CCNA Data Center
DCICT 640-916

NAVAID SHAMSEE, CCIE NO. 12625
DAVID KLEBANOV, CCIE NO. 13791
HESHAM FAYED, CCIE NO. 9303
AHMED AFROSE
OZDEN KARAKOK, CCIE NO. 6331

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Navaid Shamsee, David Klebanov, Hesham Fayed, Ahmed Afrose, Ozden Karakok

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About the Authors

Navaid Shamsee, CCIE No.12625, is a senior solutions architect in the Cisco Services organization. He holds a master's degree in telecommunication and a bachelor's degree in electrical engineering. He also holds a triple CCIE in routing and switching, service provider, and data center technologies. Navaid has extensive experience in designing and implementing many large-scale enterprise and service provider data centers. In Cisco, Navaid is focused on security of data center, cloud, and software-defined networking technologies. You can reach Navaid on Twitter: @NavaidShamsee.

David Klebanov, CCIE No.13791 (Routing and Switching) is a technical solutions architect with Cisco Systems. David has more than 15 years of diverse industry experience architecting and deploying complex network environments. In his work, David influences strategic development of the industry-leading data center switching platforms, which lay the foundation for the next generation of data center fabrics. David also takes great pride in speaking at industry events, releasing publications, and working on patents. You can reach David on Twitter: @DavidKlebanov.

Hesham Fayed, CCIE No.9303 (Routing and Switching/Data Center), is a consulting systems engineer for data center and virtualization based in California. Hesham has been with Cisco for more than 9 years and has 18 years of experience in the computer industry, working with service providers and large enterprises. His main focus is working with customers in the western region of the United States to address their challenges by doing end-to-end data center architectures.

Ahmed Afrose is a solutions architect with the Cisco Cloud and IT Transformation (CITT) services organization. He is responsible for providing architectural design guidance and leading complex multitech service deliveries. Furthermore, he is involved in demonstrating the Cisco value propositions in cloud software, application automation, software-defined data centers, and Cisco Unified Computing System (UCS). He is experienced in server operating systems and virtualization technologies and holds various certifications. Ahmed has a bachelor's degree in Information Systems. He started his career with Sun Microsystem-based technologies and has 15 years of diverse experience in the industry. He was also directly responsible for setting up Cisco UCS Advanced Services delivery capabilities while evangelizing the product in the region.

Ozden Karakok, CCIE No. 6331, is a technical leader from the data center products and technologies team in the Technical Assistant Center (TAC). Ozden has been with Cisco Systems for 15 years and specializes in storage area and data center networks. Prior to joining Cisco, Ozden spent five years working for a number of Cisco's large customers in various telecommunication roles. Ozden is a Cisco Certified Internetwork Expert in routing and switching, SNA/IP, and storage. She holds VCP and ITIL certifications and is a frequent speaker at Cisco and data center events. She holds a degree in computer engineering from Istanbul Bogazici University. Currently, she works on Application Centric Infrastructure (ACI) and enjoys being a mother of two wonderful kids.
About the Technical Reviewer

Frank Dagenhardt, CCIE No. 42081, is a systems engineer for Cisco, focusing primarily on data center architectures in commercial select accounts. Frank has more than 19 years of experience in information technology and holds certifications from HP, Microsoft, Citrix, and Cisco. A Cisco veteran of more than eight years, he works with customers daily, designing, implementing, and supporting end-to-end architectures and solutions, such as workload mobility, business continuity, and cloud/orchestration services. In recent months, he has been focusing on Tier 1 applications, including VDI, Oracle, and SAP. He presented on the topic of UCS/VDI at Cisco Live 2013. When not thinking about data center topics, Frank can be found backpacking, kayaking, or at home spending time with his wife Sansi and sons Frank and Everett.
Dedications

Navaid Shamsee: To my parents, for their guidance and prayers. To my wife, Hareem, for her love and support, and to my children, Ahasn, Rida, and Maria.

David Klebanov: This book is dedicated to my beautiful wife, Tanya, and our two wonderful daughters, Lia and Maya. You fill my life with great joy and make everything worth doing! In the words of a song: “Everything I do, I do it for you.” This book is also dedicated to all of you who relentlessly pursue the path of becoming Cisco-certified professionals. Through your dedication you build your own success. You are the industry leaders!

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—Navaid Shamsee

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—David Klebanov

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—Hesham Fayed
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—Ahmed Afrose

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—Ozden Karakok
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<td>Other Study Tasks 889</td>
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- Appendix B Memory Tables
- Appendix C Memory Tables Answer Key
- Appendix D Study Planner
Icons Used in This Book

- Layer 2 Switch
- Layer 3 Switch
- Nexus Switch
- Nexus 7000 Switch
- Router
- Printer
- PC
- Laptop
- Server
- IP Phone
- WAN Switch
- Frame Relay Switch
- Cable Modem
- DSLAM
- CSU/DSU
- Access Point
- Hub
- Bridge
- Phone
- PIX Firewall
- ASA
- Network Cloud
- Ethernet Connection
- Serial Line
- Virtual Circuit
- Ethernet WAN
- Wireless

Command Syntax Conventions

The conventions used to present command syntax in this book are the same conventions used in the IOS Command Reference. The Command Reference describes these conventions as follows:

- **Boldface** indicates commands and keywords that are entered literally as shown. In actual configuration examples and output (not general command syntax), boldface indicates commands that are manually input by the user (such as a *show* command).
■ *Italic* indicates arguments for which you supply actual values.
■ Vertical bars (|) separate alternative, mutually exclusive elements.
■ Square brackets ([ ]) indicate an optional element.
■ Braces ({{}}) indicate a required choice.
■ Braces within brackets ([[ ]]) indicate a required choice within an optional element.
Introduction

About the Exam

Congratulations! If you are reading far enough to look at this book’s Introduction, you’ve probably already decided to pursue your Cisco CCNA Data Center certification. Cisco dominates the networking marketplace, and after a few short years of entering the server marketplace, Cisco has achieved significant market share and has become one of the primary vendors for server hardware. If you want to succeed as a technical person in the networking industry in general, and in data centers in particular, you need to know Cisco. Getting your CCNA Data Center certification is a great first step in building your skills and becoming a recognized authority in the data center field.

Exams That Help You Achieve CCNA Data Center Certification

Cisco CCNA Data Center is an entry-level Cisco data center certification that is also a prerequisite for other Cisco Data Center certifications. CCNA Data Center itself has no other prerequisites. To achieve the CCNA Data Center certification, you must pass two exams: 640-911 Introduction to Cisco Data Center Networking (DCICN) and 640-916 Introduction to Cisco Data Center Technologies (DCICT), as shown in Figure I-1.

The DCICN and DCICT exams differ quite a bit in terms of the topics covered. DCICN focuses on networking technology. In fact, it overlaps quite a bit with the topics in the ICND1 100-101 exam, which leads to the Cisco Certified Entry Network Technician (CCENT) certification. DCICN explains the basics of networking, focusing on Ethernet switching and IP routing. The only data center focus in the DCICN exam is that all the configuration and verification examples use Cisco Nexus data center switches.

The DCICT exam instead focuses on technologies specific to the data center. These technologies include storage networking, Unified Computing (the term used by Cisco for their server and networking products), and virtualization. The only data center focus in the DCICT exam is that all the configuration and verification examples use Cisco Nexus data center switches.

Figure I-1  Path to Cisco CCNA Data Center Certification

The DCICN and DCICT exams differ quite a bit in terms of the topics covered. DCICN focuses on networking technology. In fact, it overlaps quite a bit with the topics in the ICND1 100-101 exam, which leads to the Cisco Certified Entry Network Technician (CCENT) certification. DCICN explains the basics of networking, focusing on Ethernet switching and IP routing. The only data center focus in the DCICN exam is that all the configuration and verification examples use Cisco Nexus data center switches.

The DCICT exam instead focuses on technologies specific to the data center. These technologies include storage networking, Unified Computing (the term used by Cisco for their server and networking products), and virtualization. The only data center focus in the DCICT exam is that all the configuration and verification examples use Cisco Nexus data center switches.
for its server products and services), Unified Fabric, network services, and data networking features unique to the Cisco Nexus series of switches.

**Types of Questions on the Exams**

Cisco certification exams follow the same general format. At the testing center, you sit in a quiet room in front of the PC. Before the exam timer begins, you can complete a few other tasks on the PC; for example, you can take a sample quiz just to get accustomed to the PC and the testing engine. Anyone who has basic skills in getting around a PC should have no problems with the testing environment.

After the exam starts, you will be presented with a series of questions, one at a time, on the PC screen. The questions typically fall into one of the following categories:

- Multiple choice, single answer
- Multiple choice, multiple answers
- Testlet
- Drag-and-drop (DND)
- Simulated lab (sim)
- Simlet

The first three items in the list are all multiple-choice questions. The multiple-choice format requires you to point to and click a circle or square beside the correct answer(s).

Cisco traditionally tells you how many answers you need to choose, and the testing software prevents you from choosing too many answers. The testlet asks you several multiple-choice questions, all based on the same larger scenario.

DND questions require you to move some items around in the graphical user interface (GUI). You left-click the mouse to hold the item, move it to another area, and release the mouse button to place the item in its destination (usually into a list). For some questions, to get the question correct, you might need to put a list of items in the proper order or sequence.

The last two types, sim and simlet questions, both use a network simulator to ask questions. Interestingly, the two types enable Cisco to assess two very different skills. First, sim questions generally describe a problem, while your task is to configure one or more routers and switches to fix it. The exam then grades the question based on the configuration you changed or added. Basically, these questions begin with a broken configuration, and you must fix it to answer the question correctly.

Simlet questions also use a network simulator, but instead of answering the question by changing or adding the configuration, they include one or more multiple-choice questions. These questions require you to use the simulator to examine network behavior by interpreting the output of `show` commands you decide to leverage to answer the question. Whereas sim questions require you to troubleshoot problems related to configuration, simlets require you to analyze both working and broken networks,
correlating show command output with your knowledge of networking theory and configuration commands.

You can watch and even experiment with these command types using the Cisco Exam Tutorial. To find the Cisco Certification Exam Tutorial, go to www.cisco.com and search for “exam tutorial.”

What’s on the DCICT Exam?

Everyone wants to know what is on the test, for any test, ever since the early days of school. Cisco openly publishes the topics of each of its certification exams. Cisco wants the candidates to know the variety of topics and get an idea about the kinds of knowledge and skills required for each topic.

Exam topics are very specific and the verb used in their description is very important. The verb tells us to what degree the topic must be understood and what skills are required. For example, one topic might begin with “Describe....” another with “Configure....” another with “Verify....” and another with “Troubleshoot....” Questions beginning with “Troubleshoot” require the highest skills level, because to troubleshoot, you must understand the topic, be able to configure it (to see what’s wrong with the configuration), and be able to verify it (to find the root cause of the problem). Pay attention to the question verbiage.

Cisco’s posted exam topics, however, are only guidelines. Cisco’s disclaimer language mentions that fact. Cisco makes an effort to keep the exam questions within the confines of the stated exam topics, and we know from talking to those involved that every question is analyzed for whether it fits the stated exam topic.

DCICT 640-916 Exam Topics

The exam topics for both the DCICN and DCICT exams can be easily found at Cisco.com by searching. Alternatively, you can go to www.cisco.com/go/ccna, which gets you to the page for CCNA Routing and Switching, where you can easily navigate to the nearby CCNA Data Center page.

Over time, Cisco has begun making two stylistic improvements to the posted exam topics. In the past, the topics were simply listed as bullets with indentation to imply subtopics under a major topic. More often today, including for the DCICN and DCICT exam topics, Cisco also numbers the exam topics, making it easier to refer to specific ones. Additionally, Cisco lists the weighting for each of the major topic headings. The weighting tells the percentage of points from your exam, which should come from each major topic area. The DCICT contains six major headings with their respective weighting, shown in Table I-1.
Table I-1  Six Major Topic Areas in the DCICT 640-916 Exam

<table>
<thead>
<tr>
<th>Number</th>
<th>Exam Topic</th>
<th>Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Cisco Data Center Fundamental Concepts</td>
<td>30%</td>
</tr>
<tr>
<td>2.0</td>
<td>Data Center Unified Fabric</td>
<td>20%</td>
</tr>
<tr>
<td>3.0</td>
<td>Storage Networking</td>
<td>18%</td>
</tr>
<tr>
<td>4.0</td>
<td>Data Center Virtualization</td>
<td>14%</td>
</tr>
<tr>
<td>5.0</td>
<td>Cisco Unified Computing</td>
<td>17%</td>
</tr>
<tr>
<td>6.0</td>
<td>Data Center Network Services</td>
<td>1%</td>
</tr>
</tbody>
</table>

Note that while the weighting of each topic area tells you something about the exam, in the authors’ opinion, the weighting probably does not change how you study. All six topic areas hold enough weighting so that if you completely ignore an individual topic, you probably will not pass. Furthermore, data center technologies require you to put many concepts together, so you need all the pieces before you can understand the holistic view. The weighting might indicate where you should spend a little more time during the last days before taking the exam, but otherwise, plan to study all the exam topics.

Tables I-2 through I-7 list the details of the exam topics, with one table for each of the major topic areas listed in Table I-1. Note that these tables also list the book chapters that discuss each of the exam topics.

Table I-2  Exam Topics in the First Major DCICT Exam Topic Area

<table>
<thead>
<tr>
<th>Number</th>
<th>Exam Topic</th>
<th>Chapter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Cisco Data Center Fundamentals Concepts</td>
<td>1</td>
</tr>
<tr>
<td>1.1</td>
<td>Describe Network Architectures for the Data Center and the Purpose and Functions of Various Network Devices</td>
<td>1</td>
</tr>
<tr>
<td>1.1a</td>
<td>LAN</td>
<td>1</td>
</tr>
<tr>
<td>1.1b</td>
<td>SAN</td>
<td>6, 8</td>
</tr>
<tr>
<td>1.2</td>
<td>Describe the Modular Approach in Network Design</td>
<td>1</td>
</tr>
<tr>
<td>1.3</td>
<td>Describe the Data Center Core Layer</td>
<td>1</td>
</tr>
<tr>
<td>1.4</td>
<td>Describe the Data Center Aggregation Layer</td>
<td>1</td>
</tr>
<tr>
<td>1.5</td>
<td>Describe the Data Center Access Layer</td>
<td>1</td>
</tr>
<tr>
<td>1.6</td>
<td>Describe the Collapse Core Model</td>
<td>1</td>
</tr>
<tr>
<td>1.7</td>
<td>Describe FabricPath</td>
<td>1</td>
</tr>
<tr>
<td>1.8</td>
<td>Identify Key Differentiator Between DCI and Network Interconnectivity</td>
<td>4</td>
</tr>
<tr>
<td>1.9</td>
<td>Describe Configure and Verify vPC</td>
<td>1</td>
</tr>
<tr>
<td>Number</td>
<td>Exam Topic</td>
<td>Chapter</td>
</tr>
<tr>
<td>--------</td>
<td>----------------------------------------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>1.10</td>
<td>Describe the Functionality of and Configuration of Port Channels</td>
<td>1</td>
</tr>
<tr>
<td>1.11</td>
<td>Describe and Configure Virtual Device Contexts (VDC)</td>
<td>3</td>
</tr>
<tr>
<td>1.12</td>
<td>Describe the Edge/Core Layer of the SAN</td>
<td>6</td>
</tr>
<tr>
<td>1.13</td>
<td>Describe the Cisco Nexus Product Family</td>
<td>2, 7</td>
</tr>
<tr>
<td>1.14</td>
<td>Configure and Verify Network Connectivity</td>
<td>5</td>
</tr>
<tr>
<td>1.15</td>
<td>Identify Control and Data Plane Traffic</td>
<td>5</td>
</tr>
<tr>
<td>1.16</td>
<td>Perform Initial Setup</td>
<td>5</td>
</tr>
</tbody>
</table>

**Table I-3**  
*Exam Topics in the Second Major DCICT Exam Topic Area*

<table>
<thead>
<tr>
<th>Number</th>
<th>Exam Topic</th>
<th>Chapter</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0</td>
<td>Data Center Unified Fabric</td>
<td>10</td>
</tr>
<tr>
<td>2.1</td>
<td>Describe FCoE</td>
<td>11</td>
</tr>
<tr>
<td>2.2</td>
<td>Describe FCoE Multihop</td>
<td>12</td>
</tr>
<tr>
<td>2.3</td>
<td>Describe VIFs</td>
<td>3</td>
</tr>
<tr>
<td>2.4</td>
<td>Describe FEX Products</td>
<td>2</td>
</tr>
<tr>
<td>2.5</td>
<td>Perform Initial Setup</td>
<td>11</td>
</tr>
</tbody>
</table>

**Table I-4**  
*Exam Topics in the Third Major DCICT Exam Topic Area*

<table>
<thead>
<tr>
<th>Number</th>
<th>Exam Topic</th>
<th>Chapter</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.0</td>
<td>Data Center Storage Area Networking</td>
<td>6, 7</td>
</tr>
<tr>
<td>3.1</td>
<td>Describe Initiator Target</td>
<td>6</td>
</tr>
<tr>
<td>3.2</td>
<td>Verify SAN Switch Operations</td>
<td>9</td>
</tr>
<tr>
<td>3.3</td>
<td>Describe Basic SAN Connectivity</td>
<td>6</td>
</tr>
<tr>
<td>3.4</td>
<td>Describe the Different Storage Array Connectivity</td>
<td>6, 8</td>
</tr>
<tr>
<td>3.5</td>
<td>Verify Name Server Login</td>
<td>9</td>
</tr>
<tr>
<td>3.6</td>
<td>Describe, Configure and Verify Zoning</td>
<td>6, 9</td>
</tr>
<tr>
<td>3.7</td>
<td>Perform Initial Setup</td>
<td>9</td>
</tr>
<tr>
<td>3.8</td>
<td>Describe, Configure and Verify VSAN</td>
<td>6, 9</td>
</tr>
</tbody>
</table>
### Table I-5  Exam Topics in the Fourth Major DCICT Exam Topic Area

<table>
<thead>
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<th>Exam Topic</th>
<th>Chapter</th>
</tr>
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<tr>
<td>4.0</td>
<td>Data Center Server Virtualization</td>
<td>17</td>
</tr>
<tr>
<td>4.1</td>
<td>Describe Device Virtualization</td>
<td>3</td>
</tr>
<tr>
<td>4.2</td>
<td>Describe Nexus 1000v</td>
<td>18</td>
</tr>
<tr>
<td>4.3</td>
<td>Verify Initial Setup and Operations for Nexus 1000v</td>
<td>18</td>
</tr>
</tbody>
</table>

### Table I-6  Exam Topics in the Fifth Major DCICT Exam Topic Area

<table>
<thead>
<tr>
<th>Number</th>
<th>Exam Topic</th>
<th>Chapter</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.0</td>
<td>Cisco Unified Computing</td>
<td>13</td>
</tr>
<tr>
<td>5.1</td>
<td>Describe and Verify Discovery Operation</td>
<td>14</td>
</tr>
<tr>
<td>5.2</td>
<td>Describe, Configure and Verify Connectivity</td>
<td>14, 15</td>
</tr>
<tr>
<td>5.3</td>
<td>Perform Initial Setup</td>
<td>14</td>
</tr>
<tr>
<td>5.4</td>
<td>Describe the Key Features of UCSM</td>
<td>14, 16</td>
</tr>
</tbody>
</table>

### Table I-7  Exam Topics in the Sixth Major DCICT Exam Topic Area

<table>
<thead>
<tr>
<th>Number</th>
<th>Exam Topic</th>
<th>Chapter</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.0</td>
<td>Data Center Network Services</td>
<td>19</td>
</tr>
<tr>
<td>6.1</td>
<td>Describe Standard ACE Features for Load Balancing</td>
<td>19</td>
</tr>
<tr>
<td>6.2</td>
<td>Describe Server Load Balancing Virtual Context and HA</td>
<td>19</td>
</tr>
<tr>
<td>6.3</td>
<td>Describe Server Load Balancing Management Options</td>
<td>19</td>
</tr>
<tr>
<td>6.4</td>
<td>Describe How the Cisco Global Load Balancing Solution</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Integrates with Local Cisco Load Balancers</td>
<td></td>
</tr>
<tr>
<td>6.5</td>
<td>Describe Cisco WAAS Needs and Advantages in the Data</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Center</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE** Because it is possible that the exam topics may change over time, it might be worth the time to double-check the exam topics as listed on the Cisco website (www.cisco.com/go/certifications and navigate to the CCNA Data Center page).
About the Book

This book discusses the content and skills needed to pass the 640-916 DCICT certification exam, which is the second and final exam to achieve CCNA Data Center certification. This book’s companion title, *CCNA Data Center DCICN 640-911 Official Cert Guide*, discusses the content needed to pass the 640-911 DCICN certification exam.

We strongly recommend that you plan and structure your learning to align with both exam requirements.

Book Features

The most important and somewhat obvious objective of this book is to help you pass the DCICT exam and help you achieve the CCNA Data Center certification. In fact, if the primary objective of this book were different, the book’s title would be misleading! At the same time, the methods used in this book to help you pass the exam are also designed to make you much more knowledgeable in the general field of the data center and help you in your daily job responsibilities.

This book uses several tools to help you discover your weak topic areas, to help you improve your knowledge and skills with those topics, and to prove that you have retained your knowledge of those topics. Importantly, this book does not try to help you pass the exams only by memorization, but by truly learning and understanding the topics. CCNA entry-level certification is the foundation for many of the Cisco professional-level certifications, and it would be a disservice to you if this book did not help you truly learn the material. This book helps you pass the CCNA exam by using the following methods:

- Helping you discover which exam topics you have not mastered
- Providing explanations and information to fill in your knowledge gaps
- Supplying exercises that enhance your ability to grasp topics and deduce the answers to subjects related to the exam
- Providing practice exercises on the topics and the testing process via test questions on the CD

Chapter Features

To help you customize study time using this book, the core chapters have several features that help you make the best use of your time:

- “Do I Know This Already?” Quizzes: Each chapter begins with a quiz that helps you determine the amount of time you need to spend studying the chapter.
- Foundation Topics: These are the core sections of each chapter. They explain the protocols, concepts, and configuration for the topics in the chapter.
- Exam Preparation Tasks: At the end of the “Foundation Topics” section of each chapter, the “Exam Preparation Tasks” section lists a series of study activities that should be completed at the end of the chapter. Each chapter includes the activities
that make the most sense for studying the topics in that chapter. The activities include the following:

- **Review Key Topics:** The Key Topic icon is shown next to the most important items in the “Foundation Topics” section of the chapter. The “Review Key Topics” activity lists the key topics from the chapter and their corresponding page numbers. Although the content of the entire chapter could appear on the exam, you should definitely know the information listed in each key topic.

- **Complete Tables and Lists from Memory:** To help you exercise your memory and memorize certain lists of facts, many of the more important lists and tables from the chapter are included in a document on the CD. This document lists only partial information, allowing you to complete the table or list.

- **Define Key Terms:** Although the exam might be unlikely to ask a question such as, “Define this term,” the CCNA exams require that you learn and know a lot of networking terminology. This section lists the most important terms from the chapter, asking you to write a short definition and compare your answer to the Glossary at the end of this book.

- **References:** Some chapters contain a list of reference links for additional information and details on the topics discussed in that particular chapter.

**Part Review**

The part review tasks help you prepare to apply all the concepts you learned in that part of the book. Each book part contains several related chapters. The part review includes sample test questions that require you to apply the concepts from multiple chapters in that part, uncovering what you truly understood and what you did not quite yet understand.

The part reviews list tasks, along with checklists, so that you can track your progress. The following list explains the most common tasks you will see in the part review:

- **Review “Do I Know This Already?” (DIKTA) Questions:** Although you have already seen the DIKTA questions from the chapters in a part, answering those questions again can be a useful way to review facts. The “Part Review” section suggests that you repeat the DIKTA questions, but use the Pearson IT Certification Practice Test (PCPT) exam software that comes with the book, for extra practice in answering multiple-choice questions on a computer.

- **Answer Part Review Questions:** The PCPT exam software includes several exam databases. One exam database holds part review questions, written specifically for part reviews. These questions purposefully include multiple concepts in each question, sometimes from multiple chapters, to help build the skills needed for the more challenging analysis questions on the exams.

- **Review Key Topics:** Yes, again! They are indeed the most important topics in each chapter.

- **Open Self-Assessment Questions:** The exam is unlikely to ask a question such as, “Define this term,” but the CCNA exams require that you learn and know a lot of
technology concepts and architectures. This section asks you some open questions that you should try to describe or explain in your own words. This will help you develop a thorough understanding of important exam topics pertaining to that part.

Final Prep Tasks

Chapter 21, “Final Review,” lists a series of tasks that you can use for your final preparation before taking the exam.

Other Features

In addition to the features in each of the core chapters, this book, as a whole, has additional study resources, including the following:

- **CD-based practice exam:** The companion CD contains the powerful PCPT exam engine. You can answer the questions in study mode or take simulated DCICT exams with the CD and activation code included in this book.

- **eBook:** If you are interested in obtaining an e-book version of this title, we have included a special offer on a coupon card inserted in the CD sleeve in the back of the book. This offer enables you to purchase the *CCNA Data Center DCICT 640-916 Official Cert Guide, Premium Edition* e-book and practice test at a 70 percent discount off the list price. In addition to three versions of the e-book—PDF (for reading on your computer), EPUB (for reading on your tablet, mobile device, or Nook or other e-reader), and Mobi (the native Kindle version)—you will receive additional practice test questions and enhanced practice test features.

- **Companion website:** The website [www.ciscopress.com/title/9781587144226](http://www.ciscopress.com/title/9781587144226) posts up-to-the-minute material that further clarifies complex exam topics. Check this site regularly for new and updated postings written by the authors that provide further insight into the more troublesome topics on the exam.

- **PearsonITCertification.com:** The website [www.pearsonitcertification.com](http://www.pearsonitcertification.com) is a great resource for all things IT-certification related. Check out the great CCNA articles, videos, blogs, and other certification preparation tools from the industry’s best authors and trainers.

Book Organization, Chapters, and Appendixes

This book contains 20 core chapters—Chapters 1 through 20, with Chapter 21 including some suggestions for how to approach the actual exams. Each core chapter covers a subset of the topics on the 640-916 DCICT exam. The core chapters are organized into sections. The core chapters cover the following topics:

Part I: Data Center Networking

- **Chapter 1, “Data Center Network Architecture”:** This chapter provides an overview of the data center networking architecture and design practices relevant to the exam. It goes into the detail of multilayer data center network design and technologies, such as port channel, virtual port channel, and Cisco FabricPath.
configuration and verification commands for these technologies are also included in this chapter.

■ Chapter 2, “Cisco Nexus Product Family”: This chapter provides an overview of the Nexus switches product family. The chapter explains the different specifications of each product, which includes Nexus 9000, Nexus 7000, Nexus 6000, Nexus 5000, Nexus 3000, and Nexus 2000.

■ Chapter 3, “Virtualizing Cisco Network Devices”: This chapter covers the virtualization capabilities of the Nexus 7000 and Nexus 5000, using Virtual Device Contexts (VDC) and Network Interface Virtualization (NIV). It details the VDC concept and the VDC deployment scenarios. The different VDC types and commands used to configure and verify the setup are also included in the chapter. Also covered in this chapter is the NIV—what it is, how it works, and how it is configured.

■ Chapter 4, “Data Center Interconnect”: This chapter covers the latest Cisco innovations in the data center extension solutions and in LAN extension in particular, which is called Overlay Transport Virtualization (OTV). It goes into detail about OTV, how it works, and how it is deployed. Commands to configure and how to verify the operation of the OTV are also covered in this chapter.

■ Chapter 5, “Management and Monitoring of Cisco Nexus Devices”: This chapter provides an overview of operational planes of the Nexus platform. It explains the functions performed by each plane and the key features of data plane, control plane, and management plane. It also provides an overview of out-of-band and in-band management interfaces. The Nexus platform provides several methods for device configuration and management. These methods are also discussed with some important commands for initial setup, configuration, and verification. This chapter also identifies the mechanism available in the Nexus platform to protect the control plane of the switch.

Part II: Data Center Storage-Area Networking

■ Chapter 6, “Data Center Storage Architecture”: This chapter provides an overview of the data center storage-networking technologies. It compares Small Computer System Interface (SCSI), Fibre Channel, network-attached storage (NAS) connectivity for remote server storage, and storage-area network (SAN). It covers Fibre Channel protocol and operations in detail. The edge/core layer of the SAN design is also included.

■ Chapter 7, “Cisco MDS Product Family”: This chapter provides an overview of the Cisco Multilayer Data Center Switch (MDS) product family in four main areas: Cisco MDS Multilayer Directors, Cisco MDS Multiservice and Multilayer Fabric Switches, Cisco MDS Software and Storage Services, and Data Center Network Management. This chapter goes directly into the key concepts of the Cisco Storage Networking product family, and the focus is on the current generation of modules and storage services solutions.
Chapter 8, “Virtualizing Storage”: Storage virtualization is the process of combining multiple network storage devices into what appears to be a single storage unit. Server virtualization is partitioning a physical server into smaller virtual servers. Network virtualization is using network resources through a logical segmentation of a single physical network. Application virtualization is decoupling the application and its data from the operating system. This chapter guides you through storage virtualization concepts answering basic what, why, and how questions. It goes directly into the key concepts of storage virtualization.

Chapter 9, “Fibre Channel Storage-Area Networking”: This chapter provides an overview of how to configure Cisco MDS 9000 Series multilayer switches and how to update software licenses. It also describes how to verify virtual storage-area networks (VSAN), zoning, the fabric login, fabric domain, VSAN trunking, and setting up an ISL port using the command-line interface. This chapter goes directly into the practical configuration steps of the Cisco MDS product family and discusses topics relevant to Introducing Cisco Data Center Technologies (DCICT) certification. It also covers the power-on auto provisioning (POAP).

Part III: Data Center Unified Fabric

Chapter 10, “Unified Fabric Overview”: This chapter provides an overview of challenges faced by today’s data centers. It focuses on how Cisco Unified Fabric architecture addresses those challenges by converging traditionally disparate network and storage environments while providing a platform for scalable, secure, and intelligent services. It also takes a look at some of the technologies allowing extension of the Unified Fabric environment beyond the boundary of a single data center.

Chapter 11, “Data Center Bridging and FCoE”: This chapter introduces principles behind IEEE data center bridging standards and explains how they enhance traditional Ethernet environments to support convergence of network and storage traffic over a single Unified Fabric. It discusses FCoE protocol and its operation over numerous switching topologies leveraging a variety of Cisco Fabric Extension technologies. It also takes a look at different cabling options to support a converged Unified Fabric environment.

Chapter 12, “Multihop Unified Fabric”: This chapter discusses various options for multihop FCoE topologies to extend the reach of Unified Fabric beyond the single-hop boundary. It takes a look at characteristics of each option, as well as their benefits and challenges. It also discusses the use of converged Unified Fabric leveraging Cisco FabricPath technology.

Part IV: Cisco Unified Computing

Chapter 13, “Cisco Unified Computing System Architecture”: This chapter begins with a quick fly-by on the evolution of server computing, followed by an introduction to the Cisco UCS value proposition, hardware, and software portfolio. Then the chapter explains UCS architecture in terms of component connectivity options and unification of blade and rackmount server connectivity. It also details the Cisco Integrated Management Controller architecture and purpose.
Chapter 14, “Cisco Unified Computing System Manager”: This chapter starts by describing how to set up, configure, and verify the Cisco UCS Fabric Interconnect cluster. It then describes the process of hardware and software discovery in Cisco UCS. It also explains how to monitor and verify this process.

Chapter 15, “Cisco Unified Computing System Pools, Policies, Templates, and Service Profiles”: The chapter starts by explaining the hardware abstraction layer in more detail and how it relates to stateless computing, followed by explanations of logical and physical resource pools and the essentials to create templates and aid rapid deployment of service profiles. As a bonus, you also see notes, tips, and most relevant features.

Chapter 16, “Administration, Management, and Monitoring of Cisco Unified Computing System”: This chapter starts by explaining some of the important features used when administering and monitoring Cisco UCS. It also gives you an introduction to Cisco UCS XML, goUCS automation toolkit, and the well-documented UCS XML API using the Python SDK.

Part V: Data Center Server Virtualization

Chapter 17, “Server Virtualization Solutions”: This chapter takes a peek into the history of server virtualization and discusses fundamental principles behind different types of server virtualization technologies. It evaluates the benefits and challenges of server virtualization while offering approaches to mitigate performance and security concerns.

Chapter 18, “Cisco Nexus 1000V and Virtual Switching”: The chapter starts by describing the challenges of current virtual switching layers in data centers, and then introduces the distributed virtual switches and, in particular, the Cisco vision—Cisco Nexus 1000V. The chapter explains installation options, commands to verify initial configuration of virtual Ethernet modules, virtual supervisory modules, and integration with VMware vCenter Server.

Part VI: Data Center Network Services

Chapter 19, “Cisco ACE and GSS”: This chapter gives you an overview of server load balancing concepts required for the DCICT exam. It describes Cisco Application Control Engine (ACE) and Global Site Selector (GSS) products and their key features, which helps in choosing the correct solution for the load balancing requirements in the data center. It also details different deployment modes of ACE and their application within the data center design. GSS and ACE integration is also explained using an example.

Chapter 20, “Cisco WAAS and Application Acceleration”: This chapter gives you an overview of the challenges associated with a wide-area network. It explains the Cisco WAAS solution and describes the concepts and features that are important for the DCICT exam. Cisco supports a range of hardware and software platforms that are suitable for various wide-area network optimization and application acceleration
requirements. An overview of these products is also provided in this chapter. The methods used to optimize the WAN traffic are also discussed in detail.

Part VII: Final Preparation

- **Chapter 21, “Final Review”:** This chapter suggests a plan for exam preparation after you have finished the core parts of the book, in particular explaining the many study options available in the book.

- **Appendix A, “Answers to the ‘Do I Know This Already?’ Quizzes”:** Includes the answers to all the questions from Chapters 1 through 20.

- **The Glossary** contains definitions for all the terms listed in the “Definitions of Key Terms” section at the conclusion of Chapters 1 through 20.

Appendixes On the CD

- **Appendix B, “Memory Tables”:** Holds the key tables and lists from each chapter, with some of the content removed. You can print this appendix and, as a memory exercise, complete the tables and lists. The goal is to help you memorize facts that can be useful on the exams.

- **Appendix C, “Memory Tables Answer Key”:** Contains the answer key for the exercises in Appendix B.

- **Appendix D, “Study Planner”:** A spreadsheet with major study milestones enabling you to track your progress through your study.
Reference Information

This short section contains a few topics available for reference elsewhere in the book. You may read these when you first use the book, but you may also skip these topics and refer to them later. In particular, make sure to note the final page of this introduction, which lists several contact details, including how to get in touch with Cisco Press.

Install the Pearson IT Certification Practice Test Engine and Questions

The CD in the book includes the Pearson IT Certification Practice Test (PCPT) engine (software that displays and grades a set of exam-realistic multiple-choice, drag-and-drop, fill-in-the-blank, and testlet questions). Using the PCPT engine, you can either study by going through the questions in study mode, or you can take a simulated DCICT exam that mimics real exam conditions.

The installation process requires two major steps. The CD in the back of this book has a recent copy of the PCPT engine. The practice exam (the database of DCICT exam questions) is not on the CD. After you install the software, the PCPT software will use your Internet connection and download the latest versions of both the software and the question databases for this book.

NOTE The cardboard CD case in the back of this book includes both the CD and a piece of thick paper. The paper lists the activation code for the practice exam associated with this book. Do not lose the activation code.

NOTE Also on this same piece of paper, on the opposite side from the exam activation code, you will find a one-time-use coupon code that will give you 70% off the purchase of the CCNA Data Center DCICT 640-916 Official Cert Guide, Premium Edition eBook and Practice Test.

Install the Software from the CD

The software installation process is routine as compared with other software installation processes. If you have already installed the PCPT software from another Pearson product, you do not need to reinstall the software. Simply launch the software on your desktop and proceed to activate the practice exam from this book by using the activation code included in the CD sleeve. The following steps outline the installation process:

Step 1. Insert the CD into your PC.

Step 2. The software that automatically runs is the Cisco Press software to access and use all CD-based features, including the exam engine. From the main menu, click the option to Install the Exam Engine.
Step 3. Respond to windows prompts as with any typical software installation process.

The installation process gives you the option to activate your exam with the activation code supplied on the paper in the CD sleeve. This process requires that you establish a Pearson website login. You will need this login to activate the exam, so please do register when prompted. If you already have a Pearson website login, there is no need to register again. Just use your existing login.

Activate and Download the Practice Exam

When the exam engine is installed, you should then activate the exam associated with this book (if you did not do so during the installation process) as follows:

Step 1. Start the PCPT software from the Windows Start menu or from your desktop shortcut icon.

Step 2. To activate and download the exam associated with this book, from the My Products or Tools tab, click the Activate button.

Step 3. At the next screen, enter the activation key from paper inside the cardboard CD holder in the back of the book. Then click the Activate button.

Step 4. The activation process will download the practice exam. Click Next, and then click Finish.

When the activation process completes, the My Products tab should list your new exam. If you do not see the exam, make sure that you have selected the My Products tab on the menu. At this point, the software and practice exam are ready to use. Just select the exam and click the Open Exam button.

To update a particular product’s exams that you have already activated and downloaded, select the Tools tab and click the Update Products button. Updating your exams will ensure that you have the latest changes and updates to the exam data.

If you want to check for updates to the PCPT software, select the Tools tab and click the Update Application button. This will ensure that you are running the latest version of the software engine.

Activating Other Products

The exam software installation process and the registration process have to happen only once. Then for each new product, only a few steps are required. For instance, if you buy another new Cisco Press Official Cert Guide or Pearson IT Certification Cert Guide, extract the activation code from the CD sleeve in the back of that book; you do not even need the CD at this point. From there, all you have to do is start PCPT (if not still up and running) and perform Steps 2 through 4 from the previous list.
PCPT Exam Databases with This Book

This book includes an activation code that allows you to load a set of practice questions. The questions come in different exams or exam databases. When you install the PCPT software and type in the activation code, the PCPT software downloads the latest version of all these exam databases. With the DCICT book alone, you get four different “exams,” or four different sets of questions.

You can choose to use any of these exam databases at any time, both in study mode and practice exam mode. However, many people find it best to save some of the exams until exam review time, after they have finished reading the entire book. Here is a suggested study plan:

■ During part review, use PCPT to review the DIKTA questions for that part, using study mode.
■ During part review, use the questions built specifically for part review (the part review questions) for that part of the book, using study mode.
■ Save the remaining exams to use with Chapter 21, “Final Review,” using practice exam mode.

The two modes inside PCPT give you better options for study versus practicing a timed exam event. In study mode, you can see the answers immediately, so you can study the topics more easily. Also, you can choose a subset of the questions in an exam database; for instance, you can view questions from the chapters in only one part of the book.

Practice exam mode creates an event somewhat like the actual exam. It gives you a preset number of questions, from all chapters, with a timer event. Practice exam mode also gives you a score for that timed event.

How to View Only DIKTA Questions by Part

Each “Part Review” section asks you to repeat the Do I Know This Already (DIKTA) quiz questions from the chapters in that part. Although you could simply scan the book pages to review these questions, it is slightly better to review these questions from inside the PCPT software, just to get a little more practice in how to read questions from the testing software.

To view these DIKTA (book) questions inside the PCPT software, follow these steps:

Step 1. Start the PCPT software.

Step 2. From the main (home) menu, select the item for this product, with a name like DCICT 640-916 Official Cert Guide, and click Open Exam.

Step 3. The top of the next window that appears should list some exams; select the box beside DCICT Book Questions, and deselect the other boxes. This selects the “book” questions (that is, the DIKTA questions from the beginning of each chapter).
Step 4. In this same window, click at the bottom of the screen to deselect all objectives (chapters), then select the box beside each chapter in the part of the book you are reviewing.

Step 5. Select any other options on the right side of the window.

Step 6. Click Start to start reviewing the questions.

How to View Only Part Review Questions by Part

The exam databases you get with this book include a database of questions created solely for study during the part review process. DIKTA questions focus more on facts, with basic application. The part review questions instead focus more on application and look more like real exam questions.

To view these questions, follow the same process as you did with DIKTA/book questions, but select the part review database instead of the book database, as follows:

Step 1. Start the PCPT software.

Step 2. From the main (home) menu, select the item for this product, with a name like DCICT 640-916 Official Cert Guide, and click Open Exam.

Step 3. The top of the next window should list some exams; select the box beside Part Review Questions, and deselect the other boxes. This selects the questions intended for part-ending review.

Step 4. On this same window, click at the bottom of the screen to deselect all objectives, and then select (check) the box beside the book part you want to review. This tells the PCPT software to give you part review questions from the selected part.

Step 5. Select any other options on the right side of the window.

Step 6. Click Start to start reviewing the questions.

For More Information

If you have any comments about the book, submit them via www.ciscopress.com. Just go to the website, select Contact Us, and type your message.

Cisco might make changes that affect the CCNA data center certification from time to time. You should always check www.cisco.com/go/certification for the latest details.

The CCNA Data Center DCICT 640-916 Official Cert Guide helps you attain the CCNA data center certification. This is the DCICT exam prep book from the only Cisco-authorized publisher. We at Cisco Press believe that this book certainly can help you achieve CCNA data center certification, but the real work is up to you! We trust that your time will be well spent.
Getting Started

It might look like this is yet another certification exam preparation book—indeed, it is. We welcome your decision to become a Cisco Certified Network Associate Data Center professional! You are probably wondering how to get started, and today you are making a very significant step in achieving your goal. A team of five data center professionals came together to carefully pick the content for this book to send you on your CCNA data center certification journey.

Strategizing about your studying is a key element to your success. Spend time thinking about key milestones you want to reach, and plan accordingly to review material for exam topics you are less comfortable with. This “Getting Started” chapter guides you through building a strategy toward success. Take time to review it before starting your CCNA data center certification journey.

A Brief Perspective on the CCNA Data Center Certification Exam

Cisco sets the bar somewhat high for passing its certification exams, including all the exams related to CCNA certifications, such as CCNA data center. These exams challenge you from many angles, such as your ability to analyze, configure, and troubleshoot networking features, understand relevant technology landscape, and analyze emerging technology trends. The CCNA data center exam puts your knowledge in network, storage, compute, virtualization, and security to the test.

Many questions in the CCNA data center certification exam apply to connectivity between the data center devices. For example, a question might give you a data center topology diagram and then ask what needs to be configured to make that setup work, what needs to be considered when designing that topology, what is the missing ingredient of the solution, and so on. You will need certain analytical problem-solving skills. Such skills require you to prepare by doing more than just reading and memorizing this book’s material. This book offers a solid foundation for the knowledge required to pass the CCNA data center certification exam, but at the same time it also encourages you to continue your journey to become a better data center networking professional.

Suggestions for How to Approach Your Study with This Book

Although Cisco certification exams are challenging, many people pass them every day. So, what do you need to do to be ready to pass the exam? We encourage you to build your theoretical knowledge by thoroughly reading this book and taking time to remember the most critical facts. At the same time, we also encourage you to develop your practical
knowledge by having hands-on experience in the topics covered in the CCNA data center certification exam.

Think about studying for the CCNA data center certification exam as preparing for a marathon. It requires a bit of practice every day.

What I Talk About When I Talk About Running is a memoir by Haruki Murakami in which he writes about his interest and participation in long-distance running. Murakami started running in the early 1980s; since then, he has competed in more than 20 marathons and an ultramarathon. On running as a metaphor, he wrote in his book: “For me, running is both exercise and a metaphor. Running day after day, piling up the races, bit-by-bit I raise the bar, and by clearing each level I elevate myself. At least that’s why I’ve put in the effort day after day: to raise my own level. I’m no great runner, by any means. I’m at an ordinary—or perhaps more like mediocre—level. But that’s not the point. The point is whether or not I improved over yesterday. In long-distance running the only opponent you have to beat is yourself, the way you used to be.”

Similar principles apply here, and the only opponent you have to beat is yourself.

This Book Is Compiled from 20 Short Read-and-Review Sessions

First, look at your study as a series of read-and-review tasks, each on a relatively small set of related topics. These topics are structured to cover main data center infrastructure technologies, such as Network, Computer, Server Virtualization, and Storage-Area Networks in a Data Center.

This book has 20 content chapters covering the topics you need to know to pass the exam. Each chapter consists of numerous “Foundation Topics” sections and “Exam Preparation Tasks” at the end. Take time to review this book chapter by chapter and topic by topic. Plan your time accordingly and make progress every day. Each chapter marks key topics you should pay extra attention to. Review those sections carefully and make sure you are thoroughly familiar with their content.

This book organizes the content into topics of a more manageable size to give you something more digestible to build your knowledge.

Practice, Practice, Practice—Did I Mention: Practice?

Second, plan to use the practice tasks at the end of each chapter.

Each chapter ends with practice and study tasks under the heading “Exam Preparation Tasks.” Doing these tasks, and doing them at the end of the chapter, really helps you get ready. Do not put off using these tasks until later! The chapter-ending “Exam Preparation Tasks” section helps you with the first phase of deepening your knowledge and skills of the key topics, remembering terms, and linking the concepts in your brain so that you can remember how it all fits together.

The following list describes the majority of the activities you will find in “Exam Preparation Tasks” sections:

- Review key topics
Approach each chapter with the same plan. Based on your score in the “Do I Know This Already?” (DIKTA) quiz, you can choose to read the entire core (Foundation Topics) section of the chapter or just skim the chapter. DIKTA is a self-assessment quiz appearing at the beginning of each content chapter. Remember, regardless of whether you skim or read thoroughly, do the study tasks in the “Exam Preparation Tasks” section at the end of the chapter. Table 1 shows the suggested study approach for each content chapter.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Suggested Study Approach for the Content Chapter</th>
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<tbody>
<tr>
<td>Take DIKTA Quiz High Score ➤ Light reading of Foundation Topics ➤ Do Exam Prep Tasks</td>
<td></td>
</tr>
<tr>
<td>Take DIKTA Quiz Low Score ➤ Careful reading of Foundation Topics ➤ Do Exam Prep Tasks</td>
<td></td>
</tr>
</tbody>
</table>

In Each Part of the Book You Will Hit a New Milestone

Third, view the book as having six major milestones, one for each major topic.

Beyond the more obvious organization into chapters, this book also organizes the chapters into six major topic areas called book parts. Completing each part means that you have completed a major area of study. At the end of each part, take extra time to complete “Part Review” tasks and ask yourself where your weak and strong areas are. Acknowledge yourself for completing major milestones. Table 2 lists the six parts in this book.

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Six Major Milestones: Book Parts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part I, Data Center Networking</td>
<td>Preparation Tasks</td>
</tr>
<tr>
<td>Part II, Data Center Storage-Area Networking</td>
<td>Preparation Tasks</td>
</tr>
<tr>
<td>Part III, Data Center Unified Fabric</td>
<td>Preparation Tasks</td>
</tr>
<tr>
<td>Part IV, Cisco Unified Computing</td>
<td>Preparation Tasks</td>
</tr>
<tr>
<td>Part V, Data Center Server Virtualization</td>
<td>Preparation Tasks</td>
</tr>
<tr>
<td>Part VI, Data Center Network Services</td>
<td>Preparation Tasks</td>
</tr>
</tbody>
</table>

Note that the “Part Review” directs you to use the Pearson Certification Practice Test (PCPT) software to access the practice questions. Each “Part Review” instructs you to repeat the DIKTA questions while using the PCPT software. It also instructs you how to access a specific set of questions reserved for reviewing concepts at the “Part Review.” Note that the PCPT software and exam databases included with this book also give you the rights to additional questions. Chapter 21, “Final Review,” gives some recommendations on how to best use those questions for your final exam preparation.

Consider setting a goal date for finishing each part of the book and reward yourself for achieving this goal! Plan breaks—some personal time out—to get refreshed and motivated for the next part.
Use the Final Review Chapter to Refine Skills

Fourth, do the tasks outlined at the end of the book in Chapter 21.

Chapter 21 has two major goals. First, it helps you further develop the analytical skills you need to answer the more complicated questions in the exam. Many questions require that you cross-connect ideas about design, configuration, verification, and troubleshooting. More reading will not necessarily develop these skills; this chapter’s tasks give you activities to make further progress.

The tasks in the chapter also help you find your weak areas. This final element gives you repetition with high-challenge exam questions, uncovering any gaps in your knowledge. Many of the questions are purposely designed to test your knowledge in areas where the most common mistakes and misconceptions occur, helping you avoid some of the pitfalls people experience with the actual exam.

Set Goals and Track Your Progress

Finally, before you start reading the book, take the time to make a plan, set some goals, and be ready to track your progress.

Although making lists of tasks might or might not appeal to you, depending on your personality, goal setting can help everyone studying for these exams. To set the goals, you need to know what tasks you plan to do. The list of tasks does not have to be very detailed, such as putting down every single task in the “Exam Preparation Tasks” section, the “Part Review” tasks section, or the “Final Review” chapter. Instead, listing only the major tasks can be sufficient.

You should track at least two tasks for each typical chapter: reading the “Foundation Topics” section and doing the “Exam Preparation Tasks” section at the end of the chapter. Of course, do not forget to list tasks for “Part Reviews” and the “Final Review.” Table 3 shows a sample of a task planning table for Part I of this book.

| Table 3  Sample Excerpt from a Planning Table |
|-----------------|-----------------|-----------------|-----------------|
| **Element** | **Task** | **Goal Date** | **First Date Completed** | **Second Date Completed (Optional)** |
| Chapter 1 | Read Foundation Topics | | | |
| Chapter 1 | Do Exam Prep Tasks | | | |
| Chapter 2 | Read Foundation Topics | | | |
| Chapter 2 | Do Exam Prep Tasks | | | |
| Chapter 3 | Read Foundation Topics | | | |
| Chapter 3 | Do Exam Prep Tasks | | | |
| Chapter 4 | Read Foundation Topics | | | |
| Chapter 4 | Do Exam Prep Tasks | | | |
| Chapter 5 | Read Foundation Topics | | | |
Use your goal dates as a way to manage your study, and do not get discouraged if you miss a date. Pick reasonable dates that you can meet. When setting your goals, think about how fast you read and the length of each chapter’s “Foundation Topics” section, as listed in the Table of Contents. If you finish a task sooner than planned, move up the next few goal dates.

If you miss a few dates, do not start skipping the tasks listed at the ends of the chapters! Instead, think about what is impacting your schedule—family commitments, work commitments, and so on—and either adjust your goals or work a little harder on your study.

### Other Small Tasks Before Getting Started

You will need to complete a few overhead tasks, such as install software, find some PDFs, and so on. You can complete these tasks now or do them in your spare time when you need a study break during the first few chapters of the book. Do not delay; should you encounter software installation problems, you have sufficient time to resolve them before you need the tool.

Register (for free) at the Cisco Learning Network (CLN, http://learningnetwork.cisco.com) and join the CCNA data center study group. This mailing list allows you to lurk and participate in discussions about CCNA data center topics, for both the DCICN and DCICT exams. Register, join the group, and set up an e-mail filter to redirect the messages to a separate folder. Even if you do not spend time reading all the posts yet, later, when you have time to read, you can browse through the posts to find relevant topics. You can also search the posts from the CLN website. There are many recorded CCNA data center sessions from the technology experts, which you can listen to as much as you want. All the recorded sessions last a maximum of one hour.

Install the PCPT exam software and activate the exams. For more details on how to load the software, refer to the “Introduction,” under the heading “Install the Pearson Certification Practice Test Engine and Questions.”

Keep calm, and enjoy the ride!
This chapter covers the following exam topic:

Describe Device Virtualization
Virtualizing Cisco Network Devices

There are two types of device virtualization when it comes to Nexus devices. The first is how to partition one physical switch and make it appear as multiple switches, each with its own administrative domain and security policy. That approach has its own benefits and business requirements.

The other option is how to make multiple switches appear as if they are one big modular switch. That approach has its own benefits and business requirements, too. This chapter covers the virtualization capabilities of the Nexus 7000 and Nexus 5000 switches using Virtual Device Context (VDC) and Network Interface Virtualization (NIV).

“Do I Know This Already?” Quiz

The “Do I Know This Already?” quiz enables you to assess whether you should read this entire chapter thoroughly or jump to the “Exam Preparation Tasks” section. If you are in doubt about your answers to these questions or your own assessment of your knowledge of the topics, read the entire chapter. Table 3-1 lists the major headings in this chapter and their corresponding “Do I Know This Already?” quiz questions. You can find the answers in Appendix A, “Answers to the ‘Do I Know This Already?’ Quizzes.”

Table 3-1 “Do I Know This Already?” Section-to-Question Mapping

<table>
<thead>
<tr>
<th>Foundation Topics Section</th>
<th>Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Describe Device Virtualization</td>
<td>1–7</td>
</tr>
</tbody>
</table>

CAUTION  The goal of self-assessment is to gauge your mastery of the topics in this chapter. If you do not know the answer to a question or are only partially sure of the answer, you should mark that question as wrong for purposes of the self-assessment. Giving yourself credit for an answer you correctly guess skews your self-assessment results and might provide you with a false sense of security.
1. How many VDCs are supported on Nexus 7000 SUP 1 and SUP 2E (do not count admin VDC)?
   a. SUP1 support 4 * SUP 2E support 4
   b. SUP1 support 4 * SUP 2E support 6
   c. SUP1 support 2 * SUP 2E support 8
   d. SUP1 support 4 * SUP 2E support 8

2. Choose the different types of VDCs that can be created on the Nexus 7000. (Choose three.)
   a. Default VDC
   b. Admin VDC
   c. Storage VDC
   d. OTV VDC

3. True or false? We can assign physical interfaces to an admin VDC.
   a. True
   b. False

4. Which command is used to access a nondefault VDC from the default VDC?
   a. connectTo
   b. switchto vdc [vdc name]
   c. vdc [id] command and press Enter
   d. switchto {vdc name}

5. True or false? The Nexus 2000 Series switch can be used as a standalone access switch.
   a. True
   b. False

6. The VN-Tag is being standardized under which IEEE standard?
   a. 802.1qpg
   b. 802.1Qbh
   c. 802.1BR
   d. 802.Qbr

7. In the VN-Tag fields, what does the acronym VIF stand for?
   a. VN-Tag initial frame
   b. Virtual interface
   c. Virtualized interface
   d. VN-Tag interface
Foundation Topics

Describing VDCs on the Cisco Nexus 7000 Series Switch

The Virtual Device Context (VDC) is used to virtualize the Nexus 7000 switch, meaning presenting the Nexus 7000 switch as multiple logical switches. Within a VDC, you can have a unique set of VLANs and VRFs allowing the virtualization of the control plane. Each VDC will have its own administrative domain allowing the management plane as well to be virtualized. You can assign a line card to a VDC or a set of ports to the VDC.

Without creating any VDC on the Nexus 7000, the control plane runs a single VDC; within this VDC are multiple processes and Layer 2 and Layer 3 services running, as shown in Figure 3-1. This VDC is always active and cannot be deleted.

Virtualization using VLANs and VRFs within this VDC can still be used. When enabling multiple VDCs, these processes are replicated for each VDC. Within each VDC you can have duplicate VLAN names and VRF names, meaning you can have VRF production in VDC1 and VRF production in VDC2.

When enabling Role-Based Access Control (RBAC) for each VDC, each VDC administrator will interface with the process for his or her own VDC. Figure 3-2 shows what the structure looks like when creating multiple VDCs. You can have fault isolation, separate administration per VDC, separate data traffic, and hardware partitioning.
The following are typical use cases for the Cisco Nexus 7000 VDC, which can be used in the design of the data center:

- Creation of separate production, development, and test environments
- Creation of intranet, extranet, and DMZ
- Creation of separate organizations on the same physical switch
- Creation of separate application environments
- Creation of separate departments for the same organization due to different administration domains

VDC separation is industry certified; it has NSS labs for Payment Card Industry (PCI) compliant environments, Federal Information Processing Standards (FIPS 140-2) certification, and Common Criteria Evaluation and Validation Scheme (CCEVS) 10349 certification with EAL4 conformance.

**VDC Deployment Scenarios**

There are multiple deployment scenarios using the VDCs, which enable the reduction of the physical footprint in the data center, which in turn saves space, power, and cooling.
Horizontal Consolidation Scenarios

VDCs can be used to consolidate multiple physical devices that share the same function role. In horizontal consolidation, you can consolidate core functions and aggregation functions. For example, using a pair of Nexus 7000 switches you can build two redundant data center cores, which can be useful in facilitating migration scenarios. This can happen by creating two VDCs, as shown in Figure 3-3. VDC1 will accommodate Core A and VDC2 will accommodate Core B. You can allocate ports or line cards to the VDCs, and after the migration you can reallocate the old core ports to the new core.

![Figure 3-3 Horizontal Consolidations for Core Layer](image)

Aggregation layers can also be consolidated, so rather than building a separate aggregation layer for test and development, you can create multiple VDCs called Aggregation 1 and Aggregation 2. Aggregation 1 and Aggregation 2 are completely isolated with a separate role-based access and separate configuration file. Figure 3-4 shows multiple aggregation layers created on the same physical devices.

![Figure 3-4 Horizontal Consolidation for Aggregation Layers](image)
Vertical Consolidation Scenarios

When using VDCs in vertical consolidation, you can consolidate core functions and aggregation functions. For example, using a pair of Nexus 7000 switches, you can build a redundant core and aggregation layer. Although the port count is the same, it can be useful because it reduces the number of physical switches. This can happen by creating two VDCs, as shown in Figure 3-5. VDC1 accommodates Core A and Aggregation A; VDC2 accommodates Core B and Aggregation B. You can allocate ports or line cards to the VDCs.

Another scenario is consolidation of core aggregation and access while you maintain the same hierarchy. Figure 3-6 shows that scenario; as you can see, we used a pair of Nexus 7000 switches to build a three-tier architecture.

VDCs for Service Insertion

VDCs can be used for service insertion and policy enforcement. By creating two separate VDCs for two logical areas inside and outside, as shown in Figure 3-7, for traffic to cross VDC-A to go to VDC-B it must pass through the firewall. This design can make service insertion more deterministic and secure. Each VDC has its own administrative domain, and traffic must go out VDC-A to reach VDC-B. The only way is through the firewall.
Understanding Different Types of VDCs

As explained earlier in the chapter, the NX-OS on the Nexus 7000 supports Virtual Device Contexts (VDC). VDCs simply partition the physical Nexus device into multiple logical devices with a separate control plane, data plane, and management plane. Connecting two VDCs on the same physical switch must be done through external cables; you cannot connect VDCs together from inside the chassis. The following list describes the different types of VDCs that can be created on the Nexus 7000:

- Default VDC: When you first log in to the Nexus 7000, you log in to the default VDC. You must be in the default VDC or the Admin VDC (discussed later in the chapter) to do certain tasks, which can be done only in these two VDC types. The default VDC is a full-function VDC; the admin always uses it to manage the physical device and other VDCs created. The default VDC has certain characteristics and tasks that can only be done in the default VDC, which can be summarized in the following:
  - VDC creation/deletion/suspend
  - Resource allocation—interfaces, memory
  - NX-OS upgrade across all VDCs
  - EPLD upgrade—as directed by TAC or to enable new features
  - Ethanalyzer captures—control plane traffic
  - Feature-set installation for Nexus 2000, FabricPath, and FCoE
  - Control Plane Policing (CoPP)
  - Port channel load balancing
  - Hardware IDS checks control
  - ACL capture feature enabled

**NOTE** With CPU shares, you don’t dedicate a CPU to a VDC rather than giving access and assigning priorities to the CPU. CPU shares are supported only with SUP2/2e.

- Nondefault VDC: The nondefault VDC is a fully functional VDC that can be created from the default VDC or the Admin VDC. Changes in the nondefault VDC affect only that VDC. An independent process is started for each protocol per VDC created. There is a separate configuration file per VDC, and each VDC has its own RBAC, SNMP, and so on.

- **ADMIN VDC**: The Admin VDC is used for administration functions. You can enable starting from NX-OS 6.1 for SUP2/2E modules, and starting from the NX-OS 6.2(2) for SUP1 module, you can create the admin VDC in different ways:
  - During a fresh switch boot, you will be prompted to select an Admin VDC.
Enter the `system admin-vdc` command after boot. In that case, the default VDC becomes the Admin VDC, and all nonglobal configuration in the default VDC will be lost.

Enter the `system admin-vdc migrate new vdc name` command. All nonglobal configuration on the default VDC will be migrated to the new VDC.

The Admin VDC has certain characteristics that are unique to the Admin VDC.

- You cannot assign any interface to the Admin VDC; only mgmt0 can be assigned to the Admin VDC.
- When you enable the Admin VDC, it replaces the default VDC. You must be careful or you will lose the nonglobal configuration.
- After the Admin VDC is created, it cannot be deleted or changed back to the default VDC. To change back to the default VDC you must erase the configuration and do a fresh boot script.

**NOTE** Creating the Admin VDC doesn’t require the advanced package license or VDC license.

**Storage VDC:** The storage VDC is a nondefault VDC that helps maintain the operation model when the customer has a LAN admin and a SAN admin. The storage VDC relies on the FCoE license and doesn’t need a VDC license. The storage VDC counts toward the total number of VDCs. We can create only one storage VDC on the physical device. After the creation of the storage VDC, we assign interfaces to it. There are two types of interfaces, dedicated FCoE interfaces or shared interfaces, which can carry both Ethernet and FCoE traffic. Figure 3-8 shows the two types of ports.

![Figure 3-8 Storage VDC Interface Types](image-url)
NOTE To run FCoE, Sup2/2e is required.

With Supervisor 1 you can have up to four VDCs and one Admin VDC, which requires 8 GB of RAM because you must upgrade to NX-OS 6.2. Supervisor engine 2 can have up to four VDCs and one Admin VDC. With Supervisor engine 2E you can have up to eight VDCs and one Admin VDC. Beyond four VDCs on Supervisor 2E we require a license to increment the VDCs with an additional four.

Interface Allocation

The only thing you can assign to a VDC are the physical ports. At the beginning and before creating a VDC, all interfaces belong to the default VDC. After you create a VDC, you start assigning interfaces to that VDC. A physical interface can belong to only one VDC at a given time. When you create a shared interface, the physical interface belongs to one Ethernet VDC and one storage VDC at the same time. When you allocate the physical interface to a VDC, all configurations that existed on it get erased. The physical interface gets configured within the VDC. Logical interfaces, such as tunnel interfaces and switch virtual interfaces, are created within the VDC, and within a VDC, physical and logical interfaces can be assigned to VLANs or VRFs.

NOTE All members of a port group are automatically allocated to the VDC when you allocate an interface. For example, in the N7K-M132XP-12 (4 interfaces × 8 port groups = 32 interfaces) and N7K-M132XP-12L (same as non-L M132) (1 interface × 8 port groups = 8 interfaces). All M132 cards require allocation in groups of four ports, and you can configure eight port groups. Interfaces belonging to the same port group must belong to the same VDC. See the example for this module in Figure 3-9.

VDC Administration

The operations allowed for a user in VDC depend on the role assigned to that user. Users can have multiple roles assigned to them, and the NX-OS provides four default user roles:

- **Network-admin**: The first user account that is created on a Cisco Nexus 7000 Series switch in the default VDC is admin. The network-admin role is automatically assigned to this user. The network-admin role gives a user complete read and write access to the device, and it is available only in the default VDC. This role includes the ability to create, delete, or change nondefault VDCs.
Network-operator: The second default role that exists on Cisco Nexus 7000 Series switches is the network-operator role. This role grants the user read-only rights in the default VDC. The network-operator role includes the right to issue the `switchto` command, which can be used to access a nondefault VDC from the default VDC. By default, no users are assigned to this role. The role must be assigned specifically to a user by a user who has network-admin rights.

VDC-admin: When a new VDC is created, the first user account on that VDC is admin. The VDC-admin role is automatically assigned to this admin user on a nondefault VDC. This role gives a user complete control over the specific nondefault VDC. However, this user does not have any rights in any other VDC and cannot access other VDCs through the `switchto` command.

VDC-operator: The VDC-operator role has read-only rights for a specific VDC. This role has no rights to any other VDC.

When a network-admin or network-operator user accesses a nondefault VDC by using the `switchto` command, that user is mapped to a role of the same level in the nondefault VDC. That means a user with the network-admin role is given the VDC-admin role in the nondefault VDC. A user with the network-operator role is given the VDC-operator role in the nondefault VDC.

**NOTE** You can create custom roles for a user, but you cannot change the default user roles for a VDC. User roles are not shared between VDCs; each VDC maintains its user role database.

**VDC Requirements**

To create VDCs, an advanced license is required. The license is associated with the serial number of a Cisco Nexus 7000 switch chassis. The storage VDC is enabled using the storage license associated with a specific line card. You can try the feature for the 120-day grace period. When the grace period expires, any nondefault VDCs will be removed from the switch configuration.

**NOTE** The grace period operates across all features in a license package; the license package can contain several features. When you enable a feature, the countdown for the 120 days doesn't stop if a single feature of the license package is already enabled. To stop the grace period, all the features of the license package must be stopped, so if you enable a feature to try it, but another feature was enabled, for example, 100 days before, you are left with 20 days to install the license.

As stated before, VDCs are created or deleted from the default VDC only. You need network admin privileges to do that. Physical interfaces also are assigned to nondefault VDCs from the default VDC.
Verifying VDCs on the Cisco Nexus 7000 Series Switch

The next few lines show certain commands to display useful information about the VDC. As shown in Example 3-1, the `show feature-set` command is used to verify and show which feature has been enabled or disabled in a VDC.

**Example 3-1  Displaying the Status of a Feature Set on a Switch**

```console
N7K-VDC-A# show feature-set
<table>
<thead>
<tr>
<th>Feature Set Name</th>
<th>ID</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>fabricpath</td>
<td>2</td>
<td>enabled</td>
</tr>
<tr>
<td>fex</td>
<td>3</td>
<td>disabled</td>
</tr>
</tbody>
</table>

N7K-VDC-A#
```

The `show feature-set` command in Example 3-1 shows that the FabricPath feature is enabled and the FEX feature is disabled.

The `show vdc` command displays different outputs depending on where you are executing it from. If you are executing the command from the default VDC, this command displays information about all VDCs on the physical device.

**Example 3-2  Displaying Information About All VDCs (Running the Command from the Default VDC)**

```console
N7K-Core# show vdc
<table>
<thead>
<tr>
<th>vdc_id</th>
<th>vdc_name</th>
<th>state</th>
<th>mac</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>prod</td>
<td>active</td>
<td>00:18:ba:d8:3f:fd</td>
</tr>
<tr>
<td>2</td>
<td>dev</td>
<td>active</td>
<td>00:18:ba:d8:3f:fe</td>
</tr>
<tr>
<td>3</td>
<td>MyVDC</td>
<td>active</td>
<td>00:18:ba:d8:3f:ff</td>
</tr>
</tbody>
</table>
```

If you are executing the `show vdc` command within the nondefault VDC, which in our case is the N7K-Core-Prod, the output displays information about the current VDC.

**Example 3-3  Displaying Information About the Current VDC (Running the Command from the Nondefault VDC)**

```console
N7K-Core-Prod# show vdc
<table>
<thead>
<tr>
<th>vdc_id</th>
<th>vdc_name</th>
<th>state</th>
<th>mac</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>prod</td>
<td>active</td>
<td>00:18:ba:d8:3f:fd</td>
</tr>
</tbody>
</table>
```

To display the detailed information about all VDCs, execute `show vdc detail` from the default VDC, as shown in Example 3-4.
Example 3-4  Displaying Detailed Information About All VDCs

```plaintext
N7K-Core# show vdc detail
vdc id: 1
vdc name: N7K-Core
vdc state: active
vdc mac address: 00:22:55:79:a4:c1
vdc ha policy: RELOAD
vdc dual-sup ha policy: SWITCHOVER
vdc boot Order: 1
vdc create time: Thu May 14 08:14:39 2012
vdc restart count: 0

vdc id: 2
vdc name: prod
vdc state: active
vdc mac address: 00:22:55:79:a4:c2
vdc ha policy: RESTART
vdc dual-sup ha policy: SWITCHOVER
vdc boot Order: 1
vdc create time: Thu May 14 08:15:22 2012
vdc restart count: 0

vdc id: 3
vdc name: dev
vdc state: active
vdc mac address: 00:22:55:79:a4:c3
vdc ha policy: RESTART
vdc dual-sup ha policy: SWITCHOVER
vdc boot Order: 1
vdc create time: Thu May 14 08:15:29 2012
vdc restart count: 0
```

You can display the detailed information about the current VDC by executing `show vdc {vdc name} detail` from the nondefault VDC, as shown in Example 3-5.

Example 3-5  Displaying Detailed Information About the Current VDC When You Are in the Nondefault VDC

```plaintext
N7K-Core-prod# show vdc prod detail
vdc id: 2
vdc name: prod
vdc state: active
vdc mac address: 00:22:55:79:a4:c2
vdc ha policy: RESTART
vdc dual-sup ha policy: SWITCHOVER
vdc boot Order: 1
vdc create time: Thu May 14 08:15:22 2012
vdc restart count: 0
```
Chapter 3: Virtualizing Cisco Network Devices

To verify the interface allocation per VDC, execute `show vdc membership` from the default VDC, as shown in Example 3-6.

**Example 3-6  Displaying Interface Allocation per VDC**

```
N7K-Core# show vdc membership
vdc_id: 1 vdc_name: N7K-Core interfaces:
  Ethernet2/1  Ethernet2/2  Ethernet2/3
  Ethernet2/4  Ethernet2/5  Ethernet2/6
  Ethernet2/7  Ethernet2/8  Ethernet2/9
  Ethernet2/10 Ethernet2/11 Ethernet2/12
  Ethernet2/13 Ethernet2/14 Ethernet2/15
  Ethernet2/16 Ethernet2/17 Ethernet2/18
  Ethernet2/19 Ethernet2/20 Ethernet2/21
  Ethernet2/22 Ethernet2/23 Ethernet2/24
  Ethernet2/25 Ethernet2/26 Ethernet2/27
  Ethernet2/28 Ethernet2/29 Ethernet2/30
  Ethernet2/31 Ethernet2/32 Ethernet2/33
  Ethernet2/34 Ethernet2/35 Ethernet2/36
  Ethernet2/37 Ethernet2/38 Ethernet2/39
  Ethernet2/40 Ethernet2/41 Ethernet2/42
  Ethernet2/43 Ethernet2/44 Ethernet2/45
  Ethernet2/48
vdc_id: 2 vdc_name: prod interfaces:
  Ethernet2/47
vdc_id: 3 vdc_name: dev interfaces:
  Ethernet2/46
```

If you execute `show VDC membership` from the VDC you are currently in, it will show the interface membership only for that VDC.

You can save all the running configurations to the startup configuration for all VDCs using one command. Use the `copy running-config startup-config vdc-all` command, which is executed from the default VDC.

**Example 3-7  Saving All Configurations for All VDCs**

```
N7K-Core# copy running-config startup-config vdc-all
[########################################] 100%
```

To display the running configurations for all VDCs, use the `show running-config vdc-all` command, executed from the default VDC. You cannot see the configuration for other VDCs except from the default VDC.

You can navigate from the default VDC to the nondefault VDC using the `switchto` command, as shown in Example 3-8.
Example 3-8  Navigating Between VDCs on the Nexus 7000 Switch

N7K-Core# switchto vdc Prod
TAC support: http://www.cisco.com/tac

To switch back to the default VDC, use the switchback command. You cannot execute the switchto command from the nondefault VDC; you must do switchback to the default VDC first before going to another VDC. Use these commands for the initial setup; after that, when you create the user accounts and configure the IP connectivity, you use Secure Shell (SSH) and Telnet to connect to the desired VDC.

Describing Network Interface Virtualization

You can deliver an extensible and scalable fabric solution using the Cisco FEX technology. The FEX technology can be extended all the way to the server hypervisor. This technology enables operational simplicity by having a single point of management and policy enforcement on the access parent switch.

Cisco Nexus 2000 FEX Terminology

The following terminology and acronyms are used with the Nexus 2000 fabric extenders:

- **Network Interface (NIF):** Port on FEX, connecting to parent switch.
- **Host Interface (HIF):** Front panel port on FEX, connecting to server.
- **Virtual Interface (VIF):** Logical construct consisting of a front panel port, VLAN, and several other parameters.
- **Logical Interface (LIF):** Presentation of a front panel port in parent switch.
- **Fabric links (Fabric Port Channel or FPC):** Links that connect FEX NIF and FEX fabric ports on parent switch.
- **Parent switch:** Switch (N7K/N5K) where FEX is connected.
- **FEX A/A or dual-attached FEX:** Scenario in which the fabric links of FEX are connected, actively forwarding traffic to two parent switches.
- **Fabric Extender (FEX):** NEXUS 2000 is the instantiation of FEX.
- **Fabric Port:** N7K side of the link connected to FEX.
- **Fabric Port Channel:** Port channel between N7K and FEX.
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- **FEX uplink**: Network-facing port on the FEX side of the link connected to N7K. The FEX uplink is also called a Network Interface (NIF).
- **FEX port**: Server-facing port on FEX, also referred to as server port or host port in this presentation. FEX port is also called a Host Interface (HIF).

Figure 3-10 shows the ports with reference to the physical hardware.

**Figure 3-10  Nexus 2000 Interface Types and Acronyms**

**Nexus 2000 Series Fabric Extender Connectivity**

The Cisco Nexus 2000 Series cannot run as a standalone switch; it needs a parent switch. This switch can be a Nexus 9000, Nexus 7000, Nexus 6000, Nexus 5600, or Nexus 5000 Series. This type of design combines the benefit of the Top-of-Rack (ToR) design with the benefit of the End-of-Row (EoR) design.

Based on the type and the density of the access ports required, dual redundant Nexus 2000 fabric extenders are placed at the top of the rack. The uplink ports from the Nexus 2000 will be connected to the parent switch, as stated before, which will be installed at the EoR. From a cabling point of view, this design is a ToR design. The cabling between the servers and the Nexus 2000 Series fabric extenders is contained within the rack. Only a small number of cables will run between the racks, which will be 10/40 Gbps.

From the logical network deployment point of view, this design is an EoR design. The FEX acts as a remote line card. The server appears as if it is connected directly to the parent switch. From an operation perspective, this design has the advantage of the EoR design; all configuration and maintenance tasks are done from the parent switch, and no operation tasks are required to be performed from the FEXs. Figure 3-10 shows the physical and the logical architecture of the FEX implementation. Refer to Chapter 2, “Cisco Nexus Product Family” in the section “Cisco Nexus 2000 Fabric Extenders Product Family” to see the different models and specifications.

**NOTE** You can connect a switch to the FEX host interfaces, but this is not a recommended solution. To make this work, you need to turn off Bridge Protocol Data Units (BPDUs) from the access switch and turn on “bpdufilter” on the Nexus 2000, which might create a loop in the network. The Nexus 2000 host ports (HIFs) do not expect to receive BPDUs on the host ports and expect only end hosts like servers.
Figure 3-11 shows the physical and logical view for the Nexus 2000 fabric extender deployment.

**Figure 3-11  Nexus 2000 Deployment Physical and Logical View**

**VN-Tag Overview**

The Cisco Nexus 2000 Series fabric extender acts as a remote line card to a parent switch, as stated earlier. All control and management functions are performed by the parent switch. Forwarding is performed by the parent switch. The physical ports on the Nexus 2000 fabric extender appear as logical ports on the parent switch, and the hosts connected to the Nexus 2000 fabric extender appear as if they are directly connected to the parent switch.

A frame exchanged between the Nexus 2000 fabric extender and the parent switch will have an information tag inserted in it called VN-Tag, which enables advanced functions and policies to be applied to it. The host connected to the Nexus 2000 fabric extender is unaware of any tags.

At the time of writing this book there is no local switching happening on the Nexus 2000 fabric extender, so all traffic must be sent to the parent switch.

VN-Tag is a Network Interface Virtualization (NIV) technology. At the beginning, VN-Tag was being standardized under the IEEE 802.1Qbh working group. However, 802.1Qbh was withdrawn and is no longer an approved IEEE project. The effort was moved to the IEEE 802.1BR in July 2011. Figure 3-12 shows the VN-Tag fields in an Ethernet frame.

**Figure 3-12  VN-Tag Fields in an Ethernet Frame**
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- d: Direction bit (0 is host-to-network forwarding; 1 is network-to-host)
- p: Pointer bit (set if this is a multicast frame and requires egress replication)
- L: Looped filter (set if sending back to source Cisco Nexus 2000 Series)
- VIF: Virtual interface

Cisco Nexus 2000 FEX Packet Flow

The packet processing on the Nexus 2000 happens in two parts: when the host send a packet to the network and when the network sends a packet to the host. Figure 3-13 shows the two scenarios.

1. Frame arrives from host.
2. Packet is forwarded over fabric link using a specific VN-Tag.
3. VN-Tag is stripped by N2K and frame is forwarded to HIF.

Figure 3-13 Cisco Nexus 2000 Packet Flow

When the host sends a packet to the network (diagrams A and B), these events occur:

1. The frame arrives from the host.
2. The Cisco Nexus 2000 Series switch adds a VN-Tag, and the packet is forwarded over a fabric link using a specific VN-Tag. The Cisco Nexus 2000 Series switch adds a unique VN-Tag for each Cisco Nexus 2000 Series host interface. These are the VN-Tag field values:
   - The direction bit is set to 0, indicating host-to-network forwarding.
   - The source virtual interface is set based on the ingress host interface.
   - The p (pointer), l (looped), and destination virtual interface are undefined (0).
3. The packet is received over the fabric link using a specific VN-Tag. The Cisco Nexus switch extracts the VN-Tag, which identifies the logical interface that corresponds to the physical host interface on the Cisco Nexus 2000 Series. The Cisco Nexus switch applies an ingress policy that is based on the physical Cisco Nexus Series switch port and logical interface:
   - Access control and forwarding are based on frame fields and virtual (logical) interface policy.
   - Physical link-level properties are based on the Cisco Nexus Series switch port.
4. The Cisco Nexus switch strips the VN-Tag and sends the packet to the network. When the network sends a packet to the host (diagram C), these events occur:

1. The frame is received on the physical or logical interface. The Cisco Nexus switch performs standard lookup and policy processing when the egress port is determined to be a logical interface (Cisco Nexus 2000 Series) port. The Cisco Nexus switch inserts a VN-Tag with these characteristics:
   - The direction is set to 1 (network to host).
   - The destination virtual interface is set to be the Cisco Nexus 2000 Series port VN-Tag.
   - The source virtual interface is set if the packet was sourced from a Cisco Nexus 2000 Series port.
   - The l (looped) bit filter is set if sending back to a source Cisco Nexus 2000 Series switch.
   - The p bit is set if this frame is a multicast frame and requires egress replication.

2. The packet is forwarded over a fabric link using a specific VN-Tag.

3. The Cisco Nexus 2000 Series switch strips the VN-Tag, and the frame is forwarded to the host interface.

Cisco Nexus 2000 FEX Port Connectivity

You can connect the Nexus 2000 Series fabric extender to one of the following Ethernet modules that are installed in the Cisco Nexus 7000 Series. There is a best practice for connecting the Nexus 2000 fabric extender to the Nexus 7000, depending on the type and model of card installed in it.

- 12-port 40-Gigabit Ethernet F3-Series QSFP I/O module (N7K-F312FQ-25) for Cisco Nexus 7000 Series switches
- 24-port Cisco Nexus 7700 F3 Series 40-Gigabit Ethernet QSFP I/O module (N77-F324FQ-25)
- 48-port Cisco Nexus 7700 F3 Series 1/10-Gigabit Ethernet SFP+ I/O module (N77-F348XP-23)
- 32-port 10-Gigabit Ethernet SFP+ I/O module (N7K-M132XP-12)
- 32-port 10-Gigabit Ethernet SFP+ I/O module (N7K-M132XP-12L)
- 24-port 10-Gigabit Ethernet I/O M2 Series module XL (N7K-M224XP-23L)
- 48-port 1/10-Gigabit Ethernet SFP+ I/O F2 Series module (N7K-F248XP-25)
- Enhanced 48-port 1/10-Gigabit Ethernet SFP+ I/O module (F2e Series) (N7K-F248XP-25E)
- 48-port 1/10-Gigabit Ethernet SFP+ I/O module (F2e Series) (N77-F248XP-23E)

Figure 3-14 shows the connectivity between the Cisco Nexus 2000 fabric extender and the N7K-M132XP-12 line card.
There are two ways to connect the Nexus 2000 to the parent switch: either use static pinning, which makes the FEX use individual links connected to the parent switch, or use a port channel when connecting the fabric interfaces on the FEX to the parent switch. This is explained in more detail in the next paragraphs.

In static pinning, when the FEX is powered up and connected to the parent switch, its host interfaces are distributed equally among the available fabric interfaces. As a result, the bandwidth that is dedicated to each end host toward the parent switch is never changed by the switch, but instead is always specified by you.

The drawback here is that if the fabric link goes down, all the associated host interfaces go down and will remain down as long as the fabric port is down. You must use the `pinning max-links` command to create several pinned fabric interface connections so that the parent switch can determine a distribution of host interfaces. The host interfaces are divided by the number of the max-links and distributed accordingly. The default value is max-links 1.

To provide load balancing between the host interfaces and the parent switch, you can configure the FEX to use a port channel fabric interface connection. This connection bundles 10-Gigabit Ethernet fabric interfaces into a single logical channel. A fabric interface that fails in the port channel does not trigger a change to the host interfaces. Traffic is automatically redistributed across the remaining links in the port channel fabric interface. If all links in the fabric port channel go down, all host interfaces on the FEX are set to the down state.

When you have VDCs created on the Nexus 7000, you must follow certain rules. All FEX fabric links belong to the same VDC; all FEX host ports belong to the same VDC; FEX IDs are unique across VDCs (the same FEX ID cannot be used across different VDCs). Figure 3-15 shows the FEX connectivity to the Nexus 7000 when you have multiple VDCs.

**Figure 3-14** *Cisco Nexus 2000 Connectivity to N7K-M132XP-12*

There are two ways to connect the Nexus 2000 to the parent switch: either use static pinning, which makes the FEX use individual links connected to the parent switch, or use a port channel when connecting the fabric interfaces on the FEX to the parent switch. This is explained in more detail in the next paragraphs.
Cisco Nexus 2000 FEX Configuration on the Nexus 7000 Series

How you configure the Cisco Nexus 2000 Series on the Cisco 7000 Series is different from the configuration on Cisco Nexus 5000, 6000, and 5600 Series switches. The difference comes from the VDC-based architecture of the Cisco Nexus 7000 Series switches. Use the following steps to connect the Cisco Nexus 2000 to the Cisco 7000 Series parent switch when connected to one of the supported line cards.

Example 3-9  Installing the Fabric Extender Feature Set in Default VDC

```
N7K-Agg(config)# install feature-set fex
```

Example 3-10  Enabling the Fabric Extender Feature Set

```
N7K-Agg(config)# feature-set fex
```

By default, when you install the fabric extender feature set, it is allowed in all VDCs. You can disallow the installed fabric extender feature set in a specific VDC on the device.

Example 3-11  Entering the Chassis Mode for the Fabric Extender

```
N7K-Agg(config)# fex 101
N7K-Agg(config-fex)# description Rack8-N2k
N7K-Agg(config-fex)# type N2232P
```

Example 3-12  Defining the Number of Uplinks

```
N7K-Agg(config-fex)# pinning max-links 1
```

You can use this command if the fabric extender is connected to its parent switch using one or more statically pinned fabric interfaces. There can be only one port channel connection.
**Example 3-13**  Disallowing Enabling the Fabric Extender Feature Set

```plaintext
N7K-Agg# configure terminal
N7K-Agg (config)# vdc 1
N7K-Agg (config-vdc)# no allow feature-set fex
N7K-Agg (config-vdc)# end
N7K-Agg #
```

**NOTE**  The N7k-agg# VDC1 is the VDC_ID, so it might be different depending on which VDC you want to connect to.

The next step is to associate the fabric extender to a port channel interface on the parent device. In Example 3-14, we create a port channel with four member ports.

**Example 3-14**  Associate the Fabric Extender to a Port Channel Interface

```plaintext
N7K-Agg# configure terminal
N7K-Agg (config)# interface ethernet 1/28
N7K-Agg (config-if)# channel-group 4
N7K-Agg (config-if)# no shutdown
N7K-Agg (config-if)# exit
N7K-Agg (config)# interface ethernet 1/29
N7K-Agg (config-if)# channel-group 4
N7K-Agg (config-if)# no shutdown
N7K-Agg (config-if)# exit
N7K-Agg (config)# interface ethernet 1/30
N7K-Agg (config-if)# channel-group 4
N7K-Agg (config-if)# no shutdown
N7K-Agg (config-if)# exit
N7K-Agg (config)# interface ethernet 1/31
N7K-Agg (config-if)# channel-group 4
N7K-Agg (config-if)# no shutdown
N7K-Agg (config-if)# exit
N7K-Agg (config)# interface port-channel 4
N7K-Agg (config-if)# switchport
N7K-Agg (config-if)# switchport mode fex-fabric
N7K-Agg (config-if)# fex associate 101
```

After the FEX is associated successfully, you must do some verification to make sure everything is configured properly.
### Example 3-15  Verifying FEX Association

```plaintext
N7K-Agg# show fex
FEX   FEX   FEX   FEX
Number Description State Model    Serial
-----------------------------------------------
101   FEX0101 Online  N2K-C2248TP-1GE JAF1418AARL
```

### Example 3-16  Display Detailed Information About a Specific FEX

```plaintext
N7K-Agg# show fex 101 detail
FEX: 101 Description: FEX0101   state: Online
    FEX version: 5.1(1)  [Switch version: 5.1(1)]
    FEX Interim version: 5.1(0.159.6)
    Switch Interim version: 5.1(1)
    Extender Model: N2K-C2248TP-1GE,  Extender Serial: JAF1418AARL
    Part No: 73-12748-05
    Module Sw Gen: 21  [Switch Sw Gen: 21]
    pinning-mode: static    Max-links: 1
    Fabric port for control traffic: Po101
    Fabric interface state:
    Po101 - Interface Up. State: Active
    Eth2/1 - Interface Up. State: Active
    Eth2/2 - Interface Up. State: Active
    Eth4/1 - Interface Up. State: Active
    Eth4/2 - Interface Up. State: Active
    Fex Port    State  Fabric Port  Primary Fabric
     Eth101/1/1  Up       Po101       Po101
     Eth101/1/2  Up       Po101       Po101
     Eth101/1/3  Down     Po101       Po101
     Eth101/1/4  Down     Po101       Po101
```

### Example 3-17  Display Which FEX Interfaces Are Pinned to Which Fabric Interfaces

```plaintext
N7K-Agg# show interface port-channel 101 fex-intf
Fabric  FEX
Interface Interfaces
---------------------------
Po101   Eth101/1/2   Eth101/1/1
```
Example 3-18  Display the Host Interfaces That Are Pinned to a Port Channel Fabric Interface

N7K-Agg# show interface port-channel 4 fex-intf

<table>
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</tr>
</thead>
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<td>Po4</td>
<td>Eth101/1/48 Eth101/1/47 Eth101/1/46 Eth101/1/45</td>
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</tr>
<tr>
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<tr>
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<td></td>
</tr>
<tr>
<td></td>
<td>Eth101/1/4  Eth101/1/3  Eth101/1/2  Eth101/1/1</td>
<td></td>
</tr>
</tbody>
</table>

Summary

- VDCs on the Nexus 7000 switches enable true device virtualization; each VDC will have its own management domain, allowing the management plane also to be virtualized.
- To send traffic between VDCs you must use external physical cables that lead to greater security of user data.
- Cisco Nexus 2000 cannot operate in a standalone mode; it needs a parent switch to connect to.
- The FEX technology can be extended all the way to the server hypervisor. This technology enables operational simplicity by having a single point of management and policy enforcement on the access parent switch.
Exam Preparation Tasks

Review All Key Topics
Review the most important topics in the chapter, noted with the key topics icon in the outer margin of the page. Table 3-2 lists a reference for these key topics and the page numbers on which each is found.

### Table 3-2 Key Topics for Chapter 3

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Define Key Terms
Define the following key terms from this chapter, and check your answers in the Glossary:

- Virtual Device Context (VDC), supervisor engine (SUP), demilitarized zone (DMZ), erasable programmable logic device (EPLD), Fabric Extender (FEX), role-based access control (RBAC), network interface (NIF), host interface (HIF), virtual interface (VIF), logical interface (LIF), End-of-Row (EoR), Top-of-Rack (ToR), VN-Tag
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