DIMACS Special Focus on Algorithmic Foundations of the Internet
Project Outcomes Report for the General Public
NSF Award CNS-0721113

The DIMACS Special Focus on Algorithmic Foundations of the Internet conducted activities devoted to understanding and advancing algorithms and protocols having the potential to contribute to an improved future Internet. The "special focus" is DIMACS's signature activity. Each special focus is a multi-year program of coordinated activities addressing a broad topic, comprising activities such as workshops, research working groups, tutorials, and research visitors. Each special focus concentrates on an area with high potential for impact that is likely to spawn continuing collaborations and lasting research activities.

The Special Focus on Algorithmic Foundations of the Internet sought to bridge the gap between networking research focused on the protocols and mechanisms underlying today's Internet and the new work needed to lay a solid foundation for a future Internet. The Internet was designed as a research network without the expectation that it would eventually be used for everything from banking, commerce, and international telecommunications to the remote management of power networks. The scale and heterogeneity of the Internet and Internet-enabled applications have far surpassed all expectations, and the Internet is responding by showing signs of strain. While many of the algorithms and protocols currently in use serve their desired purposes, others need improvement. The future Internet needs to be more secure, be easier to manage, and take greater advantage of new underlying technologies, such as sensor networks and wireless networks. This argues for the design of new protocols and mechanisms with their key properties in mind and an algorithmic mindset from the outset.

The special focus on Algorithmic Foundations of the Internet sponsored 21 events that involved roughly 1150 participants studying the Internet and related applications through an algorithmic lens. It was organized by Alejandro Lopez-Ortiz (Waterloo), Jennifer Rexford (Princeton), and Rebecca Wright (Rutgers). Special focus events drew on expertise from fields including networking, theory of computing, computer and communications security, and game theory, among others. The special focus events were:

1) Tutorial on Algorithms for Next Generation Networks
2) Workshop on Secure Internet Routing
3) Workshop on Internet Tomography
4) Workshop on Internet Privacy: Facilitating Seamless Data Movement with Appropriate Controls
5) Workshop on Approximation Algorithms in Wireless Ad Hoc and Sensor Networks
6) Tutorial on Limits of Approximation Algorithms: PCPs and Unique Games
7) Workshop on Designing Networks for Manageability
8) Workshop on Secure Routing
9) Workshop on Network Data Streaming and Compressive Sensing
10) Workshop on Parallelism: A 2020 Vision
11) Workshop on Algorithms in the Field
12) Workshop on Competitive Algorithms for Packet Scheduling, Buffering and Routing in the Internet

13) Workshop on Stochastic Networks: Reliability, Resiliency, and Optimization
14) Workshop on Systems and Networking Advances in Cloud Computing
15) Workshop on Connectivity and Resilience for Large-Scale Networks
16) Working Group on Abstractions for Network Services, Architecture, and Implementation
17) Workshop on Information-Theoretic Network Security
18) Workshop on Software Defined Networking
19) Workshop on Economic Aspects of Information Sharing
20) Workshop on Information Assurance in the Era of Big Data
21) Second Women's Workshop on Communications and Signal Processing

Participants in the 2011 DIMACS Workshop on Algorithms in the Field

The focus also involved eight long-term visitors to DIMACS, eight undergraduate students participating in our Research Experiences for Undergraduates (REU) program, and a number of graduate students participating in events and engaged in research. Project-related research conducted by DIMACS visitors and faculty led to results that include: models for generating synthetic wireless call data that capture the mobility patterns of real populations while preserving privacy; improved results on best-response dynamics in asynchronous settings (such as the Internet), showing that verifying guaranteed convergence is intractable in general but solvable in several environments of interest; and a framework for sampling from dynamic data sets that allows near-uniform sampling from millions or even billions of possible items via a compact data structure that takes up only tens of kilobytes. REU projects resulted in several publications, including one developing a dynamic secret-question system for Web authentication for which the student won a first place individual award at the Phi Beta Lambda Leadership Conference.

DIMACS
Center for Discrete Mathematics & Theoretical Computer Science
Founded as a National Science Foundation Science and
Technology Center