

## C. PROJECT SUMMARY

The last decade brought a major change in experimentation practices in several areas of computer science, as researchers shifted from using simulation and theory to using network testbeds. Over this time many diverse testbeds have been built throughout the world, and the trend of building better, bigger and more diverse testbeds continues. On the other hand, there have been no studies on testbed use. Specifically, knowing who uses testbeds, for what research and what are the use patterns and practices would help testbed builders and funders understand the impact of their work and direct their efforts to maximize the payoff.

**Intellectual Merit:** This research aims to analyze existing data about testbeds, and collect new data, to understand how testbeds are used, by whom and for what purpose. We aim to follow the usage trends over time and attempt to infer and analyze short-term and long-term trends. We also aim to understand what motivates people to use testbeds and what hinders their use. For those factors that hinder testbed use we aim to understand if they stem from a specific research field, a specific testbed practice or if they are inherent in the nature of network testbeds. We also aim to revisit current testbed use policies such as on-demand resource allocation on first-come-first-served basis, and allowing users to keep resources for as long as they want, and evaluate how well this fits researcher needs.

Specifically, we seek to answer the following questions: (1) What research benefits from network testbeds? (2) How are testbeds used today and by whom? (3) What are advantages and disadvantages of testbeds from user point of view? and (4) How effective are testbed use policies in meeting user needs? To a large extent these questions can be answered by analyzing data about users, projects, experiments and resources in testbeds that run Emulab control software [?]. We strongly believe that testbeds that do not run Emulab control software collect a lot of similar data and that our analysis scripts, after some minor translation to account for format and scope differences, could be applied to this data as well. Some questions we posed require collection of additional data, which we will undertake during this project.

As our goal with this research is not only to detect usage trends but also to analyze their cause, it is essential to acquire data from many and diverse testbeds. We propose to focus on 3 Emulab-type testbeds, one of which we are closely associated with (DETER [?]), and on 2 non-Emulab type testbeds. We have strong connections with founders of all these testbeds, which we plan to leverage to obtain their data and preferably collaboration on this project. If time permits, we will also approach a wider set of testbeds in attempt to increase our data set diversity.

The lead PI on this project, Dr. Mirkovic, and her collaborator Dr. Hussain (paid from non-NSF sources) have been working with the DETER testbed [?] for four years, as developers and points of contact for user queries. They are also researchers in the networking field and have a wide range of experience in using diverse network testbeds, such as Emulab [?], Orbit [?], Planetlab [?] and DETER [?]. They are thus uniquely qualified to lead this effort.

**Broader Impact:** This research will help computer science community and its funders build better testbeds, and it will help them manage the existing testbeds better. Knowing what research benefits from testbeds helps direct efforts to recruiting and serving those users well. Understanding user diversity helps direct outreach efforts, and customize user support to communities that most need this. Information about use patterns and the interplay between testbed policies and users' use needs will improve testbed management and possibly lead to policy changes to more effectively use existing resources. Finally, understanding points of satisfaction and problems for testbed users will help testbed developers direct their efforts to better serve the user community.

**Why EAGER:** The proposed work is exploratory and in its early stages. It champions an untested, but very probable idea that testbed usage data holds priceless nuggets of information to guide testbed development in the future. It is potentially transformative since its results may radically change the way testbeds are managed, and increase the payoffs of investment in testbeds.