

Geoff Kuenning
Professor
Harvey Mudd College
1673 Kenyon Pl
Claremont, CA 91711-2905 USA
+1 909 607-1610 / geoff@cs.hmc.edu

Education

- 1997 Ph.D., Computer Science, University of California, Los Angeles.
1974 M.S., Computer Science, Michigan State University, 1974. Minor: Linguistics.
1973 B.S. *cum laude*, Computer Science and Electrical Engineering, Michigan State University, 1973.
Minor: Music theory.

Areas of Research

File systems, distributed and replicated systems, computer systems tracing, performance measurement, solid-state storage, experimental methodology.

Appointments

- 2020–2021 **Director of Computer Science Clinic**, Harvey Mudd College
2011–2017 **Director of Computer Science Clinic**, Harvey Mudd College
2010– **Professor**, Harvey Mudd College
2005–2006 **Acting Director of Computer Science Clinic**, Harvey Mudd College
2004–2010 **Associate Professor**, Harvey Mudd College
1998–2004 **Assistant Professor**, Harvey Mudd College
1998–2003 **Consultant**, UCLA LASR research group
1984– **Principal Consultant**, Interrupt Technology Corporation

Research Grants

- 2019–2023 *Optimizing and Understanding Large Parameter Spaces in Storage Systems*, NSF.
2017–2023 *National File System Trace Repository*, NSF.
2013–2016 *Workload-Aware Storage Architectures for Optimal Performance and Energy Efficiency*, NSF.
2013–2016 *National File System Trace Repository*, NSF.
2014 *Big Data, Small Energy*, Rose Hills Foundation.
2013 *Fundamental Advance in National and International Cyber Security Curricula for Core Computer Science and Engineering Classes*, Intel Corporation.
2009–2012 *Modular CS1 from the Inside Out: Computational Thinking for all STEM Students*, NSF.
2009–2012 *Performance- and Energy-Aware HEC Storage Stacks*, NSF.
2009–2011 *File System Trace Repository*, NSF.
2006–2008 *File System Trace Repository*, NSF.
2003 *Analysis of Operating System Scheduler Behavior*, Beckman Foundation.
2001 *Support Tools for Memory-Based Filesystem*, NSF.
1999 *Active-Network Applications*, Beckman Foundation.

- 1997 *Investigation of clustering methods*, Microsoft Corporation.
1994–1996 *TRAVLER mobile computing project*, ARPA, 1994–1996 (under supervision of G. Popek).

Teaching History

Undergraduate Courses Taught

Data Structures and Program Development; Architecture and Operating Systems; Computer Systems; Advanced Operating Systems; Computer Systems Performance Analysis; Advanced Computer Architecture; Introduction to Computer Science; File Systems; Introduction to Academic Writing

One-Day Courses Taught

Experimental Methodology for Software Systems.

Graduate Courses Taught

Experimental Methodology for Software Systems.

Industry Courses Taught

X Windows Internals, Unix Kernel Internals.

Honors and Awards

- 2021 ACM Lifetime Member
2016 IEEE Life Member
2015 NCWIT EngageCSEdu Engagement Excellence Award
2000 Outstanding Reviewer, IEEE Internet Computing Magazine
1997 UCLA Engineering Achievement Award
1989 UCLA Chancellor’s Fellow in Computer Science

Professional Service

Chair, ACM Transactions on Storage Editor-in-Chief search, 2022
Steering Committee, Usenix Annual Technical Conference (ATC), 2019–
Co-chair, Usenix Annual Technical Conference (ATC), 2021
Associate Editor, ACM Transactions on Storage, 2019–
Steering Committee, Usenix Conference on File and Storage Technologies (FAST), 2016–
Guest Editor, ACM Transactions on Storage, 2017.
Co-chair, 15th Usenix Conference on File and Storage Technologies (FAST), 2017
Co-chair, SNIA I/O Tools, Traces, and Analysis Working Group, 2007–
NSF Panelist (2004, 2005, 2005, 2010, 2014, 2017, 2022)

Refereeing: ACM Mobile Computing and Communications Review; ACM Symposium on Applied Computing; ACM Symposium on Operating Systems Principles (SOSP); ACM Transactions on Dependable and Secure Computing; ACM Transactions on Storage; CPSR Student Essay Contest; Encyclopedia of Computer Science; IEEE Computer; IEEE Infocom; IEEE Internet Computing; IEEE Personal Technologies; IEEE Transactions on Computers; IEEE Wireless Networks; International Journal of Computers and Applications; Mobicom; SIGCSE Annual Conference; Software—Practice and Experience; Symposium on Applied Corporate Computing; Usenix Annual Technical Conference (ATC); Usenix Conference on File and Storage Technologies (FAST)

Program committees: ACM Conference on Systems and Storage (SYSTOR); International Workshop on Active Middleware Services; SustainIT Workshop; Usenix Annual Technical Conference (ATC); Usenix Conference on File and Storage Technologies (FAST); Usenix Conference on Hot Topics in Storage Systems (HOTSTORAGE); Usenix Symposium on Internet Technologies and Systems (USITS)

Treasurer, ACM Symposium on Operating Systems Principles (SOSP), 2009

Professional Organizations

ACM, IEEE Computer Society, Usenix, PFIR, EFF, Sigma Xi, SIGOPS, SIGMETRICS

Citizenship

United States Citizen

Languages

Fluent in English and German; some French and Italian

Expert Witness

- 2014 *Riverbed Technology, Inc., v. Silver Peak Systems, Inc.*, Case IPR2014-00245, United States Patent Trial and Appeal Board
- 2005 *Research in Motion, Ltd., v. InPro Licensing S.A.R.L.*
- 2003 *Interealty v. MRMLS*
- 2000 *Sun Microsystems v. Microsoft Corp.* (no action filed)
- 1992 *Digital Equipment Corp. v. Clearpoint Research Corp.*, Civil Action No. 91-11344-H, Federal District Court (Mass.)

Publications

Refereed Journals

- [1] Anjul Tyagi, Tyler Estro, Geoff Kuenning, Erez Zadok, and Klaus Mueller. PC-Expo: A metrics-based interactive axes reordering method for parallel coordinate displays. *IEEE Transactions on Visualization and Computer Graphics*, 29(1):712–722, January 2023.
- [2] Zhen “Jason” Sun, Geoff Kuenning, Sonam Mandal, Philip Shilane, Vasily Tarasov, Nong Xiao, and Erez Zadok. Cluster and single-node analysis of long-term deduplication patterns. *ACM Transactions on Storage*, 14(2), May 2018.
- [3] Ming Chen, Geetika Babu Bangera, Dean Hildebrand, Farhaan Jalia, Geoff Kuenning, Henry Nelson, and Erez Zadok. vNFS: Maximizing NFS performance with compounds and vectorized I/O. *ACM Transactions on Storage*, 13(3):21:1–21:24, 2017.
- [4] Sarah Diesburg, Christopher Meyers, Mark Stanovich, An-I Andy Wang, and Geoff Kuenning. TrueErase: Leveraging an auxiliary data path for per-file secure deletion. *ACM Transactions on Storage*, 12(4), August 2016.
- [5] Charles Weddle, Mathew Oldham, Jin Qian, An-I Andy Wang, Peter Reiher, and Geoff Kuenning. PARAD: A gear-shifting power-aware RAID. *ACM Transactions on Storage*, 3(3), October 2007.
- [6] An-I Andy Wang, Geoff Kuenning, and Peter Reiher. Using permuted states and validated simulation to analyze conflict rates in optimistic replication. *SCS Simulation: Transactions of the Society for Modeling and Simulation International*, 83(8):551–569, August 2007.
- [7] An-I Andy Wang, Geoff Kuenning, Peter Reiher, and Gerald Popek. The Conquest file system: Better performance through a disk/persistent-RAM hybrid design. *ACM Transactions on Storage*, 2(3):309–348, August 2006.

- [8] Nam T. Nguyen, An-I Andy Wang, Peter Reiher, and Geoff Kuenning. Electric-field-based routing: A reliable framework for routing in manets. *ACM Mobile Computing and Communications Review*, 2(2), April 2004.
- [9] David Ratner, Peter Reiher, Gerald J. Popek, and Geoffrey H. Kuenning. Replication requirements in mobile environments. *Mobile Networks and Applications*, 6(6):525–534, November 2001.
- [10] Alexey Rudenko, Peter Reiher, Gerald Popek, and Geoffrey H. Kuenning. Saving portable computer battery power through remote process execution. *ACM Mobile Computing and Communications Review*, 2(1), Winter 1998.
- [11] T. W. Page, R. G. Guy, J. S. Heidemann, D. Ratner, P. Reiher, A. Goel, G. H. Kuenning, and G. J. Popek. Perspectives on optimistically replicated peer-to-peer filing. *Software—Practice and Experience*, 28(2):155–180, February 1998.
- [12] Geoffrey H. Kuenning, Peter Reiher, and Gerald J. Popek. Experience with an automated hoarding system. *Personal Technologies*, 1(3):145–155, September 1997.
- [13] Geoffrey H. Kuenning. Kitrace: Precise interactive measurement of operating systems kernels. *Software—Practice and Experience*, 25(1):1–22, January 1995.

Refereed Conferences

- [1] Tyler Estro, Mário Antunes, Pranav Bhandari, Anshul Gandhi, Geoff Kuenning, Yifei Liu, Carl Waldspurger, Avani Wildani, and Erez Zadok. Guiding simulations of multi-tier storage caches using knee detection. In *Proceedings of the 31st International Symposium on Modeling, Analysis and Simulation of Computer and Telecommunication Systems (MASCOTS)*, Stony Brook, NY, October 2023. IEEE.
- [2] Yifei Liu, Gautam Ahuja, Geoff Kuenning, Scott Smolka, and Erez Zadok. Input and output coverage needed in file system testing. In *Proceedings of the 15th USENIX Workshop on Hot Topics in Storage and File Systems*, Boston, MA, July 2023. USENIX Association.
- [3] Wei Su, Yifei Liu, Gomathi Ganesan, Gerard Holzmann, Scott Smolka, Erez Zadok, and Geoff Kuenning. Model-checking support for file system development. In *Proceedings of the USENIX Workshop on Hot Topics in Storage and File Systems*, Virtual, July 2021. ACM.
- [4] Ibrahim Umit Akgun, Geoff Kuenning, and Erez Zadok. Re-animator: Versatile high-fidelity storage-system tracing and replaying. In *Proceedings of the 13th ACM International Systems and Storage Conference (SYSTOR)*, Haifa, Israel, October 2020. <https://www.fsl.cs.sunysb.edu/~umit/files/reanimator.pdf>.
- [5] Zhen Cao, Geoff Kuenning, and Erez Zadok. Carver: Finding important parameters for storage system tuning. In *Proceedings of the 18th USENIX Conference on File and Storage Technologies*, pages 43–57, Santa Clara, CA, February 2020. USENIX Association.
- [6] Zhen Cao, Geoff Kuenning, Klaus Mueller, Anjul Tyagi, and Erez Zadok. Graphs are not enough: Using interactive visual analytics in storage research. In *Proceedings of the USENIX Workshop on Hot Topics in Storage and File Systems*, Renton, WA, July 2019. USENIX Association.
- [7] Ming Chen, Dean Hildebrand, Henry Nelson, Jasmit Saluja, Ashok Sankar Harihara Subramony, and Erez Zadok. vNFS: Maximizing NFS performance with compounds and vectorized I/O. In *Proceedings of the 15th USENIX Conference on File and Storage Technologies*, Santa Clara, CA, February 2017. USENIX Association.
- [8] Erez Zadok, Dean Hildebrand, Geoff Kuenning, and Keith Smith. POSIX is dead! long live... errr... what exactly? In *Proceedings of the 9th USENIX Workshop on Hot Topics in Storage and File Systems*, Santa Clara, CA, July 2017. USENIX Association.
- [9] Zhen Sun, Geoff Kuenning, Sonam Mandal, Philip Shilane, Vasily Tarasov, Nong Xiao, and Erez Zadok. A long-term user-centric analysis of deduplication patterns. In *Proceedings of the 32nd International Conference on Massive Storage Systems and Technology (MSST)*, Santa Clara, CA, May 2016.

- [10] Sonam Mandal, Geoff Kuenning, Dongju Ok, Varun Shastry, Philip Shilane, Sun Zhen, Vasily Tarasov, and Erez Zadok. Using hints to improve inline block-layer deduplication. In *Proceedings of the 14th USENIX Conference on File and Storage Technologies*, Santa Clara, CA, February 2016.
- [11] Ming Chen, Dean Hildebrand, Geoff Kuenning, Soujanya Shankaranarayana, Bharat Sing, and Erez Zadok. Newer is sometimes better: An evaluation of NFSv4. In *ACM SIGMETRICS Conference Proceedings*, Portland, OR, June 2015.
- [12] Ming Chen, Dean Hildebrand, Geoff Kuenning, Soujanya Shankaranarayana, Vasily Tarasov, Erez Zadok, and Ksenia Zakirova. NFSv4.1 performance under a microscope. In *Proceedings of the USENIX Large Installation Systems Administration Conference*, Seattle, WA, November 2014. USENIX Association. Extended abstract.
- [13] Vasily Tarasov, Deepak Jain, Geoff Kuenning, Sonam Mandal, Karthikeyani Palanisami, Philip Shilane, Sagar Trehan, and Erez Zadok. Dmddedup: Device mapper target for data deduplication. In *Proceedings of the Ottawa Linux Symposium*, Ottawa, Canada, July 2014.
- [14] Vasily Tarasov, Deepak Jain, Dean Hildebrand, Renu Tewari, Geoff Kuenning, and Erez Zadok. Improving I/O performance using virtual disk introspection. In *Proceedings of the 5th USENIX Workshop on Hot Topics in Storage and File Systems*, San Jose, CA, June 2013. USENIX Association.
- [15] Adam Cozzette, Kathryn Lingel, Steve Matsumoto, Oliver Ortlieb, Jandria Alexander, Joseph Betser, Luke Florer, Geoff Kuenning, John Nilles, and Peter Reiher. Improving the security of Android inter-component communication. In *Proceedings of the IFIP/IEEE International Symposium on Integrated Network Management*, Ghent, Belgium, May 2013.
- [16] Vasily Tarasov, Dean Hildebrand, Geoff Kuenning, and Erez Zadok. Virtual machine workloads: The case for new benchmarks for NAS. In *Proceedings of the 11th USENIX Conference on File and Storage Technologies*, pages 307–320, San Jose, CA, February 2013. USENIX Association.
- [17] Sarah Diesburg, Christopher Meyers, Mark Stanovich, Michael Mitchell, Justin Marshall, Julia Gould, An-I Andy Wang, and Geoff Kuenning. TrueErase: Per-file secure deletion for the storage data path. In *Proceedings of the Annual Computer Security Applications Conference*, Orlando, FL, December 2012.
- [18] Vasily Tarasov, Amar Mudrankit, Will Buik, Philip Shilane, Geoff Kuenning, and Erez Zadok. Generating realistic datasets for deduplication analysis. In *Proceedings of the USENIX Annual Technical Conference*, Boston, MA, June 2012. USENIX Association.
- [19] V. Tarasov, S. Kumar, J. Ma, D. Hildebrand, A. Povzner, G. Kuenning, and E. Zadok. Extracting flexible, replayable models from large block traces. In *Proceedings of the 10th USENIX Conference on File and Storage Technologies*, San Jose, CA, February 2012. USENIX Association.
- [20] Zachary Dodds, Ran Libeskind-Hadas, Christine Alvarado, and Geoff Kuenning. Evaluating a breadth-first CS1 for scientists. In *SIGCSE '08: Proceedings of the 39th SIGCSE Technical Symposium on Computer Science Education*, pages 266–270, Portland, OR, March 2008. ACM.
- [21] Zach Dodds, Christine Alvarado, Geoff Kuenning, and Ran Libeskind-Hadas. Breadth-first cs 1 for scientists: Curriculum and assessment. In *ITiCSE 2007: Proceedings of the 12th Annual Conference on Technology in Computer Science Education*, pages 23–27, Dundee, Scotland, June 2007.
- [22] Charles Weddle, Mathew Oldham, Jin Qian, An-I Andy Wang, Peter Reiher, and Geoff Kuenning. PARAID: A gear-shifting power-aware RAID. In *Proceedings of the 6th USENIX Conference on File and Storage Technologies*, San Jose, California, February 2007. USENIX Association.
- [23] An-I Andy Wang, Geoff Kuenning, and Peter Reiher. Using permuted states and validated simulation to analyze conflict rates in optimistic replication. In *Proceedings of the International Symposium on Performance Evaluation of Computer and Telecommunication Systems (SPECTS)*, Philadelphia, PA, July 2005.
- [24] Jun Li, Toby Ehrenkranz, Geoff Kuenning, and Peter Reiher. Simulation and analysis on the resiliency and efficiency of malnets. In *Proceedings of the IEEE Symposium on Measurement, Modeling, and Simulation of Malware*, pages 262–269, Monterey, CA, June 2005. IEEE.

- [25] Jelena Mirkovic, Max Robinson, Peter Reiher, and Geoff Kuenning. Alliance formation for DDoS defense. In *Proceedings of the ACM New Security Paradigms Workshop*. ACM, August 2003.
- [26] An-I Wang, Geoffrey H. Kuenning, Peter Reiher, and Gerald J. Popek. The effects of memory-rich environments on file system microbenchmarks. In *Proceedings of the International Symposium on Performance Evaluation of Computer and Telecommunication Systems (SPECTS)*, Montreal, Canada, July 2003.
- [27] Nam Nguyen, Peter Reiher, and Geoffrey H. Kuenning. Detecting insider threats by monitoring system call activity. In *Proceedings of the 2003 IEEE Workshop on Information Assurance*, United States Military Academy, West Point, NY, June 2003. IEEE.
- [28] An-I Wang, Peter Reiher, Rajive Bagrodia, and Geoffrey H. Kuenning. Understanding the behavior of the conflict-rate metric in optimistic peer replication. In *Proceedings of the 5th International Workshop on Mobility in Databases and Distributed Systems*, Aix-en-Provence, France, September 2002. IEEE.
- [29] Kylie M. Evans and Geoffrey H. Kuenning. A study of irregularities in file-size distributions. In *Proceedings of the International Symposium on Performance Evaluation of Computer and Telecommunication Systems (SPECTS)*, San Diego, CA, July 2002.
- [30] An-I Andy Wang, Geoffrey H. Kuenning, Peter Reiher, and Gerald J. Popek. Conquest: Better performance through a disk/persistent-RAM hybrid file system. In *Proceedings of the 2002 USENIX Annual Technical Conference*, Monterey, CA, June 2002. USENIX Association.
- [31] Geoffrey H. Kuenning, Wilkie Ma, Peter Reiher, and Gerald J. Popek. Simplifying automated hoarding methods. In *Proceedings of the Fifth ACM International Workshop on Modeling, Analysis and Simulation of Wireless and Mobile Systems*, Atlanta, Georgia, September 2002. ACM.
- [32] Alexey Rudenko, Peter Reiher, Gerald Popek, and Geoffrey H. Kuenning. The remote processing framework for portable computer power saving. In *Proceedings of the ACM Symposium on Applied Computing*, San Antonio, TX, February 1999. ACM.
- [33] Geoffrey H. Kuenning, Rajive Bagrodia, Richard G. Guy, Gerald J. Popek, Peter Reiher, and An-I Wang. Measuring the quality of service of optimistic replication. In *ECOOP Workshop on Mobility and Replication*, Brussels, Belgium, July 1998.
- [34] Geoffrey H. Kuenning and Gerald J. Popek. Automated hoarding for mobile computers. In *Proceedings of the 16th Symposium on Operating Systems Principles*, pages 264–275, St. Malo, France, October 1997. ACM.
- [35] Geoffrey H. Kuenning. The design of the SEER predictive caching system. In *Proceedings of the Workshop on Mobile Computing Systems and Applications*, Santa Cruz, CA, December 1994.
- [36] Geoffrey H. Kuenning, Gerald J. Popek, and Peter Reiher. An analysis of trace data for predictive file caching in mobile computing. In *USENIX Conference Proceedings*, pages 291–306. USENIX Association, June 1994.

Books and Book Chapters

- [1] Christine Alvarado, Zachary Dodds, Geoff Kuenning, and Ran Libeskind-Hadas. *CS for All*. Franklin, Beedle, 2019.
- [2] Christine Alvarado, Zachary Dodds, Geoff Kuenning, and Ran Libeskind-Hadas. CS for scientists and engineers. Unpublished manuscript, March 2012.
- [3] An-I Andy Wang, Geoffrey H. Kuenning, and Peter Reiher. Multipath routing in ad hoc networks. In Kia Makki, Niki Pissinou, Kami Makki, and E. K. Park, editors, *Mobile and Wireless Internet: Protocols, Algorithms and Systems*, chapter 10, pages 245–262. Kluwer Academic Publishers, Boston, 2003.
- [4] Geoffrey H. Kuenning. Real-time Unix. In Mitchell Waite, editor, *Unix Papers for Unix Developers and Power Users*. Howard W. Sams & Co., 1987.

Other

- [1] George Amvrosiadis, Ali R. Butt, Vasily Tarasov, Erez Zadok, Ming Zhao, Irfan Ahmad, Remzi H. Arpaci-Dusseau, Feng Chen, Yiran Chen, Yong Chen, Yue Cheng, Vijay Chidambaram, Dilma Da Silva, Angela Demke-Brown, Peter Desnoyers, Jason Flinn, Xubin He, Song Jiang, Geoff Kuenning, Min Li, Carlos Maltzahn, Ethan L. Miller, Kathryn Mohror, Raju Rangaswami, Narasimha Reddy, David Rosenthal, Ali Saman Tosun, Nisha Talagala, Peter Varman, Sudharshan Vazhkudai, Avani Waldani, Xiaodong Zhang, Yiyang Zhang, and Mai Zheng. Data storage research vision 2025: Report on NSF Visioning Workshop held May 30–June 1, 2018. Technical report, National Science Foundation, 2018.
- [2] Jazmin Ortiz, Elizabeth Krenkel, Emily Dorsey, and Geoff Kuenning. Frequency-based block re-ordering. Poster and Work-in-Progress Report presented at the Workshop on Supporting Diversity in Systems Research, October 2015.
- [3] Ming Chen, Dean Hildebrand, Geoff Kuenning, Soujanya Shankaranarayana, Bharat Sing, and Erez Zadok. Is NFSv4.1 ready for prime time? *login.*, 40(3):6–12, June 2015.
- [4] Geoff Kuenning. On teaching style and maintainability. *login.*, 38(3):6–9, June 2013.
- [5] Linda Werner, Geoff Kuenning, Mark Sebern, Jim Vallino, and Eric Wong. Software engineering education via the use of corporate-sponsored projects: A panel discussion of the approaches, benefits, and challenges for industry-academic collaboration. Panel session at the 26th Conference on Software Engineering and Training, May 2013.
- [6] Peter Reiher, Jun Li, and Geoff Kuenning. Midgard worms: Sudden nasty surprises from a large resilient zombie army. Technical Report UCLA-CSD-040019, University of California, Los Angeles, Computer Science Department, Los Angeles, CA, April 2004.
- [7] Geoff Kuenning and Ethan L. Miller. Anonymization techniques for URLs and filenames. Technical report UCSC-CRL-03-05, Storage Systems Research Center, Jack Baskin School of Engineering, University of California, Santa Cruz, Santa Cruz, California, September 2003.
- [8] An-I Andy Wang, Geoffrey H. Kuenning, Peter Reiher, and Gerald J. Popek. The Conquest file system—life after disks (position summary). In *Proceedings of the 8th Workshop on Hot Topics in Operating Systems*, Schloß Elmau, Germany, May 2001. IEEE.
- [9] Geoffrey H. Kuenning. A cron daemon for portable computers. Technical Report UCLA-CSD-990044, University of California, Los Angeles, Los Angeles, CA, September 1999.
- [10] Geoffrey H. Kuenning, David H. Ratner, Peter Reiher, Gerald J. Popek, and Richard G. Guy. Cooperative chaos. Technical Report UCLA-CSD-970041, University of California, Los Angeles, Los Angeles, CA, November 1997.
- [11] Geoffrey Houston Kuenning. *Seer: Predictive File Hoarding for Disconnected Mobile Operation*. PhD thesis, University of California, Los Angeles, Los Angeles, CA, May 1997. Also available as UCLA CSD Technical Report UCLA-CSD-970015.
- [12] David Ratner, Peter Reiher, Gerald J. Popek, and Geoffrey H. Kuenning. Replication requirements in mobile environments. Presented at the First Dial M for Mobility, October 1997.
- [13] Geoffrey H. Kuenning. A minimal multitasking operating system for real-time controllers. *SIGSMALL Newsletter*, 7(2), October 1981.
- [14] Geoffrey H. Kuenning. Designing real-time software systems. *SIGSMALL Newsletter*, 7(2), October 1981.

References

Available upon request