

Meng Xu

Assistant Professor

meng.xu.cs@uwaterloo.ca
<https://cs.uwaterloo.ca/~m285xu/>
DC 2639, 200 University Ave W, Waterloo, ON, N2L 3G1

RESEARCH INTERESTS

My research focuses on **system and software security**, with an emphasis on

- secure-by-design languages (*e.g.*, Rust, Move)
- automated security analysis (*e.g.*, fuzz testing, symbolic execution), and
- runtime defense techniques (*e.g.*, moving target defense, secure hardware).

My research has been applied to identify and address security and privacy issues in *system, web, mobile, IoT*, and *smart contract* applications.

ACADEMIC EXPERIENCE

Assistant Professor, Cheriton School of Computer Science
University of Waterloo *Sep 2021 – Present*
Waterloo, ON, Canada

Research Scientist, Move Developer Platform Team,
Facebook / Novi *Sep 2020 – Sep 2021*
Menlo Park, CA, United States

Research Intern, Security, Privacy, and Cryptography Group
Microsoft Research (Advisor: Dr. Marcus Peinado) *May 2018 - Aug 2018*
Redmond, WA, United States

Research Intern, Infer Team,
Facebook *Jan 2018 - Apr 2018*
Menlo Park, CA, United States

Visiting Scholar,
CISPA (Advisor: Prof. Michael Backes) *May 2017 - Aug 2017*
Saarbrücken, Germany

EDUCATION

Georgia Institute of Technology,
Ph.D., Computer Science (Advisor: Prof. Taesoo Kim) *Aug 2014 – Jul 2020*
Atlanta, GA, United States

Nanyang Technological University,
B.Engineering., Computer Science, *First Class Honor*
B.Business., Business Administration, *First Class Honor* *Aug 2010 – May 2014*
Singapore

PHD THESIS

Finding Race Conditions in Kernels: the Symbolic Way and the Fuzzy Way

The scale and pervasiveness of concurrent software pose challenges for security researchers: race conditions are more prevalent than ever, and the growing software complexity keeps exacerbating the situation — expanding the arms race between security practitioners and attackers beyond memory errors. As a consequence, we need a new generation of bug hunting tools that not only scale well with increasingly larger codebases but also catch up with the growing importance of race conditions.

In this thesis, two complementary race detection frameworks for OS kernels are presented: multi-dimensional fuzz testing and symbolic checking. Fuzz testing turns bug finding into a probabilistic search, but current practices restrict themselves to one dimension only (sequential executions). This thesis illustrates how to explore the concurrency dimension and extend the bug scope beyond memory errors to the broad spectrum of concurrency bugs. On the other hand, conventional symbolic executors face challenges when applied to OS kernels, such as path explosions due to branching and loops. They also lack a systematic way of modeling and tracking constraints in

the concurrency dimension (e.g., to enforce a particular schedule for thread interleavings) The gap can be partially filled with novel techniques for symbolic execution in this thesis.

PUBLICATIONS

Be Careful of What You Embed: Demystifying OLE Vulnerabilities

Yunpeng Tian, Feng Dong, Haoyi Liu, Meng Xu, Zhiniang Peng, Zesen Ye, Shenghui Li, Xiapu Luo, Haoyu Wang

In *Proceedings of the 2025 Annual Network and Distributed System Security Symposium (NDSS)*, February, 2025

SeMalloc: Semantics-Informed Memory Allocator

Ruizhe Wang, Meng Xu, N. Asokan

In *Proceedings of the 2024 ACM Conference on Computer and Communications Security (CCS)*, October, 2024

BliMe Linter

Hossam ElAtali, Xiaohe Duan, Hans Liljestrand, Meng Xu, N. Asokan

In *Proceedings of the 2024 IEEE Secure Development Conference (SecDev)*, October, 2024

SerdeSniffer: Enhancing Java Deserialization Vulnerability Detection with Function Summaries

Xinrong Liu, He Wang, Meng Xu, Yuqing Zhang

In *Proceedings of the 2024 European Symposium on Research in Computer Security (ESORICS)*, September, 2024

uBOX: A Lightweight and Hardware-assisted Sandbox for Multicore Embedded Systems

Xia Zhou, Yujie Bu, Meng Xu, Yajin Zhou, Lei Wu

In *IEEE Transactions on Dependable and Secure Computing (TDSC)*, September, 2024

CO3: Concolic Co-execution for Firmware

Changming Liu, Alejandro Mera, Engin Kirda, Meng Xu, Long Lu

In *Proceedings of the 2024 USENIX Security Symposium (SEC)*, August, 2024

S2malloc: Statistically Secure Allocator for Use-After-Free Protection And More

Ruizhe Wang, Meng Xu, N. Asokan

In *Proceedings of the 2024 Conference on Detection of Intrusions and Malware & Vulnerability Assessment (DIMVA)*, July, 2024

AddressWatcher: Sanitizer-Based Localization of Memory Leak Fixes

Aniruddhan Murali, Mahmoud Alfadhel, Mei Nagappan, Meng Xu, Chengnian Sun

In *Transactions on Software Engineering (TSE)*, July, 2024

Monarch: A Fuzzing Framework for Distributed File Systems

Tao Lyu, Liyi Zhang, Zhiyao Feng, Yueyang Pan, Meng Xu, Mathias Payer, Sanidhya Kashyap

In *Proceedings of the 2024 USENIX Annual Technical Conference (ATC)*, July, 2024

Research Report: Not All Move Specifications Are Created Equal

Meng Xu

In *Proceedings of the 2024 Workshop on Language-Theoretic Security (LangSec)*, May, 2024

Securing Aptos Framework with Formal Verification

Junkil Park, Teng Zhang, Wolfgang Grieskamp, Meng Xu, Gerardo Di Giacomo, Kundu Chen, Yi Lu, Robert Chen

In *Proceedings of the 2024 International Workshop on Formal Methods for Blockchains (FMBC)*, April, 2024

FuzzSlice: Pruning False Positives in Static Analysis Warnings through Function-Level Fuzzing

Aniruddhan Murali, Noble Mathews, Mahmoud Alfadel, Mei Nagappan, Meng Xu
In *Proceedings of the 2024 International Conference on Software Engineering (ICSE)*, April, 2024

Sense: Enhancing Microarchitectural Awareness for TEEs via Subscription-Based Notification

Fan Sang, Jaehyuk Lee, Xiaokuan Zhang, Meng Xu, Scott Constable, Yuan Xiao, Michael Steiner, Mona Vij, Taesoo Kim
In *Proceedings of the 2024 Annual Network and Distributed System Security Symposium (NDSS)*, February, 2024

Finding Specification Blind Spots via Fuzz Testing

Ru Ji, Meng Xu
In *Proceedings of the 2023 IEEE Symposium on Security and Privacy (Oakland)*, May, 2023

Fast and Reliable Formal Verification of Smart Contracts with the Move Prover

David Dill, Wolfgang Grieskamp, Junkil Park, Shaz Qadeer, Meng Xu, Emma Zhong
In *Proceedings of the 2022 International Conference on Tools and Algorithms for the Construction and Analysis of Systems (TACAS)*, April, 2022

* **EAPLS Best Paper Award**

* **SCP Best Tool Paper Nomination**

Finding Bugs in File Systems with an Extensible Fuzzing Framework

Seulbae Kim, Meng Xu, Sanidhya Kashyap, Jungyeon Yoon, Wen Xu, Taesoo Kim
In *ACM Transactions on Storage (ToS)*, May, 2020

Krace: Data Race Fuzzing for Kernel File Systems

Meng Xu, Sanidhya Kashyap, Hanqing Zhao, Taesoo Kim
In *Proceedings of the 2020 IEEE Symposium on Security and Privacy (Oakland)*, May, 2020

Finding Semantic Bugs in File Systems with an Extensible Fuzzing Framework

Seulbae Kim, Meng Xu, Sanidhya Kashyap, Jungyeon Yoon, Wen Xu, Taesoo Kim
In *Proceedings of the 2019 ACM Symposium on Operating Systems Principles (SOSP)*, October, 2019

Dominance as a New Trusted Computing Primitive for the Internet of Things

Meng Xu, Manuel Huber, Zhichuang Sun, Paul England, Marcus Peinado, Sangho Lee, Andrey Marochko, Dennis Mattoon, Rob Spiger, Stefan Thom
In *Proceedings of the 2019 IEEE Symposium on Security and Privacy (Oakland)*, May, 2019

Stopping Memory Disclosures via Diversification and Replicated Execution

Kangjie Lu, Meng Xu, Chengyu Song, Taesoo Kim, Wenke Lee
In *IEEE Transactions on Dependable and Secure Computing (TDSC)*, October, 2018

QSYM: A Practical Concolic Execution Engine Tailored for Hybrid Fuzzing

Insu Yun, Sangho Lee, Meng Xu, Yeongjin Jang, Taesoo Kim
In *Proceedings of the 2018 USENIX Security Symposium (SEC)*, August, 2018

* **USENIX Security Best Paper Award**

Precise and Scalable Detection of Double-Fetch Bugs in OS Kernels

Meng Xu, Chenxiong Qian, Kangjie Lu, Michael Backes, Taesoo Kim
In *Proceedings of the 2018 IEEE Symposium on Security and Privacy (Oakland)*, May, 2018

Prevention of Cross-update Privacy Leaks on Android

Beumjin Cho, Sangho Lee, Meng Xu, Sangwoo Ji, Taesoo Kim, Jong Kim
In *Computer Science and Information Systems (Com.SIS)*, January, 2018

Checking Open-Source License Violation and 1-day Security Risk at Large Scale
Ruian Duan, Ashish Bijlani, Meng Xu, Taesoo Kim, Wenke Lee
In *Proceedings of the 2017 ACM Conference on Computer and Communications Security (CCS)*,
October, 2017

PlatPal: Detecting Malicious Documents with Platform Diversity
Meng Xu, Taesoo Kim
In *Proceedings of the 2017 USENIX Security Symposium (SEC)*, August, 2017

Bunshin: Compositing Security Mechanisms through Diversification
Meng Xu, Kangjie Lu, Taesoo Kim, Wenke Lee
In *Proceedings of the None USENIX Annual Technical Conference (ATC)*, July, 2017

Toward Engineering a Secure Android Ecosystem: A Survey of Existing Techniques
Meng Xu, Chengyu Song, Yang ji, Ming-Wei Shih, Kangjie Lu, Cong Zheng, Ruian Duan,
Yeongjin Jang, Byoungyoung Lee, Chenxiang Qian, Sangho Lee, Taesoo Kim
In *ACM Computing Surveys (CSUR)*, August, 2016

UCognito: Private Browsing without Tears
Meng Xu, Yeongjin Jang, Xinyu Xing, Taesoo Kim, Wenke Lee
In *Proceedings of the 2015 ACM Conference on Computer and Communications Security (CCS)*,
October, 2015

TEACHING EXPERIENCE	Course Instructor , Software and Systems Security (CS 489/698), University of Waterloo	<i>Spring 2023</i>
	Course Instructor , Computer Security and Privacy (CS 458/658), University of Waterloo	<i>Winter 2023</i>
	Course Instructor , Software Security Seminar (CS 858), University of Waterloo	<i>Fall 2022</i>
	Course Instructor , Computer Security and Privacy (CS 458/658), University of Waterloo	<i>Winter 2022</i>
	Teaching Assistant , Information Security Lab (CS 6265), Georgia Institute of Technology Instructor: Prof. Taesoo Kim	<i>Fall 2015</i>
	Teaching Assistant , Introduction to Information Security (CS 6035), Georgia Institute of Technology Instructor: Prof. Wenke Lee	<i>Spring 2019</i>

FUNDING	BlackBerry Research Grant (BlackBerry) CAD \$200,000 [50% share]	<i>2023</i>
	CPI + AI Seed Grant (University of Waterloo) CAD \$20,000 [50% share]	<i>2023</i>
	Unrestricted Research Gift (Meta / Novi) USD \$50,000 [100% share]	<i>2022</i>
	Amazon Research Award (Amazon)	

USD \$60,000 [100% share]	2022
NGI Assure (NLnet Foundation) Euro €34,319 [50% share]	2022
Discovery Grant (NSERC) CAD \$170,000 [100% share]	2022
Discovery Launch Supplement (NSERC), CAD \$12,500 [100% share]	2022
Start-up Grant (University of Waterloo) CAD \$120,000 [100% share]	2021

PROFESSIONAL
SERVICE

PC Member	
The Network and Distributed System Security Symposium (NDSS)	2024
International Symposium on Research in Attacks, Intrusions and Defenses (RAID)	2023
IEEE Conference on Dependable and Secure Computing (DSC)	2022
ACM Conference on Computer and Communications Security (CCS)	2018
Shadow PC Member	
IEEE Symposium on Security and Privacy (Oakland)	2018
European Conference on Computer Systems (EuroSys)	2018
External Reviewer	
Network and Distributed System Security Symposium (NDSS)	2018, 2019, 2020
IEEE Symposium on Security and Privacy (Oakland)	2019
ACM Conference on Computer and Communications Security (CCS)	2015, 2017, 2019
USENIX Security Symposium (Security)	2015, 2018
USENIX Annual Technocal Conference (ATC)	2017, 2018
IEEE International Conference on Distributed Computing Systems (ICDCS)	2017
Journal Reviewer	
IEEE Transactions on Dependable and Secure Computing (TDSC)	2020
Computers & Security	2016

INVITED TALKS

Finding Race Conditions in Kernels: the Symbolic Way and the Fuzzy Way	
University of Waterloo	Jan 2020
University of Santa Barbara	Feb 2020
Purdue University	Feb 2020
Simon Fraser University	Feb 2020
CISPA, Saarland University	Feb 2020
Microsoft Research, Redmond	Mar 2020
Rutgers University	Mar 2020
ETH Zurich	Mar 2020
National University of Singapore	Apr 2020
Precise and Scalable Detection of Double-Fetch Bugs in Kernels	
Facebook	Apr 2018
Baidu USA	Apr 2018
Microsoft Research	Jul 2018
Internet Security Conference	Sep 2018
Chinese Academy of Sciences	Sep 2018

Purdue University, CERIAS Security Seminar	<i>Oct 2018</i>
Security through Multi-Layer Diversity CISPA, Saarland University	<i>Jun 2017</i>
UCognito: Private Browsing without Tears Ionic Security Georgia Tech, Cybersecurity Lecture Series	<i>Apr 2016</i> <i>Sep 2015</i>

OPEN SOURCE CONTRIBUTIONS	<p>Linux kernel: for patching double-fetch bugs in drivers, filesystems, and scheduler. https://git.kernel.org/pub/scm/linux/kernel/git/torvalds/linux.git</p> <p>FreeBSD kernel: for patching double-fetch bugs in networking stack. https://svnweb.freebsd.org</p> <p>Facebook Infer: for scaling it to the whole Facebook codebase. https://github.com/facebook/infer</p> <p>Hydra: an extensible fuzzing framework for finding semantic bugs in file systems. https://github.com/sslab-gatech/hydra</p> <p>Deadline: a precise and scalable double-fetch detector written as an LLVM pass. https://github.com/sslab-gatech/deadline</p> <p>PlatPal: a malicious PDF detector based on platform diversity. https://github.com/sslab-gatech/platpal</p> <p>Bunshin: an efficient N-version execution engine with multi-threading support. https://github.com/sslab-gatech/bunshin</p> <p>UCognito: an universal implementation of private browsing mode for browsers and more. https://github.com/sslab-gatech/ucognito</p> <p>Playcrawl: a GooglePlay app crawler with supporting for crawling old app versions https://github.com/sslab-gatech/playcrawl</p>
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AWARDS & SCHOLARSHIPS	<p>EAPLS Best Paper Award <i>2022</i></p> <p>USENIX Security Distinguished Paper Award <i>2018</i></p> <p>Atlanta Startup Battle 1st Place <i>2018</i></p> <p>Georgia Tech IISP Cybersecurity Demo Day Winner <i>2018</i></p> <p>Georgia Tech IISP Cybersecurity Demo Day Finalist <i>2016</i></p> <p>Singapore MOE Scholarship for Undergraduate Studies <i>2010 - 2014</i></p>
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REFERENCES	<p>Dr. Taesoo Kim (advisor) Catherine M. and James E. Allchin Early Career Associated Professor, +1 404-385-2934 School of Computer Science, taesoo@gatech.edu Georgia Institute of Technology https://taesoo.gtisc.gatech.edu</p> <p>Dr. Wenke Lee Professor and John P. Imlay Jr. Chair, +1 404-385-2879 School of Computer Science, wenke@cc.gatech.edu</p>
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Georgia Institute of Technology

<http://wenke.gtisc.gatech.edu>

Dr. Michael Backes

Professor, Chair of Information Security & Cryptography,
Computer Science Department,
Saarland University

+49 (0)681-302-3249

backes@cs.uni-saarland.de

<https://www.infsec.cs.uni-saarland.de/~backes/>

Dr. Marcus Peinado

Architect,
Security, Privacy, and Cryptography Group,
Microsoft Research

+1 206-349-1619

marcuspe@microsoft.com

<https://www.microsoft.com/en-us/research/people/marcuspe/>