

# IEEE-TCPP Parallel and Distributed Computing Curriculum Initiative

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**TCPP Curriculum Initiative:**

<https://tcpp.cs.gsu.edu/curriculum/>

## Some Participants at the NSF Planning Workshop, Washington DC, Feb 5-6, 2010



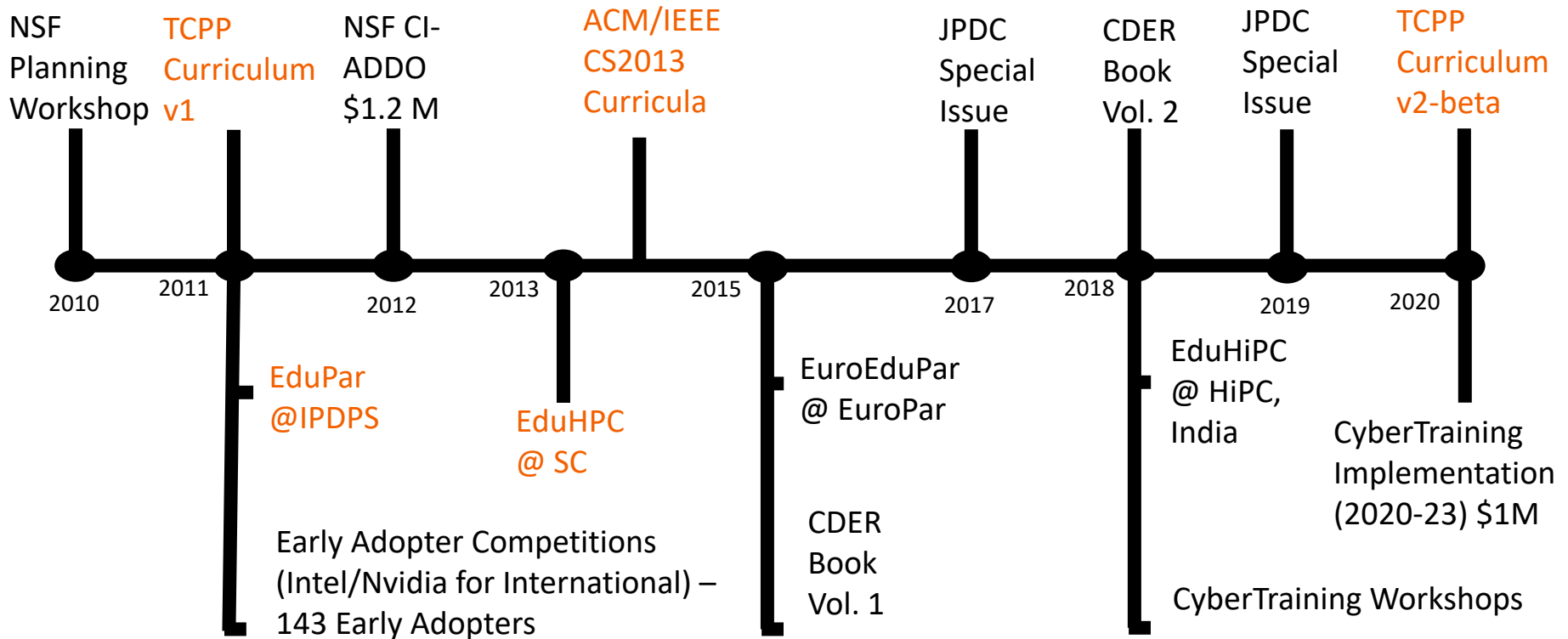
### Main Outcomes

- Priority: Core curriculum revision at undergraduate level

- Preliminary Core Curriculum Topics

- Sample Intro and Advanced Course Curriculums

# CDER Timeline



### 3 Curriculum Areas + Cross-Cutting Architecture, Programming, Algorithms

# TCCP Curriculum Example

Algorithms Topics		Bloom#	Course	Learning outcome and teaching notes
<b>Algorithmic problems</b>				Algorithmic problems section contains parallel algorithms for certain problems. The important thing here is to emphasize the parallel/distributed aspects of the topic
<i>Communication and Synchronization</i>				Understand (at the pseudo-code level) how certain patterns of communication can be implemented in a parallel/distributed model. Also appreciate the cost of communication in PDC.
	Reduction and Broadcast for communication and synchronization	<b>C</b>	Data Struc/Algo	Understand, for example, how recursive doubling can be used to for all-to-one reduction, and its dual, one-to-all reduction, in $\log(p)$ steps. The same applies to all-to-all broadcast and all-to-all reduction. Recognize that all-to-all broadcast/reduction are synchronizing operations in a distributed (event-driven) environment.
	Parallel Prefix (Scan)	<b>C</b>	Data Struc/Algo	Understand the structure of at least one simple parallel prefix algorithm. One could consider recursive or iterative approaches (such as those of Ladner-Fischer, Kogge-Stone, Brent-Kung)
	Multicast	<b>N</b>		
	Permutation	<b>N</b>		

# Early Adopter and Training Programs

- Over 140 institutions worldwide
  - Spring-11: 16 institutions ; Fall'11: 18;
  - Spring-12: 21; Fall-12: 25 institutions, Fall-13: 25 institutions, Fall-14: 25, Fall-15: 13
  - Most from US (4 year to research institutions, one high school)
  - Some from South America, a few from Europe, fewer from Asia (India, China, Indonesia, Singapore), Middle East
- **NSF CyberTraining PDC** Workshops - Summer 2018-21
  - **UMass/Maryland; Tennessee Tech**
  - NSF/Intel funded stipend up to \$5K/proposal
  - *Instructor training + adoption plans*

# Edu\* Workshop Series

- **EduPar-11** at Alaska, IPDPS-2011
  - Receive feedback from the Adopters
  - Stimulate discussion of curricular and other educational issues.
- EduPar-12 at Shanghai, IPDPS-2012
  - A regular satellite workshop of IPDPS
  - EduPar-15 @IPDPS, May, India; EduPar-16, Chicago, EduPar-17 in Orlando; EduPar-18 in Vancouver, EduPar-19 @ IPDPS, Brazil, **EduPar'20, EduPar21 – online, EduPar22 in France – May22**
- **EduHPC Workshop at SC-13** + BOF at SIGCSE-14
  - EduHPC-14 @ SC-14, Nov – New Orleans; EduHPC-15 in Austin, EduHPC-16, EduHPC-17, EduHPC-18 in Dallas, EduHPC-19 @ SC in Denver
  - **EduHPC-20 @ SC - online, EduHPC-21 @ SC – hybrid**
- **Euro-EduPar Aug 2015**; Euro-EduPar-2016, EEP-2017, EEP-18,
- **EduHiPC 2018 @ HiPC in Bangalore** – for India and the region
  - EduHiPC'19 @ HiPC in Hyderabad Dec'19
  - **EduHiPC'21 @ HiPC in Bangalore**

# NSF/TCPP Curriculum Initiative – Additional Resources

- CDER Book series:
  - Vol 1: Topics in Parallel and Distributed Computing
    - Introducing Concurrency in Undergraduate Courses, *Morgan Kaufman*
  - Vol 2: Topics in Parallel and Distributed Computing
    - Enhancing the Undergraduate Curriculum: Performance, Concurrency, and Programming on Modern Platforms, *Springer*
    - **Free Pre-Print Version** on CDER site (44K downloads)
    - **Plan for 3<sup>rd</sup> Volume** – Experience of Adopters
      - Exemplars + Resources on courses and topics
- CDER Heterogenous Cluster
  - Multi-core, GPU, Shared/Distributed Memory, **Hadoop/Spark**
  - **Ask for class accounts**
- **JPDC Special Issue** - Keeping up with Technology: Teaching Parallel, Distributed and High-Performance Computing (2017, 2019, 2021)

# CDER Courseware Website

## Upload and Search Course Material

- **Type:**
  - Slides, Syllabus, Tutorial, Video
  - Animation, Article, Award, Blog, Book, Competition
  - Course Template, Course Module, Data
  - Hardware Access, Software/Tools
  - Proposal, Report
- **Courses:**
  - CS1, CS2, Systems, Data Structures and Algorithms, ...

- **NSF/TCPP Topic/Subtopic Classification:**

ALGORITHMS

Parallel and Distributed Models and Complexity

Algorithmic Paradigms

Divide & conquer (parallel aspects)

Algorithmic problems

ARCHITECTURE

PROGRAMMING

CROSS-CUTTING

- [open](#) - Work in Progress



# Curriculum Version II Activities

	Areas	Architecture	Algorithms	Programming
<b>New Aspects</b>	<b>Area Lead/ Aspect Lead</b>	Chip Weems	Anshul Gupta	Alan Sussman
<b>Exemplars</b>	Sushil Prasad	Karen Karavanic, Eric Freudenthal	Erik Saule, Duane Merrill, David Bunde	David Brown, Eric Freudenthal
<b>Distributed</b>	Vaidyanathan Ramachandran	Vaidyanathan Ramachandran, Manish Parashar	Vaidyanathan Ramachandran, Costas Busch, Denis Trystram	Alan Sussman, Chi Shen
<b>Big Data</b>	Trilce Estrada	Craig Stunkel	Cynthia Phillips,	Debzani Deb
<b>Energy</b>	Krishna Kant, Craig Stunkel	Craig Stunkel, Karen Karavanic	Denis Trystram	John Dougherty
<b>Pervasive</b>	Sheikh Ghafoor	Craig Stunkel, Eric Freudenthal	Robert Robey, Martina Barnas	Sheikh Gafoor, Eric Freudenthal

- **Timeline:**
  - **Version-2-beta released @ EduHPC'20**
    - **Public Feedback:** [sushil.prasad@utsa.edu](mailto:sushil.prasad@utsa.edu)
  - **Companion Activities:**
    - Exemplars
    - CE-oriented TCPP Curriculum
    - Competencies-based - knowledge, skills and attitudes
- NSF Institute Planning Grant => 5 planning workshops
  1. SC'19
  2. SIGCSE'20 - online
  3. July 27, 2020 – online
  4. Mar 26-27, 2021 - online
  5. **NSF Report Workshop – Oct'21**