

CONTACT INFORMATION      GitHub: [stephenlienharrell](#)  
ORCID: [0000-0001-5327-525X](#)  
Latest CV Version: [harrell.cc](#)

EDUCATION                **B.S., Computer Science**  
Minors: Gender Studies; Sociology  
Purdue University

RECENT PROFESSIONAL POSITIONS      **HPC Engineering Scientist**, Texas Advanced Computing Center (TACC), The University of Texas at Austin, March 2020 - present

**Senior Computational Scientist**, Research Computing, Purdue University, April 2014 - March 2020

**Senior HPC Systems Administrator**, Research Computing, Purdue University, July 2008 - April 2014

**Linux Systems Administrator**, Enterprise, Google, April 2006 - June 2008

*Complete work history below*

- PEER REVIEWED PUBLICATIONS
23. Bird, R., Tan, N., Luedtke, S., **Harrell, S.**, Taufer, M., Albright, B. *VPIC 2.0: Next Generation Particle-in-Cell Simulations*, IEEE Transactions on Parallel and Distributed Computing, Volume 33, Issue 4, April, 1 2022, Pages 952-963  
[10.1109/tpds.2021.3084795](#)
  22. Cawood, M., **Harrell, S.**, Evans, R., *BenchTool: a framework for the automation and standardization of HPC performance benchmarking*, PEARC'21: Practice and Experience in Advanced Research Computing, Virtual Conference, July 19th-22nd, 2021  
[10.1145/3437359.3465611](#)
  21. Wu, T., **Harrell, S.**, Lentner, G., Younts, A., Weekly, S., Mertes, Z., Maji, A., Smith, P., Zhu, X., *Defining Performance of Scientific Application Workloads on the AMD Milan Platform*, PEARC'21: Practice and Experience in Advanced Research Computing, Virtual Conference, July 19th-22nd, 2021  
[10.1145/3437359.3465596](#)
  20. Smith, P., **Harrell, S.** *Research Computing on Campus - Application of a Production Function to the Value of Academic High-Performance Computing*, PEARC'21: Practice and Experience in Advanced Research Computing, Virtual Conference, July 19th-22nd, 2021  
[10.1145/3437359.3465564](#)

19. Ruhela, A., **Harrell, S.**, Evans, R., Zynda, G., Fonner, J., Vaughn, M., Minyard, T., Cazes, J., *Characterizing Containerized HPC Application Performance at Petascale on CPU and GPU Architectures*, ISC High Performance, June 24th-Jul 2nd, 2021  
10.1007/978-3-030-78713-4\_22
18. Evans, R., Cawood, M., **Harrell, S.**, Huang, L., Liu, S., Lu, C., Ruhela, A., Wang, I., Zhang, Z., *Optimizing GPU-enhanced HPC System and Cloud Procurements for Scientific Workloads*, ISC High Performance, June 24th-July 2nd, 2021  
10.1007/978-3-030-78713-4\_17
17. Ruhela, A., Vaughn, M., **Harrell, S.**, Zynda, G., Fonner, J., Evans, R., Minyard, T., *Containerization on Petascale HPC Clusters* The International Conference for High Performance Computing, Networking, Storage, and Analysis (SC20), November 16th-19th, 2020.  
10.26153/tsw/12168
16. Kumar, R., Jha, S., Mahgoub, A., Kalyanam, R., **Harrell, S.**, Song, X. C., Kalbarczyk, Z., Kramer, W., Iyer, R., Bagchi, S. *The Mystery of the Failing Jobs: Insights from Operational Data from Two University-Wide Computing Systems*”, 2020 50th Annual IEEE/IFIP International Conference on Dependable Systems and Networks (DSN), Valencia, Spain. Jun 29th-Jul 2nd, 2020  
10.1109/DSN48063.2020.00034
15. Younts, A., **Harrell, S.** *”Teaching HPC System Administrators”*, Journal of Computational Science Education, Volume 11, Issue 1, Pages 100-105, 2020  
10.22369/issn.2153-4136/11/1/16
14. **Harrell, S.**, Hillery, E., Zhu, X. *”Introducing Novices to Scientific Parallel Computing”*, Journal of Computational Science Education, Volume 11, Issue 1, Pages 88-92, 2020  
10.22369/issn.2153-4136/11/1/14
13. Thota, A., Weakley, L.M., Fulton, B., Younts, A., **Harrell, S.**, Dennis, H.E., Huber, L., Michael, S., Snapp-Childs, W., Dietz, D., Phillips, C., Zhu, X. *”Research Computing Desktops: Demystifying Research Computing for Non-Linux Users”*, PEARC19: Proceedings of the Practice and Experience in Advanced Research Computing 2019, Chicago, IL. July 28th-August 1st, 2019  
10.1145/3332186.3332206
12. Smith, P., **Harrell, S.**, Younts, A., Zhu, X. *”Community Clusters or the Cloud: Continuing Cost Assessment of On-premises and Cloud HPC in Higher Education”* PEARC19: Proceedings of the Practice and Experience in Advanced Research Computing 2019 on Sustainability, Success and Impact, Chicago, IL, July 28th - August 1st, 2019  
10.1145/3332186.3333155

11. **Harrell, S.**, Kitson, J., Bird, R., Pennycook, J., Sewall, J., Jacobsen, D., Asanza, D., Hsu, A., Kim, H., Robey, R. *"Effective Performance Portability"*, P3HPC18: International Workshop on Performance, Portability and Productivity in HPC, Dallas, TX. November 16th, 2018  
10.1109/P3HPC.2018.00006
10. **Harrell, S.**, Brazil, M., Younts, A., Dietz, D., Smith, P., Gough, E., Zhu, X., Adino, G. *"Mentoring Undergraduates into Cyber-Facilitator Roles"*, PEARC18: Proceedings of the Practice and Experience in Advanced Research Computing 2018 on Sustainability, Success and Impact, Pittsburgh, PA. July 22nd-26th, 2018  
10.1145/3219104.3219138
9. Grant, R., Smith, S., **Harrell, S.**, Younts, A., Smith, P. *"Windows-based Workflows on Linux-based Beowulf Clusters"*, PEARC18: Proceedings of the Practice and Experience in Advanced Research Computing 2018 on Sustainability, Success and Impact, Pittsburgh, PA. July 22nd-26th, 2018  
10.1145/3219104.3219118
8. **Harrell, S.**, Howard, A. *"Hybrid HPC Cloud Strategies from the Student Cluster Competition"*, 2018 IEEE 11th International Conference on Cloud Computing (CLOUD), San Francisco, CA. July 2nd-7th, 2018  
10.1109/CLOUD.2018.00031
7. Smith, P., St. John, J., **Harrell, S.** *"There and Back Again: A Case Study of Configuration Management of HPC"*, HPCSYSPROS17: HPC Systems Professionals Workshop, Denver, CO. November 13th, 2017  
10.1145/3155105.3155110
6. Akin, D., Belgin, M., Bouvet, T., Bright, N., **Harrell, S.**, Haymore, B., Jennings, M., Knepper, R., LaPine, D., (Cherry), F., Maji, A., Neeman, H., Reynolds, R., Sherman, A., Showerman, M., Tillotson, J., Towns, J., Turner, G., Zimmerman, B. *"Linux Clusters Institute Workshops: Building the HPC and Research Computing Systems Professionals Workforce."*, HPCSYSPROS17: HPC Systems Professionals Workshop, Denver, CO. November 13th, 2017  
10.1145/3155105.3155108
5. Baldwin, M., Zhu, X. Smith, P., **Harrell, S.**, Skeel, R., Maji, A. *"Scholar: A Campus HPC Resource to Enable Computational Literacy"*, EduHPC-16: Workshop on Education for High-Performance Computing, Salt Lake City, UT. November 14th, 2016  
10.1109/EduHPC.2016.009
4. Mitra, S., Javagal, S., Maji, A., Gambelin, T., Moody, A., **Harrell, S.**, Bagchi, S. *"A Study of Failures in Community Clusters: The Case of Conte"*, 7th IEEE International Workshop on Program Debugging (IWPD 2016), Ottawa, Canada, October 23rd-27th, 2016  
10.1109/ISSREW.2016.7

3. **Harrell, S.**, Nam, H. A., Vergara, V., Keville, K., Kamalic, D. "*Student Cluster Competition: A Multi-disciplinary Undergraduate HPC Educational Tool*", EduHPC-15: Workshop on Education for High-Performance Computing, Austin, TX. November 16th, 2015  
10.1145/2831425.2831428
2. **Harrell, S.**, Smith, P., Smith, D., Hoeffler, T., Labutina, A., Overmyer, T. "*Methods of Creating Student Cluster Competition Teams*", TeraGrid 2011. Salt Lake City, UT. July 18th-21st, 2011  
10.1145/2016741.2016795
1. Carlyle, A., **Harrell, S.**, Smith, P. "*Cost-effective HPC: The Community or the Cloud?*", IEEE International Conference on Cloud Computing Technology and Science. Indianapolis, IN. November 30th-December 3rd, 2010  
10.1109/CloudCom.2010.115

GRANTS  
AWARDED

**PI** at the Texas Advanced Computing Center on a subaward within the NSF Program "Advanced Cyberinfrastructure Coordination Ecosystem: Services & Support (ACCESS)" on the grant *Track 4: Advanced CI Coordination Ecosystem: Monitoring and Measurement Services*. (2022)  
Award # 2137603

**PI** at the Texas Advanced Computing Center (TACC) within the NSF Program "CISE Community Research Infrastructure" on the collaborative (Purdue/TACC) grant, *Open Computer System Usage Repository and Analytics Engine*. (2020)  
Purdue Award #2016704, TACC Award # 2016608

RESEARCH  
FELLOWSHIPS

**Information Science and Technology Institute Fellowship** for the Parallel Computing Summer Research Internship within the National Security Education Center at Los Alamos National Laboratory (2018)

AWARDS

**Traxler Family Award for Community Service**  
HPC System Professionals Workshop, 2021

**Special Section Guest Editor** for

**Harrell, S.**, Michael, S., Maltzahn, C., "Advancing Adoption of Reproducibility in HPC: A Preface to the Special Section", IEEE Transactions on Parallel and Distributed Systems, Volume 33, Issue 9, September 2022, Pages 2011-2013  
10.1109/tpds.2021.3128796

Plale, B., **Harrell, S.** "Transparency and Reproducibility Practice in Large-scale Computational Science: A Preface to the Special Section", IEEE Transactions on Parallel and Distributed Systems, Volume 32, Issue 11, November 2021, Pages 2607-2608  
10.1109/tpds.2021.3058393

Garrett, C. Kris, **Harrell, S.**, Heroux, M. "Special Issue on SCC17 Reproducibility Initiative.", Parallel Computing, Volume 79, November 2018, Pages 48-49  
10.1016/j.parco.2018.10.001

**Executive Assistant** for the International Conference for High Performance Computing, Networking, Storage and Analysis [SC] (2023)

**Committee Chair** for

ACM SIGHPC Computational & Data Science Fellowship (2021 - Present)

Families@SC program at the International Conference for High Performance Computing, Networking, Storage and Analysis [SC] (2022)

Reproducibility Journal Special Issue at the International Conference for High Performance Computing, Networking, Storage and Analysis [SC] (2018, 2020, 2021)

Registration, Store and Merchandise at the International Conference for High Performance Computing, Networking, Storage and Analysis [SC] (2021 (Vice))

Reproducibility Challenge at the International Conference for High Performance Computing, Networking, Storage and Analysis [SC] (2016, 2020)

Exhibitor Forum at the International Conference for High Performance Computing, Networking, Storage and Analysis [SC] (2018, 2020)

Intel Extreme Performance Users Group Annual Conference [IXPUG] (2020)

Students@SC program at the International Conference for High Performance Computing, Networking, Storage and Analysis [SC] (2019)

Facilitation of Advanced Research Computing Track at the Practice and Experience in Advanced Research Computing Conference [PEARC] (2019)

Program at the HPC Systems Professionals Workshop [HPCSYSPROS] (2018)

Technical Papers at the Practice and Experience in Advanced Research Computing Conference [PEARC] (2018)

Student Cluster Competition at the International Conference for High Performance Computing, Networking, Storage and Analysis [SC] (2015 (Deputy), 2016, 2017)

**Program Committee Member** for

Tutorials at the International Conference at the High Performance Computing, Networking, Storage and Analysis [SC] (2021)

Technical Papers at the Practice and Experience in Advanced Research Computing Conference [PEARC] (2018, 2019, 2021)

Reproducibility Challenge/ACM Results Replicated badge at the International Conference for High Performance Computing, Networking, Storage and Analysis [SC] (2016, 2017, 2018, 2019, 2020, 2021)

EDUCAUSE Annual Conference (2019)

Student Cluster Competition at the International Conference for High Performance Computing, Networking, Storage and Analysis [SC] (2015, 2018)

Student Volunteers at the International Conference for High Performance Computing, Networking, Storage and Analysis [SC] (2017, 2018)

HPC Systems Professionals Workshop [HPCSYSPROS] (2016)

**Senior Member** of the Association of Computing Machinery (ACM)

**Student Program Coordinator** for Special Interest Group High Performance Computing (SIGHPC), Association of Computing Machinery (ACM), Aug 2019 - Present

**Steering Committee Member** for the OpenHPC Technical Steering Committee (2020 - 2021)

**Organizing Committee Member** for

Virtual Logistics Operations at the High Performance Computing, Networking, Storage and Analysis [SC] (2021)

ACM SIGHPC Systems Professionals Workshop [HPCSYSPROS] (Co-Located with SC) (2016, 2019, 2020, 2021)

ACM SIGHPC Systems Professionals Symposium (Co-Located with PEARC) (2019, 2021)

**Ad-Hoc Reviewer** for

NSF Frontera Allocation Proposals: Large Resource Allocation (LRAC), Large Scale Community Partnerships (LSCP), and Pathways (2020 - Present)

ACM SIGHPC/Intel Computational & Data Science Fellowship (2018 - Present)

NSF/Internet2 Exploring Clouds for Acceleration of Science Program (2019)

XSEDE Expert Mentoring Producing Opportunities for Work, Education, and Research (EMPOWER) (2019)

**Secretary** for System Professionals Virtual Chapter, Special Interest Group High Performance Computing (SIGHPC), Association of Computing Machinery (ACM), June 2018 - June 2020

**Deputy Regional Campus Champion** for XSEDE Campus Champions Region 6 (2017-2020)

**Student Cluster Competition Team Advisor** for the Purdue team at SC10, SC11, SC12, ISC13, SC13, ASC14, SC14 and ISC15

INVITED

PRESENTATIONS

*"Estimating Containerization Overheads on multi-Petaflop CPU and GPU HPC platforms"* Ruhela, A., **Harrell, S.**, Energy High Performance Computing Conference, Houston, TX, March 1-3, 2022.

*"VPIC 2.0: High-Performance Particle-in-Cell on Modern Hardware Architectures"* Luedtke, S., Bird, R., Tan, N., **Harrell, S.**, Taufer, M., Albright, B., 63rd Annual Meeting of the American Physical Society Division of Plasma Physics, Pittsburgh, PA November, 8th-12th, 2021.

*"Containerized Application Performance at Petascale"* Evans, T., Ruhela, A., **Harrell, S.** BigHPC Webinar Series - On the Road to HPC: Major Challenges and New Opportunities, Presented Online, July 22nd, 2021. (Webinar)

*"VPIC: Performance Portability on Modern Hardware Architectures"* Luedtke, S., Bird, R., Tan, N., **Harrell, S.**, Taufer, M., Albright, B., SIAM Conference on Computational Science and Engineering 2021 (CSE21), Presented Online, March 1st-5th, 2021.

*"SC20 Virtual Student Cluster Competition Reproducibility Challenge Webinar"* **Harrell, S.**, Taufer, M., Plale, B., Vergara, V., Michael, S., Hidayetoglu, M., Bicer, T., Presented Online, August 6th, 2020. (Webinar)

*"Utilization of Iot and Cloud-Edge Technologies for the Continuous Measurement of Emissions from Fertilized Fields"* Grant, R. H., Lin, C.-H., Johnston, C. T., **Harrell, S.**, Zuelly, B., Maji, A. K., and Smith, C. B. The American Society of Agronomy, Crop Science Society of America and Soil Science Society of America Annual Meetings, San Antonio, TX, November 13th, 2019. (Presentation Video)

*"Educating and Training Students for Roles as HPC Systems Professionals"* **Harrell, S.** at workshop on Community Building for High-Performance Computing Curriculum Development (CBHPCCD19), Tulsa, OK, June 11th, 2019. (Presentation)

*"Interactive Supercomputing"* Panel Presentation with Thota, A., **Harrell, S.**, Younts, A., Guilfoo, B., Paschke, S. at the Midwest Research Computing Consortium Meeting, May 23rd, 2019. (Presentation)

*"ACM SIGHPC Systems Professionals Virtual Chapter (HPCSYSPROS) Overview"* **Harrell, S.** CaRCC Ecosystem Workshop. St Louis, MO. April 9th-10th, 2019. (Presentation)

*"Student Cluster Competition Reproducibility Challenge: A Brief History Panel Presentation"* Taufer, M., Heroux, M., Gamblin, T., **Harrell, S.**, Fursin, G. The 1st Workshop on Reproducible, Customizable and Portable Workflows for HPC. Dallas, TX. November 11th, 2018. (Presentation)

*"Mentoring Undergraduates Through Competition Panel Presentation"* Gorda, B., Chou, J., Hartman-Baker, R., Smith, D., Shi, X., **Harrell, S.** at the 2015 ACM/IEEE International Conference for High Performance Computing, Networking, Storage and Analysis, SC15, Austin, TX, November 15th-20th, 2015. (Presentation)

UNREVIEWED  
PUBLICATIONS

Kitson, J., **Harrell, S.** *"Plasma Meets Portability: A journey to performance, portability, and productivity in a Particle-in-Cell physics code"*, Los Alamos National Laboratory 18th Annual Student Symposium, August 1st, 2018. (Poster)

Mitra, S., Javagal, S., Gamblin, T., Moody, A., **Harrell, S.**, Bagchi, S. *Cluster Workload Analytics Revisited.*, DSN 2016: The 46th Annual IEEE/IFIP International Conference on Dependable Systems and Networks, Toulouse, France, June 28th-July 1st, 2016. (Fast Abstract)

Baldwin, M., Cook, S., Shin, J., **Harrell, S.** *"Visualization of Weather Information Using a Scalable Database"*, Second Symposium on High Performance Computing for Weather, Water, and Climate, New Orleans, LA, January 10th-14th, 2016. (Poster)

Cook, S., **Harrell, S.** *"Creating a Scalable Database for Weather Research"* XSEDE15, St. Louis, MO, July 26th-30th, 2015. (Poster)

**Harrell, S.**, Cotton, B., Baldwin, M., Howard, A. *"Developing a Scientific Computing Cluster Course for the Undergraduate Curriculum."*, Summit for Educators in System Administration, Washington D.C., November 3rd-8th, 2013. (Poster)

INSTRUCTION

**University Courses**

*Lab in Atmospheric Science* EAPS 230, Purdue University, Fall 2015

*Cluster Challenge* EAPS 391, Purdue University, Spring 2014, Fall 2014, Spring 2015

*Advanced Scientific Computing* EAPS 591, Purdue University, Fall 2015

*Forecast Verification* EAPS 591, Purdue University, Fall 2012

*Scientific Computing* EAPS 391, Purdue University, Spring 2012, Spring 2013

**Tutorials**

*Modern HPC Tools*, High-performance Computing on Frontera, Texas Advanced Computing Center, March 3rd, 2022

*Containerization at Petascale on CPU and GPU Architectures in Practice*, Applied Parallel Programming Institute, Texas Advanced Computing Center, June 3rd, 2021 (lab materials)



*"Build-A-Cluster Workshop: A Hands-on tutorial session for building a cluster to support parallel scientific computing codes"* **Harrell, S.**, Younts, A., Maji A. (Presentation, Tutorial Files)

Esceula de Verano Universidad EAFIT, Medellin, Colombia, July 21st-23rd, 2015.

Linux Clusters Institute Workshop on high performance clustered computing, Norman, OK, May 18th-22nd, 2015.

Linux Clusters Institute Workshop on high performance clustered computing, Champaign-Urbana, IL, Aug 4th-8th, 2014.

## WORK HISTORY

### **HPC Engineering Scientist**

Texas Advanced Computing Center, Austin, Texas

March 2020 - Present

Benchmarked scientific software for future systems and architectures.

Maintained scientific software packages on XSEDE and leadership class clusters.

Wrote and supported multiple grant submissions and awards as Co-PI and senior personnel.

### **Summer Research Intern**

Los Alamos National Laboratory, Los Alamos, New Mexico

May 2018 - August 2018

Modified the Vector Particle in Cell (VPIC) code to work within the Kokkos performance-portability framework.

Benchmarked Kokkos and hand-optimized versions of VPIC on multiple different platforms and accelerators including ARM, NVidia GPU, Skylake and KNL.

### **Senior Computational Scientist**

Purdue University, West Lafayette, Indiana

April 2014 - March 2020

Designed and implemented specialized research platforms and HPC workflows for faculty and academic departments.

Served as interim manager for the Research Engineering team which is responsible for all faculty-facing research services that Research Computing provides.

Advocated to move HPC into the classroom through resources such as the Scholar Cluster and co-developed curriculum with faculty.

Assisted with prose, architecture design and benchmarking on multiple grant submissions as Senior Personnel and Co-PI.

### **Senior HPC Systems Administrator**

Purdue University, West Lafayette, Indiana

July 2008 - April 2014

Wrote video encoding service that used HPC clusters for classroom video tool, DoubleTake, in Python.

Deployed and maintained many Top500 computational research resources with other members of my team including Conte, Carter, Coates, and others.

Created managed desktop image based on Ubuntu and cfengine for scientific research developers.

Wrote open source DNS management system in Python, leading a team of 4, for Purdue's DNS environment.

### **Linux System Administrator**

Google, Mountain View, California

April 2006 - June 2008

Wrote data-center automation including SSH key management, database interfaces, virtualization automation, power management, Linux installation and command line tools in Python.

Primary code reviewer and unit/regression test author on the team.

Administered internal development Linux cluster.

Planned and helped implement 500+ machine data-center build-outs and moves.

Installed, diagnosed, maintained, and repaired hardware broken machines in internal cluster.

### **Audio Engineer**

Omega Institute, Rhinebeck, New York

March 2004 - November 2005

Setup live sound systems and recording rigs for concerts and lectures.

Recorded conferences and musicians for reproduction and sale.

Mixed live house sound for musicians and faculty.

Recorded and edited lectures and music in Protools for quality and content.

Designed and deployed a large wireless 802.11b/g network over three acres of dense foliage.

**Linux Engineer** (contract)

Roving Planet (defunct), Denver, Colorado

September 2003 - December 2003

Created micro Linux image for appliance firewall.

Developed install and boot processes for diskless appliances.

Integrated new boot and configuration processes into existing automatic install and configuration scripts.

**Linux System Administrator** (contract)

Alliente (defunct), Sunnyvale, California

September 2003 - December 2003

Implemented and maintained production and development environment monitoring.

Built and maintained all incoming mail servers.

Assisted in live co-location and platform migration.

24/7 on-call support for all production Linux machines.

**QA Analyst** (contract)

Sony Computer Entertainment of America, San Mateo, California

March, 2002 - May, 2002

Organized, designed and implemented network and security test plans for the PS2 Network Adapter.

Implemented multiple network testing environments for the testing of the PS2 Network Adapter.

Tested network and gameplay of PS2 titles.

**Technical Support Representative** (contract)

Electronic Arts, Redwood City, California

September, 2001 - March, 2002

Answered customer queries concerning Westwood, Origin, and Maxis games on Windows and DOS platforms via incoming phone calls and e-mails.

Researched bugs and problems with games to find suitable workarounds.

Tested gameplay of new EA titles.

### **Linux System Administrator**

Shutterfly, Redwood City, California

November, 2000 - March, 2001

Administered server farms that provided customers with photo rendering, printing and storage.

Evaluated security advisories and responded to relevant issues.

Setup and maintained all co-located Solaris and HP production servers.

Created and maintained perl and shell scripts to help with logging and day-to-day administration and maintenance.

Participated in 24/7 emergency support for all production servers.

### **Technical Support Engineer**

Cobalt Networks (defunct), Mountain View, California

August, 1999 - November, 2000

Provided customer support for Linux appliances running services including sendmail, bind, proftpd, apache, and the Cobalt UI.

Led team overseeing four technical support staff members.

Added features to Linux appliances such as PHP and webmail.

Traveled to customer sites for on-site support of migration from NT to Linux-based Cobalt servers.

### **Audio Engineer Intern**

Russian Hill Recording Studio (defunct), San Francisco, California

April, 1999 - June, 1999

Front desk duties, telephone, appointments.

Assisted clients with information, parking, and other as needed.

Assisted recording engineers as needed to run cords, setup, and take-down.