1092-93-287 **Erik M Ferragut*** (efn@ornl.gov), **Jason Laska**, **Alex Melin** and **Seddik M Djouadi**.
Graph-Based Analysis of Cyber-Physical System Resiliency. Preliminary report.

Although cyber-physical security has become an important area of research, rigorous definitions of resilience have yet to be standardized, and the related control system analytics are still scarce. A linear control system can be described for time $t \geq 0$ by the matrix equation $\dot{x}(t) = Ax(t) + Bu(t)$ with $x(t)$ the system state, A the $n \times n$ system dynamics matrix, $u(t)$ the control input, and B the $n \times k$ control matrix. In a control-signal loss scenario, columns of B are eliminated by an attacker.

We define the control resiliency of the system, r_d, to be the vector of the number of sets of columns of size d whose removal renders the system uncontrollable. We propose measuring resilience with a lexicographic ordering on r_d. By using an independently derived characterization of controllability, we easily relate each column of B to the collection of eigenvalues made controllable by it, so that computation of r_d reduces to a graph-related enumeration problem. We then show that (1) complete enumeration of r_d, being equivalent to set covering, is NP-complete, but (2) the lexicographically most significant part of r_d can be computed in linear time. (A similar analysis applies to observability resilience to sensor loss.) (Received August 13, 2013)