

Centre for Communications Research

Collaboration and Technology Transfer between Academia and Industry: Some Case Studies

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Director, Centre for Communications Research



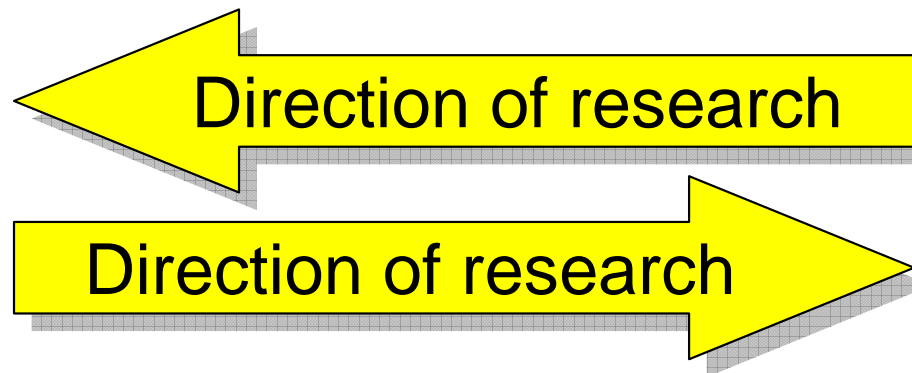
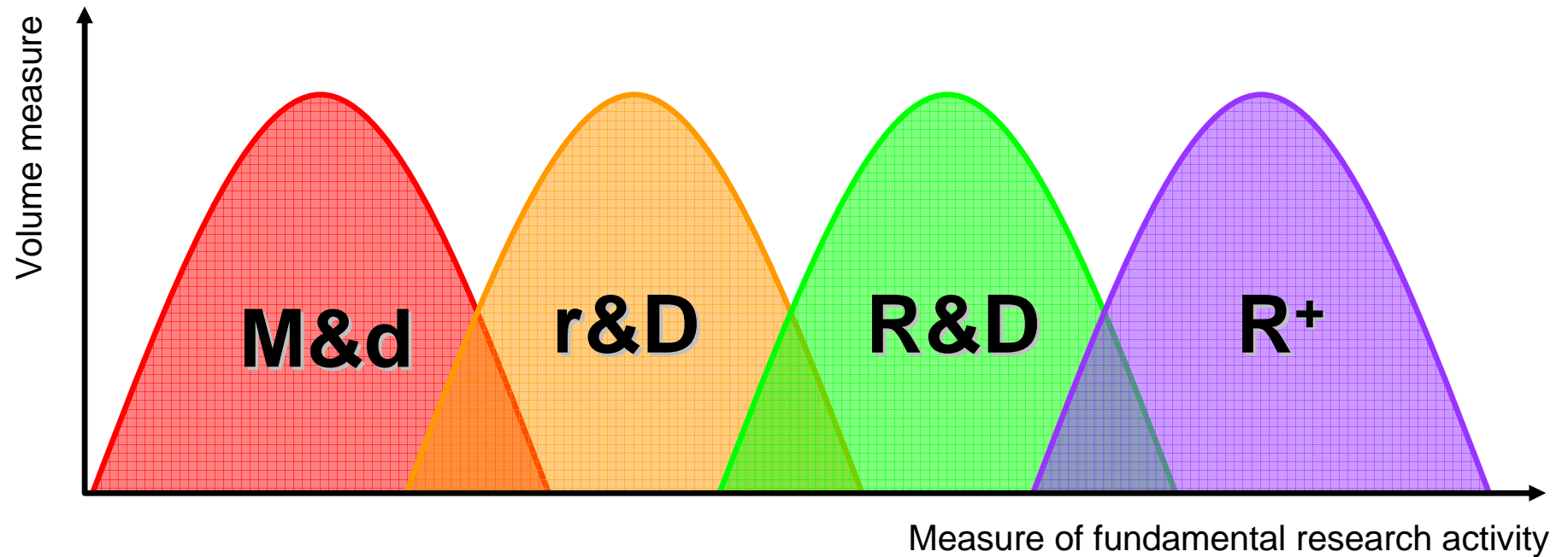
“Reality is merely an illusion,
albeit a very persistent one!”

“*Commercialisation* is merely
an illusion, albeit a very *time-*
consuming and costly one!”

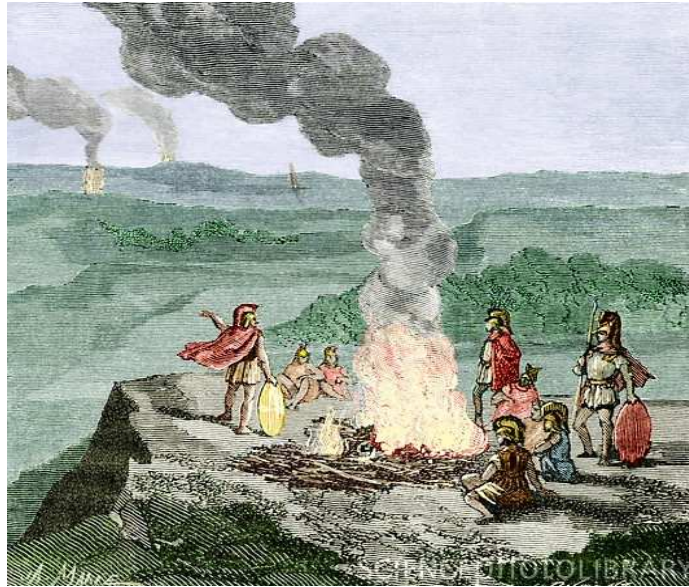
Introduction

- Perspectives on R & D
- Where do universities fit in?
- CCR, its vision and some of its achievements

Perspectives on R&D



Mobile communications in history



Credit: Sheila Terry/Science Photo Gallery



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Credit: Sheila Terry/Science Photo Gallery

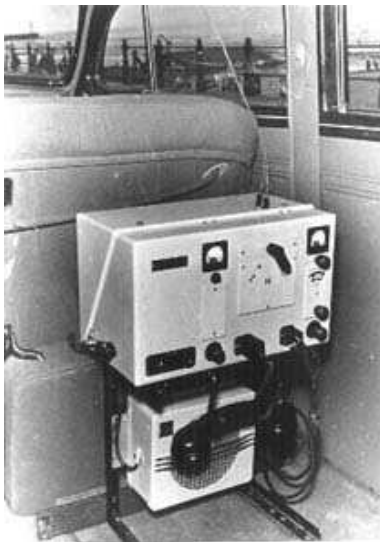


Credit: Leslie J Borg/Science Photo Gallery

Marconi



Mobile communication in its infancy



A personal change in direction: Early 1970s

- Importance of diversity
 - Gas discharges, semiconductors and their applications to radar, telecoms and high-speed digital circuits
- During the Fuel Crisis of 1974
 - Cost of oil rocketing
 - Impacting business
- Changes to allocation of spectrum for mobile communications
 - Continuous reduction over several years
- What role could efficient mobile communications play?

Modulation

An apparent dead end - 1973

- Wireless communications world-wide largely based on Frequency Modulation (FM)
- AM not recognised internationally for mobile
- Mobile communications bandwidth continually being reduced
- The only solution was to increase spectrum allocation
 - Apparently too difficult to solve the problems of transmission
- Alternative approaches required

Raytracing for propagation prediction

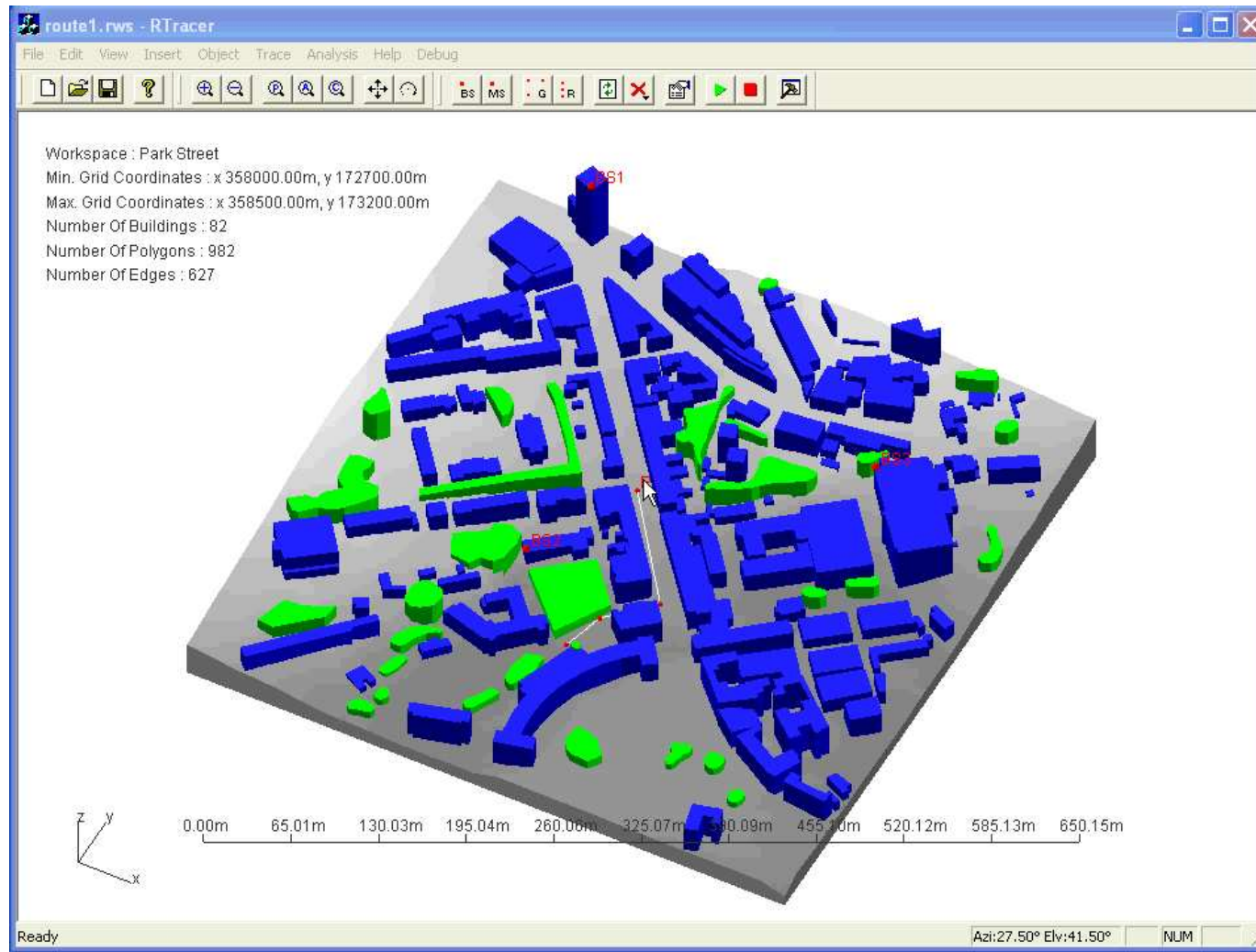
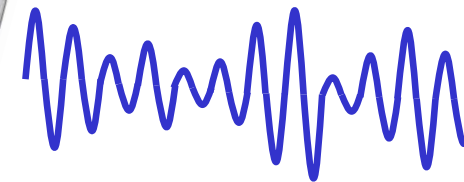
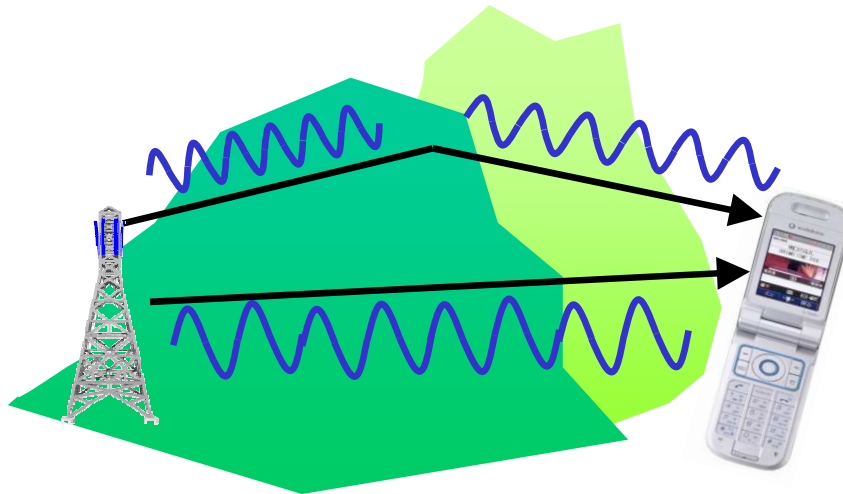
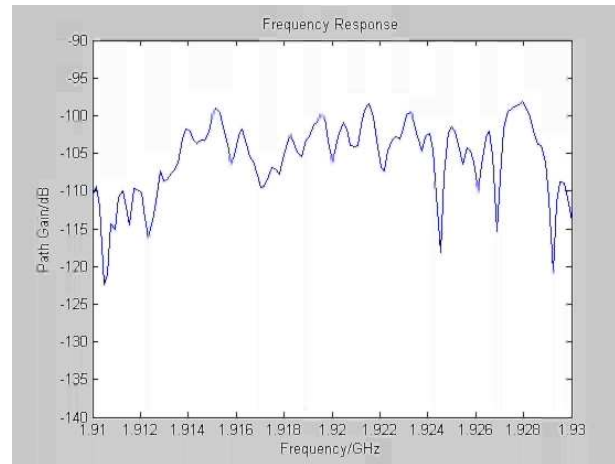


Illustration of multipath fading distortion



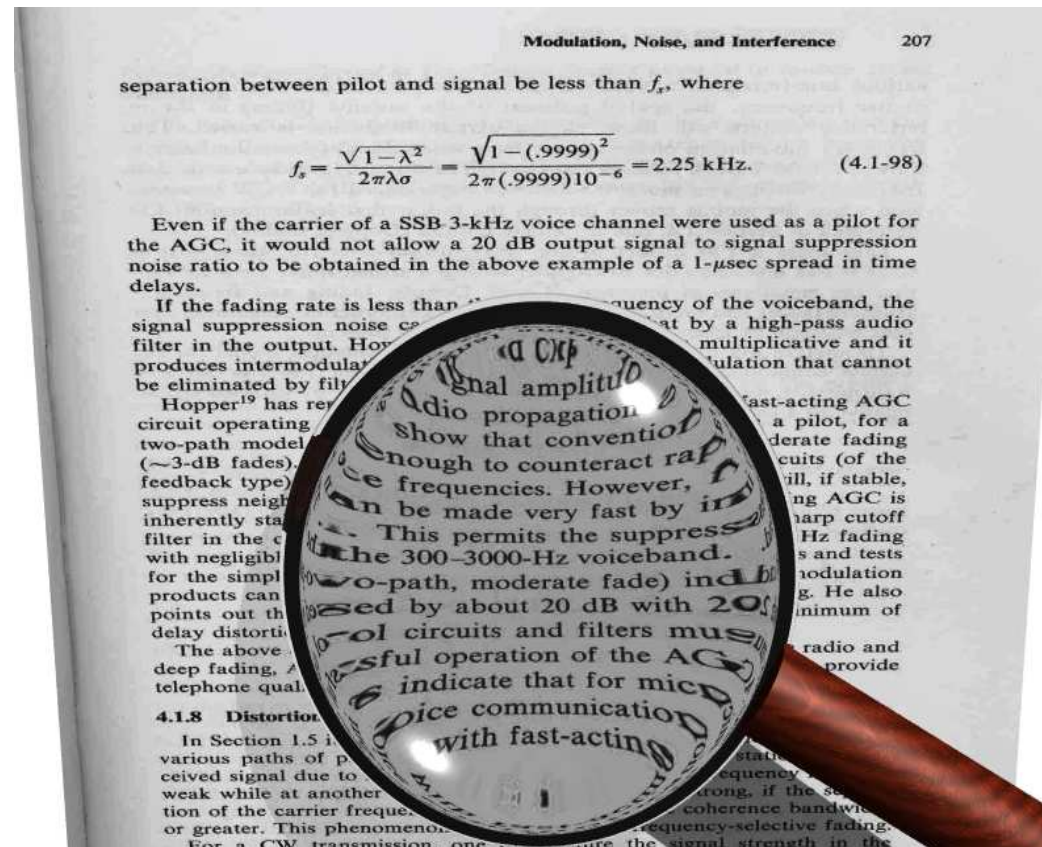
Faded signal

Conventional AM Radio



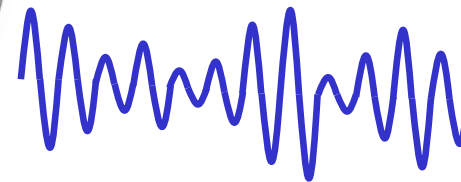
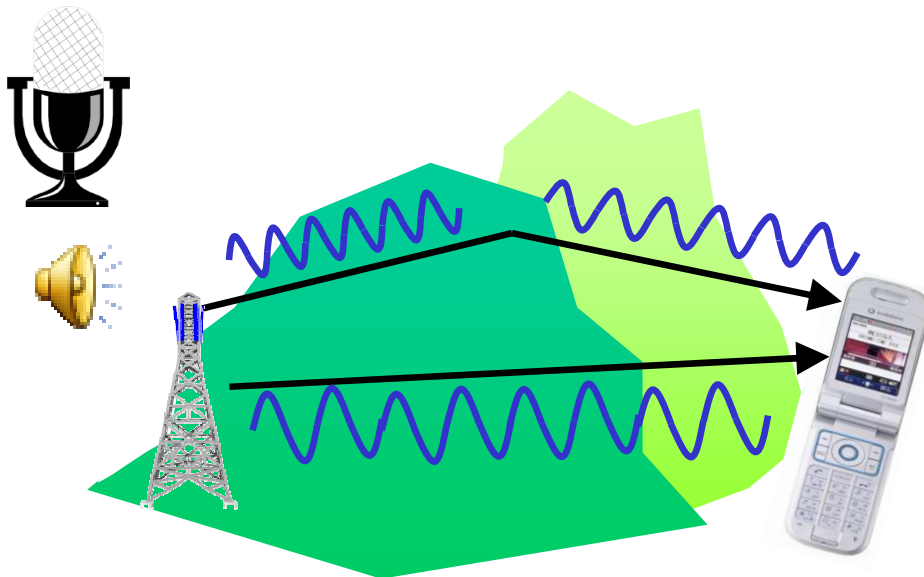
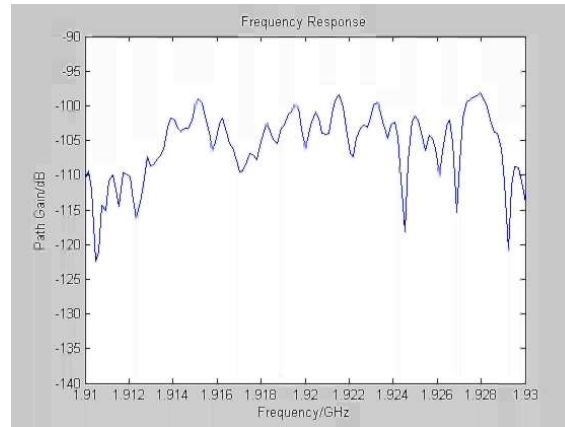
Achieving the impossible?

“The above considerations indicate that for microwave mobile radio and deep fading, AM and SSB voice communication channels cannot provide telephone quality signals, even with fast-acting AGC of any type.”



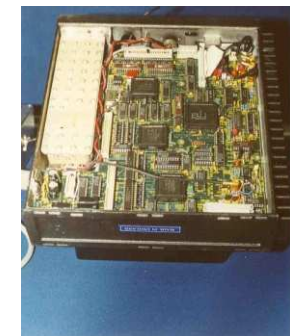
Microwave Mobile Communications, William C Jakes (ed.), pub. John Wiley & Sons, 1974

Solution to multipath fading distortion



Faded signal

Conventional AM Radio



Feed-forward Signal

Regeneration (FFSR) as employed in US West demonstrator

Early mobile developments (circa:1980)

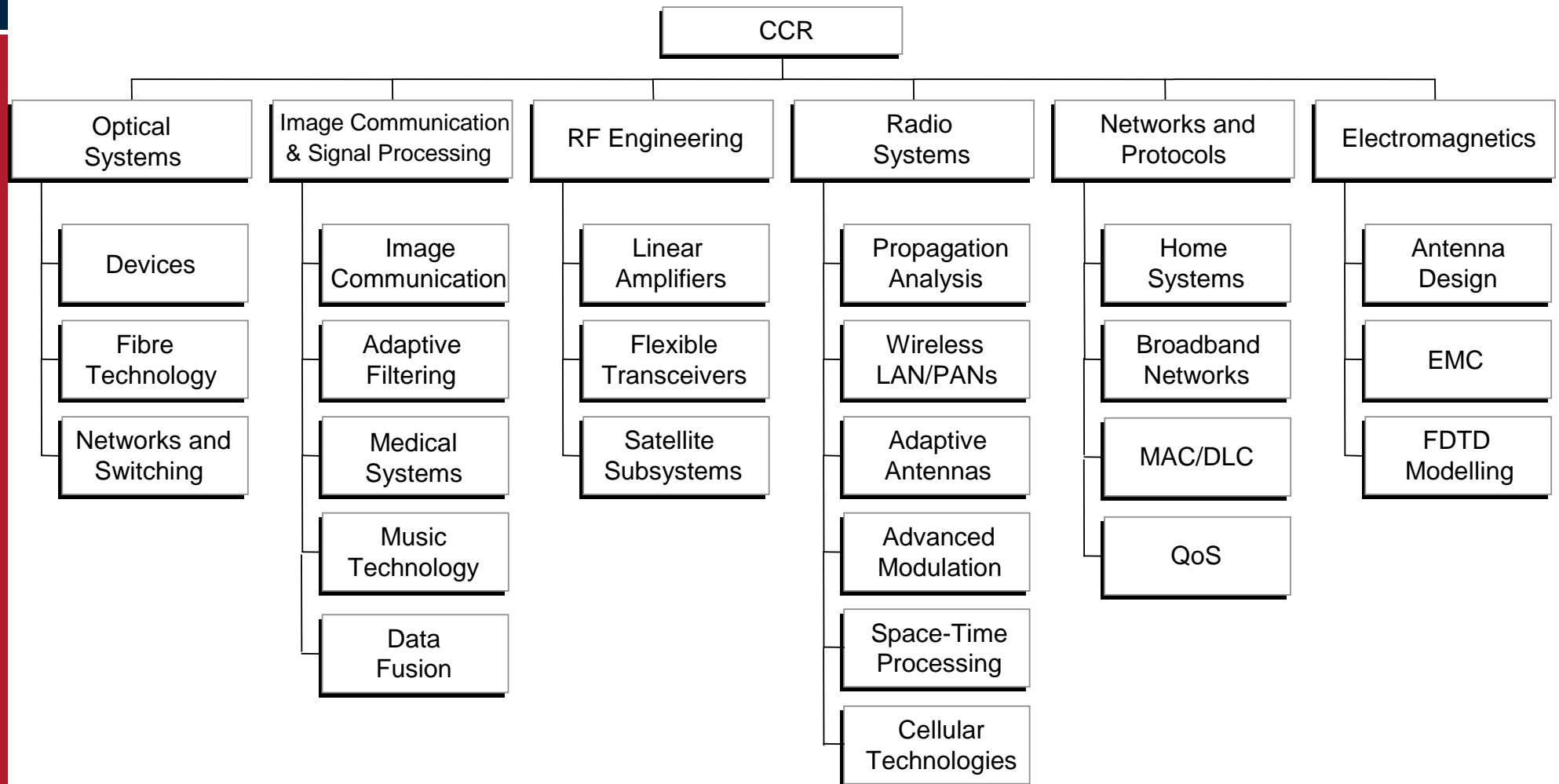


Image from PYE Museum Website <http://www.qsl.net/gm8aob/group.htm>
© J M Briscoe 2004

Centre for Communications Research

- Interdisciplinary research centre within Department of Electrical and Electronic Engineering
- Established in 1987
- Successful model repeated around the world
- Currently home to over 140 researchers involved in areas including:
 - Wireless Communications
 - Electromagnetics
 - Signal processing
 - Networks and Protocols
 - Photonics & Quantum Information

Organisation & Structure of Research

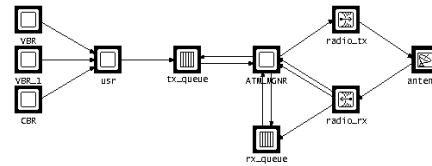


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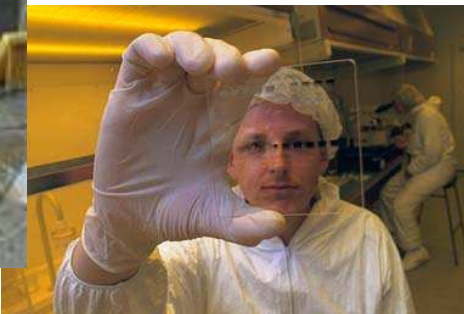


Image & Video Coding

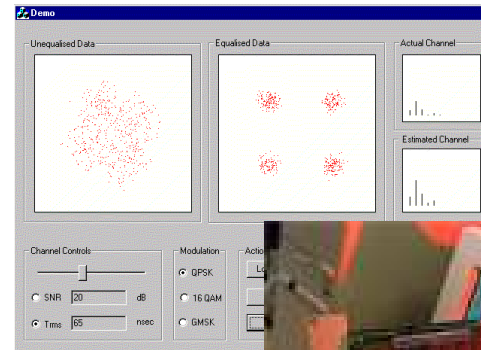
Networks & Protocols



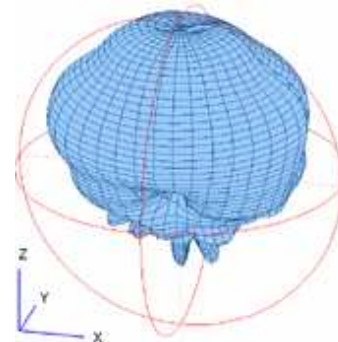
RF Engineering



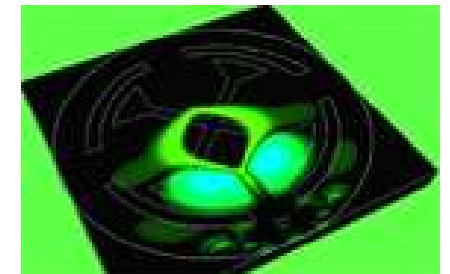
Optical Communications



Radio Systems Engineering



Electromagnetics



Sources of Funding

- The CCR attracts funding from:

UK EPSRC & TSB

Industry, both European and International with companies such as AKM, Kyocera, Fujitsu, Toshiba, Mitsubishi, BT, Micron, Motorola, Ericsson, HP Labs , QinetiQ, Thales, Sony, ST Micro BBC & Granada

European Commission

Government Departments/Agencies, e.g., MOD

Virtual Research Centres, such as the Mobile VCE

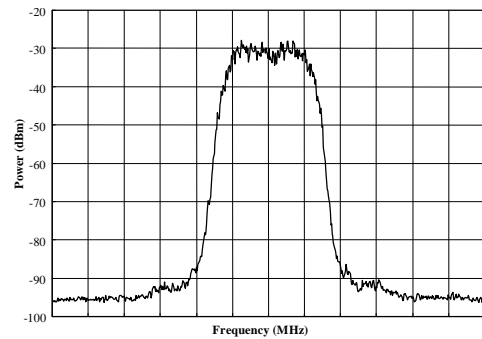
University Innovation Centre (UIC) scheme for collaborative research in Communications, Content and Computing, through 3CR Ltd.

Key achievements

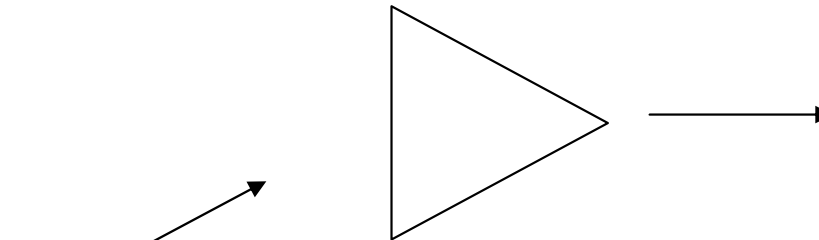
- Raytracing
 - Outdoor, indoor, hotspot...
- State of art RF amplifiers
 - Highly linear, power efficient
- Linearised mixers & linear modulation
- Smart antenna arrays
 - Diversity, SIMO, MIMO, testbeds
- CDMA
- Spatial temporal propagation
 - Modeling and measurement
- Physical layer/MAC layer interactions
 - Novel protocols and radio resource management

Amplifiers

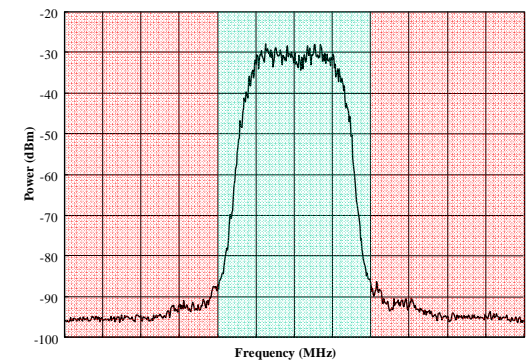
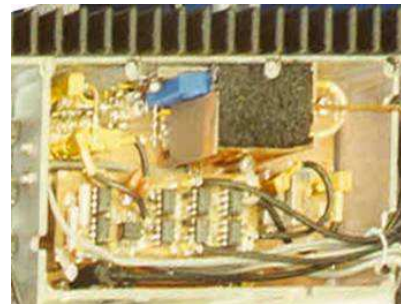
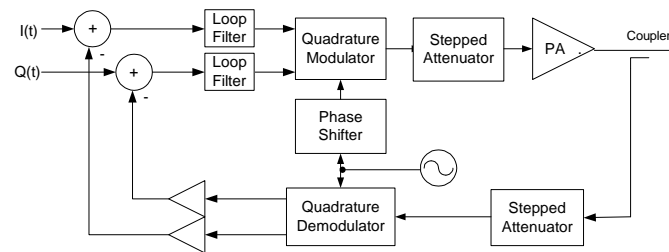
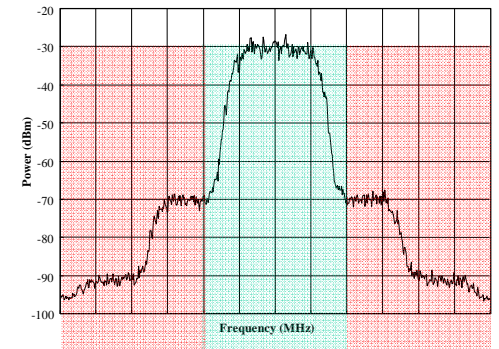
RF Amplification for Linear Modulation



Linear
Modulated
waveform
(DQPSK)

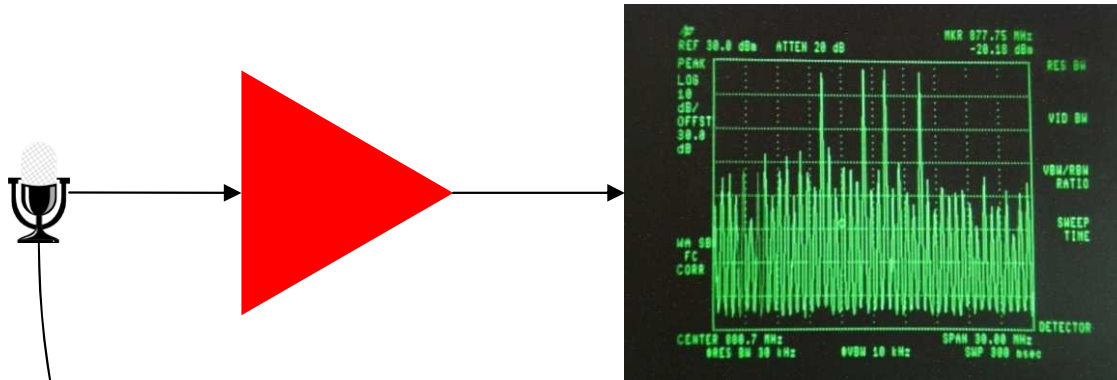


Conventional
RF Amplifier

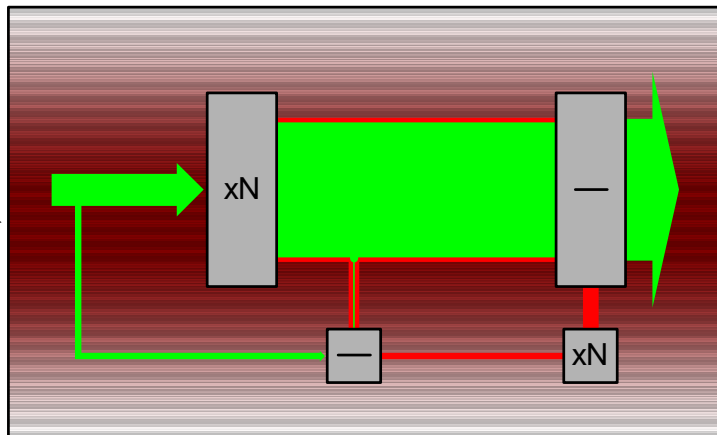
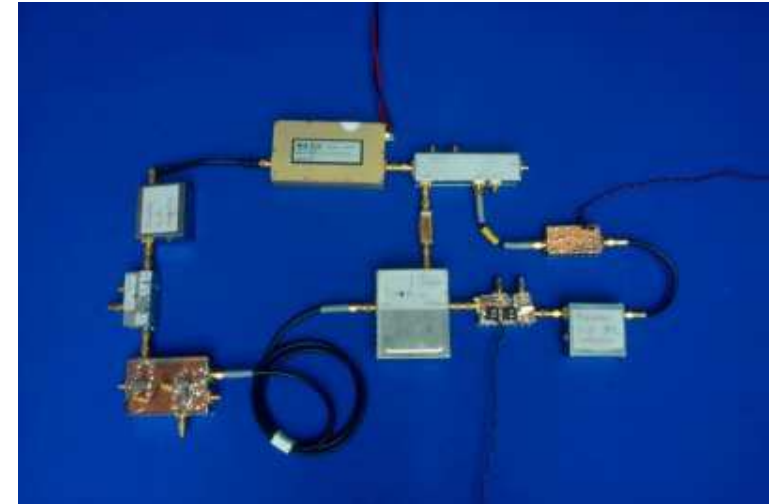


Linearised RF
Amplifier

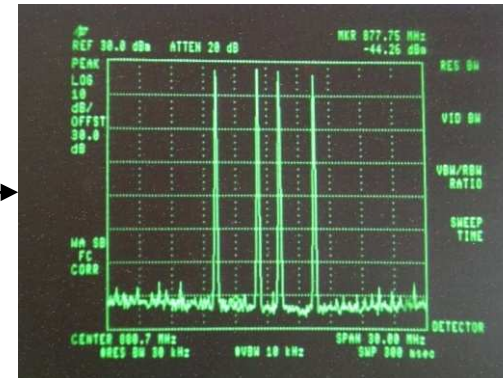
Broadband Linearised Amplifier



Conventional Amplifier

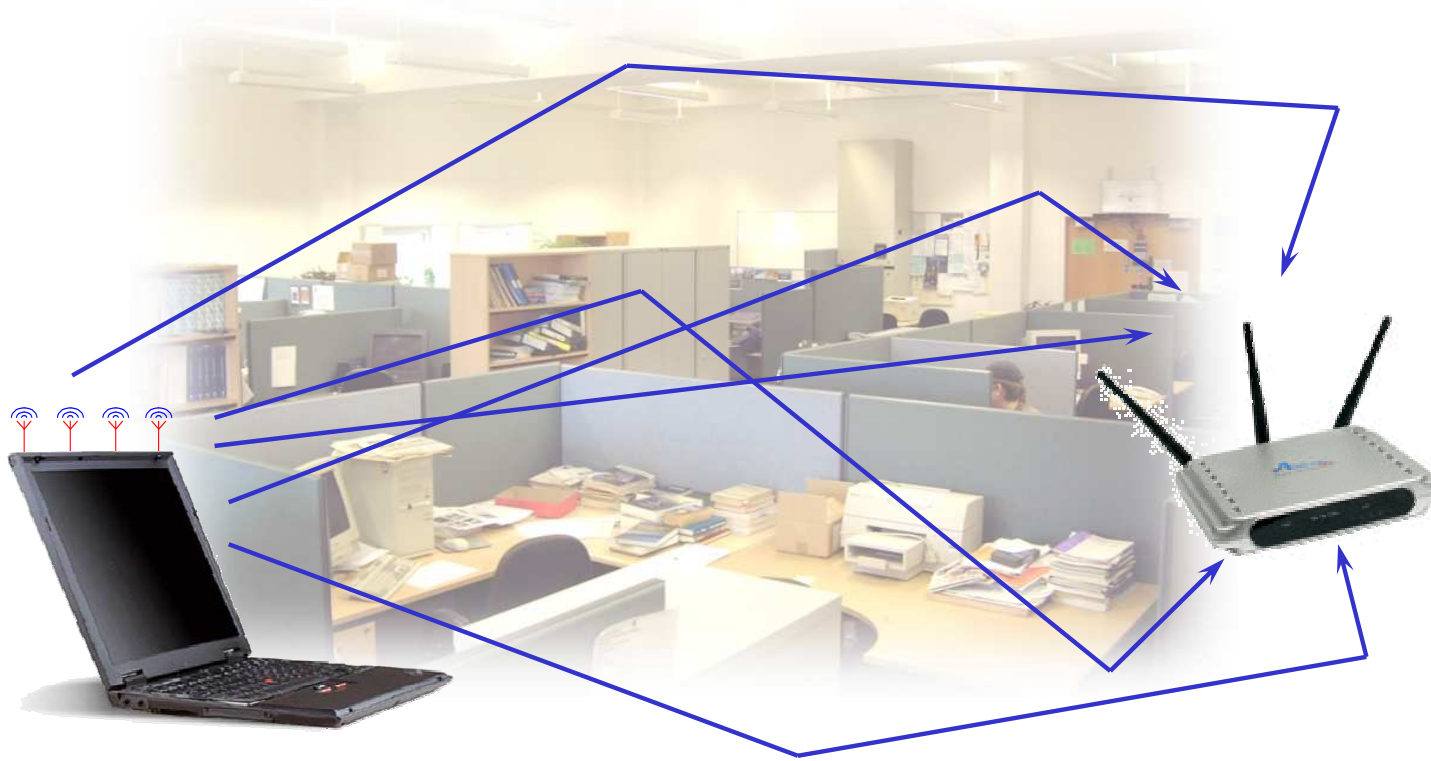


Feed-forward
Linearised Amplifier



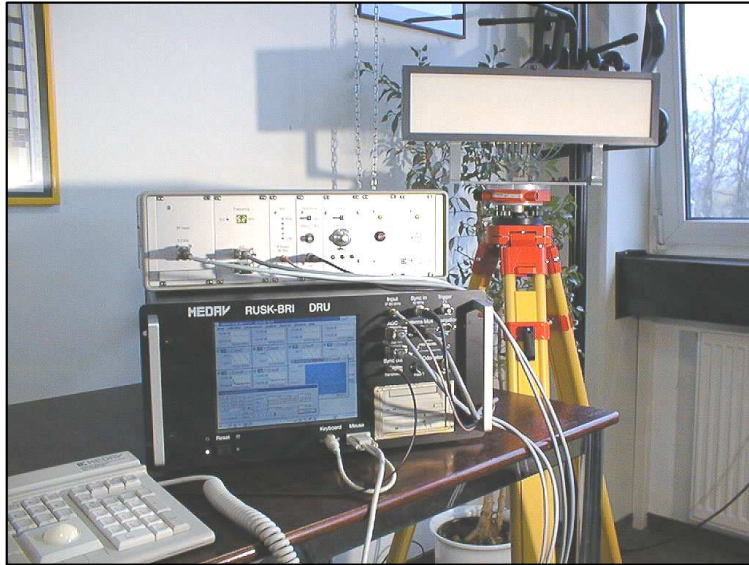
MIMO

MIMO: Multiple Input Multiple Output

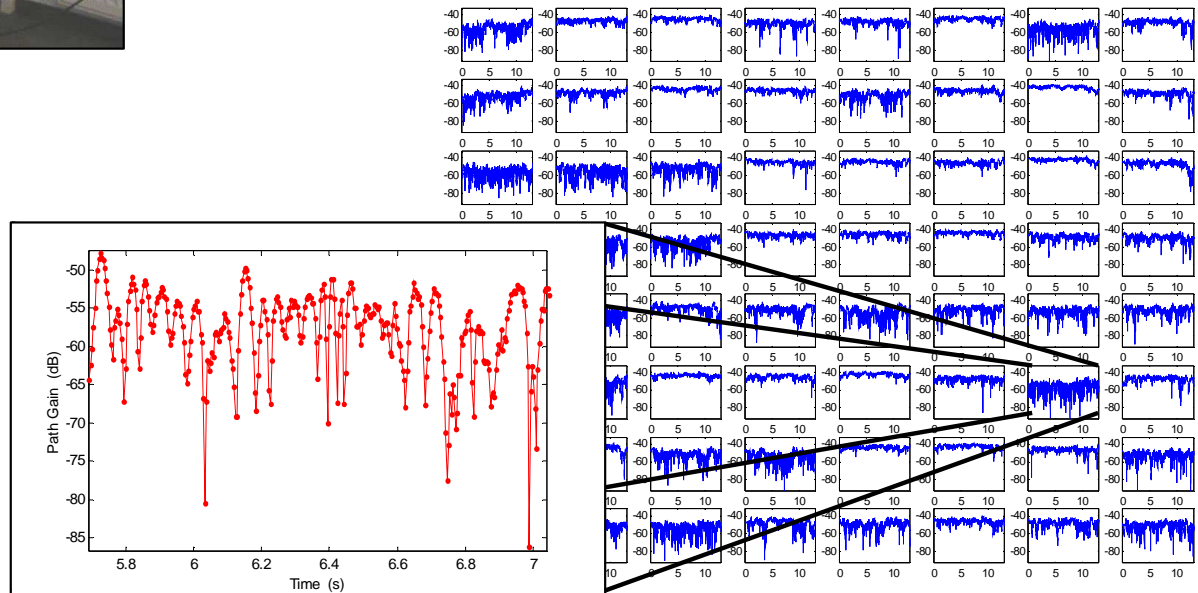


- High data rates
- Spectrum efficient
- Better performance and coverage

MIMO: Propagation measurement & analysis

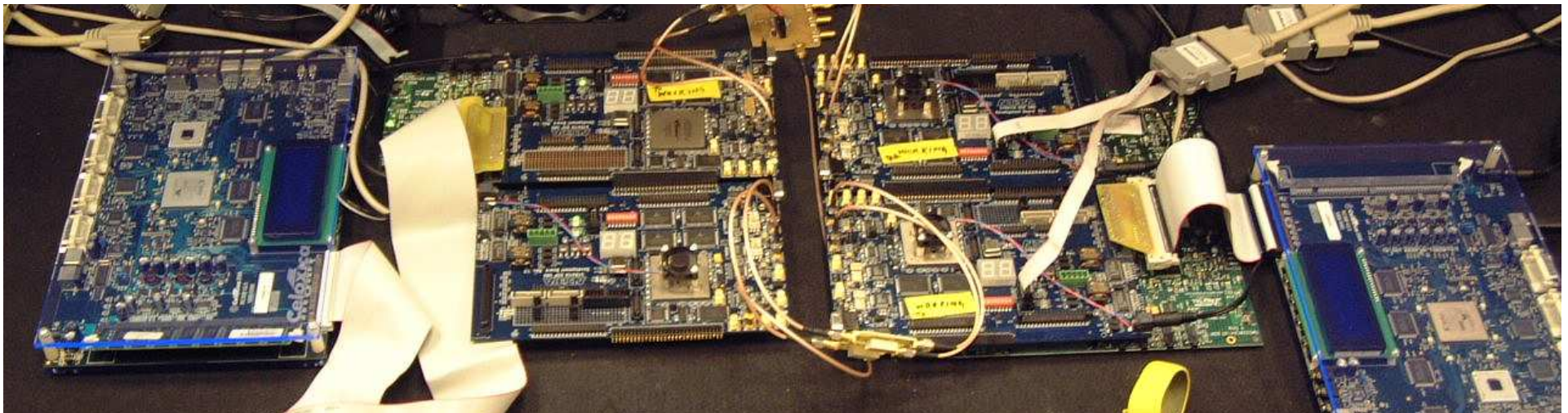
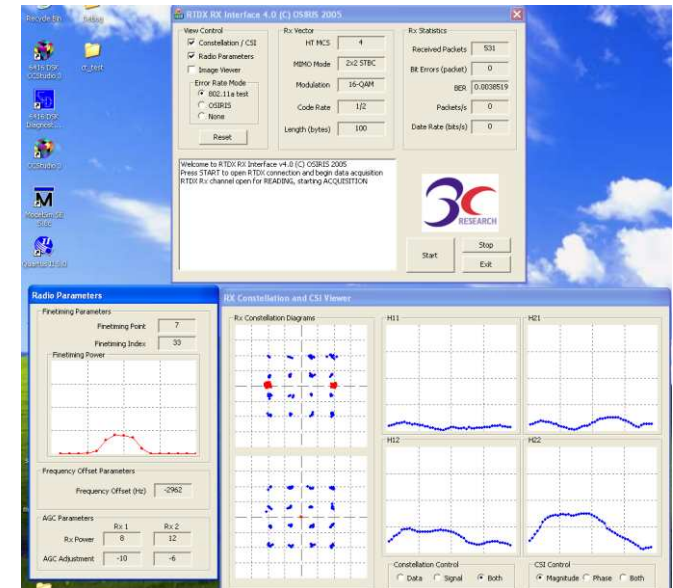


- State of the art channel sounding
- Extensive analysis & modelling
- Fundamental understanding of MIMO communication
- Realistic simulations



MIMO: Real-time MIMO hardware testbed

- DTI funded project
- Transfer of knowledge, skills and expertise from theory to simulation, through to implementation



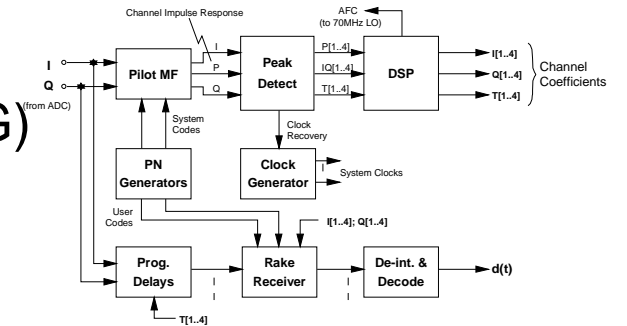
Further examples of innovation



Speech Scrambler



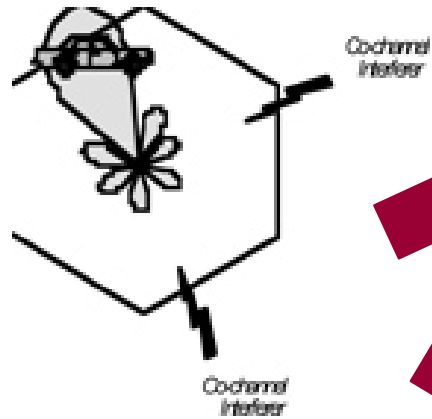
Wideband CDMA (pre 3G)



Conformal Antennas



Underpinning of New Research Concepts

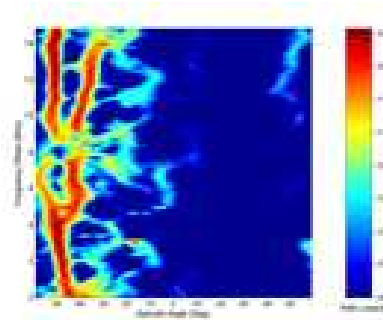


EPSRC
Engineering and Physical Sciences
Research Council

**Adaptive Antennas for
Cellular (1986-1990)**

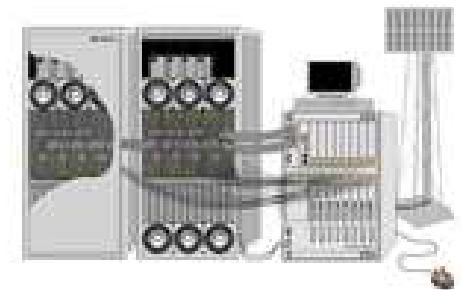


**EU RACE & ACTS
TSUNAMI Projects
(1994-1998)**



EPSRC
Engineering and Physical Sciences
Research Council

**Optimisation of Adaptive
Antennas for UMTS
(1997-2000)**



**Commercial
Exploitation**

Underpinning of New Research Concepts



**EU SATURN
(1987-1990)**



**WLANs & Adaptive
Antennas (1986-2002)**



**Mobile VCE Core 2
(2000-2004)**



**Spectrum
Efficiency
Scheme**



What is Mobile VCE ?

- *Mobile VCE is a company established by the industry to facilitate effective industry-led long-term research in mobile communications*
- *Mobile VCE provides its members with*
 - *a Virtual Centre of True Excellence – access to the highest quality research skills & staff*
 - *research that is timely, leading-edge and industrially-relevant*
 - *innovation - valuable IPR*
 - *mechanisms to facilitate commercial spin-off*
 - *very high financial gearing of members' subscriptions*

MVCE Industrial Members: many of the world's leading communications companies define & steer MVCE's long-term, world-class research



Alcatel-Lucent



Recap

- *Universities are primary sources for fundamental research*
- *Fundamental research married to application is of importance to both universities and the industry*
- *CCR has been highly successful in industry/academic collaboration*

Thank you for your attention

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