

# Shinan Liu

CS PH.D. STUDENT IN COMPUTER SECURITY

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*“Becoming a hacker, poet and practical idealist.”*

## Education

### The University of Chicago

PH.D. STUDENT IN COMPUTER SCIENCE

*Illinois, USA*

*Sep. 2019 - PRESENT*

- Advisor: Prof. Nick Feamster (ACM Fellow, MIT Tech Review 35 under 35)
- Google Scholar citations: 94; i-10 index: 3

### University of Electronic Science and Technology of China

B.S. IN INFORMATION SECURITY@YINGCAI HONORS COLLEGE

*Sichuan, P.R. China*

*Sep. 2015 - June 2019*

- GPA 3.79/4.0; Rank 6/125; TOEFL 103(S25); GRE V152 Q170 AW3.5;

## Experience

### Secure Localization Team, Virginia Tech (Prof. Yaling Yang and Prof. Gang Wang)

LEADER

*Blacksburg, USA*

*January 2019 - April 2019*

- Leading a group of 9 excellent researchers from Virginia Tech, Microsoft Research, Facebook and UESTC.
- Designing innovative methods for defending GPS spoofing attacks.

### NISL, Tsinghua University(Prof. Jianwei Zhuge and Pro. Haixin Duan)

RESEARCH ASSISTANT

*Beijing, P.R. China*

*April 2018 - August 2018*

- Designed a course in Wireless Security.
- Taught developers from China Mobile Wireless and mobile security at Huawei Hangzhou Research Center.

### KnowWhy Co., Ltd.

FRONTEND INTERN DEVELOPER

*Chengdu, P.R. China*

*Nov. 2017 - Jan. 2018*

- Implemented several web pages in a tech-stack of Slim/SCSS/CoffeeScript/Ruby on Rails/MongoDB, focusing on high-availability, fault tolerance, and auto-scaling.

### Microsoft Research Asia(Dr. Yuanchao Shu)

SHORT-TERM RESEARCH INTERN

*Beijing, P.R. China*

*Sep. 2017*

- Designed and implemented a User Study focusing GPS spoofing attack in road navigation scenario. It consists of an interview, a questionnaire and a driving simulation.
- Developed a driving simulator based on Android and video game Euro Truck Simulator II. This system simulates the actual GPS spoofing attack in Budapest when using mobile navigators.

### Dominity Security Co., Ltd.

FOUNDER/CEO

*Chengdu, P.R. China*

*Aug. 2017*

- Found Dominity Security Co., Ltd. with 14 excellent peers and serve as CEO.
- Had an investment intention with Shanghai Newgen VC on 2 million yuan.
- Applied for 3 invention patents and got 2 utility patents, all of which were successfully documented.

### Qihoo 360 Unicorn Team

SECURITY RESEARCH INTERN

*Beijing, P.R. China*

*July 2017 - Aug. 2017*

- Researched on drone detection and anti-drone techniques.
- Implemented a drone detection system based on spectrum analysis using software-defined radio(SDR) and convolutional neural network(CNN).
- Open-sourced it on company website and got praises from team leader.

## Research

### INTERESTS

My research interests lie widely in the area of networked system, security and HCI. I focus my eyes on security threats in Internet of Things(IoT) and Cyber Physical Systems(CPS). Specifically, my research focuses on 3 folds: 1) utilizing physical/network layer attacks to sense and achieve application layer threats; 2) acquiring wide-spread knowledge of threats by large-scale measurements; 3) acknowledging influences of threats by human-in-the-loop assessment. I also design and implement attack and defense methods on networked systems(such as smart home, self-driving cars, GPS, LTE, and etc.) using techniques like Traffic Analysis, Deep Learning and Software Defined Radio(SDR).

## PROJECTS

### Detecting Low-Power Attack in Cellular Network

Illinois, USA

SAND LAB

Sept. 2019 - March. 2020

- This project focuses on mitigating low-power attacks in cellular networks. Mobile or seamless spoofing attackers exist widely in the wild, which are hard to detect. Because considering environmental noises, these attacks can be embedded into those fluctuations.
- We use spectrogram as a primitive to conduct anomaly detection. I collected and generated TB-level jamming, low-power spoofing and Fake base station attacks within the context of LTE. And my collaborator and I used a technique called machine unlearning to do semi-supervised learning to figure out these attacks.

### Robust Defending Mechanism Against GPS Spoofing

Virginia, USA

SECURE LOCALIZATION TEAM (WORK WITH RESEARCHERS FROM VT, MSR AND FACEBOOK)

Aug. 2018 - April 2019

- The robustest way to deal with GPS spoofing is to use Angle-of-Arrivals, but a big problem is that AoA calculation traditionally need specialized hardware. Our high-level idea is to simulate and derive Angle-of-arrivals based on rotation using devices like smartphones with no hardware modifications.

### Multi-sensor Fusion based Localization Analysis

CA, USA

WITH JUNJIE SHEN AND ALFRED CHEN

Nov. 2018 - Jan. 2019

- Self-driving cars are usually equipped with redundant and complementary sensors, e.g., LiDAR, GPS, and IMU, and use Multi-Sensor Fusion (MSF) algorithms to combine the observations. However, it is largely unclear how robust these MSF algorithms are in presence of practical sensor attacks such as GPS spoofing. Our preliminary results shows that a well-designed spoofing strategy is able to deviate the localization estimation of a representative MSF implementation by 2 meters in as short as 10 seconds. This could achieve a lane-level diversion, which would be a huge threat to self-driving cars.

### GPS Stealthy Manipulation

Sichuan, P.R. China

SECURE LOCALIZATION TEAM (WORK WITH RESEARCHERS FROM VT, MSR AND FACEBOOK)

Nov. 2015 - May 2018

- To divert mobiles to malicious locations, naive GPS spoofing attacks may never be practical. Therefore, we developed spoofing to stealthy manipulation. the goal of it is to use GPS spoofing techniques to trigger turn-by-turn navigation to guide the victim to a wrong destination without being noticed.
- Our key idea is to slightly shift the GPS location so that the fake navigation route matches the shape of the actual roads. By that means, we can trigger physically possible instructions that leads to dangerous places. We designed iterative attacking algorithm and measured the effects in physical environment and on actual users.

### MAPRO & SecRF

Sichuan, P.R. China

DOMINITY SECURITY TECHNOLOGY Co., LTD.

Jan. 2017 - Oct. 2017

- We introduce MAPRO as a shield and filter to malicious GNSS spoofing signals. It's an embedded device which can be easily carried and settled beside valuable infrastructures.
- The key idea is to use SDR platforms to tranceive and process on GNSS signals(GPS, Beidou, GLONASS). Features are extracted and signals are categorized by a CNN model we trained. Then we use a technique called friendly spoofing to adjust physical signals to a normal state.
- We extend the frequency band to get more protections on other RF applications and then comes SecRF. MAPRO & SecRF are products we designed to secure GPS/RF-assisted devices in Dominity Security Technology Co., Ltd.

### DeepDronIndicator

Beijing, P.R. China

QIHOO 360 UNICORN TEAM

July 2017 - Aug. 2017

- Drones appearing in airport and private places are threatening, because those "flying laptops" disorder the aero-security and have capacity to get privacy without being noticed. Therefore, DeepDronIndicator is a project focusing on detecting the flying directions of a drone.
- By monitoring the control loop(wireless channels) of a drone, its appearance and motions can get indicated. Further implementation involves localizing the drone and intelligently landing it by smart GPS and ADS-B spoofing.

## TECHNICAL SKILLS

<b>Traffic Analysis</b>	WireShark, TCPDump, netML, nPrint
<b>Software Defined Radio</b>	GNU Radio(HackRF, LimeSDR, USRP)
<b>Machine &amp; Deep Learning</b>	Sk-Learn(SVM), Tensorflow(CNN, LSTM, etc.)
<b>Programming Language</b>	C, C++, Python, Java
<b>Development Skill</b>	Web(LAMP and Rails stacks), Android

## Publication

### CONFERENCE

#### [C1] Stars can tell: A Robust Method to Defend against GPS Spoofing Attacks Using Off-the-shelf Chipset

Vancouver, B.C., Canada

SHINAN LIU\*, XIANG CHENG\*, HANCHAO YANG, YUANCHAO SHU, XIAORAN WENG, PING GUO, KEXIONG (CURTIS) ZENG, GANG WANG, YALING YANG 30th USENIX Security Symposium(USENIX Security'21)

Aug. 11-13, 2021

#### [C2] Characterizing Service Provider Response to the COVID-19 Pandemic in the United States

Virtual, USA

SHINAN LIU, PAUL SCHMITT, FRANCESCO BRONZINO, NICK FEAMSTER. The Passive and Active Measurement Conference 2021(PAM'18)

March, 2021

#### [C3] All Your GPS Are Belong To Us: Towards Stealthy Manipulation of Road Navigation Systems

Baltimore, MD, USA

KEXIONG (CURTIS) ZENG, SHINAN LIU, YUANCHAO SHU, DONG WANG, HAUYU LI, YANZHI DOU, GANG WANG AND YALING YANG. 27th USENIX Security Symposium(USENIX Security'18)

Aug. 15-17, 2018

## WORKSHOP

### [W1] A Practical GPS Location Spoofing Attack in Road Navigation Scenario

KEXIONG (CURTIS) ZENG, YUANCHAO SHU, **SHINAN LIU**, YANZHI DOU AND YALING YANG. *18th ACM Workshop on Mobile Computing Systems and Applications(Hotmobile'17)*

Sonoma, CA, USA

Feb. 21–22, 2017

## JOURNAL

### [J1] Investigations on the local structures of Cu<sup>2+</sup> at various BaO concentrations in 59B2O3-10K2O-(30x)ZnO-xBaO-1CuO glasses

Jiarui Jin, Shaoyi Wu, Jian Hong, **SHINAN LIU**, Minxian Song, Baohua Teng, Minghe Wu. *Philosophical Magazine*, 97:31, 2858-2870

London, UK

July 2017

## POSTER

### [Po1] Security Analysis of Multi-Sensor Fusion based Localization in Autonomous Vehicles

Junjie Shen, Jun Yeon Won, **SHINAN LIU**, Qi Alfred Chen, Alexander Veidenbaum. *Network & Distributed System Security Symposium NDSS'19 DISTINGUISHED POSTER PRESENTATION*

San Diego, CA, USA

Feb. 24-27, 2019

## PATENT

### [Pa1] A Secure Method and Device to Deliver Satellite Signals

**SHINAN LIU**, Xin Zhou, Xibo Yang, Rui Kang, Gaoxiang Wu, Hao Du, Rui Kang, Shengzhi Qin, Sai Xu. *National Institution of Intellectual Property, P. R. China*.

Chengdu, P.R.China

March, 2020

### [Pa2] A Satellite Signal Classification and Detection Method and Device

Shengzhi Qin, Xibo Yang, Sai Xu, Xin Zhou, Rui Kang, **SHINAN LIU**, Gaoxiang Wu, Hao Du. *National Institution of Intellectual Property, P. R. China, ZL 2017 1 0478901*.

Chengdu, P.R.China

Dec., 2019

### [Pa3] A Wireless Signal Classification and Detection Method and Device

Rui Kang, **SHINAN LIU**, Xin Zhou, Hao Du, Xibo Yang, Sai Xu, Shengzhi Qin, Gaoxiang Wu. *National Institution of Intellectual Property, P. R. China, ZL 2017 2 1275895.5*

Chengdu, P.R.China

July, 2018

### [Pa4] A Software-Defined Wireless Signal Reception Device and System

Hao Du, Rui Kang, Gaoxiang Wu, Sai Xu, **SHINAN LIU**, Shengzhi Qin, Xibo Yang, Xin Zhou. *National Institution of Intellectual Property, P. R. China, ZL 2017 2 1090307.0*

Chengdu, P.R.China

March, 2018

## Honors & Awards

2019	<b>Daniels Fellowship</b> , UChicago CS department fellowship	Chicago, USA
2019	<b>NDSS'19 Distinguished Poster Presentation Award</b> , The only team who received this award	San Diego, USA
2019	<b>Best Undergrad Thesis</b> , 1 out of 12 Students in UESTC	Sichuan, P.R.China
2018	<b>Excellent Graduate of Sichuan Province</b> , Top 1% Student of the University	Sichuan, P.R.China
2018	<b>Network Security Scholarship</b> , 1 of 66 Undergraduate Students Who Won this National Award	Beijing, P.R.China
2017	<b>Highest Prize</b> , 10th National University Students Information Security Competition	Xian, P.R.China
2017	<b>National Third Prize &amp; Provincial Golden Prize</b> , 15th National Challenge Cup	Shanghai, P.R.China
2017	<b>Golden Award</b> , 3rd Internet+ Innovation Entrepreneurship Competition of Sichuan Province	Chengdu, P.R.China
2017	<b>4th Place</b> , 1st Tianfu Cup Entrepreneurship Competition	Chengdu, P.R.China
2017	<b>National Finalist</b> , 2nd Innovation Competition at Yinchuan	Yinchuan, P.R.China
2017	<b>National Finalist</b> , 2nd Head to Silicon Valley Entrepreneurship Competition	Shanghai, P.R.China
2017	<b>1st Place</b> , Being a U-reader	Chengdu, P.R.China
2016	<b>Silver Prize</b> , National English Competition	Chengdu, P.R.China
2016	<b>Leadership Award</b> , G-MEO American University Summer Camp	Washington DC, USA
2015	<b>Best Writer</b> , UESTC radio station	Chengdu, P.R.China
2015	<b>Several First Prizes</b> , Competitions of presentation, reading and writing	Chengdu, P.R.China

## Activity

### TECHNICAL TALK

#### All Your GPS Are Belong To Us: Towards Stealthy Manipulation of Road Navigation Systems@USENIX Security'18

TOGETHER WITH KEXIONG (CURTIS) ZENG

- Presented half of the talk in front of session attendees.

Baltimore, USA

Aug., 2018

#### A Practical GPS Location Spoofing Attack in Road Navigation Scenario@Turing Conference UESTC Div.

THE ONLY UNDERGRADUATE INVITEE

- Presented our work in front of professors and graduate students.

Chengdu, P.R. China

Feb., 2018

## MAPRO: a GNSS protection system based on SDR and CNN@XDef'17

STUDENT KEYNOTE SPEAKER

- Introduced the system design and implementation of MAPRO, emphasizing on current situations of GPS spoofing attacks.

Wuhan, P.R. China

Nov., 2017

## Attack and Defense: A Systematic Review on Wireless Threats

STUDENT REPORTER OF UESTC NETWORK SECURITY INNOVATION PROGRAM

- Introduced a systematic review on threats and countermeasures faced by modern wireless networks.

Chengdu, P.R. China

Oct., 2017

## DDI: Deep Learning in Drone Direction Indication

INTERN RESEARCHER

- Introduced the system design and implementation of DDI.

Beijing, P.R. China

Aug., 2017

## A Practical GPS Location Spoofing Attack in Road Navigation Scenario@HotMobile'17

TOGETHER WITH KEXIONG (CURTIS) ZENG

- Presented half of the talk in front of session attendees.

Sonoma, CA, USA

Feb., 2017

## TEACHING

### CS15400 Introduction to Computer System

TEACHING ASSISTANT.

- Teach project / lab sessions, prepare homeworks and hold TA hours.

Chicago, USA

Fall quarter, 2020

### CS23400 Mobile Computing

TEACHING ASSISTANT.

- Ran lab sessions and held TA hours.

Chicago, USA

Winter quarter, 2020

### Introduction to IoT security

INVITEE OF HUAWEI HANGZHOU RESEARCH INSTITUTE

- Taught developers of Chinese Mobile IoT security and e-crime basics.
- Ran labs to reproduce existing cellular attacks.

Hangzhou, P.R.China

April, 2018

### Introduction to wireless security

INVITEE OF BLUEWHALECTF INC.

- Taught general public the basics of wireless security in GSM/LTE networks and GPS security.

Shanghai, P.R.China

Aug., 2018

## ACADEMIC SERVICES

2020 **Committee Member**, IAG (International Association of Geodesy) GNSS Interference and Spoofing

Chicago, USA

## EXTERNAL REVIEWER

2020 **1 paper**, IEEE Transactions on Intelligent Transportation Systems

2017 **2 papers**, IEEE Conference on Computer Communications (INFOCOM)

Chicago, USA

Chengdu, P.R.China