

# CHANGHAO WU

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## EDUCATION

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**Xi'an Jiaotong University**, Xi'an, China

September 2015 – May 2019

Bachelor in Computer Science and Technology

GPA: 3.8/4.3 Rank: Top 5/158

**University of California, San Diego**, La Jolla, CA

February 2017 - June 2017

Exchange student in Computer Science and Engineering

GPA: 4.0

**Brown University**, Providence, RI

August 2019 - Present

Master of Science in Computer Science

Current GPA: 4.0

## RESEARCH

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**Ministry of Education Key Lab for Intelligent Networks and Network Security**

Xi'an, China

Advised by Prof. Hao Li, Prof. Chengchen Hu

2017 – 2019

Project: *Programming Network Stack for Middleboxes with Rubik*

- Designed Rubik, a domain-specific language for the middlebox stack, which decreases coding efforts for building a TCP/IP stack by two orders of magnitude (*e.g.* from 20,000 lines to 300 lines).
- Prototyped the compiler of Rubik and built various realistic cases using Rubik language, including 12 reusable protocol parsers, 4 network stacks, and 3 open-source middleboxes.
- Conducted optimizations in the IR and the backend of the compiler for improving the processing throughput, *e.g.*, the TCP/IP stack built on Rubik outperformed state-of-the-art by 23%.

**Brown Systems Research Group**

Brown University, Providence, RI

Advised by Prof. Theophilus Benson

Aug 2019 - Present

Current Project: *aFabric: Towards a Holistic View for Managing Hardware Accelerators in the Cloud*

- Model an operating system managing heterogeneous hardware in the cloud.
- Analyze and model the data dependency and consistency problems in P4 programs.
- Formalize the optimization problem of deploying P4 applications across the accelerators.
- Design heuristics to reduce optimization problem's searching space and solving time.

## PUBLICATION

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**Programming Network Stack for Middleboxes with Rubik**

Hao Li, **Changhao Wu**, Guangda Sun, Peng Zhang, Danfeng Shan, Tian Pan, Chengchen Hu

@ Usenix NSDI 2021

**aFabric: Towards a Holistic View for Managing Hardware Accelerators in the Cloud**

**Changhao Wu**, Theophilus Benson

@ CoNEXT'20 Student Workshop

## PROFESSIONAL EXPERIENCE

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Intern @ Compiler Team, Barefoot Networks Division, Intel

Jun - Aug 2020

Mentored by Dr. Han Wang

- Understood the implementation of a compiler and became familiar with p4c compiler's infrastructure.
- Created a new backend for P4->DPDK translation, translating P4 code to an assembly-like format.
- Modified a lisp parser to parse the assembly and load the instructions into P4 DPDK runtime on the fly.

## SKILLS

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- Programming Languages: C = Python = P4 = C++ > MATLAB > SQL
- Familiar with systems development tools: bash, ssh, gcc, make, docker, k8s *etc.*

## ARTIFACTS

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- the Prototype for *Programming Network Stack for Middleboxes with Rubik*  
Github Repo: <https://github.com/ants-xjtu/rubik>
- a DPDK backend for p4c compiler finished as an intern at Barefoot networks  
Github Repo: <https://tinyurl.com/y474adr7>