Siva Kesava Reddy KAKARLA

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Senior Researcher, Microsoft Research

Interested in researching all aspects of the design and implementation of high-performance network automation tools with insights from verification, testing, anomaly detection, algorithms, and automata theory.

Employment

Microsoft Senior Researcher — Aug '22 — Present
Redmond, WA Networking Research Group • Microsoft Research (MSR)

Education

M. S. , Ph. D. (UCLA) Computer Science — Fall '17 — Spring '22
Advisors: Prof. Todd Millstein and Prof. George Varghese
GPA: 4.0 / 4.0
University of California, Los Angeles • CA, USA

B. Tech. (IIT-Kgp) Computer Science and Engineering (with Honors) — Fall '13 — Spring '17
GPA: 9.67 / 10.0
Indian Institute of Technology, Kharagpur • India

Selected Awards

SIGCOMM ACM SIGCOMM Dissertation Honorable Mention — 2023
Runner up of the SIGCOMM Doctoral Dissertation Award for Outstanding PhD Thesis in Computer Networking and Data Communication. "The committee found the research impressively rigorous and thorough, and of critical importance to Internet security."

ANRP IRTF/IETF Applied Networking Research Prize — 2023
For the work on checking the correctness of DNS nameservers.

UCLA Outstanding Graduate Student Research Award — 2022
One of 4 recipients across all of graduate computer science students.

UCLA Dissertation Year Fellowship (DYF) — 2021 — 2022
Awarded to students planning to teach or be in research after their graduation.

Meta Facebook PhD Fellowship Award Finalist (In top 3.5% of applicants worldwide) — 2021
"Fellowship supports exceptional PhDs in a variety of technology research domains."

SIGCOMM Best Student Paper Award — 2020
For the first work on formally modeling the Domain Name System (DNS).

UCLA Dean's Graduate Student Research (GSR) Fellowship — 2018 — 2019
Supported by UCLA graduate Dean for the 2018—2019 academic year.

UCLA Graduate Dean's Scholar Award (GDSA) — 2017
Awarded to department's top incoming PhD student. "To enhance UCLA's competitiveness for the most highly recruited doctoral students admitted to the department."

Publications

HotNets '24 **Towards Safer Heuristics With $\mathcal{X}$plain**
Pantea Karimi, Solal Pirelli, Siva Kesava Reddy Kakarla, Ryan Beckett, Santiago Segarra, Beibin Li, Pooria Namyar, Behnaz Arzani.
Proceedings of the 23rd ACM Workshop on Hot Topics in Networks, HotNets 2024, pages 68–76.

HotNets '24 **End-to-End Performance Analysis of Learning-enabled Systems**
Pooria Namyar, Michael Schapira, Ramesh Govindan, Santiago Segarra, Ryan Beckett, Siva Kesava Reddy Kakarla, Behnaz Arzani.
Proceedings of the 23rd ACM Workshop on Hot Topics in Networks, HotNets 2024, pages 86–94.

SIGCOMM '24 **Rethinking Machine Learning Collective Communication as a Multi-Commodity Flow Problem (TE-CCL).**
Xuting Liu, Behnaz Arzani, Siva Kesava Reddy Kakarla, Liangyu Zhao, Vincent Liu, Miguel Castro, Srikanth Kandula, Luke Marshall.
Proceedings of the ACM SIGCOMM 2024 Conference, pages 16–37.

PLDI '24 **DIFFY: Data-driven Bug Finding for Configurations**
Siva Kesava Reddy Kakarla, Francis Y. Yan, Ryan Beckett.
Proceedings of the ACM on Programming Languages, Volume 8, Issue PLDI, Article 155.

NSDI '24 **MESSI: High-Coverage Testing for BGP Implementations.**
Rathin Singha, Rajdeep Mondal, Ryan Beckett, Siva Kesava Reddy Kakarla, Todd Millstein, George Varghese.
Proceedings of the 21st USENIX Symposium on Networked Systems Design and Implementation, NSDI 2024, pages 1009–1023.

arXiv '23 **Oracle-based Protocol Testing with Eywa.**
Siva Kesava Reddy Kakarla, Ryan Beckett.
CoRR, abs-2312-06875.

HotNets '23 **A Holistic View of AI-driven Network Incident Management.**
Pouya Hamadanian, Behnaz Arzani, Sadjad Fouladi, Siva Kesava Reddy Kakarla, Rodrigo Fonseca, Denizcan Billor, Ahmad Cheema, Edet Nkposong, Ranveer Chandra.
Proceedings of the 20th ACM Workshop on Hot Topics in Networks, HotNets 2021, pages 116–122.

NSDI '22 **SCALE: Automatically Finding RFC Compliance Bugs in DNS Nameservers.**
Invited for an article in ⟨USENIX ;login: Magazine⟩
⟨IRTF/IETF Applied Networking Research Prize (ANRP)⟩
Siva Kesava Reddy Kakarla, Ryan Beckett, Todd Millstein, George Varghese.
Proceedings of the 19th USENIX Symposium on Networked Systems Design and Implementation, NSDI 2022, pages 307–323.

HotNets '21 **How Complex is DNS?**
Siva Kesava Reddy Kakarla, Ryan Beckett, Todd Millstein, George Varghese.
Proceedings of the 20th ACM Workshop on Hot Topics in Networks, HotNets 2021, pages 116-122.

SIGCOMM '21 **CAMPION: Debugging Router Configuration Differences.**
Alan Tang, Siva Kesava Reddy Kakarla, Ryan Beckett, Ennan Zhai, Matt Brown, Todd Millstein, Yuval Tamir, George Varghese.
Proceedings of the ACM SIGCOMM 2021 Conference, pages 748–761.

SIGCOMM '20 **GROOT: Proactive Verification of DNS Configurations.**
⟨Best Student Paper Award⟩
Siva Kesava Reddy Kakarla, Ryan Beckett, Behnaz Arzani, Todd Millstein, George Varghese.
Proceedings of the Conference of the ACM Special Interest Group on Data Communication, SIGCOMM 2020, pages 310–328.

NSDI '20 **Finding Network Misconfigurations by Automatic Template Inference (SELFSTARTER).**
Siva Kesava Reddy Kakarla, Alan Tang, Ryan Beckett, Karthick Jayaraman, Todd Millstein, Yuval Tamir, George Varghese.
Proceedings of the 17th USENIX Symposium on Networked Systems Design and Implementation, NSDI 2020, pages 999–1013.

arXiv '19 **Expect More from the Network: DDoS Mitigation by FITT in Named Data Networking.**
Zhiyi Zhang, Vishrant Vasavada, Siva Kesava Reddy Kakarla, Eric Osterweil, and Lixia Zhang.

CoRR, abs-1902-09033.

GLOBECOM '17 **IEEE 802.11ac DBCA: A Tug of War between Channel Utilization and Fairness.**
Mahankali Saketh, Siva Kesava Reddy Kakarla, Raja Karmakar, Samiran Chattopadhyay, Sandip Chakraborty.
Proceedings of the IEEE Global Communications Conference, 2017, pages 1–6.

Mentoring (Interns)

MIT	Pantea Karimi – Joint with Behnaz Arzani, Ryan Beckett	2024
EPFL	Solal Pirelli – Joint with Behnaz Arzani, Ryan Beckett	2023
UCLA	Rathin Singha – Joint with Ryan Beckett, Nikolaj Bjørner	2023
UPenn	Xuting Liu – Joint with Behnaz Arzani	2023

Academic Service

CoNEXT	Program Committee Member	2025
NSDI	Program Committee Member	2025
CoNEXT	Program Committee Member	2024
ANRW	Applied Networking Research Workshop Program Committee Member	2024
SIGCOMM	Judge for the ACM SIGCOMM Student Research Competition (SRC)	2023
SIGCOMM	Poster/Demo track Program Committee Member	2023
ANRW	Applied Networking Research Workshop Program Committee Member	2023
SIGCOMM	Artifact Evaluation Committee Member	2022
SIGCOMM	Artifact Evaluation Committee Member	2021

Research Tools Impact

DIFFY
- A push-button configuration analyzer that detects likely bugs in structured configurations by learning a template with "holes" from example configurations to capture variations and using unsupervised learning to find anomalous parameter as likely bugs
- Uses a novel template synthesis algorithm to extract similarities in JSON configurations by minimizing a regular-expression-aware edit distance with dynamic programming
- Scales to analyze thousands of configurations within seconds, outperforming existing tools by 2–3 orders of magnitude, and identified a bug in a protocol timer value that previously caused a major outage in a Microsoft's WAN

TE-CCL
- Optimizes collective communication (AllGather and AlltoAll) using a traffic-engineering-based approach, improving scalability without compromising solution quality.
- Achieves $2\times$ better performance than the prior state-of-the-art (TACCL) on supported topologies while scaling to larger topologies.
- Outperforms TACCL by $2.14\times$ and RCCL by $3.18\times$ in algorithm bandwidth on a testbed.

MESSI
- Automatically tests black-box BGP implementations using a model-based approach, addressing challenges like BGP's stateful nature and complex structures in route maps.
- Discovered **22** correctness bugs across 5 widely used BGP implementations (FRR, Quagga, GoBGP, BIRD, Batfish), of which 8 are already fixed
- Found 18 previously unknown bugs, with issues spanning route-map logic, route aggregation, and community lists, demonstrating gaps even in mature implementations

FERRET
- Performs automated testing of DNS nameserver implementations by using symbolic execution of the DNS formal model
- Scales better than symbolic testing and finds deeper (RFC violation) bugs than fuzz testing
- Found **30** bugs across 8 different open-sourced DNS implementations, including popular implementations such as Bind, PowerDNS, Knot, and NSD, of which **20** are fixed
- Found a critical vulnerability where an attacker with little effort could **crash** Bind nameservers and resolvers remotely (High-severity rated CVE-2021-25215)
- Found **4** bugs in Amazon Route 53 DNS implementation (tests now part of CI/CD pipeline)

GROOT
- Verifies efficiently that a property of interest holds for all possible DNS queries by reducing the extremely large space of possible queries to a smaller set of *query equivalence classes*
- Found multiple issues of delegation inconsistencies, cyclic zone dependencies, and rewrite blackholing in minutes in the Microsoft zone files with over 500k records
- Revealed **109** new bugs in 10 seconds in a large campus network with over a hundred thousand records
- Found around **160k** issues of blackholing in 3 minutes, which initiated a cleanup of the zone files of a large CDN with over 3.5 million records

SELFSTARTER
- Automatically finds configuration errors without a specification via a form of outlier detection on inferred templates
- Found **33** route policies with previously unknown bugs in the Microsoft wide area network
- Inferred templates provide *actionable* feedback to the operators to remediate the errors

Work Experience

Amazon (Intern) — Finding DNS RFC Compliance Errors in Amazon Route 53 DNS
with *John Backes*, Automated Reasoning Group • Remote — Sep '21 — Dec '21

Google (Intern) — Finding Topology Errors by Graph Templating of Google Networks
with *Jayaram Mudigonda and Anees Shaikh*, NetInfra Group • Remote — Jun '20 — Sep '20

Microsoft (Part-Time Contract) — Verification of DNS Configurations
with *Ryan Beckett and Behnaz Arzani*, MNR Group • Remote — Oct '19 — Feb '20

Microsoft (Intern) — Verification of DNS Configurations
with *Ryan Beckett and Behnaz Arzani*, MNR Group • Redmond, WA — Jun '19 — Sep '19

UCLA (Teaching Assistant) — CS 118 – Computer Network Fundamentals
with *Prof. George Varghese* • Los Angeles, CA — Sep '19 — Dec '19

UCLA (Graduate RA) — Formal Methods for a Robust DNS
with *Prof. Todd Millstein and Prof. George Varghese* • Los Angeles, CA — Sep '19 — Jun '22

UCLA (Graduate RA) — Misconfigurations by Template Inference
with *Prof. Todd Millstein and Prof. George Varghese* • Los Angeles, CA — Sep '17 — Jun '19

IIT-Kgp (Undegraduate RA) — Does QUIC Kill Your Data Plan? A View Using YouTube Adaptive Streaming Clients
with *Prof. Sandip Chakraborty*, Complex Network Research Group • India — Aug '16 — Apr '17

LinkedIn (Intern) — Enhancement of LinkedIn spam detection tool with Mockito tests
with *Prashanth Nimmagadda*, Content Filtering Team • India — May '16 — Jul '16

IISc Bangalore (Intern) — Experimenting with Akka Package
with *Prof. Komondoor V. Raghavan*, Compilers, PL and SE Group • India — May '15 — Jul '15

Selected Talks

Hedge Podcast — Recorded an episode for the podcast discussing the DNS complexity — Jun '22

DNS-OARC 37 — Find Bugs in your DNS Zone files Before Deployment with GROOT — Feb '22

UCLA Seminar	Formal Methods for a Robust DNS	Jan '22
NetVerify 2021	Exploiting Formal Methods To make Domain Name System More Robust (Network Verification Workshop in conjunction with the 29th IEEE ICNP 2021)	Nov '21
DNS-OARC 35	“So you think your Nameservers are Correct?”: Finding Errors Automatically in Nameserver Implementations	May '21