ELECTRICAL ENGINEERING

Network Analysis and Management for

Cyber-Physical Systems and Their Applications

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Dissertation under the direction of Professor Gabor Karsai

Cyber-Physical Systems (CPS) are becoming increasingly distributed in nature. These distributed systems interact closely with the physical world and require the use of communications channels between the computational nodes of the system as well as to external systems. Since such systems are generally remotely deployed and managed, applications deployed onto the systems must be analyzed and verified before deployment to ensure that the network can provide enough resources to the applications and to ensure that applications will not degrade the system's overall functionality. To facilitate the development of these systems, we created analysis techniques for accurately and precisely predicting run-time application network performance and resource utilization from design-time models of the network and the applications. To validate this work, we developed network traffic production and measurement code and used run-time network emulation to enforce the network characteristics. Using these experimental results, we compared the accuracy and precision of our predictive techniques with state of the art analysis techniques. Furthermore, we implemented our modeling semantics in a communications middleware to measure the data production of each application and compared it against the application's network resource requirements. By comparing the stated resource requirements to the application's actual resource utilization, we could detect deviations and take mitigation actions. Using this measurement and detection, we showed how denial of service (DoS) and distributed DoS (DDoS) attacks could be mitigated.

Approved _____ Date _____

Gabor Karsai, Ph.D.