Power-efficient, Delay and Spatial Error Tolerant, Dynamic 3D Network Analysis

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With the advent of smart devices and mobility, today's networks are increasingly dynamic. This research assesses optimal low-power communication between devices in ever-changing networks, while considering delay and disruption tolerance. My aim was to design and code an efficient algorithm in Java to determine a least-power communication solution in a dynamic 3D network, considering spatially correlated faults and delays. Each device's motion and power output are given, which determine their coordinates and connections at any given time. After calculating all possible spatially correlated faults in polynomial time, I check if a path exists between the source and sink nodes. This determines the path, power usage, and time step after disruption for each fault, allowing the user to make calculated decisions. I have proved it is possible to determine critical regions in a 3D network in polynomial time (although an infinite number of possible regions exist) and analyze the least power path over multiple time steps. The program is modular, allowing users to obtain results such as least power in the next 'n' time steps and delay trade-off. This project has been extended to incorporate packet switching without a complete path existing between the source and sink at any time as in the case of smart automobile networks. Hundreds of simulations confirm such tools are necessary because cases with better power at the expense of delay can be identified and addressed. Since power is imperative in today's mobile systems, this problem is vital in dynamic networks. This can have huge ramifications in environments such as war zones due to enemy jamming, deep space satellite communications, smart automobile and road networks, or meteorological settings in hurricane mapping.

Awards Won:

GoDaddy: $1,500 Forward Thinker Award

National Security Agency Research Directorate : First Place Award "Science of Security" of $3,000