BOSTON UNIVERSITY | DIVISION OF

SYSTEMS ENGINEERING

"BY DRAWING ON THE STRENGTHS OF HUMANS &
ROBOTS, LIFE CAN BE MORE PRESENT & PRODUCTIVE."
NEW FACULTY: REBECCA KHURSHID

2017/2018 ANNUAL REPORT
WHAT'S INSIDE? NEW INTERNATIONAL DUAL DEGREE, SMART
CITIES, GREEN BUILDING, STRIDES TOWARD CURING CANCER

TABLE OF CONTENTS

LETTER FROM THE HEAD

The 2017-18 Division of Systems Engineering Annual Report contains information on new research projects, PhD dissertations completed, and the scholarly output, distinctions and honors received by our faculty and graduate students.

This year, Rebecca Khurshid joined the Division as an Assistant Professor of Mechanical Engineering and Systems Engineering specializing in robot-human interaction. With this welcome addition, the Division now includes 17 faculty members with home departments in Electrical and Computer Engineering and in Mechanical Engineering, along with 14 affiliated faculty members from the College of Engineering, the College of Arts and Sciences, the Questrom School of Business, and the Medical School. Our PhD student enrollment has grown to 41 students, along with 26 students in the MS and MEng programs.

There were 4 PhD degrees awarded last year, along with 10 MS degrees and 3 MEng degrees. The Division continues to provide full financial support to all admitted PhD students through Fellowships, while our continuing PhD students remain funded from research grants received by participating and affiliated faculty with a total sponsor commitment of approximately $60M, of which over $20M came from newly awarded grants. The Report contains short descriptions of selected new grants, along with a number of honors and awards for our faculty and accomplishments by our students.

As we move forward, our continuing mission, in partnership with the Center for Information and Systems Engineering (CISE), is to support world-class interdisciplinary research activities in our primary concentration areas: Automation, Robotics and Control, Communications and Networking, Computational Biology, Information Sciences, and Production, Service and Energy Systems. I take this opportunity to once again gratefully acknowledge the contributions of all Division faculty and students who, along with our outstanding staff, continue to pursue the Division's research and educational goals.

CHRISTOS CASSANDRAS

DIVISION HEAD
DISTINGUISHED PROFESSOR OF ENGINEERING

RESEARCH

ACADEMICS

FUNDING: NEW, CONTINUING & TOTAL RECEIVED FUNDS

Bar chart with values by year:
- '08-'09: 6, 23, 29
- '09-'10: 12, 29, 41
- '10-'11: 16, 28, 44
- '11-'12: 5, 44, 49
- '12-'13: 10, 45, 55
- '13-'14: 6, 60, 66
- '14-'15: 18, 61, 79
- '15-'16: 14, 55, 69
- '16-'17: 19, 38, 57
- '17-'18: 21, 26, 47

Legend: ■ New funding　■ Continuing funding　■ Total received funding

DEGREES AWARDED

Bar chart with values by year (PhD, Masters, UG Minor):
- '10-'11: 8, 5
- '11-'12: 5, 9
- '12-'13: 5, 9, 2
- '13-'14: 6, 21, 2
- '14-'15: 6, 11, 2
- '15-'16: 7, 15, 3
- '16-'17: 4, 8, 1
- '17-'18: 4, 13

Legend: ■ PhD　■ Masters　■ UG Minor
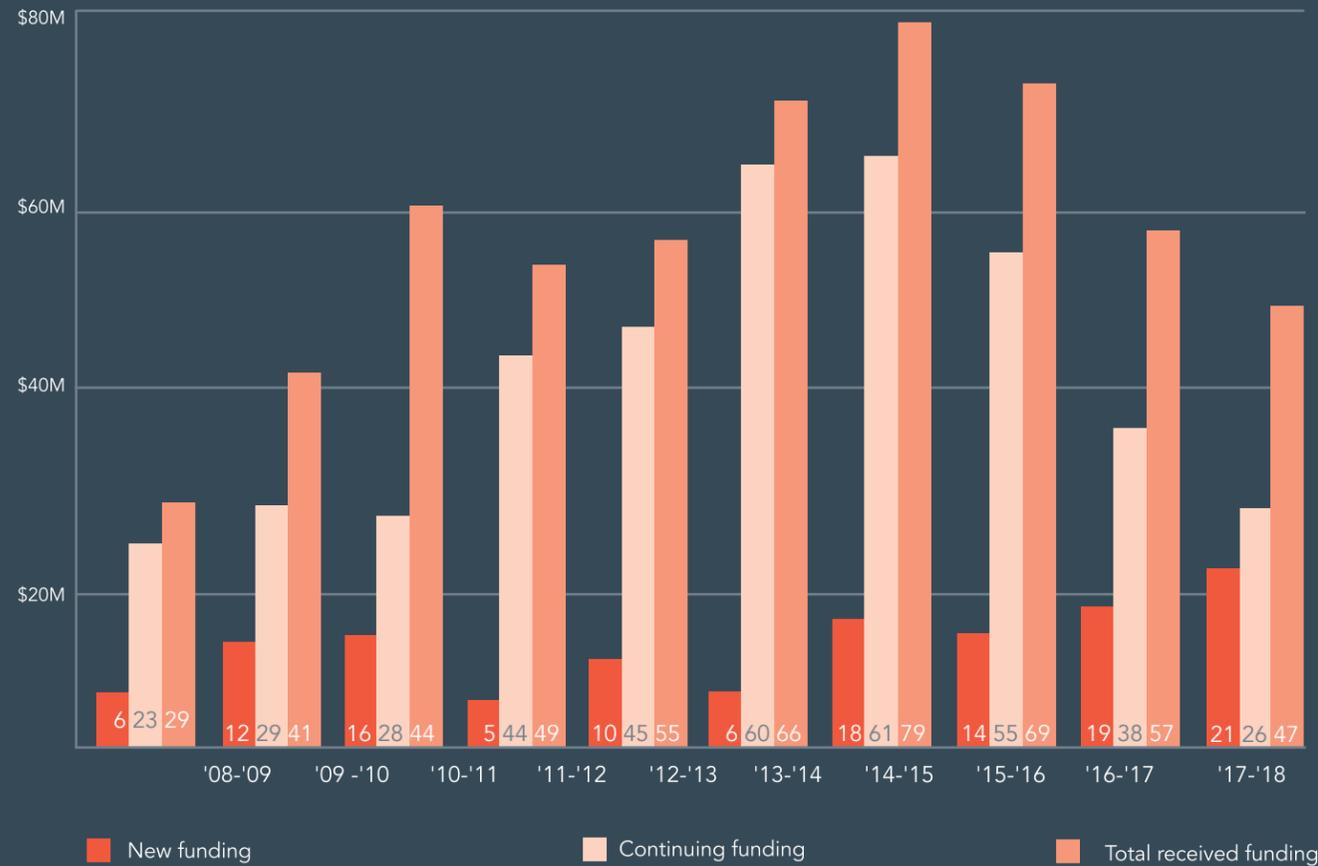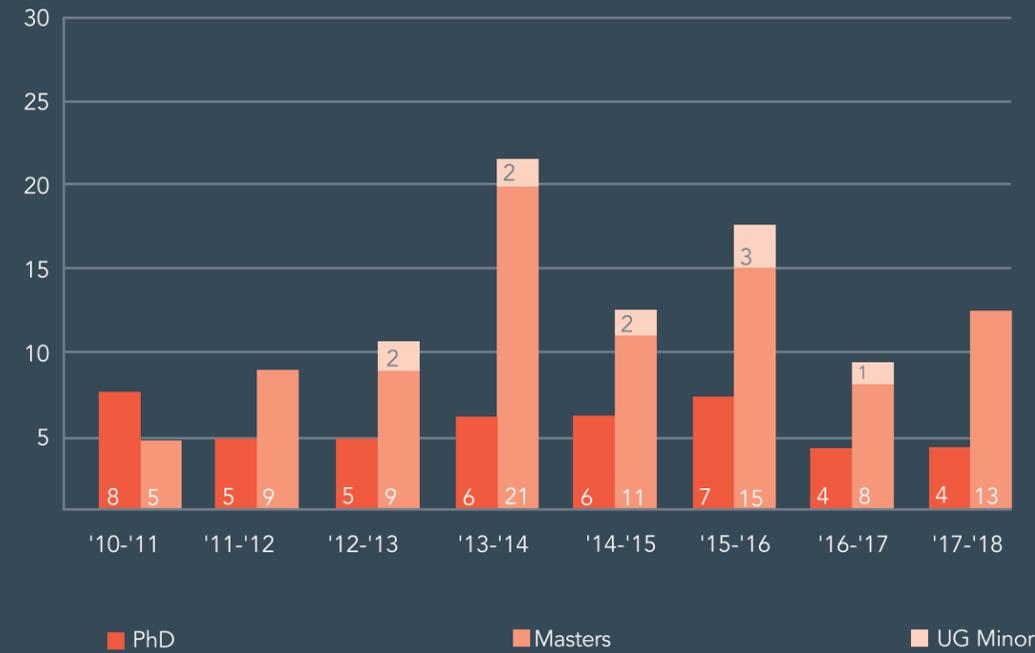
TOTAL HISTORICALLY:
75 PHD DEGREES SINCE '08
51 MS DEGREES SINCE '08
43 MEng DEGREES SINCE '11
2 MS WITH PRACTICE
DEGREES SINCE '14
10 UNDERGRAD MINORS

2017-18:
4 PHD DEGREES
**10** MS DEGREES
3 MEng DEGREES

2017-18 FUNDING

$60M
ACTIVE FUNDS
To include total anticipated
funds for ongoing grants.

$11M
EXPENDITURES

2017-18 FUNDING SOURCES

Pie chart sources:
- 15% INDUSTRY
- 12% DOD
- 7% DOE
- 2% HHS
- 6% DHS
- 18% NIH
- 40% NSF

POPULATION

Bar chart with values by year (PhD, Masters):
- '10-'11: 29, 11
- '11-'12: 28, 20
- '12-'13: 28, 32
- '13-'14: 31, 25
- '14-'15: 30, 33
- '15-'16: 32, 27
- '16-'17: 34, 24
- '17-'18: 41, 26

Legend: ■ PhD　■ Masters
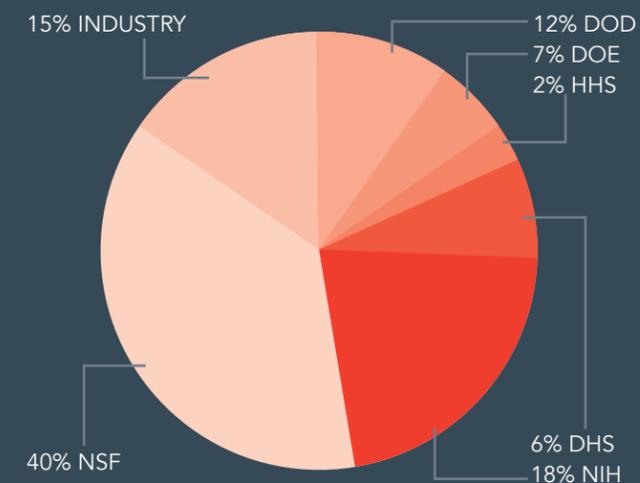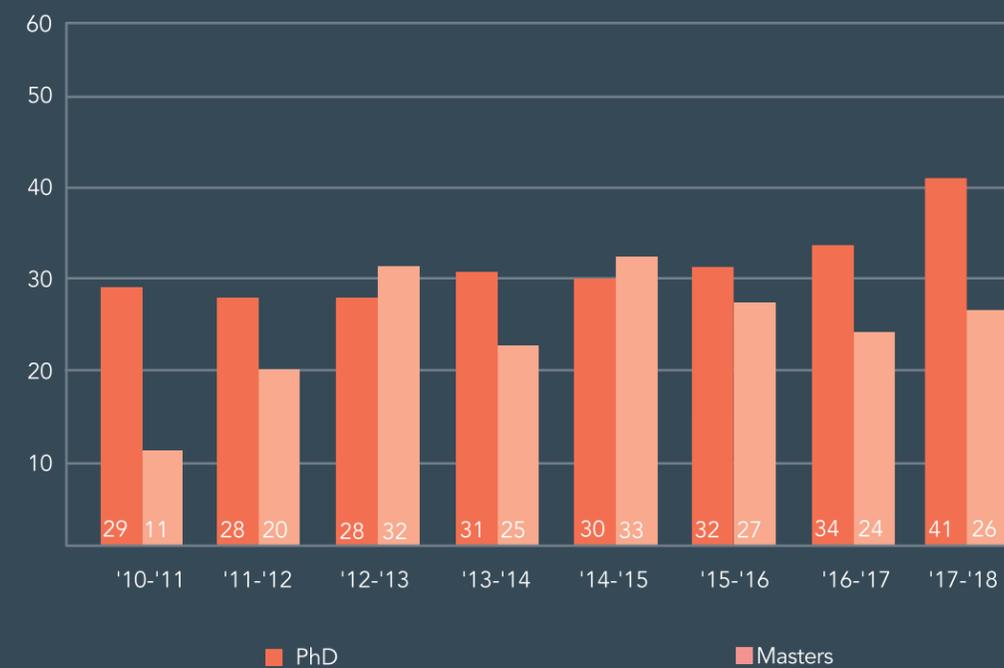
2017-18:
41 PHD STUDENTS
17 MS STUDENTS
9 MEng STUDENTS

FACULTY

SELECT RECENT HONORS

3 FELLOWSHIPS

W. CLEM KARL was elevated to AIMBE Fellow for novel contributions to sparsity-based methods for medical imaging, image processing, and image formation. He is chairman of the Department of Electrical and Computer Engineering.

ERIC KOLACZYK was elevated to AAAS Fellow for his work in life sciences. Also this year, he was elected IMS Fellow for developing statistical methods for networks.

2 CONFERENCES HOSTED

Topic: Control of Network Systems, Host: I. PASCHALIDIS

Topic: Stabilization, Safety, & Security of Distributed Systems, Host: A. TRACHTENBERG

MAJOR SOCIETAL AWARD

AVRUM SPIRA received the 2017 Research Innovation and Translation Achievement Award from the American Thoracic Society (page 9).

UNIVERSITY AWARDS

MARK CROVELLA is a recipient of the State University of New York at Buffalo Distinguished Alumni Award. M. Crovella serves as the chairman of the Department of Computer Science.

BOBAK NAZER received the 2017 BU ECE Teaching Award.

7 PLENARY SPEAKING ENGAGEMENTS

JOHN BAILLIEUL, Washington University workshop, 2017

CHRISTOS CASSANDRAS, 15th IFAC World Congress, 2017 oCPS School on Cyber-Physical Systems, 38th Intl. Petri Nets Conference, and 2017 Winter School on Intelligent Transportation

DAVID CASTAÑÓN, IEEE SPS workshop, 2017

IOANNIS PASCHALIDIS, 23rd International Symposium on Mathematical Theory of Networks and Systems (MTNS)

228 2017-18 MAJOR PUBLICATIONS

3 BOOKS

5 BOOK CHAPTERS

220 JOURNAL PAPERS

1 HIRE & 2 PROMOTIONS

REBECCA KHURSHID

R. Khurshid was hired as an Assistant Professor of Mechanical Engineering and Systems Engineering. Her research focus is robotics. She earned her PhD at the University of Pennsylvania in 2015. She conducted her postdoctoral training with the MIT's Interactive Robotics Group.

BRIAN KULIS

B. Kulis was promoted to Associate Professor of Electrical and Computer Engineering and Systems Engineering. His research focus is machine learning, statistics and large-scale data analysis. He received his PhD from the University of Texas at Austin in 2008.

BOBAK NAZER

B. Nazer, affiliated SE faculty member, was promoted to Associate Professor of Electrical and Computer Engineering and Systems Engineering. His research focus is information theory, communications, signal processing and neuroscience. He received his PhD from the University of California, Berkeley in 2009.

RESEARCH

AUTOMATION, ROBOTICS AND CONTROL

Cyber-physical systems, teams of autonomous agents, networked control systems, image-guided surgery, control of material processes and nanoscale systems.

COMMUNICATIONS AND NETWORKING

Performance analysis, pricing and resource allocation, communication protocols, cyber-security, visual light communication, and optical, wireless and sensor networks.

COMPUTATIONAL BIOLOGY

Metabolic and gene networks, systems biology and protein docking.

INFORMATION SCIENCES

Signal and image processing, multi-resolution signal modeling, multidimensional detection and estimation, geometric-based modeling and estimation, image encoding/decoding and the integration of digital signal processing with signal understanding.

PRODUCTION, SERVICE AND ENERGY SYSTEMS

Energy economics and management, smart grids, production scheduling and planning, logistics, inventory control, supply chain management and financial engineering.

TRANSPORTATION
CARS

Drivers who commute in and out of Boston have experienced the misery of rush hour. Professor **CHRISTOS CASSANDRAS** is part of a research group aiming to ease commuting traffic, and the resulting air pollution, by developing efficient, smart vehicle technology under a $4.4 million grant from the Energy Department's Advanced Research Projects Agency-Energy (ARPA-E) NEXTCAR program.

"Right now, the car's awareness of its surrounding relies completely on the eyes and ears of the driver operating it," says C. Cassandras. "But when you look at the data, humans are terrible drivers. Humans get distracted, they get tired and they can't react quickly to multiple simultaneous changes. Computers thrive in that environment. We want to create technology that enables a car to access information about its environment on its own. The car will be able to process information, act accordingly, and communicate to other vehicles and infrastructures."

Project collaborators from BU, University of Michigan, Oak Ridge National Laboratory, University of Delaware and Bosch are designing a technology that enables a plug-in hybrid car to communicate with other cars and city infrastructure. By providing cars with situational self-awareness, they will be able to efficiently calculate the best possible route, accelerate and decelerate as needed and manage their powertrain. The idea, says C. Cassandras, is to improve the efficiency of vehicles to the point where you can drive from point A to B without stopping. The result of which, would have transformative positive effects in everyday life on the environment.

"You can reduce fuel and energy consumption, which benefits the environment and lessens our dependence on expensive energy sources and you make the traffic system work more efficiently by reducing congestion," says Cassandras. "Our expectation is that we can increase these efficiencies by 20 percent."

Currently, obstacles like stoplights, heavy volume, and poorly designed infrastructure that causes bottlenecking contribute to heavy traffic. The constant stopping and starting not only wastes energy, but also expels the most harmful emissions into the atmosphere.

Excerpts of an article by Sara Cody.

PICTURED: The NEXTCAR prototype is tested at Mcity at the University of Michigan. Mcity is where the world's top vehicle technologists test equipment before it's released to the public.

■ **MORE**: BU.EDU/ENG/NEXTCAR

ENERGY
COMMERCIAL BUILDINGS

A team of College of Engineering researchers has won a $1 million contract from the Department of Energy's Advanced Research Projects Agency-Energy (ARPA-E) to develop COSSY (Computational Occupancy Sensing SYstem). COSSY is a system of sensors that can estimate the number of people in a room and adjust air flow in heating, ventilation and air conditioning (HVAC) appropriately, with the goal of saving energy.

Professor Janusz Konrad will lead the three-year project, one of 15 funded by ARPA-E and aimed at reducing HVAC energy usage, which accounts for 37 percent of energy consumed in commercial buildings in the United States.

Most commercial buildings operate air flow on a timer according to fixed schedule, typically a minimum air flow at night and an air flow matched to room's capacity during the workday. With a system of sensors that can provide an accurate count of the number of people in a room, the workday air flow can be reduced while still maintaining air quality. By reducing the air flow across many rooms in a building, the team can meet the ARPA-E's goal of 30 percent average energy savings. The team is well equipped to attack this challenge: J. Konrad specializes in signal processing and computer vision; Professor **PRAKASH ISHWAR** in machine learning; Professor **THOMAS LITTLE** in networking; and Associate Professor **MICHAEL GEVELBER** in control of commercial HVAC systems and energy. Additionally, three industrial partners have already agreed to collaborate with the BU team on the project. Researchers will develop a scalable system that uses both high-resolution panoramic cameras and low-resolution thermal door sensors. The cameras and door sensors will work together to estimate how many people are in the room at any given time. When visual privacy is of concern, just the thermal sensor will be installed so the system can still sense the number of people without using a camera.

The team will build COSSY to meet ARPA-E's requirements for accuracy, security and cost. The primary focus will be on the development of algorithms to accurately estimate the number of occupants in a room from the visual and thermal data. Developing such algorithms becomes complicated when multiple sensors are needed for large or oddly shaped rooms. The sensors must communicate with each other to make sure people are not counted multiple times. "While we will be developing COSSY to reduce energy use in commercial buildings, there is a potential for much wider impact of this technology, from optimizing room usage in educational and office buildings to maximizing hotel revenue, both based on room-occupancy analysis," J. Konrad said.

Excerpts from the College of Engineering.

KEY TAKEAWAYS:

JANUSZ KONRAD, PRAKASH ISHWAR, THOMAS LITTLE and MICHAEL GEVELBER received $1M from the DOE to develop a system of sensors that can estimate the number of people in a room and adjust air flow in heating, ventilation and air conditioning (HVAC) appropriately, with the goal of saving energy.

The project is aimed at building a sensor system that will reduce energy costs in commercial buildings.

■ **MORE**: BU.EDU/ENG/ENERGY

PRESS CLIPPINGS
RE-ROUTING
CHRISTOS CASSANDRAS and IOANNIS PASCHALIDIS use real-time traffic data to optimize re-routing for drivers to ease traffic congestion. The work was published in *Proceedings of the IEEE*, "The Price of Anarchy in Transportation the Networks: Data-Driven Evaluation and Reduction Strategies."

SMART CITIES
CHRISTOS CASSANDRAS was a Guest Co-Editor of a special issue on Smart Cities of the *Proceedings of the IEEE*. The issue included two articles co-authored by C. Cassandras and/or IOANNIS PASCHALIDIS.

PICTURED: BU's state-of-art sensor laboratory, Lighting Enabled Systems & Applications Engineering Research Center (LESA ERC), directed by T. LITTLE.

LABS

ANDERSSON LABORATORY
SEAN ANDERSSON | BU.EDU/ANDERSSONLAB
The lab explores the dynamics in nanometer-scale systems with fundamental theory, applied mathematics, and physical experiments. The work applies to nanobioscience, nanotechnology, and robotics.

ADVANCED PROCESS CONTROL LABORATORY
MICHAEL GEVELBER | BU.EDU/PCL
The lab applies a a controls-based approach to integrate process modeling, sensor development, system and control design and experimentation.

CONTROL OF DISCRETE EVENT SYSTEMS LABORATORY (CODES)
CHRISTOS CASSANDRAS | HTTPS://CHRISTOSGCASSANDRAS.ORG/CODES
The lab conducts research on modeling, design, analysis, performance evaluation, control, and optimization of a variety of discrete event and hybrid systems.

DATA SCIENCE & MACHINE LEARNING LABORATORY
VENKATESH SALIGRAMA | HTTPS://SITES.BU.EDU/DATA/
Projects related to machine learning, vision and learning, structured signal processing, and decision and control.

DEPENDABLE COMPUTING LABORATORY
WENCHAO LI | SITES.BU.EDU/DEPEND/
The research spans dependable computing, particularly the development of computational proof methods and machine learning techniques to aid the construction of safe, reliable and secure systems.

HYBRID AND NETWORKED SYSTEMS LABORATORY (PAGE 8)
CALIN BELTA | SITES.BU.EDU/HYNESS
The lab is focused on integrating algorithms and machine learning to make robots smarter and more autonomous.

INFORMATION & DATA SCIENCES LABORATORY
C. CASSANDRAS, D.CASTAÑÓN, W. KARL, B. KULIS, T. LITTLE, P. ISHWAR, B. NAZER, A. OLSHEVSKY, I. PASCHALIDIS, V. SALIGRAMA, D. STAROBINSKY, A. TRACHTENBERG, W. LI | BU.EDU/ISS
The lab designs and synthesizes secure networked systems for optimum decision-making and control.

INTELLIGENT MECHATRONICS LABORATORY
J. BAILLIEUL, S. ANDERSSON, H. WANG | BU.EDU/IML
Projects explore limited-bandwith control problems, symbolic control, cooperative systems and control, and animal-inspired agile flight control.

LABORATORY OF NETWORKING & INFORMATION SYSTEMS (NISLAB)
D. STAROBINSKI, A.TRACHTENBERG NISLAB.BU.EDU
The lab offers a perspective on modern networking with emphasis on scalability, heterogeneity, and performance.

MULTI-DIMENSIONAL SIGNAL PROCESSING LABORATORY (MDSP)
W. CLEM KARL | MDSP.BU.EDU
The lab applies computational imaging to develop statistical models to extract information from diverse and vulnerable data sources.

MULTIMEDIA COMMUNICATIONS LABORATORY
THOMAS LITTLE | HULK.BU.EDU
Projects focus on ubiquitous distributed computing, specifically in the area of distributed multimedia information systems emphasizing time-dependent and continuous media data.

NETWORKS RESEARCH GROUP
A. BESTAVROS, M. CROVELLA, A. MATTA BU.EDU/CS/NRG/
Research encompasses network measurement, architectures and protocols. Projects span from the design and implementation to analysis of networked applications and systems.

PASCHALIDIS NETWORK OPTIMIZATION & CONTROL LABORATORY
IOANNIS PASCHALIDIS | SITES.BU.EDU/PASCHALIDIS/
Research deals with optimal network design and operation, performance regulation with control algorithms, data science and industrial applications.

RELIABLE COMPUTING LABORATORY
LEV LEVITIN | BU.EDU/RELIABLE
Projects span from the design of computer chips to efficiency testing in various aspects of hardware, software, signal processing, and networks.

ROBOTICS LABORATORY
C. BELTA & S. ANDERSSON, J. BAILLIEUL, C. CASSANDRAS, R. TRON | SITES.BU.EDU/ROBOTICS
Research spans several areas of robotics, including motion planning, control, machine learning, and computer vision.

SPIRA-LENBURG LABORATORY
AVRUM SPIRA | BUMC.BU.EDU/COMPBIOMED/LABS/SPIRA-LENBURG
The lab utilizes post-genomic technologies and computational tools to better understand lung biology and disease. Its long-term goals are to improve the diagnosis, treatment, and prevention of lung disease as well as develop new research approaches.

STRUCTURAL BIOINFORMATICS LABORATORY
SANDOR VAJDA | STRUCTURE.BU.EDU
The lab focuses on the recognition of proteins and small molecules by protein receptors. Their work applies to metabolic control, signal transduction, gene regulation, rational drug and vaccine design.

VISUAL INFORMATION PROCESSING LABORATORY
PRAKASH ISHWAR | VIP.BU.EDU/
Projects relate to technology transfer in the broad areas of image, video, and multimedia processing. This visual information processing research applies to visual surveillance, 3D video, and human-computer interfaces, etc.

4 NEW FACILITIES

3 NEW LABS & 1 NEW CENTER: Collaborative and Integrative Robotics Laboratory (page 15), Center for Autonomous and Robotics Systems (page 15), Robotics Laboratory (page 15), and Dependable Computing Laboratory.

SE & CISE

CENTER FOR INFORMATION & SYSTEMS ENGINEERING

CISE is an interdepartmental research center focused on deepening and broadening interdisciplinary research in the study and design of intelligent systems. With 43 faculty affiliates across 10 departments, CISE researchers advance information and data science to solve complex problems in fields such as healthcare, communications, transportation, energy, and national security.

CISE FUNDING
The annual research expenditures for 2017-18 were $6.5 million.

CISE RESEARCH AREAS
Automation, Robotics and Control; Computational Biology and Medicine; Cyber-Physical Systems; Data Analytics; Energy Systems; Information Sciences; Networks; Smart Cities.

PRIMARY FUNCTIONS
Manages a resident scholar program

Hosts external conferences with government agencies and engineering societies

Builds alliances to strengthen the relationship between CISE faculty and their corporate partners

Runs a weekly seminar, lectures, and round table series

Offers grant management as well as seed funding (*three grants awarded this year*).

Organizes student activities

CISE PEOPLE
4 Fellows

3 IEEE society presidents, past & present

16 NSF career award recipients

4 Editors-in-Chief of a scientific journal, past & present

6 Early Career Award Recipients

ADMINISTRATION
Ioannis Paschalidis, Director

Christina Polyzos, Associate Director

Maureen Stanton, Center Administrator

PARTNERS IN RESEARCH
30 Dual faculty (SE professors & CISE affiliates)

7 Annual joint student events

22 Joint seminars (right)

2 CISE seed grants were awarded to Professors IOANNIS PASCHALIDIS and PIROOZ VAKILI.

CISE LECTURES

DR. STÉPHANE LAFORTUNE University of Michigan, Supervisory Control of Discrete Event Systems: A Retrospective and Future Perspectives

DR. KAM K. LEANG University of Utah, Autonomous Electronic Nose in Flight: Design, Control, and Motion Planning of Aerial Vehicles for Gas/Chemical Sensing

DR. NA LI Harvard University, Distributed Resource Allocation with Limited Communication

DR. GEORGIOS B. GIANNAKIS University of Minnesota, Learning Nonlinear and Dynamic Network Connectivity and Processes on Graphs

DR. ANANDA THEERTHA SURESH Google Research, Communication-Efficient and Differentially-Private Distributed Learning

DR. STEFANIE JEGELKA Massachusetts Institute of Technology, Faster Computation and Exploitation of Uncertainty

DR. YANG-YU LIU Harvard Medical School, Controlling Human Microbiota

DR. STÉPHANE LAFORTUNE University of Michigan, CISE Invited Lecture: Introduction to Discrete Event Dynamic Systems

DR. ANATOLY ZLOTNIK Los Alamos National Laboratory, CISE Invited Lecture: A Fluid Mechanics Approach for Optimizing Natural Gas Pipeline Scheduling and Coordination with Electricity Networks

DR. ADITYA GOPALAN Indian Institute of Science, Online Learning with Structure

DR. LAURENT LESSARD University of Wisconsin-Madison, Automating the Analysis and Design of Large-Scale Optimization Algorithms

DR. YUE LU Harvard University, The Scaling Limit of Iterative Algorithms for High-Dimensional Inference

DR. JING WU Shanghai Jiao Tong University, Security Control of Distributed Networked Control Systems

DR. STÉPHANE LAFORTUNE University of Michigan, Privacy Enforcement Using Obfuscation: An Event-Based Approach Using Opacity

DR. MIKE MILLER Johns Hopkins University, Computational Anatomy and Diffeomorphometry: Embedding the Brain at Meso-scale into the Soft-tissue Condensed Matter Continuum

DR. AUSTIN JONES (SE ALUMNUS '15) MIT Lincoln Laboratory, Systems Engineering for National Security Challenges

DR. STÉPHANE LAFORTUNE University of Michigan, CISE Invited Lecture: Fault Diagnosis of Discrete Event Systems

DR. BOB BARMISH University of Wisconsin-Madison, When the Expected Value is Not Expected

DR. DANIEL MOLZAHN Argonne National Laboratory, Recent Research in Power System Optimization: Feasible Space Computation and Approximation Error Quantification

DR. ABBAS RAHIMI ETH Zürich, Breaking Down the Error Barriers: From Error-Tolerance to Approximate and Brain-Inspired Computing

DR. STANLEY H. CHAN Purdue University, Image Reconstruction and Threshold Design for Quanta Image Sensors

DR. STÉPHANE LAFORTUNE University of Michigan, CISE Invited Lecture: Introduction to Petri Nets and their Control using the Case Study of Deadlock Avoidance in Concurrent Software

DR. EDUARDO SONTAG Northeastern University, Dynamic Response Phenotypes in Systems Biology: Scale-Invariance and Monotone I/O Systems

DR. JAVAD LAVAEI University of California, Berkeley, High-performance Optimization Methods for Power Systems: Theory, Algorithms, and Case Studies

DR. IVAN DOKMANIĆ University of Illinois at Urbana–Champaign, Euclid's bag of tricks for moving points and unlabeled distances

DR. AMIR HERZBERG University of Connecticut, Towards Practical Anonymous Messaging: AnonPoP and beyond

DR. PANAGIOTIS ANDRIANESIS Boston University, Systems Engineering Forum: Distributed Energy Resources: Challenges and Opportunities in Active Electricity Distribution Networks

DR. VIVEK BORKAR Indian Institute of Technology Bombay, Alekseev Formula and Stochastic Recursive Algorithms

DR. DEJAN NIČKOVIĆ Austrian Institute of Technology, CISE Invited Lecture: Fault Explanation Guided by STL Specifications

Events listed in order of occurrence.

THE MISSION

BU SE offers a unique approach to academics. Rather than just focusing on specific application areas, the curriculum offers a holistic view of the field: a fundamental science-based education applicable to all aspects of modeling, analysis, simulation, control, optimization and management of complex systems.

GLOBAL PARTNERSHIP

2017-18 was the inaugural year of the dual engineering degree program between Boston University and Tsinghua University in Beijing. Students are selected from the Department of Automation at Tsinghua University to enroll in BU's courses for two semesters. They then will return to Tsinghua University to complete the program. The first group of students to enroll arrived in September 2017.

RANKED #1

US News & World Report ranks partner Tsinghua University as top global engineering program in the world.

OVERVIEW

THE PROGRAM

THE DIVISION OF SYSTEMS ENGINEERING CUTS ACROSS NUMEROUS DEPARTMENTS AT BU TO PROVIDE A WELL-ROUNDED PERSPECTIVE OF THE ENVIRONMENT IN WHICH A SYSTEM IS HOUSED. An education in systems engineering touches on skillsets based in areas like electronics, mechanics, chemistry, biology, business management, logistics, and more. Graduates are equipped with unique skills to adapt to a variety of domains.

2017-18 SUMMER INTERNSHIPS

RUI CHEN, BOSCH
ARIAN HOUSHMAND, SCOTTY LABS (START-UP)
YUFAN LUO, JUNIPER NETWORKS
TAIYAO WANG, PHILIPS RESEARCH
YUE ZHANG, FACEBOOK
NAN ZHOU, PHILIPS RESEARCH
HENGHUI ZHU, PHILIPS RESEARCH

PHD 2017-18 DEGREES

FENG NAN, *Learning to Predict Under a Budget*
Advised by **V. SALIGRAMA**

XINMIAO SUN, *Static and Dynamic Optimization Problems in Cooperative Multi-Agent Systems*
Advised by **C. CASSANDRAS**

SHUAI WANG, *Paradigm and Paradox in Power Networks*
Advised by **J. BAILLIEUL**

JING ZHANG, *Detection and Optimization Problems with Applications in Smart Cities*
Advised by **I. PASCHALIDIS**

CURRENT POPULATION BREAKDOWN

PROG.	DOMESTIC		INTERNATIONAL		
	FEMALE	MALE	FEMALE	MALE	TOTAL
PhD	2	3	10	25	40
MS	3	3	4	7	17
MEng	0	1	2	5	8
TOTAL	5	7	16	37	65

40%

FEMALE STUDENTS

While the national average of female engineering students is 24%, at BU 40% of systems engineering students are female. Source: Council of Graduate Schools, 2016.

GRADUATE STUDENT FUNDING

FUNDING SOURCE	PHD	MS	MEng
Doctoral Research Fellows	27.5		
Systems Fellows	6		
Dean's Fellows	6		
Graduate Teaching Fellows	.5		
Tuition Scholarship		2	1
TOTAL	**40**	**2**	**1**

43

SYSTEMS STUDENTS FUNDED

PhD students are guaranteed funding for up to five years provided satisfactory academic performance.

ACCOMPLISHMENTS

ROBOTICS PROGRAM
RECOGNIZED AS ONE OF THE NATION'S TOP BY *ANALYTICS INSIGHT*

Many of the largest, resource-rich companies in the country—including Google, Amazon and Uber—are now investing in creating autonomous robotics. BU researchers take a unique approach to the field by focusing on robotics teams as cooperative dynamic systems.

NOTEWORTHLY LABS IN 2017-18:

HYBRID AND NETWORKED SYSTEMS LABORATORY
CALIN BELTA and the HyNeSs Lab focus on integrating algorithms and machine learning to make robots smarter and more autonomous. The research has implications for disaster relief, military aid and agriculture.

CONTROL OF DISCRETE EVENT SYSTEMS LABORATORY
CHRISTOS CASSANDRAS believes cooperation and intelligence are key to autonomous systems. He applies this approach to CODES lab research projects on Smart Cities. One project involves creating an *internet of cars* that can communicate with each other and their surroundings to make driving safer and more energy efficient.

NEW: CENTER FOR AUTONOMOUS AND ROBOTICS SYSTEMS
The Center will focus on three main research application areas: the science of autonomy, robotic vehicles and manipulators, and microbiological robots. These areas target the growing ambition to bring artificial intelligence into the physical world. CALIN BELTA directs the lab.

NEW: COLLABORATIVE AND INTEGRATIVE ROBOTICS LABORATORY
REBECCA KHURSHID launched CAIR in 2017 to create robotic technology to allow humans — of all skill and ability levels — and their robotic counterparts to accomplish previously impossible tasks.

PICTURED: Baxter the robot. Baxter lives in the Robotics Laboratory.

STUDENT SPOTLIGHTS:

RUIDI CHEN
ADVISOR: I. PASCHALIDIS

Conference Publication: Ruidi Chen, Ioannis Paschalidis and Michael Caramanis. 56th IEEE Conference on Decision and Control (CDC), Melbourne, Australia. "Strategic equilibrium bidding for electricity suppliers in a day-ahead market using inverse optimization."

Journal Publication: Theodora Brisimi, Ruidi Chen, Theofanie Mela, Alex Olshevsky, Ioannis Paschalidis and Wei Shi. "Federated learning of predictive models from federated Electronic Health Records." *International Journal of Medical Informatics*, 2018.

Journal Publication: Ruidi Chen, and Ioannis Paschalidis. "Outlier detection using robust optimization with uncertainty sets constructed from risk measures." *ACM SIGMETRICS Performance Evaluation Review*, 2018.

Journal Publication: Ruidi Chen and Ioannis Paschalidis. "A robust learning approach for regression models based on distributionally robust optimization." *Journal of Machine Learning Research*, 2018.

CHRISTY LIN
ADVISOR: P. ISHWAR

Journal Publication: Weicong Ding, Christy Lin, and Prakash Ishwar. "Node Embedding via Word Embedding for Network Community Discovery." *IEEE Transactions on Signal and Information Processing over Networks*, 2017.

ATHAR ROSHANDELPOOR
ADVISOR: P. VAKILI

Student Travel Award: GHC 2018

Journal Publication: Shahrooz Zarbafian, Mohammad Moghadasi, Athar Roshandelpoor, Nan Feng, Keyong Li, Pirooz Vakili, Sandor Vajda, Dima Kozakov and Ioannis Paschalidis. "Protein docking refinement by convex underestimation in the low-dimensional subspace of encounter complexes." *Scientific Reports*, 2018.

ARTIN SPIRIDONOFF
ADVISOR: A. OLSHEVSKY & I. PASCHALIDIS

Oral Presentation: 2018 American Control Conference, Milwaukee, USA. "Fully Asynchronous Push-Sum with Growing Intercommunication Intervals."

YUE ZHANG
ADVISOR: C. CASSANDRAS

Conference Publication: 2017 IEEE Conference on Decision and Control, Melbourne, Australia. "Decentralized Optimal Control for Connected Automated Vehicles at Intersections Including Left and Right Turns."

Conference Publication: 2018 IEEE Conference on Control Technology and Applications, Copenhagen, Denmark. "The Penetration Effect of Connected Automated Vehicles in Urban Traffic: an Energy Impact Study."

Conference Publication: 2018 IEEE Conference on Decision and Control, Florida, USA. "A Decentralized Optimal Control Framework for Connected Automated Vehicles at Urban Intersections with Dynamic Resequencing."

PICTURED: R. Khurshid's students manipulate the movement of robots to mimic human emotions.

Visit the Systems Engineering social media accounts to see a video of the robots deflating with disappointment and bouncing with happiness.

BUSYSTEMSENGINEERING

@BU_SYSTEMSENG

COMMUNITY

THE STRENGTH OF THE SYSTEMS COMMUNITY IS BUILT ON A BROAD-BASED GROUP OF FIELD EXPERTS

As exemplified by the Division's faculty, SE professors hail from three different colleges to collaborate on research.

COLLEGE OF ARTS AND SCIENCES
  Bioinformatics Program
  Department of Computer Science
  Department of Mathematics and Statistics
COLLEGE OF ENGINEERING
  Department of Biomedical Engineering
  Department of Electrical and Computer Engineering
  Department of Mechanical Engineering
  Division of Materials Science and Engineering
QUESTROM SCHOOL OF BUSINESS

SEAN ANDERSSON
Associate Professor, ME
Robotics, control theory, scanning probe microscopy, single molecule tracking
PhD, University of Maryland, 2003
BU Kern Fellow, 2012 & 2013
NSF CAREER Award, 2009

JOHN BAILLIEUL
Distinguished Professor of Engineering, ME & ECE
Robotics, control of mechanical systems, mathematical system theory, information-based control theory
PhD, Harvard University, 1975
IEEE, IFAC & SIAM Fellow
BU College of Engineering Inaugural Distinguished Lecturer Series Award, 2008

CALIN BELTA
Professor, ME, ECE & Bioinformatics
Verification and control of dynamical systems, hybrid systems, symbolic control, robot motion planning and control, gene and metabolic networks
PhD, University of Pennsylvania, 2003
IEEE Fellow
AFOSR Young Investigator Award, 2008
NSF CAREER Award, 2005

MICHAEL CARAMANIS
Professor, ME
Mathematical programming, control and stochastic systems
PhD, Harvard University, 1976
BU College of Engineering Service Award, 2004

CHRISTOS CASSANDRAS
Distinguished Professor of Engineering, ECE
Division Head, SE
Discrete event and hybrid systems, stochastic optimization, simulation, manufacturing systems, communication and sensor networks, multi-agent systems
PhD, Harvard University, 1982
IEEE & IFAC Fellow
BU College of Engineering Distinguished Scholar Award, 2014
IEEE Control Systems Society President, 2012
IBM/IEEE Smarter Planet Challenge prize, 2011 & 2014
IEEE Control Systems Technology award, 2011
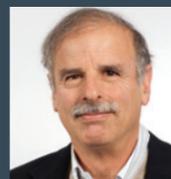
DAVID CASTAÑÓN
Professor, ECE
Stochastic control, estimation optimization, image understanding and parallel computation.
PhD, Massachusetts Institute of Technology, 1976
IEEE Fellow
IEEE Control Systems Society Past President, 2008

PRAKASH ISHWAR
Professor, ECE
Statistical signal processing, machine learning, information theory, secure multiparty computation, visual information processing and analysis
PhD, University of Illinois Urbana, Champaign, 2002
IEEE Transactions on Signal Processing Associate Editor, 2012-2014
NSF CAREER Award, 2005

REBECCA KHURSHID
Assistant Professor, ME
Robotics
PhD, University of Pennsylvania, 2015

BRIAN KULIS
Associate Professor, ECE
Machine learning, statistics, large-scale data analysis
PhD, University of Texas at Austin, 2008
BU Peter J. Levine Career Development Professorship, 2015
NSF CAREER Award, 2015

ALEX OLSHEVSKY
Assistant Professor, ECE
Control and algorithms for multi-agent systems, sensor networks, distributed optimization, control of large-scale systems
PhD, Massachusetts Institute of Technology, 2010
AFOSR Young Investigator Award, 2015
NSF CAREER Award, 2014

IOANNIS PASCHALIDIS
Professor, ECE & BME; Director of CISE
Systems and control, networking, applied probability, optimization, operations research, computational biology, medical informatics, and bioinformatics.
PhD, Massachusetts Institute of Technology, 1996
IEEE Fellow
IEEE Transactions on Control of Network Systems Inaugural Editor-in-Chief
BU College of Engineering Distinguished Faculty Fellow, 2011–2016
IBM/IEEE Smarter Planet Challenge prize, 2014

JAMES PERKINS
Associate Professor, ME
Real-time scheduling and control of manufacturing systems, supply chain management, resource pricing and congestion control in communications networks
PhD, University of Illinois, Urbana-Champaign, 1993

VENKATESH SALIGRAMA
Professor, ECE
Machine learning, computer vision, information theory, and statistical signal processing
PhD, Massachusetts Institute of Technology, 1997
IEEE Fellow
NSF CAREER Award, 2005
Presidential Early Career Award, 2003
ONR Young Investigator Award, 2002
United Technologies Outstanding Achievement Award, 1997

DAVID STAROBINSKI
Professor, ECE
Wireless and vehicular networks; QOS and traffic engineering; network economics; cyber security
PhD, Technion, Israel Institute of Technology, Israel, 1999
DOE Early Career Award, 2004
NSF CAREER Award, 2002
IEEE CNS Best Paper Award, 2016

ROBERTO TRON
Assistant Professor, ME
Intersection of automatic control, robotics and computer vision, with a particular emphasis on applications of Riemannian geometry and on distributed problems involving teams of multiple agents
PhD, Johns Hopkins University, 2012

PIROOZ VAKILI
Associate Professor, ME
Monte Carlo simulation, optimization, computational biology, computational finance
PhD, Harvard University, 1989

HUA WANG
Associate Professor, ME; Associate Division Head, SE
Control of nonlinear phenomena, intelligent systems and control, complex networks, cooperative control, robotics, and applications in biological, energy and aerospace systems
PhD, University of Maryland at College Park, 1993
IEEE International Best Paper Award, 2013
BU College of Engineering Faculty Service Award, 2012

AZER BESTAVROS
Professor, CS; Director, Hariri Institute
Scalable Internet protocols and systems, application of game theory to the design of systems and networks, resource colocation and management for cloud computing, virtualization and programming support for cyber systems, compositional analysis and verification of complex systems.
PhD, Harvard University, 1992

MARK CROVELLA
Professor, CS
Performance evaluation, focused on parallel and networked computer systems, detecting and understanding anomalies in IP networks, efficient network monitoring, network security
PhD, University of Rochester, 1994

MICHAEL GEVELBER
Associate Professor, ME & MSE
Development of control and sensing systems for electrospinning of nanofibers, plasma spray, ebeam deposition, crystal growth, CVD, and intelligent building HVAC systems
PhD, Massachusetts Institute of Technology, 1988

W. CLEM KARL
Professor of ECE & BME; Chair, ECE
Computational imaging, detection and estimation, inverse problems, biomedical signal and image processing
PhD, Massachusetts Institute of Technology, 1991

ERIC KOLACZYK
Professor, Mathematics and Statistics
Statistical modeling of instrumental data in temporal, spatial, and network-indexed contexts
PhD, Stanford University, 1994
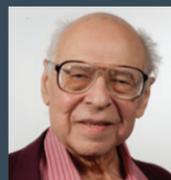
LEV LEVITIN
Distinguished Professor, ECE
Information theory, physics of communication and computing, complex and organized systems, quantum theory of measurement, reliable communication and computing, bioinformatics
PhD, Gorky University, 1969

WENCHAO LI
Assistant Professor, ECE
A.I. Safety, human cyber physical systems, formal methods, design automation
PhD, University of California, Berkeley, 2013

THOMAS LITTLE
Professor, ECE; Associate Dean of Educational Initiatives, COE; Associate Director NSF Smart Lighting ERC
Computer networking, mobile computing, distributed systems, multimedia streaming and storage, visible light communications
PhD, Syracuse University, 1991

ABRAHAM MATTA
Professor and Chair, CS
Management and economics of virtualized distributed systems, transport and routing protocols for the Internet and wireless networks, feedback-based control design and analysis, architectures for protocol design and large-scale traffic management, modeling and performance evaluation
PhD, University of Maryland at College Park, 1995

BOBAK NAZER
Associate Professor, ECE
Information theory, communications, signal processing, and neuroscience
PhD, University of California, Berkeley, 2009

EROL PEKÖZ
Professor, Operations & Technology Management
Applied probability and statistics, rare events, Stein's method queuing theory and statistical methods for health care data
PhD, University of California Berkeley, 1995

AVRUM SPIRA
Alexander Graham Bell Professor of Healthcare Entrepreneurship; Chief, Division of Computational Biomedicine; Director, Translational Bioinformatics Program
Lung cancer and COPD genomics, smoking and airway gene expression, bioinformatics
MD, McGill University, 1996

ARI TRACHTENBERG
Professor, ECE
Cyber security, algorithms, error-correcting codes
PhD, University of Illinois, Urbana-Champaign, 2000

SANDOR VAJDA
Professor, BME & Chemistry; Director, BMERC
Scientific computing, primarily optimization, computational chemistry and biology, including protein and peptide structure determination, protein engineering, and drug design
PhD, Hungarian Academy of Science, Hungary, 1983

ADMINISTRATION

CHRISTOS G. CASSANDRAS
Division Head

HUA WANG
Associate Head

RUTH MASON
Division Director

ELIZABETH FLAGG, ED.M.
Graduate Programs Manager

CHERYL STEWART
Communications Manager, 2017

GABRIELLA MCNEVIN, MS
Communications Manager, 2018

GRADUATE COMMITTEE

HUA WANG, Chair
SEAN ANDERSSON
CALIN BELTA
ALEX OLSHEVSKY
REBECCA KHURSHID
ELIZABETH FLAGG

POSTDOCS

PANAGIOTIS ANDRIANESIS: *Power systems economics, optimization, distributed algorithms,* PhD, University of Thessaly, Greece, 2016

YAO MA: *Machine learning, reinforcement learning, online learning,* PhD, Tokyo Institute of Technology, 2015

XIANGYU MENG: *Smart city control, distributed algorithms,* PhD, University of Alberta, Canada, 2014

VISITING COMMITTEE

TAMER BASAR
Director, Center for Advanced Study; Swanlund Endowed Chair, Department of Electrical and Computer Engineering; CAS Professor of Electrical and Computer Engineering, Center for Advanced Study; Research Professor, Coordinated Science Laboratory; Research Professor, Information Trust Institute, University of Illinois at Urbana- Champaign

DIMITRIS BERTSIMAS
Boeing Professor of Operations Research and Co-Director, Operations Research Center, Massachusetts Institute of Technology

YU-CHI (LARRY) HO
Professor Emeritus, Harvard University; Chief Scientist and Chair Professor, Center for Intelligent and Networked Systems, Tsinghua University, Beijing, China

KIRK E. JORDAN
IBM Distinguished Engineer, Data Centric Systems, IBM T.J. Watson Research; Chief Science Officer, IBM Research UK; Member, IBM Academy of Technology

P. R. KUMAR
University Distinguished Professor and College of Engineering Chair in Computer Engineering, Texas A&M University

MARK T. MAYBURY
Vice President and Chief Technology Officer, The MITRE Corporation

STEFAN MIESBACH
Vice President and Director, Unify Inc., Service Practice Circuit

ROBERT R. TENNEY
Former Vice President, BAE Systems Advanced Information Technology

PRAVIN VARAIYA
Professor of Electrical Engineering and Computer Sciences, University of California, Berkeley

BU DIVISION OF SYSTEMS ENGINEERING
15 Saint Mary's Street, Room 117
Brookline, MA 02446

BU.EDU/SE

ENSURING THE SEAMLESS INTEGRATION OF TECHNOLOGY INTO EVERYDAY LIFE

2017/2018 Annual Report

SELECT RESEARCH AREAS

SMART CITIES & TRANSPORTATION

$4.4M

CHRISTOS CASSANDRAS advances the *internet-of-cars* (page 7).

$.5M

CHRISTOS CASSANDRAS AND IOANNIS PASCHALIDIS optimize vehicle routing to ease traffic congestion.

HEALTHCARE

$25M

AVRUM SPIRA develops tools for early lung cancer diagnosis and establishes Johnson and Johnson partnership (page 9).

$1.6M

IOANNIS PASCHALIDIS develops a system to predict the risk of heart disease and diabetes.

$1.5M

SANDOR VAJDA launches ClusPro a widely-used tool for protein-protein docking.

$1M

ERIC KOLACZYK develops seizure intervention therapy.

ROBOTICS

$2.4M

CALIN BELTA directs teams of robots to survey areas with collapsed buildings and debris.

$1M

ROBERTO TRON is developing disaster relief technology for aerial vehicle search-and-rescue.

ENERGY

$1M

JANUSZ KONRAD, PRAKASH ISHWAR, THOMAS LITTLE and MICHAEL GEVELBER are developing next generation sensors for HVAC systems.