University of Massachusetts Dartmouth
Center for Scientific Computing and Visualization Research

Annual Report for July 1, 2017 – June 30, 2018

1 Goal and Mission

The Center for Scientific Computing and Visualization Research (CSCVR) at UMass Dartmouth unites a group of highly-qualified and well-trained scientists with complementary backgrounds and interests who develop and use computational algorithms to simulate and visualize complex physical problems. The impetus for the formation of the center came from the awareness of our significant multidisciplinary and interdisciplinary expertise in scientific computing, and the desire to leverage existing strengths to build an internationally recognized center of excellence at UMass Dartmouth.

The primary mission of the center is to transcend the traditional departmental boundaries and form a close-knit and collaborative multidisciplinary group that will combine wide range of mathematical, computational, and scientific skills to make significant impact across the field of computational science. Our activities focus on creating a supportive and collaborative environment for computational science, and to support the computational needs of the CSCVR faculty and students. The CSCVR's website can be accessed at `http://cscvr.umassd.edu`.

2 Activities and Accomplishments

2.1 Major CSCVR endeavors

- **Fostering collaboration and mentorship of junior faculty and students.** A major component of our activities this year has been to support and mentor junior faculty. This year the CSCVR directors helped junior faculty members with editing grant proposals and also provided text on diversity, work environment, data management plans, and computational resources, to support proposal development.
- **New research instrumentation through an ONR DURIP grant for $643,899.** We requested new cutting-edge equipment from the Office of Naval Research (ONR) through the Defense University Research Instrumentation Program (DURIP) to enable the application-driven development of innovative numerical methods to simulate complex multiscale physical problems, and the related education and training a mathematical and computational workforce. This proposal was a collaborative effort among the members of the CSCVR. Profs. Gottlieb and Khanna led the proposal, and were joined by Profs. Tandon, Heryudono, Mayes, Cowles, Field, Chen, Raessi, Tootkaboni, Dong, Bucci.

  This parallel computer cluster is a highly specialized research instrument which will allow us to further scientific development of innovative mathematical methods suitable for high performance simulations of a variety of challenging problems. Our current aging cluster has been a huge success and has had significant scientific impact. Over six years of use, that cluster has completed over a million independent jobs that have resulted in 31 peer-reviewed publications in top journals and conferences. The system has averaged over 85% utilization, with a 99% uptime. Furthermore, the availability of an HPC cluster has served to catalyze many interdisciplinary research collaborations which have driven the development of novel mathematical methods for a variety of complex problems. The new cluster will re-invigorate these efforts by stimulating development of novel

numerical approaches for cutting-edge computational architecture. The availability of this cluster will allow for the training of the next generation of high performance computing experts, who are currently graduate or undergraduate students, and will support the interdisciplinary Ph.D. program in computational science and engineering. Graduate students will benefit from the opportunity to develop cutting-edge parallel and GPU-accelerated algorithms for a variety of challenging physical problems, in a truly multi-disciplinary setting.

Since the CSCVR received the funding from ONR (early June), the Center Directors have been hard at work finalizing the system specifications, and working with vendors on the final pricing. Since the purchase involves significant federal funds, the campus required going through an open bid process. After taking into account several constraints (grant requirements, cooling limitations in our local data center, budget, software needs, CSCVR usage experience, etc.) the hardware specifications were finalized, and an open RFP was initiated in mid-June. As of the writing of this document, a final vendor has been selected and the purchase process is continuing forward. A brief outline of this ew 1300-core system appears below.

50 compute nodes: 24-core Intel "Skylake" nodes, 48GB memory, 1TB SSD local disk (15 of these would have one Nvidia V100 GPU each).
A separate head-node, and a storage node: 16-core Intel "Skylake" nodes, 96GB memory, 1TB SSD local disk.
Two OpenPOWER nodes: 32-core IBM POWER9 nodes, 128GB memory, 1TB SSD local disk (two Nvidia V100 GPUs in each with NVLINK2).
Storage: 132 TB ZFS storage array.
Network: Infiniband EDR and 10G Ethernet.
Software: TotalView license (128 processes), PGI compilers with OpenACC (floating license), Intel compilers and libraries.

- **Leadership at the MGHPCC.** The Center played a critical role in enabling major changes in governance and hardware architecture at the MGHPCC facility. Recall, that the Massachusetts Green High Performance Computing Center (MGHPCC) is a data center dedicated to research computing, operated by five of the research-intensive universities in Massachusetts: Boston University, Harvard University, MIT, Northeastern University, and the University of Massachusetts. This 5 year old facility provides race space and 15,000+ core cluster for use by UMass researchers.

  Since the beginning, the governance of the UMass component of this facility had been designated to the Amherst and Medical School campuses. This resulted in several unfortunate choices – from the perspective of the other campuses – since the needs of the Amherst and Medical School researchers were always given top priority. For example, the UMass shared cluster hardware was designed primarily for scientists in the life sciences, and CSCVR affiliates found that their codes scaled very poorly on these machines, and in fact are much faster on the Center's old local machine by a factor of 10 (and if GPUs are included, a factor of 100).

  Over the past two years the CSCVR Directors strongly advocated for major changes, not only in the cluster hardware configuration, but also the facility's governance structure. This required assembling a strong coalition of researchers from other disadvantaged UMass campuses with just enough technical and political support to bring about a major change. Here are the changes that were implemented this year:

  1. All the requested changes by CSCVR members to the hardware configuration are now complete. A portion of the cluster now offers much improved parallel scaling performance and comes with a dedicated queue. New GPU-nodes have been added.

2. There is a new Faculty Advisory Committee (FAC) that has representatives from all UMass campuses. The FAC makes recommendations on changes, purchases, upgrades, policies, etc. associated with the UMass shared cluster. Both the CSCVR Directors serve on the FAC. Prof. Khanna serves as a one of the two co-Chairs of the FAC.
3. The UMass MGHPCC Steering Committee now has representatives from all UMass campuses. Previously, the committee only included members from Amherst and the Medical School.
4. The CSCVR Directors also serve as two UMass system representatives on the MGHPCC REO Committee. This Research, Education & Outreach (REO) committee includes representatives from all the consortium universities. It is chaired by Drs. Chris Hill (MIT) and David Kaeli (NEU). Along with HPC Day, this committee membership has enabled the Center members to network with similar researchers across the state. This has also helped propel the CSCVR towards regional prominence – which is one the Center's main missions.

- **Major participation in the LCC NSF proposal.** As mentioned above, the CSCVR Directors now serve on the MGHPCC REO Committee. Part of the role of this committee is to look for collaborative opportunities and assemble teams of researchers and university leaders to pursue the most promising ones. As an example of this, the consortium submitted a proposal to the NSF to establish a "Leadership Class Facility" (LCC) at the MGHPCC. This proposal, led by MIT's Chris Hill, requests funding to build a $60M national supercomputer (a successor to NSF's Blue Waters) at the MGHPCC. Prof. Khanna was asked to serve as the Co-PI from the UMass system – owing to his GPU expertise. It is uncommon for our campus to be in a leadership position of a large state-wide initiative of this type. This is a clear example of the CSCVR being widely recognized for its strengths, and the many efforts made by the CSCVR Directors on its behalf bearing fruit. This LCC proposal is still pending a decision at the NSF.

2.2 CSCVR student and faculty accomplishments, prizes, and grant awards

2.2.1 Student successes

- The CSCVR has graduated its second large cohort of multiple graduate students this past academic year. These graduations will aid the campus in maintaining its recently earned DRU-R2 classification. CSCVR graduates Sidafa Conde (Ph.D. Advisor Gottlieb / Heryudono, Math.), Zachary Grant (Ph.D. Advisor Gottlieb, Math.), Jiahua Jiang (Ph.D. Advisor Chen, Math.).
- Sidafa Conde (Ph.D. Advisor: Gottlieb / Heryudono, Math.) is a postdoctoral fellow at Sandia National Laboratories in New Mexico.
- CSCVR Director Dr. Gottlieb's Ph.D. student Zachary Grant received the 2017 SIAM Student Paper Prize and presented his winning paper at the SIAM Annual Meeting, held July 10–14, 2017 in Pittsburgh, Pennsylvania. SIAM recognized Grant for the paper, Explicit Strong Stability Preserving Multistage Two-Derivative Time-Stepping Schemes, co-authored with Andrew Christlieb of Michigan State University, Sigal Gottlieb of the University of Massachusetts, Dartmouth, and David C. Seal of the United States Naval Academy. The paper was published in Journal of Scientific Computing in 2016. An interview with Zach appears in SIAMs spotlight.
- Zachary Grant (Ph.D. Advisor Gottlieb, Math.) was awarded the prestigious Householder Fellowship at Oak Ridge National Lab.

  Each Householder Fellowship appointment is fully funded for a period of three years for recipients with proven exceptional academic records and achievements, along with

formal mentorship and guidance designed to facilitate successful integration and alignment of their research activities within DOE programs. Recipients are expected to conduct research of the highest quality and impact, elevate the reputation of the Laboratory, and become scientific leaders in their field. The fellowship offers collaborative research opportunities in active Programs at ORNL, a highly competitive salary, moving expenses, and a generous professional travel allowance. The selected individual will be mentored by a senior scientist within CAM, but are encouraged to pursue their own research agenda, through access to the most advanced computer architectures, and opportunities to facilitate technology transfer from the laboratory research environment to industry and academia through training of new Mathematicians and computational scientists.

From `https://www.ornl.gov/careers/alston-s-householder-fellowship`.

- Jiahua Jiang (Ph.D. Advisor: Chen, Math.) is beginning a postdoctoral fellowship at Virginia Tech University.
- Leah Isherwood (Ph.D. Advisor: Gottlieb, Math.) worked at NUWC as a Research Intern in Summer 2017 and at Lincoln Lab in Summer 2018.
- Professor Saeja Kim brought two undergraduate students (Courtney Burns, Kimberly Matsuda) and two EAS-CSE graduate students (Jiahua Jiang, Rebecca Pereira) to an invited event Wheaton College, Summit for Women in STEM, Norton, MA, March 24, 2018. The two undergraduate students gave oral presentations based on their research; the two graduate students tended to UMass Dartmouth table for recruiting undergraduates to our EAS-CSE PhD program during a student networking session; Professor Kim served as one of facilitators for concurrent Courage Breakup Groups session.
- Thanks to the CSCVR summer fellowship, EAS PHD student, Xuejing Wang, and CEN MSc student Mehskat Botshekan supervised by CSCVR members Louhghalam and Tootkaboni attended the Engineering Mechanics Institute (EMI) Conference (EMI2018) in Cambridge and presented their research.
- Graduate students Nick Valm and Ardalan Nejat, supervised by CSCVR affiliates, Asadpoure, Tootkaboni and Louhghalam, presented their research on systematic design of lattice structures subject to uncertainty in geometric imperfections as well as stability constraints, in the Engineering Mechanics Institute (EMI) conference (EMI2018). Nick was partially supported by the CSCVR s summer fellowship.
- Dr. Scott Field supervised an honors thesis for undergraduate Derek Marshall, who is now starting a job in data analytics at Capital One's headquarters in Texas
- The graduate students Prosenjit Biswas, Rojin Ghandriz, and Asia Haque from Jun Lis (MNE) research group received the 2nd place prize in Dassault Systemes Additive Manufacturing Hackathon Competition. In this event, participants work in team using simulation tools to overcome design and manufacturing challenge problems from additive manufacturing industry.
- Alec Yonika, Ph. D. student, and Izak Thuestad, MS student, recently published their research findings on different aspects of black hole physics in top research journals. Dr. Khanna is their research advisor.
- M.S. physics students Pritom Mozumdar and Gabriel Casabona, submitted a paper on a new mechanism for detonation initiation in thermonuclear supernovae. Dr. Fisher is their research advisor.

2.2.2 Faculty accomplishments and grants

- Research conducted in the CSCVR on black holes, engineering and biofilms are among the papers published at UMass Dartmouth included in the 2017–2018 Nature Index. The Nature Index, developed by the Nature Publishing Group, tracks research publications among a selection of 68 high-impact journals. These publications by CSCVR members account for over half of the total campus-wide high-impact publications over the past year!
- CSCVR faculty member Scott Field (Mathematics) was recently awarded a $26,560 grant from the National Institute of Aerospace to assess the viability of discontinuous Galerkin methods for solving challenging fluid simulation problems (such as rocket re-entry) of interest to NASA Langley.
- *Data Center Dynamics* magazine published a thoroughly researched story about Sony PlayStations and their supercomputing legacy, with a detailed interview with CSCVR Director, Dr. Khanna. The story appears on page 44 of the April/May issue.
- Dr. Khanna published a paper that demonstrates the existence of extreme black holes that until now were thought to be theoretical and unobservable. This work upends conventional wisdom on extreme black holes, which presumed these objects were unstable, and thus did not exist in nature. This work was recently featured on local ABC6 news, where Center Ph. D. students Alec Yonika and Caroline Mallary describe their exciting contributions to this work. This work was also discussed in a public radio interview and a story in Forbes Magazine.
- CSCVR Director Prof. Gaurav Khanna's recent paper with Richard was one of small handful of papers selected for special recognition by the Classical & Quantum Gravity journal. It appears on their 2017 Highlights listing.
- In the attempt to treat several digestive ailments such as inflammatory or allergic diseases, doctors and scientists did not have an accurate prediction system to find the right balance of bacteria to produce a healthy gut. But now, due to the research conducted by CSCVR faculty member Vanni Bucci alongside colleagues at Dana-Farber Cancer Institute, a prediction model exists that could yield effective tools in the quest for digestive health. Read more about their work here.
- Dr. Bo Dong was awarded a new, 3-year NSF grant titled, " Multiscale and Hybridizable Discontinuous Galerkin Methods for Dispersive Equations and Systems" for $269,185.
- A recent *New York Times* article, "Does Climate Change Have Anything to Do With Floods in Thailand?", features CSCVR faculty member Dr. Amit Tandon. Professor Tandon studies ocean systems using a combination of analytical modeling and high-performance computing techniques.
- In January 2018, Prof. Robert Fisher gave an invited plenary presentation, "The Fate of Exploding White Dwarfs" at the 231st meeting of the American Astronomical Society in Washington, D.C., where M.S. physics student Pritom Mozumdar also presented a poster on his thesis research.
- Prof. Fisher was awarded three grants, a 2018-2021 NASA Astrophysics Theory Program $150,000 award as PI, an NSF XSEDE supercomputer award (valued at $36,000), and a 2018 NASA NuSTAR-XMM-Newton award as Co-PI ($26,750 UMass Dartmouth share).
- Louhghalam, in collaboration with researchers from Institute for NanoBio Technology at the Johns Hopkins University studied the impact of spatial structure of the actin cap on protecting the cell nucleus from extracellular physical disturbances. The study which was recently published in Nature communication (`https://www.nature.com/articles/s41467-017-02217-5`) combines experimental results and computational simulation to explain the behavior of cells under mechanical stimuli according to the load-carrying mechanism.
- Thanks to the mentorship of the CSCVR director, CSCVR member Louhghalam received a $44,950 grant from National Science Foundation for promoting diversity and inclusion within the EMI research community.

- CSCVR faculty member Asadpoure and his collaborators, CSCVR faculty member Tootkaboni and Lorenzo Valdevit of UCI, published their research on potential of multi-material design using topology optimization in dramatically improving energy dissipation characteristics. This study was published in Computer Methods in Applied Mechanics and Engineering Journal. Asadpoure also presented his research in a number of conferences including New. Mech 2017, SES 2017 and EMI 2018.
- Lance Fiondella, ECE Dept. was awarded a major award from the National Science Foundation, CAREER: Software Reliability and Security Assessment: Modeling and Algorithms, PI: L. Fiondella. (Amount: $452,454). Duration: 9/18-8/23.
- Dr. Scott Field was awarded a 3-year NSF grant from the highly competitive Gravity Theory program totaling $193,437. Dr. Field also co-organized an international weeklong workshop on surrogate modeling at the Albert Einstein Institute in Golm, Germany.
- The CSCVR faculty support the largest number of doctoral students in the *Engineering & Applied Sciences Ph.D.* program. Currently (Fall 2018) the program has 41 students, of which 18 are supported by center faculty (in the *Computational Science*) option. Associate Director Gaurav Khanna serves as the director of this program.
- CSCVR Directors served as guest editors for a special issue of IEEE's *Computing in Science & Engineering* magazine on scientific advances enabled through supercomputing.

3 Total Revenue

Source	Amount
Indirect cost distribution	$28,224.94

4 Total Expenditures by Category

The Director's stipend and course release from his College budget. As the center did not receive its own budget allocation this year, we spent money infrequently. Our major source of funds was indirect cost distributions, which we have been saving up until we have sufficient funds for substantial needs. In the table below we report each of our expense this year:

Code	Expense detail	Amount	Description
PAY	Graduate Student Payroll & Fees	$8,170.10	student funding
PAY	Fringe benefits	$86.99	Fringe for student funding
EX	Travel	$6,744.03	Seed Grants: student and faculty travel
AP	Foreign Travel	$2,768.68	Seed Grants: student travel to conference
AP	Conference Misc & Temp Space	$1,387.23	Refreshments for seminars and events
AP	Non-employee expenses	$138.23	Seminar expenses
AP	IT Equipment under $5,000	$2,374.40	Seed Grants: computer for faculty member
AP	Lab Supplies	$197.74	TX2 cluster supplies
AP	Books/Periodicals - NonLibrary	$192.10	Books for Wrinkle in Time event
AP	Lab Supplies	$363.51	Backup AC unit for the PS3 container
AP	Office & Administrative Supplies	$494.14	Coffee maker
TEL	Telecom Services Voice	$25.08	Telecon cost
	Total Expenses	**$22,942.23**	

5 Employees and Consultants

5.1 Unofficial Staff

Although the center does not officially have any administrative assistants, Ms. Jill Peters (Math) and Ms. Deborah Raposa (Engineering) have been very helpful to us. In particular, Ms. Raposa has

assisted us with purchases for the CSCVR, and Ms. Peters with purchases and conference / event organization. In addition, Physics Dept. computer technician, Glenn Volkema, has been providing significant hardware support.

5.2 Internal Board of Center Affiliates

The CSCVR continues to grow as we have been hiring more faculty who have computational interests.
Alireza Asadpoure (Assistant Professor of Civil Engineering)
Ramprasad Balasubramanian (Professor of Computer and Information Science).
John R. Buck (Professor of Electrical and Computer Engineering)
Vanni Bucci (Assistant Professor of Biology)
Geoffrey Cowles (Associate Professor in the Dept. of Fisheries Oceanography)
Yanlai Chen (Assistant Professor of Mathematics)
Joohyun Chung (Assistant Professor of Nursing)
Geoff Cowles (Associate Professor of Estuarine and Ocean Sciences)
Gary Davis (Professor of Mathematics)
Bo Dong (Assistant Professor of Mathematics)
Scott Field (Professor of Mathematics)
Dana Fine (Assistant Professor of Mathematics)
Lance Fiondella (Assistant Professor of ECE)
Robert Fisher (Associate Professor of Physics)
Sigal Gottlieb (Professor of Mathematics)
Adam Hausknecht (Professor of Mathematics)
Alfa Heryudono (Associate Professor of Mathematics)
Gaurav Khanna (Professor of Physics)
Firas Khatib (Assistant Professor in the Computer and Information Science Department)
Saeja Kim (Professor of Mathematics)
David Koop (Assistant Professor of Computer and Information Science).
Steven Leon (Chancellor Professor Emeritus of Mathematics)
Jun Li (Assistant Professor of Mechanical Engineering)
Arghavan Louhghalam (Assistant Professor of Civil Engineering)
Maricris Mayes (Assistant Professor of Chemistry)
Mehdi Raessi (Associate Professor of Mechanical Engineering)
Ming Daniel Shao (Assistant Professor of Computer and Information Science)
Maoyuan Sun (Assistant Professor of Computer and Information Science)
Amit Tandon (Professor of Mechanical Engineering and Estuarine and Ocean Sciences)
Mazdak Tootkaboni (Associate Professor of Civil Engineering)
Cheng Wang (Associate Professor of Mathematics)
Jay Wang (Associate Professor of Physics)
Donghui Yan (Assistant Professor of Mathematics)

5.3 External Scientific Advisory Board

One of our first objectives once the center was approved was to create a scientific advisory board comprised of leaders in the field of scientific computing and related sciences to assist in directing the CSCVR's research agenda, advise on research directions and trends in the field, and help identify appropriate collaboration and funding opportunities. Our current scientific advisory board consists of:
Mark Barnell, AFRL (Rome, NY)
Marsha Berger, NYU, `https://cs.nyu.edu/berger/`

Jack Dongarra, University of Tennessee and Oak Ridge National Lab
http://www.eecs.utk.edu/people/faculty/dongarra/
Paul Fischer, UIUC, http://mechanical.illinois.edu/directory/faculty/fischerp
Ian Foster, Argonne National Lab, http://www.ci.anl.gov/people/profile.php?id=285
Antony Jameson, Stanford University, http://aero-comlab.stanford.edu/jameson/
Kirk Jordan, IBM, http://researcher.watson.ibm.com/researcher/view.php?person=us-kjordan
Randy LeVeque, University of Washington, http://faculty.washington.edu/rjl/
Robert Panoff, Shodor Foundation, http://www.shodor.org/about/board/panoff/
Stanley Osher, UCLA, http://www.math.ucla.edu/~sjo/
Richard Price, University of Texas, http://www.phys.utb.edu/~rprice/rprice.html
Chi-Wang Shu, Brown University, http://www.dam.brown.edu/people/shu/
Alex Pothen, Purdue University, Director of a DOE-funded Petascale Computing Group http://www.cs.purdue.edu/homes/apothen/

6 Physical Space Occupied

6.1 Physical facilities

The center facility is in the Textiles building room 105 (TXT105). The center room renovation was completed in summer 2013 and provides an attractive and inviting work and collaboration space for faculty and students to congregate and has served as a catalyst for a number of new multidisciplinary projects. The CSCVR facility has spaces for students and visitors to work and flexible collaboration spaces that can be used for seminars, large and small group meetings, lunches, and informal gatherings. The computer clusters belonging to the CSCVR are housed in the data center, and in a refrigerated container with a new mural designed by a Physics undergraduate.

6.2 Computational Resources

iDataPlex CPU/GPU cluster The CSCVR has high performance computing facilities consisting of an IBM cluster with a total of 80 nodes (640 CPU cores), with 64 Nvidia Tesla GPU cards, networked with QDR Infiniband, and providing over 50 TB of NAS storage. This equipment was purchased in 2011 by two federal grants: an AFOSR DURIP grant and an NSF MRI award, as well as startup funds for new faculty members, Mehdi Raessi and Mazdak Tootkaboni. Our computational facilities reflect our emphasis on, and expertise in, GPU computing. At last count, the computational facility now supports 20 faculty investigators and 50 postdoctoral, graduate and undergraduate student users. Additionally, it has been utilized in several undergraduate and graduate courses in the Mechanical Engineering, Mathematics, and Physics departments. The cluster has very high utilization (over 80%) and has completed over *1 million* separate compute jobs since its installation.

Playstation cluster: UMass Dartmouth pioneered the use of Sony PlayStation3s for astrophysics research back in 2007 when Gaurav Khanna of the Physics Department created a computer cluster

of 16 PS3s and ran his black hole research simulations at supercomputer-level performance. These facilities were significantly augmented 3 years ago when Dr. Barnell's group at the Air Force Research Lab (AFRL) at Rome, NY granted CSCVR nine full racks (396 units) of Sony PlayStation 3s for research computing. This equipment transfer was done under Gaurav Khanna's CRADA (AFRL) agreement.

ARNiE: In 2015 we received donations of two supercomputers in response to the New York Times article on Prof. Gaurav Khanna's novel use of PlayStations for his computational research in black hole astrophysics. The larger system amongst the two was built in 2012 at cost nearing a million dollars and consists of 180 servers installed in 10 racks, integrated over a gigabit network. This cluster (called ARNiE, after our campus' mascot) nodes have 8-core Intel Core i7 CPUs, an Nvidia CUDA "Fermi" GPU and 24 GB of main memory. The cluster also has 130 TB of attached (available) storage that was recently upgraded to 200 TB.

Elroy: The CSCVR recently debuted a new innovative prototype supercomputer built entirely of mobile-devices (in particular, Nvidia Tegra X1 components used to build tablets) dubbed "Elroy". The system's total raw compute capacity is 16 teraflop/s and consumes just over 300W total power. The unique feature of this 32-node system is its extremely high power efficiency – an order-of-magnitude larger than traditional systems. This was made possible by leveraging recent, very significant power-efficiency related advances that have been cleverly engineered into current cell phones and other mobile devices (to prolong battery life). Power-efficiency is a limiting factor in large scale supercomputing as well, due to the expenses associated to large power consumption and corresponding cooling requirements. Elroy demonstrates a unique approach towards potentially meeting this challenge. This project was a result of a collaborative effort between the CSCVR and UMass Dartmouth CITS.

Rapid Prototyping Server I & II: Rapid prototyping servers (RPS1, RPS2) are high-end Linux servers with dual 3.2 GHz multicore Xeon CPUs, 256GB RAM, and a single high-end CUDA GPU each. Popular rapid prototyping software such as Anaconda Python 2 and 3, Julia, MATLAB with parallel computing toolbox, and Mathematica with GPU support were also installed. With convenient feature such as UMassD logon, the server can also be seen as an extension of faculty's office workstations or as a test machine prior to scaling up computing jobs to UMass Dartmouth multinode servers: ARNiE and HPCC or MGHPCC (UMass-wide supercomputer). Prototyping projects currently conducted on these machines include, but not limited to, deep learning with Mathematica, numerical simulation of systems of PDEs, development of new time-stepping methods, and preconditioning techniques for generalized finite difference sparse systems.

Solar-panel-powered GPGPU computing system: The CSCVR also used the HPC day '17 to debut a small prototype GPGPU computing system, that is powered purely using solar panels. The unique feature of this system is its extremely high power efficiency – an order-of-magnitude larger than traditional systems, made possible by leveraging highly-efficient consumer electronics (in particular,

Nvidia Shield TV "set-top" units). The CSCVR has a history of developing innovative supercomputers from using gaming consoles to more recently, using video-gaming graphics cards and mobile-devices.

HPE SwitchBlade: Through a combination of a HPE "SwitchBlade" grant and start-up funds from two new faculty (Asadpoure and Louhghalam), the CSCVR installed a 8-node blade system with a total of 320 cores and nearly half a TB of main memory. The system will be used to support of the research of the new faculty and also explore virtualization in HPC.

MGHPCC: The University of Massachusetts system acquired a shared HPC cluster, which came online at the very end of 2013 that currently sports over 15,000 processing CPU cores and a large mount of memory. This cluster is installed at the MGHPCC. Unfortunately, this cluster was designed primarily for scientists in the life sciences, and CSCVR affiliates have found that their codes scale poorly on these machines, and in fact are faster on our old local machine by a factor of 10 (and if our GPUs are included, a factor of 100). Over the past year, several of these issues were addressed. CSCVR Directors continue to work closely with the UMass Dartmouth administration and the UMass President's office to advocate for the needs of the CSCVR researchers.

Visualization equipment: In addition to the two 80" Sharp touchscreen displays, the center also procured and installed an interactive Panasonic 3D TV and an Oculus Rift VR system.

7 Projected Budget and Goals for Coming Year

In the past we requested funding for the CSCVR to support over thirty faculty affiliates and close to thirty students and postdoctoral researchers. This funding was not given. This year it became clear that beyond the director stipend and course releases, the CSCVR is expected to support itself using the indirect funds allocation from the affiliates' grants.

We have managed to accomplish much on these limited funds: first and foremost, we are providing close mentoring of the junior faculty in research and grantsmanship and we are often told that this was a major contribution to their success in receiving grants, retention and to their general sense of well-being in their departments. CSCVR affiliates are among the most successful researchers on campus, as evidenced by innovative publications and success in attaining grant funding. Second, the CSCVR has increased its visibility on and off campus, resulting in increased awareness of our strengths in high performance computing and attracting significant donations of hardware. We have created an identity as a center of multidisciplinary scientific computing that is now recognized nationally. This has greatly benefitted us in attracting new hires.

7.1 Proposed Budget for 2018–2019

Director's Stipend	$15,000
Course buyouts (1 per semester)	$15,000
CSCVR Student Tech Support	$20,000
CSCVR Fellowship (one doctoral student)	$20,000
Seed funding for CSCVR affiliates	$20,000
Computational needs	$8,000
Total	**$98,000**

7.2 Goals

The following are our priorities for the coming year:

- Continue to increase our visibility both within the campus and outside, through seminars and conferences.

- Create and maintain mentoring and collaboration opportunities for center affiliates, through regular seminars, workshops, lunches, and other informal events (picnics), as well as meeting with junior faculty to create mentoring relationships.
- Maintain and upgrade our computational facilities. Thanks to Associate Director Gaurav Khanna and Dean Balasubramanian, we are also maintaining our current computational facilities. We are also working with the CIO Holger Dippel and Andrew Darling to ensure that the university Data Center be regularly updated to ensure stability of our electrical and cooling system.
- Formulate a strategic spending plan in line with the initial center proposal that will inform us how to best use the CSCVR funds which are a portion of the indirect cost recovery from affiliate's grants. We have worked and will continue to work on building up donations and increasing the revenue stream from the indirect cost recovery from affiliate's grants, which was approximately $28,000 this past year. To date, we used this account to purchase new hardware and to fund faculty projects including student funding, travel, and research seminars, as well as other CSCVR activities.