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TCP/IP

Exam #70-059

MICROSOFT CERTIFIED SYSTEMS ENGINEER

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TCP/IP

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About the Author

Richard Burke is the president of a firm that specializes in computer network consulting and development of training materials related to computer networks. He has a Ph.D. in Physics and a M.S. in Computer Engineering. Prior to starting his own business, Richard was in charge of the Networking Technologies Department at Wake Technical Community College in North Carolina, where he taught a wide range of computer networking courses. He was also the director and instructor for the "Networking Fundamentals" course at the American Research Group, Inc., a commercial training organization.

Acknowledgments

In order to implement the network required for the development of this book and to do the exercises at the end of each chapter, a significant amount of hardware and software was required. The author is grateful to the publisher, Course Technology, which purchased the Windows NT 4.0 Server operating system. The help of Joanie Miller, Eldrice Murphy and Keith Snyder of the IBM PC Product Review Division in the Research Triangle Park of North Carolina was also needed to make the book possible. The Product Review Division loaned me an Intellistation Z Pro workstation and the Windows NT Workstation operating system and provided free technical support on an as-needed basis. This support included delivery of the product and a house call on one occasion. I wish doctors still did that. The second workstation used on the development network was loaned by the Multimedia Laboratory at North Carolina State University. This was the result of time and effort by Professor Mladen Vouk who provided other valuable support when asked.

There were a number of occasions when a colleague, Duane Reaugh of DTS Software, Inc. of Raleigh provided networking insight. Pin Point Software Corporation and Peter Halliday of Network World were kind enough to donate copies of Click Net and Net Draw, respectively. These software applications provide excellent network device clip art. Invaluable discussions were had with Scott Anderson and Lori Bush of Cisco Systems. Lori provided us with a copy of Ciscoworks, an excellent router management tool. John Feldmeier of Technically Elite, Inc. (formerly Network Applications Technology, Inc. [NAT]) provided a Beta2 copy of MeterWare for Windows95/NT. This is an excellent generic network management utility based on the TCP/IP protocol SNMP. The staff at Black Box Corporation, particularly Patricia Race, was helpful on a number of occasions. Black Box donated a Quick Test Plus device which, as its name implies, provides a quick test that cables are correctly connecting device interfaces.

As anyone who has ever written a book knows, the cooperation and patience of several people over a long time period are critical to success of the project. The author wishes to thank the Managing Editor, Kristen Duerr, and the Project Manager, Jennifer Normandin, of Course Technology, and the Development Editor, Mary Terese Cozzola of Writing and Editing Services, Inc. for their support in making this book possible. Finally, the willingness of a spouse to sacrifice a lot of companionship during an effort such as this cannot be overvalued. Arlene Burke contributed peace of mind throughout the process.

FOREWORD

The big technology question for the '90s and beyond is, "Are you certified?" Certification is rapidly becoming the key to professional career enhancement for network engineers, technicians, software developers, web designers, and even professional office workers.

WHY BECOME A MICROSOFT CERTIFIED PROFESSIONAL?

Becoming a Microsoft Certified Professional can open many doors for you. Obtaining the appropriate Microsoft Certified Professional credentials can provide a formal record of your skills to potential employers. Certification can be equally effective in helping you secure a raise or promotion.

The Microsoft Certified System Engineer (MCSE) program is made up of a series of required and elective exams in several different tracks. Combinations of individual courses can lead to certification in a specific track. Most tracks require a combination of required and elective courses. (Internetworking with Microsoft TCP/IP on Microsoft Windows NT 4.0 Exam #70-059 is among the required course offerings.) Your MCSE credentials tell a potential employer that you are an expert in TCP/IP.

WANT TO KNOW MORE ABOUT MICROSOFT CERTIFICATION?

There are many additional benefits to achieving Microsoft Certified status. These benefits apply to you as well as to your potential employer. As a Microsoft Certified Professional (MCP), you will be recognized as an expert on Microsoft products, have access to ongoing technical information from Microsoft, and receive special invitations to Microsoft conferences and events. You can obtain a comprehensive, interactive tool that provides full details about the Microsoft Certified Professional Program online at **www.microsoft.com/train_cert/cert/cert.htm**. For more information on texts from Certification Insider Press that will help prepare you for certification exams, visit our site at **www.certificationinsider.com**.

When you become a Microsoft Certified Professional, Microsoft sends you a Welcome Kit that contains the following:

1. Microsoft Certified Professional wall certificate. Also, within a few weeks after you have passed any exam, Microsoft sends you a Microsoft Certified Professional Transcript that shows which exams you have passed.

2. License to use the Microsoft Certified Professional logo. You are licensed to use the logo in your advertisements, promotions, proposals, and other materials, including business cards, letterheads, advertising circulars, brochures, yellow page advertisements, mailings, banners, resumes, and invitations.

3. Microsoft Certified Professional logo sheet. Before using the camera-ready logo, you must agree to the terms of the licensing agreement.
4. Access to technical and product information directly from Microsoft through a secured area of the MCP Web site. Dedicated forums on CompuServe (GO MECFORUM) and The Microsoft Network, which enable Microsoft Certified Professionals to communicate directly with Microsoft and one another.
5. One-year subscription to *Microsoft Certified Professional Magazine*, a career and professional development magazine created especially for Microsoft Certified Professionals.
6. Invitations to Microsoft conferences, technical training sessions, and special events.

A Microsoft Certified Systems Engineer receives all the benefits mentioned above and the following additional benefits:

1. Microsoft Certified Systems Engineer logos and other materials to help you identify yourself as a Microsoft Certified Systems Engineer to colleagues or clients.
2. One-year subscription to the Microsoft TechNet Technical Information Network.
3. One-year subscription to the Microsoft Beta Evaluation program. This benefit provides you with up to 12 free monthly beta software CDs for many of Microsoft's newest software products. This enables you to become familiar with new versions of Microsoft products before they are generally available. This benefit also includes access to a private CompuServe forum where you can exchange information with other program members and find information from Microsoft on current beta issues and product information.

CERTIFY ME!

So you are ready to become a Microsoft Certified Professional. The examinations are administered through Sylvan Prometric (formerly Drake Prometric) and are offered at more than 700 authorized testing centers around the world. Microsoft evaluates certification status based on current exam records. Your current exam record is the set of exams you have passed. To maintain Microsoft Certified Professional status, you must remain current on all the requirements for your certification.

Registering for an exam is easy. To register, contact Sylvan Prometric, 2601 West 88th Street, Bloomington, MN, 55431, at (800) 755-EXAM (3926). Dial (612) 896-7000 or (612) 820-5707 if you cannot place a call to an 800 number from your location. You must call to schedule the exam at least one day before the day you want to take the exam. Taking the exam automatically enrolls you in the Microsoft Certified Professional program; you do not need to submit an application to Microsoft Corporation.

When you call Sylvan Prometric, have the following information ready:

1. Your name, organization (if any), mailing address, and phone number.
2. A unique ID number (e.g., your Social Security number).
3. The number of the exam you wish to take (#70-059 for the TCP/IP exam).
4. A method of payment (e.g., credit card number). If you pay by check, payment is due before the examination can be scheduled. The fee to take each exam is currently $100.

ADDITIONAL RESOURCES

One of the best sources of information about Microsoft certification tests comes from Microsoft itself. Because its products and technologies—and the tests that go with them—change frequently, the best place to go for exam-related information is online.

If you haven't already visited the Microsoft Training and Certification pages, do so right now. As of this writing, the Training and Certification home page resides at **www.microsoft.com/Train_Cert/default.htm**. Note that it may not be there by the time you read this, or it may have been replaced by something new, because the Microsoft site changes regularly. Should this happen, please read the next section, titled "Coping with Change on the Web."

The menu options in the home page's left-hand column point to important sources of information in the Training and Certification pages. Here's what to check out:

- **Train_Cert Summaries/By Product and Technology** Use this to jump to product-based summaries of all classroom education, training materials, study guides, and other information for specific products. Under the heading "TCP/IP," you'll find an entire page of information about TCP/IP training and certification. This tells you a lot about your training and preparation options, and mentions all the tests that relate to TCP/IP.
- **Technical Certification/Find an Exam** Pulls up a search tool that lets you list all Microsoft exams and locate all exams pertinent to any Microsoft certification (MCP, MCSD, MCSE, MCT, and so on), or those exams that cover a particular product. This tool is quite useful not only to examine the options, but also to obtain specific test preparation information, because each exam has its own associated preparation guide.
- **Site Tools/Downloads** Here, you'll find a list of the files and practice tests that Microsoft makes available to the public. These include several items worth downloading, especially the Certification Update, the Personal Exam Prep (PEP) tests, various assessment exams, and a general Exam Study Guide. Try to peruse these materials before taking your first test.

Of course, these are just the high points of what's available in the Microsoft Training and Certification pages. As you browse through them—and I strongly recommend that you do—you'll probably find other information we didn't mention here that is every bit as interesting and compelling.

Coping with Change on the Web

Sooner or later, all the specifics I've shared with you about the Microsoft Training and Certification pages, and all the other Web-based resources I mention throughout the rest of this book, will go stale or be replaced by newer information. In some cases, the URLs you find here may lead you to their replacements; in other cases, the URLs will go nowhere, leaving you with the dreaded 404 error message, "File not found."

When that happens, please don't give up! There's always a way to find what you want on the Web, if you're willing to invest some time and energy. To begin with, most large or complex Web sites—and Microsoft's qualifies on both counts—offer a search engine. As long as you can get to the site itself, you can use this tool to help you find what you need.

The more particular or focused you can make a search request, the more likely it is that the results will include information you can use. For instance, you can search the string "Training and Certification" to produce a lot of data about the subject in general, but if you're specifically looking for, for example, the Preparation Guide for Exam 70-059, Internetworking with Microsoft TCP/IP on Microsoft Windows NT 4.0, you'll be more likely to get there quickly if you use a search string such as: **"Exam 70-059" AND "Preparation Guide."** Likewise, if you want to find the Training and Certification downloads, try a search string such as: **"Training and Certification" AND "download page."**

Finally, don't be afraid to use general search tools like www.search.com, www.altavista.com, or www.excite.com to find related information. Although Microsoft offers the best information about its certification exams online, there are plenty of third-party sources of information, training, and assistance in this area that do not have to follow a party line like Microsoft does. The bottom line is: if you can't find something where the book says it lives, start looking around.

INTRODUCTION

Welcome to *MCSE TCP/IP Exam Prep!* This new book from Certification Insider Press offers you real-world examples, interactive activities, and dozens of hands-on projects that reinforce key concepts and help you prepare for the exam. This book also features troubleshooting tips for solutions to common problems that you will encounter.

An interactive CD-ROM with two complete practice exams that allow you to test your skills and knowledge makes this the perfect study guide for the Microsoft certification exam. These materials have been specifically designed to help individuals prepare for Microsoft Certification Exam #70-059, "TCP/IP." Answers to end-of-chapter review questions and projects are also found on the CD-ROM.

ABOUT THE BOOK

To aid you in fully understanding TCP/IP concepts, there are many features in this book that have been designed to help you logically work through and confidently prepare for the exam.

- **Chapter Objectives** Each chapter in this book begins with a detailed list of the concepts to be mastered within that chapter. This list provides you with a quick reference to the contents of that chapter, as well as a useful study aid.
- **Illustrations and Tables** Numerous illustrations aid you in the visualization of common setups, theories, and architectures. In addition, many tables provide details and comparisons of both practical and theoretical information.
- **Chapter Summaries** Each chapter's text is followed by a summary of the concepts it has introduced. These summaries provide a helpful way to recap and revisit the ideas covered in each chapter.
- **Key Terms** Following the Chapter Summary, a list of new TCP/IP terms and their definitions encourages proper understanding of the chapter's key concepts and provides a useful reference.
- **Review Questions** End-of-chapter assessment begins with a set of review questions that reinforce the ideas introduced in each chapter. These questions not only ensure that you have mastered the concepts, but are written to help prepare you for the Microsoft certification examination.
- **Hands-on Projects** Although it is important to understand the theory behind this technology, nothing can improve upon real-world experience. With the exception of those chapters that are purely theoretical, each chapter provides a series of exercises aimed at providing you with hands-on implementation experience.
- **Case Projects** Finally, each chapter closes with a section that proposes a real-world situation. You are asked to evaluate the situation and decide upon the course of action to be taken to remedy the problems described. This valuable tool helps the reader sharpen decision-making and troubleshooting skills.

Text and Graphic Conventions Used in this Book

Wherever appropriate, additional information and activities have been added to this book to help the reader better understand what is being discussed in the chapter. Icons throughout the text alert readers to additional materials. The icons used in this book are described below.

Note icons present additional helpful material related to the subject.

Tip icons highlight suggestions on ways to attack problems you may encounter in a real-world situation. The author has practical experience with how TCP/IP works in real business situations.

Caution icons appear in the margin next to concepts or steps that often cause difficulty. Each caution anticipates a potential mistake and provides methods for avoiding the same problem in the future.

Hands-on project icons precede each hands-on activity in this book.

Case project icons are located at the end of each chapter. They mark a more involved, scenario-based project. In this extensive case example, readers are asked to independently implement what they have learned.

Where Should You Start?

This book is intended to be read in sequence, from beginning to end. Each chapter builds upon those that precede it, to provide a solid understanding of internetworking with TCP/IP. After completing the chapters, you may find it useful to go back through the book, and use the review questions and projects to prepare for the Microsoft certification test for TCP/IP (#70-059). Readers are also encouraged to investigate the many pointers to online and printed sources of additional information that are cited throughout this book.

Don't Miss it! Valuable Information at the End of the Book

In addition to its core materials, this book includes information that is worthy of further investigation.

- **Appendix: Useful Windows NT TCP/IP Diagnostic Utilities** The diagnostic utilities provided by Windows NT that were found to be most useful in demonstrating the concepts that are covered and to analyze the results are described.
- **Glossary** This is a complete compendium of all of the acronyms and technical terms used in this book, with definitions.

HARDWARE AND SOFTWARE REQUIREMENTS

Before You Begin

Individuals who wish to get the most from these materials should have access to a networked PC that is running Microsoft Windows 95, Windows NT Workstation 4.0, or Windows NT Server 4.0. If you have access to a Web browser, you will be able to complete all of the exercises in this book. The following table summarizes the requirements and recommendations (in parentheses) for each of these operating systems:

Item	Windows 95	NT Workstation 4.0	NT Server 4.0
MB RAM	16 (32)	12 (64)	16 (64)
MB Disk space	90 (200)	116 (400)	124 (1,000)
CPU	386/16 (486+)	486/33 (Pentium)	486/33 (Pentium)
Display type	VGA(SVGA)	VGA(SVGA)	VGA(SVGA)
Network	Yes	Yes	Yes

When it comes to any of these operating systems, it's wise to meet the recommended configurations, rather than the minimum configurations. While each of them will work at the minimum configurations, such systems will be slow and sometimes painful to use. In fact, it's nearly impossible to give any of these operating systems too much memory, disk space, or CPU power. These various Windows environments almost exemplify the notion that "more is better" when it comes to such things.

SYSTEM REQUIREMENTS FOR TEST PREP SOFTWARE:

- 8 MB RAM (16 MB recommended)
- VGA/256 Color display or better
- 4X CD-ROM Drive
- Windows NT 4.0 or Windows 95

ABOUT THE CD-ROM

To become a Microsoft Certified Professional, you must pass rigorous certification exams that provide a valid and reliable measure of technical proficiency and expertise. The CD-ROM that comes with this book can be used in conjunction with the book to help you assess your progress in the event you choose to pursue Microsoft Professional Certification. The CD-ROM contains specially designed test simulation software that features two 58-question practice exams. The questions were expertly prepared to test your readiness for the official Microsoft certification examination on TCP/IP (Exam #70-059). The practice exam questions simulate the interface and format of the actual certification exams.

PRACTICE EXAM FEATURES:

- 58 questions, just like the actual exam
- 90-minute timed test to ensure exam readiness
- Questions can be marked and answered later
- Graphical representation of your test grade

SOLUTIONS TO END-OF-CHAPTER QUESTIONS AND PROJECTS

For further help in making sure you are prepared for the TCP/IP certification exam, we have included solutions for the end-of-chapter Review Questions, Hands-on Projects, and Case Projects on the CD.

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CHAPTER ONE

COMMUNICATIONS ARCHITECTURES

This chapter provides you with a review of communications architecture concepts. This book examines one communications architecture: the **Transmission Control Protocol/Internet Protocol (TCP/IP)** and its implementation with Microsoft Windows NT 4.0. The purpose of this chapter is to highlight concepts that form the basis of network communications in general and are fundamental to the topics covered in this book.

IN THIS CHAPTER YOU WILL:

- LEARN ABOUT PEER-TO-PEER COMMUNICATIONS ARCHITECTURE
- LEARN ABOUT CLIENT/SERVER COMMUNICATIONS ARCHITECTURE
- LEARN ABOUT THE OSI REFERENCE MODEL
- LEARN ABOUT LOCAL AREA NETWORK (LAN) COMMUNICATIONS
- LEARN ABOUT FRAMES
- LEARN ABOUT WIDE AREA NETWORK (WAN) COMMUNICATIONS
- LEARN ABOUT THE CASE PROJECT

COMMUNICATIONS ARCHITECTURES

Architecture is the art and science of designing and building structures. In a **communications architecture**, the structure is not a tangible object, such as a house or school, but rather a system of rules and practices that enable computers to share information over a network. The architectural structure of a house precedes any other step in its completion, such as installing electrical wiring or putting up drywall. Similarly, in a computer network, the communications architecture underlies all other processes involved in connectivity, including hardware (such as cables connecting the computers) or software (such as the network operating system or application programs). Just as a building is constructed of many integrated parts, a working communications architecture requires the integration of many **protocols** (rules). Both a building and a communications architecture are too complex to be constructed from only one element. Therefore, as you will see, several protocols are combined to construct a communications architecture. Finally, the roof of a building depends on the building for support. Application programs, such as word processing, spreadsheet, or database software, are the "roof" of a communications architecture in that they require network resources and so are supported by the communications architecture.

There is no one communications architecture—many are in use today. These include IBM's System Network Architecture (SNA), Digital Equipment Corporation's DECnet, Banyan's Vines, Apple's AppleTalk, the Microsoft and IBM NetBIOS Extended User Interface (NetBEUI), Novell's IPX/SPX, TCP/IP, and the Open System Interconnection (OSI) Model. Each of these architectures was developed according to a slightly different approach. Some architectures are designed with a particular operating system in mind—for example, TCP/IP and the UNIX operating system, and AppleTalk and the Macintosh operating system. However, if the appropriate software interface module is provided, most communications architectures can be made to work with any operating system. This interoperability is common in today's networking environment. For example, even though NetBEUI is the communications architecture native to Microsoft Windows Networking, the emphasis of this book is on the use of the TCP/IP architecture with Windows NT 4.0.

The application programs that you run on your computer have been designed to work with a particular operating system, such as DOS or Windows. The function of operating systems is to manage the resources on your computer and, in so doing, to satisfy your request for service. However, when your application program makes a request for service that requires the request to be passed across the network to a server, the **Network Operating System (NOS)** in the server will handle that request. A network operating system is one that is designed to handle many simultaneous requests for service and to provide secure file sharing. The NOS must have access to the same communications architecture as the computer that sent the request. In the networking environment that is explored in this book, workstations using the Windows NT 4.0 Workstation operating system and servers using the Windows NT 4.0 Server operating system use the same communication architectures. Thus communication is not a problem. If you were to add a computer to the network that is running a different operating system, such as DOS or Macintosh System 7.x, your server would need an additional software module that would translate the request from the "foreign" operating system