Performance Evaluation Laboratory

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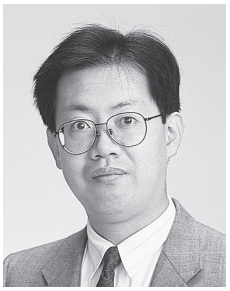

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The laboratory mission in the broad sense is to contribute to:

- Cost-Efficient Data Center Networking
- Resilient Information Management System for Disaster Recovery
- Cooperative Communication and Networking
- Modeling and Performance Evaluation of Cognitive Radio Networks

Cost-Efficient Data Center Networking

With the rising demands on cloud services, the electricity consumption has been increasing drastically as the main operational expenditure (OPEX) to data center providers. The geographical heterogeneity of electricity prices motivates us to study the task placement problem over geo-distributed data centers. We exploit the dynamic frequency scaling technique and formulate an optimization problem that minimizes OPEX while guaranteeing the

quality-of-service, i.e., the expected response time of tasks.

Resilient Information Management System for Disaster Recovery

We design and implement a resilient information management (RIM) system applicable under network-isolated environment. RIM can be set up immediately after a disaster happens to serve people as an information collection and distribution system in disaster area, regardless of the Internet availability. It consists of several distributed information centers, each of which is capable of wireless communication covering a limited area. With such system, people can share and acquire information from any information center distributed in the disaster area via their mobile devices like smartphones.

Cooperative Communication and Networking

As the wireless communication channel is shared in nature, cooperative communication has been proposed recently as an effective way to mitigate channel impairments in wireless networks. With user cooperation, single-antenna mobile terminals in a multi-user environment share antennas from other mobiles to generate a virtual multiple antenna system that exploits the spatial multiplexing and diversity gains to improve spectrum and energy efficiency of wireless networks.

In addition to the user cooperation, cooperative networking has received significant attention recently as an emerging network design strategy for future wireless networks. Next generation wireless networks will be heterogeneous by integrating different access networks, such as IEEE 802.15 WPAN, IEEE 802.11 WLAN, IEEE 802.16 WMAN, GPRS, EDGE, WCDMA, satellite networks, etc. Smart interactions among the network nodes have been proposed in order to enhance the QoS of their connections and the performance of the whole network.

Modeling and Performance Evaluation of Cognitive Radio Networks

With the emergence of a variety of wireless multimedia applications, most of the usable radio spectrum has been densely allocated, which leads to the problem of spectrum scarcity worldwide. However, extensive measurement studies have indicated that the prime radio spectrum experiences significantly low utilization efficiency because of the current static spectrum allo-

cation policy. Sparked by recent advances in cognitive radios, a new communication paradigm presents a possible solution to the spectrum inefficiency problem, which allows secondary users equipped with cognitive radios to opportunistically access unoccupied bands of licensed spectrum while limiting the interference perceived by the primary users. Such networking paradigm is referred to as Cognitive Radio Networks (CRNs). In this research, we studied the joint resource allocation schemes in cognitive femtocell networks.

Refereed Journal Papers

[pengli-01:2013] Song Guo Peng Li and Hai Jin. On the multicast capacity in energy-constrained lossy wireless networks by exploiting intra-batch and inter-batch network coding. *IEEE Transactions on Parallel and Distributed Systems*, 24(11):2251–2260, Nov. 2013.

pengli

[pengli-02:2013] Song Guo Peng Li and Zixue Cheng. Joint optimization of electricity and communication cost for meter data collection in smart grid. *IEEE Transactions on Emerging Topics in Computing*, 1(2):297–306, Dec. 2013.

pengli

[pengli-03:2013] Song Guo Peng Li and Victor C.M. Leung. Maximum-lifetime coding tree for multicast in lossy wireless networks. *IEEE Wireless Communication Letter*, 2(3):295–298, 2013.

pengli

[sguo-01:2013] Quan Chen, Minyi Guo, Qianni Deng, Long Zheng, Song Guo, and Yao Shen. HAT: History-based Auto-Tuning MapReduce in Heterogeneous Environments. *Journal of Supercomputing*, 64(3):1038–1054, June 2013.

This paper proposes a History-based Auto-Tuning (HAT) MapReduce scheduler, which calculates the progress of tasks accurately and adapts to the continuously varying environment automatically.

[sguo-02:2013] Peng Li, Song Guo, and Victor Leung. Maximum-Lifetime Coding Tree for Multicast in Lossy Wireless Networks. *IEEE Wireless Communications Letters*, 2(3):295–298, June 2013.

We study the multicast lifetime maximization (MLM) problem in lossy wireless networks with AWGN channel and Rayleigh fading channel. We find that using network coding it can be solved by transforming into an equivalent min-max tree problem.

[sguo-03:2013] Bin Tang, Baoliu Ye, Sanglu Lu, and Song Guo. Coding-Aware Proportional-Fair Scheduling in OFDMA Relay Networks. *IEEE Transactions on Parallel and Distributed Systems*, 24(9):1727–1740, September 2013.

We study the proportional-fair scheduling problem in the presence of network coding in OFDMA relay networks. Considering the trade-off

between performance and overhead, we propose two models, global approach (GA) and local approach (LA), under which the corresponding problems are shown both NP-hard. For the GA model, we show that it cannot be approximated within some constant factor. Hence we propose a heuristic algorithm with low time complexity. For the LA model, we propose a theoretical polynomial time approximation scheme (PTAS), and also present a practical greedy algorithm with approximation factor of 0.5.

[sguo-04:2013] Honglei Jiang, Hai Jin, Song Guo, and Xiaofei Liao. A Measurement-based Study on User Management in Private BitTorrent Communities. *Wiley Journal of Concurrency and Computation: Practice and Experience*, 25(14):2052–2066, September 2013.

The measurement results presented in this paper are based on large-scale experiments conducted over six representative Private BitTorrent (PT) sites for over a year. We find that the stricter registration will lead to fewer new users, resulting in a scalability problem. Our measurement and analysis pose a direction for the design of new incentive mechanisms that take the difficulty of enrollment into the consideration.

[sguo-05:2013] Peng Li and Song Guo. On the Multicast Capacity in Energy-Constrained Lossy Wireless Networks by Exploiting Intra-batch and Inter-batch Network Coding. *IEEE Transactions on Parallel and Distributed Systems*, 24(11):2251–2260, November 2013.

We study a fundamental problem in determining the multicast capacity in energy-constrained wireless networks with lossy transmission links. Both theoretical results and practical algorithm are presented.

[sguo-06:2013] Peng Li, Song Guo, and Zixue Cheng. Joint Optimization of Electricity and Communication Cost for Meter Data Collection in Smart Grid. *IEEE Transactions on Emerging Topics in Computing*, 1(2):297–306, December 2013.

By exploring the fact that electricity power reserved by sending meter data via leased secondary channels would be charged at a lower price, we study the problem to find the optimal solution of channel selection and transmission scheduling such that the overall cost of both power and communication is minimized.

[sguo-07:2013] Deze Zeng, Song Guo, Yong Xiang, and Hai Jin. On the Throughput of Two-way Relay Networks using Network Cod-

ing. *IEEE Transactions on Parallel and Distributed Systems*, 25(1):191–199, January 2014.

We study the network throughput using network coding and explore how the maximum throughput can be achieved in a two-way relay wireless network. We invent the concept of Network Coding Cliques, upon which a formal analysis on the network throughput using network coding is elaborated. Our theoretical findings have been validated by simulation as well.

[sguo-08:2013] Peng Li, Song Guo, Jiankun Hu, and Ruhul Sarker. Lifetime Optimization for Reliable Broadcast and Multicast in Wireless Ad-hoc Networks. *Wireless Communications and Mobile Computing*, 14(2):221–231, February 2014.

We consider the reliable broadcast and multicast lifetime maximization problems in energy-constrained wireless ad-hoc networks. In unreliable networks, we prove them NP-complete and propose heuristic algorithms. Simulation results show that the proposed algorithms can significantly increase the network lifetime compared with the traditional algorithms under various distributions of error probability on lossy wireless links.

[sguo-09:2013] Peng Li, Song Guo, Weihua Zhuang, and Baoliu Ye. On Efficient Resource Allocation for Cognitive and Cooperative Communications. *IEEE Journal on Selected Areas in Communications*, 32(2):264–273, February 2014.

We study the problem of maximizing the minimum transmission rate among multiple source-destination pairs using cooperative communication (CC) in a cognitive radio network under the joint consideration of relay assignment and channel allocation.

[sguo-10:2013] Zhuo Li, Wen-Zhong Li, Song Guo, Xin Liu, Sang-Lu Lu, and Dao-Xu Chen. On Gateway Selection in Disruption Tolerant Networks. *Ad Hoc & Sensor Wireless Networks*, 20:223–243, 2014.

We address the problem of choosing suitable gateways from all the nodes to reduce traffic overhead and delay of information access in Disruption Tolerant Networks.

Refereed Proceeding Papers

[pengli-04:2013] Peng Li and Song Guo. Delay minimization for reliable data collection on overhead transmission lines in smart grid. In *Computing, Communications and IT Applications Conference (ComComAp)*, pages 147–152, April 2013.

pengli

[pengli-05:2013] Toshiaki Miyazaki Peng Li, Song Guo and Victor C.M. Leung. Joint optimization of transmission scheduling and relay assignment for cooperative communications. In *IEEE International Conference on Communications (ICC)*, pages 6338–6342, June 2013.

pengli

[pengli-06:2013] Song Guo Peng Li and Zixue Cheng. Joint relay assignment and channel allocation for energy-efficient cooperative communications. In *IEEE Wireless Communications and Networking Conference (WCNC)*, pages 626–630, 2013.

pengli

[pengli-07:2013] Song Guo Peng Li and Weihua Zhuang. Interference cancellation and rate maximization in full-duplex cooperative communications. In *IEEE Global Communications Conference (GLOBECOM)*, pages 1–5, 2013.

pengli

[sguo-11:2013] Lin Gu, Deze Zeng, Song Guo, and Baoliu Ye. Leverage Packing Cars in a Two-tier Data Center. In *IEEE Wireless Communications and Networking Conference (WCNC)*, Shanghai, China, April 2013.

[sguo-12:2013] Deze Zeng, Song Guo, Shui Yu, and Ivan Stojmenovic. Stochastic Modeling and Analysis of Opportunistic Computing in Intermittent Mobile Cloud. In *IEEE Conference on Industrial Electronics and Applications (ICIEA)*, Melbourne, Australia, June 2013.

[sguo-13:2013] Peng Li, Song Guo, Zixue Cheng, and Athanasios Vasilakos. Joint Relay Assignment and Channel Allocation for Energy-Efficient Cooperative Communications. In *IEEE Wireless Communications and Networking Conference (WCNC)*, Shanghai, China, April 2013.

[sguo-14:2013] Shui Yu, Robin Doss, Wanlei Zhou, and Song Guo. A General Cloud Firewall Framework with Dynamic Resource Allocation.

In *IEEE International Conference on Communications (ICC)*, Budapest, Hungary, June 2013.

[sguo-15:2013] Peng Li, Song Guo, Toshiaki Miyazaki, and Victor Leung. Joint Optimization of Transmission Scheduling and Relay Assignment for Cooperative Communications. In *IEEE International Conference on Communications (ICC)*, Budapest, Hungary, June 2013.

[sguo-16:2013] Huawei Huang, Deze Zeng, Song Guo, Hong Yao, and Toshiaki Miyazaki. Stochastic Analysis on Epidemic Dissemination of Lifetime-Controlled Messages in DTNs. In *IEEE International Wireless Communications and Mobile Computing Conference (IWCMC)*, Cagliari, Italy, July 2013.

[sguo-17:2013] Xinwang Liu, Qian Zhu, and Song Guo. Three new uncertainty bound methods of Karnik-Mendel Algorithms. In *IEEE International Conference on Fuzzy Systems (FUZZ)*, Hyderabad, India, July 2013.

[sguo-18:2013] Kaimin Wei, Deze Zeng, Song Guo, and Ke Xu. Social-aware Relay Node Selection in Delay Tolerant Networks. In *IEEE International Conference on Computer Communications and Networks (ICCCN)*, Nassau, Bahamas, August 2013.

[sguo-19:2013] Mianxiong Dong, Kaoru Ota, Suguo Du, Haojin Zhu, and Song Guo. ANTS: Pushing the Rapid Event Notification in Wireless Sensor and Actor Networks. In *IEEE International Conference on Ubi-Media Computing (UMEDIA)*, Aizu-Wakamatsu, Japan, November 2013.

[sguo-20:2013] Shoichi Yamaguchi, Toshiaki Miyazaki, Junji Kitamichi, Song Guo, Tsuneo Tsukahara, and Takafumi Hayashi. Programmable Wireless Sensor Node Featuring Low-power FPGA and Microcontroller. In *IEEE International Conference on Ubi-Media Computing (UMEDIA)*, Aizu-Wakamatsu, Japan, November 2013.

[sguo-21:2013] Deze Zeng, Song Guo, Huawei Huang, Shui Yu, and Victor C.M. Leung. Optimal VM Placement in Data Centers with Architectural and Resource Constraints. In *IEEE International Conference on High Performance Computing and Communications (HPCC)*, Zhangjiajie, China, November 2013.

[sguo-22:2013] Lin Gu, Deze Zeng, and Song Guo. Vehicular Cloud Computing: A Survey. In *IEEE Globecom Workshop on Cloud Computing Systems, Networks, and Applications*, Atlanta, USA, December 2013.

[sguo-23:2013] Lin Gu, Deze Zeng, and Song Guo. QoS-aware Task Placement in Geo-distributed Data Centers with Low OPEX using Dynamic Frequency Scaling. In *IEEE International Conference on High Performance Computing and Communications (HPCC)*, Zhangjiajie, China, November 2013.

[sguo-24:2013] Peng Li and Song Guo. Delay minimization for reliable data collection on overhead transmission lines in smart grid. In *Computer, Communications and IT Applications Conference (ComComApp)*, Hong Kong, China, April 2013.

[sguo-25:2013] Shui Yu, Wanlei Zhou, Song Guo, and Minyi Guo. A Dynamical Deterministic Packet Marking Scheme for DDoS Traceback. In *IEEE Global Telecommunications Conference (Globecom)*, Atlanta, USA, December 2013.

[sguo-26:2013] Song Guo Peng Li and and Weihua Zhuang. Interference Cancellation of Full-duplex Cooperative Communications. In *IEEE Global Telecommunications Conference (Globecom)*, Atlanta, USA, December 2013.

[sguo-27:2013] Deze Zeng, Toshiaki Miyazaki, Song Guo, Tsuneo Tsukahara, Junji Kitamichi, and Takafumi Hayashi. Evolution of Software-Defined Sensor Networks. In *IEEE MSN Workshop on Software Defined Sensor Networks*, Dalian, China, December 2013.

[sguo-28:2013] Toshiaki Miyazaki, Hiroki Iwata, Koji Kobayashi, Shoichi Yamaguchi, Deze Zeng, Song Guo, Junji Kitamichi, Takafumi Hayashi, and Tsuneo Tsukahara. DASN: Demand-addressable Sensor Network for Active Information Acquisition. In *ACM International Conference on Ubiquitous Information Management and Communication (IMCOM)*, Siem Reap, Cambodia, January 2014.

[sguo-29:2013] Toshiaki Miyazaki, Shoichi Yamaguchi, Koji Kobayashi, Jyunji Kitamichi, Song Guo, Tsuneo Tsukahara, and Takafumi Hayashi. A Software Defined Wireless Sensor Network. In *IEEE International Conference on Computing, Networking and Communications (ICNC) Workshop*, Honolulu, USA, February 2014.

[sguo-30:2013] Lin Gu, Deze Zeng, Song Guo, and Shui Yu. Type-aware Task Placement in Geo-distributed Data Centers with Low OPEX using Data Center Resizing. In *IEEE International Conference on Computing, Networking and Communications (ICNC)*, Honolulu, USA, February 2014.

Grants

[sguo-31:2013] Song Guo. Context-Aware System Guaranteeing Quality of Service for a Wide Area, 2010-2013.

PI, Joint Research Fund of Olympus Corporation

[sguo-32:2013] Toshiaki Miyazaki, Takfumi Hayashi, Tsuneo Tsukahara, Jyunji Kitamichi, and Song Guo. Demand Addressable Sensor Network, 2012-2014.

SCOPE (Strategic Information and Communications R&D Promotion Programme, MIC) Project

[sguo-33:2013] Song Guo and Toshiaki Miyazaki. Development of a Resilient Information Management System Applicable under Network-isolated Environment, 2013.

PI, Fukushima Revitalization Research Fund

[sguo-34:2013] Song Guo. Renewable Energy Powered Data Centers, 2013.

PI, 10. University of Aizu Competitive Research Fund

Academic Activities

[sguo-35:2013] Song Guo, 2013.

TPC Member: IEEE ICNC, IEEE WCNC, IEEE Globecom, IEEE PIMRC, IEEE INFOCOM, IEEE IWCMC

[sguo-36:2013] Song Guo, 2006-2013.

ACM, Senior Member

[sguo-37:2013] Song Guo, 2001-2013.

IEEE, Senior Member

[sguo-38:2013] Song Guo, 2013.

Publication Chair, IEEE MCSoC
General Chair, IEEE NEST
General Co-Chair, MobiQuitous
Program Chair, IEEE MSN
Program Chair, MUSIC

[sguo-39:2013] Song Guo, 2013.

Associate Editor, IEEE Transactions on Parallel and Distributed Systems
Editor, Wireless Networks - Springer
Editor, Wireless Communications and Mobile Computing Wiley
Editor, International Journal of Distributed Sensor Networks
Area Editor, EAI Transactions on Industrial Networks and Intelligent Systems
Area Editor, International Journal of Communication Networks and Information Security
Editor, International Journal of Engineering Business Management
Editor, Human-centric Computing and Information Sciences

Ph.D and Others Theses

[sguo-40:2013] Mianxiong Dong. PhD Thesis: Efficient Algorithms for Resource Management and Service Provision in Wireless Networks, The University of Aizu, 2013.

PhD Supervisor: Song Guo

[sguo-41:2013] Hirokazu Odagiri. Graduation Thesis: Security Camera System Using Android, The University of Aizu, 2013.

Thesis Advisor: Song Guo

[sguo-42:2013] Kohei Iimura. Graduation Thesis: Rescue System using Wireless Networks and Remote Database, The University of Aizu, 2013.

Thesis Advisor: Song Guo

[sguo-43:2013] Miki Imai. Graduation Thesis: Connecting Routes of Multistream using Application Editor, The University of Aizu, 2013.

Thesis Advisor: Song Guo

[sguo-44:2013] Takashi Saito. Graduation Thesis: Smart Car Parking Lot Management System, The University of Aizu, 2013.

Thesis Advisor: Song Guo

[sguo-45:2013] Wei-Lun Chang. DDP Master Thesis: An Artificial Bee Colony Algorithm for Data Collection Path Planning in Sparse Wireless Sensor Networks, The University of Aizu & Chao Yang University of Technology, 2013.

Master Supervisor: Song Guo

[sguo-46:2013] Chih-Wei Hsu. DDP Master Thesis: Optimal Device-to-Device Relay Algorithm Maximizing Multicast Throughput, The University of Aizu & Chao Yang University of Technology, 2013.

Master Supervisor: Song Guo