



CCF Overview

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Computing and Communication Foundations (CCF)

- Why Foundations?

The Division of Computing and Communication Foundations (CCF) supports research and education that advances the **foundations** of computing and communication.



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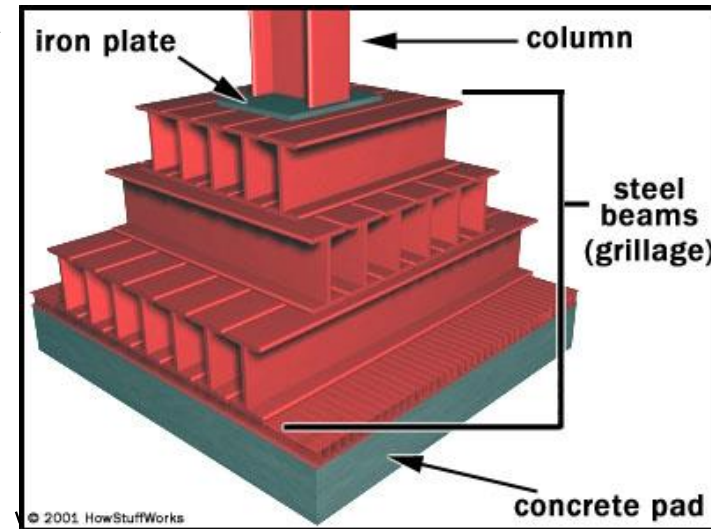
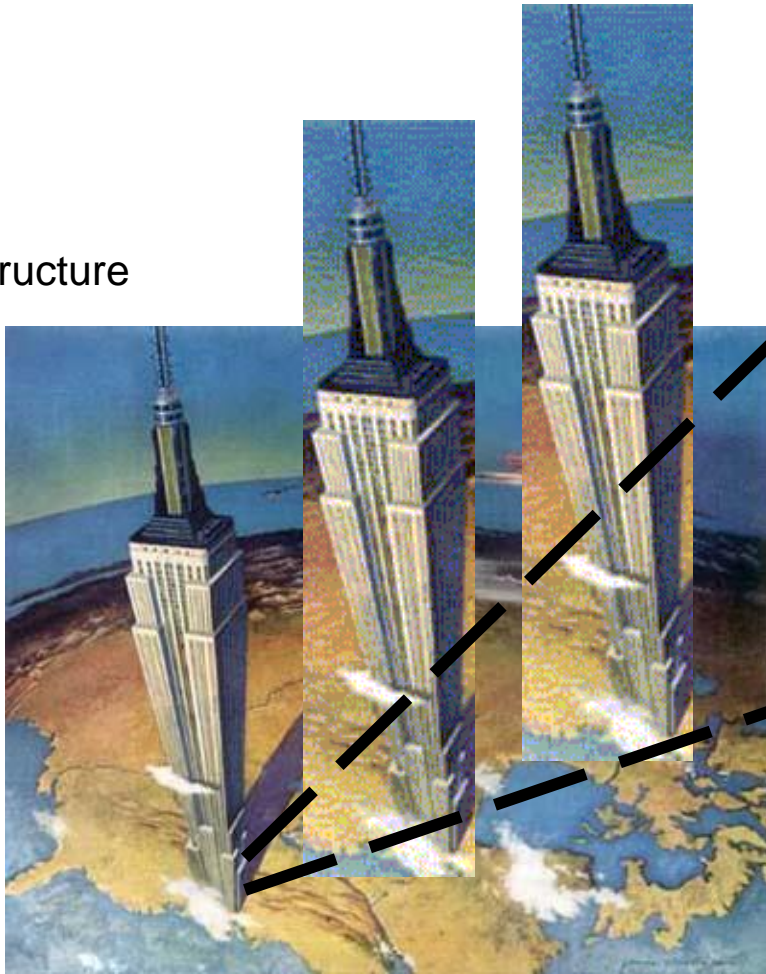


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Foundations Everywhere

Infrastructure



The design of computing systems can only properly succeed if it is well grounded in theory; the important concepts in a theory can only emerge through protracted exposure to application.

Robin Milner, Turing Award 1991

Systems



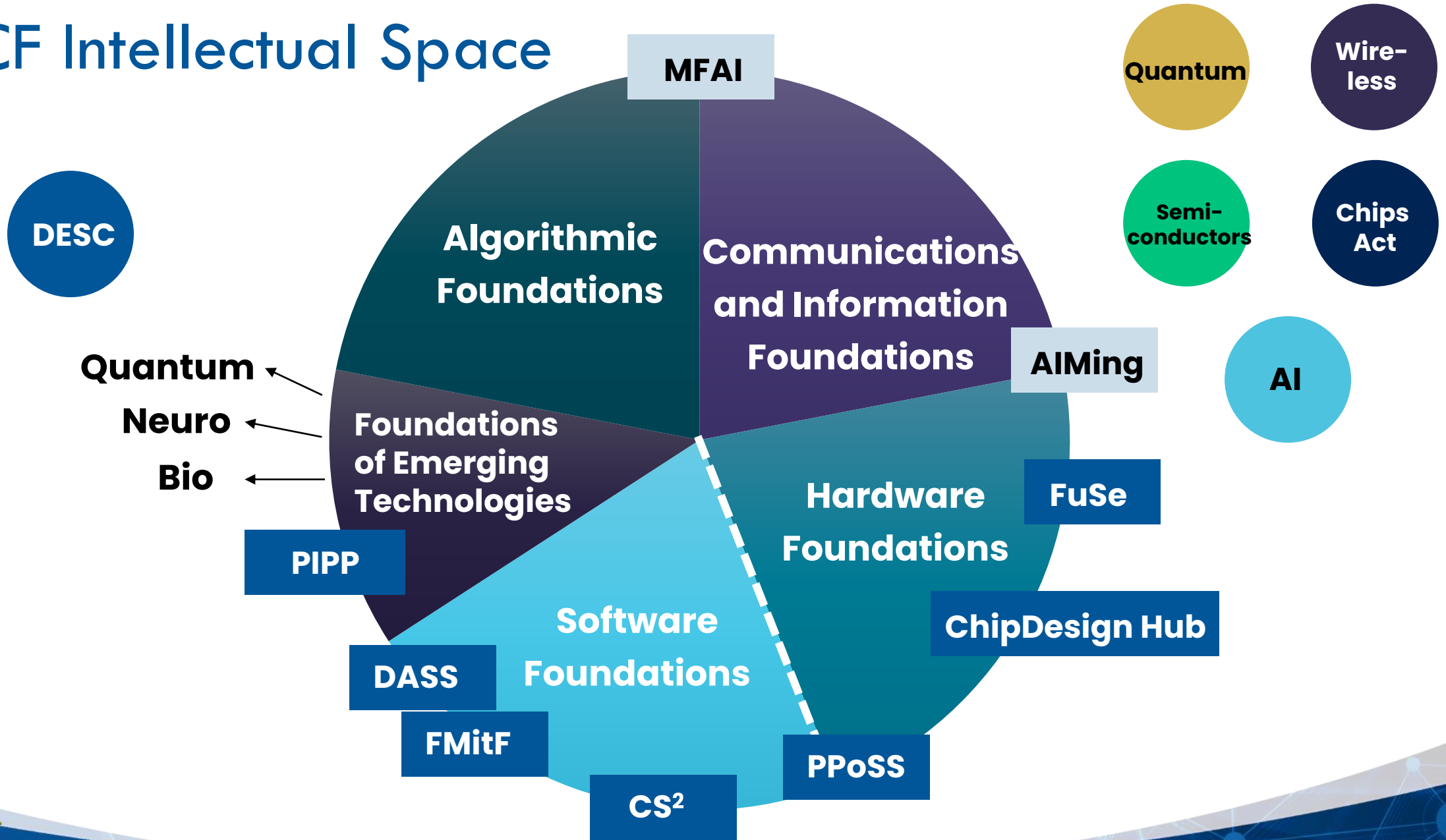
CCF Overview

Clusters (Programs):

- Software and Hardware Foundations (SHF)
- Algorithmic Foundations (AF)
- Communications and Information Foundations (CIF)
- Foundations of Emerging Technologies (FET)
- Education and Workforce (EWF) – *newly moved from CNS*

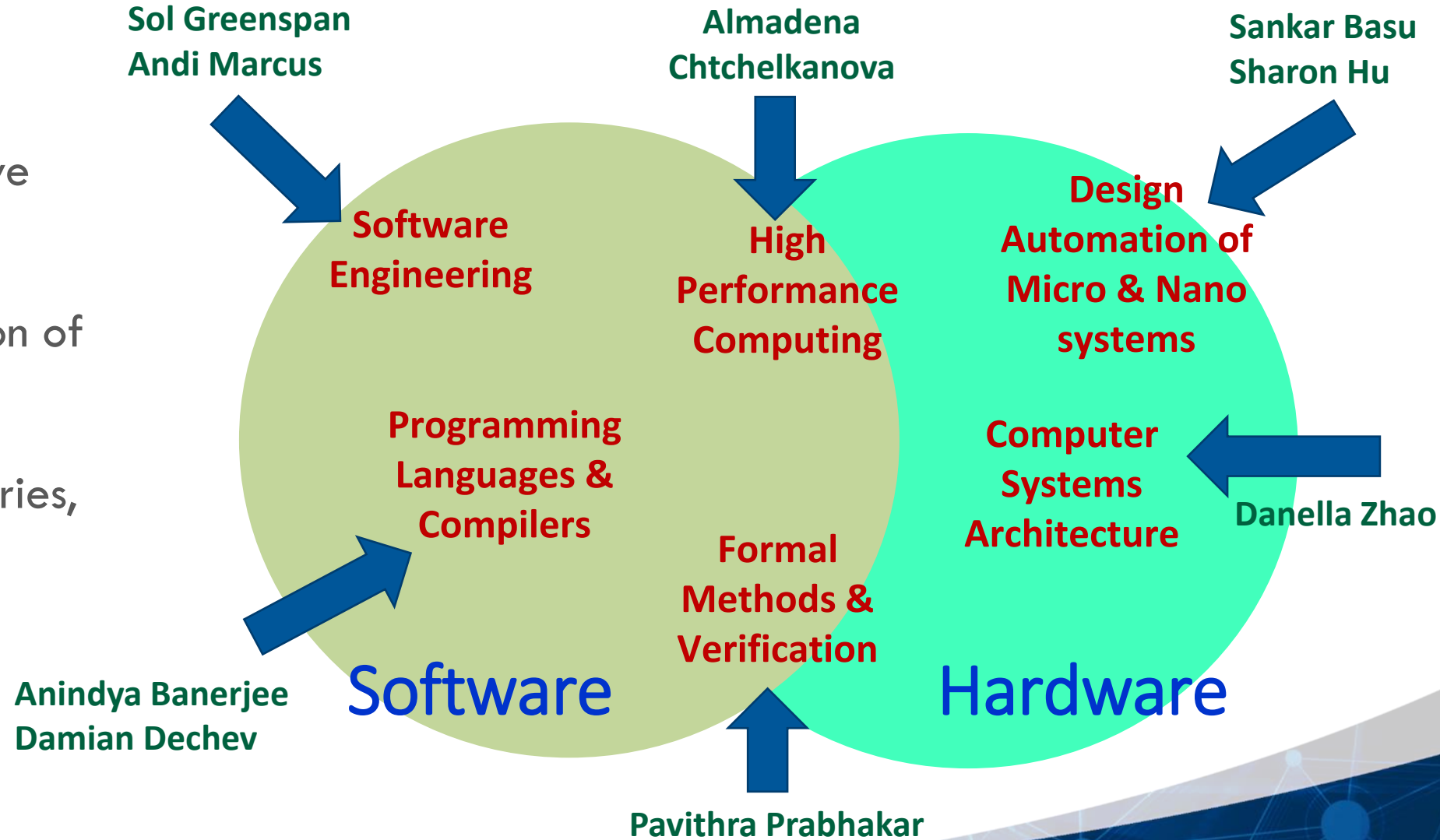


CCF Intellectual Space



SHF: Software and Hardware Foundations Cluster

SHF program supports potentially transformative research in the design, verification, operation, utilization, and evaluation of computer software and hardware through novel approaches, robust theories, high-leverage tools, and lasting principles.



AF: Algorithmic Foundations Cluster

Current PDs: Peter Brass (IPA), Karl Wimmer (IPA), Tracy Kimbrel (Expert)

AF supports the design and analysis of algorithms, where the analysis can be in many different measures: complexity, approximation ratio, competitive ratio etc.

Some subtopics of AF are **graph algorithms**, **string algorithms**, **combinatorial optimization**, **online algorithms**, **external-memory algorithms**, **parallel algorithms**, **distributed algorithms**, **machine learning theory**, **algorithmic game theory**, etc.

Work suitable for AF is characterized by well-specified problems and rigorous mathematical proofs.

AF research groups are typically small and concentrated at top-twenty institutions; broadening the institutional basis of CS Theory research is an important problem for the AF program.



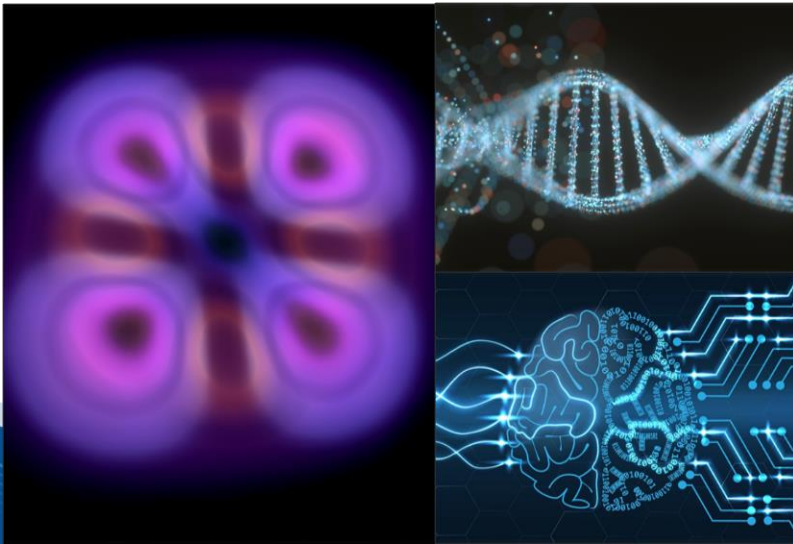
FET Foundations of Emerging Technologies Cluster

FET supports overarching fundamental research in disruptive technologies and models in computing and communication.

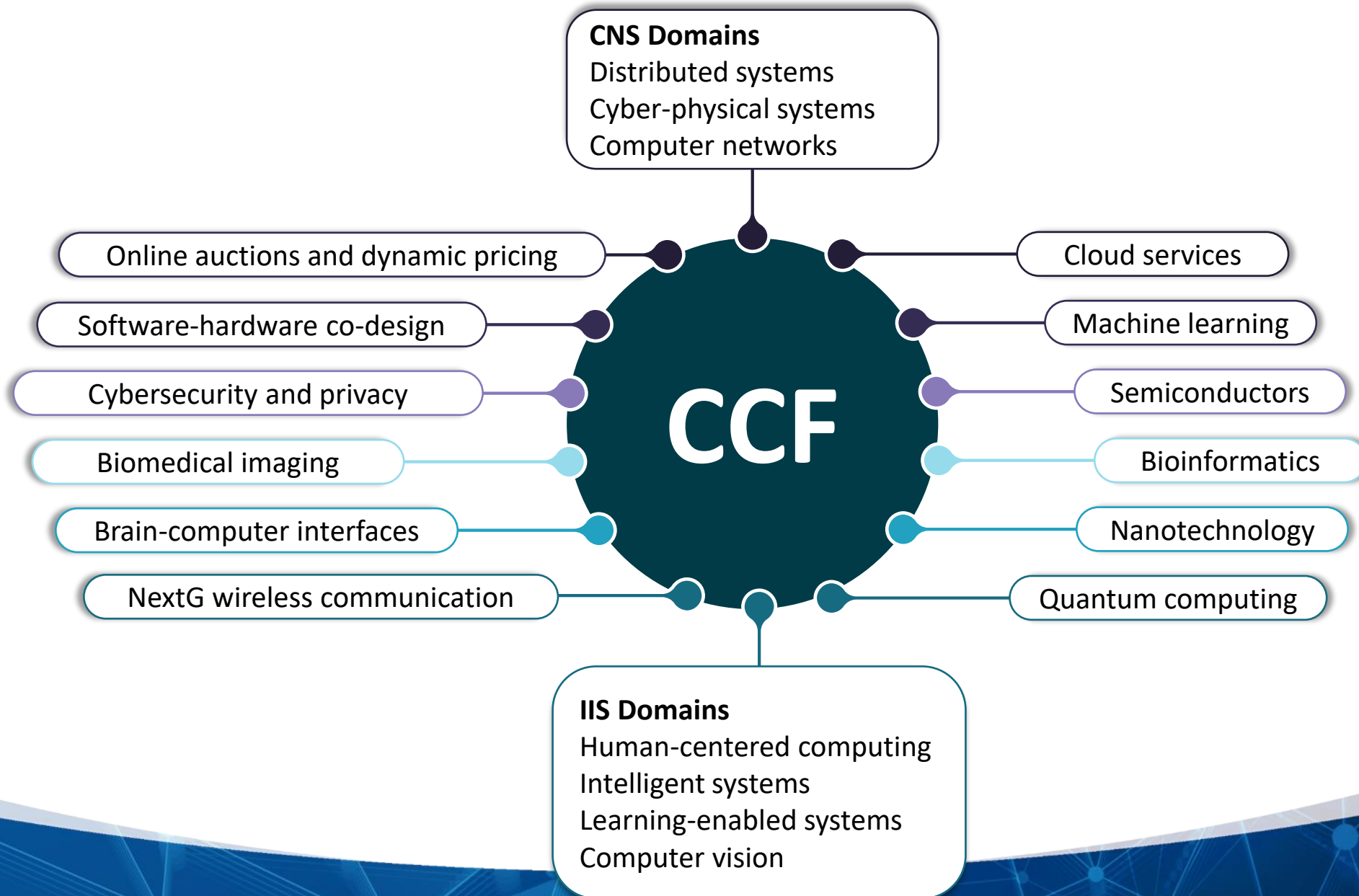
Goal: To foster radical innovations in computing and communication modalities, in topics spanning fields of research funded by core CCF programs, e.g. theory, algorithms, software, hardware, and architecture

Three main topics:

- Quantum computing - **quantum computing and communication** and other quantum-based approaches for processing exchanging, and using information.
(PDs: Elizabeth Behrman, Almadena Chtchelkanova, Dmitri Maslov)
- Biological systems - Explores opportunities **at the intersection of biology and computer science**, with a specific focus on activities that advance understanding of computing and communication processes in biological systems **to recreate or use them** as models for, or demonstrations of, innovative computing and communication systems.
(PDs: Stephanie Gage, Mitra Basu)
- Neuromorphic computing - Promotes research that demonstrates how computational and engineering principles can be synergistically advanced to **mimic brain-like problem solving with novel neural and cognitive architectures**.
(PD: Sankar Basu)



CCF Provides Foundations which Enable (among others)



Some Cross-cut programs

- Designing Accountable Software Systems (DASS)
- Formal Methods in the Field (FMitF)
- Principles and Practices of Scalable Systems (PPoSS)
- Mathematical Foundations of Artificial Intelligence (MFAI)
- Artificial Intelligence, Formal Methods, and Mathematical Reasoning (AIMing)
- Design for Environmental Sustainability in Computing (DESC)
- Chip Design Hub
- Correctness for Scientific Computing Systems (CS²)
- Predictive Intelligence for Pandemic Prevention (PIPP)
- Future of Semiconductors (FuSe)
- Expeditions in Computing





QUESTIONS ?