UHF Broadband and Multi Band RF Design

A two day programme for engineers and team leaders involved in UHF broadband multi band cellular transceiver and integrated UHF (TV) receiver design. The programme is also relevant to policy makers needing to understand **how the RF performance of user devices** including smart phones, lap tops and net books **determines future spectral value**.

Date

Wednesday 29th September and Thursday 30th September 2010

Venue

Smith Centre Fellow's Room The Science Museum - the Science Museum is a short walk from South Kensington or Gloucester Road tube stations. The workshop includes a privileged evening guided tour of the telecommunication exhibits in the museum.

For long distance delegates, the venue is accessible from all major airports and London main line stations. Fast transfers can be arranged from London's Heathrow airport. Overnight accommodation in local hotels can be booked via the **Imperial College web site**

Background

Modern RF design procedures draw on a wide range of computer modelling tools but successful RF design is still dependent on engineers having an in depth understanding of RF component and RF circuit behaviour. Additionally, open and closed loop adaptive techniques implemented at base band have to be closely coupled with RF measurement and RF circuit behaviour over a wide range of operating conditions.

The programme draws on over 40 years of practical RF design experience combined with an in depth exposure to modern simulation and RF and baseband optimisation techniques and includes a comprehensive review and analysis of new passive and active materials, new components and innovative circuit and adaptive control techniques.

Objectives

To review UHF and multiband transmitter/receiver architecture options, particularly the main performance influencing parameters in multiband multi standard transceivers. To characterise these parameters and consider how they can be optimised in terms of device and design options, 'good practice' circuit layout techniques and system implementation.

Delegates will learn how to optimise component choices and design processes to achieve

- Optimisation of key UHF/ multiband and multi standard RF parameters including noise, gain, stability, sensitivity, selectivity and power efficiency.
- An understanding of individual parameters and how they influence RF and baseband system performance and overall network performance.

Scope

This is a **practical** rather than academic programme focusing on real life components and design processes and performance optimisation techniques.

The programme goes 'behind the results' to understand how RF circuits and related base band functions behave under a wide range of operational conditions. We review the 'do's and don'ts' of RF and base band design procedures to ensure greater consistency in end product performance.

The techniques addressed in the programme will assist design engineers to make more informed device, design and architectural choices and to implement those choices with greater confidence.

The Design Challenge

Design and manufacturing teams are being asked to produce mobile phones, lap tops and base stations that cover at least five frequency bands.

However the requirement is broadening to include UHF transmit and receive capability either in the 700 MHz band (USA and parts of Asia) or 800 MHz band (Europe and other parts of Asia).

Some devices, particularly 'larger than smart phone form factor devices' are also expected to receive DVB-T or ATSC TV broadcasts and there are present discussions on the viability of re broadcasting TV using cellular base station hardware.

The 700 and 800 MHz UHF bands introduce specific design challenges both in terms of operational bandwidth and size constraints including a need to implement adaptive matching and other adaptive techniques in order to increase operational bandwidth beyond traditional 'good practice' limits.

Additionally the transceivers have to co exist at a minimum with the 850 MHz and 900 MHz bands, 1800 and 1900 MHz bands, 1.9/2.1 GHz (Band 1) and other radio functions, for example Wi Fi and Bluetooth at 2.4 GHz and GPS and FM receivers.

In the longer term there will be a need to support 2.6 GHz, possibly 3.5GHz and additional regionally specific allocations. Integrated 'White Space' cognitive transceivers have also been proposed.

A requirement to support multiple standards introduces significant complexity, for example a need to support higher order modulation options and symbol orthogonality implies a need to control linearity and minimise noise and distortion in all parts of the transmit and receive chain.

In parallel, an assumed market need for high peak average data rates suggests a need to deliver base band sampling and processing across extended 10, 15 or 20 MHz channel bandwidths.

Present design solutions for multi band have used tried and trusted architectures and RF design options that have relied on discrete switch paths for each band. This results in component duplication but also introduces additional insertion loss and poor isolation.

Other options exist but need to be carefully implemented to realise performance gain within acceptable cost parameters.

Agenda

DAY ONE

09.00 – 09.30	**Band plan over view – low band (700/850/900 MHz), mid band (1500/1800/1900/2100) and high band (2.4/2.6/3.5GHz), design and performance requirements**

09.30 – 10.30	**Specification and performance needed to achieve co existence** *The Receiver Front End* – how receiver front-end performance is a key factor in determining overall sensitivity. Selectivity – the distribution of bandwidth to achieve co-channel and adjacent channel performance. Gain distribution to achieve dynamic range. Image response suppression in the superhet receiver. RF filter specifications. The Direct Conversion (Zero IF) receiver approach versus the Superhet. *The Receiver Backend* – how modulation type and transmit/receive oscillator stability influence/determine IF bandwidth. Demodulation processing gain – digital processing gain. The TX chain – RF PA operational bandwidth constraints and PA efficiency versus linearity implications.
10.30 – 11.00	**Coffee**
11.00 – 12.30	**Current specification and performance limitations** Present TX/RX bandwidth limits and performance trade offs including matching considerations *Impedance Matching* – defined matching objectives with simple and complex loads. Frequency conscious matching networks (Pi & T), Q *The Smith Chart* – a tool to display matching efficiency *'S' Parameters* – using the forward (incident) and reverse (reflected) power concept to understand 'S' parameters. The practical benefits of using 'S' parameters to define 2 port network characteristics. *VSWR* – as a measure of power transfer (hence matching) efficiency – the effect on transmit stability.
12.30 – 13.30	**Lunch**
13.30 – 15.00	**Improving performance through the use of new active and passive materials** In this session we review new passive materials, new active materials and their present and possible future potential in delivering flexible RF front ends that can meet present and future cost and performance expectations. The session includes a study of RF MEMS, silicon on sapphire and BST based devices and related functional and system performance.
15.00 – 15.30	**Tea**
15.30 – 17.00	**Utilizing new component technology in receiver and transmitter architectures** *Adaptive matching & tuneable filter options* –techniques to improve efficiencies over wide bandwidth TX and RX, bandwidth limits, stability, response times and architectural considerations including control line implementation issues.
17.00 – 17.45	**Implementation case study**
17.45 – 18.45	**Networking drinks and light refreshments**
18.45 – 22.00	Visit to the Science Museum adults only **Lates Evening** including a guided tour hosted by one of the telecommunication subject experts at the Museum. Exhibits with relevance to **telecommunications** include **Cooke and Wheatstone's telegraph of 1837, Thomson's Galvanometer**, **Bell's Osborne Telegraph of 1878**, **telephones designed by Alexander Graham Bell** , **Fleming's 1904 diode valve**, **Lee de Forrest's 1907 triode valve**, **a 1943 radio with the first printed circuit board** and **early British transistors from 1950 to 1953.** Exhibits with direct relevance to **communications and computing** include the **1832 Babbage Difference Engine**, **the 1950 Automatic Computing Engine,** **the 1976 Cray 1A supercomputer,** the **1976 Apple 1A Computer** and the **Strowger exchange.**

DAY TWO

09.00 – 10.30	**Design Study 1 – present co existence architectures** Case study of a **five band GSM/HSPA+ phone,** typical architecture and RX/TX performance, possible performance gain opportunities using open or closed loop adaptive matching and other 'new' component and circuit optimisation techniques

	and related system implementation considerations.
10.30 – 11.00	**Coffee**
11.00 – 12.30	**Design Study 2 – future co existence architectures** **Seven band** multi standard handset including an **LTE UHF 700 and 800 MHz transceiver**. Device and design options, cost and performance benchmarks.
12.30 – 13.30	**Lunch**
13.30 – 15.00	**Design Study 3** **Seven band** multi standard handset including an **LTE UHF 700 and 800 MHz transceiver** and **DVB T/ATSC UHF receiver.** Device and design options, cost and performance benchmarks.
15.00 – 15.30	**Tea**
15.30 – 17.00	**Design Study 4** **Ten band** multiband handset including an **LTE UHF 700 and 800 MHz transceiver, LTE 2.6 GHz transceiver, DVB T/ATSC receiver** and **extended LTE 10, 15 and 20 MHz channel spacing**. Device and design options, cost and performance benchmarks.
17.00-17.30	**Summary and close**

About RTT

Since 1986, RTT has been providing an international client base with technology assessment and technology related telecommunication seminar programmes and workshops. RTT works closely with the international academic, scientific and industrial research and regulatory community including international standardisation bodies.

RTT's present research focus centres primarily on wireless RF design and implementation, appliance design, air interface and network design including integration with copper, cable and fibre network topologies.

About the Presenters

Roger Belcher

Roger Belcher has a background of over 30 years in the RF communications industry, including an apprenticeship at Marconi, design and development of antennae and radar processing equipment for Plessey Radar, technical marketing for Texas Instruments, antennae and modem design for satellite communications for Racal and design of RF test equipment and associated hardware/software development for Rohde and Schwarz. He has been Technical Director of RTT since 1985.

A co-author of the 'Mobile Radio Servicing Handbook' - (Heinemann Butterworth, UK), 'Data Over Radio' - (Quantum Publishing, Mendocino, USA) and '3G Handset and Network Design' – (Wiley Publishing, New York), Mr Belcher also writes regularly for a number of European trade and scientific journals.

Mr Belcher's most recent project has been to develop a series of 3G Design programmes targeted at the trans national system silicon, manufacturing, network operator and regulatory community.

In addition to public programmes, Mr Belcher also presents in-house programmes to US, Asia and/or European companies involved in developing or implementing next generation telecommunication products with a particular focus on RF performance optimisation.

Geoff Varrall

Geoff Varrall joined RTT in 1985 as an executive director and shareholder to develop RTT's international business as a provider of technology and business services to the wireless and telecommunications industry.

He co-developed RTT's original series of design and facilitation workshops including 'RF Technology', 'Data Over Radio', 'Introduction to Mobile Radio', and 'Private Mobile Radio Systems and developed 'The Oxford Programme', a five day strategic technology and market programme presented annually with the Shosteck Group. Over the past twenty years, several thousand senior level delegates have attended these programmes.

A co-author of the **Mobile Radio Servicing Handbook** (Heinemann Butterworth, UK), **Data Over Radio**, (Quantum Publishing, Mendocino, USA and **3G Handset and Network Design** (John Wiley, New York), Geoff also writes regularly for a number of European trade journals and chairs a broad cross section of industry conference and trade events.

Geoff is actively involved in a number of wireless heritage initiatives that help use past technology and engineering experience to solve present industry problems and recently helped to coordinate the Cellular 25 event held at the Science Museum, marking twenty five years of cellular in the UK.

Cost

£995 plus VAT. This includes all presentations, paper notes, memory stick, lunch, coffee and tea on both days, early evening drinks and refreshments on Day One followed by a privileged guided tour of telecommunication exhibits in the Museum.

To make a reservation e-mail **geoff@rttonline.com** or phone 00 44 208 744 3163

Making Telecoms Work Shops

UHF Broadband and Multi Band RF Design is the first of a series of one day, two day and five day work shops for engineers and product managers bringing new telecommunication products and services to market.

Making Telecoms Work Shops provide a cost and time efficient way in which telecommunication engineers, product managers and policy makers can access technical information and advice not readily available elsewhere in the public domain. The workshops demonstrate how engineering issues can be practically resolved and how performance gains and cost savings can be achieved.

Session topics will cover all physical connectivity media including wireless, cable, copper and fibre. The work shops are generally held at or close to the Science Museum and are scheduled to coincide with evening events at the museum that have particular relevance to the future of telecommunications and information and communications technology. The workshops are intended to cover costs and raise money for a proposed new gallery at the museum, The Making of Modern Communications.

More information on Making Telecoms Work Shops can be found on our linked web site
www.makingtelecomswork.com