VirginiaTech
VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Computer Science Seminar Series

National Capital Region

Percolation Theoretic Adaptations for Cyber Resilience

Speaker: Dr. Jin-Hee Cho
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1:00PM- 2:00PM, NVC T3

Abstract

Percolation theory has been extensively studied in the areas of physics and network science in order to measure the degree of network resilience in terms of the network connectivity in a large-scale network. In percolation theory, the so called percolation threshold refers to the fraction of nodes occupied in the network where the low threshold implies that a network is still being well connected even if many nodes or edges are removed from the network, indicating a high network resilience. In this sense, network resilience is mainly studied in a sense of fault-tolerance, which is commonly measured by the size of a giant component (or the largest cluster) in the network. In this talk, we aim to extend the concept of network resilience by including adaptability and recoverability, in addition to fault-tolerance. We propose percolation theory based adaptation strategies by leveraging the concept of site and bond percolation processes (i.e., removing / adding a node or an edge, respectively).

First, this talk will discuss the concept of percolation theory and how percolation-based adaptation or recovery can increase network connectivity under random or targeted attacks. Second, this talk will address a network resilience problem under correlated, cascading failures. We discuss how the proposed percolation theoretic adaptations can enhance network connectivity, task completion, and resource utilization with minimum cost in a mission-oriented network. In such a network, a node is executing multiple tasks while the network may suffer from correlated, cascading failures due to overloaded nodes caused by other nodes' failures or being compromised. Third, considering the philosophy of the diversity for survivability in ecology, we will discuss how software diversity can enhance network resilience when the bond percolation based adaptations are made based on a software diversity metric. In this work, we define a node's software diversity based on the concept of the eigenvector centrality metric where the software diversity is estimated by the dissimilarity between the node's software version and its neighbors' software versions within a given maximum hop. Lastly, this talk will conclude the new findings, discuss the insights and limitations of the proposed percolation theoretic adaptation strategies, and suggest the future work directions.

Biography

Dr. Jin-Hee Cho received the MS and PhD degrees in computer science from the Virginia Tech in 2004 and 2008, respectively. She is currently a computer scientist at the U.S. Army Research Laboratory (USARL), Adelphi, Maryland. Dr. Cho has published over 88 peer-reviewed technical papers in leading journals and conferences in the areas of trust management, cybersecurity, metrics and measurements, network performance analysis, resource allocation, agent-based modeling, uncertainty reasoning and analysis, information fusion / credibility, and social network analysis. She has been actively involved with ARL's collaborative research programs and collaborated with US academia, industry, and government researchers. In addition, Dr. Cho is actively collaborating with international research partners in academia and government through various international research programs under the US Department of Defense, including UK, Canada, Australia, New Zealand, Singapore, Norway, and South Korea. She received the best paper awards in IEEE TrustCom'2009, BRIMS'2013, IEEE GLOBECOM'2017, and 2017 ARL's publication award. She is a winner of the 2015 IEEE Communications Society William R. Bennett Prize in the Field of Communications Networking. In 2016, Dr. Cho was selected for the 2013 Presidential Early Career Award for Scientists and Engineers (PECASE), which is the highest honor bestowed by the US government on outstanding scientists and engineers in the early stages of their independent research careers. She is a senior member of the IEEE and a member of the ACM.