RTT TECHNOLOGY TOPIC
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WiFi TDD, LTE TDD and LTE FDD Coexistence

3 Group recently announced plans to roll out a dual mode FDD/TDD LTE network in Sweden and Denmark.

The TDD spectrum in Band 1 allocated over ten years ago and expensively acquired at auction by a cross section of operators remains unused. The reasons for this are many and various. Some of the reasons are explored in this month's technology topic and are referenced in earlier topics.

The RTT December 2010 Technology Topic **LTE TDD** discussed the merits and demerits of TDD versus FDD.

The RTT January 2011 Technology Topic **LTE Advanced and LT HSPA Big Band Economics** analysed the impact of channel bonding on Adjacent Channel Leakage Ratio performance using WiFi as a reference example. Channel bonding was identified as one of several techniques which delivered higher peak data rates for single users at the cost of a loss of average throughput for other users.

The performance loss is partly the result of an increase in user to user interference. The effects are apparent both within the host system and between the host system and spectrally adjacent systems. The spectrally adjacent systems could be WiFi TDD, LTE TDD or LTE FDD or other narrow band or wide band radio networks. This is a combination of user to user and system to system interference – in effect external interference.

However there is also a loss of performance within the front end of the users' device – in effect internal interference.

The combination of these factors has a significant impact on the link budget which in turn has a profound effect on network economic calculations.

Regulatory authorities are keen to bring additional TDD bands to market but this it at odds with a standards and band planning policy which makes coexistence harder rather than easier to achieve, channel bonding being one example.

This month's Technology Topic reviews present LTE and WiFi TDD allocations, proposed LTE TDD allocations and related FDD/TDD and LTE/WiFi coexistence issues.

We highlight a disconnect between regulatory policy and technology and engineering constraints and suggest that this may lead to an increase in performance loss and economic harm litigation **(RTT March 2011 Technology Topic**, and **Patent litigation cost (RTT February 2011 Technology Topic).**

These issues and the cost consequences of these issues are increasing rather than decreasing over time – never a good place to be.

TDD Band allocations
It could be argued that allocating and implementing TDD in additional bands to those already allocated would improve scale economy and make R and D and component investment more worthwhile. The table below summarizes the present 3GPP TDD bands.

Band	Identifier	Frequencies MHz
33	TDD 2000	1900-1920 (TDD1)
34	TDD 2000	2010-2025 (TDD2)
35	TDD 1900	1850-1910

36	TDD 1900	1930-1990
37	PCS center gap	1910-1930
38	IMT extension – centre gap	2570-2620
39	China TDD	1880-1920
40	China TDD	2300-2400
41	2600 US (Clearwire)	2496-2690
	C Band	3400-3600
	C band	3600-3800

Note that after more than ten years bands 33 and 34 remain more or less completely unused due to the non availability of TDD/FDD dual mode devices. None of the legacy or proposed new TDD bands are straight forward in terms of their immediate coexistence with adjacent FDD spectrum. The centre gap bands 38 and 39 for example will have an impact on proximate FDD channels. Band 40 in China is immediately adjacent to WiFi. Theoretically if both systems could be coordinated, coexistence might be more manageable. As this is unlikely technically or commercially then rapid roll off filters are required to provide sufficient ACLR protection. Channel bonding in any of these bands will increase the performance requirement and by implication insertion loss of these front end filters. Over tight specifications might also result in filter fly back.

These bands are not the only ones proposed for TDD.

In the US the Wireless Communications Service (WCS) band at 2300 MHz is presently configured as paired (FDD) and unpaired (TDD) spectrum though most present deployed systems are TDD.

The available channels are either side of the Satellite Digital Audio Radio Service which has to date allowed only low out of band emission levels though these rules are currently under review by the FCC.

A	B	C	SDARS				D	A	B
2305	2310	2315					2345	2350	2355
2310	2315	2320	2320			2345	2350	2355	2360

Additionally the US band between 2495 and 2690 MHz presently occupied by the Broadband Radio Service and Educational Broadband Service has also been proposed as a TDD band. There is also potentially a US TDD band between 2155 to 2180 MHz.

None of these bands align directly with other existing band allocations. All are proximate to other spectrum where interference could be an issue particularly if channel bonding is used. None of the nationally specific or operator specific proposals individually or together have sufficient scale to be technically or commercially viable.

More fundamentally there are conflicting views as to how the TDD bandwidth could be used.

The S band TDD bandwidth could be used to support highly asymmetric services but the inter and intra system level interference that this would cause would be problematic. The impact on adjacent FDD bands would be particularly hard to model and manage and an increase in performance loss/economic harm litigation can be confidently predicted.

Alternatively the TDD bands could just be regarded as performing a similar function to WiFi. There are several flaws in this argument. The TDD bandwidth is in licensed spectrum with an amortized investment cost that needs to be recovered. It is economically naïve to think that it can compete with WiFi operating in free unlicensed spectrum.

TDD has a higher TX output power than WiFi. Theoretically this allows for larger cells to be deployed but practically the higher TX power desensitizes the receive path both within the user equipment (residual TX power leaking through to the RX time slots) and at system level (user to user interference).

Wi Fi also has a much larger amount of contiguous bandwidth available, 80 MHz at 2.4 GHZ and 200 MHz at 5 GHz. **Additionally WiFi tri band chip sets are becoming available that add in a 60 GHz transceiver** at which point TDD looks even more embarrassingly pedestrian.

All of which begs the question as to why TDD is presently being so actively promoted.

One reason is that it allows regulators to bring additional spectrum to market which people seem willing to buy despite the interference litigation liabilities which they are either unaware of or choose to ignore.

A second reason is that over the past few years WiMax has been strenuously promoted in terms of its single user peak data rate capabilities prompting the 3GPP standards making community to give LTE TDD a higher standards priority and spectral allocation priority despite any convincing evidence of related economic or technical benefit. You might think that the poor technical and commercial performance of all presently installed WiMax networks might now be prompting a reappraisal of this policy approach.

Thirdly China decided TDD should be a preferred technology to be deployed locally. Partly this is on the assumption that urban coverage will be at Wi Fi density levels therefore it makes sense to have similarly configured TDD system solutions.

However to restate the obvious, high single user peak data rates in TDD systems translate directly into performance loss for all other on channel and adjacent channel users. In FDD systems, interference within the user equipment front end is mitigated by the duplex spacing and user to user interference is mitigated by the duplex gap.

This is why we have used FDD systems for the past fifty years and why we will continue to use them for the foreseeable future. They are simply more efficient from a system level perspective providing better sensitivity in noise limited environments and more graceful degradation in interference limited environments.

We therefore have yet another example of regulatory policy and standards making adding rather than reducing cost and compromising rather than improving delivery cost economics. It is a continuing surprise and disappointment that policy decisions are made and implemented with insufficient technical and engineering due diligence. The impacts of those decisions are made more extreme by the willingness of bid teams to ignore or discount technology and engineering costs in bid valuation. This can be explained in terms of simple timing. A successful bid for spectrum will generally result in an immediate gain in stock valuation. The technology and engineering costs incurred only become obvious three to four years later.

These particular disconnects can only be corrected as and when or if shareholders take a longer term view of technology investments, standards bodies provide more rigorous qualification of the practical rather than perceived marketing value of proposed work items and regulators take into account technology and engineering risks and costs when formulating allocation and auction policy. At present all of the above seem unlikely.

2011 Mobile Broadband Economics- RF cost and performance workshop
RTT has a new in company workshop for 2011 which analyses how LTE Advanced and LT HSPA multi band and extended multi band user equipment determines network density, network cost and user quality of experience metrics. If you would like a detailed agenda for this workshop please e mail **geoff@rttonline.com**

LTE Study from RTT
RTT has produced a 70 page study on LTE user equipment and LTE network economics. The study is written by RTT with statistics and economic modelling from **The Mobile World** and is sponsored by **Peregrine Semiconductor** and **Ethertronics.**

The study, 'LTE User Equipment, network efficiency and value' is available free of charge from the linked web site **www.makingtelecomswork.com**

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An additional level of detail on this topic and related topics can be accessed via the **Resources section** of our linked web site **www.makingtelecomswork.com**

www.makingtelecomswork.com provides 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 web site also provides information on RTT workshops, **Making Telecoms Work Europe**, **Making Telecoms Work Asia** and **Making Telecoms Work in the US.** The workshops demonstrate how engineering issues can be practically resolved and how performance gains and cost savings can be achieved. European work shops are held at the Science Museum in Kensington West London. **Information on the next workshop is available here.**

A number of sponsorship opportunities are available linked to the web site and related Science Museum telecom industry educational initiatives.

If you would like more information on these opportunities please e-mail **geoff@rttonline.com** or phone **00 44 208 744 3163**

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RTT, the **Jane Zweig 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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