



Outdoor IEEE 802.11 Testbed

Institute for Telecommunication Sciences (ITS)



- **Interoperability**
- **Propagation induced data channel impairments**
- **TCP and UDP testing**
- **Signal strength to throughput correlation**
- **Video over Wi-Fi**
- **VoIP parameter measurements - jitter and delay**
- **RF characterization of 802.11 signals**
Spectral behavior in 2.4 GHz

As prices have fallen, the number of 802.11-based wireless local area networks (WLAN) has significantly increased. This technology represents a significant telecommunication resource and therefore is of interest to ITS. In the past year, efforts have been made to investigate the operating parameters of 802.11-based wireless data systems from a number of viewpoints.

The low cost of 802.11 equipment has been accompanied by a concomitant wide variation in capabilities. A secondary aspect of the large number of different systems involved in ITS testing has been the capability to investigate the interoperability between different 802.11 WLAN cards and access points (AP). This work has also pointed out compatibility issues regarding the use of 802.11g WLAN cards in 802.11b systems and vice versa.

Because the wireless channel is more complex than the wired channel, protocols like 802.11b exhibit sophisticated behavior at the physical layer which is not easily discernable to the application. A particular result of this behavior concerns the hidden effects of physical layer impairments upon network performance. A portion of the experiments conducted at ITS are designed to investigate the correlation between network parameters and RF channel characteristics. For example, gross signal strength measurements may be poor indicators of achievable network throughput. In addition, retransmissions mandated by error indications at the physical layer may adversely impact jitter and latency parameters. Although this impact is not detrimental to TCP data transmissions, it may prove to be significant for real-time packet-based communications using RTP, i.e., VoIP. The Institute is uniquely qualified to investigate realtime voice services over Wi-Fi networks because of an existing voice quality program.

Another real-time application that promises to be of increasing interest is packet video over 802.11 networks. Experiments within this realm take advantage of existing video quality measurement expertise at the Institute. These experiments take the form of low frame rate transmissions and thus represent a different measurement regime from the commercial video quality that has been previously studied.

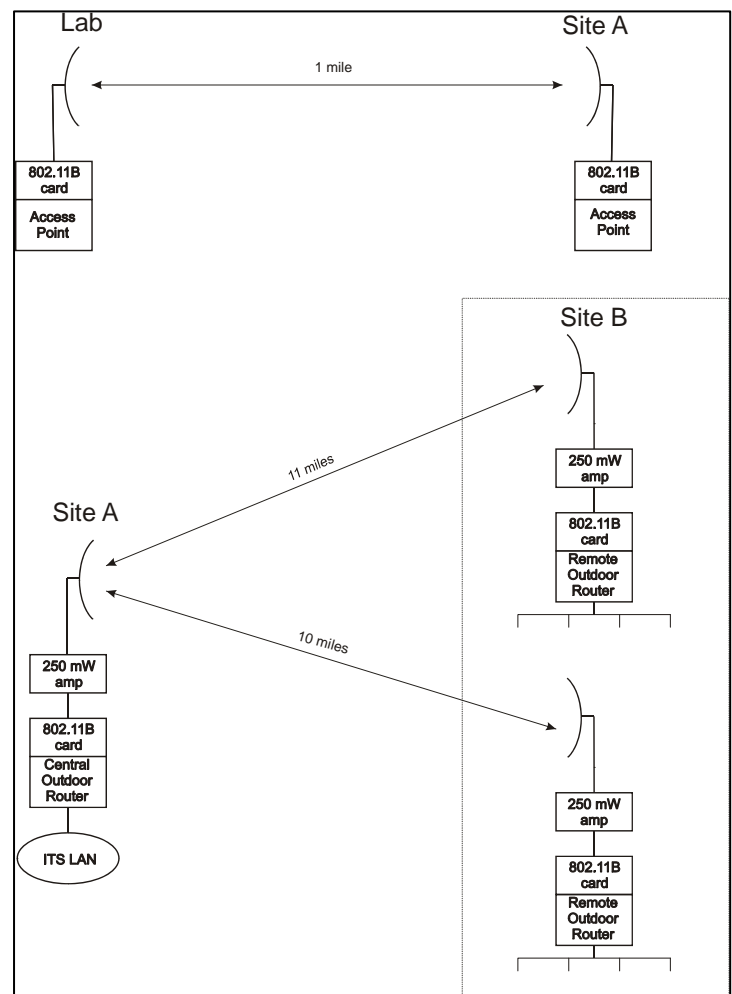


Figure 1. Long-range outdoor links between the Green Mountain field site and the Table Mountain field site near Boulder, Colorado.

Currently, ITS has setup multiple long-range outdoor links, shown in Figures 1 and 2, to explore the impact of environmental factors on communications over 802.11-based carriers. The links consist of 1, 10, and 11 mile distances. This testbed utilizes no proprietary technology but is based on commercial-off-the-shelf equipment. A high-gain directional antenna, shown in Figure 3, is employed at each end of the link to provide the required directionality and gain. The experimental installation is capable of providing information about the RF characteristics of the channel as well as multiple packet network parameters. For non-real-time TCP networks, this includes throughput measurements and for real time transmissions measurements like delay, jitter and instantaneous packet loss are available.

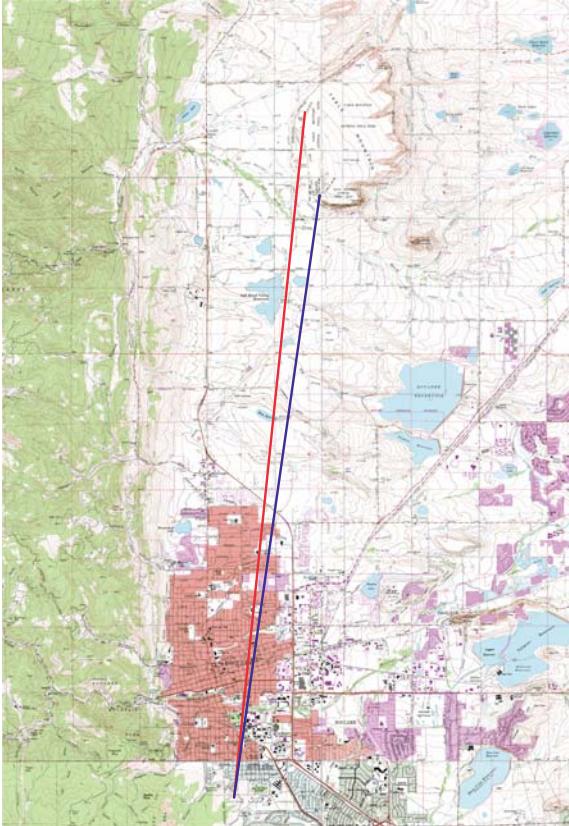


Figure 2. Long-range outdoor links between the Green Mountain field site and the Table Mountain field site near Boulder, Colorado.



Figure 3. High-gain directional antenna employed at one outdoor link at the Table Mountain field site (photograph by C. Redding).

Contact: Christopher Redding
303-497-3104
credding@its.bldrdoc.gov

Institute for Telecommunication Sciences
325 Broadway, Boulder, Colorado 80305
<http://www.its.bldrdoc.gov>

The Institute for Telecommunication Sciences (ITS), located in Boulder, Colorado, is the research and engineering arm of the National Telecommunications and Information Administration (NTIA) of the U.S. Department of Commerce. ITS receives direct support from the Department of Commerce and is sponsored by other government agencies and U.S. industry. ITS performs telecommunications research and provides technical engineering support on a reimbursable basis. ITS also has cooperative research agreements with private companies.

(2006)