

# Project Summary

## CRI: Developing the Next-Generation Open-Source Network Simulator (ns-3)

The PIs propose a managed software development program to comprehensively re-design, enhance and maintain the popular *Network Simulator (ns)*, to address research and educational challenges for next generation of data networks. In our four-year plan, we will i) refactor the simulator's architecture, ii) develop new networking protocol models for wireless, iii) provide new opportunities for software encapsulation, and iv) integrate the tool with virtual network testbeds. We will also introduce proven open-source practices that should enable *ns* development and software maintenance to become self-sustaining in the future, based on a large community of developers and power users. The importance of supporting research and education via freely available simulation tools, in such a critical discipline as data networking, cannot be overstated.

The proposed effort is the logical next step of the highly successful *ns* project, which has been funded and developed (both directly and indirectly) under several previous research projects since 1997, including DARPA VINT, DARPA SAMAN, and NSF CONSER. *ns* enjoys widespread use in the research community; the simulation code has been contributed by over one hundred individuals and organizations, and use of the simulator is consistently referenced in 10 to 25% of the papers in the top conferences in the field. Since existing funding sources have expired for *ns* development and maintenance, the PIs believe that a specific infrastructure project is needed to improve the scalability, modularity, and protocol model library of *ns* and to move *ns* towards a more sustainable development and software maintenance model.

*ns-3* will be different from *ns-2* in several crucial ways. First, the software core will be refactored to improve both scalability (a current bottleneck with existing wireless and high-speed simulations) and extensibility. Notably, chief goals are the incorporation of a distributed simulation framework (developed by Riley for both *ns* and the *Georgia Tech Network Simulator*) and revisiting the object-oriented design towards the development of implementation-like APIs that allow incorporation of the large body of open-source networking software, such as routing daemons and packet trace analyzers. Emulation capabilities will be revamped, for better integration with experimental testbeds. The wireless modules will be completely rewritten and extended to track advances in this key area. A renewed emphasis on the development of educational scripts will be facilitated by our refactored (more implementation-like) architecture. Finally, the project will move to the Sourceforge open-source development site, a new community of developers will be brought into the project, and documentation (some of which is many years out-of-date) will be significantly updated.

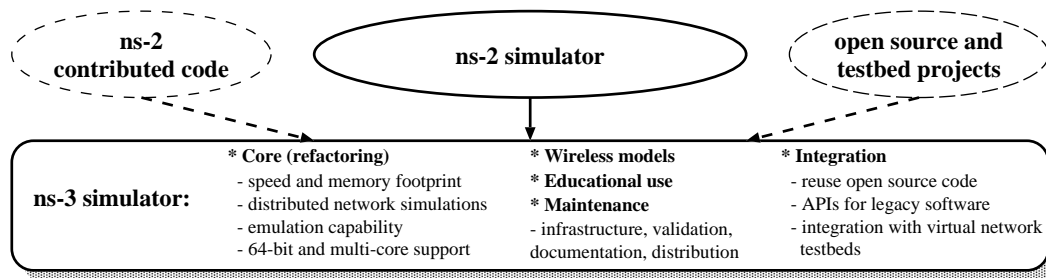


Figure 1: Summary of *ns-3* project objectives.

**Intellectual merit of the proposed activity.** Progress in data networking is heavily reliant on simulations. The research community favors a flexible, scalable, open-source simulator for that purpose. Based on their collective experience in developing and using network simulators, the PIs believe that the needs identified in Figure 1 are not being met with the legacy *ns* simulator or other similar tools. This project will advance the state-of-the-art in simulator design of the identified areas, along with supporting the the mundane yet critical activities of code maintenance, documentation, integration, validation, and educational script generation.

**Broader impacts of the proposed research activity.** The broader impact is manifold. Since the resulting simulation code will be freely available to any individual or organization, *ns-3* will facilitate a significant increase in use for new simulation-oriented research as well as integration into courseware. Further, the project will emphasize a software development model that encourages and incorporates contributions from the user community. The large user and developer base of *ns* will extend its capabilities beyond those available in commercial tools in many respects (most notably the library of protocol models available), thereby making it the first choice for network simulation.