Lixing Song

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EDUCATION

University of Notre Dame, Notre Dame, IN, USA
Ph.D. in Computer Science and Engineering, 2014 - 2018(expected)
GPA 4.0/4.0; Advisor: Aaron Striegel

Ball State University, Muncie, IN, USA
M.S. in Computer Science, 2013 - 2014
GPA 4.0/4.0; Advisor: Shaoen Wu

The University of Southern Mississippi, Hattiesburg, MS, USA
PhD student in Computer Science, 2011-2013 (Moved with advisor)
GPA 4.0/4.0; Advisor: Shaoen Wu

Wuhan University, Wuhan, China
B.E. in Electrical Engineering, 2007-2011
Overall GPA 83.5/100, Major GPA 87/100

RESEARCH INTERESTS **Wireless Networking, Mobile Computing, Internet of Things**: WiFi protocol optimization, cross-layer design, large scale empirical measurement, crowdsourcing, heath care with smart devices

SELECTED HONORS

IEEE SECON Travel Grant, National Science Foundation (NSF), San Diego, CA, USA, 2017
Department 3rd Paper Winner of the Graduate Research Symposium, University of Southern Mississippi, MS, USA, 2011
Excellent Project for National Innovative Experiment Program For Undergraduates, Wuhan University, China, 2011

TEACHING EXPERIENCE

Mentoring Undergrad Summer Research 2016-2017
University of Notre Dame
Teaching Assistant *2015*
Understanding Wireless: Technology, Economics, and Policy (11,000+ participants) by `edX`
Lecture Substitute *2014*
Computer Networking, Ball State University

PROFESSIONAL PROJECTS

Exploring LTE Bandwidth Characterization University of Notre Dame, Notre Dame, IN, USA
Leader 07/2017 - present

- Unlike Ethernet and WiFi networks, cellular performs centralized resource allocation. Bandwidth characterization on a cellular network is intrinsically different and remains non-trivial challenges. We explore the physical layer information from testbed (via the Mobile Insight tool) to understand the various unique properties of cellular bandwidth. Eventually, we want to design an end-to-end bandwidth estimation tool that can help infer the instant UE bandwidth in an efficient fashion.

Accurate and efficient passive WiFi characterization University of Notre Dame, Notre Dame, IN, USA
Leader 09/2016 - present

- By leveraging the properties of frame aggregation in tandem with Block ACK, we proposed a novel technique to only use control packets to passively conduct accurate and comprehensive characterization on WiFi traffic. Moreover, we have shown that the default WiFi scan can provide enough opportunity to effectively observe without cost listen on channels. The approach has been evaluated in lab environment and real-world scenarios.

Leveraging Frame Aggregation for AP selection University of Notre Dame, Notre Dame, IN, USA
Leader 03/2016 - 08/2016

- This work leverages the frame aggregation characteristics of modern WiFi as an AP load estimation metric in order to help guide a mobile client to select the best AP. By adopting machine learning techniques, we are able to train the model to predict expected throughput based on instant collected measurements. The experimental results show the system achieves better selection accuracy than other cross-layer metrics.

Fast Mobile Network Characterization University of Notre Dame, Notre Dame, IN, USA
Leader 05/2015 - present

- The project aims to build a suite of tools to deliver **fast, lightweight, accurate** performance goals while doing so in a manner that does not require modification to the core of the client itself. We leverage inherent properties of TCP originally proposed by Savage (TCP Sting) and expand upon with the previous work on RIPPS (Rogue wireless Packet Payload Slicer) coupled with dynamic packet shaping. The estimation results give nearly instantaneous estimates about the link from various aspects, e.g, available bandwidth, achievable throughput and ect. The work is primarily built with C++ with `libpcap`.

NetHealth University of Notre Dame, Notre Dame, IN, USA
Technical Support on Web Portal 01/2015 - present

- This project instrumented a five hundred smart phone users providing them with smart phone agent, and health armband (Fitbit HR) over a period of two years. The focus of the work is to explore network effects from a sociological perspective. Our particular research focus leverages the co-location data gleaned from the study to explore next-generation cellular and WiFi architectures.

WiFi Probe Requests Measurement Ultra Dense Scenario University of Notre Dame, Notre Dame, IN, USA
Co-Leader 08/2014 - 11/2015

- This project focused on exploring the impact of probe request frames in practice, especially large venues such as a football stadium. In order to conduct realistic measurement on the impact of WiFi probe requests, we launched WiFi monitor data collection during several home games. Through data analysis plus further lab experiments, we explored the extent to which probe request can effect network performance as well as energy.

SIMPLEX: Symbol-level Information MultiPLEX Ball State University, Muncie, IN, USA
Leader 05/2013 - 12/2013

- This project proposed a symbol-level information multiplexing mechanism, *SIMPLEX*, that exploits link margin in wireless networks to minimize channel under-utilization. Multiplexing is achieved by carrying extra information through a type of specially designed symbols inserted. The key enabler of the inserting and detecting such specially symbols is a per-bit channel assessment scheme that hierarchically estimates the error probability of a received symbol. Through the GNU SDR testbed experiments and NS3 simulation, we evaluate the performance of *SIMPLEX* on different network scenarios.

Wireless Shared key extraction from unauthorized channel Ball State University, Muncie, IN, USA
Leader 05/2013 - 12/2013

- This project proposed a cross-layer solution that generate secret shared keys from wireless channel. It leverages the per-symbol channel dynamics on both time and frequency domain. By using these information, we can generate identical shared keys for transmitter and receiver by exploiting the reciprocity of channel. This solution consists of merits that: (1) the per-symbol granularity improves the volume of available uncorrelated channel measurements and so does KGR; 2) the solution exploited subtle channel fluctuations in frequency domain that does not require mandatory user movements to create sufficient temporal variations; and (3) it measures noise-free channel response that suppresses key bit disagreement between trusted users.

WiFi Cross-layer Rate Adaptation University of Southern Mississippi, Hattiesburg, MS, USA
Leader 08/2011 - 04/2013

- This project proposed accurate physical layer metric that is derived from symbol offset on constellation map. By exploit this metric, we can achieve accurate wireless channel estimation in per-bit granularity. With upper layer adaptive protocols support, the proposed method can deliver responsive accurate rate adaptation under the various dynamic channel scenarios. The method was implemented and evaluated on both Software-Defined-Radio (GNU Radio) and NS3.

Wireless Sensor + SMS solution for remote monitor service Wuhan University, Wuhan, Hubei, China
Research Leader at National Innovative Experiment Program For Undergraduates

- We implemented an experimental remote architectural pressure monitoring system. We used the sensor chips–TelosB coupled with GMS module to automatically send SMS alter to remote phones once emergency occurred.

PUBLICATIONS

Peer-Reviewed

1. **Lixing Song** and A. Striegel. SEWS: A Channel-Aware Stall-Free WiFi Video Streaming Mechanism. In: *Proceedings of the 28th Workshop on Network and Operating Systems Support for Digital Audio and Video*. NOSSDAV'18. **to appear**. Amsterdam, Netherlands: ACM, 2018. ISBN: 978-1-4503-5772-2/18/06. DOI: 10.1145/3210445.3210449. https://doi.org/10.1145/3210445.3210449.
2. **Lixing Song** and A. Striegel. Leveraging Frame Aggregation for Estimating WiFi Available Bandwidth. In: *14th Annual IEEE International Conference on Sensing, Communication, and Networking, SECON 2017, San Diego, CA, USA, June 12-14, 2017*. 2017, pp.1–9. DOI: 10.1109/SAHCN.2017.7964908. https://doi.org/10.1109/SAHCN.2017.7964908.
3. **Lixing Song** and A. Striegel. Leveraging frame aggregation to improve access point selection. In: *2017 IEEE Conference on Computer Communications Workshops, INFOCOM Workshops, Atlanta, GA, USA, May 1-4, 2017*. 2017, pp.325–330. DOI: 10.1109/INFCOMW.2017.8116397. https://doi.org/10.1109/INFCOMW.2017.8116397.
4. R. Purta, S. Mattingly, **Lixing Song**, O. Lizardo, D. Hachen, C. Poellabauer, and A. Striegel. Experiences measuring sleep and physical activity patterns across a large college cohort with fitbits. In: *Proceedings of the 2016 ACM International Symposium on Wearable Computers, ISWC 2016, Heidelberg, Germany, September 12-16, 2016*. 2016, pp.28–35. DOI: 10.1145/2971763.2971767. http://doi.acm.org/10.1145/2971763.2971767.
5. **Lixing Song**, S. Wu, and H. Wang. SIMPLEX: Symbol-Level Information Multiplex. *IEEE Internet of Things Journal* 3(5) (2016), 757–766.
6. X. Hu, **Lixing Song**, D. V. Bruggen, and A. Striegel. Is There WiFi Yet?: How Aggressive Probe Requests Deteriorate Energy and Throughput. In: *Proceedings of the 2015 ACM Internet Measurement Conference, IMC 2015, Tokyo, Japan, October 28-30, 2015*. 2015, pp.317–323. DOI: 10.1145/2815675.2815709. http://doi.acm.org/10.1145/2815675.2815709.
7. **L. Song** and S. Wu. AARC: Cross-layer wireless rate control driven by fine-grained channel assessment. In: *2015 IEEE International Conference on Communications, ICC 2015, London, United Kingdom, June 8-12, 2015*. 2015, pp.3311–3316. DOI: 10.1109/ICC.2015.7248835. http://dx.doi.org/10.1109/ICC.2015.7248835.
8. Y. Zhu, C. Tang, **L. Song**, S. Wu, and S. Biaz. Analytical and comparative investigation of 60 GHz wireless channels. *Telecommunication Systems* 60(1) (2015), 179–186.
9. Y. Zhu, **L. Song**, S. Wu, H. Wang, and C. Wang. Cooperative Stepwise Relaying and Combining for Multihop Vehicular Wireless Communication. *IEEE T. Vehicular Technology* 64(6) (2015), 2663–2671.
10. C. Tang, **L. Song**, J. Balasubramani, S. Wu, S. Biaz, Q. Yang, and H. Wang. Comparative Investigation on CSMA/CA-Based Opportunistic Random Access for Internet of Things. *IEEE Internet of Things Journal* 1(2) (2014), 171–179.
11. **L. Song** and S. Wu. Cross-layer wireless information security. In: *23rd International Conference on Computer Communication and Networks, ICCCN 2014, Shanghai, China, August 4-7, 2014*. 2014, pp.1–9. DOI: 10.1109/ICCCN.2014.6911744. http://dx.doi.org/10.1109/ICCCN.2014.6911744.

12. **L. Song**, S. Wu, H. Wang, and Q. Yang. Distributed MapReduce engine with fault tolerance. In: *IEEE International Conference on Communications, ICC 2014, Sydney, Australia, June 10-14, 2014*. 2014, pp.3626–3630. DOI: 10.1109/ICC.2014.6883884. http://dx.doi.org/10.1109/ICC.2014.6883884.
13. Y. Zhu, C. Tang, **L. Song**, Q. Yao, and S. Wu. Cooperative Binary Relaying and Combining for multi-hop wireless communication. In: *2012 IEEE Global Communications Conference, GLOBECOM 2012, Anaheim, CA, USA, December 3-7, 2012*. 2012, pp.4205–4210. DOI: 10.1109/GLOCOM.2012.6503777. http://dx.doi.org/10.1109/GLOCOM.2012.6503777.

Demos/Posters

1. **Lixing Song** and A. Striegel. "FMNC - rapid and accurate wifi characterization: demo". In: *Proceedings of the 22nd Annual International Conference on Mobile Computing and Networking, MobiCom 2016, New York City, NY, USA, October 3-7, 2016*. 2016, pp.499–500. DOI: 10.1145/2973750.2985619. http://doi.acm.org/10.1145/2973750.2985619.

In Preparation

1. **Lixing Song** and A. Striegel. *A Lightweight Cellular Bandwidth Characterization Scheme*. **To be submitted**. 2018.
2. **Lixing Song** and A. Striegel. *A Passive Client Side Control Packet-based WiFi Traffic Characterization Mechanism*. **To be submitted**. 2018.

Intellectual Properties

1. A. Striegel and **Lixing Song**. "Rapid End-to-End Path Characterization involving Wireless Network Hops". Patent US Patent Application 62/351,225 (US). June 2016.
2. **Lixing Song** and A. Striegel. "Novel Technique for Client-Side Passive Detection of WiFi Access Point Load". Copyright 2016 Notre Dame (US). 2016.
3. **Lixing Song** and A. Striegel. "Simplified Mechanism for Conveying Residual Capacity at a Wireless Access Point". Copyright 2016 Notre Dame (US). 2016.

Talks& Presentations

Leveraging Frame Aggregation for Estimating WiFi Available Bandwidth *IEEE SECON 2017*	*San Diego, CA, 2017*
FMNC: Rapid and Accurate WiFi Characterization: demo *ACM MobiCom 2016*	*New York, NY, 2016*
Fast Mobile Network Characterization *Broadband Wireless Access and Applications Center (BWAC)*	*Notre Dame, IN, 2015*
WiFi Cross-Layer Rate Adaptation *Graduate Research Symposium, University of Southern Mississippi*	*Hattiesburg, MS, 2011*

Review Experience

INFOCOM'2016(assigned)
IEEE Transaction on Mobile Computing
EURASIP Journal on Wireless Communications and Networking
Journal of Network and Systems Management

Professional Services

Wireless Institute Colloquium Student Coordinator	*12/2017 Notre Dame, IN, USA*
INFOCOM Student Volunteer	*04/2016 San Francisco, CA, USA*
MOBICOM Student Volunteer	*10/2016 New York City, NY, USA*

References

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