Singapore Cybersecurity Consortium

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Scaling Network Security Using In-Network Computation

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Abstract

The increasing network traffic volume and application demands have significantly raised the bar for the effectiveness of network security solutions. Traditional approaches, unfortunately, are not keeping up with the large network traffic (100Gbps or more) and concurrent flows (hundreds of thousands) in data center and enterprise networks. In this talk, I will introduce a new approach to network security that addresses this widening gap -- by deploying novel network security systems on new generation programmable network hardware. To that end, I will first present dSketch, our recent work that leverages reconfigurable switches to improve heavy-hitter detection for a wide range of network security applications. In dSketch, we propose a new time-decaying algorithm that runs completely on the data plane of programmable switches. By moving away from traditional interval-reset approaches, dSketch improves the detection rate of heavy-hitters by 5-10%. Moreover, dSketch is resource efficient and can be easily integrated with standard switch functionalities. Next, I will present DIDA, our in-network DDoS detection and mitigation system. DIDA is a distributed in-network defense architecture for amplified reflection DDoS (AR-DDoS) attacks, deployed at the programmable edge routers in ISP networks. We design efficient approximate data structures to track per-user connections in the switch data plane, leading to orders of magnitude faster detection and mitigation of AR-DDoS attacks. We show empirically that DIDA can detect and mitigate 99.8% of amplification attacks containing 7,000 different sources. In the last part of the talk, I will briefly discuss our on-going effort to use programmable network interface cards (SmartNICs) to provide line-rate network traffic analysis for real-world network security applications.

Speaker Bio

Jialin Li is an Assistant Professor in the School of Computing at the National University of Singapore. Before joining NUS, he received his PhD from the University of Washington in 2019 and his bachelor's degree from the University of Michigan in 2012. His current research interests are in the systems design for reconfigurable hardware, and co-designing distributed systems with data center networks. His research has been recognized with best paper awards at NSDI and OSDI.