RTT TECHNOLOGY TOPIC
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UHF Broadband and Multi Band RF Design

The launch of Apple's iPad has generated countless column inches of industry comment but no one seems to have quite nailed the answer as to what users will do with the device.

The consensus seems to be that iPads will change the way that rich media is consumed on the move.

However the form factor of the device, smaller than a lap top but larger than a smart phone, suggests a sit down or sit back experience – very different from how mobile phones are used today.

If this is true, then some form of TV connectivity would seem sensible. This could be IPTV over Wi Fi or cellular but equally could include ATSC and/or DVB T.

It has become fashionable to dismiss terrestrial television as an increasingly irrelevant delivery medium but in practice terrestrial broadcasters still hold a number of trump cards in terms of linear and non linear content, delivery bandwidth and political, social and business collateral.

This gives us an excuse to revisit the pros and cons of integrating ATSC and DVB T in to 'larger than smart phone' devices. It also allows us to revisit the merits/demerits of coupling portable TV reception with cellular multi band multi standard broadband connectivity, to analyse the related RF design challenges and to introduce our new **UHF broadband multiband RF Design Programme.**

Column inches produced by RTT to date on the RF challenges and opportunities of cellular and TV integration include

3GTV August 1999
Broadcast Over Cellular June 2005
The Battle For Broadcast Bandwidth February 2007
3 Way Radio June 2007
LTE TV May 2009

The generic argument is that terrestrial TV will continue to be one of the most economic and power efficient delivery platforms for content and information and that the use of MPEG and JPEG encoding and compression schemes at the application layer and IP protocols at the transport layer, if combined with closer physical bearer integration, would result in a closer coupling of these traditionally separate delivery platforms.

We suggested that LTE could potentially provide the basis for this closer integration and that this process of technology and engineering convergence would translate into new market and business opportunities.

However in order to maintain its ubiquity as a delivery medium, terrestrial digital TV would need to be received by **portable terminals used indoors without an aerial**. This implies a very substantial increase in signal strength and/or an improved link budget of the order of several tens of dB’s. High definition broadcasting would need another 10 to 12 dB though whether this would ever be worthwhile for portable form factor devices is open to debate.

Either way, the only practical way in which acceptably consistent TV coverage could be realized would be to rebroadcast the DVB T or ATSC multiplex via local cellular transmitters or via in building repeaters. Alternatively TV signals could be piped down from a roof top aerial and rebroadcast from an indoor femtocell.

However even with signal re broadcasting, portable receivers would benefit from having improved sensitivity and selectivity. Several factors now make this a more plausible scenario.

Cellular base station transmitters in the 700 MHz (US) and 800 MHz (European) UHF band need to be sufficiently linear to transmit the cellular OFDM signal with minimal distortion. It is therefore not unrealistic to consider adding ATSC or DVB T broadcast to the TX chain.

Cellular handsets and portable lap tops will have to add 700 and 800 MHz UHF LTE TX/RX functionality. It is therefore not unrealistic to consider adding DVB T and ATSC receive functionality to these devices.

Indeed it could be argued that **extended RF connectivity might be a pre condition of mass market adoption for the emerging cross over form factor devices that combine traditional lap top, net book and smart phone functionality**, of which the iPad is one example.

However there are some practical RF design and performance issues that have to be addressed before these products can be realized. Substantially these are determined by the characteristics of the UHF band and the need for these devices to provide cellular connectivity in the 850/ 900, 1800, 1900, 2100 and 2600 MHz bands.

So for example it might seem sensible to have an ATSC and DVB T receiver that worked across the whole UHF band from 470 to 862 MHz and a transceiver that could cover the cellular bands from the bottom of the US 700 MHz band at 698 MHz to the top of the proposed European UHF cellular band at 862 MHz.

In practice such a device, even with adaptive matching and tracking filters, would have unacceptable sensitivity and selectivity on the RX path, poor transmission efficiency on the TX path and the dynamic range needed would incur an unacceptable power drain.

Adding other bands introduces additional switch paths which introduce insertion loss and poor isolation. Some of the trade offs become evident by looking at a seven band antenna. The particular example, **(follow link)** uses a 3D structure to create an antenna which will work for LTE700, GSM 850, GSM900, PCN/GSM 1800, PCS 1900, WCDMA 2100 and LTE 2600.

Unsurprisingly it does not aspire to cover the TV bands below LTE 700 but just looking at the stated performance for cellular connectivity suggests a substantial efficiency loss at 700 MHz. Although the device is configured to support MIMO, the amount of decorrelation gain achievable from the device at lower frequencies must also be open to question.

The link budget gain of working at 700 MHz or 800 MHz is about 8 or 9 dB when compared to 1800 or 1900 MHz and rather more when compared to 2600 MHz. This is a function of reduced propagation loss. In building penetration in particular should be notably better and should translate into improved coverage and or higher average data throughput rates. However these gains are academic if off set by RX and TX efficiency losses in the user’s device.

The form factor of an I pad or net book or lap top provides some extra space but this advantage can be off set by higher noise floors generated by display drivers or other proximate processor activity.

Additionally the decision has to be made as to whether the TV receiver should be expected to work **simultaneously** with broadband cellular. This would mean additional parallel processing but more importantly would also require careful implementation to avoid desensitization of the TV receiver by the LTE transmit path.

Commercially it would seem that this is a problem worth solving. On line connectivity viewed in parallel with broadcast content could provide the basis for a whole new generation of interactive two way content coupled with real time peer to peer or peer to multi peer communication.

Technically it is a non trivial challenge. The assumption is often made that this kind of dual functionality will become easier to deliver as software defined radios and or cognitive radios become more pervasive.

Unfortunately this is only partly true. Cellular transceivers today still route band specific signals through band specific filters and band specific power and low noise amplifier components. All of these devices have individual matching components.

Getting acceptable performance from a TV receiver integrated with a cellular multi band transceiver would probably also require discrete low, mid and high band signal paths if the whole UHF band had to be covered. Even if digital TV is eradicated globally from the upper UHF bands then a single receive chain would still seem unlikely for a device capable of receiving DVB T and ATSC broadcast.

The alternative is to manufacture devices that are regionally or nationally or band specific but this frustrates scale economy and prevents products being used universally. The holy grail is to produce high Q tracking filters that can be channel rather than band specific combined with active components that can maintain their efficiency over extended operational bandwidths but these devices remain an ambition rather than a present reality at least in present transceiver designs.

But incremental progress is being made. The industry news flow tends to concentrate on base band devices but in practice the advances being made in new passive and active materials including RF MEMS, silicon on sapphire and BST based devices are likely to be at least as important although system issues including control line implementation have to be carefully considered.

If this is a topic that you are interested in, then take a look at the new **UHF Broadband and Multi Band RF Design Programme** from RTT.

We case study four RF front end applications.

A **five band multi standard (GSM and HSPA+)** phone, performance optimized with open and closed loop adaptive matching combined with innovative filtering techniques.

A **seven band** multi standard handset **including an LTE UHF 700 and 800 MHz transceiver.**

A **seven band** multi standard handset including an **LTE UHF 700 and 800 MHz transceiver** and **DVB T/ATSC UHF receiver.**

A ten band multi standard 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.**

Although intended for engineers with pre knowledge of RF design, the workshop is accessible to a wide range of delegates from a wide range of backgrounds.

For example if you are involved in new product planning or in spectral planning including future bid valuation or in business modeling then you will find this workshop useful and relevant.

If you would like to attend or sponsor this event then contact geoff@rttonline.com

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We aim to introduce new terminology and new ideas to clarify present and future technology, engineering, market and business issues.

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RTT, the **Shosteck Group** and **The Mobile World** are presently working on a number of research and forecasting projects in the cellular, two way radio, satellite and broadcasting industry.

If you would like more information on this work then please contact

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