



The MassCAN 2015–2018 Strategic Plan

Implementing Computer Science Education in Massachusetts

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Executive Summary

Mission and Vision

The Massachusetts Computing Attainment Network (MassCAN), founded in 2013, is a public-private coalition of education, industry, nonprofit, and academic partners who share a common interest in transforming computer science (CS) education in Massachusetts. The initiative works to create and offer the highest quality K–12 CS education to every student in the state. It was established by taking a broad, systematic approach to transforming public education for CS that addresses standards, curriculum, professional development (PD), teacher leadership, advocacy, public awareness, industry engagement, after-school programs, and collaboration with school districts.

MassCAN is working toward two high-level outcomes: (1) preparing our youth for 21st century success by inspiring them and developing their technology and problem-solving skills and analytic abilities, which can be applied in any capacity and to any field, and (2) expanding the Massachusetts workforce to increase success across all information-based sectors of our economy. MassCAN strives to achieve these outcomes by focusing on four goals:

1. Expand opportunities for all Massachusetts K–12 students to learn CS
2. Promote opportunities for all students, especially many more females and underrepresented minorities, to pursue CS careers
3. Inform and inspire educators, administrators, parents, and students about the extraordinary employment opportunities available in technology fields across all industries and nonprofits—locally, nationally, and globally
4. Mobilize, organize, and collaborate with partners across Massachusetts in industry, education, nonprofits, and the public sector to achieve the above goals

Future Strategy and Plan

The high-level objectives of the MassCAN 2015–2018 Strategic Plan, which will have prioritized and staggered implementation over three years, are broken down into three elements: policy, programming, and operations and communications.

POLICY

- Work with public and private partners in Massachusetts to establish new K–12 Digital Literacy and Computer Science (DLCS) standards, curriculum frameworks, licensure or endorsement requirements, and other policies as necessary to enable Massachusetts to offer computing education that is aligned with the full range of the Commonwealth's educational offerings and is of commensurate excellence.

PROGRAMMING

- **Teacher Leadership and Professional Development:**

Through MassCAN's regional university-based CS PD hubs, establish interconnected, collaborative professional learning communities of teachers across the state who are trained to provide K–12 education that is aligned with the state's new DLCS standards

In collaboration with MassCAN partners, offer a range of state-of-the-art PD opportunities and resources that scale in response to ongoing demand from school districts

Implement a Teacher Leadership program to prepare an expanding group of teacher leaders to participate in train-the-trainer programs to become facilitators of CS PD programs

OUTCOME: In three years, MassCAN partners will have offered Computer Science Principles PD to 150 teachers, Exploring Computer Science PD to 450 teachers, Growing Up Thinking Scientifically PD to 400 teachers, Bootstrap PD to 400 teachers, Creative Computing PD to 200 teachers, and CodeStudio PD to 2,500 teachers.

Fully fund teachers to attend and present at state and national conferences

- **District Engagement:** Plan and implement a pilot program to work with three to six school districts (representative of the state's school districts) over several years to ensure that educational opportunities within districts are broad, deep, and long-lasting.
- **Equity—Engaging Females and Underrepresented Minorities:** Develop and implement a programmatic strategy to dramatically increase the number of female and underrepresented minority students who are interested in and have the opportunity to participate in computing education programs, and implement a range of retention strategies to successfully support these students through program completion.
- **Assessment:** Collaborate with other partners at the state and national levels in coordinating semi-annual meetings of CS curriculum developers, their assessment teams, and independent experts to expedite the development of effective assessment instruments for a range of CS courses and to establish alignment across CS assessment instruments developed for different courses.
- **Business Engagement and Workforce Development:**

Collaborate with industry leaders and the Mass. Department of Higher Education to establish a Work Group, whose task is to recommend specific policy and higher education programmatic changes that will result in a range of near-term solutions to CS and information technology (IT) workforce shortages

Create a value proposition, based on MassCAN's engagement in K–16+ CS education and workforce solutions, to more effectively engage industry leaders in providing financial support and opportunities for employees to participate in MassCAN's policy and program work

OUTCOME: Over three years, six school districts will have formed a multi-sector District CS Advisory Council, will be implementing a K–12 plan for CS education, and will be sharing results with other districts.

OUTCOME: Over three years (using the 2013–2014 school year as baseline), there will be a 66% increase in the participation of female and underrepresented minority students in CS courses.

OUTCOME: As a result of semi-annual meetings of national partners over three years, independent national experts agree that the process of sharing information and expertise has expedited the development and use of CS assessment instruments.

OUTCOME: A multi-sector work group has developed—and supported statewide adoption of—policies and programs that demonstrably improve the postsecondary preparation of non-college graduates and the unemployed and underemployed for employment in CS and IT careers; MassCAN has tripled the number of CEOs who provide support to advance its CS education and workforce mission and programs.

OPERATIONS AND COMMUNICATIONS

- **Coalition:** Enhance the engagement and effectiveness of the MassCAN Advisory Board and Leads; connect, inform, mobilize, and advise a wide range of additional partners who wish to advance MassCAN's mission and goals and to increase the overall impact of CS education through better coordination of efforts across the Commonwealth.
- **Operations:**

Execute the mission and goals of MassCAN with high integrity, transparency, efficiency, and accountability

Recruit a diverse staff capable of providing outstanding leadership

Regularly communicate actions taken to achieve outcomes and other important initiative news

OUTCOME: MassCAN Advisory Board and Leads have met monthly, expanded in size, and provided leadership to Work Groups.

OUTCOME: MassCAN has hired a diverse leadership staff, established a communications network through its website, provided annual reports, and established working relationships with national leaders.

Build and maintain relationships with state and national leaders

- **Fundraising:**

Double the impact of the annual \$1.5 million of Massachusetts public funds that have been legislatively allocated to MassCAN by raising the required matching non-state funds sourced from foundations, federal grants, industry, and elsewhere from the private sector

OUTCOME: MassCAN has met or exceeded its legislatively required 1:1 match of non-state funds for each of the three years.

Raise an additional \$500 thousand in 2015–2016 to fund additional programming needs and to demonstrate to the Commonwealth's public leadership the strong statewide support for computing education and the importance of continuing MassCAN's public funding in successive years

- **Public Awareness:**

MassCAN will implement a broad internal and external communications strategy that involves a powerhouse website and a robust, widely circulated bi-monthly e-newsletter

The Mass. Technology Leadership Council (MassTLC) Education Foundation will play the lead role in inspiring, educating, and motivating individuals and communities to engage in driving the adoption of computing education in Massachusetts schools

OUTCOME: MassCAN has expanded and regularly updates its website, and broadly disseminates a bi-monthly e-newsletter; the MassTLC Education Foundation led a public awareness campaign that increased participation in both the Hour of Code and the Technovation Challenge.

The MassTLC Education Foundation will play the lead role in supporting the annual roll-out of the Hour of Code, the Technovation Challenge, and other similar programs

Introduction

Mission and Vision

The Massachusetts Computing Attainment Network (MassCAN) is working to create and offer the highest-quality K–12 computer science (CS) education to every student in Massachusetts. The initiative was established by taking a broad, systematic approach to transforming public education for CS that addresses a number of elements, including standards, curriculum, professional development (PD), teacher leadership, advocacy, public awareness, industry engagement, after-school programs, and collaboration with school districts. This broad approach is based on two observations:

- Historically, programs that target a small subset of these elements have generated value for small numbers of students but have not demonstrated measurable change in our educational system or outcomes
- Creating impact in a sustainable way requires all of these elements to be aligned

MassCAN is a public-private coalition of education, industry, nonprofit, and academic partners who share a common interest in transforming CS education in Massachusetts. MassCAN intends to achieve two outcomes: (1) preparing our youth to be successful in the 21st century by inspiring them and developing their technology and problem-solving skills analytic abilities, which can be applied in any capacity and to any field, and (2) expanding the Massachusetts workforce of the future by increasing our success across all information-based sectors of our economy.

MassCAN will work to achieve these outcomes by focusing on four key goals:

1. Expand opportunities for all Massachusetts K–12 students to learn CS
2. Promote opportunities for all students, especially females and underrepresented minorities, to pursue careers in CS
3. Inform and inspire educators, administrators, parents, and students about the extraordinary employment opportunities available in technology fields across all industries and nonprofits—locally, nationally, and globally
4. Mobilize, organize, and collaborate with partners across Massachusetts in industry, education, nonprofits, and the public sector to achieve the above goals

These goals embody the educational mission of the program. Educating students is the most direct way to prepare our students for living and working in the rapidly evolving world of the 21st century. Additionally, we are hopeful that many students will be both inspired and prepared to meet the growing needs of a Massachusetts economy that is becoming increasingly dependent on information-based sectors, including biotechnology, health care, high-tech, financial services, and nonprofits.

Achieving these outcomes also depends on engaging industry more actively in students' educational experience, and complementing classroom work with industry visits, internships, after-school programs, and opportunities for career advice and sharing perspectives.

Our strategic approach is designed to yield several ancillary benefits beyond the explicit goals of the initiative:

- Massachusetts students will have the basic computing skills necessary to understand technology developments in the 21st century and to be able to apply analytic and problem-solving skills in a range of other subjects, including math and science.

- Massachusetts students in every part of the state, including large numbers of young women and underrepresented minorities, will be prepared and inspired to lead and innovate in a future economy that is dependent on and driven by computer technology.
- Massachusetts will continue to grow and thrive as the nation's leading knowledge and information-based state economy, in part by becoming a national leader in implementing CS education broadly and deeply.
- New relationships and collaborations will emerge from the initiative that will drive new opportunities beyond the scope of the MassCAN mission, creating a model for cross-sector, public-private partnerships that can be applied elsewhere.

The breadth of MassCAN's work and its unique approach frequently cause it to be mischaracterized. Here are some examples of this confusion:

- **MassCAN is a nonprofit.** *No.* MassCAN coalition partners raise funds to employ a small number of people who, historically, are employed by Education Development Center, Inc. (EDC), a nonprofit that has a prestigious reputation for driving educational change nationally. Funds raised by MassCAN partners (e.g., National Science Foundation [NSF] funds) are also used to staff people at institutions other than EDC. MassCAN's intent is to stimulate partnerships and collaborations with only a small staff.
- **MassCAN is an industry advocacy group.** *No.* MassCAN partners include industry organizations (the Massachusetts Business Roundtable, Massachusetts Technology Leadership Council [MassTLC], Massachusetts Competitive Partnership) who advocate on behalf of the initiative. MassCAN partners also include the Massachusetts Department of Elementary and Secondary Education (Mass. DESE), which works closely with MassCAN staff to develop CS standards and collaborate on NSF-funded efforts (e.g., a STEM-C award for developing new K–5 educational opportunities), and chapters of the Computer Science Teachers Association (CSTA), which comprises teachers throughout the state. MassCAN employs a small number of staff who advocate for transformative changes in Massachusetts CS education.
- **MassCAN is a direct service provider.** *No.* MassCAN has identified, mobilized, and helped fund third parties (e.g., trainers from Growing Up Thinking Scientifically [GUTS], Bootstrap, and Exploring Computer Science programs) to provide PD and training to teachers. MassCAN leadership includes several CS teachers who help facilitate PD and training. Our goal is to build capacity in Massachusetts to provide training for our teachers—growing this capacity within our existing institutions is crucial to the initiative's sustainability.

Origin of the MassCAN Initiative

MassCAN was created in 2013, emerging out of three concurrent forces of change in computing education and workforce development.

The first “force of change” occurred at the national level, where there were several significant developments:

- Under Jan Cuny's direction, the Computing Education program within NSF's Directorate for Computer and Information Science and Engineering began a program to research and redefine CS education, shifting focus from developing programming skills to understanding the broader concepts embodied by computational thinking. This remarkable shift focused on three key initiatives: developing a new high school introductory course titled Exploring Computer Science (ECS), developing a robust program of PD to train thousands of high school teachers in the new pedagogy required for this course, and creating the CS10K Professional Learning Community,¹ which supports teachers in CS10K projects across the United States through its website resources.

¹ The CS10K Community is a component of NSF's CS10K initiative, which seeks to have 10,000 well-trained CS teachers in 10,000 high schools across the United States.

- After many years of collaboration between the College Board and leading experts in the CS education field, Lien Diaz, Senior Director of the Curriculum and Content Development AP Program at the College Board, led a significant initiative to develop a new CS AP course, titled Computer Science Principles (CSP). A small number of teacher PD programs have been launched for this AP course, and the first CSP AP exam will be available in the 2016–2017 school year.
- Under the leadership of former national CSTA Director Chris Stephenson, CSTA became a national leader in conducting research and issuing a wide range of reports on K–12 CS topics, including the national guide *CSTA K–12 Computer Science Standards*. Additionally, CSTA played a hugely important role assisting in the formation of local CSTA chapters in a number of states across the country.
- The nonprofit Code.org was launched in 2103 by Ali and Hadi Partovi—each of whom had founded technology companies that they sold to Microsoft—to provide access to CS education to students across the country, especially young women and underrepresented minorities. Code.org’s Hour of Code program has been hugely successful at introducing CS and demystifying it for millions of teachers and students. Additionally, Code.org has mounted an effective national marketing campaign to promote CS education; led a national effort to support states in adopting legislation and policies supportive of CS education; provided new, easily accessible curriculum; and provided PD to thousands of U.S. teachers. Code.org has extraordinary financial support from the national business community as well as community support from individuals who contribute through the website. The Partovis continue to be active investors in Code.org as well.
- New and successful programs—such as Bootstrap, developed by Emmanuel Schanzer and colleagues, and GUTS, developed by Irene Lee at the Santa Fe Institute (both of which are targeted at middle schools)—are creating new ways to infuse computing concepts into math and science.

The second “force of change” occurred at the state level. Massachusetts has a rich history of developing renowned programs to enhance education relating to engineering and computing, each characterized by deep investments and success at the national and international levels. For example:

- The Commonwealth Alliance for Information Technology Education and the Expanding Computing Education Pathways (ECEP) Alliance, led by CS Professor Emeritus Rick Adrion and Project Manager Rene Fall at UMass Amherst, are focused on facilitating state-level systemic change to improve the quality of computing education, broaden participation in computing, and increase the number of students in the pathway to computing and computing-intensive degrees.
- The Museum of Science, under the leadership of President Ioannis Miaoulis, has played a pioneering role in introducing engineering into the Massachusetts state standards and has developed the *Engineering Is Elementary* (K–5) and *Engineering the Future* (9–12) curricula and related teacher PD programs. These successful models have heavily influenced MassCAN’s drive to develop computing standards and educational offerings. The museum is now launching a new Computer Science Education Initiative to address formal and informal educational needs.
- UMass Lowell initiatives:

CS Professor Fred Martin has for several years partnered with local school districts to pilot and develop iSENSE (isenseproject.org), a web system for sharing and visualizing scientific data that is intended to be a resource for middle school and high school science, math, and engineering instruction.

Funded by a MA state MMSP grant awarded to Methuen Public Schools in spring 2015, Fred and colleague Samantha Michalka (of Machine Science Inc.) have a partnership to train 45 Methuen middle school math, science, and technology teachers in use of iSENSE. They are presently working with the first cohort of 15 teachers, who are taking a new UMass Lowell graduate course being taught on site in Methuen, 91.587 Computer Science Education in Secondary School (Fall 2015). Two more cohorts will take the course over the following two years.

Martin received an NSF ITEST grant in 2014 in partnership with the districts of Everett and Medford to develop the Middle School Pathways in Computer Science project (cspathways.org). In collaboration with the district's technology, engineering, art, and library teachers, the project is developing at 15 to 20-hour school year computing curriculum where students develop mobile apps for social good (using MIT App Inventor). The project is also conducting three years of summer camps for district middle school students; the first camps were held in summer 2015 and attracted approx. 80 students across the two districts.

UMass Lowell Professor Holly Yanco is the director of the New England Robotics Validation and Experimentation (NERVE) Center. And co-developed with Professor Martin the Artbotics program, Artbotics is a program that has been designed to introduce students to art, computer science, and robotics, by creating interactive, kinetic sculptures. The program has been used by many age levels, including middle school, high school, and college, with a variety of technologies.

- Broadening Advanced Technological Education Connections (BATEC), an NSF ATE National Center of Excellence based at UMass Boston and led by Deborah Boisvert, is dedicated to increasing the capacity, seamless advancement, and robustness of career-focused pathways in the fields of CS and information technology (IT) and their intersections with security and data. BATEC models include the Tech Apprenticeship program, which places high school students in technology summer internships at a wide range of companies in Greater Boston; and the Summer Institute, which provides PD to approximately 140 educators each year. BATEC also conducts labor market research to understand the workforce needs of its regions.
- MIT App Inventor, developed by Hal Abelson at MIT and Mark Friedman at Google, is an innovative beginner's introduction to programming and app creation that transforms the complex language of text-based coding into visual, drag-and-drop building blocks. The simple graphical interface grants even an inexperienced novice the ability to create a basic, fully functional app within an hour or less. In 2015, the MIT App Inventor community consists of nearly 3 million users representing 195 countries.
- The Scratch program at the MIT Media Lab's Lifelong Kindergarten Group, led by Professor Mitchel Resnick, uses Scratch, a visual programming language, to provide a media-rich visual programming environment for children. The ScratchEd program developed by Assistant Professor Karen Brennan at the Harvard Graduate School of Education provides a robust online environment to support teachers in introducing Scratch in formal and informal education settings.
- The nonprofit Fab Foundation works to provide access to the tools, knowledge, and financial means to use technology and digital fabrication to educate, innovate, and invent, thereby creating opportunities to improve lives and livelihoods around the world. Formed in 2009 (and emerging from MIT's Center for Bits & Atoms Fab Lab Program), the Foundation's programmatic areas of focus are education, organizational capacity building and services, and business opportunities.

Also at the state level (albeit New Hampshire, rather than Massachusetts), the FIRST (For Inspiration and Recognition of Science and Technology) Robotics Competition was created in 1989 by Dean Kamen, an inventor, entrepreneur, and tireless advocate for science and technology. FIRST's mission is to inspire young people to be science and technology leaders by engaging them in exciting mentor-based programs that build science, engineering, and technology skills; that inspire innovation; and that foster well-rounded life capabilities, including self-confidence, communication, and leadership.

The third "force of change" occurred at the local level:

- In January 2009, former Governor Deval Patrick charged the Tech Hub Collaborative, organized by the Innovation Institute at the Massachusetts Technology Collaborative (MassTech), with the mission of creating collaboration among high-tech companies, education institutions, and the public sector to stimulate and grow Massachusetts' high-tech economy.

- A key challenge identified during the early stages of this work was the need to expand the pipeline of students feeding the growing computing technology workforce needs of the Massachusetts economy.
- After several years of workshops with students and educators, connection-building, and white papers, Steve Vinter, Google Engineering and Site Director for Massachusetts, led an intense effort to synthesize the work of the program and to create a strategy for change at the state level.
- At the December 14, 2012, meeting of the Governor's STEM Advisory Council, Vinter gave a presentation titled "STEM and Computing in Massachusetts: A Proposal to Change K–12 Massachusetts Computing Education." The presentation was well-received, and Vinter was asked to develop a plan reflecting this strategy.
- The concept of a MassCAN initiative emerged from a series of meetings between co-founders Vinter and Jim Stanton, founder and former director of the LIFT (Leadership Initiatives for Teaching and Technology) STEM teacher externship program and long-time STEM education activist. Vinter and Stanton met with a team of senior EDC staff, led by Managing Project Director Joyce Malyn-Smith, to explore the potential "fit" with EDC. Additional conversations with EDC leadership resulted in an interest and willingness on EDC's part to host MassCAN staff and serve as MassCAN's fiscal agent.
- Shortly after this meeting, Google and MassTech provided the initial funds to launch MassCAN, and Stanton moved to EDC as a Senior Project Director and MassCAN Executive Director.
- Stanton and Malyn-Smith assembled an EDC team to write "MassCAN Action Plans for Scaling K–12 Computer Science in Massachusetts," which provided a blueprint for taking a long-term, comprehensive, and systematic approach to address key standards and related policies, curriculum, teacher PD, and public awareness.

The MassCAN "Leads" (leaders of affiliated programs) comprise the following:

- **University partners:** Rick Adrion and Renee Fall (UMass Amherst/ECEP), Deborah Boisvert (UMass Boston/BATEC), Fred Martin (UMass Lowell), and Josh Sheldon (MIT/Media Lab/App Inventor Program)
- **K–12 education partners:** Padmaja Bandaru and David Petty (Greater Boston Chapter of CSTA)
- **Business partners:** Steve Vinter (Google), Amy Sprung (Microsoft), JD Chesloff (Massachusetts Business Roundtable), Tom Hopcroft (MassTLC), and Bryan Jamele (Massachusetts Competitive Partnership)
- **Nonprofit partners:** Peter Wong (Museum of Science), Linda Noonan (Massachusetts Business Alliance for Education), and Joyce Malyn-Smith (EDC)
- **State government partners:** Jake Foster (Director, STEM, Massachusetts Department of Elementary and Secondary Education) Allison Scheff (Executive Director of STEM, Massachusetts Department of Higher Education), Christine Williams (Associate Director of Workforce Development, Massachusetts Department of Higher Education), and Sarah Rahman (Director of Strategic Initiatives, MassTech)

Additionally, MassCAN is supported by an Advisory Board, which the legislature requires as a condition of state funding. Advisory Board members are nominated by designated organizations and appointed by the governor. The nominating organizations and their appointees are as follows: Massachusetts Association of Superintendents—Dr. Eric Conti, Superintendent, Burlington Public Schools; Greater Boston CSTA—Hans Batra, Math and CS teacher and Robotics coach, Needham High School; Public University Computer Science Department—Rick Adrion, CS Professor Emeritus of UMass, Amherst, co-PI on the NSF-funded Expanding Computing Education Pathways Grant; Society of Women Engineers, Boston—Danielle Curcio, Chief Software Engineer, Raytheon; Metropolitan Council for Education Opportunity (METCO), Inc.—Kalise Wornum, METCO Coordinator, Wellesley Public Schools; Massachusetts Competitive Partnership—Bryan Jamele, Executive VP; Federally Funded R&D Center—Carole Mahoney, Department Head, Agile and Adaptive Software Engineering, MITRE Corporation; MassTLC—Tom Hopcroft, President; and Massachusetts Business Roundtable—MassCAN Board Chair Steve Vinter, Massachusetts Engineering and Site Director, Google.

Future Strategy and Plan

The 2015–2018 Strategic Plan builds on MassCAN’s original “MassCAN Action Plans for Scaling K–12 Computer Science in Massachusetts,” plan and extends it in three ways:

- This plan incorporates the learnings from our work over the past two years in CS PD, standards development, and collaboration with partners, and the experience of the MassCAN leadership team in driving the initiative over this period.
- It creates a deeper plan for our work, highlighting the need to engage industry and the challenges of recruiting, engaging, and supporting women and underrepresented minorities.
- It spans a three-year horizon, as required by the state legislative funding for MassCAN of \$1.5 million, awarded in the summer of 2015.

The high-level objectives of the MassCAN 2015–2018 Strategic Plan, which will have a prioritized and staggered implementation over three years, are broken down into three key elements: policy, programming, and operations and communications. The objectives within each element are outlined below.

POLICY

- Work with partners and other public institutions in Massachusetts to establish the standards, policies, and resource investments necessary to enable Massachusetts to offer K–12 computing education that is aligned with the full range of the Commonwealth’s educational offerings and is of commensurate excellence.

PROGRAMMING

- **Teacher Leadership and Professional Development:**
 - Establish an interconnected, collaborative professional learning community of teachers across the state who are trained to provide broad and deep K–12 computing education that is aligned with the state’s new Digital Literacy and Computer Science (DLCS) standards
 - In collaboration with MassCAN partners, offer a range of state-of-the-art PD opportunities and resources that scale in response to ongoing demand from school districts
 - Implement a Teacher Leadership program to prepare an expanding group of teacher leaders each year to participate in train-the-trainer programs to become facilitators of CS PD programs
 - Fund teachers to attend and present at state and national conferences
- **District Engagement:** Plan and implement a pilot program to work for several years with three to six school districts (representative of the state’s school districts) to ensure that educational opportunities within districts are broad (they span the full K–12 spectrum), deep (they touch a large percentage of students), and long-lasting (they don’t disappear in response to organizational upheaves, teacher departures, etc.). It is expected that the work with the initial six districts will develop a deeper understanding of what is required to effectively engage and support districts across the state—and provide advocates and models from which other districts can learn.
- **Equity—Engaging Females and Underrepresented Minorities:** Develop and implement a programmatic strategy to dramatically increase the number of female and underrepresented minority students who are interested in and have the opportunity to participate in computing education programs, and implement a range of retention strategies to successfully support these students through program completion.
- **Assessment:** Collaborate with other partners at the state and national levels to coordinate semi-annual meetings of CS curriculum developers, their assessment teams, and independent experts to expedite the

development of effective assessment instruments for a range of CS courses and to establish alignment across CS assessment instruments developed for different courses.

- **Business Engagement and Workforce Development:**

- Collaborate with industry leaders and the Department of Higher Education to establish a Work Group, whose goal is to recommend specific policy and higher education programmatic changes that will result in a range of near-term solutions to CS and IT workforce shortages
- Create a value proposition based on MassCAN's engagement in K–16+ CS education and workforce solutions to more effectively engage industry leaders in providing financial support and opportunities for employees to participate in MassCAN's policy and program work

OPERATIONS AND COMMUNICATIONS

- **Coalition:**

- Enhance the engagement and effectiveness of the MassCAN Advisory Board and Leads
- Connect with, inform, mobilize, and advise a wide range of additional partners who wish to advance MassCAN's mission and goals
- Increase the overall impact of CS education through better coordination of the disparate efforts underway across the Commonwealth

- **Operations:**

- Carry out the mission and goals of MassCAN with high integrity, efficiency, transparency, and accountability
- Recruit a diverse staff who are capable of providing outstanding leadership
- Communicate program news and information, both internally and externally, in a timely and effective manner
- Report on actions taken to achieve outcomes
- Build and maintain relationships with state and national leaders

- **Fundraising:**

- Double the impact of the annual \$1.5 million of Massachusetts public funds that were legislatively allocated to MassCAN by raising the required matching non-state funds sourced from foundations, federal grants, industry, and elsewhere from the private sector
- Raise an additional \$500 thousand in 2015–2016 to fund additional programming needs and to demonstrate to the Commonwealth's public leadership the strong support in Massachusetts for computing education and the importance of continuing MassCAN's public funding in successive years

- **Public Awareness:**

- MassCAN will implement a broad internal and external communications strategy that involves a powerhouse website and a robust, widely circulated bi-monthly e-newsletter
- The MassTLC Education Foundation will play the lead role in inspiring, educating, and motivating individuals and communities to get engaged in driving the adoption of computing education in Massachusetts schools, and in supporting the annual roll-out of the Hour of Code, the Technovation Challenge, and other similar programs

Progress to Date

Since MassCAN was created in early 2013, it has collaborated with partners to achieve important outcomes in three areas: winning federal grants to develop curriculum and provide teacher PD, partnering with Mass. DESE to

develop K–12 DLCS standards, and providing K–12 CS PD programs in three regions of the state: Boston, MetroWest, and Western Massachusetts.

- MassCAN, under the leadership of our partner EDC and collaborating partners UMass Amherst, UMass Boston/BATEC, Framingham State University, Goodman Consulting Group, and the Massachusetts Technology Leadership Council, won a three-year, \$1 million NSF grant (Massachusetts Exploring Computer Science Partnership) to provide PD and otherwise prepare 110 high school teachers to offer the ECS course.
- In August 2015, MassCAN partners EDC and Mass. DESE won a major NSF STEM+C Design and Development award of \$2.1 million for three years to integrate computational thinking into grades 1–6.
- MassCAN is partnering with Mass. DESE to develop new K–12 standards for DLCS. MassCAN helped to assemble a DLCS Standards Work Group of 34 volunteers (representing K–12 education, industry, and academics) to draft standards, prepared for and facilitated the 12 monthly Work Group meetings, and submitted final standards to the Massachusetts Board of Education, which are awaiting review.
- In the summer of 2014, Code.org partnered with MassCAN to provide PD for the ECS course for 25 teachers from the Greater Boston area.
- Kelly Powers, MassCAN's Director of Computer Science Teacher Leadership, secured funding from Google to enable 18 high school teachers to take the summer 2015 Mobile Computer Science Principles (CSP) PD program.
- Code.org arranged to cover all costs for six Massachusetts high school teachers to take a CSP-Code PD program in New York City in the summer of 2015.
- As of fall 2015, more than 100 teachers from the Boston, MetroWest, and Western Massachusetts regions have received PD to teach ECS, and a large majority are teaching the course to students in the 2015–2016 school year.
- Over the past year, Facebook, the ECEP Alliance at UMass Amherst, the MassTLC Education Foundation, and Verizon have provided funding for 80 middle school teachers from across the state to take the Bootstrap PD program
- During the same period, Vertex Pharmaceuticals, State Street Bank Foundation, the UMass Amherst ECEP Alliance, and Google supported 100 middle school teachers in taking the GUTS PD program.
- In the summer of 2014, Code.org provided a train-the-trainer program on the CodeStudio training for a five-member team of Massachusetts teachers. CodeStudio infuses computing concepts into a 20-unit curricula for each of the grades K–5. To date, more than 300 teachers from around the state have been trained in this PD program.
- Together with the MassTLC Education Foundation and the ECEP Alliance at UMass Amherst, MassCAN championed Massachusetts CS teachers and helped create the state's two CSTA chapters.
- The Massachusetts Technology Collaborative and Google led an industry, foundation, and public partner effort to launch and sustain MassCAN by raising \$500 thousand in operational funds.
- In the winter and spring of 2015, the MassTLC Education Foundation, Microsoft, and MassCAN supported the engagement of 30+ schools in the Technovation Challenge, an entrepreneurship challenge where middle and high school girls develop a mobile app. Two of the teams, Phillips Andover Academy and Winchester High School, went on to place second and third in the International Competition in San Francisco.

Three-Year Plan

The elements of MassCAN's Strategic Plan fall within three broad areas: Policy, Programming, and Operations and Communications. Each element is discussed below. For each, we present the following:

- A rationale for the work in this area
- The objective of this element
- High-level goals for the work in this area
- A three-phase plan of work and the priority level of each action:
 - Year 0: Work to date prior to this three-year effort
 - Year 1: The first-year plan for this effort
 - Year 3: The full plan for work completed in three years

Each Year 1 outcome has a priority of 1 or 2. “1” means that this work *must be done* for the initiative to be successful, and “2” means that this work is important but may be deferred if resources or priority 1 efforts contravene. Year 2 and 3 priorities will be set by the work groups, assuming future funding. The year 2 and 3 priorities listed below are primarily reasonable placeholders.

Policy

Massachusetts public education offerings are determined by a combination of state standards, guidelines, related policies, and decisions made at the school district level regarding what courses are offered and who is hired to teach those courses. Less than 0.02% of students graduating from Massachusetts high schools have been introduced to computational thinking as measured by the number of students taking the AP Computer Science course [The 10th Annual Report to the Nation, State Supplement-Massachusetts, February 11, 2014, College Board and MA DESE Student Enrollment 2013]. Student performance on the AP Computer Science A test in Massachusetts is worse than on any other AP test, with the largest number of students scoring a 1 (worst score) (The 10th Annual Report to the Nation, State Supplement-Massachusetts, February 11, 2014, College Board). Other than AP Computer Science A (Java Programming), computing education is addressed on an ad hoc basis:

- There is no coherent plan driving the selection of computing classes offered across the state.
- The few courses offered are not based on standards, and they have no curriculum frameworks underlying them.
- The courses are unaligned with math and science offerings.
- The courses are inconsistent from district to district.
- The courses are taught by teachers who are offered no guidelines for certification or licensure related to computing.
- The courses do not count for graduation requirements or math/science credit in college.

The status of computing education offerings in Massachusetts is similar to the situation in other states. While there are major initiatives in more than 10 states either to introduce standards, provide licensure requirements, mandate courses for all students, and/or make CS a graduation requirement, in many states the rush to action has resulted in frustrating and unintended consequences—particularly in the area of teacher licensure; virtually no state has a comprehensive set of interrelated policies that effectively drive broad adoption of CS education.

MassCAN’s Policy agenda is to work with partners and public institutions in Massachusetts to establish the standards, policies, and resource investments necessary to enable Massachusetts to offer K–12 computing education that is aligned with the full range of Commonwealth’s educational offerings and is of commensurate excellence.

First, MassCAN will create a multi-sector Policy Work Group that, with staff support, will research and develop policy positions on the following recommended actions (and other topics and actions recommended by Policy Work Group members):

- Driving the adoption of voluntary DLCS standards in Massachusetts that include crosswalks to the Common Core and the state's Science, Technology, and Engineering standards
- Establishing DLCS curriculum frameworks to provide resources for course development and classroom instruction
- Establishing teacher licensure and endorsement requirements for teaching CS
- Developing a *Guide to K–12 Computer Science Curriculum and Resources*, aligned with the state CS standards and curriculum framework, that supports the development of two types of CS programs:
 - Courses, tools, and resources at the elementary and middle school levels that support all students in developing the basic CS knowledge necessary to effectively function in an increasingly technological world
 - Courses and pathways at the high school level that support students in exploring a variety of CS-related fields and/or courses that prepare them for CS majors at two- and four-year postsecondary levels
- Integrating computing education into MassCore, the recommended, comprehensive set of subject-area courses and units to prepare students for college
- Encouraging public universities to adapt their math/science requirements to incorporate rigorous computing courses
- Encouraging statewide Career Technical Education programs to include and promote CS-related education and careers
- Advocating additional policy changes to promote computing education

MassCAN will then collaborate with relevant state agencies and boards and, where appropriate, the state legislature to assure adoption of the recommended policies.

Table 1: Policy Plans and Outcomes

Year 0 Outcomes	Year 1 Outcomes	Year 3 Outcomes
The MassCAN initiative includes a number of new members with substantial expertise and a willingness to work to achieve shared policy goals.		
MassCAN and Mass. DESE have supported and guided a multi-sector Work Group in developing new DLCS standards for late 2015 adoption by the Board of Education.	<p>The Board of Education has adopted the DLCS standards for Massachusetts. <i>Priority 1</i></p> <p>Mass. DESE and MassCAN have held regional hearings to explain the new standards to school districts and teachers. <i>Priority 2</i></p>	MassCAN and DESE have determined a timeline for future updates to the DLCS standards.
MassCAN state and national partners have conducted their initial research on CS licensure and endorsement issues.	Supported by MassCAN and Mass. DESE, the Policy Work Group has developed a detailed set of recommendations to implement CS licensure and endorsement requirements. <i>Priority 1</i>	<p>CS licensure and endorsement policies have been adopted by Mass. DESE.</p> <p>Massachusetts is now positioned as a national leader in CS policy, standards, frameworks, and licensure, and as a leading laboratory for designing the means by which</p>

		states implement CS education in their public schools.
MassCAN is actively engaged with state and national policy leaders, discussing both emerging policies as well as those that have been implemented.	MassCAN and Mass. DESE have established a Task Force, including MassCAN Policy Work Group members, to begin developing DLCS curriculum frameworks. <i>Priority 1</i>	DLCS curriculum frameworks have been adopted, and Mass. DESE and MassCAN partners have provided regional workshops to share them with districts.

Programming

TEACHER LEADERSHIP AND PROFESSIONAL DEVELOPMENT

The large majority of Massachusetts school districts have no dedicated teachers teaching CS. Currently, there are no CS standards or curriculum frameworks and no licensure or endorsement requirements. MassCAN and some of its partners (EDC, UMass Amherst, UMass Boston, and Framingham State University) are the primary providers of middle and high school CS PD; Code.org and the Scratch teams at MIT and Harvard Graduate School of Education are important providers of K–5 CS PD. Even with the expected growth of providers of CS PD, the challenge of reaching all potential CS teachers in Massachusetts within the next 10 years is daunting.

Many of those who are starting to teach CS are highly innovative, risk-taking teachers who know that factors beyond their classrooms also contribute to success. They know that strong district buy-in and support are necessary for a well-developed CS K–12 program to take root and that more teachers in the district must be supported in participating in CS PD. However, even when computing education in classrooms has been spearheaded by highly dedicated and knowledgeable teachers, there is a need to provide strong district support and to provide a local community of learners so teachers can support one another around new CS courses and concepts.

MassCAN and its partners have started this work with the introduction of strong CSTA chapters in two regions of the state, sponsorships of workshops, and the creation of PD offerings. It is MassCAN's ambition to see a durable infrastructure created in the state to support and sustain PD and Teacher Leadership opportunities in CS education.

MassCAN's Teacher Leadership and PD agenda has three objectives:

- Establish an interconnected, collaborative cohort of teachers across the state who are trained to provide both broad and deep K–12 computing education that is aligned with the state's new DLCS standards
- Offer, through MassCAN partners, a range of state-of-the-art PD opportunities and resources that scale in response to the ongoing demand from school districts
 - The PD will focus on three areas: content, the underlying principles and main concepts of CS, and pedagogy—the approach to CS teaching and learning
 - The PD will be shaped into three grade bands of curriculum strategies: K–5, 6–8, and 9–12
 - The PD will also stress the importance of making real-world connections to CS through engagement with industry
- Prepare a small group of teacher leaders each year to participate in train-the trainer programs to become facilitators of CS PD programs

Note: MassCAN will also seek to support these teachers in attending and/or presenting at a broad array of statewide and national meetings and conferences on K–12 CS education. These interactions with other state and national leaders will provide direct exposure to best practices in other districts and states, and opportunities to highlight our state's best practices.

Toward these objectives, MassCAN will create a multi-sector Teacher Leadership and PD Work Group that, with staff support, will research and develop Teacher Leadership and PD priorities for funding for the following actions, as well as other actions recommended by Work Group members:

- Advocating for school districts and teachers to plan for a K–12 approach to CS education over a three- to five-year period
- Offering PD that is aligned with the emerging DLCS standards, support an infusion model of integrating CS concepts into the K–8 curriculum, and prepare teachers for grade 9–12 CS courses that create a pathway to CS opportunities at the state’s postsecondary two- and four-year institutions
- Addressing the need for sustainable stipends, which may be an important incentive to recruit and retain a critical mass of teachers to participate in high-quality CS PD programs
- Collaborating with partners to fund and establish staggered implementation of university-based PD hubs throughout the state to provide access to PD for teachers in all school districts
- Engaging university partners in seeking a multi-year grant to establish pre-service teacher training programs that prepare teachers to meet CS licensure or endorsement certification upon graduation
- Collaborating with the Women and Underrepresented Minorities Work Group to develop programs to continually assist teachers in effectively recruiting female and underrepresented minority students for new CS courses and sustaining their interest and success in the courses
- Strengthening the community of learners for CS teachers in the state, enabling deeper collaborations, meet-ups, and access to more resources
- Building a broad cohort of facilitators across PD programs to reduce dependency on out-of-state trainers and to strengthen the state’s own PD capacity
- Assessing partnerships with online platforms (e.g., edX) to develop courses for teachers; looking at sustainable models, such as “for fee” certificate programs and scholarship programs, to subsidize costs for school districts or teachers who need financial support

Table 2: Teacher Leadership and Professional Development Plans and Outcomes

Year 0 Outcomes	Year 1 Outcomes	Year 3 Outcomes
MassCAN has identified a number of individuals with substantial expertise and a willingness to work together to set shared Teacher Leadership and PD priorities.	The multi-sector Teacher Leadership and PD Work Group has defined and set its priorities and has issued an annual report. <i>Priority 1</i>	The Work Group has set Teacher Leadership and PD priorities and target outcomes and issued an annual report.
MassCAN and its partners have developed the capacity to provide a range of CS K–12 PD programs (see Progress to Date, above).	PD offerings have been expanded to at least one new STEM region in the state, and the following PD was provided: <ul style="list-style-type: none"> • ECS PD for 100 high school teachers • CSP PD for 40 high school teachers • Bootstrap PD for 80 middle school teachers • GUTS PD for 80 middle school teachers • Creative Computing PD for 20–30 middle school teachers • CodeStudio for 450 K–5 teachers <i>Priority 1</i>	MassCAN partners offered the following PD (totals as of Year 3): <ul style="list-style-type: none"> • CSP PD to 150 teachers • ECS PD to 450 teachers • GUTS PD to 400 teachers • Bootstrap PD to 400 teachers • Creative Computing PD to 200 teachers • CodeStudio PD to 2,500 teachers
Three university hubs have	The three university hubs have	Four new university hubs have

successfully coordinated ECS PD programs.	expanded their roles to support a range of K–12 PD programs, and one new regional university hub was added. <i>Priority 1</i>	joined the three original hubs in providing K–12 CS PD programs.
Train-the-trainer programs are in place for the ECS, CSP, GUTS, Bootstrap, and Code Studio programs; 12 teachers are trained or are in training to be PD facilitators.	The train-the-trainer program was expanded to an additional 10–15 teachers; additional leadership opportunities were offered to another 15–20 teachers to support professional learning communities and/or to present at conferences. <i>Priority 1</i>	The train-the-trainer program has trained a total of 45 trainers; an additional 45 total teachers have participated in teacher leadership activities.
		A plan has been developed to expand the university hubs to the remaining two STEM regions in the state.

DISTRICT ENGAGEMENT

Many school districts offer a few computing classes, including CS AP Java Programming, Web development, robotics, and some of the new classes that MassCAN has been encouraging: Bootstrap, GUTS, ECS, and CSP. However, in no school district is there a commitment to teach computing to every student, much less at every grade level (Ashcraft, Eger, & Friend, 2012). Many schools have only one teacher who offers computing classes—and some schools have none. We know of no school districts that have DLCS plans deeply integrated into their curriculum in a way that drives students to learn the basic computing skills identified in the new DLCS standards.

Long-term capacity to offer and sustain computing education opportunities requires a broad and deep public-private partnership between the state, the business community, foundations, and key constituencies (education, civic and nonprofit leaders, parents, and students) at the local district level. Deep commitment by the school district and individual schools to make computing an integral part of the curriculum, PD for teachers, and meaningful engagement of local constituencies (e.g., a District Computer Science Advisory Council) are all essential ingredients of any effort to identify the importance of DLCS education for all children and to drive a systemic plan for providing a K–12 sequence of DLCS teaching and learning that responds to the new state standards.

The objective of MassCAN's District Engagement agenda is to ensure that educational opportunities within districts are broad (they span the full K–12 spectrum), deep (they touch a large percentage of students), and long-lasting (they don't disappear in response to organizational upheaves, teacher departures, etc.).

MassCAN will create a multi-sector District Engagement Work Group to support the current three university-based PD hubs in defining the role of modest planning grants to be provided three to six pilot school districts (representing a spectrum of urban, suburban, and rural districts) to develop a plan for a three- to five-year effort to provide a complete K–12 program of DLCS education for their district. The Work Group will do the following:

- Develop relationships with schools districts across Massachusetts to understand their individual needs, challenges, and priorities
- Develop models for broad and deep partnerships to mobilize teacher participation in PD
- Build support networks within school districts comprising school committee members, administrators, teachers, students, parents as well as employer, higher education, civic agency leaders s to support, contribute to, and advocate for creating and expanding computing education opportunities in their classrooms and after-school programs

- Support the development of additional university-based PD hubs to help drive community support of and district engagement in CS education
- Engage students in out-of-school-time CS opportunities by creating and offering after-school programs, competitions, camps, clubs, online self-study, and visits to local CS businesses, thus increasing the relevance of their studies and enabling them to apply their learnings outside the classroom

Table 3: District Engagement Plans and Outcomes

Year 0 Outcomes	Year 1 Outcomes	Year 3 Outcomes
MassCAN has identified <i>district engagement</i> as a new component of its comprehensive strategy and has begun the process of identifying potential members of this Work Group.	MassCAN has created a multi-sector District Engagement Work Group to collaborate with each of the three university-based PD hubs and to work with the pilot districts to prepare and submit to MassCAN a three- to five-year plan to provide a K–12 CS education program in their district. <i>Priority 1</i>	Having implemented the first three years of their K–12 CS education plan, the pilot districts have reported on their progress and shared their results on the MassCAN website and at regional and statewide meetings.
MassCAN is working to identify a potential funder for a multi-year effort to support the District Engagement strategy.	Together, the Work Group, hubs, and MassCAN staff developed proposals to secure a funding commitment to support implementation of the plans developed by the pilot districts. <i>Priority 2</i>	MassCAN, in collaboration with the university hubs and the pilot districts, has provided resources (e.g., videos, templates, plans) and conducted regional presentations to school district leaders and the state Associations of School Superintendents and School Committees to share its success strategies for K–12 CS programs and a repeatable, scalable model for K–12 CS education at the district level.

EQUITY—ENGAGING FEMALES AND UNDERREPRESENTED MINORITIES

It is broadly recognized that the number of females and underrepresented minorities in the high-tech industry is so low as to be considered a crisis (President’s Council of Advisors on Science and Technology, 2010). Currently, the US CS workforce is approximately 69% white, 18% Asian, 5.8% black and 4.6% Hispanic and 75% male [Science and Engineering Indicators, Chapter 3, National Science Foundation]. This implies an industry culture that is resistant to employing talented women and underrepresented minorities, which is simply not a sustainable workforce growth model.

In addition to a business culture that is perceived as unwelcoming and unsupportive, there are a number of other equity-related issues:

- Female and underrepresented minority students have little or no exposure to DLCS in grades K–12; there are few if any courses offered in these fields, and there is little or no exposure to role models.
- Too few of these students choose DLCS majors, receive the support necessary to persist in the major, and, again, have adequate exposure to role models.
- Too few female and underrepresented minority students graduate from college with the necessary DLCS credentials.

In recognition of the urgent need to address this systemic pipeline problem, many of the nation’s leading companies including Intel, Google and facebook have recently launched major campaigns to prepare and recruit many more women and underrepresented minorities.

The objective of MassCAN's Equity agenda is to highlight the dramatic lack of participation of women and underrepresented minorities in the extraordinarily important and professionally rewarding fields of technology and CS and to dramatically increase the number of female and underrepresented minority students who have the opportunity to participate in K–12 DLCS programs.

Toward this objective, MassCAN will establish an Equity Work Group of industry professionals, university and K–12 educators, and non-profit leaders to define MassCAN's priorities, create an action plan, and work to address the following areas:

- Identifying and promoting innovative national programs, such as those developed by the National Center for Women in Technology; Institute for Women in Trades, Technology, and Science; Institute for African-American Mentoring in Computing Sciences; and Computing Alliance of Hispanic-Serving Institutions
- Identifying and building deep relationships with a small set of school districts—particularly those with a disproportionately high level of underrepresented minorities—who are committed to expanding computing education at all grade levels for female and underrepresented minority students, and supporting their efforts to develop successful models that can be adopted and adapted elsewhere
- Using, developing, and/or making available a range of educational resources to support districts and teachers as they seek to engage, recruit, and sustain the participation of K–12 female and underrepresented minority students in DLCS courses
- Raising awareness of why learning about computing at ages 9–11 and providing pathways for further study will dramatically improve the pipeline of students interesting in CS
- Seeking partnerships with out-of-school-time programs (e.g., Technovation Challenge, Black Girls Code, Black Boys Code) to expand students' opportunities to experience success
- Exploring the use of online courses for high schools where DLCS courses are not offered

Table 4: Equity—Engaging Females and Underrepresented Minorities Plans and Outcomes

Year 0 Outcomes	Year 1 Outcomes	Year 3 Outcomes
MassCAN has identified the need to expand the engagement of females and underrepresented minority students as a central component of its comprehensive strategy and has begun the process of identifying members of an Equity Work Group.	MassCAN's multi-sector Equity Work Group has developed proposals to fund consultants/staff and to set priorities for the greater engagement of females and underrepresented minority students in CS. <i>Priority 1</i>	Through collaborations with in-school and out-of-school-time programs, the Equity Work Group has developed and expanded opportunities to engage females and underrepresented minority students in CS, and has issued an annual report of its progress.
MassCAN has identified strategies developed by a number of national programs to support districts' and teachers' efforts to recruit and engage more females and underrepresented minorities in CS.	MassCAN partners as offered three to five training sessions to support teachers and districts who seek to engage more females and underrepresented minorities in CS, and has added numerous useful resources on this topic to its website. <i>Priority 2</i>	MassCAN has offered a cumulative total of 9–15 training sessions to support teachers and districts who seek to engage more females and underrepresented minorities in CS.
MassCAN and its partners MassTLC and Microsoft were very successful at promoting participation in the Technovation Challenge program.	MassCAN collaborated with the MassTLC Education Foundation and Microsoft to engage additional partners in the Technovation Challenge and similar out-of-school-time programs. <i>Priority 1</i>	MassCAN has increased the number of partners who are engaged in the Technovation Challenge and similar out-of-school-time programs.

ASSESSMENT

Like many other states, Massachusetts is experiencing something that is fairly unique in public education: the introduction of a new academic discipline into the traditional K–12 academic program. Over just the last five years, we have seen the introduction of two new high school CS courses, ECS and CSP, which were developed with funding from NSF; the latter has been selected by the College Board as a new AP CS course. In grades K–8, there are numerous efforts to infuse CS concepts into the traditional curriculum, especially in math and science.

Many of these courses and efforts are so new that their assessments are still in development, which creates a certain tension. On the one hand, assessment development is a rigorous, time-consuming, iterative, and expensive process. On the other hand, as CS courses and PD programs proliferate, a range of interested parties will want to know whether students are actually learning meaningful skills and knowledge.

The objective of MassCAN's Assessment agenda is to play a leadership role at the state and national level, with other lead partners, in both expediting the development of assessment instruments for K–12 CS courses and establishing, if possible, alignment across assessment instruments developed for different courses. This will be achieved in two ways:

- By convening, twice a year, some of the country's leading experts on K–12 assessment, developers of new K–12 CS courses, and their assessment teams to share information about the development of assessment instruments
- By working with other lead partners to obtain funding for the development of assessments for promising new CS courses

MassCAN will do the following:

- In collaboration with other partners (e.g., the Computer Science Foundation for New York City [CSNYC]), plan how to raise the funds needed to have the national leaders who are driving CS course assessment come together to expedite the process of bringing high-quality CS program assessments to the marketplace
 - **Note:** Ideally, there would be two such events per year, for three or more years.
- Explore raising funds to hire a consultant with substantial assessment experience to guide MassCAN in supporting the development of both state and national assessments
- Advocate for the participation of MassCAN-supported programs and school districts in piloting assessment instruments, which will both support and expedite the assessment development process
- Support CSTA's national call (*Support Sowing the Seeds: A Landscape Study on Assessment in Secondary Computer Science Education*) for (1) developing an online repository of assessment items for K–12 CS teachers, (2), developing a community of practice surrounding the use of assessment in CS classrooms, and (3) designing and delivering PD to increase K–12 CS teachers' assessment literacy and their ability to understand and implement classroom assessment

Table 5: Assessment Plans and Outcomes

Year 0 Outcomes	Year 1 Outcomes	Year 3 Outcomes
MassCAN has held exploratory conversations with CSNYC, NSF, EDC, and the College Board and has determined that there is substantial interest in planning to convene regular national meetings.	MassCAN held the first jointly sponsored CS National Assessment meeting to stake out a strategy for bringing assessments for CS courses to the market. <i>Priority 1</i> MassCAN has explored<<the feasibility of>> hiring a consultant	The CS National Assessment meetings held by MassCAN have advanced the development of assessment instruments and created a common framework for instrument development.

	with substantial assessment experience to guide MassCAN's role in supporting the development of course/unit assessments for Massachusetts teachers. <i>Priority 1</i>	
Based on several discussions with the Stanford Research Institute (SRI), EDC's Massachusetts Exploring Computer Science Partnership (MECSP) will be a field-test site to pilot the assessment of the ECS course.	EDC's MECSP program university hubs have selected three school districts where ECS is being taught to field-test SRI's new pilot assessment. <i>Priority 2</i>	All Massachusetts schools teaching ECS are using SRI's course assessment.
MassCAN has held conversations with the College Board regarding being a field-test site for assessment items.		All schools teaching CSP are encouraging their students to participate in the College Board CSP College Board AP course assessment.

BUSINESS ENGAGEMENT AND WORKFORCE DEVELOPMENT

Historically, industry contributes to educational programs in two ways: through philanthropic initiatives or for recruiting purposes. A focus on K–12 education for a workforce that typically has great need for college graduates makes it difficult to tap into the recruiting focus. Similarly, most industry philanthropic investments have deep connections to existing programs that they've independently established; they are rarely focused on computing; and traditionally, by nature, they don't collaborate with a wide range of other companies. The inability to connect directly with industry recruiting efforts, and the competition with existing philanthropic investments, makes it difficult for MassCAN to raise industry funding without creating a zero-sum discussion around existing investments.

MassCAN will work with 21c, LLC, founder and principal, Tripp Jones to engage in a series of discussions with business, higher education, and workforce leaders toward the following goals:

- Better understand both the near-term workforce needs of technology-related industries and the issues related to potential near term, postsecondary solutions needed to effectively re-train the state's unemployed and underemployed with the strongest STEM skills.
- Propose a plan to engage business, higher education, and workforce leaders in working on specific steps to more efficiently and effectively increase the local, near-term talent pool

Additionally, MassCAN and 21c, LLC, will do the following:

- Work with our current business partners to expand the number of industry participants who play a leadership role in the MassCAN initiative and who contribute their advocacy, experience, and ability to mobilize industry resources, volunteers, and funding in support of the initiative
- Foster relationships with national and local tech, biotech, finance, and health care organizations, and further expand and deepen our relationships with a broader set of industries and organizations
- Build higher-level relationships with industries, specifically engaging with CEOs in Massachusetts to understand and lend their voice to the criticality of Massachusetts' competitiveness, CS education, and workforce development

- Collaborate with the MassTLC Education Foundation to radically increase the number of industry volunteers who participate in computing-related activities loosely or directly associated with MassCAN, and the number of teachers and students who are engaged in CS courses that involve industry volunteers

Table 6: Business Engagement and Workforce Development Plans and Outcomes

Year 0 Outcomes	Year 1 Outcomes	Year 3 Outcomes
MassCAN has engaged in a series of preliminary conversations with Tripp Jones to explore strategies for an array of partners to address near-term CS and IT education and workforce needs.	MassCAN has sub-contracted with 21C, LLC, to develop a plan for a collaborative effort to engage the business community, higher education institutions, the Massachusetts Board of Higher Education, and other interested parties in working to address near-term CS and IT education and workforce needs. <i>Priority 1</i>	MassCAN has supported the state and private sector in adopting policies and programs that demonstrably improve the postsecondary preparation of non-college graduates and the unemployed and underemployed for employment in CS and IT careers.
MassCAN has engaged in a series of preliminary conversations with Tripp Jones on engaging Massachusetts CEOs in understanding and lending their voice to the criticality of our state's competitiveness, CS education, and workforce development.	MassCAN has doubled the number of CEOs who are providing support to advance the initiative's CS education and workforce development work. <i>Priority 1</i>	In three years, MassCAN has tripled the number of CEOs who are providing support to advance the initiative's CS education and workforce development work.

Operations and Communication

COALITION

While there is an enormous number of potential MassCAN partners, they have different and sometimes competing interests, limited time and resources, and deep and sometimes long-term commitments to their existing programs. The challenge of building a valuable coalition is to overcome these factors by identifying common interests and creating new opportunities for cooperation and collaboration. Since there isn't a long history of Massachusetts public-private coalitions with a large number of actively engaged partners over an extended period of time, particularly in public education, our challenge is to gather learnings from research on and best practices of coalitions in other domains and locations and then apply them to this unique initiative.

In addition, the initiative needs to significantly improve communication between the 10+ partners who are actively involved in various aspects of MassCAN and to find more scalable ways to engage new partners.

The objective of the MassCAN coalition is to connect, inform, mobilize, and advise a wide range of partners who wish to advance MassCAN's mission and goals, and to loosely coordinate their typically disparate efforts relating to computing education to increase the overall impact of their work.

MassCAN will work closely with strategic advisor and 21C, LLC, founder Tripp Jones to empower its Advisory Board and Leads to play leadership roles in defining and advancing MassCAN's goals and objectives through the Work Groups that best capitalize on their interests and expertise. MassCAN will do the following:

- Establish Policy, Teacher Leadership and PD, District Engagement, Equity, Assessment, Business Engagement and Workforce Development, and Public Awareness Work Groups, in many cases led by Advisory Board and Leads, and assist Work Group leaders in recruiting additional talent from industry, education, and public service to advance MassCAN's agendas in these areas

Note: The DLSC Standards Work Group is an excellent example of the success of this model.

- Significantly increase the number of partner organizations participating in MassCAN Work Groups
- Regularly disseminate high-quality communications on the activities of MassCAN partners
- Create a forum for MassCAN partners to convene and communicate electronically

Table 7: Coalition Plans and Outcomes

Year 0 Outcomes	Year 1 Outcomes	Year 3 Outcomes
The MassCAN Advisory Board and Leads have met several times and have set up a regular meeting schedule for FY16.	The MassCAN Advisory Board, Leads, and staff have recruited additional members to participate in the Policy, Teacher Leadership and PD, District Engagement, Business Engagement and Workforce Development, Public Awareness and Equity Work Groups, and the Work Groups have held regular meetings. <i>Priority 1</i>	The MassCAN Advisory Board, the Leads, and each of MassCAN's Work Groups are functioning at a high level and have set priorities that guide their activities; the results of Work Group activity are reported annually.
	MassCAN staff have supported the between-meetings work of the Work Groups and have provided strong communications support through the website and regular e-newsletters. <i>Priority 1</i>	MassCAN staff have supported the between-meetings work of the Work Groups and have provided strong communications support through the website and regular e-newsletters.

OPERATIONS

To date, MassCAN has had only two full-time employees dedicated to the initiative; the initiative's work is driven through the generosity of a large network of volunteers and by partners who have overlapping missions and independent funding. Two advisory groups oversee the MassCAN initiative: (1) a MassCAN Leads group (the leaders of affiliated programs) of about 15 people, and (2) the MassCAN Advisory Board, nine people with formal oversight responsibility explicitly defined by the MassCAN funding legislation. As the number of dedicated staff for MassCAN expands, so does the complexity of its operations and the importance of these advisory groups. This complexity is further increased by expanding the MassCAN initiative as described above.

MassCAN has been exceedingly fortunate to have EDC agree to be both the fiscal agent and the physical home for the initiative. EDC is a large, well-established, international nonprofit specializing in health and education. In the field of education, EDC is widely respected for its broad research, program and operations management, curriculum development, evaluation work, and expertise across a range of academic disciplines, covering pre-school to community college. Currently EDC is the recipient of three major NSF grants addressing K–12 CS education. In addition to providing operational, financial, fundraising, conference, and legal support, EDC provides a very rich collegial work environment where many staff both inform and benefit from MassCAN's presence.

Operations include staffing, accounting, strategy, administration, communications, and connecting partners to the initiative. The objective of MassCAN's operations is to carry out the mission and goals of the initiative with high integrity, transparency, efficiency, and accountability. MassCAN also seeks to maintain a modest infrastructure footprint while promoting scaling efforts primarily through the work of its partners.

MassCAN staff will focus on the following operations priorities:

- Operating with efficiency, transparency, and integrity
- Hiring a diverse staff of leaders to assist in carrying out MassCAN's goals and objectives
- Working closely with the Advisory Board and Leads, and ensuring that all major MassCAN decisions are reviewed by these groups

- Providing accountability for all funds raised from every source, and abiding by the terms of each funding agreement
- Communicating program news and information, both internally and externally, in a timely and effective manner
- Building and maintaining relationships with state and national leaders

Through these efforts, MassCAN seeks to provide advance notice of the strategy, plans, and intentions of all parties who work closely with MassCAN.

Table 8: Operations Plans and Outcomes

Year 0 Outcomes	Year 1 Outcomes	Year 3 Outcomes
MassCAN is firmly established at EDC; it has provided leadership in supporting the development of DLCS standards, coordinated multiple CS PD programs with partners, and issued its first report: <i>MassCAN Action Plans for Scaling K–12 Computer Science in Massachusetts</i> .	MassCAN has issued a report encompassing its progress in achieving Strategic Plan outcomes and the accomplishments of the Advisory Board, Leads, and Work Groups. <i>Priority 1</i>	MassCAN has continued to report on its progress in achieving Strategic Plan outcomes and the accomplishments of the Advisory Board, Leads, and Work Groups.
The MassCAN Advisory Board was appointed by the governor and has held several meetings; the Leads have also met several times.	MassCAN has held regular meetings of the Advisory Board, Leads, and Work Groups, and posts meeting minutes on its website. <i>Priority 1</i>	MassCAN has held regular meetings of the Advisory Board, Leads, and Work Groups, and posts meeting minutes on its website.
MassCAN has developed a network to assist in recruiting a talented and diverse staff.	MassCAN has hired four talented and diverse staff members to support the work of the Advisory Board, Leads, and Work Groups. <i>Priority 1</i>	MassCAN has maintained a staff sufficient to support the high functioning of its Advisory Board, Leads, and Work Groups.
	MassCAN has issued an annual report to state and non-state funders and the public, identifying programmatic support and outcomes. <i>Priority 1</i>	MassCAN has issued annual reports to state and non-state funders and the public, identifying programmatic support and outcomes.

FUNDRAISING

The primary objective of fundraising is to meet and then exceed the goal set in the \$1.5 million FY16 state grant to MassCAN by raising matching non-state funds of \$1.5 million from foundations, federal grants, the private sector, and individual donors. The state funds provide for a basic infrastructure (staffing and full office accommodations, strategic planning, website development, support for university PD hubs, and participation in national meetings). The non-state funds will be dedicated to the following:

- Expanding MassCAN's ability to work on multiple policy initiatives simultaneously to better drive support for CS education
- Providing a range of K–12 PD programs for teachers in the Boston, MetroWest, and Western Massachusetts regions, through their university-based PD hubs, and then expanding to one or more additional regions of the state in succeeding years
- Developing a robust Teacher Leadership program to train PD facilitators and professional learning community facilitators and to support teachers who are interested in presenting at state and national meetings and conferences

- Supporting the development and implementation of MassCAN's Equity agenda
- Implementing the three- to five-year K–12 CS pilot program with three to six school districts
- Supporting MassCAN in co-hosting a national conference to advance the development of assessment instruments in support of CS education
- Implementing the annual evaluation of MassCAN's operations and Work Group functioning and achievements
- Creating a new data manager position to assist MassCAN in systematically gathering, organizing, and maintaining data on program participants and outcomes, coordinating contacts and mailing lists, and assisting MassCAN partners in improving their program-based data

MassCAN will undertake an aggressive fundraising effort to take action on this very ambitious agenda because of its extraordinary commitment to implementing these items. In addition, we want to demonstrate to the Commonwealth's public leadership the strong support in Massachusetts for computing education and the importance of continuing MassCAN's public funding in successive years, and to further expand the programs we provide.

MassCAN will collaborate with its strategic advisor, 21c, LLC, to successfully do the following:

- Match the \$1.5 million in state funds and raise an additional \$500 thousand in 2015–2016 to fund additional programming needs
- Mobilize partners, including academic institutions, nonprofits, school districts, and public agencies, to pursue funding opportunities from foundations and federal grants
 - **Note:** We're well-positioned to achieve this goal because of the breadth of the MassCAN initiative, its innovative approach, and the wealth of talent in Massachusetts to create compelling programming.
- Expand discussions with industry partners who are interested in building their pipeline of future employees from the local talent pool and who are passionate about the importance of computing education
 - **Note:** Our goal is to double the number of industry partners funding MassCAN and to achieve broad representation from the information-based sectors, including high-tech, biotech, finance, and health care.
- Increase the visibility of sponsors and models for sponsorship (create membership categories and donor levels, offer donor events, provide funding for scholarships, etc.); learn lessons from exceptional organizations that have premier fundraising success, including the Boston Museum of Science, Year-Up, the Boston Boys & Girls Club, and the Children's Museum; and build partnerships with these organizations and their fundraising teams to develop campaigns and events
- Cultivate relationships with wealthy donors who are passionate about CS and education, including leaders in technology and alumni from our prestigious educational institutions
- Develop campaigns that focus on equity, and apply those funds directly to programming in support of this priority
- Renew funding partnerships with organizations that have funded MassCAN to date, including Code.org and the Commonwealth of Massachusetts

Table 9: Fundraising Plans and Outcomes

Year 0 Outcomes	Year 1 Outcomes	Year 3 Outcomes
MassTech, the Boston Foundation, EDC, and Google provided	MassCAN has collaborated with 21c, LLC, to engage a fundraising partner	MassCAN has renewed its legislative support for state funding and has met

substantial funding to launch MassCAN's startup phase; State Street Bank, Vertex Pharmaceuticals, Verizon, and Facebook provided early-stage program funding.	to play a significant role in helping MassCAN meet or exceed its legislatively required match fund goal of \$1.5 million. <i>Priority 1</i>	or exceeded its legislatively required match fund goal of \$1.5 million through broad engagement of federal, foundation, and private sector partners.
	MassCAN has mobilized its partners, including academic institutions, nonprofits, school districts, and public agencies, to pursue funding opportunities from foundations and federal grants. <i>Priority 2</i>	MassCAN and its partners have established a strong track record of successfully winning grants and support from an array of non-state sources.

PUBLIC AWARENESS

Educational change is most easily achieved when it is demand-driven—and in Massachusetts today, the demand for computing education is marginal as witnessed by the very small number of CS course offerings in schools across the state. The purpose of establishing standards and curriculum frameworks for CS courses is to help guide teachers toward providing a high level of quality in the content of and pedagogy for computing education in their classrooms. The standards are *not* being developed to mandate that school districts teach computing. Instead, our intent is to create demand for computing education: from teachers who are eager to innovate and to provide students with these essential 21st century literacy skills, from students who are eager to learn by taking interesting and inspiring classes about the creation of technology, from parents who are passionate about expanding their children's skill sets and preparing them to enter the workforce, from superintendents who understand the value of creating these educational opportunities, and from guidance counselors who understand the career opportunities and pathways that computing skills offer.

While the supply of STEM college graduates has significantly increased over the past ten years in response to broad advocacy and public awareness campaigns, computing has historically been absent from the STEM message—with two notable exceptions:

- MassCAN partners Code.org and the MassTLC Education Foundation have collaborated to promote broad participation in the Hour of Code event during the annual Computer Science Education Week in December
- MassCAN partners MassTLC and Microsoft have played the lead roles in promoting teacher and student participation in the Technovation Challenge

Creating demand for computing education will require a broad public awareness campaign targeted to administrators, educators, and the public.

The objective of MassCAN's Public Awareness agenda is to inspire, educate, and motivate students, parents, teachers, administrators, and policy and industry leaders across the state to get engaged in driving the adoption of computing education in Massachusetts schools, and to create broad awareness of the importance of K–12 computing education through social, traditional, and online media.

MassCAN will create a multi-sector, deeply knowledgeable Public Awareness Work Group to work toward the following priorities (as well as other actions recommended by Work Group members):

- Providing stakeholders with materials through a “best in class” website that will help them successfully advocate for computing education among their constituencies and the broader public
- Developing a campaign to inform and galvanized key stakeholder groups and the broader public to increase the support needed to make change happen at scale

- Creating and broadly circulating a content-rich e-newsletter that highlights the work of partners, inspires collaboration, and provides a common voice for all MassCAN partners
- Supporting lead partner MassTLC in launching an array of campaigns to more broadly create a groundswell of interest and engagement in advocating for all students to have opportunities to participate in CS courses and after-school programs
- Developing a social media presence to expand opportunities for engagement
- Ensuring that all Public Awareness efforts employ meaningful, easy-to-understand content that can be used by any interested party to help drive expansion of computing education across Massachusetts

Table 10: Public Awareness Plans and Outcomes

Year 0 Outcomes	Year 1 Outcomes	Year 3 Outcomes
Teachers, librarians, and school districts across Massachusetts have engaged in the Hour of Code.	MassCAN has collaborated with MassTLC Education Foundation, Mass. DESE, Code.org, and other partners to grow and track participation in the Hour of Code. <i>Priority 1</i>	Local and statewide news stories have been generated about broad and diverse student participation in the Hour of Code, CS courses, and out-of-school-time programs in all parts of the state.
A basic website (www.masscan.net) is available to the public.	Together with MassCAN's Communications Director and website contractor, the Public Awareness Work Group has developed a content-rich, highly functional website. <i>Priority 1</i>	The website continues to be guided by the Work Group; its usage metrics validate that it is widely useful to partners and the general public and that there is growing adoption of K–12 programs throughout the state.
A mailing list for the e-newsletter has been created.	A content rich e-newsletter is broadly circulated bi-monthly, January through June. <i>Priority 2</i>	The e-newsletter is circulated monthly; its usage metrics validate its broad usefulness in supporting MassCAN's goals of scaling and equity.
	The Communications Director has supported a range of social media efforts. <i>Priority 2</i>	The social media strategy has been validated as valuable for engaging both tech-savvy and younger audiences.

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