Hyeonmin Lee

Network Security & Measurement Researcher

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I am a **postdoctoral research associate** in the Department of Computer Science at the University of Virginia (UVA), where I work with Prof. Yixin Sun.

(i) **Research Interests:** Network security, including *DNS security*, *Email security*, and *PKI/TLS*
  ○ Often utilize *Internet measurements* to identify potential security problems or vulnerabilities
(ii) **Research Papers:** Five papers, three of which were published in top-tier conferences including USENIX Security and The Web Conference (formerly known as WWW)
(iii) **Project Experiences:** More than ten research projects with institutions such as Virginia Tech, Rochester Institute of Technology, University of Twente, SIDN Labs, NLnet Labs, etc.
(iv) **Technical Background:** DNS security (e.g., DNSSEC, DoT, DoH), Email security (e.g., STARTTLS), PKI, DANE, TLS, IoT, etc.

Professional Experience

Postdoctoral Research Associate, Dept. of Computer Science — **Oct 2023 — Present**
University of Virginia — *Charlottesville, VA, United States*
○ [DNS-Web] I conduct research on DNS security and web security, utilizing internet measurement to identify issues within them.

Postdoctoral Researcher, Dept. of Computer Science and Engineering — **Apr 2022 — Sep 2023**
Seoul National University — *Seoul, South Korea*
○ [TLS-DNS] I analyzed how key materials can be distributed in DNS to reduce the TLS handshake time (Publication [C4]).
○ [DANE-Web] I investigated the possibility of adopting DANE for the web by analyzing the issues in the current web ecosystem.

Technical Research Personnel*, Dept. of Computer Science and Engineering — **Mar 2019 — Feb 2022**
Seoul National University — *Seoul, South Korea*
∗Technical Research Personnel is a form of military service (a combination of military service with a Ph.D. program) in which the service is fulfilled by carrying out research on technology. While fulfilling the service, I participated in or led several research projects; Please note that I had not been involved in any military-related projects.
○ [DANE-Email] I investigated how the DANE protocol is deployed and managed in the SMTP ecosystem (Publications [C3, C2]).

Visiting Student, The Center for Cybersecurity — **May 2019 — Aug 2019**
Rochester Institute of Technology — *Rochester, NY, United States*
○ [Email-DANE] I analyzed DANE to measure its deployment in the real-world (Publication [C2]).

Education

Ph.D., Computer Science and Engineering, *Seoul National University*, (Seoul, South Korea) — **Mar 2016 — Feb 2022**
○ [Ph.D. Thesis] "Understanding the DANE Ecosystem in Email: How Is It Deployed and Managed?"
○ [Advisors] *Prof. Taekyoung "Ted" Kwon (Seoul National University)*, *Prof. Taejoong "Tijay" Chung (Virginia Tech)*

B.S., Computer Science and Engineering, *Seoul National University*, (Seoul, South Korea) — **Mar 2011 — Feb 2016**
Visiting Student, Information Technology, *Uppsala University*, (Uppsala, Sweden) — **Fall 2014**

Publications

[C4] ZTLS: A DNS-based Approach to Zero Round Trip in TLS handshake — **TheWebConf'23**
Sangwon Lim, **Hyeonmin Lee**, Hyunsoo Kim, Hyunwoo Lee, and Ted "Taekyoung" Kwon
In Proceedings of the ACM Web Conference 2023 (formerly WWW), Austin, United States, Apr 2023

[C3] Under the Hood of DANE Mismanagement in SMTP — **USENIX Security'22**
Hyeonmin Lee, Md. Ishtiaq Ashiq, Moritz Müller, Roland van Rijswijk-Deij, Taekyoung "Ted" Kwon, Taejoong Chung
In Proceedings of the 31st USENIX Security Symposium, Boston, United States, Aug 2022

[C2] A Longitudinal and Comprehensive Study of the DANE Ecosystem in Email — **USENIX Security'20**
Hyeonmin Lee, Aniketh Gireesh, Roland van Rijswijk-Deij, Taekyoung "Ted" Kwon, Taejoong Chung
In Proceedings of the 29th USENIX Security Symposium, Boston, United States, Aug 2020

[C1] Development of Cellular Core Network Enabling Network Function Virtualization — **JCCI'18**
Hyeonmin Lee, Junghwan Song
The 28th Joint Conference on Communication and Information, Yeosu, Korea, May 2018

[J1] TwinPeaks: An Approach for Certificateless Public Key Distribution for the Internet and Internet of Things — **Computer Networks**
Eunsang Cho, Jeongnyeo Kim, Minkyung Park, **Hyeonmin Lee**, Chorom Hamm, Soobin Park, Sungmin Sohn, Minhyeok Kang, Ted "Taekyoung" Kwon
Elsevier Computer Networks (SCI-E)

[P1] A Longitudinal and Comprehensive Study of the DANE Ecosystem in Email **USENIX Security'22**
Hyeonmin Lee, Md. Ishtiaq Ashiq, Moritz Müller, Roland van Rijswijk-Deij, Taekyoung "Ted" Kwon, Taejoong Chung
Poster Session in the 31st USENIX Security Symposium, Boston, United States, Aug 2022

Research Project Experience (Selected)

A Study for the Future-oriented DANE-based Web Architecture to Solve Problems in the Current TLS-based Web Ecosystem
Primary Investigator **Sep 2022 — Aug 2023**
(Funded by *Basic Science Research Program - National Research Foundation of Korea*)

- [Project Goal] This project aimed to investigate the impact of adopting the DANE protocol for peer authentication on the Web ecosystem.
- [Keywords] Web, Transport Layer Security (TLS), Authentication, DANE.
- [Role] I analyzed the possibility of adopting DANE for the web by analyzing the issues (e.g., key sharing) in the current CA-based web ecosystem.

Research on Secure DNS and Privacy aware Packet Filtering Technology
System Designer/ Programmer **Aug 2022 — Jul 2023**
(Funded by *Samsung Electronics*)

- [Project Goal] This project aimed to create a secure DNS environment for mobile devices by analyzing the performance of DNS over TLS (DoT) and DNS over HTTPS (DoH) and designing a DNS packet filtering mechanism.
- [Keywords] Domain Name System (DNS), DNS over TLS (DoT), DNS over HTTPS (DoH), Packet filtering.
- [Role] I designed a system that filters packets using DNS packets and implemented it based on BIND9.

Abnormal Detection and Forensic Techniques using IoT Network Traffic Analysis
Project Manager/System Designer/Programmer **Mar 2021 — Nov 2021**
(Funded by *Korea Institute of Information Security & Cryptology (KIISC)*)

- [Project Goal] This project aimed to develop a system for detecting anomalies or attacks in IoT networks and generating evidence for digital forensics by collecting IoT network traffic.
- [Keywords] IoT network, Network security, Machine learning, Abnormal detection, DDoS.
- [Role] I designed the entire system aimed at detecting anomalies in IoT networks.

Patents

- **Method for Performing Mutual Authentication in Communication using Locator ID Separation Protocol, Apparatus, and System for Performing the Same**
  Ted "Taekyoung" Kwon, **Hyeonmin Lee**, Hyunwoo Lee
  - Registration No. 10-2476081, South Korea, Dec 2022
- **Network System and Method for Performing Message Security Thereof**
  Ted "Taekyoung" Kwon, Hyunwoo Lee, Myungchul Kwak, **Hyeonmin Lee**, Junghwan Lim, Yoojung Shin
  - Registration No. 10-2265611, South Korea, Jun 2021
- **Communication Method Based on Integrated Flat ID and System**
  Ted "Taekyoung" Kwon, Hyunwoo Lee, Myungchul Kwak, **Hyeonmin Lee**, Dongjun Lee, Hyunchul Oh
  - Registration No. 10-2023115, South Korea, Sep 2019

Talks & Presentations

APNIC Blog, Online post, "Under the hood of DANE mismanagement in SMTP"	Sep 2022
USENIX Security Symposium, Boston, "Under the Hood of DANE Mismanagement in SMTP"	Aug 2022
USENIX Security Symposium, Online, "A Longitudinal and Comprehensive Study of the DANE Ecosystem in Email"	Aug 2020

Skills

Tools and Languages	Python (proficient), C/C++, Java, Go, Spark, Hadoop, Git, LaTeX, Linux OS
Knowledge Background	DNS, DNS Security (i.e., DNSSEC, DoT, DoH), SMTP, Email Security (i.e., STARTTLS), PKI, DANE, TLS, Network Protocols (i.e., TCP, IP, HTTP, HTTPS, QUIC), IoT, Edge computing

References

Yixin Sun (ys3kz@virginia.edu)
- Assistant Professor, Department of Computer Science, University of Virginia, Charlottesville, VA, United States

Taekyoung "Ted" Kwon (tkkwon@snu.ac.kr)
- Professor, Department of Computer Science and Engineering, Seoul National University, Seoul, South Korea

Taejoong (Tijay) Chung (tijay@vt.edu)
- Assistant Professor, Department of Computer Science, Virginia Tech, Blacksburg, VA, United States

Research Project Experience (Complete List)

A Study for the Future-oriented DANE-based Web Architecture to Solve Problems in the Current TLS-based Web Ecosystem
Primary Investigator Sep 2022 — Aug 2023
(Funded by *Post-Doctoral Domestic and Overseas Training Program - National Research Foundation of Korea*)
- [Project Goal] At present, the DANE protocol is mainly used for SMTP server authentication in mail transfers. This project aimed to investigate the impact of adopting the DANE protocol for peer authentication on the Web ecosystem.
- [Role] Primary Investigator

Research on Secure DNS and Privacy aware Packet Filtering Technology Aug 2022 — Jul 2023
(Funded by *Samsung Electronics*)
- [Project Goal] This project aimed to design a secure DNS environment for mobile devices, which includes analyzing the performance of DoT/DoH in the mobile environment, designing a packet filtering mechanism based on DNS packets.
- [Role] System Designer / Programmer

Research on Traceability for Data Stability on Cloud-edge Lifecycle Apr 2020 — Dec 2021
(Funded by *Institute for Information and Communication Technology Promotion (IITP)*)
- [Project Goal] This project aims to develop a technology that ensures the stability and traceability of cloud data by leveraging Trusted Execution Environment (TEE).
- [Role] Programmer

Abnormal Detection and Forensic Techniques using IoT Network Traffic Analysis Mar 2021 — Nov 2021
(Funded by *Korea Institute of Information Security & Cryptology (KIISC)*)
- [Project Goal] This project aims to develop a system that detects anomalies (or attacks) in IoT networks and generates evidence for digital forensics by collecting IoT network traffic.
- [Role] Project Manager (Lab.) / System Designer / Programmer

Versatile Network System Architecture for Multi-dimensional Diversity This project aims to design a network architecture that covers diverse network devices, services, or resources, especially, in the edge network. Apr 2016 — Dec 2020
(Funded by *Institute for Information and Communication Technology Promotion (IITP)*)
- [Project Goal] This project aims to design a network architecture that covers diverse network devices, services, or resources, especially, in the edge network.
- [Role] Project Manager (Lab.) / System Designer / Programmer

Research on GPU Acceleration for Fully Homomorphic Encryption Feb 2020 — Nov 2020
(Funded by *Korea Institute of Information Security & Cryptology (KIISC)*)
- [Project Goal] This project aims to accelerate Fully Homomorphic Encryption (FHE) techniques using GPUs, including research that reduces CPU-GPU interaction and CPU-to-GPU memory dependencies.
- [Role] Programmer

Research on Distributed Web Structure and Counterplan Aug 2019 — Nov 2019
(Funded by *Korea Internet and Security Agency (KISA)*)
- [Project Goal] The project aims to analyze trends in the Distributed Web and draw a blueprint for applying it to the domestic web ecosystem.
- [Role] Researcher

Research on Trust and Security Scheme for Interconnection of Heterogeneous Networks Sep 2018 — Nov 2018
(Funded by *Electronics and Telecommunications Research Institute (ETRI)*)
- [Project Goal] The purpose of this task is to analyze the authentication and networking methods of diverse IoT products and to propose a new framework to solve problems arising in heterogeneous network environments.
- [Role] Researcher

Research and Development of Open 5G Reference Model Aug 2016 — Feb 2019
(Funded by *Giga KOREA Foundation*)
- [Project Goal] This project aims to develop an open-source 5G reference model and implement a simulator to test it.
- [Role] System Designer / Programmer

Development of Network Security Acceleration for Next-generation Low-power SoC Jul 2015 — Dec 2015
(Funded by *Samsung Electronics*)
- [Project Goal] This project aims to design a system that reduces the overhead of the TLS handshake through a delegation in communications among low-power devices.
- [Role] Programmer