BUCKNELL UNIVERSITY

UNDERGRADUATE RESEARCH PROPOSAL

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A MECHANISM FOR TRANSIENT DETECTION IN METRICS ESTIMATED WITH THE NS-3 NETWORK SIMULATOR

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PART A

PROJECT DESCRIPTION

As society continues to develop and grow, the ability to network has become a vital skill. Computer networks are a crucial means of sharing information and data. As the public becomes more dependent on information and connectivity, they demand more of computer networks.

The two types of computer networks are hard-wired and wireless. Although hard-wired are more reliable, they are not portable and conflict with the need for mobility while accessing and sharing information. As the nodes in wireless networks have weaker connections, their protocols continue to be developed and enhanced so that the communication channels are reliable. While these improvements to wireless networks progress, research to test and analyze the predicted behavior of these connections is essential. In order to determine the behavior and/ or the performance of networks, simulations are beneficial because they create a controlled environment. To predict network behavior, complicated mathematical processes and computer simulations must be applied. Users of these methodologies often introduce errors in the process, which stand as road blocks on the way to successful simulation of network behavior.

Researchers use a wide range of methodologies including a mix of simulations, and mathematics to compile and analyze output data. Results of simulations often have "little credibility" because researchers often overlook the "random nature and the need for proper statistical analysis of simulation output data" [3]. Therefore, it has become increasingly difficult for data to be confirmed and standardized for dissemination of scientific results. On top of that, the collection process can be exhausting, consuming of time and resources, which renders few people able to compile trustworthy results. This faulty research has lead to an influx of flawed results and conclusions, as evidenced in the literature [1,2,3]. It is a research requirement that "any scientific activity should be based on controlled and independently repeatable experiments" but as researchers became more impatient they used a "brute force approach" to these simulations, which led to many unacceptable results [1]. The combination of these issues has lead to a crisis of credibility in the network simulation field.

In response to this confusion, the ns-3 network simulator was created so that it could be widely used and applied as a standardized system. Ns-3 is free software that is distributed, modified, and redistributed by any user allowing it to have a greater user base. Although the

simulator has proven to be a big improvement in the research of computer networking, it is complicated, especially for inexperienced users. Professor Perrone is developing an architecture that will allow novice users to create successful network simulation experiments, while also enhancing the capabilities of more advanced users [5]. He used an analogy to describe his work which I believe helps to justify the development of an experiment automation framework for ns-3. He said that ns-3 is like a bike and although it moves relatively smoothly, the rider still needs training wheels to help keep them stable so they do not fall off and get hurt. I will help with the creation of those training wheels by focusing my efforts on the application of valid statistical methods for output data processing.

Transient data is data which does not follow the general trend of results. This data is not an accurate representation of the whole and therefore must be detected and discarded before statistical metrics are computed. Transient data can bias the statistical results, skewing the findings and making them unreliable. This is one of the main causes of the credibility crisis in network simulations.

Although a reliable network simulator now exists, it doesn't include transient detection and deletion in the output data stream. Through the research I will to do with Prof. Perrone, I will work on a mechanism for the detection and deletion of transient data to improve the reliability of the simulator's results. This research with Prof. Perrone will be a unique opportunity to develop new skills in computer programming and enhance my ability as I continue with Bucknell's Computer Engineering degree program.

METHODS

To do this work I will use statistical processes and analyze the data generated. I will run simulations using ns-3 and use its facilities for collecting data. I will use previously developed mathematical technology referred to as *variance reduction techniques* [3] and other resources including stochastic steady-state simulation to create a program that will allow me to analyze data [1,3]. In addition to adding to my knowledge of statistics, I will be learning two programming languages that are currently not covered in the core Computer Science curriculum (C++ and Python). My goal is to create a program that will analyze that data to detect the end of the transient results so that we can compute valid statistics on this body of simulation data. Such a program was developed to work with an earlier network simulator, ns-2, but I will create a new program that works with the ns-3 simulator and within the larger context of Prof. Perrone's automation framework. This program will be user-friendly and widely accepted in everyday experiments.

TIME LINE

Week 1: review of literature on statistical methods

Week 2 and 3: studying of programming languages used in the ns-3 simulator

Week 4 to 6: implementation of prototype

Week 7 to 8: validation and debugging of code

OUTCOMES

This project fits well within Prof. Perrone's research agenda. We believe that my results will help to create a more stable method of analyzing and using network simulations in an effort to make the field more reliable and constructive. I will work on writing a computer program for the ns-3 simulator that will take a series of measurements, go through a statistical process, and tell the user whether or not a data point is part of the transient data. I will produce a program that will fit in the larger context of a framework to automate experiments in ns-3. Prof. Perrone and I believe that my work will be beneficial to the entire user base of ns-3. We expect that this work will result in material that can be submitted as conference publication.

PART B

REASEARCH ENVIRONMENT

I will be working closely with Prof. Perrone throughout my summer research. He will be working on campus regularly during the summer as well. We will have three regularly scheduled meetings every week. Additionally, since Prof. Perrone believes strongly in an "open door" policy, I will be able to speak with him about any questions or problems that I may have while doing my work at any time. I will be using standard computer science labs, which have both Linux and Macintosh machines to develop code and execute experiments to evaluate results.

REFERENCES

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[2] D. McNickle, G. Ewing, and K. Pawlikowski, "Transient deletion and the quality of sequential steady-state simulation," in *Proceedings of the 21st European Conference on Modeling and Simulation*, Prague, Czech Republic, June 2007.

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[4] T. R. Henderson, S. Roy, S. Floyd, and G. F. Riley, "ns-3 project goals," in Proceedings from the 2006 workshop on ns-2: the IP network simulator (WNS2' 06), 2006.

[5] L. F. Perrone, C. Cicconetti, G. Stea, and B. C. Ward. "On the automation of computer network simulators." In *Simutools '09: Proceedings of the 2nd International Conference on Simulation Tools and Techniques*, pages 1-10, 2009.