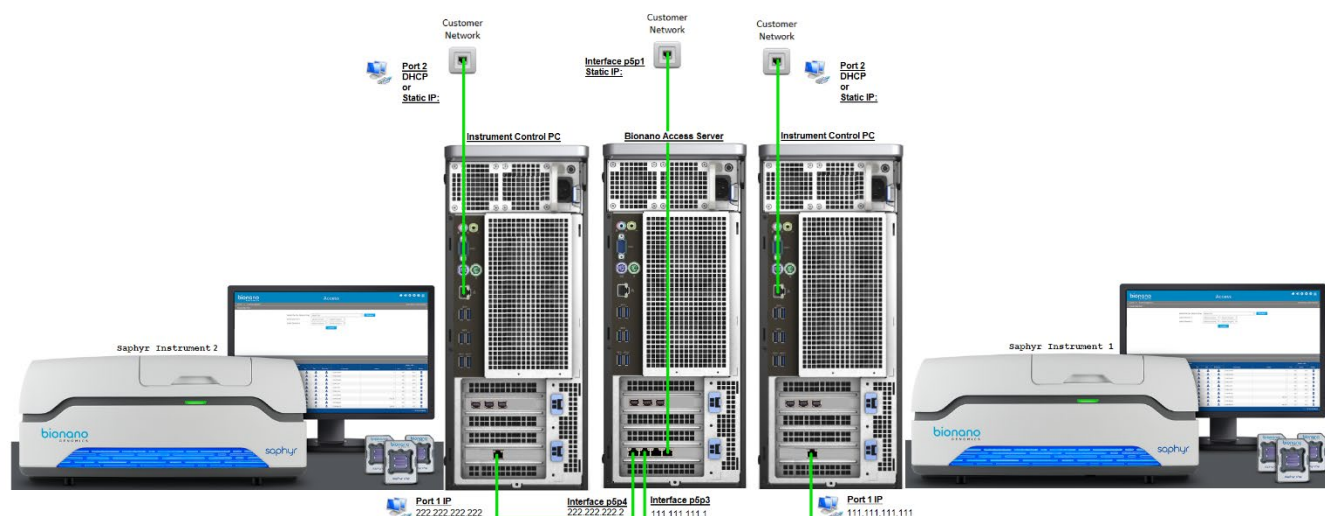

Figure 4. Dual System Configuration

Bionano Access Server NIC Card: Four ports, p5p4 to p5p1 (descending order, left to right)

- P5p4: To Saphyr Instrument Controller 2 (60368) NIC Card Adaptor 1
- P5p3: To Saphyr Instrument Controller 1 (60368) NIC Card Adaptor 1
- P5p1: To Customer Network

Saphyr Instrument Controller 1 NIC Card: Two ports, Adaptor 1, and Adaptor 2 (bottom and top)

- Ethernet Adaptor 1 (bottom): Tether to Bionano Access Server NIC Card p5p3
- Ethernet Adaptor 2 (top): To Customer Network
- If there is a third port in the middle (as with the Dell 5860 PC), ignore it.

Saphyr Instrument Controller 2 NIC Card: Two ports, adaptor 1 and adaptor 2 (bottom and top)

- Ethernet Adaptor 1 (bottom): Tether to Bionano Access Server NIC Card p5p4
- Ethernet Adaptor 2 (top): To Customer Network
- If there is a third port (as with the Dell 5860 PC), ignore it.

Customer Network Connection Configuration

1. Log in to Saphyr ICS using the SysAdmin credentials.

2. In **Saphyr ICS** Main Menu, select **System Settings** (**Figure 5**).
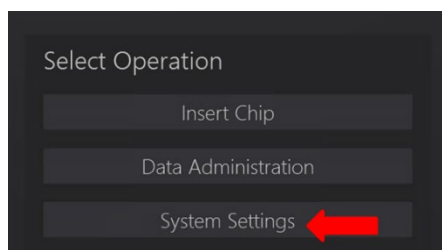

Figure 5. System Settings

3. If a proxy server is required to connect to the customer network, check Enable Proxy Server, provide the full proxy URL (and optionally, the proxy credentials) and click **Apply Proxy Settings** (**Figure 6**). HTTPS proxy URLs are not supported. **NOTE:** There must be a tethered connection between the Instrument Controller and the Bionano Access Server when using a proxy server. Connecting to the Bionano Access Server through a proxy server is not supported.
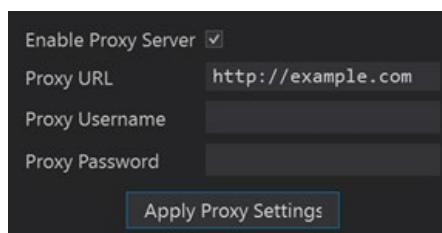

Figure 6. Proxy Settings

4. Select **Ethernet Server Adapter** tab (**Figure 7**).

   NOTE: The ethernet port will only show up if there is an active connection on the port. Ensure the Instrument Controller is connected to the customer network.
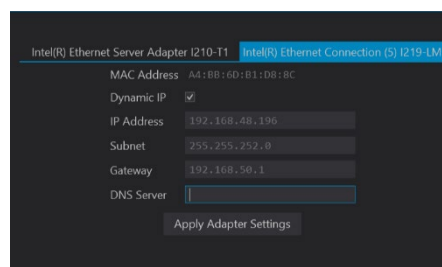

Figure 7: Ethernet Server Adapter Tab

The I219-LM connection is used to connect to the customer network. This port is located on the motherboard. It can be configured for static IP or DHCP. The MAC Address is available on this screen. Enter the correct network settings and click **Apply Adapter Settings**. **NOTE:** The I210-T1 connection is used for the direct tethered connection to the Bionano Access Server and will have been configured by Bionano support personnel during installation.

Saphyr/Bionano Compute Server/s Cabling and Operation

The customer may adopt one of the networking options seen in **Figure 8.** if not utilizing a Compute on Demand solution.
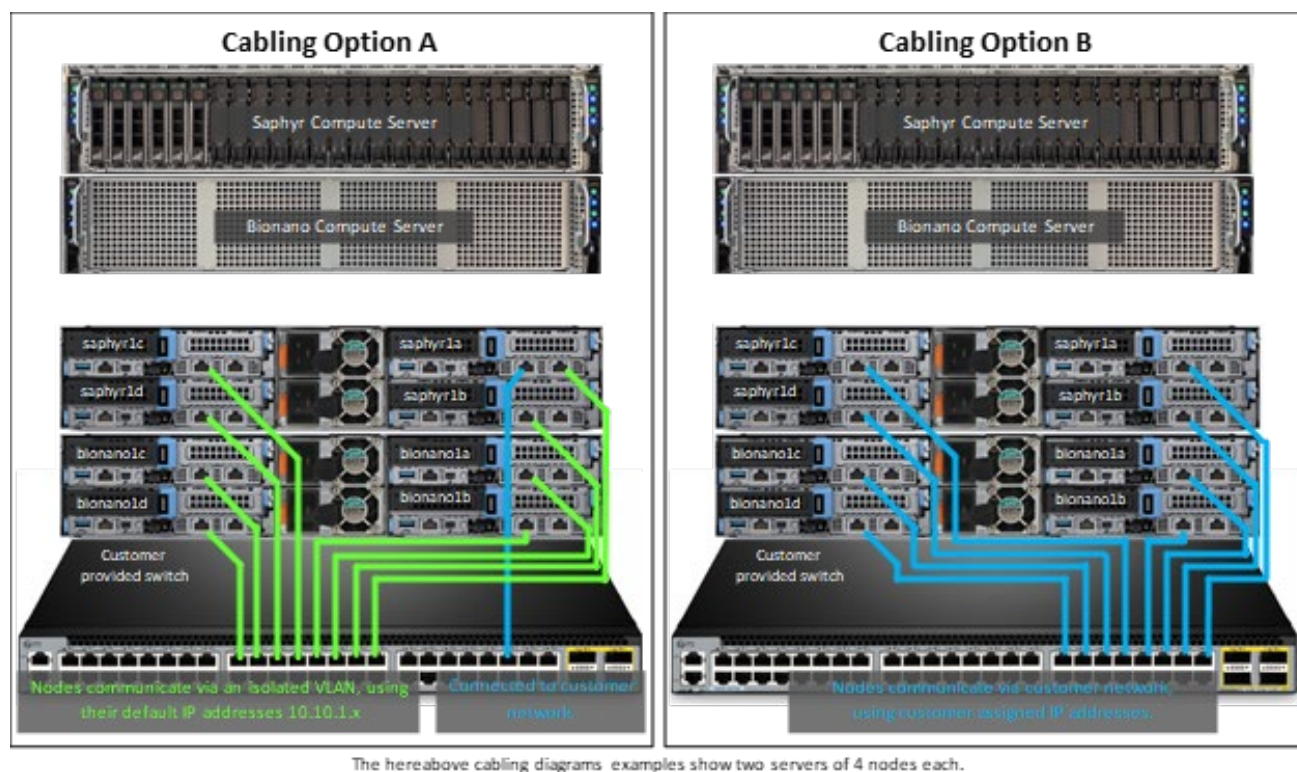

Figure 8. Compute Server Data Center Options

INTRODUCTION OF DATA CENTER OPTION A

This default Compute configuration requires one static IP address for the Saphyr1a Compute Node in the data center. The remaining Compute nodes will be on a separate custom subnet. The Saphyr1a node will be dual homed. It will have one static IP accessible to the Bionano Access server and one IP address on the subnet with the other Compute nodes. IP routing will be used on Saphyr1a to direct responses from the Compute nodes back to the Bionano Access Server. The internal subnet addressing will come preconfigured as 10.10.1.0/24.

INTRODUCTION OF DATA CENTER OPTION B

This configuration requires one static IP address <u>per node</u>.

The customer must provide the following:

• Network Switch

• Network Cabling

• The static IP addresses, netmask, gateway, and DNS for Compute servers.

![bionano logo]

Introduction of Saphyr and Bionano Compute Server (optional)

The number of Compute servers required for installation will be determined based on user Compute requirements and environmental conditions. The Compute servers work together as a cluster to perform various bioinformatic operations including *de novo* assembly, variant annotation, and scaffolding to name a few. Each Compute cluster must have at least one Saphyr Compute which serves as the head node with storage and the SLURM master installed. Additional Bionano Computes are added to scale the cluster to fit user specific demands. A single Bionano Access Server can be configured to interact with multiple Compute clusters if required.

Each Compute server has four nodes, each having two network ports (**Figure 9** and **Table 6**) and a separate iDRAC port for remote management.
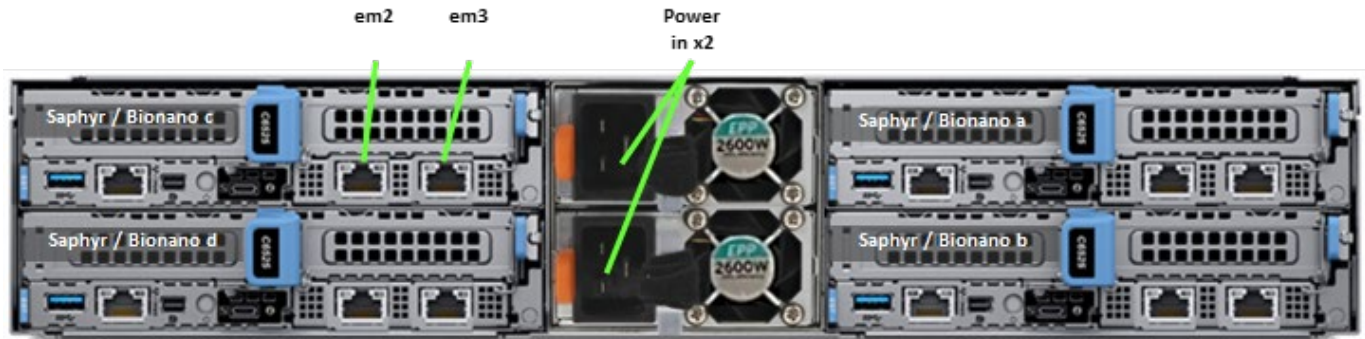

Figure 9. Saphyr Compute Ports (Similar for Bionano Compute)

Table 6. Saphyr Compute Ports (Similar for Bionano Compute)

Type	Requirements/Specifications	
Provided By	Bionano (additional purchase)	
Software	• RedHat Enterprise Linux 9.x • Python • Perl	• R • SLURM • Singularity
Space	• 2U rackmount server (to be provided by customer) • Rails and cords supplied with server	
Power	• Dual 2600 W Hot-plug Redundant Power Supplies (Recommended: APC Smart-UPS 3000VA LCD RM 2U UPS -rack mounted). • 2 6' IEC320-C19/C20 250V power cables. Users outside of the United States are required to supply two 2m long, country specific IEC 60320-C19/C20 power cords (in some cases, the FSE may be able to provide the suitable power cord).	
Network	5 X 1 GB Ethernet connection	

Introduction of Bionano Compute Servers (optional purchase)

The recommended configuration includes one Bionano Compute Server. At least one Saphyr Compute Server is required before adding any Bionano Compute systems (**Table 7**).

Table 7. Bionano Compute Servers

Type	Requirements/Specifications	
Provided By	Bionano (additional purchase)	
Software	• RedHat Enterprise Linux 9.x • Python • Perl	• R • SLURM • Singularity
Space	• 2U rackmount server (to be provided by customer) • Rails and cords supplied with server	
Power	• Dual 2600 W Hot-plug Redundant Power Supplies (Recommended: APC Smart-UPS 3000VA LCD RM 2U UPS -rack mounted). • 2 6' IEC320-C19/C20 250V power cables. Users outside of the United States are required to supply two 2m long, country specific IEC 60320-C19/C20 power cords (in some cases, the FSE may be able to provide the suitable power cord).	
Network	5 X 1 GB Ethernet connection	

NOTE: See the *Saphyr Compute Networking Options* section for more details.

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Appendix A - Legacy Saphyr Compute Options

Figure 10 illustrates the configuration for Dell with two port network cards. **Figure 11** illustrates the configuration options for the Gen 3 server.
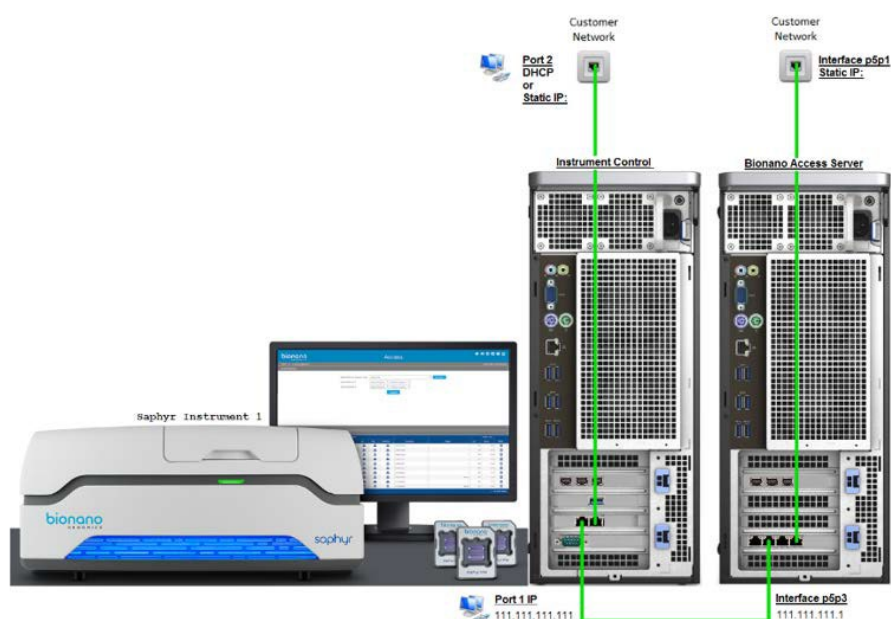

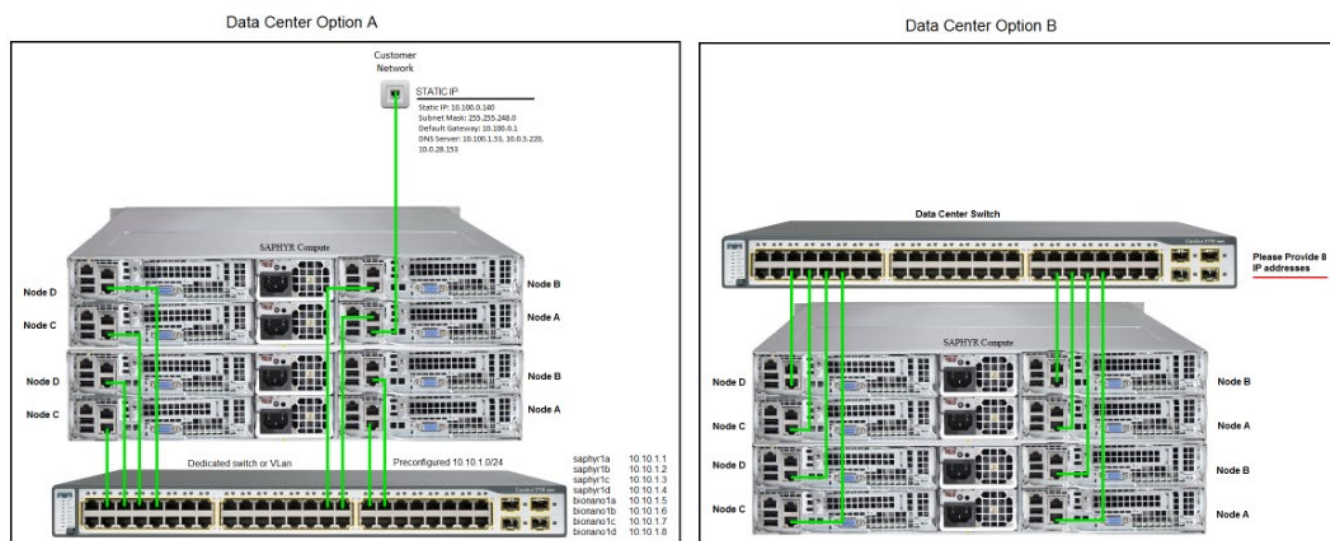**Figure 10**. Configuration with Two Port Network Cards

Figure 11. Configuration Options for Gen 3 server Option A and B

Appendix B - Verifying Firewall Configuration for Saphyr ICS

1. Log in to Saphyr ICS using the SysAdmin credentials.

2. Select the **Lock** icon in the top toolbar to display the **Bionano Assure** dropdown and select the **Test Network Connection** button, see in **Figure 12**. The network test can result in several possible messages shown in **Table 8**.
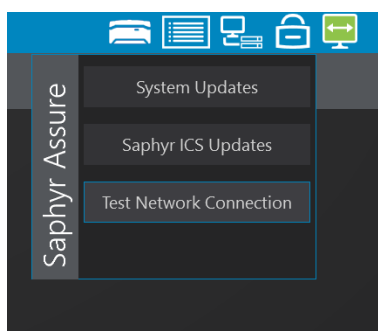

Figure 12. Test Network Connection

Table 8. Test Network Connection Results

No network problems detected.	Success
Ethernet connection failed.	No physical ethernet cable network connection
Bionano Access connection failed.	Could not reach Access server (<ipaddress>:3005)
Bionano Assure connection failed.	Could not reach api.saphyrassure.com
Bionano Assure storage connection failed.	Could not reach blob.core.windows.net
TeamViewer connection failed.	Could not reach teamviewer.com
Windows Update connection failed.	Could not reach microsoft.com

3. This step is applicable only to Saphyr ICS version 5.2 and higher.

If the network test was successful but Saphyr ICS connections still are not functional, an internal DNS server may be interfering. To test this, in **Saphyr ICS** Main Menu shown in **Figure 14**, select **System Settings**, then select the **URL Test** tab. Select a URL and verify that the embedded web browser does not show an internal DNS page (some URLs will display a blank page, and this is expected). See also **Figure 13**.
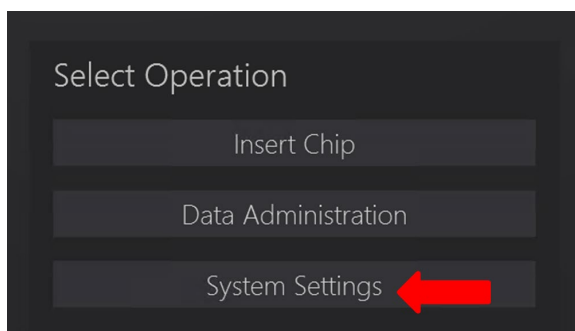
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Figure 13. **URL Test** Tab
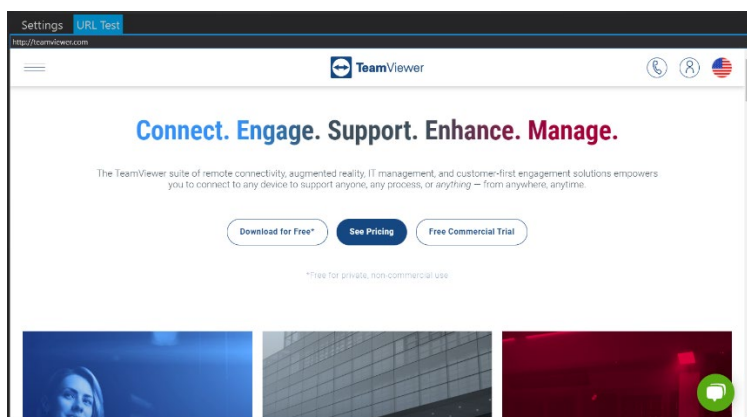
Figure 14. System Settings Technical Assistance

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Technical Assistance

For technical assistance, contact Bionano Technical Support.

You can retrieve documentation on Bionano products, SDS's, certificates of analysis, frequently asked questions, and other related documents from the Support website or by request through e-mail and telephone.

TYPE	CONTACT
Email	support@bionano.com
Phone	Hours of Operation: Monday through Friday, 9:00 a.m. to 5:00 p.m., PST US: +1 (858) 888-7663 Monday through Friday, 9:00 a.m. to 5:00 p.m., CET UK: +44 115 654 8660 France: +33 5 37 10 00 77 Belgium: +32 10 39 71 00
Website	www.bionano.com/support
Address	Bionano, Inc. 9540 Towne Centre Drive, Suite 100 San Diego, CA 92121

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