Research Statement

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August 31, 2022

My Research Philosophy

I do not see teaching and research as two separate activities. In my experience, my research deepens my teaching, and my teaching opens up new possibilities for research. As mentioned in my teaching statement, I see my teaching as an act of worship. Since my research is intertwined with teaching, I also see my research as an act of worship.

Besides its role in teaching, my research is chiefly motivated by seeking out the "truth." The Bereans "received the message with great eagerness and examined the Scriptures every day to see if what Paul said was true." (Acts 17:11). They were not satisfied just by hearing Paul's messages; they sought out the truth by examining the Scripture themselves day after day. Most of academic research obviously do not address the biblical truth. However, it does not mean they have nothing to do with truth. The "truth" for modern CS research could be proving the *correctness* of a computer algorithm, finding the *most efficient way* to solve a problem, or measuring the *true* performance of a computer system or network. I believe that my research is God-honoring if it helps bring out some truth about a research problem.

I also see my research (and development) as a direct way to serve others (i.e., fulfilling the Creation Mandate). I therefore do not evaluate the impacts of my research just based on the number of publications and grants (although they are important). I also look for opportunities (e.g., consultancies) to develop and deploy the research deliverables to solve real-world problems. As a result, my research is no longer just an intellectual exercise inside my lab. I can now dialogue and communicate with people who could benefit from my research. Their feedbacks often help me understand what I miss in my myopic view of research.

My Research Experience

The first phase of my research career was started in my graduate school studies and post-doc with the IBM T. J. Watson Research Laboratory. My primary interest was in the area of performance modeling of computer networks (particularly in token-passing networks). The second phase was in The Hong Kong Polytechnic University. My main research in this phase focused on the Internet infrastructure and security. The research methodology was shifted from analytical modeling to experimental and system approach, such as Internet measurement and system development. The overall goal of my research on the network measurement and security is to advance the state-of-the-art and their applications that will benefit individual Internet users.

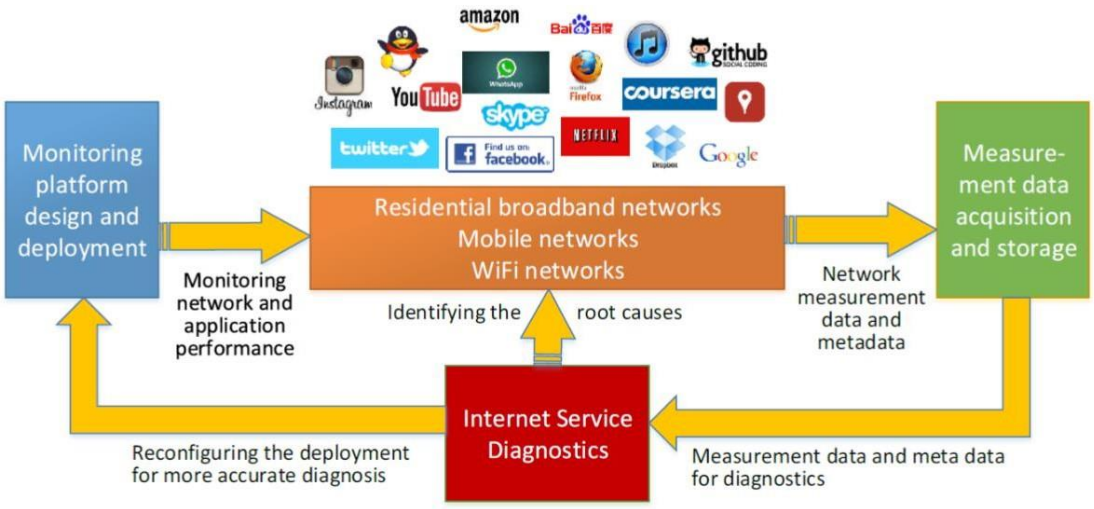
I have been leading an Internet Infrastructure and Security Laboratory in the Computing Department for about 20 years and a research group on Internet Services Monitoring and Diagnostics in the Division of Smart Cities under PolyU's Research Institute for Sustainable Urban Development for three years. I also helped establish a Cyber Security and Privacy Laboratory in the Department in 2015. I was the recipients of the Faculty's Industrial and Engineering Services Grant Achievement Awards in 2009 and 2012 and Most Active Consultant Award (Merit).

My Research Interests

Internet infrastructure

For more than 15 years my research team innovated and developed novel measurement methods, measurement appliances and tools, and distributed measurement platforms. Our work can be best illustrated in the figure below. The research problem is how to monitor and diagnose network problems automatically and effectively for different types of networks, including enterprise networks, residential broadband networks, campus WiFi networks and mobile networks.

Some examples of our work below:



- (Advancing network measurement methodologies) We innovated several new end-to-end measurement methods that offer more accurate measurement results and more measurement features, but without additional infrastructural support. These results were reported in many top conference papers (IEEE JSAC, ACM CoNEXT, ACM IMC and USENIX ATC).
- (Improving the accuracy of network measurement) We diagnosed several sources that lead to network measurement inaccuracy and proposed solutions to mitigate them for web browsers and smartphones. The results were reported in IEEE Trans. Mobile Computing, ACM CoNEXT and IEEE INFOCOM.
- (Advancing quality-of-experience measurement) We developed several novel methods to enhance users' quality of experience (QoE) for video services, including an optimal selection of initial video bitrate and detecting low-quality workers. The results were reported in IEEE JAC, IEEE Trans. Multimedia, and ACM MMSys.
- (Advancing mobile network measurement) We developed a novel method of crowdsourcing network performance data from users' smartphones and implemented in an Android app. This new method has a number of distinct advantages over other measurement apps. The results were reported in USENIX ATC and IEEE IWQoS.

Internet security

My research team has been working on the Internet security and privacy problems for around 20 years. The topics cover smart denial-of-service attacks and their defenses, network covert channels, web privacy, network measurement security, trust-based onion

routing and Android security and privacy. Some examples of our work below:

- (Android security and privacy) Our team discovered a number of serious vulnerabilities in Android apps, including open ports, indirect file leaks and file:// vulnerabilities. We used novel static analysis methods and a crowdsourcing approach to understand and mitigate these vulnerabilities. The results were published in NDSS, IEEE/IFIP DSN, IEEE MoST and ISC).
- (Advancing the defense against network attacks) My team has studied several important security and privacy problems on the Internet, including secure onion routing, denial-of- service attacks, privacy leaking, network covert communications, and feedback security. The findings were published in top journals and conferences: IEEE Trans. Information Forensics and Security, IEEE Trans. Dependable and Secure Computing, NDSS, ACSAC, and IEEE/IFIP DSN.

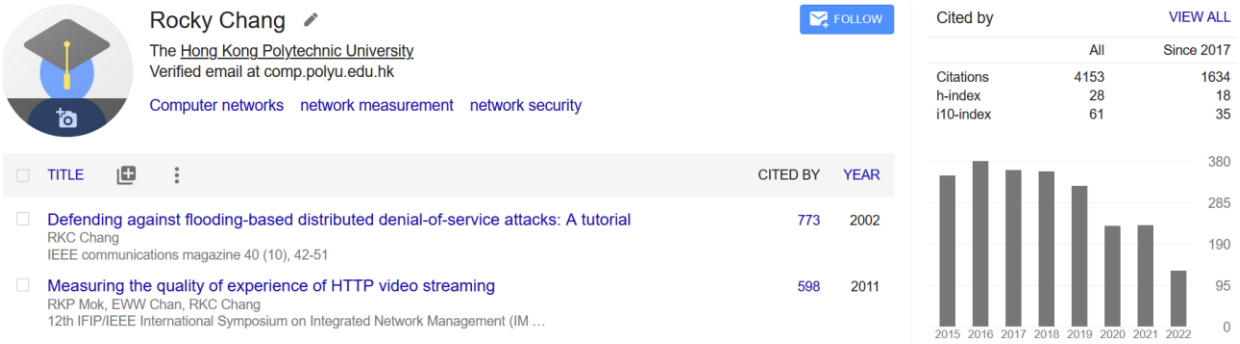
My Research Outputs and Impacts

There are five types of research outputs and impacts: research publications, research students, research funding, consultancy services and international connection.

Research publications: I have published around 100 refereed journal and conference papers. My team members and I published in top journal papers and top conference papers.

- Top journals: IEEE Trans. Mobile Computing, IEEE Trans. Multimedia, IEEE J. Sel. Areas in Communications, IEEE Trans. Dependable and Secure Computing, and IEEE Trans. Information Forensics and Security
- Top conferences: Computer networking (ACM CoNEXT'09, '11, '16, IEEE INFOCOM'15, '92, '91, '90), Computer systems (USENIX ATC'05, '09, '17), network measurement (ACM IMC'10, '13, '16), and Internet security (NDSS'05, '11, '19, IEEE/IFIP DSN'21)

My overall Google Scholar index as of 21 August 2022: Citations: 4153, h-index: 28, and i10-index: 61



Research students: I have graduated seven PhD students and seven MPhil students. The PhD students are now with Hong Kong and Mainland China universities (Hong Kong Polytechnic University, Xiamen University and Southern University of Science and Technology), research center (CAIDA at UC/San Diego), and industry (e.g., Google and Akamai). Two other MPhil students further received their PhDs in the US and Singapore.

Research funding: As the chief investigator, my recent research funding comes from five Hong Kong Innovation and Technology Commission (ITC) project (close to HKD 9 million) and one Huawei Innovation Research Program projects (HKD $615,000). Most of the

funding are in the area of network measurement (close to 90%) and the rest in the area of mobile security. For the four ITC projects on network measurement, three of them are for designing novel measurement methods (i.e., upstream) and one of them is for developing network measurement systems (i.e., midstream). I also received an ITC funding for deploying the measurement systems in nonprofit organizations (i.e., downstream).

Consultancy services: I have engaged in two long-term consultancy projects using our network measurement methods and systems. The first one is providing network-quality measurement service to the Hong Kong Academic and Research Network (HARNET) for ten years. We have developed and operated a platform to help the eight universities in Hong Kong discover and diagnose network performance problems and monitor the providers' performance. The second is deploying a similar network measurement system for a government department (whose identity cannot be revealed) from 2013 to 2019. The total consultancy funding received is around HKD 4 million.

International connections: I have established professional connections to researchers in different parts of the world (such as US, Mainland China, Japan, Sweden, Australia, and Taiwan). Among them, I am mostly connected to the network measurement community through my involvement in the technical program committees of ACM IMC (Internet Measurement Conference) and PAM (Passive and Active Measurement) Conference. I also visited University of Technology Sydney as a Key Technology Partner Visiting Fellow and spent my eight-month sabbatical with Huawei Technologies as a Principal Researcher.