A. Executive Summary of Initiative

Establishing Electrical Engineering and Computer Science (EECS) as a strategic focus area at UC Merced will: 1) expand the research excellence the University already has in these increasingly important fields; 2) allow the campus to achieve its goal of enrolling 1,000 graduate students by 2020; and 3) benefit the Central Valley through economic stimulation and highly employable undergraduate educational programs. The foundation to achieve these goals already exists in the form of the EECS graduate emphasis area and Computer Science and Engineering (CSE) undergraduate program. Additional resources, primarily in the form of faculty FTEs and adequate research space and instructional space, are needed to grow the campus' EE component to: 1) expand into new but synergistic research areas, and 2) create an undergraduate program in EE.

We will build the existing strong foundation to reach a group of around 30 faculty members by 2020 through continued steady hiring in CS (5) plus a larger number in EE (10) and "joint" (5). This group should advise in excess of 200 graduate students (about 2/3 PhD), a significant contribution to UCM's goal of enrolling 1,000 graduate students. There is tremendous untapped potential in graduate education in EECS at UCM. The EECS graduate program received 114 applications (66 for the PhD program) in the 2013-14 cycle which is over 20% of the campus' total despite the EECS ladder rank faculty constituting less than 8% of the campus. A larger EECS group could of course cover the disciplinary requirements, but, most importantly, it will enable more-than-proportional growth in large-scale interdisciplinary funded projects, in externally funded PhD students, and in fee-paying MS students whose tuition could be recycled into fellowships and bridge/backstop funding to enable more aggressive PhD student recruiting.

UCM and its School of Engineering are at a critical juncture in their growth. This strategic academic focusing exercise is the ideal and possibly last opportunity to create a strong EE program. Establishing EECS as a focus area will achieve this and other important steps towards creating the next great University of California campus.

B. Definition of Thematic Area

Electrical engineering and computer science are not separate disciplines but lie on a continuum with increasing overlap. The boundary between hardware and software continues to blur due to cross-fertilization such as software adopting modular components that were traditional to hardware and hardware becoming software-like via programmable logic. The ever-increasing diffusion of embedded devices combining computation, sensing, and communication further contributes to this trend. UCM is in a unique position to grow a truly unified EECS program, an opportunity not possible at well-established institutions.

UCM already has successfully built research strength in artificial intelligence, cloud computing, computational neuroscience, computer animation, computer graphics, computer networks, computer theory, computer vision, cyber-physical systems, databases, distributed systems, embedded networked sensor systems, image processing, machine learning, robotics, speech processing, and wireless communication. Some of these are strictly CS areas while others encompass both CS and EE. We will continue to build strength in these areas as well as expand into new ones guided by future societal needs. Potential areas of growth include high-performance computing, data and network security, medical information systems, smart grids, computer architecture and VLSI design, hardware/software co-design, storage architectures for data centers, remote sensing, signal processing, control and optimization, nano- and micro-electro-mechanical systems, bio-sensing devices and energy-efficient circuits. Our vision is to build strength in key core and applied areas so that an assortment of multi-disciplinary collaborations can be established with other programs in the School of Engineering and other Schools at the University.

On the educational side, we will continue to grow a robust graduate program in EECS and, in response to heavy demand, we anticipate growing the number of students pursuing MS degrees. We will also expand the undergraduate program to include an EE offering. These steps are essential for UCM to achieve the objectives set forth in the 2020 vision.

With respect to the nine themes identified by the SAF Working Group, EECS is a more sharply defined theme within 7) Information, Computational, and Data Sciences, and Engineering. However, it is an area of research and scholarship that makes significant contributions to several of the other themes including: 3) Human Health; 4) Innovation and Entrepreneurship; 5) Environmental Sustainability; 6) Energy and Energy Systems; 8) Matter Science and Engineering: from theory to application; and 9) Life Sciences.

In addition to developing a strong core EECS program, we anticipate numerous interdisciplinary collaborations with existing and proposed research initiatives (e.g., SPARC, CIDER, CHASE, the UC Merced Center for Theory and Computation, and the Computational and Data Science initiative).

C. Intellectual Components of the Initiative

We live in an era of automation and information. More than ever before, we have the opportunity to tackle problems whose solutions will radically change our everyday life and improve our standard of living. And many, if not most, of these solutions are driven or enabled by discoveries and advances in EECS. Challenges and opportunities exist in big data analysis, health care, energy, and security, just to name a few. These challenges require contributions from multiple research areas along the EECS continuum which is why a unified program is essential. EECS is poised to make contributions to the following key areas with immediate benefits to a large fraction of the world's population. These are just a sample of domains where basic research in EECS will result in significant societal and economical impacts on a global scale.

- *Health care.* The federal budget for health care is over 1 trillion USD as of 2014 and is expected to increase rapidly over the coming years. Providing effective yet affordable health care is an urgent challenge. EECS is in a unique position to help address this challenge through improved data acquisition and analysis. Detecting influenza epidemics using search engine query data (Nature 2009) is just one of the abundant examples that illustrate the leading role EECS can play in this new health care era. Systematically monitoring patient health, aggregating and analyzing data, and ensuring privacy and security require contributions from multiple EECS research areas ranging from wearable computers to data mining and security.

- *Security and privacy*. The Internet revolution brought great benefits, opened new opportunities, but also created new challenges with huge societal impacts. In an interconnected world, absolutely secure access to computer, mobile, and cloud systems will be an unavoidable requirement to sustain the economy, promote civic participation, and advance knowledge. Our dependence on automated systems goes well beyond private Internet access though. Power plants and energy distribution networks, transportation networks, and strategic infrastructure are increasingly automated and interconnected. Designing secure hardware and software that prevent breaches is critical to national security in the current climate of active cyberwarfare development (see Smart Grid below).

- *Energy*. The US is a leader in the production and supply of energy, and is one of the world's largest energy consumers. Growing consumer demand and world class EECS innovation make the US the world's most attractive market. There are three green subsectors that are heavy influenced by EECS research: Renewable Energy, Building Energy Efficiency, and the Smart Grid. These domains are at the core of several EECS research areas, including novel computer networks and protocols, sensor networks, the internet of things, new sensors and cyber infrastructure, more efficient direct energy converters, new predictive maximum power point tracking (MPPT) devices, innovative energy storage hardware, to name just a few.

- *Robotics and artificial intelligence.* Robots and autonomous systems have become pervasive in our society. Flexible manufacturing plants with robots working side by side with humans are "inshoring" formerly outsourced jobs and leading the resurgence of American manufacturing. Autonomous vehicles are becoming a reality that will make transportation safer, more efficient, and greener. First responders are increasingly relying on robotic technology to improve their response capabilities and save human lives. New sensors, more reliable communication devices, and better algorithms will further advance these systems. A skilled workforce and research centers of excellence are needed to ensure California and the US retain their leadership role in this area.

D. UCM's Role

UC Merced has already achieved significant research excellence in EECS. The 12 core and three affiliated faculty members of the EECS graduate program have brought over $7M in extramural funds[1]; have been awarded four NSF CAREER Awards, one DOE Early Career Scientist and Engineer Award (with another pending), and one Presidential Early Career Award for Scientists and Engineers; serve on the editorial boards of 24 high-impact journals; advise 32 mostly PhD graduate students; and have graduated 6 MS and 13 PhD students who have been placed in faculty, competitive postdoc and industrial research positions, and have even started their own companies.

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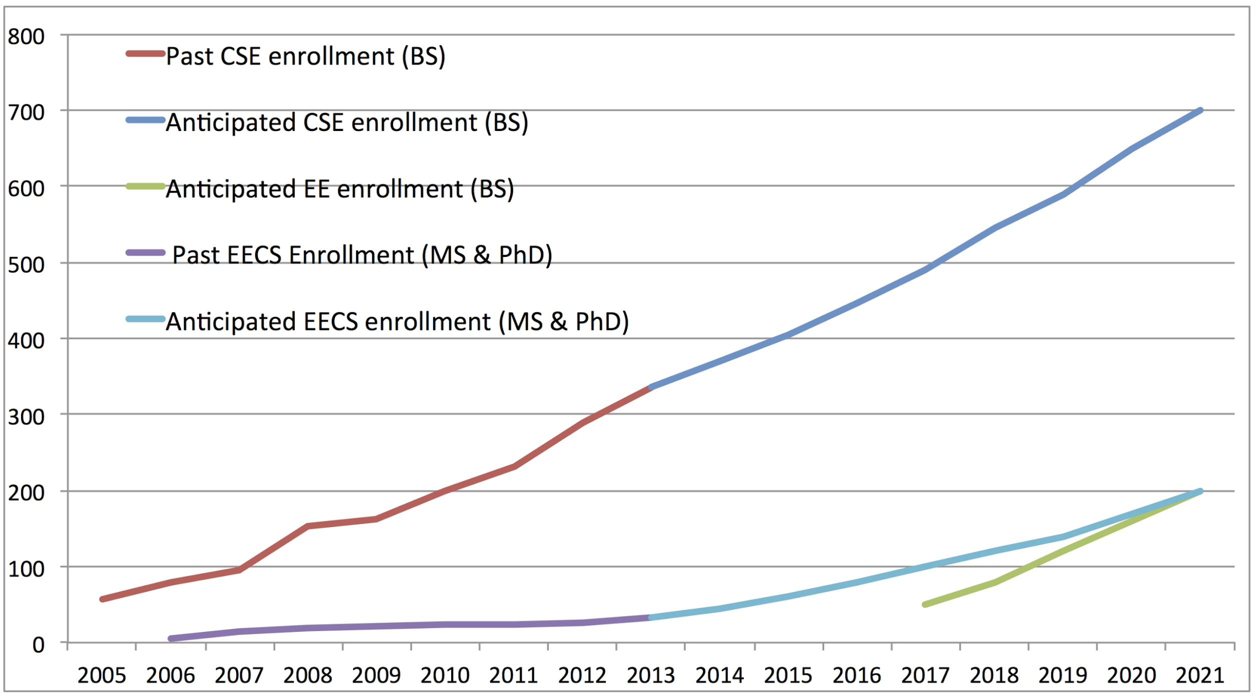
[1] A list is available at http://eecs.ucmerced.edu/SAFData

As substantiated by the above data, the existing faculty has already established itself as being competitive in select areas when compared to programs within UC and other research universities. Establishing EECS as a strategic focus area at UCM is critical to broadening this competitiveness to areas in which we currently do not have faculty expertise but are key to tackling the societal-level problems described above. We envision a group of at least 30 EECS faculty members advising in excess of 200 graduate students (of which about 70 are MS students). At the undergraduate level, we anticipate around 900 students in the undergraduate programs in EE and CS (see attached impact metric worksheet). The chart below depicts past and anticipated growth for the various programs.



Past and anticipated growth of the graduate EECS and undergraduate CSE and EE programs. Note that past EECS graduate enrollment has been primarily PhD students.

UCM and its School of Engineering are at a critical juncture in their growth. This strategic academic focusing exercise is the right time to invest in EECS. Failure to do so when other top research universities, e.g., Stanford, are investing heavily in this area risks jeopardizing our competitiveness and goal of creating the next great University of California campus. Moreover, it hinders UC Merced's capability to train students in high-demand areas with bright career opportunities in sectors heavily demanded in California and nationwide. This will directly impact the leverage the University has on attracting external funding from funding agencies, the private sector, and its alumni.

E. Faculty Participation

The proposed unified EECS program builds upon the existing EECS graduate emphasis area and CSE undergraduate program. A full-fledged EECS program will be built around the following faculty, many of whom, in addition to their affiliation with EECS, are core members of the Mechanical Engineering, Cognitive and Information Sciences, Biological Engineering and Small-scale Technologies, or Management programs: Stefano Carpin, Miguel Carreira-Perpinan, Alberto Cerpa, YangQuan Chen, Dan Hirleman, Ariel Escobar, Sungjin Im, Changqing Li, Marcelo Kallmann, Paul Maglio, Shawn Newsam, David Noelle, Erik Rolland, Florin Rusu, Mukesh Singhal, and Ming-Hsuan Yang. The EECS affiliated faculty are already collaborating with a number of other disciplinary groups on campus; broadening the areas represented will naturally lead to additional research collaborations. At the undergraduate level, EE curricula would be synergistic with Mechanical Engineering, Bioengineering, Materials Science and Engineering, Environmental Engineering, Physics, and Applied Mathematical Sciences.

F. Special Programmatic Needs

Appropriate resources are needed to implement the vision we put forward, but the return on investment in the medium to long term will justify the initial commitment. It will be necessary to allocate appropriate resources to attract top faculty and competitive graduate students. This includes: infrastructure with adequate space for research and graduate education (see appendix for a tentative list); competitive startup packages; state-of-the-art equipment, computer hardware and software, networks, and interfaces; and appropriate administrative support. In order to compete with the top institutions for the best graduate students, attractive multi-year financial offers in the form of combined fellowships and TA positions will need to be provided. Finally we would like to point out the benefit of not starting a program from scratch, but rather expanding an already distinguished area at UC Merced.