



TOPIC: University of Maryland University College: Master of Science in Cloud Computing Architecture

COMMITTEE: Education Policy and Student Life

DATE OF COMMITTEE MEETING: January 13, 2015

SUMMARY: The proposed Master of Science in Cloud Computing Architecture satisfies an increasing need for professionals with cloud-based computing skills. With the unique threats posed to data security by the increase in use of cloud-based solutions, having a workforce prepared to address these threats is critical. The proposed program will prepare students to have broad, high-level knowledge and skill sets from multiple disciplines, while facilitating a deep understanding of the applicability of these disciplines to the cloud environment.

The proposed program focuses on cloud computing solutions from both design and implementation perspectives. Students will work on real world cloud design issues for state-of-the-art open source technologies, including having access to a real production-ready cloud environment to fully exercise the skills required to design, setup, configure, and optimize a cloud computing environment. During the preparation of this proposal, experts were consulted to gain their perspectives of the appropriate topics to cover in a cloud computing curriculum.

The proposed program has a distinct value proposition in meeting the needs of industry. Spending on public and private IT cloud services is expected to generate nearly 14 million jobs worldwide by 2015, according to a study released in early 2012 by analyst firm IDC2. Cloud computing services has not only altered the way providers operate, but it has also shaken up the traditional structure of the IT department and placed new demands on staff members who are faced with reinventing their own careers as a result of this evolving technology.

The proposed M.S. in Cloud Computing Architecture program is unique in that there are no degree programs in cloud computing offered at any Maryland higher education institution, as determined by a search of the MHEC inventory of approved programs offered in Maryland.

ALTERNATIVE(S): The Regents may not approve the program or may request further information.

FISCAL IMPACT: No additional funding is necessary. The program will be supported through tuition.

CHANCELLOR'S RECOMMENDATION: That the Committee on Education Policy and Student Life recommend that the Board of Regents approve the proposal from the University of Maryland University College to offer the Master of Science in Cloud Computing Architecture.

COMMITTEE RECOMMENDATION: Approval

DATE: January 13, 2015

BOARD ACTION:

DATE:

SUBMITTED BY: Joann Boughman

301-445-1992

jbooughman@usmd.edu

UNIVERSITY SYSTEM OF MARYLAND INSTITUTION PROPOSAL FOR

- New Instructional Program
- Substantial Expansion/Major Modification
- Cooperative Degree Program

University of Maryland University College

Institution Submitting Proposal

Master of Science in Cloud Computing Architecture

Title of Proposed Program

Master of Science

Degree to be Awarded

Fall 2015

Projected Implementation Date

0700

Proposed HEGIS Code

11.1003

Proposed CIP Code

The Graduate School

Department in which program will be located

Aric Krause, PhD, Vice Provost and Dean

Department Contact

(240) 684-2400

Contact Phone Number

aric.krause@umuc.edu

Contact E-Mail Address

Marie A. Cini

Signature of President or Designee

9/19/14

Date

University of Maryland University College
Master of Science in Cloud Computing Architecture

University of Maryland University College (UMUC) proposes to offer a new academic program, the Master of Science (M.S.) in Cloud Computing Architecture. The new degree will require successful completion of six courses for a total of 36 semester hours of graduate-level coursework.

Mission

The mission of University of Maryland University College is to offer top-quality educational opportunities to adult students in Maryland, the nation, and the world, setting the global standard of excellence in adult education. By offering academic programs that are respected, affordable and accessible technologically and through a variety of face-to-face formats, UMUC broadens the range of career opportunities available to students, improves their lives, and maximizes their economic and intellectual contributions to Maryland, the nation, and the world.

This mission is rooted in UMUC's institutional purpose as stipulated by State statute (Md. Education Code Ann. § 13-101(2012)); specifically that the university shall:

- (1) Operate as Maryland's open university, serving nontraditional students who reside in Maryland, the United States and around the world;
- (2) Provide the citizens of Maryland with affordable, open access to higher education;
- (3) Continue as a leader in distributed education.

As the public state and national leader in distance and distributed education, UMUC awards associate's, bachelor's, master's and doctoral degrees, as well as undergraduate and post-baccalaureate certificates. The university's academic inventory offers programs that are core to any public university, but UMUC's mission to the adult student results in an emphasis on workforce relevant programs. Consequently, the university awards degrees and certificates in the arts and humanities, behavioral and social sciences, business and management, health-related fields, computing, education and technology, including degrees in fields facing critical shortages, such as cybersecurity, information assurance and graduate level teacher training in STEM areas. As part of its emphasis on workforce needs, UMUC offers non-credit professional development programs such as those in executive leadership and hosts professional conferences and meetings that support the economic and societal needs of the State.

This proposal aligns with UMUC's mission to offer high quality, workplace relevant academic programs to adult students that expand their range of career opportunities. The proposed Master of Science in Cloud Computing Architecture satisfies an increasing need for professionals with cloud-based computing skills. With the unique threats posed to data security by the increase in use of cloud-based solutions, having a workforce prepared to address these threats is critical. The proposed program will prepare students to have broad, high-level knowledge and skill sets from multiple disciplines, while facilitating a deep understanding of the applicability of these disciplines to the cloud environment.

Rationale and Need for the Proposed Program

Cloud computing is an emerging field that has enormous growth potential. In a November 2012 white paper by IDC researchers by Anderson and Gantz, entitled “Climate Change: Cloud’s Impact on IT Organizations and Staffing,” the following conclusions were noted¹:

- In 2012, more than 1.7 million cloud computing technology jobs globally were unfilled due to lack of training and certification.
- IDC found that “lack of training, certification, or experience” are the top reasons why positions are remaining unfilled.
- Demand for cloud computing technology professionals was projected to grow by 26% annually through 2015.
- Approximately 2/3 of global firms are migrating to cloud technology and over 50% of global firms have cited that cloud technology is a corporate priority.
- The need for cloud based skills will grow at 6 times the rate of overall IT skills.

The proposed program is being designed to satisfy this need for cloud-based skills. UMUC’s M.S. in Cloud Computing Architecture is unique because it is focused on how various technologies are implemented in a cloud environment supporting cloud-based solutions.

The proposed program focuses on cloud computing solutions from both design and implementation perspectives. Students will work on real world cloud design issues for state-of-the-art open source technologies, including having access to a real production-ready cloud environment to fully exercise the skills required to design, setup, configure, and optimize a cloud computing environment.

During the preparation of this proposal, experts were consulted to gain their perspectives of the appropriate topics to cover in a cloud computing curriculum. The following are comments from some of these consultants.

Felicia Levy, Ph.D – EMC (UMUC adjunct faculty member):

“Speaking as a cloud person for EMC, we are constantly looking to hire people who understand the so called third generation of computing. We need people who have experience looking at the previous generation (Client/Server) and can assist clients in migrating to the cloud computing environment. We find that there is a lack of skilled professionals. The people who are out there usually have specific experience having gone through a migration once, but lack the general foundational understanding in order to be able to apply it to different scenarios in different environments. I believe the program as you’ve proposed, will address this market gap. Cloud services is one of the fastest growing sectors in the IT industry. People who have real world experience are highly sought after and highly compensated. To be able to come to the table and say that not only do you have real world experience in designing and implementing a cloud architecture, but you also have a degree that focused on cloud computing, would make you

¹ Retrieved December 18, 2014 from

<http://news.microsoft.com/download/presskits/learning/docs/IDC.pdf>

a viable candidate. The problem that many people find is that unless their organization is undergoing a transformation, there are limited opportunities to design and implement a cloud architecture. This program could meet this gap for students thereby making the program very appealing to many people who had not previously thought about getting a master's degree. It would also appeal to people in the workforce who are trying to update their skills but are unable to do so because of their current work environment and their inability to access a cloud environment in which to develop their new skills. There is a definite need for this type of program within the academic world."

Andy Head, RTP - University Relations for IBM (graduate of University of Maryland College Park):

"IBM recognizes cloud computing as one of the most important transformative innovations that has occurred within the last decade. It is completely changing how companies do business, how students of all ages are taught, how faculty perform research, etc. etc. Therefore, training future students on the subject is one of the most important endeavors that today's educational institutions can embark upon. IBM and RTP CAS therefore fully support the establishment of a cloud architecture program at UMUC, and look forward to collaborating in support of its creation."

Messan Bamezon – Accenture (graduate of UMUC):

"Bringing the Cloud Architecture major to the school is definitely a good idea. Personally, it is something I have been looking for in a master's program, as the next step in my career is to become an application/solution architect. I will be the first student to register for classes once the program is available."

Market Demand

The proposed program has a distinct value proposition in meeting the needs of industry. Spending on public and private IT cloud services is expected to generate nearly 14 million jobs worldwide by 2015, according to a study released in early 2012 by analyst firm IDC².

Cloud computing services has not only altered the way providers operate, but it has also shaken up the traditional structure of the IT department and placed new demands on staff members who are faced with reinventing their own careers as a result of this evolving technology.

As shown in Figure 1, there is a range in the size of the cloud computing market share according to the estimates given by three technology research firms; the size differences are likely due to differences in the terminology and definitions employed by the research firms. Forrester Research predicted that the global cloud computing market would reach \$241 billion in 2020, while Gartner placed the global cloud computing market at \$176.8 billion in 2015. And IDC expected the global cloud computing market to reach \$79.5 billion in 2014 from \$21.5 billion in 2010.

² Retrieved December 18, 2014 from

http://news.microsoft.com/download/features/2012/idc_cloud_jobs_white_paper.pdf

Figure 1. Cloud Market Forecasts from three different research firms³

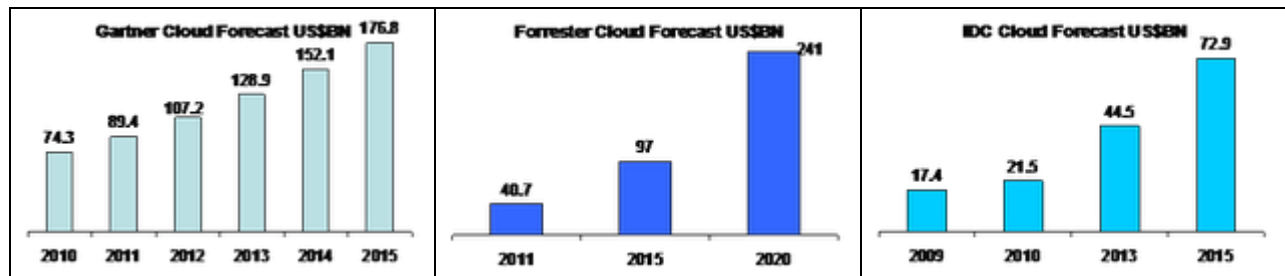
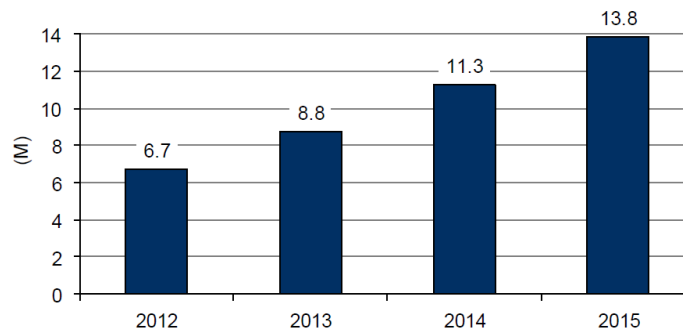


Figure 2 below shows that the projected number of total jobs created in cloud computing is expected to reach 13.8 million by the end of 2015. The source is 2012 IDC white paper by Gantz, Toncheva and Minton, entitled “Cloud Computing’s Role in Job Creation.”⁴

Figure 2. Cloud Computing Impact on Jobs

Cloud Computing Impact on Jobs: Total Cumulative Jobs Generated by Cloud Computing Worldwide at Year-End, 2012–2015



Source: IDC, 2012

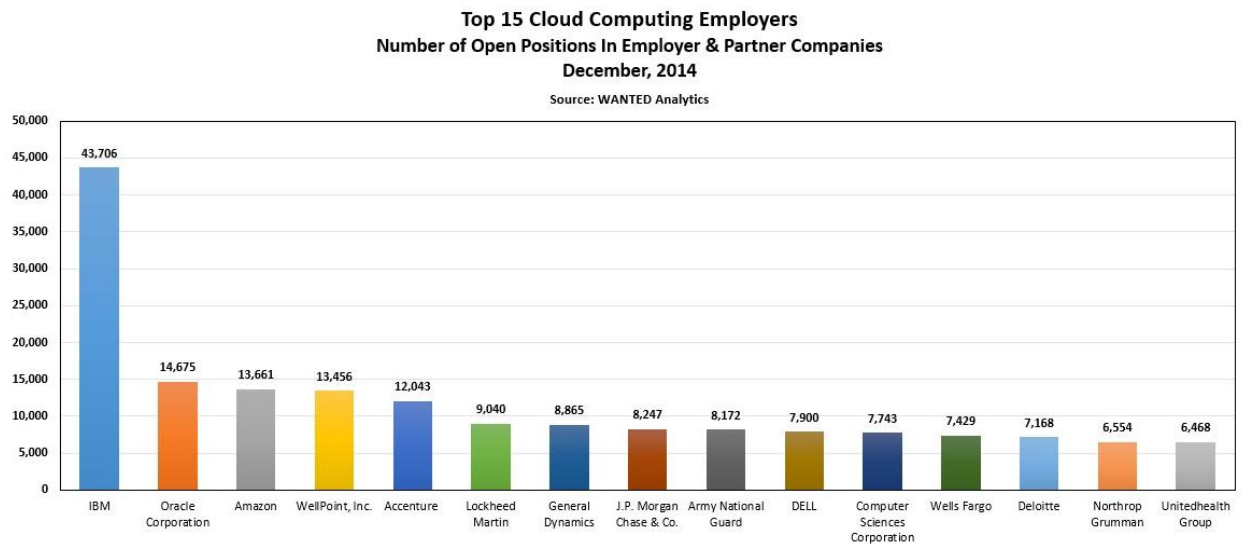
Other evidence of demand is evident in the numbers of open positions for cloud computing related jobs by major employers, as depicted in Figure 3 from Forbes.com⁵:

³ Retrieved December 18, 2014 from <http://analysiscasesstudy.blogspot.com/2011/11/global-cloud-computing-industry-2011.html>

⁴ Retrieved December 18, 2014 from http://news.microsoft.com/download/features/2012/IDC_Cloud_jobs_White_Paper.pdf

⁵ Retrieved on December 10, 2014 from: <http://www.forbes.com/sites/louiscolombus/2014/12/12/where-cloud-computing-jobs-will-be-in-2015/>

Figure 3. Top 15 Cloud Computing Employers



Source: Forbes.com

According to the careers website O*NETOnline (<http://www.onetonline.org/>), the following job categories related to cloud computing are in higher than average demand:

- Computer and Information System Managers
- Network & Computer System Administrators
- Computer System Analyst
- Computer Programmer
- Computer User Support Specialist
- Web Administrator

Program Duplication

The proposed M.S. in Cloud Computing Architecture program is unique in that there are no degree programs in cloud computing offered at any Maryland higher education institution, as determined by a search of the MHEC inventory of approved programs offered in Maryland.

As indicated below, two Maryland universities offer individual courses in cloud computing, but not full programs:

- The Johns Hopkins University offers Hadoop: Big-Data Apps in the Cloud (a non-credit short course open to the public); 605.431 Cloud Computing; and 605.741 Distributed Database Systems: Cloud Computing and Data Warehouses.
- University of Maryland College Park offers ENTS 649B Special Topics in Networking: Cloud Computing.

Relevance to Historically Black Institutions (HBIs)

A search of the MHEC inventory of approved academic programs in Maryland found no graduate or undergraduate program in cloud computing offered at the four Historically Black Institutions (HBI) in Maryland (Bowie State University, Coppin State University, University of Maryland Eastern shore, and Morgan State University). Thus, UMUC's proposed program will have no impact on the uniqueness and institutional identities and missions of the HBI's, and will not harm these schools.

Characteristics of the Proposed Program

The curriculum of the proposed program is being developed in alignment with industry needs. The needs of the industry are well-described in an unpublished report "Cloud Computing Qualitative Exploration Summary Report" presented to the Institute of Electrical and Electronics Engineers by TNS Landis, an international strategic consulting firm:

The roles and skills sets for an IT professional are changing from managing machines and developing software to include negotiating SLAs and third-party provisioning and this needs to be reflected in the educational offerings. This means that the course of study should not only address the technical issues associated with cloud computing but also the business case. The courses should provide and share real-world implementation scenarios for deploying clouds. This should include use cases, how to address usage model pain points, understanding and charting requirements, reasons for implementing, how to approach clouds, and mapping an existing infrastructure to a cloud.

Student Audience and Potential Careers

The proposed program is aimed at experienced professionals with the desire to enhance their skill sets that can meet cloud computing challenges.

To remain competitive and achieve market growth, the United States must promote productivity through the use of technology. The Washington DC metropolitan area is home to the largest concentration of scientific and engineering professionals in the nation's workforce. This program will help this workforce enhance their skills to fill the increasing job needs in the cloud computing arena.

Although the Maryland community will form a natural base for outreach to prospective students, the program aims to draw students from across the nation and the world.

The primary potential career field for graduates of this program is a solution architect or IT consultant. However, the program is applicable to a host of other IT disciplines in which people do not want to change their career but want to be more effective in working in their field as cloud computing begins to intersect their environment, including those working in the fields of

networking, software engineering, database management, systems engineering, and data center operations.

A search of in-demand job titles shows that Cloud computing/networking has not yet emerged as a specialized title; however, cloud computing skills are required within common job titles in current usage, such as:

- Software Engineer
- Software Development Engineer
- Systems Engineer

Description of Proposed Program

The learning demonstrations that students complete to successfully master the course content will be presented in the context of transformation of an organization's existing architecture to a cloud-based solution. The overriding question posed to the students throughout the program is: "How does an organization get from where it is now to a cloud computing environment?" Students will be obliged to address the technical issues from a strategic perspective, examining the current application alignment and application suitability to the cloud. Students will also take into account organizational structure, communications, and operational business processes, including financial management and cost model implications.

Student Learning Outcomes

The M.S.in Cloud Computing Architecture will have two distinct objectives upon which students will focus:

- Cloud Computing Design and Architecture Objective

Students will be able to describe the standards upon which cloud solutions are built. They will also map private cloud services and offerings to business needs and solve any related IT issues. Finally, students will ensure that the solution is the best solution for the problem and that it addresses all of the requirements.

- Cloud Computing Solution Implementation Objective

Students will be able to construct a private cloud solution architecture aligned with the business requirements. They will implement the specific cloud technologies and offerings that should be employed in the solution. Finally they will demonstrate that the solution architecture and selected components effectively addressed the business problem.

The student who completes the Cloud Computing Architecture program will be able to:

- Perform as consultant/practitioners who can understand client requirements.

- Explain cloud computing concepts and applicable benefits in addressing the requirements, design effective solutions to address the business issues using cloud computing architecture and design principles. These principles include the ability to implement cloud solutions that account for cloud security and compliance fundamentals, deployment automation and elastic sizing of environments, and multi-tenant implications.
- Explain the impact of cloud computing on service management.
- Demonstrate an understanding of consumer and provider perspectives on setting up cloud environments, evaluated cloud solution architecture.
- Manage the process of migrating and transitioning to a cloud environment.

Evaluation and assessment for the program will take place in the required courses, including regular course evaluations, review of grade distributions, and faculty review of student performance on embedded course assessments. Additional review includes tracking of student completion rates and assessment of attainment of student learning outcomes.

General Requirements for the Program

The M.S. in Cloud Computing Architecture will require 36 semester hours of course work, as shown in the table below. To promote success in the program, additional self-paced modules will be available for those who have a need to fill gaps or reach a level of proficiency prior to beginning their course of study.

Required Courses	Semester Hours
DCL 600 Decisive Communication and Leadership (to be required of all entering graduate students)	6
CCA 610 Cloud Services	6
CCA 620 Cloud Computing Framework & Technologies	6
CCA 630 Cloud Integration, Standards, & Security	6
CCA 640 Cloud Migration and Management	6
CCA 670 Capstone: Cloud Computing Solutions Implementation	6
Total	36

Program Course Descriptions

See Appendix

Enrollment Projections

The following enrollment projections are based upon expected completion of the program in two 2 years and a year-to-year retention rate of 90%.

	Year One	Year Two	Year Three	Year Four	Year Five
First Year Students	50	55	60	65	70
Second Year Students	none	45	50	55	60
Total	50	100	110	120	130

It is anticipated that approximately 70 degrees will be awarded each year after the program reaches steady state.

Program Delivery and Principles of Good Practice.

The proposed program will be offered fully online.

UMUC's approach to online learning is to provide a highly interactive environment that supports the development of skills in written communication, critical thinking, specialized program knowledge, information literacy, and technology fluency – the five graduate learning areas identified as institutional-level learning outcomes by the university's *Institutional Plan for the Assessment of Student Learning*.

Curriculum and Instruction

UMUC is committed to providing the best online teaching and learning possible and to excellence in all of its programs. There is no difference in coherence, cohesiveness, or academic rigor between programs offered in traditional instructional formats and those offered from a distance. Each program is designed to result in learning outcomes appropriate to the rigor and breadth of the program and all programs assess student achievement of defined learning outcomes through regular and formal assessment planning. Online and onsite courses and programs are fully aligned and integrated -- designed around the same learning outcomes and principles, overseen and taught by the same faculty, held to the same standards, and assessed in the same way.

All of UMUC's online courses have been designed by faculty members in appropriate disciplines in collaboration with instructional designers and other experts in the field. Course learning outcomes and course descriptions are the same for every section of the course. The learning outcomes for each course are the foundation of the course; the learning activities, assessments and content of the course are in alignment with the outcomes and provide a clear pathway for mastery of the outcomes.

Role and Mission

All programs at UMUC are designed to be consistent with the mission of the institution. Each program has a mission and program outcomes aligned to the university mission as described in the catalog.

All existing UMUC programs are subject to periodic program reviews, including the review of the appropriateness of the technology being used to meet a program's objectives. The results of periodic program reviews are reported to the University System of Maryland (USM).

Evaluation and Assessment

Students have the opportunity to evaluate course and faculty through a standard evaluation of every course. In addition, faculty are evaluated by their supervisors on a pre-determined schedule using a standard evaluation instrument, on the basis of direct observation.

Formal evaluation of student learning occurs within courses and programs via annual review of student performance in authentic learning demonstrations. Learning goals and competencies are aligned to learning demonstrations that comprise the curriculum. Annually, student performance across learning demonstrations is evaluated to determine where curricular improvements may be required. Changes are made to curriculum and/or student support models. The process supports a continuous cycle of improvement.

Additional evaluation includes tracking of student retention, grade distributions and cost-effectiveness. Regular academic program reviews consider all factors related to academic quality, curriculum currency and relevance, student support and adequacy of facilities.

Demonstrable Quality of Program Faculty

Cloud computing is a new area, so the pool of faculty in this specific field is limited. However, because this program will take a multidisciplinary approach, UMUC already has a substantial roster of faculty with expertise in related areas, including telecommunications, database, software engineering, systems engineering, cyber security and project management. A terminal degree is generally required to teach at the graduate level, although an occasional exception can be made in the case of an individual with a master's degree and exceptional professional credentials. Teaching effectiveness is monitored by class observation and student course evaluations. UMUC is actively recruiting faculty to expand offerings in areas related to the proposed program.

The following is a partial list of faculty with their terminal degree title, academic title/rank, and status, and the courses they will teach.

- Dr. David Bakuli - Ph.D. in Industrial Engineering & Operations Research, University of Massachusetts at Amherst. – CCA 610
- Dr. Ronald Benson - Ph.D. in Business Administration, Management Systems, University of Iowa – CCA 610
- Dr. Irena Bojanova – Ph.D. in Computer Science / Mathematics, Bulgarian Academy of Sciences – CCA 620
- Dr. Jay Britton – Ph.D. in Mechanical Engineering, Massachusetts Institute of Technology; minor in the Management of Technology, the MIT Sloan School of management – CCA 620

- Dr. Randall Brown - Ph.D. in Business Administration, Major: Information Systems, Operations Management, University of Texas at Arlington – CCA 630
- Dr. Robert Finkelstein – DBA with the major in systems theory and cybernetics and minor in the management of technology and innovation, George Washington University – CCA 620
- Dr. Felicia Levy - Ph.D. in Engineering Management from George Washington University – CCA 670
- Dr. Ralph Reilly – Ph.D. in Management Information Systems Technology; Human-Computer Interaction, Stevens Institute of Technology – CCA 630
- Dr. McDonald Stewart - Ph.D. in Management of Science, Technology and Innovation, George Washington University – CCA 610

Faculty Support

All UMUC faculty are trained to teach online, including training in the use of the learning management system as well as in the pedagogy of distance education. Additionally, faculty have the opportunity for additional trainings throughout the course of their employment with UMUC. All faculty have 24/7 access to support services for both on-site and on-line courses, including the learning management system.

As part of their formal training, new graduate faculty become familiar with the expectations that The Graduate School has set for them as well as for their students. Program Chairs, the administrators responsible for supervising the faculty and all aspects of an academic program, reinforce these expectations in their regular reviews of and communications with their faculty. A formal document specifying the teaching expectations of The Graduate School can be found online and is available to all faculty, students, and interested parties at

http://www.umuc.edu/faculty/facsupport/facultyexams/upload/The_Graduate_School_Faculty_Expectations.pdf.

Additional support is provided through workshops, online coaching and mentoring programs for faculty offered by the University's Faculty Development unit (<http://www.umuc.edu/faculty/facsupport/>).

UMUC's learning management system provides appropriate real-time and asynchronous interaction between faculty and students in online classes, as well as access to course materials and a wide array of online library resources. All online classes have conferences in which students interact with faculty and with each other.

Student Support

UMUC provides all students with clear, complete, and timely information on the curriculum, course and degree requirements, nature of faculty/student interactions, assumptions about technology competence and skills, technical equipment requirements, learning management system, availability of academic support services and financial aid resources, and costs and payment policies. Students have access to the complete range of student services available at UMUC in support of their distance education activities. All students are provided with the academic support they need to be successful in the online environment.

The proposed program builds on a 6-credit foundational course that provides a springboard for academic and professional success. Students begin to practice prerequisite skills related to their professions, create beneficial social networks and presence, and develop and exercise moral and ethical decision-making. Through these activities, they refresh and refine their skills in communication, critical thinking, quantitative reasoning and team leadership.

All advertising, recruiting, and admissions materials are the same for all students, and accurately represent programs and services available. Full information is available at www.UMUC.edu.

Consistency with the State's Minority Student Achievement Goals

UMUC has seven core values that reflect the University's central beliefs and serve as core principles that guide all program development and availability. Diversity, the idea that each individual brings value to the University's efforts and results, is central to the University's core values and is reflected in the Strategic Plan goal to develop a "student population of a diversity and size that meets the growth targets and financial goals of UMUC while serving the state of Maryland's national and international educational interests" (http://www.umuc.edu/visitors/about/upload/strategic_plan.pdf).

This core value is also reflected in the University's ethnically and racially diverse student body and a proven institutional record of providing higher education access to minority students, with minority defined as African Americans, Hispanics, Asian, Pacific Islander, and Native American:

- Annually, UMUC awards more degrees to African American students than any other Maryland institution.
- UMUC enrolls more African American students than any other institution in Maryland.
- Minorities make up 43% of the undergraduate population and 51% of the graduate population.
- Minorities received 39% of Bachelor's degrees, 50% of Master's degrees, and 37% of Doctoral degrees from UMUC in FY 2013.

The proposed program will provide the knowledge, skills and abilities to ensure the success of minority students during their educational experience, and also in their professional development in the discipline and in their employment.

Technology Fluency

Technology fluency is a core learning area for UMUC students and is assessed at the institutional level as well as being incorporated into all degree programs. All courses in this program will be taught entirely online so that all students will be required to use enhanced technology to complete assignments. Students will also use the online databases and the UMUC library's other extensive online holdings to fulfill course requirements. The program will thus require students to acquire and maintain a high level of technological proficiency.

Library Requirements

Extensive library resources and services are available online, 24 hours a day, seven days a week at <http://www.umuc.edu/library/index.cfm>. The UMUC Library provides research assistance in creating search strategies, selecting relevant databases, and evaluating and citing resources in a variety of formats via its Ask a Librarian service at <https://www.umuc.edu/library/libask/index.cfm>, which includes 24/7 chat and e-mail. The Subject Guides area of the library's Web site at <http://www.umuc.edu/library/libresources/subjects.cfm> provides a listing of resource guides for each subject area, with each guide containing relevant databases, Web sites, books, and other resources along with technical and citation assistance.

A guide to locating scholarly articles and using UMUC's library databases is available at <http://www.umuc.edu/library/libhow/articles.cfm>. UMUC Library OneSearch allows users to simultaneously search for scholarly articles, books, and/or other research resources via a single search engine in most of the databases to which the UMUC Library subscribes, either directly or as additional resources (<http://www.umuc.edu/library/index.cfm>).

No new library resources will be needed for the proposed program.

Facilities and Equipment

Existing resources related to facilities and equipment are adequate to meet the program needs.

Finances

No new general funds will be required for implementation of the proposed revision to this program. As shown in the following tables, the program is expected to be fully self-supporting.

Resources and Expenditures

Resource Categories	Year 1	Year 2	Year 3	Year 4	Year 5
1. Reallocated Funds	0	0	0	0	0
2. Tuition/Fee Revenue (c+g below)	\$624,600	\$1,249,200	\$1,374,120	\$1,499,040	\$1,623,960
a. #F.T. Students	0	0	0	0	0
b. Annual Tuition/Fee Rate	N/A	N/A	N/A	N/A	N/A
c. Annual Full Time Revenue (a x b)	N/A	N/A	N/A	N/A	N/A
d. # Part Time Students	50	100	110	120	130
e. Credit Hour Rate	\$694	\$694	\$694	\$694	\$694
f. Annual Credit Hours per student per year	18	18	18	18	18
g. Total Part Time Revenue (d x e x f)	\$624,600	\$1,249,200	\$1,374,120	\$1,499,040	\$1,623,960
3. Grants, Contracts, & Other External Sources	\$0	\$0	\$0	\$0	\$0
4. Other Sources	\$0	\$0	\$0	\$0	\$0
TOTAL (Add 1 - 4)	\$624,600	\$1,249,200	\$1,374,120	\$1,499,040	\$1,623,960

Expenditure Categories	Year 1	Year 2	Year 3	Year 4	Year 5
1. Total Faculty Expenses (b + c below)	\$49,356	\$98,712	\$98,712	\$148,068	\$148,068
a. Total sections taught (6 cr ea)	6	12	12	18	18
b. Total Salary (Adjunct faculty salary at \$1371 per credit hour)	\$49,356	\$98,712	\$98,712	\$98,712	\$148,068
c. Total Benefits	0	0	0	0	0
2. Total Administrative Staff Expenses (b + c below)	\$25,300	\$25,300	\$25,300	\$25,300	\$25,300
a. # FTE	0.2	0.2	0.2	0.2	0.2
b. Total Salary	\$20,000	\$20,000	\$20,000	\$20,000	\$20,000
c. Total Benefits (26.5%)	\$5,300	\$5,300	\$5,300	\$5,300	\$5,300
3. Total Support Staff Expenses (b + c below)	\$25,300	\$25,300	\$25,300	\$25,300	\$25,300
a. # FTE	0.1	0.1	0.1	0.1	0.1
b. Total Salary	\$2,530	\$2,530	\$2,530	\$2,530	\$2,530
c. Total Benefits (26.5%)	\$670	\$670	\$670	\$670	\$670
4. Equipment	0	0	0	0	0
5. Library	0	0	0	0	0
6. New or Renovated Space	0	0	0	0	0
7. Other Expenses (Course development, marketing, overhead)	0	0	0	0	0
TOTAL (Add 1 - 7)	\$99,956	\$149,312	\$149,312	\$198,668	\$198,668

Appendix Course Descriptions

Required Foundation Course

DCL 600 Decisive Communication and Leadership (6)

Prepare for academic and professional success by practicing prerequisite skills, creating a beneficial social network and presence, exploring your area of study, and exercising moral and ethical decision-making. Refresh and refine your skills in communication, critical thinking, quantitative reasoning and team leadership. Gain experience in producing both written and oral communications, enhancing presentation skills, and using spreadsheets, collaboration tools, and other business software.

Required Program Courses

CCA 610 Cloud Services (6)

Prerequisite: DCL 600. Defining the characteristics of cloud offerings; performing a thorough investigation of Cloud Services and Cloud Service Providers; Mobile Cloud Computing, Community Clouds, Government Clouds and Cloud-Based Development Environments (PaaS), differentiating applications, including engineering applications in the Cloud, personal applications of Clouds and Cloud gaming.

CCA 620 Cloud Computing Framework & Technologies (6)

Prerequisite: CCA 610. Theoretical and practical analysis of Cloud Reference Frameworks, underlying concepts and technologies; virtualization (hardware, network & I/O), Wireless Data Center Networks, Open Source Cloud Software Solutions, Developing Software for Cloud, Cloud Data Management, Large Scale Analytics in Clouds (Hadoop), and Cloud programming models (Map Reduce).

CCA 630 Cloud Integration, Standards, & Security (6)

Prerequisite: CCA 620. Exploration of the key current and future cloud related issues; Cloud Portability and Interoperability, Cloud Integration and Federation, Cloud Standards, and Cloud Security Methodologies and Practice, implementation concerns related to Privacy and Legal Compliance in the Cloud.

CCA 640 Cloud Migration and Management (6)

Prerequisite: CCA 630. Advanced analysis of the pressing issues associated with cloud implementation and the methodologies utilized to resolve these issues. Cloud Capacity Planning and Management, Fault-Tolerant Clouds, Cloud Energy Consumption, Cloud Testing, Cloud Services Evaluation, Enterprise Cloud Computing Strategy and Policy, Migrating Applications to Cloud, Identity and Access Management, Cloud Service Level Agreement (SLA), Legal aspects (cloud regulations), and Cloud Economics.

CCA 670 Capstone: Cloud Computing Solutions Implementation (6)

Prerequisite: CCA 640. Virtual implementation of a cloud environment; development of a framework for designing and implementing cloud-based solutions.