Research Statement

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I have always been a very inquisitive person. Natural phenomena have always fascinated me. Growing up in a family that valued study of science and mathematics helped a lot in preparing me to start my own scientific quest. My undergraduate days at Indian Institute of Technology, a premier institution of higher technical learning, and then my doctoral research at University of Florida under able guidance of my committee members, have showed me the path to advancing knowledge through proper and methodical scientific research.

Computers have become ubiquitous. The world is becoming increasingly networked. Cloud computing is here to stay with computing increasingly done on remote machines. I have been doing computer network and distributed systems research as part of my research at University of Florida. In order to further the field of computer network research and to make the next generation of interconnected large scale networks self* capable, we must look at natural complexities and gain perspective from them. My research would strive to bring together our understanding of natural phenomena, and specifically, our understanding of human body organization and functions to aid in designing next generation of smart interconnected networks.

Research Background

As part of my undergraduate major project, I was involved in designing a viral-infections diagnostic expert system. My major contribution was the rule based inference engine design. This project also gave me a chance to experience the dynamics of a team project. The project was executed entirely in C++ and the graphical interface was created using 'Borland Graphics Interface' APIs.

During the course of my doctoral research at University of Florida, I was involved in numerous sponsored and non-sponsored research projects. One such project was designing a covert-channel through a mix-network. I was involved in designing the covert channel. We used copy-codes and convolution coding to increase the signal fidelity in a highly noisy channel. Auto correlation was used in determining the covert message boundaries. We succeeded in showing the existence of a covert channel using statistical properties of the communication channel.

I was involved in development of 'Image based authentication' system that addresses traditional security risks that plagues any text/character based user authentication system. We decided to use sets of preselected fractal images as password element in our design. Using entropy based arguments we were able to show that our system was more secure than traditional systems. I was involved right from the very beginning of the project conceptualization to the final development and deployment. We collected usability statistics that revealed that users' authentication success rates were comparable to traditional systems and users' recall rates were much higher compared to random alphanumeric sequences.

As part of my dissertation research, we have developed a globally distributed overlay directory architecture that allows real time discovery of multicast sessions by end users. We call it 'mDNS'. The proposal allows assignments of long term stable URLs to multicast streams that users can bookmark for later access. The service remaps the URL to the most up to date session parameters in case the source modifies them. We developed a global DHT and hash based keyword routing algorithms to enable proper functionality of our scheme. Our architecture assigns Geo-coded information to multicast sessions that allows users to filter multicast search results based on geographical preferences. The overlay hierarchy is self managing with little or no system administrators' involvement. The architecture is self healing and adaptive to changes in the overlay. We have submitted an IETF RFC draft for standardization.

Ongoing Research

I am involved currently in modeling the next generation smart network system that mimics some of the macroscopic functions of our brain. We call our work "Gray Networking". While doing background survey of brain organization, we found several principles that could be incorporated in a smart network design. Some of of principles in play in our brain are 'complementary redundancy', 'plasticity', 'compartmentalization', 'selective filtration', 'feedback and feed-forward' control/data loops. Using these principles it is possible to design a network system that is highly plastic, resistant to intermittent failures and provides high availability of services to end users. Such a network could have self management, self configuration, and other self* capabilities. This work is currently in its early stages.

I am also involved in fine-tuning the 'mDNS' project in order to lessen the routing burden on nodes higher up in the hierarchy by using a LRU and LFU hybrid caching strategy. The proof-of-concept software implementation has been completed and the initial simulation tests show great potential of 'mDNS'. I am involved in re-implementation of the software to make its communication protocol in line with the proposed IETF RFC document.

Research Agenda

I am a firm believer in collaborative and interdisciplinary research. I plan to incorporate my understanding and experience of distributed systems and knowledge of network security issues together with observation of natural phenomena including understanding of human body nervous and immune systems in my future research endeavors. Cognitive networks research area is yet to see interesting breakthroughs and I plan to tackle the research problems in this area head on.

Distributed collaborative systems along with large scale overlay networks are constantly plagued with numerous security and trust issues. I want to keep on exploring the research space in this field. Solutions on improving security of a distributed systems, and yet not compromising on its usability seem difficult to come by. I plan on continuing my research to find out a sufficient middle ground between security and usability.