

Cloud Infrastructure Planning and Design

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Lab Overview

These lab exercises are designed to be used as incremental steps toward the development of a final presentation which will be made at the end of the course. Each exercise examines one component of the cloud solution. This solution is based on a fictitious company named NanCo Art Services.

This guide provides a section with tasks that the students must accomplish to create a high level design. Appendix A provides a case study of NanCo with details of the services that they wish to implement. Appendix B provides additional supporting information specific to each section of the lab.

The class will be divided into teams. You will work with your team for the duration of the course. As you work on the exercises you will be making design decisions, proposing recommendations, and assembling your team's solution for NanCo's cloud. At the conclusion of the class, each team will make a presentation to the class that explains their design as proposed to NanCo.

Your presentations should be created in PowerPoint and should include one slide or section on the following topics:

- Team overview (make this fun by inventing a team name)
- Overview of goals and requirements for a cloud infrastructure
- Cloud management infrastructure
- Consumer compute resources
- Consumer storage resources
- Consumer network resources
- Overview describing infrastructure requirements for elastic capabilities, monitoring and metering
- Overview describing infrastructure requirements to support proposed hybrid cloud capabilities
- Overview slide summarizing the required design changes to supporting BaaS.
- Conclusion and Summary (why your solution is best, and how it addresses NanCo's requirements)

You may choose to include additional topics, but you must observe a 20 minute time limit for the presentation. One or more members of your team will present your solution to the rest of the class who will play the role of a NanCo employee with minimal technical knowledge of cloud solutions. Your presentation should target the audience appropriately. They may ask questions about your design decisions and you must be able to explain them.

You will be measured on:

- The quality of your content
- Adherence to time
- Your concise articulation of how your design addresses the NanCo requirements

NOTE: Your design must NOT include products. Your design should highlight features, attributes, and functionality but NOT make specific product selections or recommendations.

Lab Exercise 1: Introduction to Cloud Design

Purpose:	Discuss and apply the concepts and definitions as presented in the lecture portion of the course, Module 1: Introduction to Cloud Design.
Tasks:	• Define key concepts for cloud technologies and terminologies. • Define key concepts in the cloud design process. • Apply assessment concepts discussed during lecture to the lab case study.
References:	Module 1: Introduction to Cloud Design Lab Case Study

Lab 1: Part 1 – Introduction to Cloud Terminology

Step	Action
1	Compare and contrast server virtualization and container virtualization.
2	Compare and contrast the three cloud service models as defined by NIST.
3	How does a cloud infrastructure design differ from a virtual infrastructure design?
4	Compare and contrast the three physical infrastructure deployment types: traditional, converged, and hyper-converged.
5	What is GRC and why is it important to a cloud architect?

Continued on next page

Lab 1: Part 2 – Introduction to Cloud Design

Step	Action
1	Why is a proper assessment an important step in the cloud design approach?
2	Identify possible sources for requirements, constraints, and dependencies during an assessment.
3	Compare and contrast logical and physical designs and their use cases.
4	Read the NanCo case study located in Appendix A of this lab guide. Identify three requirements that are specific to a cloud design and not traditional datacenter design.
5	Provide a high level overview slide describing NanCo's goals and examples of requirements and constraints as they relate to a cloud design. Note: This slide will be part of your final presentation.

End of Lab Exercise

Lab Exercise 2: Cloud Management Design

Purpose:	Develop a design and plan for deploying components that support cloud management and operations.
Tasks:	• Identify cloud management components that are relevant to a NanCo cloud design. • Provide a logical diagram that describes the cloud management infrastructure and is based on the NanCo requirements.
References:	Module 2: Cloud Management Lab Case Study

Lab 2: Part 1 – Cloud Management Design

Step	Action
1	Refer to the NanCo case study located in Appendix A of this lab guide. Identify which cloud management components may be used in the NanCo cloud. List the requirements that support this conclusion.
2	The NanCo cloud design requires infrastructure to support the cloud management components. In the Lab 2: Supporting Information section of Appendix B, you will find a table listing Cloud Management Components. This list was created from previous assessment information and CMP research. Each component will run on its own virtual machine, and the requirements for each are listed in a table. Determine the total amount of compute and storage resources required for the management infrastructure.
3	Using the information from the NanCo case study and the Lab2: Supporting information, determine the correct number of physical hosts that will be needed to support the resources from step 2. Remember that NanCo has a preferred physical server configuration.
4	Provide a high level diagram of the management infrastructure. Show the number of servers, capacity of servers, and storage. Highlight the placement for the various virtual machines in the management infrastructure.

Step	Action
5	Consumers will require access to the portal UI and API via secure HTTP. NanCo wishes to protect all other exposed interfaces and wishes to have the portal remain available as much as possible. Multiple instances of the Cloud Portal and Catalog server can be placed behind a load balancer for added availability and load distribution. Multiple instances of the Cloud Portal and Catalog Database server can be configured to use replication and a virtual IP address to improve availability. Modify the diagram from step 4 to support the additional servers, a load balancer and firewall. Note: This diagram will be part of your final presentation.

End of Lab Exercise

Lab Exercise 3: Compute Resource Design

Purpose:	Develop a design and plan for deploying consumer compute resources in a cloud infrastructure.
Tasks:	• Identify consumer compute requirements that are relevant to a NanCo cloud design. • Provide a logical diagram that describes the consumer compute resources and is based on the NanCo requirements.
References:	Module 3: Compute Resources Lab Case Study

Lab 3: Part 1 – Compute Resource Design

Step	Action
1	Refer to the NanCo case study located in Appendix A of this lab guide. Identify requirements or other general factors that could influence the selection of a hypervisor that will be deployed in the consumer compute infrastructure.
2	Using the information describing in the case study, calculate the CPU and memory requirements for the ArtPort development and two production environments.
3	In the Lab 3: Supporting Information section of Appendix B, you will find a table listing configuration management server requirements. Add this to the diagram for the management infrastructure created in Lab 2 and make any necessary adjustments.
4	Using the standard rack server configuration that was identified in Lab 2, calculate the number of servers required. Include all relevant infrastructure components and software that will exist on these hosts. Include relevant information from Lab 3: Supporting Information in Appendix B.
5	Provide a high level diagram of the compute portion of the consumer resources. Include the number of compute pools and describe their function. Note: This diagram will be part of your final presentation.

End of Lab Exercise

Lab Exercise 4: Storage Resource Design

Purpose:	Develop a design and plan for deploying consumer storage resources in a cloud infrastructure.
Tasks:	• Identify consumer storage requirements that are relevant to NanCo cloud design. • Provide a logical diagram that describes the consumer storage resources and is based on the NanCo requirements.
References:	Module 4: Storage Resources Lab Case Study

Lab 4: Part 1 – Storage Resource Design

Step	Action
1	Compare and contrast the various storage types that can be deployed in the cloud. Identify a use case for each.
2	Refer to the NanCo case study located in Appendix A of this lab guide. Determine the number storage pools that are required to meet the storage requirements. What criteria did you use for your pool classifications?
3	Identify any encryption requirements in the NanCo case study and include any supporting information in the logical design.
4	Are there any requirements for file or object storage? If so, which solution would you select and why?
5	Provide a high level diagram of the storage portion of the consumer resources. Include the number of storage pools, describe their function and show the connections between the storage and compute pools. Also, include relevant information from Lab 4: Supporting Information in Appendix B. Note: This diagram will be part of your final presentation.

End of Lab Exercise

Lab Exercise 5: Network Resource Design

Purpose:	Develop a design and plan for deploying consumer network resources in a cloud infrastructure.
Tasks:	• Identify consumer network requirements that are relevant to NanCo cloud design. • Provide a logical diagram that describes the consumer network resources and is based on the NanCo requirements.
References:	Module 5: Network Resources Lab Case Study

Lab 5: Part 1 – Local Area Network Design

Step	Action
1	Refer to the NanCo case study located in Appendix A of this lab guide and Lab 5: Supporting Information in Appendix B. Create a high level diagram of the ArtPort <u>service</u> , depicting the included applications and the network requirements. Include any additional network services or dependencies required to support this service.
2	Is network segmentation a requirement to support the ArtPort service? What method(s) are viable for supporting segmentation in this design?
3	Using the previous information, create a second high level slide with a diagram and notes showing the network connectivity and solutions needed at the <u>infrastructure layer</u> to support ArtPort in the private cloud environments. Include support for host management. Note: This diagram will be part of your final presentation.
4	Given the description of the existing physical network, are there any concerns for deploying a cloud environment? What changes should be considered? Include this information in the final presentation.

Continued on next page

Lab 5: Part 2 - Storage Network Design

Step	Action
1	Given the description of the existing physical network, are there any concerns for deploying storage in the cloud environment? What changes should be considered?
2	Using the information from case study and Lab 4, modify your design to include network support for block storage traffic.
3	Using the information from case study and Lab 4, modify your design to include network support for object or file storage traffic.

End of Lab Exercise

Lab Exercise 6: Elasticity, Monitoring, and Metering

Purpose:	Understand the role of elasticity, monitoring, and metering and its impact on a cloud design.
Tasks:	• Identify relevant elasticity, monitoring, and metering requirements for the NanCo cloud design. • Amend the NanCo cloud design to reflect these requirements.
References:	Module 6: Elasticity, Monitoring, and Metering Lab Case Study

Lab 6: Part 1 – Elasticity

Step	Action
1	Refer to the NanCo case study located in Appendix A of this lab guide and Lab 6: Supporting Information in Appendix B. Identify CMP components that will be required to support the elastic requirements of the front-end server in the ArtPort service.
2	What impact will the web server elasticity have on the consumer service infrastructure?
3	Provide a high level overview slide describing infrastructure requirements for elastic capabilities of the ArtPort.

Continued on next page

Lab 6: Part 2 – Monitoring and Metering

Step	Action
1	Describe how monitoring and metering tools will support NanCo business requirements.
2	In the Cloud Management. Components table listed in Lab 5: Supporting Information in Appendix B, two of the monitoring components have an unknown quantity listed for the data storage. Why? How would this quantity be determined?
3	Provide a high level overview slide describing infrastructure requirements for monitoring and metering. Include information about tool placement, network connections, authentication, and so on.

End of Lab Exercise

Lab Exercise 7: Hybrid Cloud Design

Purpose:	Understand the impact of hybrid cloud capabilities on a cloud design.
Tasks:	• Identify relevant hybrid cloud requirements for the NanCo cloud design. • Amend the NanCo cloud design to highlight the impact of implementing hybrid cloud capabilities.
References:	Module 7: Hybrid Cloud Capabilities Lab Case Study

Lab 7: Part 1 – Hybrid Cloud Design

Step	Action
1	Refer to the Lab 7: Supporting Information in Appendix B. Describe how this change will influence the decisions for selecting cloud management components.
2	How would you implement a solution for the authentication requirement?
3	NanCo has concerns over bandwidth requirements between the two clouds. What factors will impact bandwidth consumption? What can be done to minimize impact while adhering to the listed requirements?
4	What concerns for security exist with the development environment existing in the public cloud?
5	Provide a high level overview slide summarizing the design changes to the infrastructure supporting the public cloud environment.

End of Lab Exercise

Lab Exercise 8: Service Backups

Purpose:	Develop a design and plan for deploying resources that support backing up services in the cloud.
Tasks:	• Identify service backup requirements that are relevant to NanCo cloud design. • Provide a high level overview slide summarizing the required design changes for supporting service backups.
References:	Module 8: Disaster Recovery Lab Case Study

Lab 8: Part 1 – BaaS Infrastructure Design

Step	Action
1	Identify and list the requirements for service backups in the NanCo case study.
2	Does NanCo require image-based or agent-based backups?
3	What cloud management components will be involved when implementing service backups? What additional components will be required?
4	Provide a high level overview slide summarizing the required design changes to supporting service backups.

End of Lab Exercise

Lab Exercise 9: Final Lab Design Presentation

Purpose:	The purpose of this lab is to summarize your design proposal for NanCo.
Tasks:	• Design and prepare a presentation • Present your team's design • Articulate all aspects of your design in a 20 minute or less presentation.
References:	• Lab Guide with completed exercises • Course Material • NanCo Case Study

Note: See Lab Introduction for requirements for this lab.

End of Lab Exercise

Appendix A: NanCo Art Services Case Study

NanCo is interested in creating a new private cloud environment to support development and production efforts.

Background

NanCo Art Services is a small company that develops a service named ArtPort that is used by art galleries to act as a virtual storefront and inventory tracking system. They currently have 50 active customers. The service provides general pricing, photo upload, and general description capabilities for each piece of artwork. What differentiates this service is that it also offers features such as links to map applications to indicate area of origin, timeline software to track historical relevance and value, links to authenticity records, and other features specific to the art business. These links are external to NanCo and are accessed through various providers.

NanCo Art Services has a 100 percent virtualized datacenter on premises that hosts traditional applications. NanCo has been exploring the possibility of using a cloud for the past year. They decided to use the public cloud initially to develop and test new cloud-native applications that augment or replace some of their traditional applications. Now NanCo wishes to build a private cloud in their data center to support these new applications. One reason for a private cloud is to maintain security for some of the future applications that will be migrated to the cloud. Another reason is the ability to create a second fault domain to house applications. NanCo believes that the growth in business will justify the cost of a new cloud infrastructure and will support business transformation. They will not abandon the deployment of applications in the public cloud when it makes sense but will focus on the private cloud for much of the deployment.

Senior Management expects their core business to grow in the art gallery space, but recently, various museums have expressed interest in a modified, non-sales version of the application. They expect that the demand for the gallery version of the ArtPort service will grow to over 200 customers in the next three years. NanCo Art Services wishes to also develop a single consumer website based on ArtPort. This consumer version will be used by individuals to list and sell art from private collections. Because of the expected growth in all of these areas, the company will be hiring more employees.

The current virtual infrastructure uses a preferred vendor's products. The management and IT staff are open to exploring the use of other virtualization products. The IT staff is very knowledgeable about the virtualization products that are currently in use but is also willing and capable to support any new solution if this should be required.

NanCo currently uses a standard server configuration from a preferred vendor. They wish to continue the vendor relationship and will continue to purchase the standard server configuration as long as it makes sense. The standard server configuration is a rack server with the following configuration.

Table 1: Standard Server Configuration

Height	2U
CPU	2 x 18 core, 3.0 GHz
RAM	256 (768 max.)
Disk Controller	RAID
Disk	2 x 76Gb SAS (16 max)
NIC	2 x 10Gb
Remote Mgmt.	1Gb interface

All existing servers are currently connected to a shared storage array using iSCSI protocols.

NanCo has a hierarchical network architecture that will be used to support the cloud. It consists of two core switches, two aggregate layer switches, and four access layer switches. The core switches are connected to each other by a pair of 10Gb connections. The aggregate layer switches are connected to each core via a pair of 10Gb connections. Each access switch has a single 10Gb connection to each aggregate switch. Multi-chassis link aggregation is enabled in this environment. The network supports VLANs and currently 12 VLANs are configured. The iSCSI storage array is connected to two of the access layer switches, each at 10Gb.

NanCo currently has a backup infrastructure that can accommodate image-based and agent-based backups.

ArtPort Service

A new ArtPort service is being developed in the public cloud. NanCo plans to make this service available from a catalog, and each customer will be given its own instance of the service. The service consists of a front-end web application, back-end database, and object storage. The web server is accessible from the Internet over ports 80 and 443 only, but the database server is only accessible by the web server. The object storage will be accessible from the Internet as well.

The ArtPort service will be scalable but the initial instance will consist of two load balancer instances supporting two web application instances. ArtPort will also contain two database instances that will also have load balancers for redundancy. The database instances will have a multi-master configuration and will replicate data. After much development and testing in the public cloud environment, it was determined that the initial instance of the ArtPort application should be allocated four virtual CPUs, eight GB RAM and 50 GB of total disk space.

ArtPort Images

Rather than store local copies of all images used through the environment. NanCo has decided that all images and related metadata be stored in object based storage. They feel that this would be more efficient from a storage perspective and would aide in the process of application upgrades and service mobility. They also feel that this may be helpful with regard to performance since their clients and consumers are becoming more global.

ArtPort Private Cloud Development Environment

NanCo currently has 15 developers that contribute and test code for the application. They expect this number to grow to 30 within a year. The developers do have a common set of development tools including a code repository but the installation of supporting tools and libraries is manual.

NanCo would like each developer to be able to deploy their own instance of the ArtPort service from a catalog. It is also possible that some of the developers will need multiple instances. Each instance would be deployed from standardized templates. To maintain proper versioning and control of the development environment, an automated system will be used to deploy the latest standard applications, development tool set and automation software to each instance.

In the development environment, although the new service will have built-in redundancy, there is no guarantee of infrastructure availability and all instances will be deployed in a single fault domain. If an instance fails or is corrupted, the developer will be expected to redeploy another ArtPort service instance. A redeploy will bring the applications and tools back to the proper version and the most recent code can be checked out of the repository. Developers will be responsible for backing up any other items to a personal directory located on network accessible storage.

NanCo expects that each developer will run an initial ArtPort instance and would like an additional 30% reserved capacity for possible scaling and overhead.

ArtPort Private Cloud Production Environment for Galleries and Museums

NanCo would also like to be able to move new production versions of the application into the catalog where IT staff and external customers can deploy ArtPort with minimal manual intervention. Each instance of the service will be accessed by one client. Data for that client should be protected. The production environment will have better performance characteristics than the development environment.

In the production environment, customers will be given the option to add scheduled backups to their database instances to protect against data corruption. If data corruption occurs, a restore can be accomplished in less than 12 hours, which is well within the 1 day service level agreement. NanCo would like the backup to be implemented within its datacenter.

In the event of a web application instance failure, a new instance will be deployed. In the event that the database instance fails, processing will failover to the secondary instance. Then a new database instance will then be deployed and synchronized with the remaining active instance.

NanCo expects that each gallery will run an initial ArtPort instance and would like an additional 40% reserve capacity for possible scaling and overhead.

ArtPort Private Cloud Production Environment for Individual Consumers

NanCo plans to hire an additional team of five developers to create a consumer version of the ArtPort service. This service will have a similar architecture but the difference is that there will only be one instance running in production supporting all individuals who wish to list and sell art from private collections. The development process will be similar to the gallery version with each developers using his or her own instance. Once the consumer version is deployed, the plan is to have it elastically scale resources depending on the site usage. The desire is for additional web application instances to be deployed during peak usage times and then scaled back during times of less usage.

It is expected that the consumer version will have similar performance and protection requirements as the gallery version. NanCo plans to deploy the initial instance of the consumer version with four web application instances and two database instances. The initial resource requirements for this instance are eight virtual CPUs, 16 GB RAM and 200 GB of total disk space. NanCo would like an additional 50% reserve capacity for possible scaling and overhead.

ArtPort Tools

Once ArtPort is available, NanCo executives would like to receive a monthly report that specifies how many customers are deploying the application, how many resources they are each using, and a breakdown of the costs for those services per customer. Customers may be charged a pre-negotiated price for the ArtPort deployment, but management would like this report to help understand overall costs to determine if the current pricing strategies make sense.

Other NanCo Existing Applications

1. Due to the anticipated growth in the number of NanCo employees, and the current use of internal applications for time card and employee benefits, NanCo Human Resources would like to explore the use of external applications.
2. IT, in-order to move an existing internal application to the cloud environment, will need some special database capabilities which must stay internal and will only be used by IT
3. Two existing NanCo applications require the use of file-based storage; one application is external and has compliance requirements, and the other is internal. Both have encryption needs.

ArtPort Use in External Cloud

One of the museums that expressed a strong interest in the modified non-sales version of the ArtPort application has concerns about NanCo being able to support their anticipated heavy utilization of the application. The museum has asked NanCo to consider an option where either a hybrid model is used, or the application is completely deployed in a public cloud.

Appendix B: Supporting Information for Lab Exercises

Lab 1: Supporting Information

No additional information for this lab.

Lab 2: Supporting Information

Listed below are the cloud management components that will be used to support the NanCo cloud. This table provides the component name and the resources required to support each for a 1500 instance environment.

Table 2: Cloud Mgmt. Components

Component	Number of VMs	vCPU	RAM (GB)	OS (GB)	Data (GB)
Virtual environment element manager	1	2	12	60	50
Database server for virtual environment element manager	1	8	16	60	196
Cloud Single Sign-On servers (2 configured for HA)	2	2	3	100	0
Object storage element manager	1	2	8	60	100
Block storage element manager	1	2	8	60	100
Software-defined storage controller (3 configured for HA)	3	4	8	600	0
Software-defined network controller (3 configured for HA)	3	4	4	24	0
Primary virtual firewall appliance for cloud infrastructure (HA)	2	2	1	0.5	0
Cloud portal and catalog	1	4	16	30	0
Database server for cloud portal and catalog	1	2	4	20	0
Cloud monitoring	1	2	8	100	0
Database for cloud monitoring	1	4	12	200	?????
Cloud central logging and analysis	1	4	8	40	?????
Cloud metering	1	2	4	50	0
Orchestration engine	1	2	4	10	0

- Assume also that the storage for the management will be on an existing array in their datacenter.
- Include an additional 20% overhead on all resources to support the hypervisor and other capabilities.
- For the management infrastructure, the oversubscription ratio for vCPU/CPU is 2.
- Listed below are additional specifications for supporting infrastructure components.

Table 3: Additional Component Specifications

Component	Number of VMs	vCPU	RAM (GB)	OS (GB)	Data (GB)
Load balancer virtual appliance	1	1	2	10	0

Lab 3: Supporting Information

- For the any consumer resource infrastructure, the oversubscription ratio for vCPU/CPU is 4.
- This table describes the resources required to support a configuration management function.

Table 4: Configuration Management

Configuration mgmt. server	1	2	4	50	0
Configuration mgmt. database server	1	2	8	50	100

Lab 4: Supporting Information

After conducting an assessment for storage, you have determined that NanCo would like to use its existing storage arrays to provide block storage to the hosts in the new consumer resource pools. The company's Storage Administrator/Architect assures you that the existing arrays have the capacity to support the current and future requirements. Any other storage requirements must be added.

Lab 5: Supporting Information

- Authentication to the portal and individual services in the development environment will be implemented by integrating with NanCo's existing Active Directory service. The Active Directory service is not available from the Internet.
- All network traffic between the development environment and remotely located staff should be secured.

Lab 6: Supporting Information

Use Table 3 for load balancer sizing.

Lab 7: Supporting Information

NanCo would like to maintain provisioning the development environment in the public cloud.

New requirements:

- The public cloud instances will require authentication to the internal Active Directory Services.
- Remote developers will not connect to the public cloud directly.
- Separate templates will be used to deploy in each of the private and public clouds.
- A single portal/catalog will be used to deploy instances.
- Monitoring will be performed by the internal monitoring tools.

Lab 8: Supporting Information

- No additional information for this lab.