UNIVERSITY OF CALIFORNIA, ACADEMIC SENATE

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Chair of the Assembly of the Academic Senate
Faculty Representative to the Regents
University of California
1111 Franklin Street, 12th Floor
Oakland, California 94607-5200

September 28, 2017

MICHAEL T. BROWN
PROVOST AND EXECUTIVE VICE PRESIDENT
UNIVERSITY OF CALIFORNIA

Re: Approval of Master of Information and Cyber Security (MICS) degree UC Berkeley

Dear Michael:

In accordance with the *Universitywide Review Processes For Academic Programs, Units, and Research Units* (the "Compendium"), and on the recommendation of CCGA, the Academic Council has approved UC Berkeley's proposal to establish a self-supporting graduate program leading to a Master of Information and Cyber Security (MICS) degree.

Because this is a new degree title, and the Assembly of the Academic Senate is not meeting within 30 days of CCGA's approval, Council must approve the program per Senate Bylaw 125.B.7.

I am enclosing CCGA's report on its review of the new program, and respectfully request that your office complete the process of obtaining the President's approval.

Sincerely,

Shane N. White, Chair
Academic Council

Encl

Cc: Academic Council
Senate Director Baxter
Senate Executive Directors

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COORDINATING COMMITTEE ON GRADUATE AFFAIRS (CCGA)
Kwai Ng, Chair
kwng@mail.ucsd.edu

ACADEMIC SENATE
University of California
1111 Franklin Street, 12th Floor
Oakland, California 94607-5200

September 7, 2017

ACADEMIC COUNCIL CHAIR SHANE WHITE

Dear Shane:

In an email vote conducted during the last week of August, the Coordinating Committee on Graduate Affairs (CCGA) voted unanimously to approve UC Berkeley's proposal to establish a new, self-supporting online graduate program leading to a Master of Information and Cyber Security (MICS) degree within the School of Information, in cooperation with the School of Engineering.

The MICS program addresses the technical aspects of cyber security, as well as interdisciplinary aspects including policymaking, business models, legal frameworks, national security considerations, ethical issues, standards making, and the roles of users, government, and industry. The proposed program consists of 27 course units. In theory, a student can complete the program in one year (taking nine units in fall, spring and summer semesters). The proposers however expect that many students will take a more reduced load and complete the program in two to three years. An initial enrollment of 44 students is expected. It will grow to a steady state of about 250 students admitted each year within four to five years after launching. The program will target several categories of students, including recent graduates and mid-career professionals. The program will initially focus on targeting students with a strong technical background and later expand to include a broader set of students.

The MICS program will be taught by ladder-rank faculty in the UCB School of Information and College of Engineering, and is administered by the School of Information, sharing administration resources with another online master's program at UCB, the Master of Information and Data Science (MIDS) program. Both the School of Information and the College of Engineering will contribute faculty expertise, oversight and teaching resources.

The actual online courses of the program will be developed and delivered in collaboration with the online educational technology provider 2U as a platform provider. 2U is responsible for marketing the program, providing a technology platform, and technical support for students and faculty. Instructional design and production staff from 2U will work closely with the UCB School of Information and College of Engineering faculty to transform their courses into online offerings.

The proposal was reviewed by five highly qualified experts in the information and cyber security field, three from within the UC system and two from outside. In addition, UC Planning and Budget (UCPB) reviewed the proposal and provided comments to CCGA. Reviewers agreed that the program would fill a need and likely be in sufficient student demand to justify the program. They expressed unanimous praise for the quality and academic rigor of the proposed MICS program, with the program's curricula comparing very favorably in breadth and content with of the top cyber security programs in the country. Reviewers also agreed that MICS is an appropriate and financially-viable self-supporting professional Master's degree program.

However, the reviewers also raised some substantive concerns. One major area of scrutiny was the partnership with for-profit online provider 2U. UCPB, in particular, expressed concern over the role and oversight of the private vendor. Some reviewers also expressed concerns about dependency on 2U and whether the company wielded too much power under the current partnership arrangement. Program revenue cost-sharing with the 2U provide will be 40:60 UCB:2U.

In response, the proposers provided further evidence that the partnership was likely to be successful and would be beneficial to the campus and the School of Information (for details, see Lead Reviewer's letter enclosed). The proposers explained that the contract with 2U was a master services agreement that aggressively constrained all of the services that 2U provides to the university, ensuring that students, faculty and the university brand itself were sufficiently protected.

Another issue of concern was the availability of financial aid. In response, the proposers explained that MICS students would have access to the same need-based financial aid resources (mainly loans) as other online master's programs at UCB. Once the program is earning stable revenues, the proposers intend to return 30% of the surplus they earn from the degree to help attract qualified students who otherwise could not have attended Berkeley. CCGA asks the divisional Graduate Council to monitor the program at the three-year mark to assess enrollments and revenues, and that 30% of surplus revenues are in fact being directed to student return to aid for the program.

Other comments and concerns from the reviewers touched on topics including the balance between social/behavioral and technical content for a program on cyber risk, the related need to create the balance in course content to meet the diverse backgrounds of the student population, the structure of the capstone project, the availability of additional library resources, among others. CCGA believes the proposers have comprehensively addressed the concerns in the revised proposal submitted.

CCGA believes the proposed UC Berkeley's MICS Program has been rendered stronger by the review process. The expert reviewers have confirmed that it meets the criteria for quality and rigor. Other aspects of the proposal also seem to more than satisfy the expectations of reviewers and CCGA members.

As you know, CCGA's approval is usually the last stop of the Academic Senate side of the systemwide review and approval process except when the new degree title must be approved by

the President, under delegated authority from the Board of Regents. Given its status as a new graduate program title on the UC Berkeley campus, CCGA submits its approval of the Master of Information and Cyber Security degree program for formal approval by the Assembly of the Academic Senate.

Respectfully submitted,

Kwai Ng
Chair, CCGA

c: Robert May, Academic Council Vice Chair
CCGA Members
Hilary Baxter, Academic Senate Executive Director
Jocelyn Banaria, Academic Senate Associate Director
Michael LaBriola, Academic Senate Analyst
Kimberly Peterson, Academic Planning Analysis Manager
Chris Procello, Academic Planning and Research Analyst
Linda Song, Assistant Dean, Graduate Division
Noam Manor, Analyst, Office of Planning and Analysis
Sumei Quiggle, Associate Director UCB Academic Senate

Enclosure: 1

Report for the UC Berkeley (UCB) Proposal for a Self-Supporting Online Graduate Program leading to a Master of Information and Cyber Security (MICS) degree

Donald Smith, Lead Reviewer
August 28th, 2017

The proposal is to establish a new, self-supporting graduate program leading to a Master of Information and Cyber Security (MICS) degree within the School of Information, in cooperation with the School of Engineering, University of California, Berkeley (UCB). The proposal was reviewed by five highly qualified experts in the information and cyber security field, three from within the UC system and two from outside. In addition, UC Planning and Budget (UCPB) reviewed the proposal and provided comments to CCGA. Overall, all reviewers were highly supportive of the proposed program and recommended that it be approved. However, the reviewers and UCPB also raised some substantive concerns, as well as providing some constructive comments that the proposers systematically addressed in their response and revised proposal. The reviews were provided to the proposers. In addition, the CCGA lead reviewer also provided to the proposers a summary of the reviews with specific emphasis on the substantive comments to address in a written response and revised proposal. Following a brief description of the program, the main themes and recommendations from the reviews, as well as the proposers' response, are provided below. Overall, the proposers did an excellent job of responding to the reviewers' and UCPB's comments. I recommend that the proposed UCB Master's in Information and Cyber Security be approved.

I. Program description: The online MICS program will address the technical aspects of cyber security, as well as interdisciplinary aspects including policymaking, business models, legal frameworks, national security considerations, ethical issues, standards making, and the roles of users, government, and industry. The proposed MICS Plan II master's program consists of 27 course units. A student taking 9 units a term can complete the program in one year (counting fall, spring and summer semesters), although based on the proposers' experience with another online UCB program (the MIDS program), they expect that many students will take a more reduced load and complete the program in two - three years. The program will accept incoming students three times a year for matriculation beginning in each of the fall, spring, and summer semesters; proposers anticipate initial enrollments of 44 students, expanding to a steady state of ~250 students admitted each year within 4 – 5 years after launching, yielding ~500 students enrolled at any given time assuming the average student takes two years to graduate. The program will target several categories of students, including recent graduates and mid-career professionals. The program will initially focus on targeting students with a strong technical background and later expand to include a broader set of students.

The online MICS program will be developed and delivered in collaboration with the online educational technology provider 2U as a platform provider. 2U will be responsible for marketing the program, providing a state-of-the-art technology platform, and 24/7 technology support for students and faculty. Instructional design and production staff from 2U will work closely with the UCB School of Information and College of Engineering faculty to transform their courses into online offerings. Program revenue cost-sharing with the 2U provide will be 40:60 UCB:2U.

The MICS program will be taught by ladder-rank faculty in the UCB School of Information and College of Engineering, and will be administered by the School of Information, sharing administration resources with another online master's program at UCB, the Master of Information and Data Science (MIDS) program. Both the School of Information and the College of Engineering will contribute faculty expertise, oversight and teaching resources.

a. Degree requirements: All students will take four required 200-level courses (12 units) and five 200-level electives (15 units). There will be one required week of programmed face-to-face activities in Berkeley between faculty and students consisting of an *Immersion Week*. The Immersion will be mandatory for all students in order to build community and familiarity, including interaction with course faculty. The Immersion Week will be offered twice per year and will include a mix of cohorts. As a Plan II master's program, the program requires that each student complete a synthetic capstone project class. The capstone project is designed to integrate all of the core skills and concepts learned during the MICS program and helps prepare students to compete in the professional cyber security job market. Projects will include hands-on interaction with live, running systems, and students will have the opportunity to evaluate the security of firms such as Adobe, Airbnb, Apache, CloudFlare, Dropbox, General Motors, GitHub, Imgur, Khan Academy, New Relic, OkCupid, Shopify, Slack, Snapchat, Square, Twitter, Uber, Vimeo, Yahoo, and Zendesk. The lead faculty member for all courses, including the capstone course, will monitor the postdoc instructors and sections of the capstone course to ensure consistent quality. This faculty member will also be responsible for evaluating the appropriateness and timelines for the capstone projects. All courses in the program will include synchronous, webcam-enabled video interactions between faculty and students, maximizing opportunities for students to build relationships with faculty, and ensuring that faculty are able to connect a student's identity with his or her work.

b. Relationship with other UCB programs, and comparison to other existing programs outside UCB:
This program will not be in direct competition with any current programs at UCB or the other UCs. While all of the UC campuses (except UCSF) have a master's program in computer science, none have master's programs in cyber security. UC Irvine offers a certificate program in "Information Systems Security" through UCI Extension, but the program differs from the proposed UCB MICS program in a number of substantive ways. UCLA offers a "Master of Science in Engineering Online" program, but it focuses on computer networking and data science engineering and does not contain a cyber security emphasis.

c. Program Faculty, Workload and Faculty Compensation: All courses will be developed and primarily delivered (in the form of pre-recorded videos) by ladder faculty or, in some cases, industry professionals with unique knowledge of the field. After a course is developed, ladder faculty will, in most semesters, serve as the instructors of record, though it is anticipated that ~25% of the instructors of record each semester may be highly qualified adjunct faculty, industry professionals, or lecturers. For discussion and laboratory sections, industry professionals and postdocs will be recruited as lecturers to serve the function of teaching assistants.

UCB ladder rank faculty will invest heavily in the program in the start-up phase (building the video lecture content, assignments, exercises, and exams for the courses, etc.). This upfront effort will be compensated primarily with summer salary. Once the program is launched ladder faculty will be compensated with supplemental research funds to play the role of "lead faculty" with responsibility for overseeing the adjuncts and lecturers who run the weekly laboratory and discussion sessions of the course.

d. Program Cost and Financial Aid for Students: This self-supporting online MS program will charge students ~$69,984 (total program fee, all inclusive), which is equivalent to $2,592 per semester unit for the 27 unit program, with a proposed 5% increase starting in year three. This cost structure is based on market analyses and similar costs of comparative programs in the U.S., and the cost of mounting and sustainably offering the program in collaboration with the 2U online provider.

Financial aid will be used to build a broadly accessible program. MICS students will have access to the same need-based financial aid resources (mainly loans) as other online master's programs at UCB. In addition, once the program is earning stable revenues, the proposers state that they intend to return 30% of the surplus they earn from the degree to help attract qualified students who otherwise couldn't attend Berkeley. CCGA notes that this commitment of financial aid is indicated in the proposal and the proposers' written response to the outside reviewers, but is not included in the budget template sheet. CCGA asks that the divisional Graduate Council monitor the program at the three year mark to assess enrollments and revenues, and that 30% of surplus revenues are in fact being directed to student return to aid for the program.

II. Strengths and need of the proposed program highlighted by the five external reviews:

- **a.** There was unanimous recognition by the reviewers that the proposed MICS program would fill a need and likely be in sufficient student demand to justify the program.
- **b.** The reviewers expressed unanimous praise for the quality and academic rigor of the proposed MICS program, with the program's curricula comparing very favorably in breadth and content with of the top cyber security programs in the country.
- **c.** The reviewers agreed that MICS is an appropriate and financially-viable self-supporting professional Master's degree program.
- **d.** The reviewers universally recognized the high quality of the participating faculty and expressed their involvement is a strength of the program.

III. Challenges and weakness pointed out by the reviewers and proposers' responses (pasted from the August 16, 2017 response from the UCB proposers).

Comments from the outside reviewer are underlined, with the proposer's response in regular font.

a. Need/benefit of the program and target audience: Two reviewers raised questions about the target audience for the program. Reviewer Dr. Bishop identified a lack of clarity in the target audience for the program. This question reflects a misunderstanding, and a lack of clarity in our proposal. Our goal for the initial cohorts of MICS is to attract highly technical students. We anticipate that a typical admittee in the first year or so would have a background in computer science, electrical engineering, mathematics, information technology, or other technical field and/or relevant work experience. Since it is unlikely than any enrollee will have all the necessary background, we will recommend reading or other online resources to bring students up to speed in targeted skills. The core classes, including Secure Programming, Cryptography, Network Security, and Operating Systems Security, will also provide an opportunity for students to review subjects where their training is weak or out of date.

Over time we intend to admit students with a wider range of backgrounds by observing carefully to see what skills are missing in the applicant pool. This strategy worked well with the MIDS program: initially we only admitted students with very strong programming skills. Over time we realized that we could not admit many otherwise very strong applicants because of their lack of programming experience. We developed a rigorous "bridge" class in Python for Data Science as well as asynchronous materials in Linear Algebra and Data Structures that we offered for free to candidates who lacked these skills. This "bridge" strategy has been extremely successful. It has helped us increase the proportion of women in the program from around 10% to 27% in our most recent cohorts. We anticipate building similar "bridge" class(es) for the MICS degree (e.g. discrete math, operating systems) but want to wait to see where applicants are lacking in preparation before building the required course materials.

In sum, we will initially admit students with strong technical skills (CS or related undergraduate degrees and/ or relevant work experience.) Over time we intend to admit students with a wider range of backgrounds by building bridge classes in essential areas, such as discrete math, operating systems, or specific programming languages. This should help to broaden the pool of candidates we can enroll in the program, as well as expanding the electives to include more policy and management-related content. This approach is reflected in p. 8 of the proposal.

Reviewer Dr. Franz is concerned about the domestic v. foreign mix of students, and potential vulnerability to future changes in visa policy. Unlike the full time, on-campus computer science MS programs Dr. Franz refers to, international students in the proposed MICS degree do not need visas because they will be part-time, online students. Indeed they will not be eligible for US visas. Aside from visiting the campus for Immersion Week, they will remain in their home countries. We thus see no risks related to changes in visa policy.

We remain confident that our student body will be largely domestic, at least initially. Our online, self-supporting Master of Information and Data Science (MIDS) degree, a parallel program that we launched in 2014, has consistently attracted a student body that is 90% domestic and only 10% international students. Please note as well that the Student Interest Assessment in Appendix A, which concludes that there is substantial demand for the program, only surveyed potential students in the US.

b. Program Structure and Curriculum: Reviewer Dr. Wenke commented that instructors have not been finalized for many of the courses listed in Section 5. We recognize this issue; we have identified instructors for the core courses first, since we'll need to begin building those immediately. We will get commitments from other faculty over time; this should be easier once we have final approval since some faculty have been reluctant to commit until we have the full approval from UCOP to go forward with the degree.

We strongly agree with Dr. Borgman's comments on the importance of the complex social and behavioral issues involved in cyber risk and security, and that addition of more human-computer interaction aspects of cybersecurity would strengthen the program. While reasonable people can disagree about the proportion of social/behavioral and technical content in cyber risk, we certainly do not intend that this be a solely technical program. Everyone agrees that the degree program needs a mix of social, behavioral and technical content. One of the 3 required, foundational courses, *Beyond the Code: Cyber Security in Context*, emphasizes: "how ethical, legal, and economic frameworks enable and constrain security technologies and policies. . . (and) will introduce some of the most important macro-elements (such as national security considerations and the interests of nation states) and micro-level elements (such as behavioral economics insights into how people understand and interact with security.)"

The leadership role played by the School of Information in the program will help ensure that we maintain a healthy balance between, and integration of, technical and human/social/policy factors in cyber security. We are committed to the Usable Security class, and since we have substantial HCI expertise on our faculty, we are well positioned to add additional HCI-related electives over time.

Dr. Franz was concerned about "dependency" on technology partner 2U and specifically mentions that they have "too much power" and that there is the "potential for conflicts of interest." We do not see an imbalance of power in the relationship with 2U. In fact, the contract is a master services agreement (MSA) that aggressively constrains all of the services that 2U provides to the university, ensuring that students, faculty and the university brand itself are amply protected. Equally important, the contract serves as a mutual agreement to bring differential expertise to produce something that neither party could provide alone: We bring the reputation of the university and the expertise of the faculty in the domain of

cybersecurity curriculum and teaching. We own all admissions decisions, course and curriculum content choices, academic advising, and awarding of degrees. 2U provides the marketing expertise, the technology platform and 24/7 tech support, student/faculty support, and technical course development assistance. (To avoid any confusion, marketing is what we mean when we refer to 'recruitment.') *Our existing relationship with 2U in delivering the MIDS degree has been one of real partners with a shared goal: producing the highest quality Master's-level data science education to as many students as possible*.

There is a theoretical potential for conflicts of interest in this relationship, as in all university deals with outside entities. We are confident that none exists at this time and do not anticipate them in the future. None of our faculty invests in 2U, none has financial or other affiliations with the firm (family or otherwise), and we understand and respect the university's strong conflict of interest rules.

Anonymous reviewer 4 was concerned about the balance in course content to meet the diverse backgrounds and needs of the students, that the proposed 27 units of coursework many not be sufficient, and that courses like cryptography could be "culled" to better meet the target student body.' We have addressed concerns about students' technical preparation and backgrounds in above. The proposed 27-units of coursework is not atypical load for a technical master's program at UC Berkeley; the on-campus Master of Engineering Leadership program offered by the College of Engineering has a unit requirement of 24 units.

We also note that we have experience with the program curriculum, as many of the proposed courses are already being taught on campus. The instructor for the core Cryptography course, Prof. Doug Tygar, has been teaching classroom courses on this subject for three decades. The outline for this course is based on a course that he has offered several times at Berkeley, and he has found that in practice, students are able to master the material. He also notes that half of the material in the cryptography class is devoted to systems. Unlike a PhD-level course, which would try to train mathematical cryptographers, this course aims to expose students to different types of cryptography. This exposure allows graduates to understand the costs, benefits, and risks of different types of encryption technology, and the likely trajectory of advances in both communication needs and cryptanalysis (the science of breaking cryptographic systems).

Reviewer Dr. Bishop recommends that we develop the concentrations we propose in Section 2.1.1. We fully intend to develop concentrations. This is related to the earlier point about deliberately sequencing the type of students we admit as the program grows. Initially we assume most students will be in the science of cyber security track. Once we have the basic curriculum established, we will build electives to provide different trajectories through the coursework to meet the differing needs of our students, including those who intend to work as managers or in government and national security settings, although all applicants will be required to master some programming languages.

Dr. Bishop also raised a point about the capstone project: that the proposal implies that the only viable capstone project will only be a penetration test of some sort. We plan on using penetration testing as an initial model for the capstone, as finding and patching vulnerabilities is an essential skill. We will also allow interested students to pursue other capstone options, initially on a case-by-case basis. We anticipate formally introducing different types of capstone project as we grow the program and diversify the student body, e.g., projects focused on the policy aspects of cyber security. That said, the idea, proposed by Dr. Bishop, of having students build high assurance systems and infrastructure, is not likely to be feasible in a 27-unit program; that would be more appropriate for a Ph.D. program. It is also worth noting that many of the classes, especially the system security electives, the cryptography core class, and the secure programming core course, and the systems elective courses will have exercises and

projects that involve modifying systems and infrastructures. We have changed p. 45 of the proposal to explicitly reflect this point.

Dr. Bishop offered suggestions about the substance of the Immersion Week. Since the students will have extensive lecture content from our faculty in the program, the goal of these sessions is to engage them in discussions with one another, as well as with the faculty about current issues in cybersecurity. We believe that it is appropriate to have faculty-led sessions about cybersecurity-related research, including their own research, as well as about careers and the job market. Our career placement staff will support and supplement these activities. We have learned a great deal about what works and is valuable in Immersion weeks from MIDS. Student evaluations of the Immersion are always quite positive; in fact some come back for a second or third Immersion even though they must pay for it themselves.

c. Faculty and faculty workload: There are some questions regarding faculty workload and incentives to participate. Dr Wenke suggests that it may be necessary to give the faculty "supplementary" pay to create and manage the courses . . . . (and) it may be necessary to provide them with better incentives. He is referring particularly to faculty members from EECS, many of whom already have their summer salaries covered by research grants. We recognize this problem and have several possible solutions. In one case we have been able to "buy out" partial teaching relief for one CS faculty member. We are also working on an MOU with our Vice Provost for Faculty that will allow us to compensate faculty members additional salary (and in excess of their normal 9-month salary) for work completed during their time devoted to "professional activities" under APM 025. This arrangement has worked for other professional schools at UC Berkeley running self-supporting degree programs, including Law and Business. We believe that it will help with incentives for some of the busiest faculty members.

Anonymous reviewer 4 suggests that we may be underestimating the actual effort required for course development. We are aware that course development is extremely time consuming, but we don't believe that we are underestimating the effort required. We've developed 13 courses for our online MIDS degree to date. We've learned from that experience that while the course development process, which occurs over the course of 9-12 months, is a heavy lift, once the course has been built, the time requirement for the faculty is significantly reduced, and significantly less than a normal on-campus program.

d. Program Facilities and Resources: Reviewer Dr. Bishop observed that "the resources are adequate, indeed superlative in terms of the people involved to make a good case that the classes and advising in this proposed program will be covered, and the summer salary for creating the courses is reasonable." He goes on to recommend that the aid of a graduate student (see p. 56) to support the ladder faculty is something I would strongly encourage. We anticipate hiring graduate students to support the ladder faculty in the time consuming process of new course development. We have learned through the MIDS degree program that graduate students can be very helpful in the process of building the assignments and exercises, supplementary screen flows, and exams or projects for our online courses. We have edited p. 56 to acknowledge this role.

Reviewer Dr. Wenke raised a concern about the suitability of the computer resources for the program, and suggests a need to "procure a server farm to create a cloud-based environment for student projects." Our experience with the online MIDS degree, where students work regularly with large data files, confirms that students will need only to own a computer and have access to a good Internet connection. School of Information faculty members already run project-based courses where custom cloud services are spun-up on demand to achieve goals of privacy, security, or temporally-limited resource for students. Several MIDS courses require students to analyze extremely large datasets. To address the computing need inherent in these assignments, we've developed relationships with Amazon Web Services (AWS),

Google Cloud, and IBM Softlayer by which our program students receive free credit on the cloud platforms to complete their projects. We will continue to leverage these existing relationships for the MICS program. In addition, penetration testing will to be performed under the aegis of existing systems; e.g., HackerOne's system.

Reviewer Dr. Borgman raises a concern about our statement that no additional library resources are needed, which is unusual for a new degree. She encourages the MICS proposers to discuss library collection and access requirements with the University Librarian. We are fortunate that the Campus Librarian, Jeffrey Mackie-Mason, is a member of our faculty, so he is readily available to discuss library collection and access requirements. However since the campus has a very strong CS department and Cyber Security group, the collection is already well developed. The most important resources for MICS will be the relevant e-journals (everything from ACM, IEEE, Springer, and others), as well as the Arxiv repository. These are available to all Berkeley students, including those enrolled in MICS. It is conceivable that students who live beyond a national firewall, e.g. China or Iran, will face difficulties accessing content, but even then we have qualified expertise to assist them.

e. UCPB comments: We are perplexed that the UCPB cover letter refers twice to a Master's of Information and *Computer Science (not Cyber Security*) even though the accompanying review has the correct degree name. We also note that the critical points made in the cover letter that concludes that UCPB is "unable to support this proposal at the current time" are not substantiated by the accompanying review document. Finally, we find it odd for a system-wide committee to question the local (Berkeley) approval process and the rigor of the reviews by the Graduate Council and Divisional Council. This likely reflects campus political debates that have little to do with the substance of the MICS proposal.

The concerns raised by the UCPB include:

(i.) the apparently large and unjustified student fee increases in the early years of the program. We used the standard UCOP SSGPDP budget template to provide an overview of the projected revenue and expenses for MICS. This template displays the cost to the students in each year of the program, with tuition charged on a per-unit basis. Because this program is slated to begin in summer 2018, the cost in year one is for two semesters only; the cost in subsequent years is for all three semesters. The tuition per unit in years one and two is $2,592. We have proposed a modest 5% fee increase every other year, so years three and four would be $2,721 per unit, and years five and six $2,857 per unit. For additional clarity we are attaching the full spreadsheet that includes greater detail on proposed program finances.

(ii.) the proposal does not make clear the dedicated amount (or proportion of income) of student financial aid and whether this may change as program costs increase. We are committed to ensuring broad access to the MICS program. One of the advantages of providing the degree online is that it will make Berkeley graduate professional education available to people who currently don't have access to it because they can't relocate to Berkeley for various reasons including work obligations, family commitments or disabilities. Moreover, online students will have the opportunity to continue to work while pursuing their graduate studies. In our experience with MIDS, the vast majority of students are gainfully employed throughout their time in the program, reducing their debt burden upon graduation compared with a typical on-campus graduate student. Currently, the average *incoming* salary for a MIDS student is $81,000 - with many students also receiving employer financing support.

Our partner, 2U, will be investing heavily in marketing the program; we view this as one of the most significant steps in widening access to the degree. Financial aid is also an important element of our commitment to building a broadly accessible program. We have already worked with the campus Office of Financial Aid to ensure that MICS students will have access to the same need-based financial aid

resources (mainly loans) as our MIMS and MIDS students. Once we are earning stable revenues, our goal is to return 30% of the surplus we earn from the degree to help attract qualified students who otherwise couldn't attend Berkeley.

We plan to devote resources to: (1.) develop targeted outreach to attract new pockets of talent such as returning veterans, full time parents, individuals who live in remote or socio-economically disadvantaged areas or have disabilities; (2.) award scholarships and grants to qualified students who need financial support; and (3.) finance a loan forgiveness program for students who use their training in nonprofits, NGOs, or public service positions that make debt repayment unrealistic or unattractive. We have added this language about financial aid to the proposal on p. 59.

Our experience with the MIMS and MIDS degrees suggests that financial support for professional students in information-related fields is a less pressing need than for PhD students or undergraduates. However, we are committed to ensuring that graduates can pursue careers that do not pay top salaries, and to attracting as diverse a student body as possible. This means we want to insure that any applicant who is qualified for admission can enroll in the program, regardless of financial status.

(iii.) Concern over the role and oversight of the for-profit online provider 2U, and insufficient detail and justification for the UCB-2U revenue sharing. The decision to partner with 2U on the proposed MICS degree was made based upon our successful experience with the company in launching and offering the MIDS degree. We are confident, on the basis of that experience, that this is a beneficial arrangement that well serves the interests of the University of California. The campus-initiated Academic Program Review of the I School in 2016, as well as the annual review of MIDS by the Berkeley Graduate Council have come to the same conclusion.

We also note that other academic units on the Berkeley campus have launched online master's degree programs (e.g., EECS's Master of Integrated Circuit Design, the School of Public Health's Master of Public Health) but the MIDS program is the only online degree that has scaled and generated significant revenues for the campus and the unit. We believe that it may be one of the only successful online professional master's degree programs in the UC system.

It is also worth underscoring the scale of 2U's commitment to the program: 2U provides the funding, technology, and services critical to developing a high-quality online degree program. 2U also takes nearly all of the upfront financial risk for the partnership, investing $5-10 million of cumulative net negative cash over the first three to five years of the programs life. (They still have not recouped that investment in MIDS, which explains the long-term nature of the arrangement.) This investment is used to implement the course content we develop, market the program, build the technology infrastructure, and service students and faculty: all of which are important components of the proposed MICS degree. 2U now has 2 full-time employees located in Berkeley to work with us on MIDS, as well as 27 FTE assigned to the MIDS degree and working from 2U offices in Denver and Lanham, Maryland.

2U's marketing and admissions arm has enabled the MIDS program to scale very quickly, enrolling over 600 students to date, without sacrificing quality. We admit only a small proportion of the applicants they bring us. Those students have a median GRE quant and verbal score of 88th and 90th percentiles respectively and an average undergraduate GPA of 3.50. This quality at scale has allowed MIDS to flourish: the degree was ranked by Forbes as one of the top 6 best data science Master's degrees in the US (along with CMU, MIT, Northwestern, NYU, and Stanford).

It is worth underscoring that 2U's financial success is tied directly to the outcomes for the MICS students. In other words, the incentives are well aligned: We have a shared goal of not just enrolling students, but supporting them through graduation. 92% of students who enrolled in the MIDS program are expected to

graduate. These graduates are being placed in first-rate data science positions in companies, government, and non-profit organizations in Silicon Valley and around the world.

Reviewers express concerns about the revenue split between Berkeley and 2U. But, as Dr. Wenke observes: “the 40/60 split between UCB and 2U also seems reasonable, i.e., in the ballpark of other online degree programs.” Please note that the split for the MIDS degree was 35/65 and 2U lowered it for MICS. From the perspective of the I School, a small, new unit that receives minimal resources from central campus aside from 12 ladder-rank FTE, this partnership has been transformative. The 2U partnership allowed the School to launch and scale a high quality new degree program in a very short time frame; it is now generating revenue that covers the rising costs of our on campus programs (MIMS and a PhD program) and allows us to launch new initiatives.

Annual reviews by the UC Berkeley Graduate Council as well as external reviewers have been uniformly positive about the MIDS program. The Academic Program Review of the School of Information, which occurs every 10 years, was conducted by the campus in 2016-17. The final report by the External Review Committee (ERC)--3 faculty from peer universities (Stanford, the University of Wisconsin, and Syracuse)--concludes: “The launch of the MIDS online degree is a success and an important innovation for UCB.” They recommend that the School “aggressively expand and develop MIDS” and also suggest that “UCB should learn from the success and innovation of the MIDS degree--there are very few rigorous and sustainable synchronous online programs.” Given the concerns raised by UCPB we quote sections of the ERC report at length:

MIDS is distinguished by its emphasis on synchronous interaction with students and faculty, in small classes, carrying the ‘high-touch’ approach of the MIMS on-campus program into the online environment. Contrast this in particular to MOOC models, where the emphasis is on massive numbers of students (often in the tens of thousands) and the instructional experience is largely asynchronous.

MIDS is also distinguished by its partnership with the vendor (2U) that reflects a good balance of effort. Specifically, in return for a significant fraction of the tuition revenue from MIDS (currently 65%), 2U provides a wide array of services, including marketing, system support, admissions (not selection, but management), and student support. . . Among the services covered by 2U, operations support for working with university systems was particularly noted as a benefit of the 2U arrangement, as was ongoing student contact (2U commits to follow up several times per month with each MIDS student.) 2U also gathers feedback data on the MIDS experience and uses this to refine the platform and course content (the latter in cooperation with instructors.) 2U maintains a staff of two people in Berkeley just to service the MIDS degree, and has an additional 27 staff supporting the enterprise.

Highlights of the program include the decision to maintain small synchronous class sizes (approximately 15 students) continuing the practice of individualized attention from instructors. Multiple sections refer to the same asynchronous materials, with the materials developed by ladder faculty. Once the course is established, synchronous sections are then run by lecturers (often industry professionals) and post-docs.

All MIDS students highly praised the degree for its content, student support, and opportunities it opened up for them even before graduation. In particular, graduates praised the program for being a “model of how work worked,’ encompassing both product and team development, with a focus on approaching problems; how it ‘opened up a new way of seeing the world’ e.g. through information architecture; and how it instilled their ability to succeed in technology work environments. MIDS graduates report that the degree dramatically improved their employment prospects (e.g. a doubling of compensation in at least 2 reported cases) and that the cohort of other MIDS students has remained a valuable, ongoing asset (e.g. for problem-solving, for team formation in a start-up). Current MIDS students have found the program has already helped them in gaining internships.

(iv.) concerns about the rigor of local (on-campus) review and approval of a proposal without broad commitment from EECS. We believe that we have adequately addressed the concern about the rigor of campus review process by quoting at length the review of MIDS in the 2016 External Review Committee report, which is mirrored by Graduate Council reviews.

The concern that the proposal was approved "without broad commitment from EECS" raises the question of what constitutes an appropriate level of commitment in a very large and diverse faculty. There are over 130 faculty members in Berkeley's EECS division, of whom a very small subset are relevant contributors to this degree. The webpage of the Security (SEC) Research Group lists 7 faculty members as Primary, along with another 17 Secondary members. Faculty participation in the MICS degree is voluntary and compensated with overtime salary; it is not of concern to the overwhelming majority of EECS faculty members. (Would we ask for commitment by all faculty members in the Social Sciences Division for a self-supporting degree offered by the Departments of Geography or Demography?)

The proposal provides strong evidence of commitment of the relevant contributors to the proposed MICS degree. It includes letters of support from the Dean of the College of Engineering, the Chair of EECS division, and 5 members of the Security Research Group as well as 4 faculty from the School of Information. The letter writers are the key security faculty on campus, about whom Dr. Bishop writes: "The ladder faculty are among the top computer security educators and researchers in the world, and the program is structured to provide a technical overview in the concepts and practice of cybersecurity."

The MICS proposal was approved by Berkeley's Divisional Council and submitted for review by the Chancellor and the Vice Provost for the Faculty of the Berkeley campus. We believe that this is more than sufficient documentation of faculty and campus commitment to the proposed degree.

In summary, the proposed program is intellectually strong and the program faculty well qualified to deliver it. The partnership with the online provider 2U appears appropriate. Reviewers and UCPB concerns have been adequately addressed in the revised proposal. I have no further questions or issues with the proposal and commend the proposers for being very responsive to the reviews. I recommend its approval.