

# Proposal: Amherst Community Wireless Project

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## 1 Introduction

The Amherst Community Wireless project is a cooperative effort between UMass Amherst and the Town of Amherst. The goal of the project is to deploy a municipal wireless network covering the Town's 17 square miles of roads and facilities with wireless devices. This communication network will provide several major benefits to the Town and University:

- The network will provide Internet access to the general public. Initially, public Internet will be available for free in public places and will be an expansion of the already popular public Internet available in the downtown area. Future expansions could include low or no cost Internet in low-income residential areas or business districts. This enhances the quality of life for residents, and it makes Amherst a more attractive place to do business and visit.
- It will provide Police, Fire, EMS, and Public Works vehicles and staff a secure high-speed connection to the Town's technology infrastructure. This will meet the growing need for mobile access to public safety database systems, GIS, IP telephony, secure radio transmissions and much more, while reducing monthly reoccurring costs to communications providers.

The equipment will also support the research of Professors Levine and Corner. They study networks that are resilient to widespread failures such as extended natural disasters, poor infrastructure, and power outages — all great concerns to the government and the general public. The same research enables Levine and Corner to monitor wildlife in forested and underwater environments. They are working on projects involving monitoring of endangered wood turtles in Amherst and ocean monitoring with collaborators from the Woods Hole Oceanographic Institute.

Levine and Corner are preparing a proposal to cover the costs of purchasing and maintaining the equipment. This proposal grew out of a current deployment of wireless equipment computers on 40 buses that service the UMass campus each day, which has the goal of eventually providing news and messaging for bus passengers updated whenever the buses encounter Internet access points offered by cafes and homes. The bus project, called DieselNet is partially supported by an existing \$750,000 four-year grant from the National Science Foundation and partially from an existing DARPA 14-month grant for \$129,000<sup>1</sup>.

Several cities around the country have begun planning and deploying municipal wireless networks. These include San Francisco, CA (TechConnect; [http://www.sfgov.org/site/tech\\_connect\\_index.asp](http://www.sfgov.org/site/tech_connect_index.asp)), Portland, OR (Unwire Portland; <http://www.pdc.us/unwire/faq.asp>), and Philadelphia, PA (Wireless Philadelphia; <http://www.phila.gov/wireless>). The primary goal of each of these networks has been to provide Internet access for Town services and for the public's use, as well as to foster a healthy environment for business. What makes this project unique is the opportunity for the Town of Amherst to leverage research grant money, while strengthening the relationship between the Town and the University.

In this document, we provide a summary of the positive impacts on the public, the Town, and University researchers.

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<sup>1</sup>NSF grant award number CNS-0519881 and DARPA contract C-36-B82-S1. Both grants are part of a collaborative project with Prof. Mostafa Ammar and Prof. Ellen Zegura of the Georgia Institute of Technology, who have been awarded separate funding.

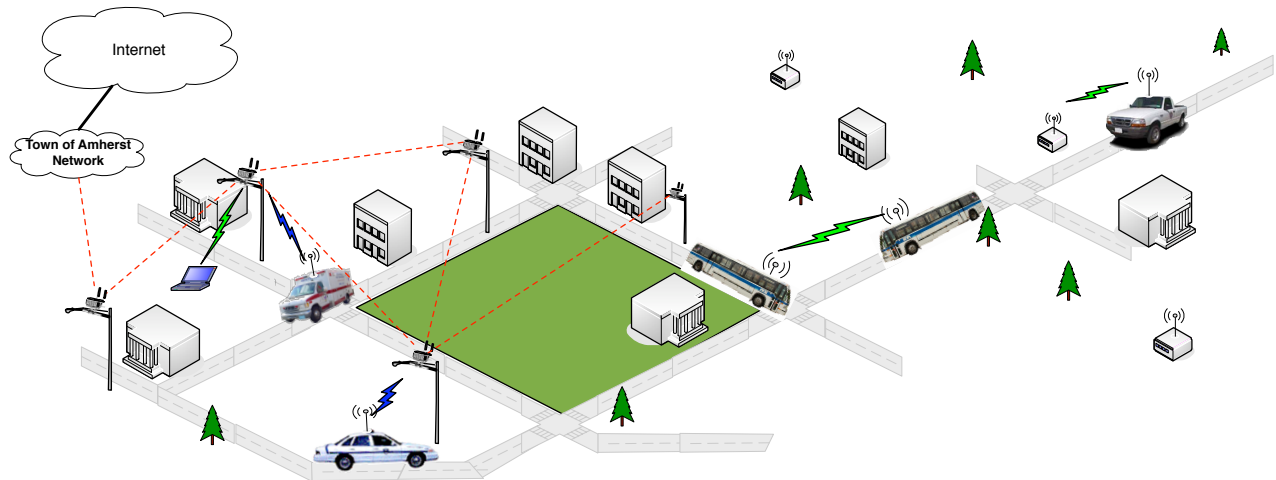


Figure 1: 17 square miles of the Town will be densely covered with access points, while the surrounding geographic area will be sparsely covered by research devices.

## 2 Benefits and Impact

This network will greatly benefit three segments of the local community: the Town government, the public, and University researchers.

### 2.1 Benefits to the Public

The public is increasingly dependent on the Internet for business, personal communication, and access to public resources and emergency information. However, the cost of accessing high-speed data services everywhere is beyond the reach of many citizens. Bridging the digital divide will greatly increase the attractiveness of the Town of Amherst to current and future citizens, as well as providing equitable access to information. While free Internet access in Amherst does not provide the complete solution, it does go a long way in providing inexpensive communication services for residents and visitors. This is because it removes the recurring fees associated with Internet access and allows people to be on line for the fixed cost of an (inexpensive) computer.

Once the network is in place, many new possibilities are available for citizens and tourists:

- The network will allow tourists to have Internet access while they roam the Town. Web site addresses could be posted that point visitors to additional information about historical sites, eateries, and inns.
- The Town will achieve a reputation for being tech-forward, increasing its attractiveness to new businesses in the technology-based economy.
- More people will be encouraged to visit commercial areas of Town, increasing economic activity.
- The network may increase the number of people who can telecommute to work, reducing congestion on Town roads.
- Passengers on buses would have Internet access while they ride the bus, increasing the attractiveness of using public transportation.
- The UMass professors have already equipped 40 UMass-PVTA buses with networking equipment and location-aware GPS devices. They are currently working with UMass Transit to program a system that will allow citizens to query the location of buses and to discover the number of minutes until the bus arrives at a particular stop. With the community wireless network in place that we are proposing, they could make such queries from anywhere in Town.

## 2.2 Benefits to Town Services

Monitoring Town assets is an essential part of providing reliable Town services, and this project provides a unique opportunity to develop these services under a unified communications infrastructure. Such a wireless network provides the opportunity to save large amounts of money spent on custom radios for voice communication and data modem services for monitoring Town assets. While it is evident that a great number of services can be enhanced with greater network connectivity, we use the Department of Public works as an example. The Department of Public Works has already identified three pressing needs for communication services:

1. Security System: There is a need to install security systems at DPW facilities and remote sites. The security system will enable remote monitoring of many of the sites, with real-time security features.
2. Traffic Light Management: There is a need to connect all Town traffic lights together to provide remote troubleshooting and maintenance, traffic calming and real-time traffic counts.
3. Improved office to worker communication: Access to GIS, the cartographic work order management system and message systems has become essential to mobile staff. Additionally, monitoring vehicle locations, speeds and mechanical status in real time will vastly improve supervisor's abilities to efficiently route vehicles (especially during winter storms and weather emergencies).

Currently DPW uses a combination of the Town fiber network, radio systems (vehicles and point-to-point radios), cell phones, leased data lines, and dedicated phone lines. Reoccurring costs to communications providers will be substantially reduced, data travels naturally over this type of wireless network and voice needs would be met with mobile IP phones connected to the Town's recently launched IP telephony system.

## 2.3 Benefits of Research to Society

Mathematicians require pencil and paper, chemists require chemicals and a laboratory, and networking professors require wireless devices and an expansive network to do their work. We are proud to work in Amherst and we believe our research can positively impact the Town. Our project seeks to advance Internet technology so that it can be used in the many environments where providing networking to mobile users is a challenge.

- Natural disasters like earthquakes, floods, and hurricanes can destroy the power grid, telephone networks, and mobile phone cell towers. Our communications infrastructure is not designed to survive such failure, leaving safety and first responders unable to coordinate.
- Power outages, like occurred on August 14, 2003 in the Northeast, and which are more common with less developed infrastructures, also pose a challenge to a reliable communications infrastructure.
- Developing areas of the world lack always-on Internet connections to remote towns and villages. This is because they lack a robust power infrastructure, dense deployment of cell phone towers, a wired Internet highway backbone, nor a reliable phone network. This maintains the digital divide between Internet-enabled countries and the rest of the world. Others are using this kind of research to provide solutions to this problem (e.g., [urlhttp://www.firstmilesolutions.com](http://www.firstmilesolutions.com)).
- Monitoring of wildlife currently requires scientists to hike into habitats and re-locate tagged animals to record one data point. There are no Internet or other communications technologies in the forrest, but our technology allows data of hourly readings of animal behavior to route itself towards the the scientists automatically.
- Underwater monitoring of our bays and oceans, including sensing of plants, sea life, and earthquake fissures requires coverage of a massive area. Very small areas can be monitored now because they require cables out to sea or densely deployed sensing devices. Our technology allows sparse coverage of a broad area of the ocean, allowing data to find its way to buoys and passing ships.

Research on these problems is broadly called *Disruption Tolerant Networking (DTN)*. Our primary research tasks involve new protocols for routing of data in DTNs and new methods of enabling mobile devices to last for months at a time using solar/battery power. Our work is in collaboration with scientists at the Georgia

Institute of Technology and Woods Hole Oceanographic Institute. Our work has three primary applications: Construction of a testbed in Amherst, MA called UMassDieselNet; currently we have hardware and software operating on 40 buses that cover 150 square miles in western mass. A miniature version of the bus-based technology coupled with some intelligent power management is enabling us to monitor endangered wood turtles in the Amherst area for ecological conservation. We also collaborate with oceanographic partners for underwater monitoring of coastal areas, including sea life and ocean bottoms.

Information on these research activities is available from <http://prisms.cs.umass.edu/diesel>.

Our funding is from the National Science Foundation (NSF) and the Defense Advanced Research Projects Agency (DARPA). The funding for the community wireless project is being proposed by Levine and Corner to DARPA. The two agencies are the primary sources of support for computer science research around the country.

For both agencies, the advancement of fundamental computer science research and the transfer of technology to industry is in their interest. DARPA has funded a number of advances in Computer Science technology since its inception in 1959 including the invention of the Internet, as well as wireless networks, GPS, and cell phones. Efforts from both agencies are responsible for the development of computer graphics, graphical user interfaces, databases, the World Wide Web, speech recognition, and high speed Internet links. The University of Massachusetts does not do classified research and Corner and Levine do not have secret clearance. All research on this project has been published in open venues and is available on the professors' web sites.

### 3 UMass Amherst Investigators

**Mark Corner** has been an Assistant Professor in the Computer Science Department at the University of Massachusetts-Amherst since 2003 after graduating with his PhD in Electrical Engineering from the University of Michigan. His primary interests lie in the areas of mobile and pervasive computing, networking, file systems and security. He was the recipient of an NSF CAREER award in 2005, Best Paper at ACM Multimedia 2005, as well as the Best Student Paper Award at Mobicom 2002.

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**Brian Neil Levine** received a PhD and a Masters degree in Computer Engineering from the University of California, Santa Cruz in 1999 and 1996, respectively. His research interests in general include network privacy and security, peer-to-peer networking, and mobility. He joined the Department of Computer Science in 1999 as an assistant professor. In 2005, he was tenured and promoted to associate professor. He is Director of the Center for Academic Excellence in Information Assurance Education at UMass Amherst, as designated by the National Security Agency in 2003. He was awarded an NSF CAREER grant in 2001 for work in peer-to-peer networking. He received the Outstanding Paper award at NDSS Symposium in 2002 for his work on Internet privacy. In 2004, he was awarded a Lilly teaching fellowship from UMass Amherst. Levine is an associate editor of the IEEE/ACM Transactions on Networking, and he is co-chair of Intl. Workshop on Network and Operating Systems Support for Digital Audio and Video (NOSSDAV) in 2006.

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