Computer Science Grand Challenge - Simplicity of Design
by Ambuj Goyal

Computer Science as a discipline has traditionally focused on optimizing performance of computing resources - Computer Architecture, Compilers, Databases, Algorithms, Operating Systems, etc., are all focused on more efficient ways of accomplishing the various computing tasks.

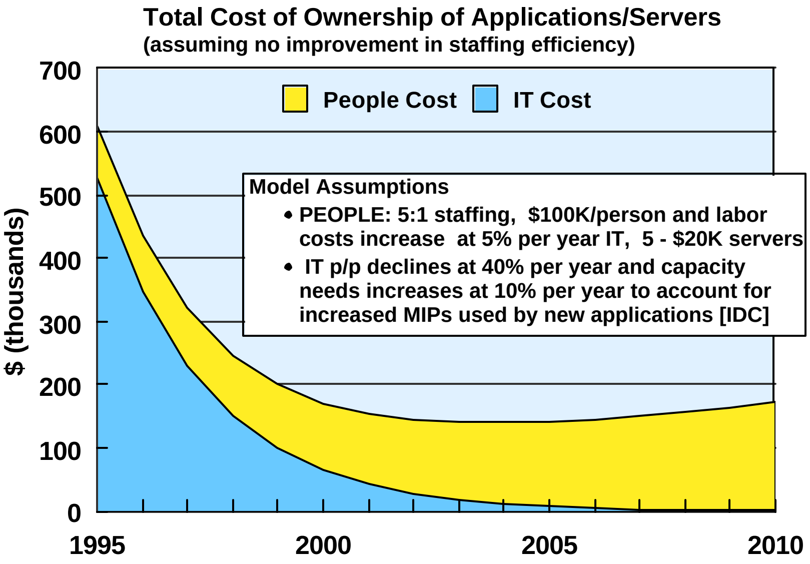
The economics of computing has changed dramatically over the last two decades. However, the Computer Science has not kept up. Today the complexity of computing dominates the costs of computing not the efficiency of the base architecture or the software that exploits it. Please refer the following two exhibits:

Exhibit 1: Number of systems a single person can operate (e.g. a person can manage 15-25 routers or 4-6 database servers)

Server Type	
Routers and Switches*	15-1 to 25-1
Average File and Print Servers	15-1 to 20-1
Large Network Operating System Servers	8-1 to 10-1
Medium Application Servers	8-1 to 10-1
File and Print Clusters (2-way)	3-1 to 5-1
Large Application Servers	3-1 to 6-1
Large Database Servers	4-1 to 6-1
Application Server Clusters (2-way)	2-1 to 3-1

Source: GartnerGroup, *IBM

Exhibit 2: An inflection on costs has occurred over the last two decades. People cost dominate.



Computer Science sub disciplines continue to focus on optimizing cost of computing resources. And, further sub disciplines have emerged to fix the design after the fact.

Terms like self-operation, self-healing and self-management are being used to reduce the people cost. Unfortunately, we are not looking at the science itself.

Shouldn't we be rethinking the basic science of computer design? Shouldn't the theory behind computer architecture, operating systems, networks, databases, etc. focus on optimizing simplicity, in addition to performance? How do we define simplicity? How do multiple "simple" systems combine in a way to remain "simple". It's a challenge to all of us to rethink the science. Otherwise, people will continue to find engineering solutions to the problem.

Do I have an answer? No. But, I certainly think it's feasible. Over the years, many daily use technologies have emerged to become utilities - e.g. power grids and telephony. Recall that in mid-1900s AT&T did a study that indicated that their operator based telephone switching systems will cause the world to run out of people (eligible operators) before everyone can have a connected telephone. Resulting efforts led to modern switching systems. Everything was changed - switching architecture, network operating systems, software design, application architecture. Computing is far more complex (because it's general purpose nature) than switching systems. But, with appropriate scientific focus we can certainly make more progress than where we are. We may have to rethink the way we design computers from the ground up, rather than coping with complexity after the fact.

Ambuj Goyal
General Manager, Solutions and Strategy
IBM Software Group

Dr. Goyal was named General Manager, Solutions and Strategy, IBM Software Group, in February, 2001. In his current position, he is responsible for setting business strategy for IBM's Software Group and delivering industry-specific solutions based on IBM's middleware.

Prior to this appointment, Dr. Goyal served as Chief Technology Officer, Application & Integration Middleware Division, which includes the WebSphere and MQ product families.

Dr. Goyal joined IBM Corporation in 1982 as a research staff member at the T.J. Watson Research Center. He was named Vice President, Services and Software, and Director, Computer Sciences in 1996. In this dual role, he was responsible for setting IBM's long-term research direction in computer sciences, as well as ensuring that the best emerging technologies contribute to IBM's services offerings and software products. He had approximately 1500 researchers reporting to him in seven labs worldwide.

Dr. Goyal's main research interests are in high performance systems, databases and distributed systems. His early work in scalable databases led to IBM's Universal Database (DB2) family. He was also responsible for setting the early direction in web application servers which led to the WebSphere product family. He also led the research efforts to create the RS/6000 SP supercomputer and the Deep Blue World Chess Champion computer.

Dr. Goyal has authored over 25 articles in various fields and has received five outstanding innovation awards from IBM for his work. He was elected an IEEE Fellow for his contributions to the theory and practice of highly dependable systems.

Dr. Goyal received his Ph.D. degree in Electrical Engineering from The University of Texas at Austin in 1982, and his Bachelor's degree from the Indian Institute of Technology at Kanpur in 1978.