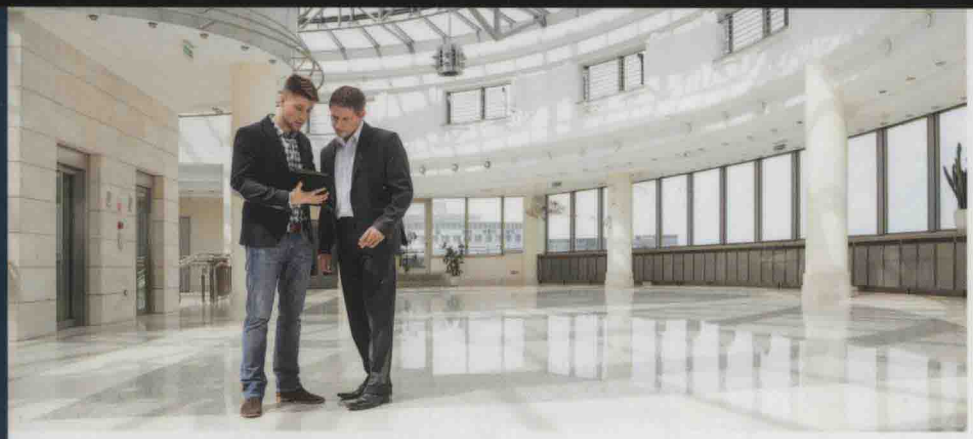

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Cisco Press
800 East 96th Street
Indianapolis, IN 46240 USA

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Published by:
Cisco Press
800 East 96th Street
Indianapolis, IN 46240 USA

Printed in the United States of America

1 16

Library of Congress Control Number: 2016934921

ISBN-13: 978-1-58714-494-3

ISBN-10: 1-58714-494-8

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Arvind maintains two CCIE certifications: Routing and Switching, and Security. He holds a Bachelor of Science degree in Electronics and Communication, a Master's degree in Electrical Engineering (MS), and a Master's degree in Business Administration (MBA). He is a coauthor of two Cisco press books, *Cisco Secure Firewall Services Module* and *TcL Scripting for Cisco IOS*.

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Stephen is a well-known speaker who has presented at several conferences and seminars worldwide. He holds a Bachelor of Science in Electrical Engineering from the University of Virginia. Stephen is based out of the Cisco office in Washington, DC.

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Amit has been involved in the development cycles of new operating systems such as IOS XR and IOS XE and delivering features such as MPLS-based Layer 2 and 3 VPNs and traffic engineering. With IOS XE, Amit has worked with platforms such as ASR 1000 and CSR 1000V right from their inception, delivering enterprise-level features like IPsec, NAT, firewalls, NetFlow, AVC, and QoS. Amit holds a Bachelor of Science degree in Electrical Engineering.

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Dedications

From Arvind:

I am thankful to God for everything. I would like to dedicate this book to my wife, Monica, and my son, Akhhill, who have been extremely patient and supportive during my long working hours. I am grateful to my parents for their blessings and for providing me with strong values.

I would also like to thank my parents-in-law, brother and family, and brother-in-law and family for all their support and wishes.

From Stephen:

I would like to dedicate this book to my wonderful and beautiful wife, Angela, and to my two incredible children, Christina and Ethan. Without your love, sacrifice, and support, this book would not have been possible. Thanks for putting up with the late nights and weekends I had to spend behind the computer and on conference calls instead of playing games, building Legos, and doing other fun family activities.

From Amit:

I would like to dedicate this book to my wife, Reshma, my daughter, Aarushi, and my parents. Without their love and support, I would never have been able to work on this. I would also like to thank my parents-in-law and my entire extended family. Their love and support have always been unconditional.

Acknowledgments

Arvind Durai:

Thanks to my wife, Monica, for encouraging me to write my third book. She inspired me and helped keep my spirits up all the time and provided her thoughts in multiple sections of this book. Thank you!!!

It was great working with Amit and Stephen. Their excellent technical knowledge and passion for writing made this writing experience a pleasure. I am looking forward to more years of working together as colleagues and friends.

Stephen Lynn:

A debt of gratitude goes to my coauthors, Arvind and Amit. Your knowledge and dedication to this project are appreciated more than you will ever know.

Acknowledgements for this book wouldn't be complete without mentioning my wife, Angela, who has endured and supported me through all my endeavors.

Amit Srivastava:

Special thanks to Arvind and Stephen, from whom I learned a lot while writing this book. I look forward to their continued support.

Our Acknowledgement

Many people within Cisco have provided feedback and suggestions to make this a great book. Thanks to all who have helped in the process, especially Ray Blair and Matt Falkner, for providing insightful input during the proposal process. A special thank you goes to our technical editors, Ray Wong and Matt Bollick, for your technical accuracy and insight into the technologies. Special thanks to Dimitris Vlassopoulos for providing his NSO lab setup and sharing his insights!

A big thank you goes out to the production team for this book, Brett Bartow, Ellie Bru, and Tonya Simpson, who have been incredibly professional and a pleasure to work with, and for making this book possible.

Contents at a Glance

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Introduction

In today's business environment, enterprise customers are under more pressure than ever to innovate and adapt to new challenges and market conditions. Enterprises want to focus their investments on their core business while reducing IT spending.

The cloud offers enterprise customers many benefits, such as lower costs and flexibility. The cloud's elastic model enables a company to increase and decrease infrastructure capacity on demand. The usage-based model offered by the cloud helps governments and enterprises reduce costs while increasing business agility by moving applications to the cloud and consuming infrastructure resources from the cloud. This leads to enterprises looking at consuming network and IT services from the cloud rather than investing in in-house operations.

The enabling technology in unlocking the cloud is virtualization. Virtualization abstracts and isolates the computing hardware and underlying infrastructure into a logical resource pool, allowing key capabilities such as resource sharing, virtual machine (VM) isolation, and load balancing. These capabilities provide the fundamental building blocks for an agile and scalable cloud environment with rapid provisioning, workload sharing, and increased availability.

The surge in applications and IT service consumption moving to the cloud highlights the need for evolved technologies and network elements in the cloud that offer security and visibility to help businesses with performance and compliance verification. Evolved networks and network services enable the provider to offer cloud services with security, performance, and availability. The Cisco Cloud Services Router 1000V (CSR 1000V) is a fully virtualized software router that offers a platform for enterprises to extend the data center to the cloud and to enforce their policies in the cloud.

The Cisco CSR 1000V provides a transparent solution for extending IT services into provider-hosted clouds. The solution offers a rich set of features, including VPN, firewall, Network Address Translation (NAT), application visibility, and WAN optimization. These functions allow enterprise and cloud providers to build highly secure, scalable, and extensible cloud networks. In addition, the Cisco CSR 1000V supports a rich set of application programming interfaces (API), providing robust integration into software-defined networking (SDN) for automated provisioning of these networks and network services and allowing simplified management and orchestration, which help in driving down costs further.

Networks inherently carry vast amounts of information, including user locations, device capabilities, topologies, and end-to-end performance characteristics. When exposed appropriately through well-defined APIs, such information can be consumed by cloud applications to fine-tune and customize their efficient delivery. The future holds the promise of increasingly rich application–network interactions.

The primary objective of this book is to simplify design aspects and architectural details in a unified resource, augmenting Cisco's existing collection of installation and configuration guides for various cloud-related products and solutions. This book covers the key

virtualization technologies used in the cloud; it provides a concise, accessible presentation of cloud network services and the different types of operational environments in the cloud. Cloud networking service and delivery concepts are reinforced with illustrative examples; architecture of SDN orchestration and its connection to Cisco CSR 1000V network services are introduced and elaborated upon. In addition, the book reviews the building blocks of the CSR 1000V, covering its architecture and software design.

This book also explains network design and deployment scenarios for the Cisco CSR 1000V, which influence its pivotal role in the cloud environment. Furthermore, the book distills how intelligent networks help providers simplify cloud service management and reduce costs through efficient scaling and optimized capacity utilization. This book provides architectural knowledge that contextualizes the roles and capabilities of these advanced networks and network services, along with discussions of design factors essential for their insertion into cloud services:

- The book introduces the readers to the cloud and provides an overview to different types of cloud operational environments, including a prelude to the evolution of virtual routers.
- Virtualization is introduced as a pivotal technology in cloud adoption.
- The book covers the details of the operating systems and hypervisors on which virtual routers run. It provides details pertaining to the operational aspects of virtual routing.
- The reader is introduced to the architecture and software design of the Cisco CSR 1000V virtual router. The reader is subsequently introduced to a comprehensive set of APIs that can be leveraged by SDN.
- The book focuses on different designs and use cases and configuration examples for routing, secure extension of enterprises to the cloud, and VM mobility. It illustrates how the CSR 1000V addresses the challenges that an architect faces in migrating toward the cloud.
- This book covers the different management techniques available to simplify operational and monitoring aspects of cloud services.

Who Should Read This Book?

This book is targeted for a technical audience responsible for architecture, design, and deployment of data center and enterprise cloud services.

This book also caters to the next generation of cloud network operators to implement enterprise features in the cloud, leveraging the CSR 1000V.

After reading this book, you will have a better understanding of the following:

- Key virtualization concepts and cloud models
- CSR 1000V software architecture and design

- SDN and the CSR 1000V platform and API
- Simplification of data center multitenant design with the CSR 1000V
- Use cases for the CSR 1000V to simplify enterprise routing in the cloud
- Operational visibility, management, and control of an enterprise network in the cloud

How This Book Is Organized

This book is organized into the following chapters.

Chapter 1: Introduction to Cloud

This chapter introduces the concept of cloud computing. It describes the various cloud models available and how virtualization enables the present-day transition to the cloud. Multitenant data center designs are illustrated, and the concept of SDN is introduced here.

Chapter 2: Software Evolution of the CSR 1000

This chapter introduces the software evolution of the Cisco Cloud Services Router (CSR 1000V). It covers the infrastructure requirements and design considerations of a CSR 1000V, and it discusses the features that a CSR 1000V brings to the virtual routing realm.

Chapter 3: Hypervisor Considerations for the CSR

This chapter describes the different hypervisor technologies available on servers to manage the hardware resources for virtual machines. Hypervisor technology selection is an important consideration when deploying the CSR 1000V.

Chapter 4: CSR 1000V Software Architecture

This chapter describes the software design of the CSR 1000V. It details the control-plane and data-plane design of the CSR 1000V. It also describes licensing requirements, software implementation, and packet flow related to the CSR 1000V.

Chapter 5: CSR 1000V Deployment Scenarios

This chapter describes the common deployment scenarios for the CSR 1000V. It depicts these scenarios using configuration examples.

Chapter 6: CSR Cloud Deployment Scenarios

This chapter describes CSR 1000V deployments in the cloud and data center environments.

Chapter 7: CSR in the SDN Framework

This chapter describes SDN components. It also provides an overview of the CSR 1000V in the OpenStack framework. Case studies in this chapter aim to educate the reader on using the APIs for user-defined outcomes.

Chapter 8: CSR 1000V Automation, Orchestration, and Troubleshooting

This chapter provides an overview of CSR 1000V management tools for orchestration, monitoring, and troubleshooting. It also illustrates the operation workflow for deploying a CSR 1000V.

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