Special Session: Disaster Managment
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Title: On the Robustness of Network Infrastructures to Disasters and Physical Attacks

Networks are vulnerable to natural disasters, such as earthquakes or floods, as well as to physical attacks, such as an Electromagnetic Pulse (EMP) attack. Such real-world events happen in specific geographical locations and disrupt specific parts of the network. Therefore, the geographical layout of the network determines the impact of such events on the network's connectivity. We focus on network analysis and design under a geographic failure model of (geographical) networks to such disasters.

Initially, we aim to identify the most vulnerable parts of data networks to attack. That is, the location of a disaster that would have the maximum disruptive effect on a network in terms of capacity and connectivity. We consider graph models in which nodes and links are geographically located on a plane, and model the disaster event as a circular disk. We develop polynomial time algorithms for finding the worst possible location for a single failure in this setting. Then, motivated by an adversary that attacks the network *multiple* times, we consider a geographic min-cut and max-flow problem. Specifically, we consider the problem of finding the minimum number of failures, modeled as circular disks, to disconnect a pair of nodes and the maximum number of failure disjoint paths between a pair of nodes.

We also develop tools to calculate network metrics after a 'random' geographic disaster. The random location of the disaster allows us to model situations where the physical failures are not targeted attacks (e.g. natural disasters). In particular, we consider disasters that take the form of a 'random' circular disk or line in a plane. Using results from geometric probability, we are able to calculate some network performance metrics to such a disaster in polynomial time. In particular, we can evaluate average two-terminal reliability in polynomial time under these 'random' cuts. This is in contrast to the case of independent link failures for which there exists no known polynomial time algorithm to calculate this reliability metric.

Finally, we study the reliability of power transmission networks under regional disasters. Initially, we quantify the effect of large-scale non-targeted disasters and their resulting cascade effects on power networks. We then model the dependence of data networks on the power systems and consider network reliability in this dependent network setting. Our novel approach provides a promising new direction for modeling and designing networks to lessen the effects of geographical disasters or attacks.