

**Cover/Signature Page - Abbreviated Template**

**Institution Submitting Request:** School of Engineering/Scientific Computing and Imaging (SCI) Institute

**Proposed Title:** Data Center Engineering Certificate

**Currently Approved Title:** NONE

**School or Division or Location:** College of Engineering: Center for Extreme Data Management Analysis and Visualization School of Computing

**Department(s) or Area(s) Location:** School of Computing, Electrical Engineering, Mechanical Engineering

**Recommended Classification of Instructional Programs (CIP) Code<sup>1</sup> (for new programs):** 14.01.0101

**Current Classification of Instructional Programs (CIP) Code (for existing programs):** 14.01

**Proposed Beginning Date (for new programs):** 08/27/2013

**Institutional Board of Trustees' Approval Date:** *MM/DD/YEAR*

SECTION NO.		ITEM
<b>Proposal Type (check all that apply): Regents' General Consent Calendar Items</b>		
<i>R401-5 OCHE Review and Recommendation; Approval on General Consent Calendar</i>		
5.1.1	<input type="checkbox"/>	Minor*
5.1.2	<input type="checkbox"/>	Emphasis*
5.2.1	<input checked="" type="checkbox"/>	Certificate of Proficiency*
5.2.3	<input type="checkbox"/>	Graduate Certificate*
5.4.1	<input type="checkbox"/>	New Administrative Unit
	<input type="checkbox"/>	Administrative Unit Transfer
	<input type="checkbox"/>	Administrative Unit Restructure
	<input type="checkbox"/>	Administrative Unit Consolidation
5.4.2	<input type="checkbox"/>	New Center
	<input type="checkbox"/>	New Institute
	<input type="checkbox"/>	New Bureau
5.5.1	<input type="checkbox"/>	Out-of-Service Area Delivery of Programs
5.5.2	<input type="checkbox"/>	Program Transfer
	<input type="checkbox"/>	Program Restructure
	<input type="checkbox"/>	Program Consolidation
5.5.3	<input type="checkbox"/>	Name Change of Existing Programs
5.5.4	<input type="checkbox"/>	Program Discontinuation
	<input type="checkbox"/>	Program Suspension
5.5.5	<input type="checkbox"/>	Reinstatement of Previously Suspended Program
	<input type="checkbox"/>	Reinstatement of Previously Suspended Administrative Unit

**Chief Academic Officer (or Designee) Signature:**

I certify that all required institutional approvals have been obtained prior to submitting this request to the Office of the Commissioner.

<sup>1</sup> CIP codes must be recommended by the submitting institution. For CIP code classifications, please see <http://nces.ed.gov/ipeds/cipcode/Default.aspx?y=55>.

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Signature

Date: *MM/DD/YEAR*

Printed Name: *Name of CAO or Designee*

## **Program Request**

The Center for Extreme Data Management, Analysis and Visualization  
(College of Engineering and Scientific Computing and Imaging (SCI) Institute)

Data Center Engineering Certificate

04/11/2013

### **Section I: Request**

The Center for Extreme Data Management, Analysis and Visualization (CEDMAV) respectfully requests permission to establish an Undergraduate Data Center Engineering Certificate. This certificate would prepare students to deal with the specific needs and challenges of the complex environments of modern data centers in government, industry, and academia. In particular, the program will provide the students with skills associated with facility planning, decision making supporting operations management, infrastructure design, and resource management for (large scale) data centers.

We seek approval to enable students to earn a certificate by taking 27 credit hours involving areas such as Computer Science, Electrical Engineering, and Mechanical Engineering. Students will choose two classes from each area plus management and capstone class on best practices in data center operations (new class). This program is designed to provide students with the broad foundational preparation needed for managing operations in modern data centers. This interdisciplinary combination of classes addresses the specific needs of this industry sector for a skilled workforce with knowledge in power and thermal engineering, computer science, general management, and best practices for managing large scale facilities.

We expect a diverse student population. Some students, possibly already working in the industry, will be allowed to go through the certificate program at a moderate pace by taking two classes per semester as described in the schedule in appendix A. Other students may take this certificate as a short intensive program and complete the coursework within a year by taking four classes per semester. Overall, the students will be required to take 27 hours of total credit to complete the certificate.

The selection of classes outlined in this certificate proposal has been developed with multiple rounds of intense consultation with faculty of the departments involved. In particular, once we identified this gap in our curriculum, the faculties in each department have been consulted to recommend which classes would best fulfill the combined needs of this interdisciplinary program. During the process, we also relied on the direct involvement of each department chair to guarantee proper coordination and each curriculum committee to validate the sound academic structure of the certificate. The proposal is being submitted after having received positive feedback from all the parties involved, as also indicated by the attached letters of endorsement from the Director of the School of Computing Al Davis, the Chair of the ECE Department Gianluca Lazzi, the Chair of the Mechanical Engineering Department Tim Ameal, and the Director of Information Systems Programs Bradden Blair.

The overall certificate will be coordinated by Valerio Pascucci and Greg Jones. They will focus on maintaining proper coordination among the departments and be available to students for general advice on the program. They will also work at maintaining effective engagement and support from industry partners

and develop opportunities for site visits to state of the art facilities, internships for hands-on experience, and guest lecturers especially in the capstone class. Given the heterogeneous structure of the program, we have also identified a coordinator in each department to advise students in a specific area. The coordinators currently identified are Jeff Philips for the School of Computing, Tim Ameal for the ME Department, Faisal Khan for the ECE Department and Bradden Blair for the Information Systems Programs.

## **Section II: Need**

The University of Utah is poised to become a world leader in research and education for training Data Center Engineers and, in general, for dealing with the Big Data challenges of the future. Dealing with massive amounts of data is emerging as one of the main challenges in information technology. With both the amount of data and uses of the data expected to grow dramatically, this challenge and the needed workforce to address it will continue to grow at a significant rate. The data growth challenge has led most industries to create data center facilities where large amounts of data are collected and processed with a variety of demands in terms of reliability, efficiency and flexibility. This trend has created a new demand for a skilled workforce with a profile that has not been addressed by the traditional structure of university curricula. In particular, people need the skills to deal with the special challenge of highly concentrated computing and networking infrastructure where one cannot separate the problems of achieving power efficiency, processing data with high performance computing resources, and managing the heat output all within an environment with little to no downtime no matter the outside environment. While the creation of new data center facilities constitutes a growing global trend, it is particularly accentuated in the state of Utah, which has proven to be an ideal ground for developing such large-scale facilities on a basis of energy efficiency principles.

In this effort, students will be trained in project management, which will add value to the Data Center community, and lead to new innovations and ventures in Utah. Our vision is that these students will be enriched with the know-how to manage, entrepreneur, and innovate data center operations, especially in their need to adopt green technologies and achieve sustainable operations. Overall they will also derive an enhanced skillset, by which they will meet a growing need of skilled Data Center Engineers. This certificate will fill the lack of programs offered in the intermountain region, which we are ready to accommodate. Currently, there are no programs offered through Intermountain universities.

Letters of Support in Appendix B

## **Section III: Institutional Impact**

It is expected this new certificate will essentially use classes that already exist. However, we will create one class that will train students in the current best practices used in running large-scale data centers: Current Data Center Operational Practices. This course will be the capstone to the program. The other courses, outlined below, are very suitable for this program and no new facilities or modifications will be needed. With a projected enrollment of 30 students, when the certificate program reaches its maturity, we do not expect a need for additional faculty commitment.

Students will experience the meshing of mechanical, electrical and computer engineering work in the early semesters of the certificate. This will allow them to develop the solid interdisciplinary training needed to work in a facility with large amounts of storage and high performance computing capabilities, which requires dealing efficiently with the power and the thermal challenges involved. The certificate will end with an immersion in the managerial dimension of the skillset required in running a large-scale data center facility and its personnel. As has been the case from the inception of this certificate, during the execution of this program we will continue to maintain direct involvement from industry and government partners both in terms of presentations in our classes as well as in organizing a series of internships where the students will be able to have additional hands-on experience on the field while developing the interactions that can lead to employment opportunities.

Following the course outline, participating students will continue to connect with other students and professionals in this field, which will require students to develop individually and in small groups, understand and identify engineering knowledge leading them to a thorough understanding of the principles of large-scale data center management.

In addition to the capstone course, the program requires students to develop and deliver skills in the Computer Science, Electrical Engineering, Mechanical Engineering and Management fields. These are courses designed to promote this new knowledge at the proper beginning level needed for this certificate.

#### **Section IV: Finances**

It is projected that there will not be any significant increase in administrative load (recruiting, admissions, orientation, advising, and career management) for the department and any eventual cost will be offset by the increase to overall enrollment with time.

We anticipate that the students will be primarily undergraduates that will pay full tuition for the courses, and include any differentials with accompanying usual and customary fees. The departments and colleges will actively pursue external funding for scholarships/assistantships. Our intent for this is to increase enrollment by 30 undergraduate students enrolled within the first 5 years.

## Section V: Program Curriculum

### All Program Courses (with New Courses in Bold)

#### Data Center Engineering Certificate

The central component of the Data Center Engineering program is a certificate that involves 8 classes in Computer Science, Electrical Engineering, Mechanical Engineering, and Management (two in each area). These classes are organized as follows:

- General requirements (6 credits):
  - OIS 5670 – Managing Service Operations (3 credits):
    - 3 credits

Service companies constitute the largest and fastest-growing segment of the economies of the United States and many other countries. To successfully compete in this emerging service economy, it is critical for business managers to understand the managerial issues and problems unique to designing, producing, marketing and delivering services. This course aims to develop a better understanding of best practices in the service sector through analysis of leading-edge firms and the strategies they have employed to create and maintain competitive advantage. Topics include the design and delivery of breakthrough services, managing the service encounter, and the role of technology, in particular information technology, in changing the nature of the service delivered and/or the way in which the service is delivered. The course relies on the analysis of a number of case studies, and includes a project where the principles developed in the course are applied to a real service organization

- **CS 5030 – Data Center Operational Practices (3 credits):**
  - 3 credits

This course will focus on the evolving design elements and the latest operational practices employed in modern, large-scale data centers for efficient management of electric power, computational and data load, and cooling. The course will include both seminars by professionals from design firms and local data centers and reports by students who have completed internships at these facilities. We will also tour several local data centers during the term and expose students to the latest green technologies adopted in Utah data centers. Enrollment is limited to those enrolled in the Data Center Engineering program with either senior or masters student standing.

- Two classes in Mechanical Engineering (Thermal Systems and Design) (7 credits):
  - ME EN 3650 Heat Transfer for non-majors (prerequisites waved)

- Credits 4

Basic mechanisms of heat transfer, law of conservation of energy, conduction, convection, radiation, heat transfer with change of phase, heat exchangers.

- One class chosen among the following three:

- ME EN 5800 Sustainable Energy Engineering:

- Credits 3

Engineering of energy collection and production systems that satisfy long-term energy needs while minimizing damage to the earth's ecosystem. Conversion of chemical and nuclear fuels to produce work or electrical energy. Solar, wind, biomass, geothermal, co-generation and direct energy conversion. Conservation, seasonal underground energy storage, and hydrogen production technologies.

- ME EN 5810 Thermal System Design:

- Credits 3

Design of steam-power plants, feed-water heater systems, pumping systems, compressor blades, turbine blades, and heat exchangers. Equation fitting and economic analysis as basis of design decisions. Optimization of thermal systems using Lagrange multipliers, search methods, dynamic programming, geometric programming, and linear programming. Probabilistic approaches to design.

- ME EN 5820 Thermal Environmental Engineering:

- Credits 3

Principles of design of systems for heating and cooling of buildings. Heat-load calculations, psychometrics, thermodynamic systems, and solar-energy concepts.

- Two classes in Computer Science (8 credits):

- CS 3810 - Computer Organization:

- Credit hours 4

An in-depth study of computer architecture and design, including topics such as RISC and CISC instruction set architectures, CPU organizations, pipelining, memory systems, input/output, and parallel machines. Emphasis is placed on performance measures and compilation issues

- CS 4400 - Computer Systems:

- Credit hours 4

Introduction to computer systems from a programmer's point of view. Machine level representations of programs, optimizing program performance, memory hierarchy, linking, exceptional control flow, measuring program performance, virtual memory, concurrent programming with threads, network programming

- Two classes in Electrical and Computer Engineering for Power Engineering (6 credits):

- ECE 2210 Electrical and Computer Engineering for Non-majors:
  - 3 credits

Fundamentals of electrical and computer engineering topics for non-electrical and computer engineers. Covers fundamentals of dc and ac circuit theory, active semiconductor devices (diodes, transistors, amplifiers), 60 Hz-power circuits and equipment (2 and 3 phase circuits, transformers, motors), transducers and actuators, safety considerations.

- ECE 3600 Introduction to Electric Power Engineering:
  - 3 credits

Introduction to AC power generation, distribution, and use. Topics will include single-phase and 3-phase power, power factors and corrections, transformers, power distribution and the grid, generation plants, and some wiring and AC motors

Course Prefix and Number	Title	Credit Hours
Required Courses		
ECE 2210	Electrical and Computer Engineering for Non-majors	3 credits
ECE 3600	Introduction to Electric Power Engineering	3 credits
ME EN 3650	Heat Transfer for non-majors	4 credits
CS 3810	Computer Organization	4 credits
CS 4400	Computer Systems	4 credits
ME EN 5800	Sustainable Energy Engineering	3 credits
ME EN 5810	Thermal System Design	
ME EN 5820	Thermal Environmental Engineering	
OIS 5670	Managing Service Operations	3 credits
CS 5030	<b>Data Center Operational Practices</b> (new class defined by Steve Corbato)	3 credits
<b>Sub-Total</b>		<b>27 credits</b>
Elective Courses		
<b>Sub-Total</b>		
Track/Options (if applicable)		
<b>Sub-Total</b>		
<b>Total Number of Credits</b>		<b>27 credits</b>

## Section VI: Program Offering

The proposed Data Center Engineering program will be offered with two main mechanisms:

- (1) as a certificate combined with an undergraduate degree offered by one of the three core departments or
- (2) as a standalone certificate offered via continuing education and certified for completion directly by the college of engineering.

The first option targets students that want to pursue a traditional degree while achieving the interdisciplinary preparation provided the certificate. In this option the certificate will be offered by designing a special version of the undergraduate programs in the following four degrees: Computer Engineering, Electrical Engineering, Mechanical Engineering, and Computer Science. For each of these degrees, we have developed a structure that uses most of the technical electives to complete the Data Center Engineering Certificate while satisfying all the requirements of the core undergraduate programs. In this way the students can be awarded a regular undergraduate degree with the addition of the certificate in data center engineering. In appendix A, we attach the four advising sheets that implement this structure and that have been approved by the relative departments.

The second option targets students that need to broaden their existing preparation and experience by pursuing the eight classes of the certificate but that do not need a full degree (e.g. they may already have a BS in computer science). These are students will not be matriculated at the University but will be allowed to register to the classes via the continuing education program (the procedure for cross listing the classes with continuing education will start upon approval of this proposal). CEDMAV and the college of engineering will manage directly this direct admission of the students to the certificate and track their progress. Upon successful completion of all the classes a certificate of completion will be issued to the students cosigned by the director of the program and the dean of the college of engineering. Appendix A also reports a possible plan for students taking the stand-alone option of the certificate.

# Appendix A: Advising Forms

STUDENT ID # \_\_\_\_\_ Name \_\_\_\_\_

## COMPUTER ENGINEERING: Data Center Engineering Certificate

2013-2014

### Bachelor of Science Degree Requirements

#### PRE-MAJOR REQUIREMENTS (7)

	Hrs	Sem	/	Grade
CS 1410 CS I or CS 2000 (4)	_____	_____	/	_____
CS 2420 CS II (4)	_____	_____	/	_____
ECE 1250 ECE Design (4)	_____	_____	/	_____
MATH 1210 Calc I (4)	_____	_____	/	_____
MATH 1220 Calc II (4)	_____	_____	/	_____
PHYS 2210 Eng Phys I (4)	_____	_____	/	_____
WRTG 2010 or ESL 1060 (3)	_____	_____	/	_____
<b>Composite Admission Score</b>	_____			

#### UPPER DIVISION WRITING REQUIREMENT (1)

WRTG 3014 (or 3015) (3) \_\_\_\_\_ / \_\_\_\_\_

#### ADDITIONAL MATH/SCIENCE CLASSES (4)

Math 2210, Math 2250 and Physics 2220 are required.  
1 additional class is required. Choose from  
Biol 1210, Chem 1210, Math 3150, Math 5600,  
CS 3200 or Physics 3740.

	Hrs	Sem	/	Grade
MATH 2210 Calc III (3)	_____	_____	/	_____
MATH 2250 DE & Lin Alg (4)	_____	_____	/	_____
PHYS 2220 Eng Phys II (4)	_____	_____	/	_____
ME 3650 Heat Transfer (4)	_____	_____	/	_____

#### MAJOR REQUIREMENTS (14 courses –all required)

	Hrs	Sem	/	Grade
ECE 1900 Freshman Seminar (.5)	_____	_____	/	_____
ECE 2240 Electric Circuits (4)	_____	_____	/	_____
CS 2100 Discrete Structures (3)	_____	_____	/	_____
ECE 2280 Eng Electronics (4)	_____	_____	/	_____
CS 3500 Software Practice (4)	_____	_____	/	_____
CS 4400 Computer Systems (4)	_____	_____	/	_____
ECE 3530 Eng Prob & Stats (3)	_____	_____	/	_____
CS/ECE 3700 Dig Sys Design (4)	_____	_____	/	_____
CS/ECE 3710 Comp Design Lab (4)	_____	_____	/	_____
CS/ECE 5780 Emb Sys Design (4)	_____	_____	/	_____
CS/ECE 3810 Comp Org (4)	_____	_____	/	_____
CS/ECE 3991 CE Jr. Seminar (.5)	_____	_____	/	_____
CS/ECE 3992 Pre-Thesis/Proj (1)	_____	_____	/	_____
LEAP 1501 Engineering Ethics (3)	_____	_____	/	_____

#### CAPSTONE EXPERIENCE (1 of the following required)

CS/ECE 4710 Sr. Project(3) \_\_\_\_\_ / \_\_\_\_\_

**OR**

CS/ECE 4991/4992 Thesis(4) \_\_\_\_\_ / \_\_\_\_\_

CS/ECE 4991 Sr Thesis I \_\_\_\_\_ / \_\_\_\_\_

CS/ECE 4992 Sr Thesis II \_\_\_\_\_ / \_\_\_\_\_

**OR**

ECE 4900/4910 Clinic (5)

ECE 4900 (2) \_\_\_\_\_ / \_\_\_\_\_

ECE 4910 (3) \_\_\_\_\_ / \_\_\_\_\_

#### TECHNICAL ELECTIVES: 6 SEMESTER HOURS

(above 3000) CS or ECE CLASSES.

Required courses can not also count in this area. Seminars, CS 3050/51, 5010/20, and 5050/51 may not be counted. Also, only one Independent Study class may be counted. All courses must be completed for a grade of C- or higher

Class #	Hrs	Sem	/	Grade
CS/ECE _____	( )	_____	/	_____
CS/ECE _____	( )	_____	/	_____
CS/ECE _____	( )	_____	/	_____
CS/ECE _____	( )	_____	/	_____

#### DATA CENTER ENG. REQUIREMENTS:

1. CS 5030, Data Center Operations
2. ECE 3600 Introduction to Electric Power Eng.
3. OIS 5670, Managing Service Operations
4. ME EN 5800 Sustainable Energy Engineering or ME EN 5810 Thermal System Design or ME EN 5820 Thermal Environmental Engineering

#### BREADTH & DEPTH REQUIREMENT

For Accreditation purposes, Computer Engineering students are required to demonstrate a breadth and depth of knowledge outside of the field of Computer Engineering. Regardless of the Intellectual Explorations and General Education requirements being waived by the University of Utah, all CE students must complete the following for the Computer Engineering BS degree: 1 American Institutions (AI), 2 Fine Arts (FF), 2 Humanities (HF), 2 Social / Behavioral Sciences (BF), 1 Diversity (DV), & \*1 International Requirement (IR).

Additional Computer Engineering requirements: One course must be an ethics course (will fulfill an HF) and two of the above courses must be upper division (3000 or above).

NOTE: No course can count for multiple requirements within the IE area, but one course can count for an IE and multiple requirements below the dashed line. (Ex. Phil 4540 will fulfill an HF, an Ethics and Upper Division requirements. See the Undergraduate Bulletin for courses that fulfill multiple requirements.)

AMERICAN INSTITUTIONS (AI) \_\_\_\_\_

#### Intellectual Exploration (IE):

FF 1) \_\_\_\_\_  
FF 2) \_\_\_\_\_

HF 1) \_\_\_\_\_  
HF 2) \_\_\_\_\_

BF 1) LEAP 1501 \_\_\_\_\_  
BF 2) \_\_\_\_\_

#### Bachelor's Degree Requirements:

DIVERSITY 1) \_\_\_\_\_

\*INTERNATIONAL 1) \_\_\_\_\_

\* Required of students who enroll for the first time in Fall 2007 and will be required of all students starting Fall 2013, regardless of enrollment date.

#### Computer Engineering Requirements:

ETHICS 1) LEAP 1501 \_\_\_\_\_

UPPER DIVISION 1) \_\_\_\_\_

UPPER DIVISION 2) \_\_\_\_\_





<b>Data Center Engineering Certificate Requirements</b>			
<b>Group1:</b> can be used for breadth requirements			
	ECE 3600 Electric Pwr Eng	3	
	ECE 3810 Computer Org	4	
<b>Group2:</b> can be used for advanced technical electives			
	CS 4400 Computer Systems	4	
	CS 5030 Data Center Operations	3	
<b>Group3:</b> can be used for non-ECE technical electives			
	ME EN 3650 Heat Transfer	4	
	ME EN 5800 Sustainable Energy Eng. or ME EN 5810 Thermal System Design or ME EN 5820 Thermal Environmental Eng.	3	
<b>Group4:</b> additional business requirement			
	OIS 5670 Managing Service Operations	3	



**– Data Center Engineering Certificate –  
Stand-Alone Program**

**Year 1: Fall Semester**

ECE 2210	Electrical and Computer Eng. for Non-majors	3		
CS 3810	Computer Organization	4		

**Year 1: Spring Semester**

ME EN 3650	Heat Transfer	<b>4</b>		
ECE 3600	Introduction to Electric Power Engineering	<b>3</b>		

**Year 2: Fall Semester**

CS 4400	Computer Systems	<b>4</b>		
ME EN 5800 Sustainable Energy Eng. or ME EN 5810 Thermal System Design or ME EN 5820 Thermal Environmental Eng.		<b>3</b>		

**Year 2: Spring Semester**

CS 5030	Data Center Operations	<b>3</b>		
OIS 5670	Managing Service Operations	<b>3</b>		

## Appendix B: Letters of Support



March 29, 2013

Professor Pascucci,

I am glad to write this letter in support of the proposal to create a certificate in Data Center Engineering at the University of Utah.

As Director of the School of Computing, we are one of the three main departments involved in this certificate. In addition, I am also personally involved in research that develops technology that I believe will be a key to improving the performance and energy consumption of future data centers. My primary contributions to this space over that last several years has been in the development of photonic devices and architecting their use in high performance, energy efficient, warehouse scale interconnection networks. I have also worked in the development of high-capacity, energy efficient main memory systems utilizing both DRAM and non-volatile memory components. Part of this work has been with colleagues at Hewlett-Packard Laboratories. HP is a major data center manufacturer. I am therefore deeply familiar with the technological challenges involved the development and innovation of large scale data centers and the need for academic institutions to collaborate with industrial partners.

Generally, this new Certificate will fill a void in our curriculum in terms of the combined basic preparation in the three main areas of computer system architecture, power distribution, and thermal engineering. All of these expertise domains are critical for future data center engineers and operators. Students in this program will have a nearly unique opportunity and the University of Utah is one of the few places in the country that currently has both the vision and the faculty expertise to create such a program. Our industrial contacts have expressed a significant interest in helping us to develop this program in a way that is relevant both now and in the future. These industry partners will also provide an opportunity for hands on experience through internships and may also provide guidance and collaborative opportunities for the associated research efforts..

Overall, I believe the creation of this new certificate is very timely and I strongly support its approval by the University of Utah.

Sincerely,



Al Davis  
Professor & Director

**School of Computing**

50 S. Central Campus Dr Rm 3190  
Salt Lake City, Utah 84112-9205  
(801) 581-8224  
FAX (801) 581-5843

April 3, 2013

Dear Dr. Pascucci,

I am writing this letter to show my support for the creation of the Data Center Engineering Certificate at the University of Utah.

As the Director of the Master of Science in Information Systems Programs and an Assistant Professor at the David Eccles School of Business, I am always interested in advancing our curriculum offerings in ways that better prepare our students for the challenges they will face as workforce not only today but more importantly in the future decades. Data center operations have recently been an area of significant growth and job prospects are extremely good for qualified candidates in the coming years. The creation of this Data Center Engineering Certificate addresses a fundamental need: to develop an agile workforce with basic interdisciplinary knowledge in the areas of electrical, mechanical and computer engineering as well as good management practices.

The creation of Data Center Engineering Certificate at the University of Utah is a timely opportunity, as it will provide focused students who will be skilled in the management of data center operations and knowledgeable about fundamental issues related to data center engineering. The program will also attract new talent to the University of Utah, which will lead to continued growth of a talented student base. The University will also benefit more broadly from building this educational program, since it will create close ties to both government and industry, which will continue to have a growing need for medium and large data centers.

I am confident that the new certificate will be very successful under your leadership, and I look forward to new opportunities for collaboration.

Sincerely,



Bradden Blair  
Director of Information Systems Programs  
Assistant Professor  
David Eccles School of Business



Richard B. Brown  
Dean of Engineering  
1692 Warnock Engineering Building  
72 S. Central Campus Drive  
Salt Lake City, Utah 84112  
PH: (801) 585-7498 FAX: (801) 581-8692  
brown@utah.edu  
March 28, 2013

Dear Dr. Pascucci,

With this letter I am providing my support for the creation of Data Center Engineering Certificate at the University of Utah. I have been personally involved in this certificate since its inception.

In my capacity as Dean of the College of Engineering I am always concerned that we offer a curriculum that is up to date with latest technological advances in the field, and that properly prepares future generations of engineers for the opportunities they will find in their professions. For this reason I strongly support the creation of this Data Center Engineering Certificate. It will introduce a new professional profile with the basic interdisciplinary knowledge in electrical engineering, mechanical engineering, and computer science, which is highly sought now by the data center management industry, and will be in growing demand going forward. This demand will be particularly strong in our state, since we are witnessing an increasing number and size of data center installations, ranging from the massive ones from NSA and Oracle to smaller ones at local companies such as Viawest and Center7.

The introduction of this new certificate is part of an organic development that is positioning the University of Utah as a national leader in Big Data initiatives for research and education. I am very excited for the opportunity of creating this new certificate, and I look forward to the skilled workforce that will be developed in this program.

Sincerely,

Richard B. Brown  
Dean

Dear Dr. Pascucci,

I offer this letter in support of your work establishing a new Data Center Engineering Certificate at the University of Utah. Founded in 1993, XMission was the first independent Internet Provider in Utah. XMission renovated an adjacent building in 2001, converting it into a 15,000 square foot data center and greatly expanding our colocation services. Starting in 2003, the company began providing free wireless in public libraries and some local businesses and has since expanded free wireless throughout the metropolitan Salt Lake area. XMission provides streaming support for radio stations, including NPR affiliate KCPW-FM and independent radio station KRCL. An ardent support of our community, XMission also provides free accounts to hundreds of non-profit organizations and sponsors many events, including the Utah Open Source Conference, the Living Planet Aquarium, the Living Traditions Festival, the Utah Arts Festival, and the Twilight Concert Series. Additionally, we were the first ISP in Utah to upgrade to 100% renewable energy, including Rocky Mountain Power's Blue Sky program.

Over the past several years Utah has seen a rapid increase in the number and size of data centers our state hosts. The data management industry in Utah now includes large centers built by the likes of eBay, Goldman Sachs, the NSA, and Oracle not to mention the organically growing local centers like ours, Center7, Viawest, and the Tonaquint facility in St. George. Utah offers a number of benefits to these companies but a growing need for a highly trained workforce is a constant challenge. As state and regional economic development managers continue to recruit new data centers, the need for a highly skilled technical workforce will become harder to satisfy. We at XMission applaud Dr. Pascucci and the University's leadership for their creation of an educational program that will help avert this coming workforce shortage.

I give my enthusiastic support to your efforts and the certificate program and look forward to hiring these students when they finish the program.

Sincerely,



Grant Sperry

VP of Operations

XMission



Department of Mechanical Engineering

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50 S. Central Campus Dr. Rm. 2110 MEB Salt Lake City, Utah 84112 Phone (801) 581-6441 Fax (801) 585-9826 www.mech.utah.edu

April 1, 2013

Valerio Pascucci  
SCI Institute  
Campus

Dear Dr. Pascucci,

This letter is written to give my enthusiastic support for the creation of a Data Center Engineering certificate involving the departments of Mechanical Engineering, Electrical and Computer Engineering, and the School of Computing.

As the Chair of the Department of Mechanical Engineering, I have been actively involved in the design of this certificate program. In fact, I am one of the instructors that typically teach a class in Heat Transfer, which will be an integral part of this program. The proposed certificate will introduce a new professional profile into our curriculum that is clearly in need today and that will be in increasing demand in the future. The data center industry is growing at a rapid pace and requires a new workforce with a particular interdisciplinary background that includes features of mechanical, computer and electrical engineering. This is particularly true for the state of Utah where many large-scale data centers, such as those for NSA, Oracle, eBay and Twitter, have been built in the last few years. These data centers provide excellent training (e.g., with internship programs) and employment opportunities.

Establishing this certificate will allow our students to gain a competitive advantage and our university to establish a strong relationship with the data center industry. I expect this relationship to have lasting benefits since it will be a driver for new research in green technology for efficient energy management and sustainable development of large scale computing installations. Overall, the creation of this certificate will have a strategic value in establishing the University of Utah as a leader in research and education in this sector.

I look forward to the opportunity of contributing to the creation and support of this new program and I am confident that it will be successful in attracting new students to the College of Engineering.

Sincerely,

Tim Ameel, Ph.D.  
Professor and Chair



## Utah Regional Operations Center

12953 SOUTH MINUTEMAN DRIVE  
DRAPER, UTAH 84020  
(801) 432-4822

University of Utah  
Salt Lake City, Utah

2 April 2013

Dear Colleagues,

In November 2008 following a long proposal and evaluation phase involving more than 35 potential building sites from across the nation, Camp Williams, Utah was selected as the location to house our nation's first Intelligence Community (IC) Comprehensive National Cybersecurity Initiative (CNCI) data center. Not the least among the reasons for selecting Utah for this data center site was the University of Utah with its solid STEM degree programs and its legacy of continuous state-of-the-art research in computing and engineering fields.

As we prepared to construct the Utah Data center (UDC) our research indicated it would be difficult to hire the type of individuals we would need to operate our special purpose data center. Accordingly, under the direction of NSA's Associate Director for Installations and Logistics, Dr. Harvey Davis, in May of 2010 I contacted President Young and Dr. Richard Brown to discuss the possibility of developing a data center engineering degree program within the University's College of Engineering. It was thought that such a program would produce graduates that would be prepared to successfully meet the rigorous requirements for operating the UDC.

Since those early meetings I have met with Dr. Brown and his staff regularly and often to discuss curriculum development, internship opportunities and associated strategies for student recruitment. Dr. Steve Corbato, Dr. Greg Jones and Dr. Valerio Pascucci have been particularly helpful, enthusiastic and skilled at guiding the development of the Bachelor's Degree and Master's Degree curricula. In addition, together with the Governor's Office of Economic Development (GOED), Dr. Corbato, Dr. Jones and I co-sponsored the creation of the Utah Data Center Consortium (UDCC) in January 2012 to bring government, academia, and private industry together to regularly discuss and consider data center best practices, education development, and to act as an advisory body to state government officials involved in data center development in Utah.

I am very pleased with and grateful for the University's efforts to develop the data center degree programs and eager to formally implement the programs. I am confident that students who complete the data center certificate program (Bachelor's) or who are graduates of the Master's program will have the requisite education to be successful in any small, medium, or large data center anywhere in the world.

I have also spent a good deal of time with other data center operators in the region and can attest that they, too, are very eager to hire graduates from these programs. At the moment there is only one other university in the country offering similar educational opportunities. With its historically superb college of engineering, a terrific school of computing, new high-tech institutes such as SCI and CEDMAV, and the new data center programs the University of Utah will continue to solidify itself as the STEM champion in the west. As such I urge University officials to move forward with approval and implementation of the new Data Center degree programs.

Sincerely,

David M. Winberg  
Director, NSA-Utah

cc: Dr. Harvey Davis  
Ft. Meade, MD

April 2, 2013

Dr. Valerio Pascucci  
University of Utah  
Scientific Computing and Imaging Institute  
72 S. Central Campus Drive, Room 3750  
Salt Lake City, UT 84112

RE: Letter of Support for the Data Center Engineering Program

Dear Dr. Pascucci:

With this letter I would like to submit my formal support to this proposal for the creation of a Data Center Engineering Certificate at the University of Utah.

I am a USTAR Professor and the Chair of the Electrical and Computer Engineering Department. I am really glad to have my department involved in the development of this certificate, since it is introducing a much needed new component to our program. The data center industry is a major source of power management and engineering challenges that requires new research that our department is already engaged in. It also requires a new breed or workforce with a basic knowledge spanning several domains relating to the energy consumption of high performance computing platforms as well as the heat management that is associated with the high concentrations of resources in a single facility. The relevant disciplines in electrical, mechanical, and computer engineering have been traditionally separated and this separation does not serve well the workforce of modern data centers.

Introducing this new certificate will allow our departments to work in concert on the preparation of new students while engaging the relevant industry, which will also spark new possibilities for joint research. This will be of great benefit for our power engineering program that is working at addressing the major challenges of sustainable power production and management for the future generations.

I look forward to contributing to this program that I expect to be very successful in attracting new students and positioning the University of Utah as a national leader in this growing field.

Sincerely,



GIANLUCA LAZZI  
USTAR Professor and ECE Department Chair  
Editor-in-Chief, IEEE Antennas and  
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