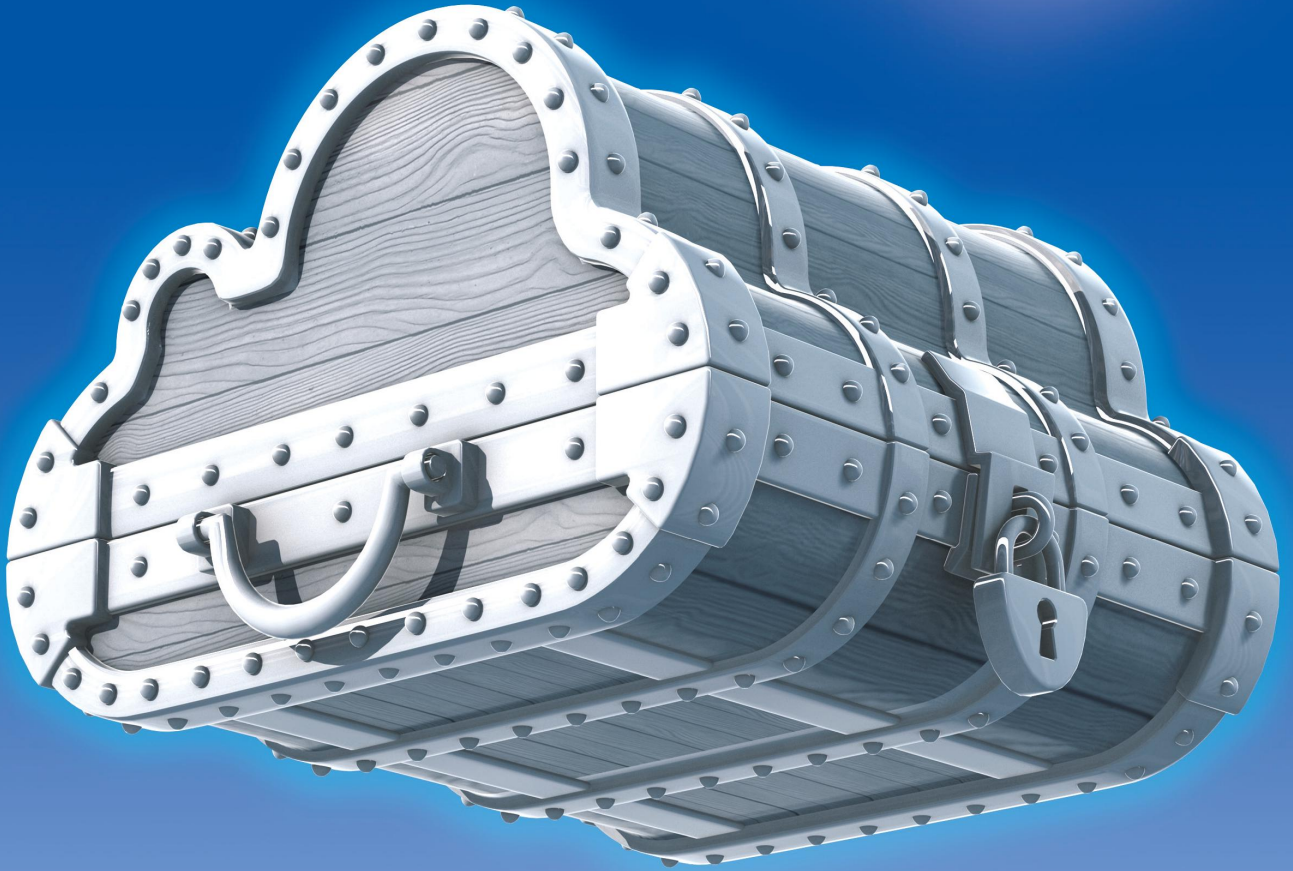


MAY • JUNE 2016

IEEE

Internet

Computing



CLOUD STORAGE



IEEE  computer society
CELEBRATING 70 YEARS

IEEE Internet Computing

MAY/JUNE 2016, VOLUME 20, NUMBER 3

DEPARTMENTS

Developing World

63 Toward Quantified Small-Scale Farms in Africa

Kala Fleming, Peninah Waweru, Muuo Wambua, Elizabeth Ondula, and Lianna Samuel

Beyond Wires

68 An Internet of Drones

Robert J. Hall

View from the Clouds

74 Developing Dependable and Secure Cloud Applications

Ingo Weber, Surya Nepal, and Liming Zhu

Standards

80 Signaling in IP-Based Networks: Retrospect and Prospect

Xiaoming Fu

COLUMNS

From the Editors

4 Spanning Web Capabilities over Clouds

M. Brian Blake

Practical Security

90 The Power (Energy) of Cryptography

Hilarie Orman

Backspace

95 Practical Solutions: Basic and Applied

Research, Science, Engineering, and Design

Vinton G. Cerf

01 Call for Papers

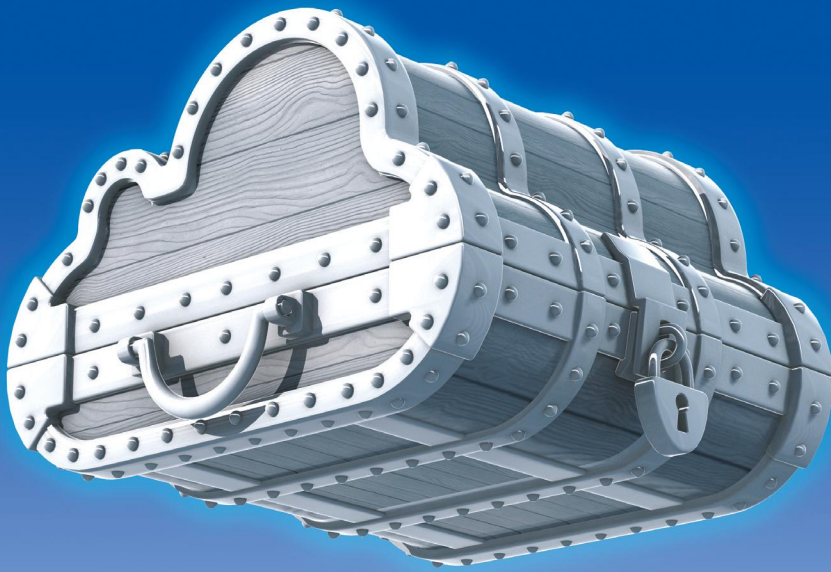
06 Advertiser Index

89 IEEE Computer Society Info

www.computer.org/internet/

This publication is indexed by ISI (Institute for Scientific Information) in SciSearch, Research Alert, the CompuMath Citation Index, and Current Contents/Engineering, Computing, and Technology. Postmaster: Send undelivered copies and address changes to IEEE Internet Computing, IEEE Service Center, 445 Hoes Ln., Piscataway, NJ 08855-1331. Periodicals postage paid at New York, NY, and at additional mailing offices. Canadian GST #125634188. Canada Post Publications Mail Agreement Number 40013885. Return undeliverable Canadian addresses to PO Box 122, Niagara Falls, ON L2E 6S8. Printed in the USA. Circulation: IEEE Internet Computing (ISSN 1089-7801) is published bimonthly by the IEEE Computer Society. IEEE headquarters: 3 Park Avenue, 17th Floor, New York, NY 10016-5997. IEEE Computer Society headquarters: 1828 L St. N.W., Suite 1202, Washington, D.C. 20036-5104. IEEE Computer Society Publications Office: 10662 Los Vaqueros Circle, PO Box 3014, Los Alamitos, Calif. 90720; (714) 821-8380; fax (714) 821-4010. Subscription rates: IEEE Computer Society members get the lowest rates and choice of media option — US\$48/1,300 for member/nonmember institutional print + online. For information on other prices or to order, go to www.computer.org/subscribe. Back issues: \$20 for members, \$173 for nonmembers. Reuse Rights and Reprint Permissions: Educational or personal use of this material is permitted without fee, provided such use: 1) is not made for profit; 2) includes this notice and a full citation to the original work on the first page of the copy; and 3) does not imply IEEE endorsement of any third-party products or services. Authors and their companies are permitted to post the accepted version of their IEEE-copyrighted material on their own Web servers without permission, provided that the IEEE copyright notice and a full citation to the original work appear on the first screen of the posted copy. An accepted manuscript is a version which has been revised by the author to incorporate review suggestions, but not the published version with copy-editing, proofreading, and formatting added by IEEE. For more information, please go to: http://www.ieee.org/publications_standards/publications/rights/paperversionpolicy.html. Permission to reprint/republish this material for commercial, advertising, or promotional purposes or for creating new collective works for resale or redistribution must be obtained from IEEE by writing to the IEEE Intellectual Property Rights Office, 445 Hoes Lane, Piscataway, NJ 08854-4141 or pubs-permissions@ieee.org. Copyright © 2016 IEEE. All rights reserved. Abstracting and Library Use: Abstracting is permitted with credit to the source. Libraries are permitted to photocopy for private use of patrons, provided the per-copy fee indicated in the code at the bottom of the first page is paid through the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923.





This special issue of *Internet Computing* surveys topics and challenges surrounding cloud storage. These include software-defined object storage in OpenStack Swift, shared services for file synchronization, convergent dispersal for secure cloud storage with high storage efficiency, quality of service for tiered storage in the cloud, and an application of cloud storage for the Internet of Things.

Cover by Giacomo Marchesi,
bucket@earthlink.net

CLOUD STORAGE

7 Guest Editors' Introduction

Robin Chen and Fred Douglis

10 IOStack: Software-Defined Object Storage

Raúl Gracia-Tinedo, Pedro García-López, Marc Sánchez-Artigas, Josep Sampé, Yosef Moatti, Eran Rom, Dalit Naor, Ramon Nou, Toni Cortés, William Oppermann, and Pietro Michiardi

19 Minerva: Proactive Disk Scheduling for QoS in Multitier, Multitenant Cloud Environments

Matthew Malensek, Sangmi Pallickara, and Shrideep Pallickara

28 Provider versus Tenant Pricing Games for Hybrid Object Stores in the Cloud

Yue Cheng, M. Safdar Iqbal, Aayush Gupta, and Ali R. Butt

36 MetaSync: Coordinating Storage across Multiple File Synchronization Services

Seungyeop Han, Haichen Shen, Taesoo Kim, Arvind Krishnamurthy, Thomas Anderson, and David Wetherall

45 CDStore: Toward Reliable, Secure, and Cost-Efficient Cloud Storage via Convergent Dispersal

Mingqiang Li, Chuan Qin, Jingwei Li, and Patrick P.C. Lee

54 Toward a Global Data Infrastructure

Nitesh Mor, Ben Zhang, John Kolb, Douglas S. Chan, Nikhil Goyal, Nicholas Sun, Ken Lutz, Eric Allman, John Wawrzyniec, Edward A. Lee, and John Kubiatawicz

For more information on these or any other computing topics, please visit the IEEE Computer Society Digital Library at www.computer.org/publications/dlib.