

## Spring 2016 Seminar Series

EXPLORING SERVER REDUNDANCY IN NONBLOCKING MULTICAST DATA CENTER NETWORKS

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10:00 AM – HEC 450

Clos networks and their variations such as folded-Clos networks (fat-trees) have been widely adopted as network topologies in data center networks (DCNs). Since multicast is an essential communication pattern in many cloud services, nonblocking multicast communication can ensure the high performance of such services. However, nonblocking multicast Clos networks are costly due to the large number of core switches required. On the other hand, server redundancy is ubiquitous in today's data centers to provide high availability of services. In this talk, we explore server redundancy in data centers to reduce the cost of nonblocking multicast Clos data center networks. First, we consider ideal fault-free data centers with no server failure. We show that the sufficient nonblocking condition on the number of core switches for multicast Clos DCNs can be significantly reduced, when the data center is 2-redundant, i.e., each server in the data center has exactly one redundant backup. We also investigate general redundant Clos DCNs where servers may have different number of redundant backups depending on the availability requirements of services, and show that a higher redundancy level further reduces the cost of nonblocking multicast Clos DCNs. Next, we extend the results to faulty data centers, where one or more active servers may fail at any time. We show that the nonblocking conditions for fault-free data centers still hold for the faulty case after reassigning active servers among edge switches. We also extend the results to the multirate network model that more accurately describes the communication environment of DCNs. Finally, we provide a multicast routing algorithm with linear time complexity to configure multicast connections in Clos DCNs.

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Yuanyuan Yang received the BEng and MS degrees in computer science and engineering from Tsinghua University, Beijing, China, and the MSE and PhD degrees in computer science from Johns Hopkins University, Baltimore, Maryland. Dr. Yang is a Professor and Graduate Program Director of Department of Electrical & Computer Engineering, a Professor of Department of Computer Science, the Director of Communications & Devices Division of New York State Center of Excellence in Wireless and Information Technology (CEWIT), and the Director of High-Performance Computing and Networking Research Lab at Stony Brook University.

Dr. Yang is internationally recognized for her contributions in parallel and distributed computing and networking areas. She was named an IEEE Fellow in 2009 "for contributions to parallel and distributed computing systems." She has been a National Distinguished Professor in China National Thousand-Talent Program since 2009. Her current research interests include data center networking, cloud computing and wireless/mobile networks. Her research group currently develops switching networks, packet scheduling algorithms and virtual machine placement algorithms in cloud computing networks, and routing protocols, deployment algorithms, energy-charging algorithms and data gathering mechanisms in wireless rechargeable sensor networks.

Dr. Yang has served as the Associated Editor-in-Chief for IEEE Transactions on Computers as well as an Associated Editor for IEEE Transactions on Computers and IEEE Transactions on Parallel and Distributed Systems. She is currently an Associate Editor for the Journal of Parallel and Distributed Computing. She has published over 300 scientific papers in leading refereed journals and conferences. She is an inventor/co-inventor of seven U.S. patents in the area of interconnection networks. She has served as a distinguished visitor of IEEE Computer Society. She received an IEEE Region 1 Award for "significant contributions in multicast switching networks" in 2002, the Best Paper Awards at the 18th IEEE International Parallel and Distributed Processing Symposium in 2004, and the 7th International Conference on Parallel and Distributed Systems in 2000, a Distinguished Leadership Award from the 15th IEEE International Conference on Computer Communications and Networks in 2006, as well as three Best Paper Awards Runner-ups. She has served as a general chair, program chair or vice chair for several major conferences and a program committee member for numerous conferences. She has received many research grants as a Principal Investigator from the U.S. National Science Foundation and the Army Research Office.

