

# Bojie Li

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4th year Ph.D. student • Joint Ph.D. program with USTC and MSRA

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## Education

University of Science and Technology of China HEFEI, ANHUI, CHINA  
**Ph.D. in Computer Science (Expected graduation in 2019)** Sept. '14 – present  
Joint Ph.D. program with Microsoft Research Asia. Advisor: Prof. Enhong Chen

University of Science and Technology of China HEFEI, ANHUI, CHINA  
**B.S. in Computer Science (School of Gifted Young)** Sept. '10 – July '14

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## Internship Experience

Microsoft Research Asia BEIJING, CHINA  
**Systems Research Group. Advisor: Dr. Lintao Zhang.** July '15 – present

Microsoft Research Asia BEIJING, CHINA  
**Wireless and Networking Research Group. Advisor: Dr. Kun Tan.** July '13 – Sept. '14

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## Research Focus

Accelerating data center infrastructure with reconfigurable hardware.

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## Publications (selected)

**KV-Direct: High-Performance In-Memory Key-Value Store with Programmable NIC**  
Bojie Li, Zhenyuan Ruan, Wencong Xiao, Yuanwei Lu, Yongqiang Xiong, Andrew Putnam, Enhong Chen and Lintao Zhang  
*Proceedings of the 26th ACM Symposium on Operating Systems Principles (SOSP'17)*

**ClickNP: Highly Flexible and High-performance Network Processing with Reconfigurable Hardware**  
Bojie Li, Kun Tan, Layong (Larry) Luo, Yanqing Peng, Renqian Luo, Ningyi Xu, Yongqiang Xiong, Peng Cheng and Enhong Chen  
*Proceedings of the 2016 ACM conference on SIGCOMM (SIGCOMM'16)*

A full list of publications is available at <https://ring0.me/publications/>.

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## Research Experience (selected)

Efficient and Scalable Total-Order Message Scattering in DCN MICROSOFT RESEARCH ASIA  
**Submitted to OSDI'18** Aug '17 – present

- Leverage programmable switches in data centers to achieve scalable and efficient total order atomic one-to-many message scattering.
- Principle: Separate the bookkeeping of order information from message forwarding.
- Control plane: Aggregate ordering and loss information using in-network computation.
- Data plane: Forward messages as usual and reorders them at receiver-end based on order information.
- Improves throughput of a transactional key-value store by 10x.

IPC-Direct: Fast and Compatible Container Networking in User Space MICROSOFT RESEARCH ASIA  
**Submitted to OSDI'18, 1st place in Microsoft Hackathon 2017 (IT Pros Category)** July '17 – present

- A high performance user-space socket architecture that is compatible with existing applications.
- Regard processes as a distributed system that communicates via message passing.
- Use shared memory for intra-server sockets, RDMA for intra-datacenter and lwIP for WAN.
- Achieves kernel bypass, zero copy and synchronization free, preserves compatibility and isolation.
- ~5x end-to-end performance for Nginx, Node.js and memcached.

KV-Direct: High-Performance Key-Value Store with Programmable NIC MICROSOFT RESEARCH ASIA  
**SOSP '17 (Shanghai, China), first author, instructed by Dr. Lintao Zhang** May '16 – Apr '17

- Extends RDMA primitives to key-value operations, enabling remote direct key-value access to the main host memory. Also supports vector operations and user-defined functions.
- Achieves up to 180 M key-value operations per second per programmable NIC, equivalent to the throughput of 20 – 30 CPU cores. Built an 1.2 billion KV ops server with 10 NICs.
- Leverages PCIe bandwidth efficiently and hide PCIe latency with optimized hash table, slab allocator, out-pf-order execution, load dispatch and client-side batching.

- HTTPS Accelerator on FPGA MICROSOFT RESEARCH ASIA  
**Global 2nd place in Cloud and Enterprise, Microsoft Hackathon** *Mar. '16 – Aug. '16*
- An efficient and scalable implementation of RSA algorithm on FPGA. Implemented in ClickNP.
  - 12x RSA 2048 private key operations compared to OpenSSL on one CPU core. Accelerate TLS connections per second of Nginx server by 4 times.
  - Lead the project and work with [Tianyi Cui](#), won one of two global prizes among 100+ Hackathon projects in Microsoft Research Asia.
- ClickNP: High Performance and Flexible Packet Processing on FPGA MICROSOFT RESEARCH ASIA  
**SIGCOMM '16 (Florianopolis, Brazil), first author, instructed by Dr. Kun Tan** *July '15 – Jan. '16*
- The first FPGA-accelerated platform for general network functions, written completely in high-level language and achieving 40 Gbps line rate as well as  $< 2\mu s$  latency at any packet size.
  - Support high throughput (25Gbps) and low latency ( $1\mu s$ ) joint CPU-FPGA processing.
  - Implement the ClickNP tool-chain, which can integrate with various commercial HLS tools.
  - [Work with two undergraduates](#) to design and implement 100 elements and 5 network functions.
- Fault-tolerant Switch Software Architecture MICROSOFT RESEARCH ASIA  
**B.S. Dissertation in Computer Science, instructed by Dr. Kun Tan** *July '13 – May '14*
- Design and implementation of a fault-tolerant switch software architecture allowing any component to fail or upgrade without interrupting data plane.
  - The control plane will automatically recover within 1 minute after the failed component restarts.
  - Designed a daemon (SyncD) to virtualize lookup tables in a commodity programmable switching chip and resolve rule conflicts among clients.

## Recent Awards

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|--|-----------------|
| Microsoft Research Asia Fellowship Award                           | <i>Oct. '17</i> |
| China National Ph.D. Scholarship                                   | <i>Oct. '17</i> |
| Global 1st place in IT Pros Category, Microsoft Hackathon 2017     | <i>Aug. '17</i> |
| Most Impact Award in Beijing Venue, Microsoft Hackathon 2017       | <i>Aug. '17</i> |
| Best Presentation Award, MSRA Student Techfest 2016                | <i>Oct. '16</i> |
| Global 2nd place in Cloud and Enterprise, Microsoft Hackathon 2016 | <i>Aug. '16</i> |

## Invited Talks

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|---|----------------------------|
| University of Science and Technology of China             | <i>Hefei, Nov. '17</i>     |
| Fudan University  | <i>Shanghai, Nov. '17</i>  |
| The First Asia-Pacific Workshop on Networking (APNet '17) | <i>Hong Kong, Aug. '17</i> |
| China SDN Research Training Camp                          | <i>Nanjing, Jul. '17</i>   |
| Microsoft Research Asia Ph.D. Forum                       | <i>Beijing, Oct. '16</i>   |
| Tsinghua University Ph.D. Forum                           | <i>Beijing, Sept. '16</i>  |
| University of Science and Technology of China             | <i>Hefei, Aug. '16</i>     |

## Skills

- Software Programming:** C, Python, Bash.
- FPGA Programming:** OpenCL, Verilog.
- Linux:** Kernel development, Network management, Server diagnostics and performance tuning.
- Networking:** SmartNIC, Programming P4 and Broadcom switches (starter).
- Web development:** JavaScript, HTML, CSS, PHP, Node.js, Flask.