

# Aggressive Research Opportunities in Computer Science Presentation to CRA Grand Challenges Meeting 6/24-26/2002

Dr. Alfred Z. Spector  
Vice President, IBM Services & Software Research

The opportunities for successful computer science research are fantastic; perhaps more so than in even recent times: This is for five reasons:

1. Geometric growth in processor performance, communication bandwidth, and storage capacity are having very real impact. Each yearly percentage increase in performance now represents a much greater absolute effect than it did last year.
2. The installed base has reached the critical mass that is needed for large, distributed applications involving many people, sensors, and actuators.
3. An enormous library of modular components and algorithmic techniques, painstakingly developed over many years, can serve as the basis for many highly integrated and powerful applications. Many core technologies work rather well today, and did not a while back; e.g., speech recognition technology.
4. Society, for the most part, increasingly accepts the benefits of more advanced I/T. For example, companies today have many of their I/T systems on a public network, whereas 10 years ago, most would not have considered this.
5. There are fascinating and changing demands placed on I/T technology itself, due to parallel processing capabilities, the memory bottleneck, issues in power, massive growth in scale and data storage, and more. The vast amount of technology we have makes for some great systems challenges.

Here are some key challenges that I view as tractable, fundable, important, and worthy of our attention. I should add that these challenges are ones to which IBM, among other entities, is devoting significant resources.

1. *Domain-specific NLP* of many forms should prove tractable, using techniques partially described in the presentation of Andrei Broder. The impact on management of semi-structured and unstructured information management will be huge. These same techniques will have a dramatic impact on call centers and many other dialog-based systems. In call centers, for example, there will be far more automation of their operations than DTMF-based call handling has been able to do.

2. *Autonomic Computing*. The cost of installing, managing, and upgrading systems and of meeting SLA requirements in the presence of stimuli with increasing dynamic range is large and getting larger. It is now important to look at the various management aspects of systems in a much more serious way, with the ultimate goal of cohesive, self-management. This is very challenging for heterogeneous, multi-component systems, but

tractable, and becoming extremely important. The presentation by Jeff Kephart discusses this in depth. I consider *dependable* or *reliable* computing a sub set of this area.

3. *Massive amount and quantity of data.* Personal databases, coherently coordinated across hundreds of millions of users, and integrated, enterprise databases of both heterogeneous data (e.g., information for drug discovery) and homogeneous data (marketing and customer-preference data) present enormous challenges. The size and the concomitant need for autonomic management is one class of real, but tractable problems. Another is security and privacy. We have many techniques at our disposal in this domain, but there is very challenging work in both technology and public policy to implement these techniques in big systems. Anant Jhingran will discuss these issues, among many others, at this conference.

4. *Continual Optimization.* With (i) the connectivity of *almost* everything we could want to monitor (devices, people, etc.), (ii) such connectivity *nearly* all of the time, (iii) an ever decreasing cost of executing transactions on data or on real world objects (via actuators or displays), (iv) the algorithmic capabilities to perform many forms of optimization on a continual basis, and (v) the processing power to support that optimization, we have the ability to optimize large systems ways that were not previously possible. While the World-Wide Web and Internet have already excited so many, it has been primarily because of reduced transaction costs. Continual optimization allows our networked systems to fundamentally alter such activities as scheduling, pricing, allocation, and organization of people, commerce, organizations, governments, societies, and the like. The impact on society and our economic system will be huge, and we are at only the earliest stages of this. Required research will be a balanced program of mathematics, distributed computing on a scale never yet achieved, security and privacy, as well as many societal issues.

5. *Usable Systems.* Computers are still used with relatively simplistic interfaces. Our processing capabilities should enable multi-modal access to applications that can make computers a more natural extension of the environment in which they operate. In addition, the metaphors that we use for operating computers are due for major upgrading, and can make computer use more natural to a larger range of users.

Certainly, there are many more important areas, but I believe this is a set of significant importance to the broad community.

## **BIO:**

Dr. Alfred Z. Spector is vice president of Services and Software in IBM Research responsible for setting IBM's worldwide services and software research strategy. Previously, Dr. Spector was the general manager of Marketing and Strategy for IBM's AIM business, responsible for a number of IBM software product families including CICS, WebSphere, and MQSeries, and the general manager of IBM's Transaction Systems business. Dr. Spector was also founder and CEO of Transarc Corporation, a

pioneer in distributed transaction processing and wide area file systems, and a computer science professor at Carnegie Mellon University. Dr. Spector is on the board of the Security Industry Middleware Council and a member of the NSF CISE Advisory Board.

Dr. Spector received his Ph.D. in Computer Science from Stanford University and his A.B. in Applied Mathematics from Harvard University. Married and a father of three young children, Dr. Spector is an avid runner.