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 Networks with QUIC***
  Kaiyu Hou, Sen Lin, Yan Chen, Vinod Yegneswaran
  Under Review, USENIX NSDI, 2022 (NSDI'22)

- ***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