RTT TECHNOLOGY TOPIC
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LTE TV

Considerable time, money and effort has been spent on mobile TV standardisation and network and handset development with to date no commensurate fiscal return.

It has been difficult to realise a return on investment partly due to competing standards, (DVB H, Media FLO, ISDBT, DMB DAB and MBMS, mobile broadcast & multicast service) and partly due to network and handset development limitations and performance constraints compounded by regional and national differences in mobile TV frequency band allocation.

Although mobile TV has been successful in some markets, for example Japan, it has failed to achieve global scale and in most markets there has been a marked reluctance by consumers to pay for mobile TV content.

The longer term economics and effectiveness of hybrid satellite and cellular networks such as DVB SH in Europe or ATC (ancillary terrestrial component) hybrid satellite and terrestrial networks in the US also remain unproven.

This might lead one to question the merit of introducing yet another mobile TV standard to service a global market that is presently non existent. However the inclusion of Multi Cast Broadcast Single Frequency Networks, MBSFN, as a work item in present and future LTE releases suggests that there is still a measure of vendor and operator confidence that mobile TV remains a worthwhile investment opportunity.

Remarkably, it may be.

In this month's technology topic we examine how MBSFN could be used to realise additional revenue and improve returns on existing spectral and network investment both for the cellular and broadcast community.

The difference between standard LTE and MBSFN - the technical detail

MBSFN is based on 7.5 KHz sub carrier spacing rather than the 15 KHz used in standard LTE. This doubles the symbol length from 66.7 microseconds to 133.4 microseconds and allows the cyclic prefix to be increased from 4.69 microseconds to 33.33 microseconds.

The cyclic prefix provides a time domain guard band between symbols to compensate for delay spread in the radio channel. A 4.69 microsecond cyclic prefix allows a delay spread of 1.5 km; a 33.33 microsecond cyclic prefix allows a delay spread of 10 kilometres. The delay spread is the difference in path length caused by multi path in cellular networks. In SFN broadcast networks, the delay spread is also a function of receiving the same signal from more than one transmitter.

The 33 microsecond cyclic prefix used in MBSFN means that TV transmissions can be broadcast simultaneously from multiple node B cellular base stations without causing inter carrier symbol interference in the receiver.

The table compares DRM, DAB, DVB broadcast networks with LTE and LTE MBSFN.

The number of sub carriers defined for DVB T and LTE excludes edge of band sub carriers used to provide a frequency domain guard band. For example the 8K DVB- T multiplex has 6817 one kHz sub carriers nestled within 8 MHz (8K times one kHz) channel spacing.

	Broadcast Wide Area			**Cellular**	**Cellular broadcast**
System	**DRM**	**DAB**	**DVB-T**	**LTE**	**LTE MBSFN**
Frequency	**<30 MHz**	**100 MHz,220 and 1400 MHz**	**700 MHz**	**Between 700 and 2.6 GHz**	
Range	**500 km**	**74km**	**67km**	**5, 30,(100 km)**	
Channel spacing	**9 KHz**	**1.536 MHz**	**7.6 MHz**	**1.4,3.0, 5,10,15,20 MHz**	**5 MHz**
Max gross data rates	**25 kbps**	**2.304 mbps**	**5 to 31.7 mbps**	**10 to 30 mbps or above depending on cell size**	
Modulation	**QAM**	**QPSK**	**QPSK 16 QAM 64 QAM**	**QPSK 16 QAM 64 QAM**	
Number of sub carriers	**204**	**1536**	**1705 (2K) 6817 (4K)**	**300 across 4.5 MHz**	**600 across 4.5 MHz**
Sub carrier spacing	**41.66 Hz**	**1 kHz**	**4.46 kHz 1.116kHz**	**15 kHz**	**7.5 kHz**
Symbol duration in microseconds	**26,660**	**1246**	**1120**	**66.7**	**133.4**
Guard interval in microseconds	**2660**	**246**	**7 to 224**	**4.69**	**33.33**

In practice a number of DVB-T networks were implemented as 2K rather than 8K networks due to receiver chip set limitations, for example in the UK where initial implementation was realised in 1997.

This prevented the implementation of a (more spectrally efficient) single frequency DVB-T network

Although the LTE MBSFN is described as a single frequency network, it could be deployed as a cluster of SFN enhanced node B base stations with frequency re use from cluster to cluster.

Present standards work is focused on either FDD or TDD implementation, known as Downlink Optimized Broadcasting within existing cellular allocations, for example the TDD bands within Band I at 2 GHz.

MBSFN investment incentive - cost saving and revenue opportunities

This however fails to capitalize on some potential major cost saving and enhanced revenue opportunities which together could provide the required incentives for MBSFN investment.

These can be identified by analysing the problems that the broadcasting and cellular industry have to solve.

As can be seen from the table, the 8K sub carrier OFDM used in DVB-T allows very large cells to be deployed which means that DVB-T broadcast networks can be very cost economic.

However to provide adequate coverage, low power in fill sites have to be deployed which add capital cost and running cost and reduce broadcast spectral efficiency.

Although this provides adequate coverage at an adequate link budget for TV's (including high definition TV's) with a roof top aerial, there is generally not enough signal strength to support portable receivers.

DVB T is already included in some cellular handsets in some markets, for example in **Germany**. However in most countries signal levels are not sufficient to deliver a sufficiently consistent user experience to support mass market adoption. Deployment of high density SFN's based on existing cellular infrastructure would overcome this problem.

Portable receivers have been the Cinderella of the TV industry for many years but the availability of lap tops with DVB or ATSC modems will potentially result in a much broader market reach. The top of the range high definition **Sony Vaio** is one example

The problem is that portable DVB devices do not work well unless connected to an outdoor aerial or a satellite dish or cable. These limit the portability of the device.

A roof mounted antenna has about 12 dBi of directional gain. A built in broad band TV antenna in a lap top will usually have negative gain, typically -7dBi, and will be looking for a signal severely attenuated by height loss (10 dB), additional building penetration loss (8dB) and location variation due to standing waves (10 dB), resulting in a received signal up to 47 dB lower than the value planned for fixed outdoor reception.

It would be prohibitively expensive to increase flux levels from the existing terrestrial broadcast networks to support acceptably ubiquitous portable TV reception, particularly portable HDTV reception.

Cellular base stations, particularly cellular base stations designed to support the 700 and 800 MHz cellular bands could however function as relay repeaters and could provide a cost effective alternative to dedicated TV repeaters.

Cellular handsets or at least some cellular handsets and mobile broadband devices including lap tops with embedded LTE modems or dongles will have 700 and 800 MHz LTE transceiver functionality.

It is therefore not inconceivable to increase LTE 700 and 800 MHz receiver bandwidth to accommodate DVB T transmissions.

Operators might question the point of including DVB reception in mobile broadband devices particularly given that many of the services are available free to air.

This however ignores the indirect revenue gain that is potentially achievable from coupling free to air TV reception with two way mobile broadband and is pragmatically probably the only way in which cellular operators will ever achieve a return from 700 and 800 MHz cellular infrastructure and spectral investment.

The ability to receive broadcast TV off air would reduce traffic load on LTE data networks delivering a capacity gain.

Hill top TV transmitters could also be used to provide extended cellular coverage. An upper limit cell radius of 100 km is included in the LTE specification.

Summary

The proximity of cellular receive and transmit bands at 700 and 800 MHz to UHF broadcast TV channels opens up the possibility of supporting digital TV transmission via cellular base stations and digital TV reception in handsets and mobile broadband devices without significant additional hardware cost.

Rebroadcasting of national and local TV from cellular transmitters would allow HDTV to be delivered to portable receivers without the need to connect portable devices to a fixed antenna.

Cellular site and hardware costs including backhaul overheads could be amortised across cellular and broadcast services.

There would be no need to ring fence or repurpose TDD bandwidth at 2 GHz for broadcasting. These channels could be used as originally intended for mobile broadband access.

The coupling of local and national linear TV broadcasting with mobile broadband would unlock new direct and indirect revenue streams both for the broadcasters and cellular operators and would provide the basis for developing innovative mass market consumer electronic products that could be clearly differentiated from present product and service offerings.

The combination of the additional revenues realisable from a more broadly based user experience combined with more broadly amortized costs could significantly improve profitability for all involved parties.

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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

geoff@rttonline.com

00 44 208 744 3163