Researcher to track spread of disease, malware and power outages

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Anil Vullikanti, an assistant professor with Virginia Tech department of computer science and a member of the Virginia Bioinformatics Institute, is developing mathematical framework that can track the spread of pandemics among populations and malware across wireless computer networks, as well as how a blackout occurring on one major power grid can cause a cascade of additional neighboring networks to fail. Credit: Virginia Tech Photo

An assistant professor with the Virginia Tech College of Engineering has won a $750,000 federal grant to formulate a mathematical framework that can track the spread of pandemics among populations and malware across wireless computer networks, as well as how a blackout occurring on one major power grid can cause a cascade of additional neighboring networks to fail.

Funded by the U.S. Department of Energy's Early Career Principal Investigator program, the five-year grant was awarded to Anil Vullikanti, an assistant professor with Virginia Tech department of computer science and a member of the Virginia Bioinformatics Institute.

He will design by computer a unified mathematical framework with an eye toward preventing future pandemics such as the recent H1NI flu virus and the 1918 influenza pandemic that is said to have killed an estimated 50 million people worldwide, as well as malware/computer virus attacks, and mass power grid network disasters akin to the so-called Northeast Blackout of 2003 that left 10 million Canadians and 45 million U.S. residents in eight states without power.

"Many of these processes can be viewed as compositions of simpler diffusion processes, and this project is to study these fundamental processes and develop a framework for their compositions," Vullikanti said. Just as, say, a family member sickened by a flu virus she came in contact with in Army basic training or an overseas business trip can return home and sicken her family and friends, who in turn sicken co-workers and neighbors, computer viruses and power grid failures spread fast and wide by proximity.

Vullikanti's methods are expected to detect vulnerabilities and improve robustness in the areas of health care, computer networking and power grid controls, in order to address key concerns for health care workers, computer industry personnel and various policy planners. He also will develop realistic models and scalable, efficient simulation tools for understanding diffusion processes within complex network systems vital to the Department of Energy.

The main challenges of the project include the huge variability in the scales and unstructured properties of the kinds of networks that arise and limited real data and models, Vullikanti said. "We will use both

theoretical and large scale simulation based methods to address the challenges of complex networks," he added.

The Career Principal Investigator grant is given to faculty in the early stages of their academic profession in the fields of applied mathematics, computer science, computational science and high-performance networks, bolstering the nation's scientific workforce by providing support to exceptional researchers during the crucial early career years, when many scientists do their most formative work.

This grant comes after Vullikanati won a National Science Foundation CAREER award a year ago for his work on Cognitive Radio Networks (CRNs). Funded at $450,000 for a five-year period, the research focuses on theoretical foundations of CRNs, which increase the spectrum utilization by opportunistically allowing unlicensed users to transmit on licensed bands without intruding on the users who are licensed. The proposed study included research on cross-layer optimization problems in such networks using a more realistic model of interference.

Provided by Virginia Tech