



Advanced Wireless Access @Bristol Instrumentation and examples of usage

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Overview

- Multi-dimensional Channel Measurement and Channel Emulation Equipment @ Bristol
- Examples of use:
 - MIMO test bed
 - MIMO OTA
 - Real-time characterisation of MIMO channels
 - Analysis of data
 - Novel scenarios
- Observations and Recommendations

🔥 Elektrobit PropSim C8

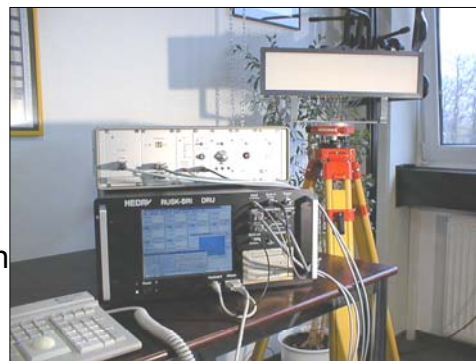


- Test real (RF) devices over arbitrary fading channels
- MIMO Channel Emulation
- RF, ABB, DBB in/out
- 350 MHz – 6.0 GHz centre freq.
- 70 MHz RF bandwidth
- CIRs with up to 8x24 (=192) paths
- 0.1 ns delay resolution, 400 μ s max. delay spread, 100 kph max. speed
- Common fading models + Doppler + shadowing + AWGN + correlation

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🔥 Medav RUSK Vector Channel Sounder

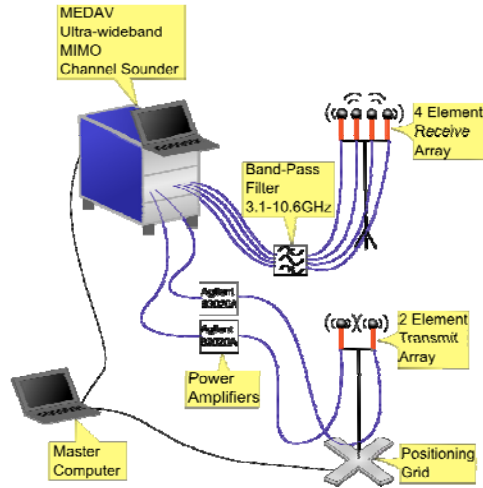
- 16 x 16 MIMO Sounding
- Remote sync for outdoor mobile operation
- 1.8 to 2.5GHz and 5.2GHz RF carrier (customisation possible)
- 120MHz sounding bandwidth (variable in 5MHz steps)
- Technique: Periodic Multi-tone
 - 0.8 - 25.6 μ s



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Medav UWB Sounder

- 3.8GHz To 10.1GHz
- 2 x 4 MIMO Operation
- Time domain
 - Correlation of PN Sequence
- Collocated Transmitter / Receiver
- 42dB dynamic range
- 20.5ms SIMO (1x4) acquisition time



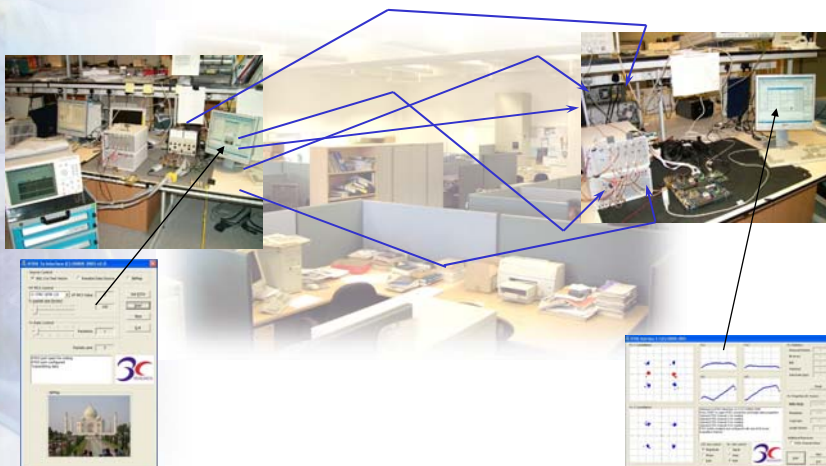
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CCR
Centre for
communications
research

3C
RESEARCH
OSIRIS

OSIRIS MIMO Demonstrator



TOSHIBA Provision
communications

STMicroelectronics

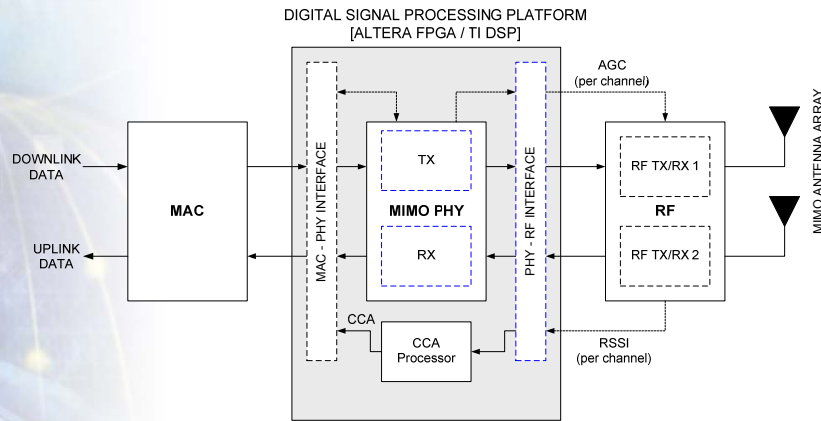
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QinetiQ

UAE
Technologies

Convergent technology research for digital media processing and communications

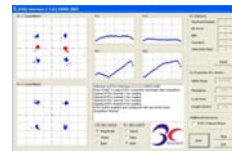
System Block Diagram



Convergent technology research for digital media processing and communications

OSIRIS MIMO Testbed

- **MIMO enabled real-time wireless modem demonstrator with IP connectivity**
 - **Compatible with 802.11a waveform design and signalling structures**
 - *Bespoke Modem implementation (Digital & Analogue RF)*
 - *Full Modulation Coding Scheme (MCS) set supported*
 - *Integrated Medium Control Access (MAC)*
 - **2 x 2 antenna configuration**
 - *Flexible antenna deployment*
 - *Scaleable*



Convergent technology research for digital media processing and communications

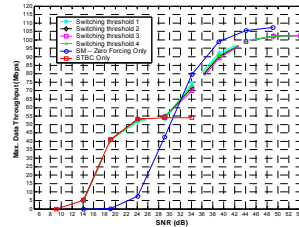
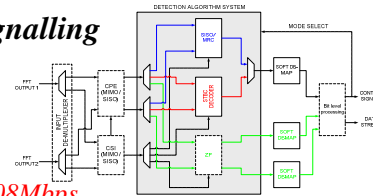
OSIRIS MIMO Testbed

– **Dynamic selection of MIMO signalling modes & MCS set:**

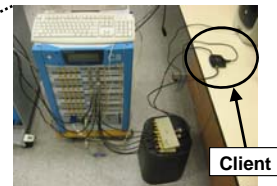
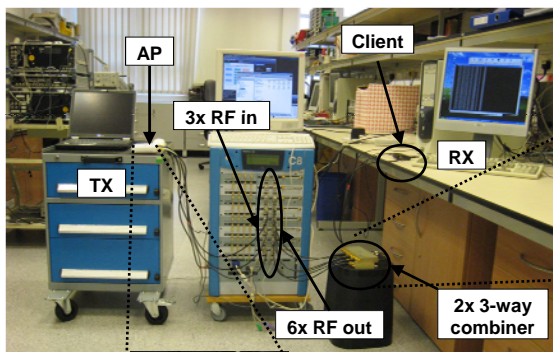
- Transmit vector structure based on 802.11n concepts
- Spatial Multiplexing for spectrum efficiency enhancement, offering 108Mbps
- Space Time Block Codes for robust operation

– **Adaptive MIMO mode selection**

- Extraction of spatial signal structure (Singular Value Decomposition - SVD)
- MAC enabled Transmit feedback

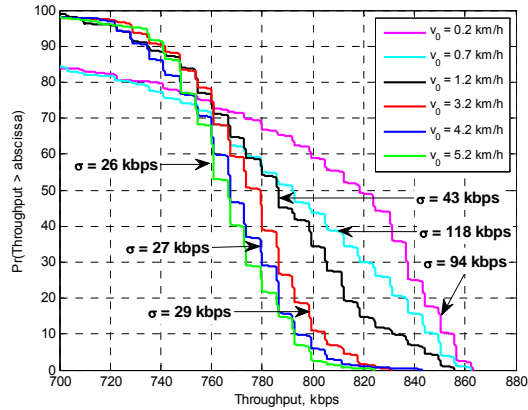


Channel Emulation: 802.11n



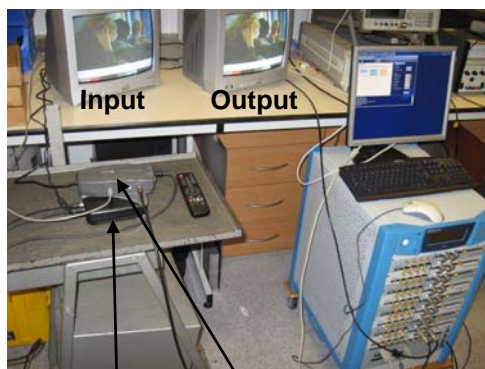
- Close emulation of 11n models
- 3 x 2 MIMO commercial pre-11n kit
- Measured 'broadcast' throughput

802.11n sensitivity to Doppler



- 11n throughput shows much sensitivity to Doppler changes
- Low data rate due to apparent limitation of AP in broadcast

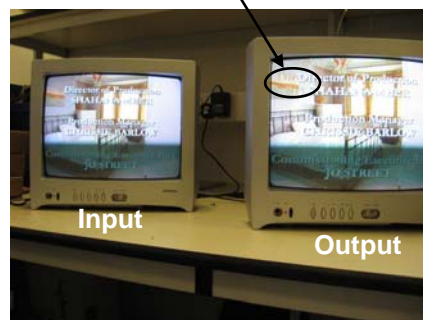
Channel Emulation: DVB-T



DVB-T
broadcast

Amplifier /
Splitter

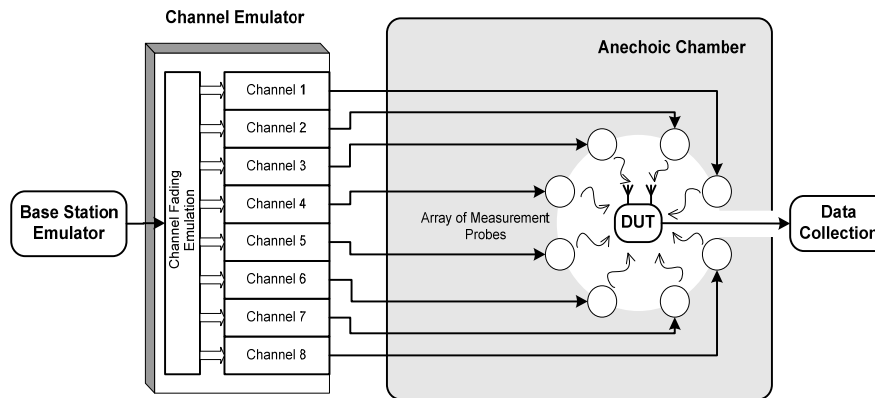
2-tap channel ghosting



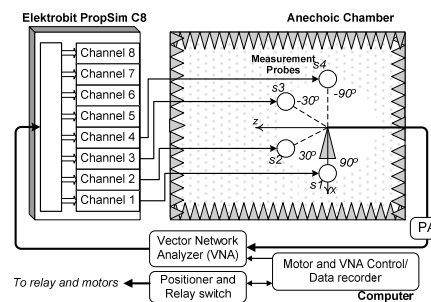
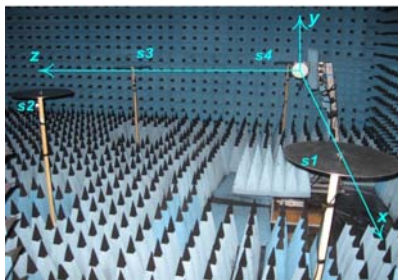
Input

Output

Over the Air performance testing (OTA)



Antenna performance evaluation (single plane)



- Four-antenna, semi-circular setup used to evaluate antenna performance in the 2D azimuth plane.
- Anechoic chamber radiation measurements of 4 probe environment.
- PropSim C8 driven by CW from the VNA.

MIMO Measurements & Analysis



- Objectives

- Capture the dynamics of the wideband 4x4 MIMO channel in an urban macrocell at 2GHz
- Compare realistic laptop and PDA terminal antenna configurations, including the effect of the user
- Compare channel statistics at 2GHz and 3.5GHz using ray-tracing tools
- Assess feedback requirements for closed loop MIMO schemes using measured channel dynamics

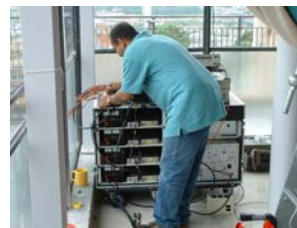
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MIMO Antenna Configurations



Elective



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Measurement Campaign



Area 3: Queens Square, Waterfront & City Centre

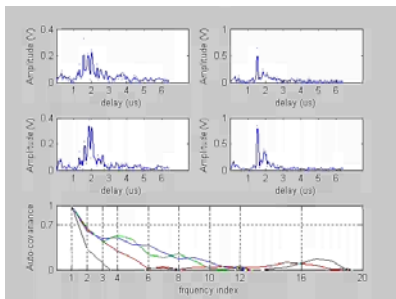


Knights Templar

Some Results

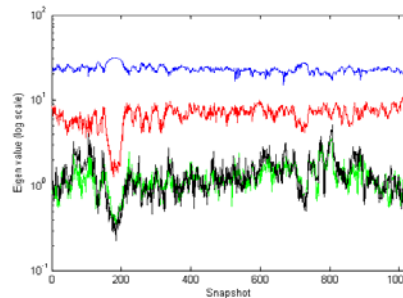


Elective



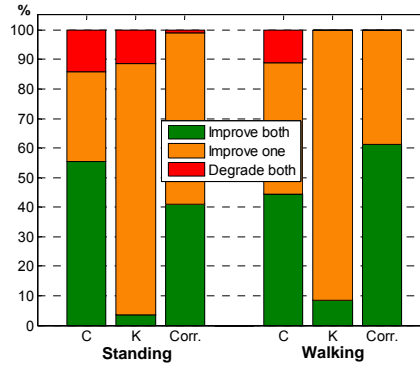
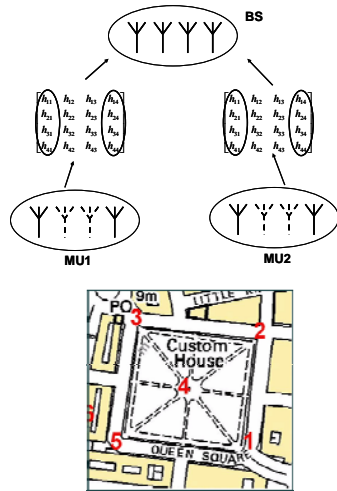
Coherence Bandwidth of Eigenvectors

Eigen dynamics for 4 x 4 system deployment



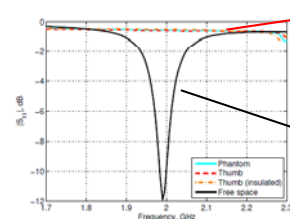
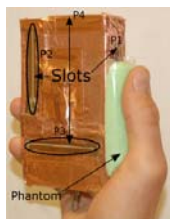
M. Webb, M Hunukumbure & M Beach, "Eigen-Coherence and Link Performance of Closed-Loop 4G Wireless in Measured Outdoor MIMO Channels", IEEE Trans on Antennas and Propagation

Virtual MIMO In Real Channels

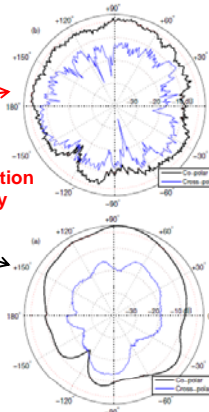


M. Webb, M. Yu, and M Beach, Propagation Characteristics, Metrics, and Statistics for Virtual MIMO Performance in a Measured Outdoor Cell, IEEE Transactions on Antennas and Propagation, Vol. 59 No. 1, Jan 2011, pp236-244.

Smart Phones: The Grip of death



-20dB reduction in Sensitivity



M. Webb, D Gibbins & M Beach, 'The Effects of User Grip on Smartphone Antenna Performance and Signal Quality', IEEE Antennas and Wireless Propagation Letters, Vol 9, 2010, pp1053-1056.

🔥 Observations and Recommendations

- Clear objectives / goals to define our activity
 - Beyond 'state-of-the-art'
 - Donor air-interface (Phy-level equipment / Network I/O)
- Resources
 - Appropriately skilled staff
 - Availability of Equipment
- Other issues
 - Risk Assessment
 - Equipment Insurance
 - Ofcom 'Non operational license'