

Kaiyu Hou

Curriculum Vitae

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I am currently a 4th year Ph.D. candidate in the Computer Science Department at Northwestern University, advised by Prof. Yan Chen. I have a broad interest in various aspects of cloud networks and network protocols. My current research focuses on network optimization of microservices/serverless based cloud. I am also working for introducing formal methods into network protocol verification.

Education

- **Ph.D. Student in Computer Science** 2017 – (2022)
Northwestern University Evanston, IL
 - Advisor: Prof. [Yan Chen](#)
 - Area: Networked System, Cloud Networking, Network Protocols
 - Thesis Topic: Configuration Security and Performance Optimization for Network Protocols
 - GPA: 3.97/4.00
- **Master's in Computer Science** 2014 – 2017
Xi'an Jiaotong University Shaanxi, China
 - Advisor: Prof. [Chengchen Hu](#)
 - Area: Software Defined Networking (SDN)
 - Rank: 1st/89 GPA: 3.81/4.00 Average: 91.7
- **B.E. in Software Engineering** 2010 – 2014
Xi'an Jiaotong University Shaanxi, China
 - Rank: 1st/78 GPA: 3.94/4.00 Average: 92.4 (in Junior and Senior years)

Work Experiences

- **SRI International** Menlo Park, CA
Senior Research Intern, at Computer Science Laboratory Jun. 2020 – Sep. 2020
 - Advisor: Dr. [Vinod Yegneswaran](#) and Dr. [Phillip Porras](#)
 - Real-time anomaly detection with P4 switches and reinforcement learning for NextG networks
- **SRI International** Menlo Park, CA
Research Intern, at Computer Science Laboratory Jun. 2020 – Sep. 2020
 - Advisor: Dr. [Vinod Yegneswaran](#)
 - Designed and implemented an enterprise-wide radio situational awareness system
 - Passively collected radio traffics, including Wi-Fi and Bluetooth, analyzed by AutoML and nPrint

Research: Cloud Networks & SDN

- **Network Optimizing for Microservices/Serverless Cloud** (work in progress) 2020 – Present
 - Microservices/serverless architectures bring flexibility but introduce network communication delay
 - Integrated **QUIC** into **OpenFaaS/K8s**, improved serverless network performance by 28%
 - Designed systematic benchmarks for the microservices network performance measurement
- **Generic Security Policy Enforcement System for SDN-based Cloud** 2017 – 2018
 - Designed a **policy language** for resource protection and management of SDN-based Cloud
 - Implemented in the **OpenDaylight** controller, and deployed on **OpenStack**

Publication: [IWQoS'18] Lightweight Resource Protection and Management System for SDN-based Cloud
- **Routing Policy for Solving Reactive Model Overhead of SDN** 2016 – 2017
 - SDN control channel bandwidth is the major bottleneck of applying reactive forwarding
 - Proposed a routing policy to reduce the SDN control channel bandwidth consumption up to 80%
 - Implemented in the **Floodlight** controller under the **OpenFlow/P4** switch and **Open vSwitch**

Publication: [ICNP'17] SoftRing: Taming the Reactive Model for Software Defined Networks

Research: Formal Methods for Network Protocols

- **Formal Verification and Vulnerability Detection of LTE/5G Protocols** 2019 - 2020
 - Used **TLA+** to formally specify the emergency call systems in **4G/5G** cellular network protocols
 - Built a **complete cellular network testbed** (USRP, OpenAirInterface) for real-world verification
 - Discovered serious availability and security issues in real-world, **acknowledged by major carriers**

Publication: [MobiSys'21] Discovering Emergency Call Pitfalls for Cellular Networks with Formal Methods
- **Formal Secure Configuration Search for Network Protocols** 2020 - 2021
 - Traditionally, researchers use secure properties to verify a protocol is safe or find counterexamples
 - We convert this decision problem into a search problem. Given the model and the properties, we aim to search the boundaries of the configuration space where the system is always secure and reliable
 - We employ inductive generalization and improved IC3 algorithm to determine the space

Publication: [Sigcomm'20 Poster] Network Protocol Safe Configuration Search in One Shot

Publication List

- **QFaaS: Accelerating and Securing Serverless Cloud Network Communications with QUIC**
Kaiyu Hou, Sen Lin, Yan Chen, Vinod Yegneswaran
Under Review, ACM CoNEXT, 2021 (CoNEXT'21)
- **Property Guided Secure Configuration Space Search**
You Li*, Kaiyu Hou*, Yan Chen, Hai Zhou (*equal contribution)
Under Review, IEEE International Conference on Computer Communications, 2022 (INFOCOM'22)
- **Discovering Emergency Call Pitfalls for Cellular Networks with Formal Methods**

Kaiyu Hou*, You Li*, Yinbo Yu, Yan Chen, Hai Zhou (*equal contribution)

ACM 19th International Conference on Mobile Systems, Applications, and Services, 2021 (MobiSys'21)

- ***Network Protocol Safe Configuration Search in One Shot***

You Li*, **Kaiyu Hou***, Hai Zhou, Yan Chen (*equal contribution)

ACM Special Interest Group on Data Communication, Poster, 2020 (SIGCOMM'20)

- ***State of the Art and Research Challenges in the Security Technologies of Network Function Virtualization***

Xiaochun Wu, **Kaiyu Hou**, Xue Leng, Xing Li, Yinbo Yu, Bo Wu, Yan Chen

IEEE Internet Computing, 2020

- ***CellScope: Automatically Specifying and Verifying Cellular Network Protocols***

Yinbo Yu, You Li, **Kaiyu Hou**, Yan Chen, Hai Zhou, Jianfeng Yang

ACM Special Interest Group on Data Communication, Poster, 2019 (SIGCOMM'19)

- ***A Lightweight Policy Enforcement System for Resource Protection and Management in the SDN-based Cloud***

Xue Leng, **Kaiyu Hou**, Yan Chen, Kai Bu, Libin Song, You Li

Computer Networks, Elsevier, 2019

- ***COIN: A fast packet inspection method over compressed traffic***

Xiuwen Sun, Hao Li, Dan Zhao, Xingxing Lu, **Kaiyu Hou**, Chengchen Hu

Journal of Network and Computer Applications, Elsevier, 2019

- ***SDNKeeper: Lightweight Resource Protection and Management System for SDN-based Cloud***

Xue Leng, **Kaiyu Hou**, Yan Chen, Kai Bu, Libin Song

IEEE/ACM 26th International Symposium on Quality of Service, 2018 (IWQoS'18)

- ***SoftRing: Taming the Reactive Model for Software Defined Networks***

Chengchen Hu, **Kaiyu Hou** (1st student author), Hao Li, Ruilong Wang, Peng Zheng, Peng Zhang, Huanzhao Wang

IEEE 25th International Conference on Network Protocols, 2017 (ICNP'17)

- ***Towards A Fast Packet Inspection over Compressed HTTP Traffic***

Xiuwen Sun, **Kaiyu Hou**, Hao Li, Chengchen Hu

IEEE/ACM 25th International Symposium on Quality of Service, 2017 (IWQoS'16)

Teaching Experiences

- CS 214: Data Structure and Data Management Spring, 2021
Teaching Assistant, Northwestern University
- CS 214: Data Structure and Data Management Winter, 2021
Teaching Assistant, Northwestern University
- CS 214: Data Structure and Data Management Fall, 2020
Teaching Assistant, Northwestern University
- CS 212, Mathematical Foundations of Computer Science Spring, 2020
Teaching Assistant, Northwestern University

- CS 340, Introduction to Networking (**Best Teaching Assistant Award**) Winter, 2020
Teaching Assistant, Northwestern University
- CS 214, Data Structure and Data Management Fall, 2019
Teaching Assistant, Northwestern University
- EECS 343, Operating Systems Spring, 2019
Teaching Assistant, Northwestern University
- EECS 340, Introduction to Networking Winter, 2019
Assistant Lecturer, Northwestern University
- EECS 340, Introduction to Networking Fall, 2018
Teaching Assistant, Northwestern University
- IT 458, Information Security and Assurance Winter, 2018
Teaching Assistant, Northwestern University
- Computer Programming (C++) for CS Honored Class Fall, 2016
Teaching Assistant, Xi'an Jiaotong University

Professional Services

- Sub-reviewer of ACM CCS (2018, 2019)
- Sub-reviewer of IEEE ICDCS (2018)
- Reviewer of IEEE/ACM Transactions on Networking (ToN)

Awards

- **Bronze Medal**, ACM-ICPC Asia Regional Contest 2012, 2013, 2014
- **Silver Medal**, ACM-ICPC China Province Contest, Chengdu 2012, 2013
- **Meritorious Winner**, Mathematical Contest in Modeling (MCM) 2013

Honor

- **Terminal Year Cabell Fellowship** 2021
Northwestern University
- **Best Teaching Assistant Award** (*Peter and Adrienne Barris Outstanding TA*) 2020
Northwestern University
- **Outstanding Graduate (Cadre) Award** 2017
Xi'an Jiaotong University
- **Excellent Postgraduate Student Leader Award** (each year) 2015, 2016
Xi'an Jiaotong University
- **Outstanding Graduate Award** 2014

Xi'an Jiaotong University

- **Excellent Student Model Nomination** (16/13000) 2013
Xi'an Jiaotong University
- **Google Excellence Scholarship** 2013
Awarded to 3 students from each of 20 top Chinese universities
- **Excellent Student Award** (each year) 2011, 2012, 2013
Xi'an Jiaotong University

Social Activities

- **Student President** of the Computer Science Dept., (Class 2017) 2014 – 2017
Xi'an Jiaotong University
- **Student Councilor**, the Student Congress of ChungYing College 2013 - 2014
Xi'an Jiaotong University
- **Chair**, the ACM-ICPC Club 2012 - 2013
Xi'an Jiaotong University
- **Science and Education Minister** of the Student Union 2011 - 2012
Xi'an Jiaotong University
- **Co-Founder & the 2nd Store Manager** of *Bingo Cafe* 2010 - 2013
ChungYing College, Xi'an Jiaotong University

Skills

- TCP/IP Protocols, 3GPP Cellular Network Protocols (NAS layer), 802.11 Protocols, QUIC Protocol
- Serverless Platforms, Microservices Networks, Cloud Networks, SDN, P4
- Formal Methods for Network Protocols, TLA+, IC3, NuSMV
- Python, Go-lang