A G r a n d C h a l l e n g e

Understanding the behavior of distributed intelligence in the Internet

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V i s i o n :

The Internet is poised to expand dramatically in the near future in some new ways. Specifically, I see small pervasive intelligent devices ubiquitously embedded in the physical world and connected to the Internet, providing the capabilities of actuators, sensors, logic, memory, processing, communications, speakers, microphones, cameras, displays, etc. Further, I see intelligent algorithms deployed at the edge of the network to provide adaptive customized interfaces to the highly mobile end user. I see intelligent software agents deployed across the network whose function it is to mine data, act on that data, observe trends, carry out tasks dynamically, adapt to their environment and provide services and functions to devices as well as to end users. I see considerably more network traffic generated, not so much by humans, but by these embedded devices, adaptive algorithms and software agents. I see large collections of self-organizing systems controlling vast fast networks. I see huge amounts of information flashing across these networks instantaneously, with this information undergoing enormous processing and informing the sophisticated decision support and control systems of our society.

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Understanding the behavior of distributed intelligence in the Internet

We must understand the behavior of this vast system of distributed intelligence with decision-making authority that will be spread across the network. The danger is that automated agents making decisions will act very quickly across global dimensions at huge bandwidths, and that means we will probably not understand what they are doing. So how do we design and deploy this capability, and how do we understand the kind of emerging behavior and unexpected consequences of devices, adaptive algorithms and software agents acting behind the scenes with whatever authority they are given or whatever authority they acquire? Not only will it be difficult to tell them what to do, there is a concern that we will actually lose control.

We've already reached the point where we can't pull the plug on these systems. We must anticipate that control will be wrested out of our hands, at least to some degree. Who is worrying or thinking about what this might mean? I am not referring only to the issue of how to make it happen but also to the question of what will be the consequences of this deployment and what kinds of controls could be or should be put in place to deal with this. Neural networks and that ilk of distributed control system, certainly don't solve these problems as they are currently structured, since, once they

solve a problem, we have no direct way to understand the characteristics of that solution.

We must adopt a more comprehensive model if we are to achieve a higher level of understanding of these phenomena. We must uncover the underlying principles of behavior of these systems. We must recognize this as a problem with which we must deal, and then we must put resources behind solving this problem.

Short Biography for Leonard Kleinrock

Dr. Kleinrock received his Ph.D. from MIT in 1963 and has served as a Professor of Computer Science at the University of California, Los Angeles since then. He received his BEE degree from City College of New York (CCNY) in 1957, an Honorary Doctor of Science from CCNY in 1997, and an Honorary Doctor of Science from the University of Massachusetts, Amherst in 2000. He was first President and Co-founder of Linkabit. He is also Founder and Chairman of Nomadix, Inc, a high-tech firm located in Southern California. He is also Founder and Chairman of TTI/Vanguard an advanced technology forum organization based in Santa Monica, California. He has published more than 225 papers and authored six books on a wide array of subjects including packet switching networks, packet radio networks, local area networks, broadband networks and gigabit networks. Additionally, Dr. Kleinrock has recently launched the field of nomadic computing, the emerging technology to support users as soon as they leave their desktop environments; nomadic computing may well be the next major wave of the Internet.

Dr. Kleinrock is a member of the National Academy of Engineering, an IEEE fellow, an ACM fellow and a founding member of the Computer Science and Telecommunications Board of the National Research Council. Among his many honors, he is the recipient of the C.C.N.Y. Townsend Harris Medal, the CCNY Electrical Engineering Award, the Marconi Award, the L.M. Ericsson Prize, the NAE Charles Stark Draper Prize, the Okawa Prize, the IEEE Internet Millennium Award, the UCLA Outstanding Teacher Award, the Lanchester Prize, the ACM SIGCOMM Award, the Sigma Xi Monie Ferst Award, the INFORMS Presidents Award, and the IEEE Harry Goode Award.