Cyber Education Project (CEP)
Outline and Path Forward (with October Updates in RED at the end)
August 25, 2014

INTRODUCTION
CEP was recently initiated by a group of interested individuals from the academic, industrial and government communities with the objective of scoping a Body of Knowledge for undergraduate computing-based cyber programs and ultimately developing ABET accreditation criteria for "cyber." This document is a brief summary of a potential path forward for CEP. We propose three major components of a path forward:

1. Scope Definition – Right now, the concept of "cyber" is being thrown around without any explicit scope definition or restrictions. We need to define what it is that we are talking about.
2. Process – Based on the IT historical exemplar that we have been loosely considering as a potential model for this effort, there are three major components of the process to get from concept to a set of accreditation criteria:
    a. Identification of the professional community – This is important for three key reasons. First, it is the professional community and/or constituents that define the related Body of Knowledge. Second, accreditation criteria are necessarily community driven. And third, in practice a professional society needs to "own" the accreditation criteria.
    b. Identification of a Body of Knowledge (BOK) for the discipline – Of course, to have a BOK, one must first define the scope of the discipline and then determine a BOK for that scope. There have been some attempts to address this, but each seems to get bogged down by the all-too broad scope of the loosely defined term cyber. Without a proper scope definition, it is impossible to canonize any existing work as appropriate for CEP.
    c. Development of a set of ABET program criteria – Obviously cyber program criteria are necessary for ABET accreditation to have any cyber-specific "teeth."
3. Process management – We need to put something in place that will manage the process. This probably needs to include:
    a. A formal steering committee;
    b. Committees for the 3 items (a, b, c) in #2 above;
    c. A timetable for the overall process, with milestones;
    d. A schedule of milestones and meetings to keep the process moving and to collaborate regarding intermediate results.
    e. The plan for the next "large" meeting, which is currently expected for early November (a day or so on either side of November 5-6) coincident with the NICE workshop in Columbia, MD.

The remainder of this document addresses the above items in turn and at the end summarizes potential steps to start moving forward.

SCOPE DEFINITION
We need to define the scope of what "cyber" means and provide an appropriate label (or set of labels) to describe the type(s) of programs that are under consideration for CEP. There are two potential approaches, with pluses and minuses to each:

1. Define a taxonomy of cyber-related disciplines and then carve out one or more disciplines to consider here for CEP.

2. Determine a single (perhaps arbitrary) discipline as the candidate for accreditation.

Clearly there are several slants on the idea of cyber and a number of different ways to slice off the piece of the world that we are considering for CEP. Approach #1 would promote a broad inclusiveness to the community, would define from the start the relationship with the larger community, and may provide a framework for future expansion. However, it will be hard to get a consensus as to the nature of this taxonomy. Approach #2 is easier. It can be declared arbitrarily, but an arbitrary declaration may (at least temporarily) alienate a portion of the community that is "out of scope."

Task 1: Decide which of these approaches we are engaging in.

Regardless of which approach we are taking to scope definition, we are probably going to wind up with one (possibly two) disciplines for consideration for immediate further development as part of "CEP Phase I."

Recommendation 1: The "CEP leadership" should make this decision explicitly in the very near future and invite people to the November meeting under an officially sanctioned label – such as "cyber operations" or "cyber science" or "cyber computing" or "cyber security."

Task 2: Summarize existing relevant professional community efforts.

For the November meeting we may want to consider starting with an overview of the results from several disparate efforts to define computing-based cyber disciplines. Four professional-community driven efforts that might be of particular interest are:

- The National Center for Education Statistics classifications related to cyber. See http://nces.ed.gov/ipeds/cipcode/Default.aspx?y=55 .
- Draft outcomes from the Military Academy Cyber Education Working Group.
- The results of the July 2014 Arlington meeting.
- The matrix (included below) from p. 15 of the ACM Education Board report entitled "Toward Curricular Guidelines for Cybersecurity" (dated August 30, 2013) and available at http://www.acm.org/education/TowardCurricularGuidelinesCybersec.pdf .

Knowledge Areas	Categories		
	Computer Security	Cybersecurity	Information Assurance
Operating systems	x		
Embedded systems	x		
Networks & network security	x	x	
Databases	x	x	
Programming	x		
Data mining / big data / analytics		x	
Forensics		x	
Cryptography	x	x	
Ethics			x
Policy	x		x
Access control	x		
Security architecture	x	x	x
Risk management		x	
Threats / attacks / defenses	x	x	

Operational issues	x		x
Legal framework		x	x
Data governance			x
Secure software design and engineering	x	x	x
Economics			x
Malware Intrusion Detection Systems Intrusion Protection Systems		x	
Botnets		x	
Web			x
Wireless	x		x
Mobile / cloud		x	
Sociology			x

Applications
  o   Healthcare
  o   Finance
  o   Critical infrastructures
		x	

Cyber warfare	x	x	

Recommendation 2: Summarize relevant undergraduate-level outcomes and/or Knowledge, Skills, and Attitudes (KSAs). Make that summary available to participants ahead of the November workshop.

A potential exercise at the November meeting would be to identify our scoped discipline(s) as column(s) and then decide which KSAs should tentatively receive X's. If our group feels that additional KSAs are needed then they can become additional rows in the matrix.

Recommendation 3: At the November meeting hold a working session (or breakout sessions and then full-group session) to validate and refine the KSAs and undergraduate-level outcomes.

PROCESS
The rapidly emerging cyber discipline(s) exhibit(s) many similar characteristics to the IT discipline in the early 2000s. The world's needs surpass our current educational potential although higher education institutions are drawing from existing disciplines to offer programs that partially address needs in industry, government, society, and the military. This motivates following a similar rapid development model to that used for the IT discipline. Paralleling this model, we should:

- Identify a formal professional society/community
- Develop a Body of Knowledge (BOK)
- Develop ABET Program Criteria for CAC

In a perfect world, these would occur sequentially – first there would be a society, then a BOK and finally Program Criteria would emerge along with an accreditation track.   However, it would likely take over 10 years for these efforts to mature in sequence, and just as was the case with IT, for the rapidly growing and dynamic cyber discipline(s) this would be way too long.

Task 3: Appoint three concurrent CEP committees (Professional Society, BOK, ABET Program Criteria) to consider these issues. Establish a mechanism for communication between the committees and sequencing of committee products that maintains the integrity of results.

Recommendation 4: Formulate mission statements for the three committees and appoint initial members at the November meeting. Ask participants as they register for the November meeting if they

are willing to join one of the committees and if so to put down preferences for which committee that would be. Ensure that you collect enough information about each potential volunteer that assignment of committees can include balancing the diversity of backgrounds.

Recommendation 5: Include in the "program" for the November meeting an opportunity for each committee to meet and work through its objectives as well as develop a plan and timeline for its work.

A few considerations for each of the three items listed above appear below.

Society/Community

In the long run we expect there to be a professional educational society that takes on the role of watching over the discipline and its needs, including establishing and keeping current a set of ethics, maintaining a relevant BOK, facilitating discipline-related pedagogical improvements, and sponsoring the discipline's accreditation efforts.

Currently, there are several cyber communities already in existence, including:
- Colloquium for Information Systems Security Education (CISSE);
- CyberCorps programs hosted by NSF;
- NIST's National Initiative on Cybersecurity Education (NICE) program;
- Military Academy Cyber Education Working Group (CEWG)
- NSA Centers of Academic Excellence (not a society per se, but definitely a community).

In addition, there is clearly interest by the ACM Education Board enough to produce the report cited earlier.

In the spirit of quickly advancing education in cyber discipline(s), it may be best to begin by asking an existing society for a closely related discipline (e.g., ACM and IEEE-CS, via CSAB – although the IEEE and others are also candidates) to at least initially take on the responsibilities. While this seems obvious, there are many details that would need to be worked out among all stakeholders, and perhaps some kind of agreement would have to be forged. This is an extremely sensitive political issue that would need to be worked through, and a carefully constructed committee appears to be in order.

IT went through similar issues that resulted in the formation of SIGITE. It would be good to populate this committee with individuals who have experience from that process, as well as members from NICE, CISSE, the CEWG and other cyber stakeholders that we may identify.

Body of Knowledge (BOK)

Developing a well-vetted BOK in a new discipline is a big task that takes several years of effort. The first IT BOK was developed in 2005, although it was not completed and formally published until 2008. An important learning point from that effort was that the strong draft IT BOK available in 2005 was solid enough that it was able to be used to concurrently explore accreditation prior to formal publication of the fully vetted BOK.

A good starting point will be the references in the Annotated Bibliography of Cyber Sciences Curriculum. In particular, see the list above under Task 2.

Recommendation 6: Integrate, refine, and scope the disparate already-developed cyber education outcomes into an initial draft BOK. Use existing forums to present, discuss, and adjust as the effort progresses. Target completion of an integrated draft within a year so that it can be more formally vetted during the 2015-2016 academic year.

Cyber Accreditation Criteria

Essential to the integrity and success of a new set of program criteria is having established a strong draft BOK prior to the first accreditation visits. Yet the world needs accredited cyber-based programs as quickly as is reasonable. Thus, we propose having a committee draft program criteria from a very early draft of the BOK, so that it can be used for early prototype accreditation much like the first cycle of IT accreditations.

The first IT programs that were accredited were accredited under the general ABET/CAC criteria, but during that first accreditation cycle all three programs were also evaluated relative to a draft set of IT program criteria. The accreditation was official under the general criteria, but the results of the prototype evaluations were used to refine and adjust the IT program criteria so that it could be adopted shortly after that.

Interestingly, the timeline for developing the IT BOK and IT Program Criteria was consistent with our concurrent recommendations.

- 2005 - Draft IT BOK available
- 2006-2007 – Pilot IT Program evaluations (at the same time programs were accredited under the general CAC criteria)
- 2008 – Formal IT BOK published after refinement, adjustments, and vetting.
- 2008-2009 cycle – ABET/CAC IT Program Criteria first used for IT accreditation

Recommendation 7: CEP Cyber Accreditation Criteria committee collaborates with the CEP BOK committee to develop program criteria just as was done for the IT Program Criteria.

Recommendation 8: As a part of the criteria development process, identify candidate cyber programs to seek general ABET/CAC accreditation and be used as a pilot for cyber program-specific criteria.

This committee would need to collaborate with the CSAB Criteria Committee, and determine issues like the appropriate commission(s), etc., as well as determine the content of the program criteria. Having one or more currently serving ABET Commissioners and/or PEVs on this committee would be helpful.

PROCESS MANAGEMENT
Some kind of process is necessary to keep the three efforts integrated and on track.

Task 4: Establish a Steering Committee with oversight and integration responsibility.

Recommendation 9: Designate one or more general members/leaders for the Steering Committee and have the other three committee chairs be on the Steering Committee.

Ultimately the Steering Committee will be responsible for the timeline, which at the macro level will include at least the following major milestones:

- o Identification of lead and cooperating societies, as well as non-ABET societies and groups who would participate as stakeholders.
- o Development of various drafts of the BOK.
- o Development of various drafts of the program criteria.
- o Final version of the criteria ready for consideration by the ABET commission(s) and the ABET Board.

Recommendation 10: Generate a draft timetable for the major milestones prior to the November meeting, and then have the three committees fill out their timelines during their work session at the November meeting.

As noted above, periodic large meetings will be needed. These meetings would presumably be open to the community, and would also provide an opportunity for the Steering Committee and other three committees to meet.

NOVEMBER 2014 MEETING COINCIDENT WITH NICE
The above plan implies a relatively straightforward agenda for this meeting. Our assumption is that the CEP leadership (the current informal Steering Committee) has identified one or more specific "names" for the discipline that we are working toward developing.

1. Identification of the scope of the discipline(s) and restrict that scope based on included and excluded KSAs and outcomes;
2. Presentation of the committee structure and seating of the committees:
   a. Steering
   b. Society
   c. BOK
   d. Criteria
3. Committees would have an initial meeting devoted to identification of committee process, tasks and deliverables, along with an estimate of the length of time needed for each deliverable. These would be presented to the group at large.
4. Milestones would be ratified by the group as a whole, and a tentative schedule of future teleconferences and "big meetings" would be identified.

SUMMARY

We summarize by listing the tasks and recommendations from the above:

Task 1: Decide which of these approaches we are engaging in.

Recommendation 1: The "CEP leadership" should make this decision explicitly in the very near future and invite people to the November meeting under an officially sanctioned label – such as "cyber operations" or "cyber science" or "cyber computing" or "cyber security."

October update: "Cyber Science" was selected; rationale and definitions for this choice will be available for discussion at the November meeting.

Task 2: Summarize existing relevant professional community efforts.

Recommendation 2: Summarize relevant undergraduate-level outcomes and/or Knowledge, Skills, and Attitudes (KSAs). Make that summary available to participants ahead of the November workshop.

October update: This will be a central focus of the November meeting, so no action on this as yet.

Recommendation 3: At the November meeting hold a working session (or breakout sessions and then full-group session) to modify the KSAs and undergraduate-level outcomes.

October update: This will be a central focus of the November meeting; expect several hours devoted to this topic on Nov 5.

Task 3: Appoint three concurrent CEP committees (Professional Society, BOK, ABET Program Criteria) to consider these issues. Establish a mechanism for communication between the committees and sequencing of committee products that maintains the integrity of results.

Recommendation 4: Formulate mission statements for the three committees and appoint initial members at the November meeting. Ask participants as they register for the November meeting if they are willing to join one of the committees and if so to put down preferences for which committee that would be. Ensure that you collect enough information about each potential volunteer that assignment of committees can include balancing the diversity of backgrounds.

October update: The three committees are now called the Cyber Science Stakeholders Committee, the Cyber Science Student Learning Outcomes Committee, and the Cyber Science Accreditation Committee. Mission / charge statements have been developed for all three and will be attached to the "call for participation" for the November meeting. Co-chairs are being identified now, and members will be sought at the November meeting.

Recommendation 5: Include in the "program" for the November meeting an opportunity for each committee to meet and work through its objectives as well as develop a plan and timeline for its work.

October update: Agreed – this is the central purpose of the November meeting.

Recommendation 6: Integrate, refine, and scope the disparate already-developed cyber education outcomes into an initial draft BOK. Use existing forums to present, discuss, and adjust as the effort progresses. Target completion of an integrated draft within a year so that it can be more formally vetted during the 2015-2016 academic year.

October update: Development of a single "monolithic" BoK has tended to derail prior efforts since doing so in a way that suits everyone remains elusive. Focus instead on student learning outcomes – a level higher than specific topics in a BoK. This allows various BoKs to exist and still fit the more general umbrella of Cyber Science.

Recommendation 7: CEP Cyber Accreditation Criteria committee collaborates with the CEP BOK committee to develop program criteria just as was done for the IT Program Criteria.

October update: Agreed, expect the collaboration will be with the Learning Outcomes committee, not focused as much on a BoK.

Recommendation 8: As a part of the criteria development process, identify candidate cyber programs to seek general ABET/CAC accreditation and be used as a pilot for cyber program-specific criteria.

October update: No action on this as yet.

Task 4: Establish a Steering Committee with oversight and integration responsibility.

Recommendation 9: Designate one or more general members/leaders for the Steering Committee and have the other three committee chairs be on the Steering Committee.

October update: This is underway now and should be finalized by the November meeting.

Recommendation 10: Generate a draft timetable for the major milestones prior to the November meeting, and then have the three committees fill out their timelines during their work session at the November meeting.

October update: This is underway now and should be finalized by the November meeting.