UNIVERSITY OF MARYLAND

UNIVERSITY SENATE

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SENATE LEGISLATION APPROVAL

Date:	November 3, 2016
To:	Wallace D. Loh
From:	Jordan Goodman Chair, University Senate
Subject:	Approval of the PCC Proposal to Establish a Post-Baccalaureate Certificate in Computer Networking
Senate Document #:	16-17-16

I am pleased to forward for your consideration the attached legislation entitled, "PCC Proposal to Establish a Post-Baccalaureate Certificate in Computer Networking." Andrew Harris, Chair of the Programs, Curricula, & Courses (PCC) Committee, presented the proposal. The University Senate approved the proposal at its November 2, 2016, meeting.

We request that you inform the Senate Office of your decision as well as any subsequent action related to your conclusion.

Enclosure: Approval of the PCC Proposal to Establish a Post-Baccalaureate Certificate in Computer Networking
Senate Document # 16-17-16

JG/rm

Cc: Mary Ann Rankin, Senior Vice President and Provost
        Reka Montfort, Executive Secretary and Director, University Senate
        Michael Poterala, Vice President and General Counsel
        Cynthia Hale, Associate Vice President for Finance and Personnel
        John Bertot, Associate Provost for Faculty Affairs
        Elizabeth Beise, Associate Provost for Academic Planning & Programs
        Sylvia B. Andrews, Academic Affairs
        Andrew Harris, Chair of the PCC Committee
        Darryll Pines, Dean, A. James Clark School of Engineering
        Zoltan Safar, Director, Master of Science in Telecommunications Program

Approved: _____   Date: 11-04-2016
        Wallace D. Loh
        President

University Senate
TRANSMITTAL FORM

Senate Document #:	16-17-16
PCC ID #:	16004
Title:	Establish a Post-Baccalaureate Certificate in Computer Networking
Presenter:	Andrew Harris, Chair, Senate Programs, Curricula, and Courses Committee
Date of SEC Review:	October 19, 2016
Date of Senate Review:	November 2, 2016
Voting (highlight one):	1. On resolutions or recommendations one by one, or 2. In a single vote 3. To endorse entire report
Statement of Issue:	The A. James Clark School of Engineering and Department of Electrical and Computer Engineering propose to establish a 12-credit Post-Baccalaureate Certificate in Computer Engineering. This certificate program will be for students who are enrolled in the Master of Science in Telecommunications program. Computer networks have become ubiquitous and relied upon every day for work, communication, and entertainment. Current trends such as cloud-based services, software-defined platforms, and large data centers reflect a need for engineers and technologists who can design, build, maintain, trouble-shoot, and secure complex and ever-growing networking infrastructures. Course requirements for the certificate program include four elective courses from the following set: ENTS689G, Special Topics: Design and Analysis of Communication Networks, and ENTS689N, Special Topics: Network Programming, or from the following course sequences: ENTS649, Special Topics in Networking, and ENTS749, Advanced Topics in Networking. These courses can also be used to fulfill the elective requirements for the Master of Science program. Students who pursue the certificate would then typically have to take one or two additional courses in addition to satisfying the minimum course requirements for the MS degree.

	This proposal was approved by the Graduate School Programs, Curricula, and Courses committee on September 26, 2016, and was approved by the Senate Programs, Curricula, and Courses committee on October 7, 2016.
Relevant Policy # & URL:	N/A
Recommendation:	The Senate Committee on Programs, Curricula, and Courses recommends that the Senate approve this new certificate program.
Committee Work:	The committee considered this proposal at its meeting on October 7, 2016. Zoltan Safar, director of the Master of Science in Telecommunications program, presented the proposal. The proposal was unanimously approved by the committee.
Alternatives:	The Senate could decline to approve this new certificate program.
Risks:	If the Senate declines to approve this certificate program, students in the Master of Science in Telecommunications program will lose an opportunity to have their focus in computer networking formally recognized.
Financial Implications:	There are no significant financial implications with this proposal.
Further Approvals Required:	If the Senate approves this proposal, it would still require further approval by the President, the Chancellor, and the Maryland Higher Education Commission.

University of Maryland PCC
Program/Curriculum/Unit Proposal

Program: Master's in Telecommunications Program (ENTS)

Department/Unit: Department of Electrical and Computer Engineering

College/School: A. James Clark School of Engineering

Proposal Contact Person (with email): Zoltan Safar zsafar@umd.edu

Type of Action (check one):

☐ Curriculum change (includes modifying minors, concentrations/specializations and creating informal specializations)

   ☐ Curriculum change is for an LEP Program

☐ *Rename a program or formal Area of Concentration*

☐ *Establish/Discontinue a formal Area of Concentration*

☐ Other:

☒ *Establish a new academic degree/certificate program*

☐ Create an online version of an existing program

☐ Establish a new minor

☐ *Suspend/Discontinue a degree/certificate program*

☐ Establish a new Master or Certificate of Professional Studies program

   ☐ New Professional Studies program will be administered by Office of Extended Studies

Italics indicate that the proposal must be presented to the full University Senate for consideration.

Approval Signatures - *Please <u>print</u> name, sign, and date. For proposals requiring multiple unit approvals, please use additional cover sheet(.).*

1. Department Committee Chair Dr. Zoltan Safar ___*Zoltan Safar*___ 04.14.16.

2. Department Chair Dr. Rama Chellappa ___*Rama Chellappa*___ 4/14/16

3. College/School PCC Chair Jenna Bucci ___*Jenna E. Bucci*___ 5/3/16

4. Dean Dr. Peter Konfinas ___*Peter Kfina*___ 5/2/2016

5. Dean of the Graduate School (if required) _____

6. Chair, Senate PCC _____

7. University Senate Chair (if required) _____

8. Senior Vice President and Provost _____

Instructions:
When approved by the dean of the college or school, please send the proposal and signed form to the Office of the Associate Provost for Academic Planning and Programs, 1119 Main Administration Building, Campus-5031, **and** email the proposal document as an MSWord attachment to pcc-submissions@umd.edu.

Summary of Proposed Action (use additional sheet if necessary):

The Master's in Telecommunications Program is proposing a new Graduate Certificate program in Computer Networking to be a subset of the existing ENTS (Master of Science) program.

Unit Code(s) (to be entered by the Office of Academic Planning and Programs): _____

Proposal to Establish a Graduate Certificate in Computer Networking

I. OVERVIEW

A. Overview and Rationale

Established in 1992, the Master of Science in Telecommunications (ENTS) program provides a unique cross-disciplinary industry-oriented graduate education in telecommunications. It is administered by the Department of Electrical and Computer Engineering in the A. James Clark School of Engineering. Students complete coursework in both the ECE Department and the Robert H. Smith School of Business. Combining rigorous technical education with invaluable business insight and entrepreneurial skills, the ENTS program offers students a unique perspective on the telecommunications industry and profession. The ENTS program caters to both full-time students and working professionals. Most ENTS courses are offered once a week and are scheduled in the afternoon or evening to suit working professionals, while some courses additionally offer daytime sections. All ENTS courses are "traditional" (residential) courses; the program does not offer off-campus locations or online options. ENTS students are responsible for a differential tuition rate and the program is considered a self-support unit within the University of Maryland. Currently, approximately 240 students are enrolled and approximately 110-120 MS degrees are awarded each year.

To be considered for admission, applicants to the ENTS program must have earned a bachelor's degree, typically in a technical field (engineering, computer science, etc.) and have an undergraduate GPA of 3.0. Applicants must also submit a personal statement and three letters of recommendation. To earn the MS in Telecommunications degree, students must successfully complete 30 credits of course work (10 three-credit courses) with a GPA of 3.0 or more and a scholarly paper. A typical ENTS student takes 6-8 core courses (up to 2 of the 8 core courses may be waived if justified) and 2-4 elective courses.

The ENTS program is taught by full-time and part-time instructors employed by the Electrical and Computer Engineering Department and the Robert H. Smith School of Business. They all hold PhDs in their respective fields (engineering/computer science or business), and they all have worked in the industry for several years and have considerable industrial experience.

As our society and technology evolves, there will be more demand for professionals who have well-rounded specialized knowledge in computer networking. Computer networks have become ubiquitous and we rely on them every day for work, communication and entertainment. Observing the current trends in networking, such as cloud-based services, software-defined platforms, large data centers and Internet of Things (IoT), our society will need more and more engineers and technologists who can design, build, maintain, trouble-shoot and secure our complex and ever-growing networking infrastructure.

We propose the creation of a Graduate Certificate Program in Computer Networking embedded in the ENTS program. The Certificate Program will be offered to current ENTS students, and its

aim is to provide official acknowledgment for acquiring focused knowledge in a particular subfield of telecommunications. Over the past years, many of our students opt to take additional electives (i.e. electives in addition to meeting the minimum degree requirements) to improve their skill sets and their marketability to employers after graduation. This trend is beneficial to both students and the program as it results in better prepared and more marketable graduates with stronger, focused technical background, thus improving the quality of our graduates. This enhances their transcripts, resumes, and chances of finding employment or promotion in their current employment, further improving the reputation of the ENTS program and alumni base. We would like to encourage, organize and recognize such efforts by offering the Graduate Certificate in Computer Networking, a well-defined, focused area within telecommunications. The certificate will be comprised of existing ENTS elective courses, which include special topics and advanced topics courses in computer networking. Within the telecommunications industry, certificates are widely accepted proof of expertise in a given technical subfield such as routing, computer security, etc. A Graduate Certificate is an appropriate recognition for the additional coursework, time and effort the student needs to invest to obtain the knowledge/expertise. The Graduate Certificate in Computer Networking will be one of several proposed certificates designed to strengthen the ENTS program.

The Master's in Telecommunications program is unique to the University System of Maryland, and thus adding certificate programs for current ENTS students would not replicate or detract from any existing programs. Since the ENTS program specializes in Telecommunications, we offer a wide range of special-topics and advanced-topics courses in Computer Networking that no other units offer. The ENTS electives will serve as the basis for the proposed Graduate Certificate Program.

In comparison, the University of Colorado Boulder (UCB) offers the "Interdisciplinary Telecom Program" (ITP). UCB has marketed ITP as "a highly-integrated and comprehensive program combining technology, policy, and business with hands-on experience." As a peer program to ENTS, ITP offers a Master of Science in Telecom. MS students have the option to pursue "tracks" in network engineering, wireless engineering, network security and telecom policy. These tracks enable students to tailor the technical content of their degree to prepare themselves for careers in industry. Embedded with the tracks is the opportunity for students, who complete the requirements, to earn the corresponding 12-credit Graduate Certificate. Students may be awarded the certificate while completing the MS degree. The Graduate Certificates include: Computer and Network Security; Network Architecture; Telecom Policy and Strategy; and Wireless Networks and Technologies.

The Graduate Certificate in Computer Networking allows ENTS students to have the option of enhancing their MS degree with specific technical knowledge and also enable them to remain competitive in the marketplace with graduates from similar degree programs at peer institutions.

Additional information:
http://www.colorado.edu/itp/
http://www.colorado.edu/itp/masters-degree
http://www.colorado.edu/itp/prospective-students/graduate-certificates

B. Student Audience

The Certificate in Computer Networking will only be available to current ENTS students. For a typical ENTS student, this will mean taking 1-2 extra electives in addition to the courses taken to satisfy the MS degree requirements.

Based on the results of a survey we have recently conducted among current ENTS students, there is a significant interest in obtaining Graduate Certificates. Out of 58 responses, 46.6% found a Graduate Certificate very valuable to their portfolios, and 36.2% found it somewhat valuable. Demonstrating their interest, 58.6% responded that they would most definitely obtain a Graduate Certificate if offered, and 32.8% responded that they would most likely obtain one. Finally, 72.4% of the responding students showed interest in obtaining a Graduate Certificate in computer networking.

We also reached out to 39 ENTS alumni to poll their opinions on the value a Graduate Certificate program. Out of 18 responses, 44.4% found it very valuable, and 44.4% found it somewhat valuable to their portfolios. We also asked if they would encourage current ENTS students to obtain a Graduate Certificate if it was offered, and 33.3% responded "yes, most definitely", and 50.0% responded "yes, most likely". Out of the responding alumni, 61.1% responded that they found a Graduate Certificate in the area of computer networking valuable.

C. Eligibility

Enrollment in this program will be limited to ENTS students, so the admission requirements are the same as for the ENTS program.

II. THE GRADUATE CERTIFICATE

A. Title

The proposed title is: Graduate Certificate in Computer Networking

B. The Award

A physical Graduate Certificate issued by the UMD Diploma Office; the achievement will also be noted on the students' transcripts.

III. CURRICULUM STRUCTURE AND REQUIREMENTS

The ENTS program has grouped its electives into course series according to specialization areas within telecommunications. The course series relevant to computer networking are Special Topics in Networking and Advanced Topics in Networking. These courses series will be included in the certificate program in order to maintain dynamic and up-to-date program offerings. New courses are offered almost every year to effectively respond to the dynamic changes in the telecommunications industry and to produce graduates who are well versed in the latest technology and telecommunications industry trends. At the end of this section, we will provide an example set of courses satisfying the certificate requirements based on our Spring 2015 and Fall 2015 offerings.

The Graduate Certificate in Computer Networking is a 12-credit program, by coursework only. The courses taken to earn the Graduate Certificate may also be counted toward meeting the MS degree requirements, and the MS degree and the Graduate Certificate may be earned and awarded in the same semester. Each student must complete four 3-credit courses from the following course list; at least two courses must be at the 700-level.

- ENTS 689G Special Topics: Design and Analysis of Communication Networks
- ENTS 689N Special Topics: Network Programming
- 649X Series: Special Topics in Networking
- 749X Series: Advanced Topics in Networking

Sample Course Descriptions:

ENTS689G: Special Topics: Design and Analysis of Communication Networks
Prerequisite: ENTS 640. This advanced-level graduate course is designed to build on the material covered in ENTS640 and to provide a practical and more in-depth view of the protocols and architectures used in real-world communication networks. The objective of this course is to give the students a reasonable combination of analytical and practical knowledge that is expected from graduate-level network engineers. Due to its practical nature, this course is highly project-oriented and multiple network design problems are visited both in the class and also as homework assignments. OPNET simulation and modeling software is used as the main tool for homeworks and projects. This course covers a combination of theoretical and practical concepts and a tentative list of covered subjects is as follows: Delay calculation in communication networks; QoS techniques in IP networks; Wired/Wireless medium access protocols and LAN technologies; Routers, Switches and other networking devices; Network planning and design; TCP protocol and traffic analysis. The course material and its projects are designed to highlight the main properties of some well-known protocols used in today's networks. Students will learn the role of fundamental theories in the initial stage of a design cycle and subsequent use of modeling and simulation tools for performance evaluation and tuning of their designs.

ENTS689N: Special Topics: Network Programming
This course teaches the fundamentals of programming in C including skills that students need for solving typical telecommunications engineering problems. Data structures, control flow, memory allocation, pointers, and sockets will be covered. In addition to the weekly

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classes and bi-weekly homework assignments, students are required to complete a final group project and make a short presentation. Students taking this course do not need to have any prior programming experience.

ENTS649X: Series Special Topics in Networking

ENTS649A Special Topics in Networking: Optical Communication Networks
Optical communication has become a classic networking technology. This course will present the state-of-the art in optical communication networks and their applications. It will provide coverage of basic optical technology and networking topics, presented in a format that is easy to understand for practical engineers and networking specialists. The course will start with a broad coverage of different physical aspects of light propagation, basic components and modulation/demodulation methods, and fundamentals of the physical-layer design. It will then proceed with optical networking, starting with a description of technologies for which optical networking is used. The course will also provide an overview of next-generation SONET technologies along with optical transport network, the generic framing procedure, and Ethernet solutions. The IEEE new resilient packet ring (RPR) protocol will be discussed. Besides the theoretical coverage, the students will be engaged in developing their understanding of optical communication networking through hands on projects.

ENTS649B Special Topics in Networking: Cloud Computing
The course will present the state of the art in cloud computing technologies and applications. The course will explore potential research directions, as well as the technologies that will facilitate the creation of a global marketplace for cloud computing services that support scientific, industrial, business, and consumer applications. Topics will include: telecommunications needs; architectural models for cloud computing; cloud computing platforms and services; security, privacy, and trust management; resource allocation and quality of service; cloud economics and business models; pricing and risk management; interoperability and internetworking; legal issues; and novel applications. Course projects will expose students to different tools and technologies used to build and utilize clouds and the related security, privacy and trust management issues.

ENTS749X: Advanced Topics in Networking

ENTS749A Advanced Topics in Networking: Network Traffic and Application Performance Analysis
Prerequisite: ENTS 640. This graduate-level course covers the fundamentals of network traffic measurement and how the information in traffic traces can be used for different purposes. We will target an important use-case of traffic analysis which is application performance management. Due to the growing trend in online services, application performance management has become an important requirement for all organizations. Furthermore, maintaining the necessary infrastructure to guarantee acceptable user experience is critical to their success. This course will take a top-down approach by reviewing the basics of application and transport layer protocols as well as the effects of various network components on the performance of an application. Through lecture and lab sessions, students will learn different traffic measurement tools and how the traffic traces can be used to evaluate the performance of an application under different conditions. The

course also briefly discusses another use-case of traffic measurement i.e., network security, through hands-on experiments with available software packages. Cryptography and security fundamentals are not covered and they are presented in detail by other specialized courses.

ENTS749B Advanced Topics in Networking: Software Defined Networking
Prerequisite: ENTS 640 and ENTS 641. This advanced-level graduate course covers software-defined networking (SDN), its key principles, building blocks, and design as well as its recent applications and uses cases in industry. SDN is a new paradigm in telecommunications that re-thinks conventional network design/operations/abstractions and makes networks openly programmable, controllable, and affordable. SDN is widely accepted by industry as a game changer, with use in domains ranging from home networks to large-scale wide-area backbone networks. The objective of this course is to provide students with practical knowledge and in-depth understanding of SDN along with the ability to design and program the control plane of networks. Programming assignments and a project in this course provide students with opportunities to work hands-on with Python programming language and with popular open-source SDN tools. Students will gain familiarity with networking needs, opportunities, and challenges in environments such as data centers.

ENTS749C Advanced Topics in Networking: Vehicular Networks
Prerequisite: ENTS 640 and ENTS 622. Modern vehicles on roads and in air use telecommunication networking for enhancing their features, operations, controls, and performance. These "connected vehicles" have in-vehicle networks of embedded systems and can communicate with passenger carried devices, neighboring vehicles, and the Internet for new features and applications. This advanced topics course studies communication network principles, designs, protocols, and standards of connected vehicles and offers practical insight into this rapidly growing networking industry. Students get hands-on experience with building Python-based applications using automobile and aircraft networked embedded systems data. Students will also learn to simulate realistic vehicular networks (e.g., in ns-3 and Matlab).

ENTS749D Advanced Topics in Networking: Networking Design and Configuration Lab
Prerequisite: ENTS 640 and ENTS 641. This networking lab course will provide hands-on experience with the configuration and management of routers and switches in a real-world networking environment using Juniper Networks devices. Students will learn how to interact with networking devices through the Junos OS and how to navigate the command line interface (CLI). Topics will include router HW and SW architecture, interfaces, routing policies, static route configuration, configuring RIP and OSPF, VLANS and their configuration, firewall filters and security policies, class of service (CoS) management, network operation monitoring, and troubleshooting. During the lab sessions, students will write and test configurations for routers and switches given a set of network specifications, policies and conditions.

An example course sequence:

1. **ENTS 689N Special Topics: Network Programming** (3 credits)
2. **ENTS 649B Special Topics in Networking: Cloud Computing** (3 credits)
3. **ENTS 749B Advanced Topics in Networking: Software-Defined Networking** (3 credits)
4. **ENTS 749D Advanced Topics in Networking: Network Design and Configuration Lab** (3 credits)

IV. STUDENT LEARNING OUTCOMES AND ASSESSMENT MEASURES

Since this graduate certificate program will be embedded in the standard ENTS curriculum, the learning outcomes will also be similar to those of the ENTS program. The items relevant to the Graduate Certificate Program are as follows:

1. Academic outcome goals:
   - Students acquire specialized knowledge and skills in the technical area of computer networking.
   - Students acquire/develop practical problem-solving, programming and analytical skills necessary to succeed in industry.
2. Academic outcome assessment measures:
   - Percentage of students scoring B or higher in relevant elective courses
   - Percentage of students who work on course-related projects requiring programming
   - Percentage of students acquiring hands-on lab experience using state-of-the art networking equipment, network design, trouble-shooting and performance evaluation tools.
3. Non-academic outcome goals:
   - Diversity: The ENTS program promotes diversity and strives to admit and educate a diverse student population.
   - Degree completion and student retention: The ENTS program will make every effort to help its students from admission to degree completion and minimize the number of students who leave the program without a degree.
   - Quality of learning experience: The ENTS program will actively improve the student experience and increase its perceived value.
4. Non-academic outcome assessment measures:
   - Diversity: Percentage of female students; percentage of female faculty /instructors; percentage of minority faculty /instructors
   - Degree completion and student retention: Percentage of students who obtain the graduate certificate within two years after entering the program
   - Quality of learning experience: Graduate student to faculty ratio in the classroom; number of students receiving education in state-of-the art facilities/labs or using state-of-the-art tools; number of offered elective courses in computer networking

V. PROGRAM ADMINISTRATION

Administrative oversight and program management will be provided by ENTS staff. This includes student services, academic advising, marketing and outreach, program evaluation and assessment, and degree requirement verification.

   A. **Program Faculty**
   The courses for this certificate program are all ENTS courses, so they will be taught by ENTS instructors.

B. Program Offerings

The program will be wholly residential. There will be no off-campus locations nor distance/online education components.

VI. FINANCE (Budget Resources)

The ENTS program is a self-support unit and the Graduate Certificate in Computer Networking program will be administered through its resources.

VII. ADDITIONAL RESOURCES

A. Library

No additional resources are needed. See library assessment (Appendix A.)

B. Facilities

No new facilities are required.

C. Outside Academic Units

This program will not rely upon courses provided through other academic units.

D. Personnel

No new personnel are required. The new program will involve a small increase in administrative work for some staff. Existing staff members have experience in handling ENTS student records.

APPENDIX A: Library Assessment

DATE: April 7, 2016

TO: Kerrie Moyseenko

           Program Coordinator, Masters in Telecommunications Program

FROM: On behalf of the University of Maryland Libraries:

           Elizabeth Soergel, Engineering Librarian

           Maggie Saponaro, Interim Head of Collection Development

           Daniel Mack, Associate Dean, Collection Strategies & Services

RE: Library Collection Assessment

We are providing this assessment in response to a proposal by the Department of Electrical and Computer Engineering's Masters in Telecommunications program in the A. James Clark School of Engineering to create Graduate Certificate in Computer Networking. We were asked to assess our collections to determine how well the Libraries will be able to support the curriculum of this proposed graduate certificate. We offer the following assessment and conclude that the Libraries are able to support this program.

Serial Publications and Research Databases

The University of Maryland Libraries currently subscribe to a large number of scholarly journals, most in online format, that publish current research in areas relating to telecommunications and computer networking. Most articles in journals that we do not own electronically are available through either the Libraries' Article Express Program or via Interlibrary Loan. The Libraries' "Database Finder" offers online access to databases that provide indexing and access to popular and scholarly journal articles, and other information sources. Many of these databases cover subject areas that would be relevant to this proposed graduate certificate. These databases can be accessed remotely by authenticating using UMD login credentials.

Most of the relevant research is available through the following databases to which the Libraries subscribe:

- IEEExplore
- ACM Digital Library
- Web of Science

In addition, the general, multidisciplinary database Academic Search Complete provides information for nearly every area of academic study. Includes an enormous collection of the

most valuable peer-reviewed full text journals, as well as additional journals, magazines, newspapers and books.

As noted previously, in those instances in which either the Libraries do not subscribe to the journal or the journal articles are available only in print format, the Libraries can supply copies through the Libraries' Article Express Program or via Interlibrary Loan.

Monographs

The Libraries' current collection of books related to computer networking is sufficient to meet the needs of the program. The ongoing acquisition of scholarly books is expected to be adequately covered through existing acquisition practices and budgeting. As the University of Maryland already has a robust tradition of acquiring materials related to computer networking, current collection development practices in the Libraries should adequately support the new graduate certificate. Monographs not already part of the collection can usually be added upon request.

While electronic format books are typically purchased, students will be able to take some advantage of the print book collection by checking out these items or requesting specific chapters be sent to them through the Libraries' Article Express program. Faculty can also request, within fair use copyright guidelines, that sections of print books be made available digitally through course reserves.

Article Express and Interlibrary Loan

These services offer online delivery of bibliographic materials that otherwise would not be available online. Article Express and Interlibrary Loan are available free of charge. As a program developed specifically to support advanced research and teaching for graduate students and faculty, the Article Express service scans and delivers journal articles and book chapters within three business days of the student's request, provided that the items are available in print on the UM Libraries' shelves. In the event that an article or chapter is not available on campus, Article Express will automatically refer the request to Interlibrary Loan (ILL). Interlibrary Loan is a service that enables borrowers to obtain online articles and book chapters from materials not held in the University System of Maryland. In addition to chapters and articles, monographs not available through the UM Libraries can also be requested through Interlibrary Loan.

Conclusion

The University of Maryland Libraries' serials holdings and research databases have an established record for providing bibliographic support for researchers and professionals in subject disciplines that are relevant to computer networking. These materials are supplemented by relevant monograph collections. In addition, the Libraries' Article Express and Interlibrary Loan services make materials that otherwise would not be available online or through the UM Libraries. The Libraries also offer students a wide range of services to ensure their success.

APPENDIX A: Library Assessment

Additionally, the libraries are already supporting the Master of Science in Telecommunications, so no additional library resources should be necessary for the proposed graduate certificate, which compliments the Masters program. As a result, our assessment is that the University of Maryland Libraries are able to meet the curricular and research needs of the proposed Graduate Certificate in Computer Networking.