Performance Evaluation Laboratory

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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.
Summary of Achievement

**Refereed Journal Papers**


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.


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.


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.


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.


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.


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.

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


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.


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.


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**
Summary of Achievement


Summary of Achievement

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


Summary of Achievement


Summary of Achievement


Grants

\hspace{1em} PI, Joint Research Fund of Olympus Corporation

\hspace{1em} SCOPE (Strategic Information and Communications R&D Promotion Programme, MIC) Project

\hspace{1em} PI, Fukushima Revitalization Research Fund

\hspace{1em} PI, 10. University of Aizu Competitive Research Fund

Academic Activities

\hspace{1em} TPC Member: IEEE ICNC, IEEE WCNC, IEEE Globecom, IEEE PIMRC, IEEE INFOCOM, IEEE IWCMC

\hspace{1em} ACM, Senior Member

\hspace{1em} IEEE, Senior Member

Summary of Achievement

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

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

PhD Supervisor: Song Guo

Thesis Advisor: Song Guo

Thesis Advisor: Song Guo

Thesis Advisor: Song Guo

Summary of Achievement

Thesis Advisor: Song Guo


Master Supervisor: Song Guo


Master Supervisor: Song Guo