Arpan Gujarati

Research Interests

Real-time systems, distributed systems, fault tolerance, reliability analysis, and scheduling

Education

2014–2020 **Ph.D. in Computer Science (*Summa Cum Laude*)**
Max Planck Institute for Software Systems (MPI-SWS), Saarbrücken/Kaiserslautern, Germany
and Technical University of Kaiserslautern (TU-KL), Kaiserslautern, Germany
Advisor: Björn B. Brandenburg (head of the Real-Time Systems Group at MPI-SWS)
Thesis: *Towards "Ultra-Reliable" CPS: Reliability Analysis of Distributed Real-Time Systems*
(submitted in December 2019, defended in October 2020)

2012–2014 **Preparatory Phase (Graduate Coursework)**
Max Planck Institute for Software Systems (MPI-SWS), Saarbrücken/Kaiserslautern, Germany
and Saarland University (UdS), Saarbrücken, Germany

2007–2011 **B.E. (Hons.) in Computer Science**
Birla Institute of Technology and Science (BITS), Pilani, India

Work Experience

2021 **Research Associate**
Computer Science Department, University of British Columbia (UBC), Vancouver, Canada
Mentor: Margo Seltzer
Focus areas: Securing industrial cyber-physical systems like robotic arms

2020–2021 **Postdoctoral Researcher**
Max Planck Institute for Software Systems (MPI-SWS), Saarbrücken/Kaiserslautern, Germany
Advisor: Jonathan Mace
Focus areas: Building efficient systems for deep neural network inference serving in cloud

2012–2019 **Graduate Research Assistant**
Max Planck Institute for Software Systems (MPI-SWS), Saarbrücken/Kaiserslautern, Germany
Advisor: Björn B. Brandenburg
Focus areas: Scheduling and fault-tolerance in real-time systems

2015 **Research Intern (three months)**
Microsoft Research, Redmond, WA, USA
Mentors: Kathryn S. McKinley, Sameh Elnikety, Yuxiong He
Focus areas: Distributed autoscaling of machine learning inference services

2011–2012 **Software Development Engineer**
Cloud Networking Group, Citrix R&D, Bengaluru, India
Manager: Sanjay Gupta
Focus areas: Management Service VM for the Xen Server

2011 **Software Development Intern**
Visual and Parallel Computing Group, Intel, Bengaluru, India
Team: Display Features and Miniport
Focus areas: Prototype code optimizations for kernel-mode graphics drivers

Honors and Awards

QRS'21 **Best Paper Award**
21st IEEE International Conference on Software, Quality, Reliability, and Security

SIGBED'21 **Paul Caspi Memorial Dissertation Award**
ACM Special Interest Group on Embedded Systems

SYSTOR'21 **Distinguished Reviewer Award**
14th ACM International System and Storage Conference

OSDI'20 **Distinguished Artifact Award**
14th USENIX Symposium on Operating Systems Design and Implementation

RTAS'20 **Distinguished Paper Award**
26th IEEE Real-Time and Embedded Technology and Applications Symposium

ECRTS'18 **Best Presentation Award**
30th Euromicro Conference on Real-Time Systems

Middleware'17 **Best Student Paper Award**
18th ACM/IFIP/USENIX International Middleware Conference

HLF'14 **Young Researcher**
2nd Heidelberg Laureate Forum

ECRTS'13 **Outstanding Paper Award**
25th Euromicro Conference on Real-Time Systems

Invited Talks

2020 **Serving DNNs like Clockwork: Performance Predictability from the Bottom Up**
Brown University (virtual). Host: Malte Schwarzkopf

2020 **Towards "Ultra-Reliable" CPS: Reliability Analysis of Distributed Real-Time Systems**
George Mason University. Host: Hakan Aydin
Washington University at St. Louis. Host: Sanjoy Baruah
Oregon State University (virtual). Host: Rakesh Bobba
IMDEA Software Institute (virtual). Host: Manuel Hermenegildo

2019 **Towards "Ultra-Reliable" CPS: Reliability Analysis of Distributed Real-Time Systems**
George Washington University. Host: Gabriel Parmer
University of Pennsylvania. Host: Linh Thi Xuan Phan

Publications

Conference Publications

DSN'22 **Arming IDS Researchers with a Robotic Arm Dataset**
Arpan Gujarati, Zainab Saeed Wattoo, Maryam Aliabadi, Sean Clark, Xiaoman Liu, Parisa Shiri, Amee Trivedi, Ruizhe Zhu, Jason Hein, and Margo Seltzer
52nd IEEE/IFIP International Conference on Dependable Systems and Networks

DSN'22 **The Fault in Our Data Stars: Studying Mitigation Techniques against Faulty Training Data in ML Applications**
Abraham Chan, Arpan Gujarati, Karthik Pattabiraman, and Sathish Gopalakrishnan
52nd IEEE/IFIP International Conference on Dependable Systems and Networks

QRS'21 **Understanding the Resilience of Neural Network Ensembles against Faulty Training Data**
Abraham Chan, Niranjhana Narayanan, Arpan Gujarati, Karthik Pattabiraman, and Sathish Gopalakrishnan
21st IEEE International Conference on Software, Quality, Reliability, and Security (virtual)

OSDI'20 **Serving DNNs like Clockwork: Performance Predictability from the Bottom Up**
Arpan Gujarati, Reza Karimi, Safya Alzayat, Wei Hao, Antoine Kaufmann, Ymir Vigfusson, and Jonathan Mace
14th USENIX Symposium on Operating Systems Design and Implementation (virtual)

RTAS'20 **Real-Time Replica Consistency over Ethernet with Reliability Bounds**
Arpan Gujarati, Sergey Bozhko, and Björn B. Brandenburg
26th IEEE Real-Time and Embedded Technology and Applications Symposium (virtual)

ECRTS'19 **From Iteration to System Failure: Characterizing the FITness of Periodic Weakly-Hard Systems**
Arpan Gujarati, Mitra Nasri, Rupak Majumdar, and Björn B. Brandenburg
31th Euromicro Conference on Real-Time Systems, Stuttgart, Germany

ECRTS'18 **Quantifying the Resiliency of Fail-Operational Real-Time Networked Control Systems**
Arpan Gujarati, Mitra Nasri, and Björn B. Brandenburg
30th Euromicro Conference on Real-Time Systems, Barcelona, Spain

EuroSys'18 **Tableau: A High-Throughput and Predictable VM Scheduler for High-Density Workloads**
Manohar Vanga, Arpan Gujarati, and Björn B. Brandenburg
13th European Conference on Computer Systems, Porto, Portugal

Middleware'17 **Swayam: Distributed Autoscaling to Meet SLAs of Machine Learning Inference Services with Resource Efficiency**
Arpan Gujarati, Sameh Elnikety, Yuxiong He, Kathryn S. McKinley, and Björn B. Brandenburg
18th ACM/IFIP/USENIX International Middleware Conference, Las Vegas, USA

RTSS'15 **When is CAN the Weakest Link? A Bound on Failures-In-Time in CAN-Based Real-Time Systems**
Arpan Gujarati and Björn B. Brandenburg
36th IEEE Real-Time Systems Symposium, San Antonio, USA

RTSS'14 **Linux's Processor Affinity API, Refined: Shifting Real-Time Tasks towards Higher Schedulability**
Felipe Cerqueira, Arpan Gujarati, and Björn B. Brandenburg
35th IEEE Real-Time Systems Symposium, Rome, Italy

ECRTS'13 **Schedulability Analysis of the Linux Push and Pull Scheduler with Arbitrary Processor Affinities**
Arpan Gujarati, Felipe Cerqueira, and Björn B. Brandenburg
25th Euromicro Conference on Real-Time Systems, Paris, France

Journal Publications

RTS'18 **Correspondence Article: A Correction of the Reduction-Based Schedulability Analysis for APA Scheduling**
Arpan Gujarati, Felipe Cerqueira, Björn B. Brandenburg, and Geoffrey Nelissen
Real-Time Systems, August 2018

RTS'15 **Multiprocessor Real-Time Scheduling with Arbitrary Processor Affinities: From Practice to Theory**
Arpan Gujarati, Felipe Cerqueira, and Björn B. Brandenburg
Real-Time Systems, Volume 51, Issue 4, pp. 440–483. Springer Verlag, 2015

Workshop and Work-in-Progress Publications

WoSoCER'20 **New Wine in an Old Bottle: N-Version Programming for Machine Learning Components**
Arpan Gujarati, Sathish Gopalakrishnan, and Karthik Pattabiraman,
10th IEEE International Workshop on Software Certification (virtual)

EMSOFT'19 **Work-in-Progress: Achal: Building Highly Reliable Networked Control Systems**
Malte Appel, Arpan Gujarati, and Björn B. Brandenburg,
15th ACM International Conference on Embedded Software, New York City, USA

CERTS'18 **Using Schedule-Abstraction Graphs for the Analysis of CAN Message Response Times**
Mitra Nasri, Arpan Gujarati, and Björn B. Brandenburg
3rd Workshop on Security and Dependability of Critical Embedded Real-Time Systems, Luxembourg

CERTS'17 **Lower-Bounding the MTTF for Systems with (m, k) Constraints and IID Iteration Failure Probabilities**
Arpan Gujarati, Mitra Nasri, and Björn B. Brandenburg
2nd Workshop on Security and Dependability of Critical Embedded Real-Time Systems, Paris, France

CERTS'17 **A Byzantine Fault-Tolerant Key-Value Store for Safety-Critical Distributed Real-Time Systems**
Malte Appel, Arpan Gujarati, and Björn B. Brandenburg,
2nd Workshop on Security and Dependability of Critical Embedded Real-Time Systems, Paris, France

Professional Activities

Technical Program Committee

RTAS Real-Time and Embedded Technology and Applications Symposium (2022)

RTSS Real-Time Systems Symposium (2021, 2022)

SYSTOR	International Systems and Storage Conference (2021, 2022)
ICDCS	International Conference on Distributed Computing Systems (2021)
Middleware	International Middleware Conference, Doctoral Symposium (2020)
ECRTS AE	Euromicro Conference on Real-Time Systems, Artifact Evaluation (2019)
RTAS BP	Real-Time and Embedded Technology and Applications Symposium, Brief Presentations (2019)
RTEST WiP	Real-Time and Embedded Systems and Technologies, Work-in-Progress (2018)

Journal Reviewer

RTS	Real-Time Systems: The International Journal of Time-Critical Computing Systems (2022)
JSys	Journal of Systems Research (2021)
TECS	ACM Transactions on Embedded Computing Systems (2019, 2020)
TDSC	IEEE Transactions on Dependable and Secure Computing (2019)

External Reviewer

ECRTS	Euromicro Conference on Real-Time Systems (2013–2015, 2019)
EMSOFT	ACM International Conference on Embedded Software (2020)
EuroSys	European Conference on Computer Systems (2013, 2016, 2019)
Middleware	ACM/IFIP International Middleware Conference (2018)
RTAS	IEEE Real-Time and Embedded Technology and Applications Symposium (2013, 2014, 2016)
RTNS	International Conference on Real-Time Networks and Systems (2014–2016)
RTSS	IEEE Real-Time Systems Symposium (2013, 2016, 2018, 2020)
SYSTOR	ACM International Systems and Storage Conference (2015, 2016)

Teaching Experience

2022 **Sessional Lecturer, Real-Time System Design (CPEN 432)**, Department of Electrical and Computer Engineering, University of British Columbia

2017 **Teaching Assistant, Operating Systems**, MPI-SWS and Saarland University

2016 **Teaching Assistant, Distributed Systems**, MPI-SWS and Saarland University

2014 **Teaching Assistant, Foundations of Cyber-Physical Systems**, MPI-SWS and TU-KL

2010 **Teaching Assistant, Data Structures and Algorithms**, BITS Pilani

Advising

2017-2018 **Malte Appel (UdS)**
Undergraduate thesis: *A BFT Key-Value Store for Safety-Critical Distributed Real-Time Systems*

2016 **Rohith R (BITS Pilani)**
Summer internship: *An Empirical Evaluation of the Temporal Behavior of Linux's CFS Scheduler*

2015 **Akshay Aggarwal (IIT Kanpur)**
Summer internship: *An Analysis of CAN in the Presence of Host and Network Faults*