INTRODUCTION TO IP ADDRESS MANAGEMENT

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Timothy Rooney

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PREFACE

Today's IP networks are growing increasingly complex, as new IP services and technologies are deployed. The increasing proliferation of IP-based devices and applications serves only to accentuate the importance of the performance of the IP network supporting these business-critical applications. If end-user devices such as laptops or VoIP phones cannot obtain an IP address via DHCP (Dynamic Host Configuration Protocol), they will be rendered unproductive and users will call the help desk. Likewise, if DNS (Domain Name System) is down, application navigation by name, phone number, or web address will likewise impair productivity and induce help desk calls. Hence, effective IP Address Management (IPAM) has become critical to maintaining high-performing IP services such as data, video, and Voice over IP (VoIP).

The practice of IPAM entails the application of network management disciplines to IP address space and associated network services, namely DHCP and DNS. The consequence of inaccurately configuring DHCP is that end users may not be able to obtain IP addresses to access the network. Without proper DNS configuration, usability of the network will greatly suffer because the name-to-address lookup process may fail. Imagine having to navigate to a website or send an email or an instant message by IP address instead of by name! It's equally important that these DHCP and DNS configurations be based on a common IP address plan, which maps out the IP address hierarchy, subnets, address pools, and domains.

The linkages among the IP address plan, DHCP server configuration, and DNS server configuration are inseparable; a change of an IP address will affect DNS information and perhaps DHCP as well. These critical network functions provide the foundation for today's converged services IP networks, which comprise most enterprise and service provider networks, so they must be managed using a rigorous approach.

This book provides a concise introduction to the technologies of IP addressing, DHCP, and DNS, as well as IPAM practice and techniques needed to manage them cohesively. A companion book, *IP Address Management Principles and Practice*, provides a deeper dive into IPAM technologies and techniques.

The objectives of this book are to help you:

- Learn the basics of IPv4 and IPv6 addressing and subnetting, DHCP, and DNS networking technologies

- Understand IPAM practices, including managing your IP address inventory and tracking of address transactions, such as allocating and splitting address space, discovering network occupancy, and managing faults and performance
- Understand the costs and justifications for properly implementing an IPAM strategy
- Learn about IPv4-IPv6 co-existence technologies and approaches

CONVENTIONS

This book is typeset in Times Roman font. *Times Roman italic* font is used for terms introduced for the first time or to provide emphasis.

To differentiate prose from example configuration information within a DHCP or DNS server for example, Courier font is used in the following manner:

`Courier plain` font — denotes keywords or literal text within a configuration file or screen.

`Courier italic` font — denotes a parameter name that in practice is substituted for a value reflecting the denoted data element or type.

ORGANIZATION

The book begins with a basic overview of IP networking, followed by chapters describing each of the three core IPAM technologies: IPv4 and IPv6 addressing, DHCP, and DNS. The next three chapters describe IPAM management techniques and practice, followed by chapters on IPv4-IPv6 co-existence, security, and the IPAM business case.

Chapter 1 — IP Networking Overview. The opening chapter provides a very basic overview of IP networking, including a discussion of protocol layering, addressing, and routing.

Chapter 2 — Internet Protocol Addressing. Chapter 2 describes the Internet Protocol (IPv4 and IPv6) primarily from an IP addressing perspective.

Chapter 3 — Dynamic Host Configuration Protocol (DHCP). Chapter 3 provides an overview of the DHCP protocol for IPv4 and IPv6 address assignment, including a discussion of basic operation and additional parameter assignment functions core to many advanced IP services such as broadband service or voice over IP.

Chapter 4 — The Domain Name System (DNS). Chapter 4 provides a basic DNS overview, including a discussion of DNS concepts, the basic resolution process, the domain tree for forward and reverse domains, and resource records.

Chapter 5 — IP Address Management Overview. This chapter introduces the concepts of IP address management (IPAM), including its major components, motivation, benefits, and basic approaches.

Chapter 6 — IP Address Management Practices. Everyday IP address management functions are described in Chapter 6, including IP address allocation and assignment, renumbering, moves, splits, joins, DHCP and DNS server configuration, inventory assurance, fault management, performance monitoring, and disaster recovery. This chapter is framed around the FCAPS network management model, emphasizing the necessity of a disciplined "network management" approach to IPAM.

Chapter 7 — IP Address Management Workflow. This chapter describes various approaches to automating IPAM functions through workflow. An introduction to workflow begins the chapter, followed by intra- and extra-IPAM automation examples, benefits, and scenarios. Examples such as IP address requests, Internet Registry reporting, and asset tracking are described.

Chapter 8 — IPv6 Deployment and IPv4 Co-Existence. Chapter 8 describes various technologies and strategies for deploying IPv6 over an existing IPv4 network.

Chapter 9 — Security Considerations. This chapter describes security related topics with respect to DHCP network access control approaches, DNS vulnerabilities and mitigation, and DNSSEC.

Chapter 10 — IP Address Management Business Case. Chapter 10 provides a business-oriented conclusion to the book, describing the business case for IPAM. This includes derivation of the business case cost basis, identification of savings when using an IP address management system, associated costs, and finally net results. An example business case is also provided.

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