Songshi Dou

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CORE COMPETENCE

- Songshi Dou's research focuses on computer networks, including Software-Defined Networking (SDN), Network Function Virtualization (NFV), Data Center Network (DCN), and Content Delivery Network (CDN). He has published 5 journal/conference papers and owned/applied 5 Chinese patents.

EDUCATION

- **Beijing Institute of Technology** — Beijing, China
  Master of Control Engineering (Supervisor: Prof. Zehua Guo) — *Sept. 2019 - Present (Jul. 2022)*
- **North China Electric Power University** — Beijing, China
  Bachelor of Automation — *Sept. 2015 - Jul. 2019*

RESEARCH EXPERIENCES

- **Path Programmability Recovery in SD-WANs under Multiple Controller Failures** — Beijing, China
  Keywords: SDN, Wide Area Network, Control Failure, Path Programmability — *Sept. 2019 - Present*

  - [**Situation**]: SDN promises good network performance in Wide Area Networks (WANs) with the logically centralized control using physically distributed controllers. In Software-Defined WANs (SD-WANs), the flexible flow control of SDN comes from path programmability. Once a flow traverses an SDN switch, it becomes a programmable flow and is able to change its forwarding path. Under unpredictable issues, the controller may fail, and its controlled switches will be unmanageable and become offline. Thus, maintaining path programmability, which enables flexible path change on flows, is crucial for maintaining network performance under traffic variation.

  - [**Action**]: We propose to improve the path programmability in SD-WANs under multiple controller failures.

    1) For all circumstances, **Matchmaker** is proposed to adaptively adjust the control cost of offline switches based on the limited control resource by changing the paths of flows to realize proper offline switches remapping.

    2) If hybrid OpenFlow/OSPF mode is supported, **RetroFlow+** can be used to recover the flow programmability and achieve low communication overhead by intelligently configuring a set of selected offline switches working under the legacy routing mode; **ProgrammabilityMedic** recovers programmability by fine-grainedly selecting a routing mode for each offline flow at each offline switch to fit the given control resource from active controllers.

    3) If network slicing techniques (e.g., FlowVisor) are supported, **ProgrammabilityGuardian** is exhibited to recover all offline flows with the similar path programmability with fine-grained flow-level mappings.

  - [**Results**]: Three papers have been published or accepted (ICDCS'21, IWQoS'20, COMNET'21); Two papers are under revision (ToN); One paper is under review (COMMAG).

- **Traffic Engineering in SD-WANs with Scalable Routing** — Beijing, China
  Keywords: SDN, Wide Area Network, Traffic Engineering (TE), Crucial Flows — *Mar. 2020 - Mar. 2021*

  - [**Situation**]: The scalability issue hinders the deployment of SDN in the WANs. Existing solutions have two issues: (1) network performance relies on complicated controller synchronization, which increases the complexity of network control; (2) fine-grained flow processing enables flexible flow control at the cost of high processing load on the controllers and high flow table occupancy on switches.

  - [**Action**]: We propose **HybridFlow** to achieve good load balancing performance using a single controller with low control overhead, which mainly employs hybrid routing and crucial flow rerouting to reduce the processing load of controller by routing the critical flows (having critical impact on network performance) with the hybrid OpenFlow/OSPF mode.

  - [**Results**]: One paper has been published (TCOM'21).

- **Controller Placement and Switch-Controller Mapping in SD-WANs** — Beijing, China
  Keywords: SDN, Wide Area Network, Critical Programmability, Control Latency — *Apr. 2021 - Aug. 2021*

  - [**Situation**]: Control latency is a critical concern for deploying SDN into WANs. An SD-WAN can be divided into multiple domains controlled by multiple controllers with a logically centralized view. The control latency is related to the placement of controllers and mappings between switches and controllers. Existing solutions usually treat switches equally and consider the propagation delay between switches and controllers as the evaluation metric, which fails to consider many important factors of dynamic network states and leads to high control latency in real-world deployment.

  - [**Action**]: We propose **ProgrammabilityExplorer** to decide proper controller placement and switch-controller mapping realizing low control latency, which differentiates the impact of switches on the control operation by jointly considering the flow programmability and critical flows.

  - [**Results**]: One paper is under revision (ISJ).

- **Multipath-aware and Resource Efficiency Guarantee in Programmable DCNs**   Beijing, China
  Keywords: DCN, Rate Limiter, Multipath Flows, Performance Isolation   *Jun. 2021 - Aug. 2021*

  - **[Situation]:** Emerging cloud services and applications request different Quality of Service (QoS) using shared links in DCNs. To meet these various requirements, programmable switch-based rater limiters are introduced to provide performance isolation and benefit from easy control and fast deployment. However, existing programmable switch-based rate limiters have two limitations: (1) multipath flows (i.e., MultiPath TCP), which are widely used in DCNs, cannot be precisely limited, and (2) the control plane solution for rationally placing rate limiters in DCNs is missing, leading to poor performance isolation.

  - **[Action]:** We propose **RateSheriff** to to provide multipath flow-aware and resource-efficient rate limiter placement for programmable switch-enabled DCNs, which can identify and associate subflows to a multipath flow by extracting and comparing specific packets and header fields and place rate limiters for single-path flows and multipath flows individually to improve rate limiting performance and balance memory utilization among programmable switches.

  - **[Results]:** One paper is under review (INFOCOM).

- **Video Quality and Popularity-aware Video Caching in CDN**   Beijing, China
  Keywords: CDN, Video Caching, Quality of Experience (QoE)   *Jun. 2021 - Aug. 2021*

  - **[Situation]:** CDN is a popular service to accelerate object transmission by dynamically caching popular objects at cache points near users. However, a limited number of cache points are deployed with limited storage space and cannot cache all videos. Existing video caching schemes for CDN fail to consider some important components of Quality of Experience (QoE), leading to poor video caching performance.

  - **[Action]:** We introduce a new QoE metric called Video Hit Experience (VHE) that jointly considers the impact of video hit ratio and video quality on QoE, and propose **HERO** to improve QoE with both proactive module and reactive module.

  - **[Results]:** One paper has been accepted (ICWS'21).

Journal Papers

- [COMNET]: **Songshi Dou**, Guochun Miao, Zehua Guo, Chao Yao, Weiran Wu, and Yuanqing Xia, "Matchmaker: Maintaining Network Programmability for Software-Defined WANs under Multiple Controller Failures", *Elsevier Computer Networks*, vol. 192, p. 108045, 2021. [**pdf**]

- [TCOM]: Zehua Guo, **Songshi Dou**, Yi Wang, Sen Liu, Wendi Feng, and Yang Xu, "HybridFlow: Achieving Load Balancing in Software-Defined WANs with Scalable Routing", *IEEE Transactions on Communications*, vol. 69, no. 8, pp. 5255-5268, Aug. 2021. [**pdf**]

Conference Papers

- [ICDCS]: **Songshi Dou**, Zehua Guo, and Yuanqing Xia, "ProgrammabilityMedic: Predictable Path Programmability Recovery under Multiple Controller Failures in SD-WANs", *IEEE International Conference on Distributed Computing Systems 2021 (ICDCS'21)*. **(Accept Ratio: 97/489=19.8%)** [**pdf**]

- [IWQoS]: Zehua Guo, **Songshi Dou**, and Wenchao Jiang, "Improving the Path Programmability for Software-Defined WANs under Multiple Controller Failures", *IEEE/ACM International Symposium on Quality of Service 2020 (IWQoS'20)*. [**pdf**]

- [ICWS]: Yijun Sun, Zehua Guo, **Songshi Dou**, and Yuanqing Xia, "Video Quality and Popularity-aware Video Caching in Content Delivery Networks", *IEEE International Conference on Web Services 2021 (ICWS'21)*. [**pdf**]

Posters and Demos

- [ICNP]: Yijun Sun, Zehua Guo, **Songshi Dou**, Junjie Zhang, Changlin Li, and Xiang Ouyang, "Poster: Enabling Fast Forwarding in Hybrid Software-Defined Networks", *IEEE International Conference on Network Protocols 2021 (ICNP'21) Poster*.

Work In Progress

- [ToN]: Zehua Guo, **Songshi Dou**, Sen Liu, Wendi Feng, Wenchao Jiang, Yang Xu, and Zhi-Li Zhang, "Maintaining Control Resiliency and Flow Programmability in Software-Defined WANs During Controller Failures", *IEEE/ACM Transactions on Networking*, Minor Revision.

- [ToN]: Zehua Guo, **Songshi Dou**, and Wenchao Jiang, "Towards Improved Path Programmability Recovery for Software-Defined WANs under Multiple Controller Failures", *IEEE/ACM Transactions on Networking*, Major revision.

- [ISJ]: **Songshi Dou**, Zehua Guo, Li Qi, Yang Li, and Chao Yao, "Critical Programmability-aware Controller Placement and Switch-Controller Mapping in SD-WANs", *IEEE Systems Journal*, Major Revision.

- [INFOCOM]: **Songshi Dou**, Zehua Guo, Yongchao He, Sen Liu, and Wenfei Wu, "RateSheriff: Multipath Flow-aware and Resource Efficient Rate Limiter Placement for Programmable Data Center Networks", *IEEE International Conference on Computer Communications 2022 (INFOCOM'22)*, Under Review.

- [COMMAG]: Zehua Guo, and **Songshi Dou**, "Maintaining Path Programmability in Software-Defined Wide Area Networks under Controller Failure", *IEEE Communications Magazine*, Under Review.

- [JNCA]: Zehua Guo, Haoran Ni, **Songshi Dou**, Chao Yao, and Thar Baker, "Network Coding-based Resilient Routing for Maintaining Data Security and Availability in Software-Defined Networks", *Elsevier Journal of Network and Computer Applications*, Under Review.

- [INFOCOM]: Yuntian Zhang, Ning Han, Zehua Guo, Junjie Zhang, **Songshi Dou**, Minghao Ye, and Tengteng Zhu, "Traffic Engineering-centric Traffic Matrix Prediction", *IEEE International Conference on Computer Communications 2022 (INFOCOM'22)*, Under Review.

PATENTS

- Zehua Guo, and **Songshi Dou**, "Optimizing Flow Programmability under Multiple Controller Failures in Software-Defined Networks", Chinese Patent, ZL202010544094.4.

- Zehua Guo, Penghao Sun, **Songshi Dou**, Yutian Zhang, Ning Han, and Yuanqing Xia, "Deep Reinforcement Learning-based Data Center Network Energy Management and Quality of Service Optimization Method", Chinese Patent, ZL202010308862.6.

- Zehua Guo, **Songshi Dou**, and Yuanqing Xia "A Scalable Routing Method for Realizing Load Balancing in Software-Defined Wide Area Networks", Chinese Patent, Application Number: 202010974299.6.

- Zehua Guo, Penghao Sun, **Songshi Dou**, Yuanqing Xia, and Honghai Ji, "A Load Balancing Method for Multi-Controller in Software-Defined Networking", Chinese Patent, Application Number: 202010094237.6.

- Zehua Guo, Yutian Zhang, Ning Han, and **Songshi Dou**, "A Traffic Engineering-centric Traffic Matrix Pridiction Method", Chinese Patent, Application Number: 202110810615.0.

PROJECTS

National Science Foundation of China, Main Participant	Beijing, China
Research on the Path Programmability Recovery of Software-Defined Wide Area Networks during Multiple Controller Failures	*Jan. 2021 - Present*
BIT Research Fund Program for Young Scholars, Main Participant	Beijing, China
Enabling Resiliency Control of Software-Defined Networks	*Jul. 2019 - Present*

HONORS AND AWARDS

OSDI 2021 Student Grant, USENIX	*2021*
ICDCS 2021 Student Registration Award, IEEE Computer Society TCDP	*2021*
CNCC 2020 Student Registration Award, China Computer Federation (CCF)	*2020*
Third Prize of China Post-Graduate Mathematical Contest in Modeling, China	*2020*
First-class Master Student Scholarship Award, Beijing Institute of Technology	*2019*
Bachelor Student Scholarship Award, North China Electric Power University	*2015, 2016, 2017*

TALKS AND PRESENTATIONS

IEEE International Conference on Distributed Computing Systems (ICDCS) 2021 [slides]	Online
ProgrammabilityMedic: Predictable Path Programmability Recovery under Multiple Controller Failures in SD-WANs	*Jul. 2021*
IEEE/ACM International Symposium on Quality of Service (IWQoS) 2020 [slides]	Online
Improving the Path Programmability for Software-Defined WANs under Multiple Controller Failures	*Jun. 2020*

LANGUAGES

- IELTS: 7 (L: 7.5, R: 8.0, W: 6.5, S: 6.0)

SKILLS

- Programming: Python, C-programming, Matlab, VB

- Tools: LaTeX, Linux, SDN theory