Smart Antenna Research Under the GloMo Program
The Problem

Limitations on Capacity
- Co-channel interference
- Multiple access interference
- Adjacent channel interference
- Multipath, fading, and noise

Reality of the Solution
- High power consumption
- Excessive computing needed

Apparent Solution
DSP Interference Rejection Techniques
Research Areas

- Adaptive Antenna and Direction Finding Algorithms and Hardware
- Hand-Held Smart Antennas
- Vector Channel Modeling
Adaptive Antenna and Direction Finding Algorithms and Hardware
Third Generation Array

- **Front End for Antenna 1**
  - **Local Oscillator**
  - **f = 1982 MHz**
  - **f = 2050 MHz**

- **Front End for Antenna 8**
  - **Local Oscillator**
  - **f = 1982 MHz**

- **ADC / DDC (SigTek ST-114)**

- **IF AMP**

- **IF LPF**

- **BPF**

- **Demodulator and Beamforming Algorithm**

- **DSP**
  - **TI C549/C541**

### Applications
- Demonstrate interference rejection through spatial filtering
- Developing spatial channel models
- Study algorithm performance
- Perform AoA estimation for position location applications
- Study algorithm performance

### Code Timing
- Spatial Filters
- Despreaders
- Demodulator
- Beamforming Algorithm
Multi-Target CMA

- RF Front End & Baseband conversion
- CMA
- Port # 1
- User 1 output
- Gram-Schmidt Orthogonalizer
- User M output
- Port # M
Accomplishments

- **Smart Antennas at the Handset**
  - Created and built 2 measurement systems to measure propagation characteristics as seen by the handset.
  - Initial data collection shows an improvement of up to 17 dB in the link budget with adaptive combining and 7 dB with diversity combining.

![Image of Antenna Unit and Measurement System]
MPRG Vector Measurement System

- Fully functional 8 elements, 1.25 MHz Bandwidth, 2.050 GHz center frequency
- Flexible for adapting various antenna/polarization inputs, carrier frequencies, bandwidths, real-time algorithms, or data collection scenarios
- Eight Harris 40214 Programmable Direct Digital Downconverters, eight C54x DSPs, one Analog Devices 21010
- New features being added
  - CDMA capability
  - Improved system executive processing
Research Issues

- Adaptive array algorithm performance in real situations
- Vector channel measurements
- Practical AOA algorithm and hardware development
- Adaptive array algorithm convergence issues
Future Work - Summer 98 Research

MPRG's vector measurement system will be located at a point along the Smart Road and will estimate the angle at which the signal arrives at the array. This angle defines the line of bearing. Channel measurements will also be made to quantify the impact of the channel on measurement accuracy.