Project Summary

WHYNET: Scalable Testbed for Next Generation Mobile Wireless Networking Technologies

The next generation of wireless communication technology is likely to rely on cross-layer interactions that extend from the application layer down to the physical devices. This project proposes to design and develop *WHYNET*, a *W*ireless *HY*brid *NET*work testbed to facilitate detailed study of such interactions and their impact on application level performance in heterogeneous wireless systems. The eventual technical impact of this testbed will be to redefine how specific innovations in wireless communication technologies are evaluated in terms of their potential to improve application-level performance as well as how alternative approaches are compared with each other. Its broader impact will be to redefine how students are trained in wireless technologies by providing a multi-disciplinary 'hands on' environment to complement purely theoretical classroom training.

WHYNET is envisaged as a hybrid testbed that combines the realism of physical testing with the scalability and flexibility of simulations. The hybrid testbed will be a networked federation of geographically distributed, heterogeneous wireless physical testbeds with multiple protocol stacks (CDMA 2000 cellular and IP), next generation physical technologies including UWB (Ultra Wide Band), MIMO (Multiple Inputs, Multiple Outputs) and SDR (Software Defined Radios), and a parallel & distributed multi-tool simulation framework. Beyond providing a more accurate & flexible evaluation framework, the hybrid testbed will facilitate a smooth transition from an abstract simulation model to an operational implementation within a single framework. For instance, protocol prototypes can communicate with simulated lower layers for repeatable results, or receive and process variable rate real multimedia application inputs for perceptual evaluation. Once the physical hardware devices are ready for testing, a portion of the target network system can be configured with real devices while the rest of the network can still reside in the simulated hardware domain. The effort will also generate a repository of wireless networking scenarios, measurements, models and implementations. A representative set of studies will be used to demonstrate the unique contributions of WHYNET for cross-layer optimization studies in particular, and mobile wireless networking in general. These include sensor networks, energy-aware networking, protocols & middleware for multi-access networking, and adaptive transport and security protocols. The testbed itself will be accessible by the research community via a web-based mechanism that will allow remote uploading of models, implementations, and configurations.

The proposed research is likely to have a broader impact on two fronts: the training of future generation of wireless engineers and wireless technology standards. Wireless engineers will need significant technical depth to contribute to a rapidly developing technology and significant technical breadth to understand how this technology fits into a market driven economy. The latter category requires engineers who are trained in "systems" aspects with an in-depth understanding of trade-offs and interactions across layers of a wireless communication system. The current course structure is not designed to produce well-trained engineers of the second type. The project team feels strongly that broad systems training can only be accomplished in "hands-on" experimental courses or projects where the students see the tradeoffs involved in real system design. The proposed testbed can enable these types of courses across the curriculum. Even though today wireless is a vertical technology, 4-5 years from now, the most interesting and challenging problems will be those related to wireless systems, so we believe that an inter-disciplinary yet closely-knit engineering program such as ours is well suited for the training of wireless engineer of tomorrow. By providing a scalable platform, methodology, and tools to support objective and accurate evaluation of protocol and technology alternatives, we expect that the testbed will also play an important role in shaping standards activity in IETF and related bodies.

A multi-disciplinary, multi-institution team has been formed to achieve the ambitious objectives of the WHYNET project. The team members have substantial expertise in design and management of physical and simulation testbeds (Bagrodia, Gerla, Rao, Takai), development of novel radio technology (Daneshrad, Fitz, Mitra), wireless systems (Mitra, Rao, Srivastava), protocol design (Gerla, Krishnamurthy, Mohapatra, Royer, Shen, Srivastava, Tripathi) and performance evaluation (Bagrodia, Gerla, Molle, Rao, Tripathi). Many of the PIs have successfully worked together on previous collaborative projects. We have also received strong support from a number of companies that play a critical role in this space including Microsoft, Hughes Research Laboratories (now part of Boeing), ST Electronics, HP, Ericsson, Intel, and Xtreme Spectrum.