UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

SDR and CR wireless research at UoC

Overview of research

- Present an overview of group's research with a thumbnail sketch of various activities.
- Will include description of
  - Senior researchers
  - Past foci of research
  - Current work
  - Some ideas for the future

- Previously much of the work was funded by FRST under the NERF programme.
- Now actively seeking support both within New Zealand and internationally.

The Group

University of Canterbury

Professor Des Taylor

- FIEEE, FRSNZ, FIPENZ, FEIC
- Published over 230 international papers

Assoc. Professor Peter Smith

- SMIEEE
- Published over 90 international papers

Dr. Philippa Martin

- Senior Lecturer, SMIEEE.
- Published over 30 international papers

Past Focus Areas

- **Advanced wireless transceiver structures**
  - SVD transceivers, MMSE combining, channel inversion, SIC, beam forming. Many papers in performance analysis.
  - Per survivor processing receivers employing state space models to adaptively equalize fading dispersive channels.
  - MIMO equalization with integrated channel estimation.
  - Developed software defined MIMO radio system (SASRATS) prototype to test many of the concepts.
- **Ultra wideband systems**
  - Novel channel models and capacity analysis presented
  - Experimental work in the U.S. on rate limits for UWB in vehicular environment.
- **Information theoretic limits on MIMO capacity**
  - Leading work on MIMO capacity analysis and performance limits.

Past Focus Areas cont'd.

- Diversity schemes, performance and reliability
  - Performance analysis of diversity systems which pioneered the application of random matrix theory in communications.
  - New high throughput (rate>1) non-orthogonal space-time block code (STBC) designs using lattice theory and list processing detection techniques.
  - HARQ schemes for non-orthogonal STBCs.
  - High rate space-time trellis codes (STTCs) for QAM using multilevel coding and antenna grouping.
  - High rate STTCs for CPFSK with potential application to emergency services systems.
  - Analysis and development of channel models, evaluation of standards models and models for polarized and 3D propagation.

Recent and On going Focus Areas

- **Cognitive radio**
  - Applications of beam forming, antenna selection, pre-coding, relays and distributed sensing to improving CR performance.
  - Prototype smart radio terminal with mode switching developed.
  - Work on CR channel allocation (Hanif will present shortly)
- **Cellular and multi-user MIMO**
  - Analysis of MIMO in a cellular context. Also, applications of CR in cellular systems. An overall focus on performance analysis in typical cellular environments.
  - Frequency domain equalization with integrated iterative channel estimation.
  - Multi-user detection for overloaded systems (Michael Krause will have more on this shortly).
- **Distributed/co-operative communication systems including relays**
  - Cellular cooperation, relay analysis and evaluation of relay benefits in realistic channels. Asymptotic relay analysis and virtual MIMO.
  - Distributed coding and detection.

Present and Future

- Network MIMO
  - Block diagonalization of channels, local cooperation, cognitive applications.
- Cognitive Radio
  - Imperfect CSI effects, and interference reduction methods.
  - Spectrum sensing based on sequential detection techniques.
- Relays
  - Capacity analysis, cognitive applications, asymptotic analysis, selection, coding and detection algorithms, equalization and channel estimation.
- Multi-user Signal Processing
  - Beam forming, precoding, selection, detection algorithms, equalization and channel estimation.