Mango Communications designs platforms for high-performance wireless research and development.

Mango was founded in 2008 as a spin-off of the Rice University Wireless Open-Access Research Platform (WARP) project. WARP provides custom, FPGA-based hardware and open-source designs to facilitate rapid prototyping of new wireless research projects. Since 2008 Mango has continued development of both the WARP hardware and open-source designs.

**MOBICOM 2014 DEMONSTRATION**

We present a demonstration of the real-time capture and analysis of multi-user MIMO (MU-MIMO) channel state information from commercial Wi-Fi devices. This demonstration is one of the many research applications enabled by the Mango Communications 802.11 Reference Design, an open-source, real-time FPGA implementation of the 802.11a/g MAC and PHY.

**Demonstration Details:**

- 5 WARP v3 nodes running the Mango 802.11 Reference Design
  - 1 is standard AP serving Internet access to Wi-Fi clients
  - 4 are quad-antenna monitors capturing per-subcarrier channel estimates for real-time analysis
- Custom Python framework coordinates runtime configuration of each node
- Custom PC application displays real-time channel estimates and SU/MU-MIMO achievable rates
- Full 802.11 MAC/PHY source available at http://warpproject.org/802.11

Custom experimental framework allows deep visibility into PHY. Per-packet, per-subcarrier channel estimates are shown.

MANGO 802.11 REFERENCE DESIGN

- Mango 802.11 Reference Design consists of:
  - OFDM PHY implemented in FPGA fabric
  - MAC implemented in bare metal C
    - DCF in low-level CPU
    - AP/STA/IBSS in high-level CPU
  - Control & measurement framework implemented in Python
  - FPGA models, C and Python code all open-source at http://warpproject.org/802.11

WARP V3 HARDWARE

- Xilinx Virtex®-6 FPGA (LX240T)
  - More than 2× the processing power of previous WARP hardware
- Two integrated RF interfaces
  - 2.4/5GHz bands with 40MHz bandwidth
  - 2×2 MIMO on-board
  - 4×4 MIMO with Mango FMC module
- Two gigabit Ethernet interfaces
- 2GB DDR3 DRAM
- Standard FMC HPC expansion slot