Wireless Data Transmission in the LTER Network

[John R. Vande Castle](#) Associate Director for Technology Development, Long Term
Ecological Research (LTER) - Network Office

This information is meant to provide some pointers to information regarding wireless data/ communication technology infrastructure under investigation and implementation within the LTER Network. The LTER Network is very interested in implementing wireless technologies for both communication and remote field data transmission.

Note: With the rapid changes in these technologies, some of this information will be outdated, and will be updated with new information as it becomes available.

The Luquillo (LUQ), North Temperate Lakes (NTL) LTER sites and the LTER Network Office (NET) have implemented wireless spread spectrum communication technologies – both for both serial (figure 1.) and Ethernet data transmission. The Luquillo (LUQ), North Temperate Lakes (NTL) and Bonanza Creek (BNZ) LTER sites have been the focus of wireless field tests by an NSF funded grant to Old Colorado City Communications (http://wireless.oldcolo.com).   Documentation of the experiences and discussions can be found at: http://wireless.oldcolo.com/biology/locationprogressreports.htm.

The LTER Network Office (NET) uses a simple 2.4ghz Ethernet-based IEEE 802.11b Spread Spectrum wireless router for laptop and mobile computer support. The wireless Ethernet used at NET is based on a Cisco/Aironet 340 access point with high gain antennae and Cisco and Lucent wireless PC cards. Currently there are many providers for standard 802.11b wireless such as 3COM, NETGEAR, LUCENT and others. A simple router/5 station system can now be set up for under $1k and network cards can be added for less than $100/station (!!!). "Residential Gateways" offered by ORINOCO/LUCNET, INTEL, 3COM and others can provide a very simple wireless solution to share a common 56kb phone, DSL/Cable modem or Ethernet connection to a small group of computer users or peripherals. The primary disadvantage of the current 2.4ghz Ethernet links are relatively limited transmission range. With a high gain antennae, distances are generally limited to less than 5km, and in fact to as little as 100m in a more enclosed environment.   NET has also used spread spectrum serial data transmission for Webcam data transmissions. Based on 900mhz "FreeWave" transmitters and high gain antennae, data transmission exceeding 30km have been achieved with clear line-of-sight as part of its "[LTER Schoolyard Collaboration](#)".

NET has investigated other forms of wireless data transmission including digital phone to computer links and CDPD computer modem links. Both of these are suitable in urban areas with available digital data providers, but can be unusable in more remote environments.   Current data throughputs of about 14.4kb, are also fairly slow for sustained data transmission, but might be acceptable for some users, such as mobile access to email. NET uses digital cellular phones with nationwide/free roaming access plans for key personnel which pay for themselves in reduced long

distance charges used even in the office. New satellite cellular phones offer similar data transmission capabilities using newer satellite data services including that offered by IRIDUM. Data services such as those provided by OMNET also use IRIDIUM data services which provide capabilities for remote data transmissions including shipboard data links.

Example Applications:

A project of Campbell Webb and Michael Donoghue was funded by NSF/BSI to use wireless devices in taxonomic collecting work and field botany. A poster:

Campbell O. Webb & Michael J. Donoghue, 2002. Communication from field in text and images using spread-spectrum radio technology; Proceedings, ESA 2002 Annual Meeting can be seen here or downloaded here.

Project information can be found at www.phylodiversity.net/etherbio.

Case Study: Wireless Technologies used at the North Temperate Lakes LTER

Example of wireless field technology at the North Temperate Lakes (NTL) LTER site - acknowledgements to Paul Hanson and staff at the NTL/LTER for documenting this effort.

 Figure 1. An example of serial spread spectrum communication between a laptop computer and a Campbell data logger located on a buoy.

As used here, "wireless" refers to spread spectrum communication in the 900+ MHz and 2.4+ GHz bands of the electromagnetic spectrum. In this case, spread spectrum has been used to facilitate serial and Ethernet computer communication. Spread spectrum requires no FCC licensing; permits high band-width data throughput; and is

implemented by many commercial vendors who build ready-to-use computer peripherals. Serial communication has been applied to uploading and debriefing dataloggers, and Ethernet has been applied to both datalogger communication and general LAN communication. For longer distances (i.e., more than a few hundred feet), line of sight is required for Ethernet links and near line of sight is required for serial. This limitation imposes restraints on both field applications and within-lab network communication.

For computer networking, wireless communication is a bit more expensive than traditional land lines, but can provide data throughput rates equivalent to standard 10 Mbit LAN rates (note that 100 Mb throughput on recent standard category 5 wiring is 10 times faster than the best wireless LAN rates). Examples of Ethernet bridges and PC cards include respectively the CISCO 340/350 Series 11Mbps DSSS Access Point ($1,200) and the CISCO Aironet 340 11MBPS DSSS ($189) [NOTE THAT THESE COSTS ARE NOW SIGNIFICANTLY LOWER]

Satellite Internet:

Although wireless provides solutions for communication within a site, its line of site limitation makes it a difficult installation for Internet connectivity over long distances. A better solution for connecting field stations to the Internet might be satellite hookups from one of several satellite vendors/ISP providers. More information can be found on this **Satellite Internet subpage.**