Wireless Internet Center for Advanced Technologies (WICAT)

A CISE-funded Center

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Millimeter-Wave Propagation: Enhancing Wireless Technology

Testing wireless signals in outdoor environments.

Wireless service providers today face a bandwidth crisis that will soon impede their growth, unless solutions that provide more bandwidth, such as millimeter-wave technologies, are perfected and adopted within the next few years. As mobile data traffic continues to increase at an exponential rate, wireless services are now faced with a bandwidth crisis, as there is not enough bandwidth at lower carrier frequencies to accommodate global data traffic. While current wireless technologies provide data rates on the order of Megabits per second, millimeter-wave devices will offer users Gigabits per second, a 1000-fold increase. These millimeter-wave technologies offer a solution to the bandwidth-crisis, as there are 10's to 100's of Gigahertz of bandwidth available at millimeter-wave frequencies. Successful development of millimeter-wave systems, however, requires accurate knowledge of how millimeter-wave signals propagate and are affected by their environment. Wireless Internet Center for Advanced Tech (WICAT) researchers at the University of Texas at Austin are developing fundamental millimeter-wave propagation models that should lead to wider propagation of wireless signals in outdoor environments. The understandings gained through this research are enabling development of improved millimeter-wave mobile broadband communication technologies and systems. This research is a breakthrough in the sense that this is the first time that millimeter wave channels are studied in an outdoor mobility environment.

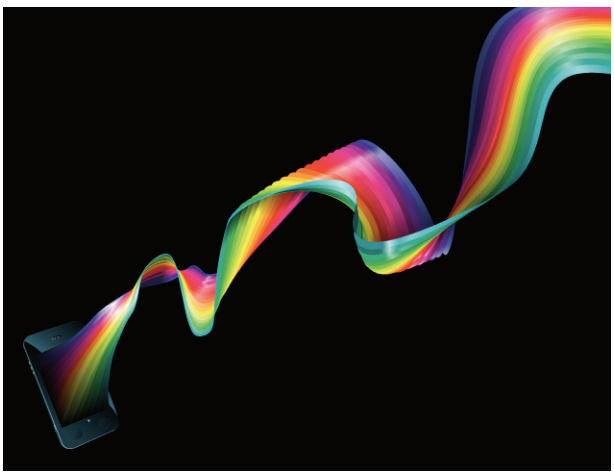
Improved applications of millimeter-wave wireless technologies are everywhere because the application space is broad and growing quickly. These include cellular-phones that will provide data rates of 10's to

100's of Gigabits per second. Data rates in these ranges will enable mobile users to download entire libraries worth of information in fractions of a second. Shorter-range applications, such as wireless home media-centers, are already available, and provide consumers a hint of what is possible with data rates several orders of magnitude greater than what is currently achievable with most wireless technologies, including streaming of high-definition media content. Data centers, which are an increasingly large consumer of electricity throughout the globe due largely to the energy required to cool larger servers, will benefit from millimeter-wave wireless technologies. These data center designs will be more space and power efficient because cables will no longer prevent servers from being arranged for optimal cooling. Millimeter-wave technologies also have applications outside of traditional communications. Homeland security will likely benefit because the nature of millimeter-wave signals are more applicable for detecting motion and for identifying objects hidden under thin layers of clothing or tissue. In the near future, security personnel will likely have mobile hand-held millimeter-wave scanning devices that can detect hidden weapons. Doctors may soon have portable scanning devices that can detect tumors without the need for more expensive technologies.

> **Economic Impact:** It is clear that millimeter-wave systems will enable continued development of wireless technological and market growth. This WICAT research provides the fundamental knowledge to support the continued growth of the communications industry - which accounts for ~8% of the GDP of the United States, or more than $1 trillion of annual revenue. This leadership in the development of millimeter-wave technologies will help ensure the global competitiveness of the communication industry of our nation. By enabling orders-of-magnitude higher data rates the nation's wireless capacity, productivity and competitiveness will be enhanced.

For more information, contact Theodore Rappaport, 512.471.6500, wireless@mail.utexas.edu.

Alleviating the Mobile Bandwidth Crunch



The rapid growth in cellular wireless traffic as a result of the popularity of smart phones has assumed crisis proportions as cellular carriers have scrambled to keep up. A widely quoted study from Cisco estimates that traffic will double every year or so for the next several years. This traffic will increasingly consist of popular video applications such as video streaming, which consumes about two orders more bandwidth than a voice call. Researchers at the WICAT are working on a variety of low cost technologies to provide the required additional bandwidth. These include cognitive radio, which makes use of unused wireless spectrum in a smart way. Other avenues include the use of 60 GHz radio technology, a part of the radio spectrum which has been shown to have much higher range, and is therefore more usable, than previously reported. Advanced wireless chan-

nel aware video compression and transmission technologies will also play a part. Finally, the notion of using relays to extend the range, coverage, and capacity of cellular networks has been pioneered by WICAT.

All of these innovations are now at various stages of adoption or consideration by the cellular network vendors, many of which are industry members of WICAT. For example, partner companies like InterDigital and Samsung have incorporated WICAT research in their future plans. WICAT has also participated in standards bodies to influence their trajectory. Once deployed by cellular carriers, these will enable new applications, many video based, that would have been infeasible without the additional bandwidth unlocked by these technologies. The focus of WICAT is to facilitate the growth of low cost, mobile access to the Internet, using innovative technology.

> **Economic Impact:** The cellular business in the US has annual revenue of approximately $200 billion and employs over 250,000 individuals. Billions are spent annually by the carriers to keep up with demand, most recently with the upgrade to the new 4G technology. We estimate that the technologies WICAT is pioneering will save carriers tens of millions of dollars over the next decade or so by providing innovative, efficiency enhancing solutions to some major problems. This will result in lower cost for consumers and a more internationally competitive industry.

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