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Spectrum constraints driving multimode and multiband systems

A Good Deal

One of the key drivers for multimode terminals is spectrum constraints. Most GSM operators would much rather have a larger assignment at 900 MHz than a dual 900-MHz and 1800-MHz assignment. Similarly, they would prefer enough spectrum to provide cordless type services using GSM rather than DECT. However, more spectrum at 900 MHz is very hard to come by; hence the drive towards multimode terminals.

Multimode operation causes a number of problems to the regulator, the spectrum manager and the monopolies regulatory body. Competition rules regarding auctions,

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coverage obligation, provision of services for which operators are not strictly licensed and roaming obligations all need to be considered.

Why consider other frequency bands and standards?

Multiband and multimode systems are more expensive, complicated and difficult to administer than their single-mode equivalents. Despite this, they have attracted interest amongst a range of operators and manufacturers. Some of the interest is because a multimode terminal might offer a more flexible platform with, e.g., DECT, providing relatively high data rates and low coverage, coupled with GSM having lower bit rates but better coverage. Another reason is to capture more roaming traffic. However, by far the overriding reason why operators are interested in multimode and multiband systems is the additional capacity it offers them. Were there no shortage of radio spectrum, then it would be unlikely that multimode and multiband systems would be of interest to more than a handful of operators.

The most intense shortage of radio spectrum is currently in the GSM band. In most countries this band has been divided amongst two GSM operators and often other users (such as analogue cellular systems) with the net result that the GSM operators typically only have some 2×10 MHz each. This amount of spectrum can only support around 4 carriers or 30 voice channels per cell, with the result that microcells are required in high-traffic areas and overall cell engineering becomes difficult.

Cellular operators have asked radio spectrum managers to provide them with additional spectrum, but the spectrum managers are constrained by other users within the GSM band (often analogue cellular systems) and also by the limited size of the bands themselves, although some pressure will be released when the GSM extension bands become available. Hence, spectrum managers have been forced to look to other parts of the band, typically at higher frequencies, as a way to satisfy the requirements of cellular operators. In order to use these bands, dual-band technology is required. In the cases where the spectrum manager has not been able to satisfy the requirements of the operator by offering additional bands, the operators themselves have looked for bands they might be able to use. Key amongst these is the DECT band, which is currently unlicensed and represents spectrum available to the operators, typically without needing sanction from the spectrum manager; hence the need for dual-mode operation. Both these solutions to congestion raise a number of questions concerning licence award and licence conditions.

Licence awards of multiband spectrum

Issuing the licences

The methods used to award licences to first-time GSM operators are now well understood. Most countries adopt either auctions or 'beauty contests'. The licence includes both access to the spectrum and a licence to provide a public communications service. The licence typically arrives with a number of constraints such as a coverage obligation. Typically, two competing GSM operators are licensed and given equal amounts of radio spectrum.

However, these methods are not wholly applicable to the award of additional spectrum required for multiband or multimode operation. Operators only need a licence to use the spectrum, not a licence to provide a public communications service. Issues involving fair competition arise. In this section we examine some of the key issues from the point of view of a spectrum manager or regulator and make predictions as to the most likely outcome. These predictions are based entirely on our experience in working with regulators and not on any evidence that a particular stance will be taken by any given regulator.

Awarding the spectrum

By implication, if dual-band spectrum is being awarded, it will be awarded to existing 900-MHz cellular operators. Hence, there will normally only be two contenders for the spectrum. Typically, the spectrum manager will want to ensure that both operators have equal amounts of spectrum. This leads to the conclusion that the use of auctions is somewhat inappropriate, since the 'winners' are already determined in advance and so do not need to bid. Indeed, any form of competition is of little use, because the winners are already predetermined.

In the UK, the government attempted to overcome this apparent guarantee of additional spectrum by requesting that the 900-MHz operators submit plans for innovative new services. Although these plans are not public, they appear to be little more than the use of 1800 MHz to provide additional capacity in high-density areas hardly new and innovative.

Spectrum constraints driving technology integration (Foto: H.R. Bramaz).

However, it was hard to see the government awarding, say, Vodafone the spectrum and Cellnet not because Vodafone's plans were more innovative. So even this approach is essentially bound to fail to produce any input of value.
The spectrum manager would appear to have two basic choices:
- Accept that the remaining 1800-MHz spectrum will be equally divided amongst the 900-MHz operators and simply give it to them.
- Decide that the spectrum should not necessarily be equally divided amongst the operators and hold some competition for the spectrum, typically an auction for each, say, a 2×1-MHz block.

It is very hard to envisage any European spectrum manager taking the second course, although there would be strong economic arguments for doing so, and so it seems likely that 900-MHz operators are virtually guaranteed an equal share of the remaining 1800-MHz spectrum.

Competition considerations
Spectrum managers are rightly keen to try to ensure that there is as level a playing field as possible between the cellular operators by ensuring that the spectrum is equally divided amongst the operators. This has lead some to ask whether, if 900-MHz operators are allowed access to the 1800-MHz spectrum, the 1800-MHz operators should be allowed access to the 900-MHz spectrum in return.
There are a number of issues surrounding this apparently reasonable question:
- In most countries there is no 900-MHz spectrum left to give to the 1800-MHz operators; hence, this is not possible – in the UK this was resolved by giving the 1800-MHz operators some more 1800-MHz spectrum.
- For 1800-MHz operators well into their build phase it would appear that 900-MHz spectrum is less useful than giving the 900-MHz operators additional 1800-MHz operators.

Nevertheless, something dearly needs to be done to maintain a level playing field with the 1800-MHz operators. Provision of the same amount of spectrum for all operators is not fair, as the 1800-MHz spectrum is less valuable than the 900-MHz spectrum due to its reduced propagation; however, calculation of a fair weighing of 900-MHz and 1800-MHz spectrum is too complex and contentious to be possible in a manner which will satisfy all parties.
Here, again, economic arguments have a role to play. By allowing any remaining 900 MHz and 1800 MHz to be auctioned with no preconceived ideas as to who should be awarded the spectrum, the relative values of the spectrum would be revealed, and operators could select the spectrum of most value to them. Again, it is hard to see European spectrum managers adopting this route.

Use of unlicensed spectrum
Some operators are contemplating dual-mode GSM/DECT services. These have the attraction of allowing the operator access to the 20 MHz wide DECT band at apparently no additional cost for the spectrum, as this is an unlicensed band. However, if the band is used by a public operator, it is not clear that its use should remain unlicensed. Otherwise there is a possibility that with a number of DECT operators private individuals will experience congestion, and DECT will become inappropriate for its primary role as a private cordless telephone system. Licensing will be difficult. DECT systems use dynamic channel allocation to find the best frequency within the available DECT band, so restricting an operator to a specific channel or part of the band would require a modification to the equipment with a resultant loss of capacity through limited trunking gains. There is unlikely to be any additional frequencies for public operator DECT systems; hence, we expect most spectrum managers to simply allow the use of dual-mode GSM/DECT. Given the relatively slow take-up of DECT in most countries to date, this is unlikely to cause problems in the short term. In countries where spectrum pricing is introduced, DECT will be particularly attractive to the operator, due to its spectrum being 'free'. In the long term, pricing mechanisms to overcome this distortion may be introduced, based on the number of deployed DECT carriers or similar.
A further issues for dual-mode GSM/DECT is the possibility of cellular operators entering a new market, such as wireless local loop (WLL). This would cause significant problems to some regulators who have issued WLL licences along with an undertaking that no further WLL operators will be licensed in a particular timespan. In practice, DECT cells are only likely to be deployed by cellular operators in high density areas such as offices; hence, for many of the WLL operators who are concentrating on domestic use, the effect of the competition will not be severe. Here we expect spectrum managers to ignore the potential to enter a new market and not to place significant restrictions in the path of operators wishing to deploy dual-mode GSM/DECT systems.

Licence conditions
There are a number of conditions which apply to cellular operators, which typically appear in their licence to provide a public telecommunications service (and not in their licence to use radio spectrum).

Coverage obligations
Most GSM operators have coverage obligations, typically of the order of 90 % of the population, within 5 years. The 1800-MHz operators often have similar obligations, although in some countries these are less onerous to allow for the reduced propagation range at 1800 MHz. Here we consider whether 900-MHz operators will have to provide similar coverage with their 1800-MHz spectrum and vice versa.
In practice, if the regulator is concerned with coverage – which we would argue he should not be – then he should be interested in 900-MHz or 1800-MHz coverage, not both. Hence, for a 900-MHz operator, there should be no obligation to provide any particular level of 1800-MHz coverage. For an 1800-MHz operator gaining 900-MHz spectrum, the issue is less clear. If their 1800-MHz coverage obligation is lower than that for the 900-MHz operator, then there would be some argument for increasing it; however, given their more difficult competitive position, we would argue against this.

Efficient use
Most spectrum managers are concerned about the efficient use of spectrum. In some countries, market mechanisms such as spectrum pricing are proposed to ensure efficient use. In others, such as Finland, measures such as traffict/MHz are proposed to transfer spectrum to operators who are more efficient.
In terms of technical efficiency, the use of 1800-MHz spectrum by 900-MHz operators is likely to be less efficient than

the use of 1800-MHz spectrum by 1800-MHz operators. This is because the spectrum will be reused less around the country, as it will only be deployed in high-density areas. This should be a concern for spectrum managers.

The simplest manner in which to ensure that its use is efficient as far as the country is concerned is to price the spectrum at the market rate and to allow trading between the different operators. Then, if the use of 1800-MHz spectrum by 900-MHz operators was 'inefficient', market mechanism would persuade the operator to sell the spectrum to operators who could make better use of it. Nonmarket approaches such as that proposed in Finland would have to be very carefully defined to ensure that the spectrum manager actually achieved what they wanted, and they would probably not work.

In practice, European spectrum managers are not ready to allow trading of cellular spectrum and will not be able to derive appropriate efficiency measures with which all parties will agree. Hence, the use of spectrum will continue in a manner which may be inefficient for the country. This will be of little concern to the operators, who will be relieved that they will not be benchmarked in any meaningful way which would affect the manner in which they would use the spectrum.

European standards and future allocations

Within Europe, spectrum managers typically require that operators use European standards where they are available. This means, for example, that dual-mode GSM/PHS equipment is unlikely to be allowed. Less clear is what will happen in the case of dual- or triple-mode GSM/DCS1800/DCS1900 phones. In principle, the 1900-MHz spectrum is already allocated to DECT and to UMTS and in any case is still used by fixed links in a number of countries; however, the availability of cellular equipment which can use this spectrum may place pressure on spectrum managers to release some of the spectrum.

This is unlikely to occur in the near future, because there is still substantial unallocated 1800-MHz spectrum in most European countries, which should satisfy demand for some time to come. In the medium to long term, the arrival of UMTS is likely to ensure that the spectrum is assigned for UMTS rather than DCS1900 (although they may be the same system in the early years of UMTS). Indeed, the issue of dual band will become significantly more important when UMTS is introduced. Existing 900-MHz operators are keen to gain UMTS spectrum and will clearly be looking for dual-mode GSM/UMTS or triple-mode GSM/DCS1800/UMTS operation in order to make the most of this spectrum.

Major issues associated with the award of UMTS spectrum will surface soon, such as:

- Exactly what mix of technology or service qualifies for UMTS licences?
- Will the proposed 2005 UMTS licence award actually be for additional GSM-based networks and, if so, should this not be brought forward on competition ground?
- How will the satellite component licence be awarded, when this is clearly a global rather than a regional issue?
- Can GSM operators run UMTS services within their spectrum assignment?
- Will the regulators be able to reach a position of technology neutrality over UMTS spectrum?

Resolving these issues will be extremely difficult. We would expect to see a mixture of existing 900-MHz and 1800-MHz operators being guaranteed some UMTS spectrum and some of the spectrum also being reserved for new entrants. As we have argued earlier, reserving spectrum could produce significant distortions and inefficiencies within the market; nevertheless, we would expect spectrum managers to do this anyway in an effort to ensure a level playing field. 9.3

Source: Conference 'Multi Mode/Band Mobile Terminals'. IBC UK, Conferences Ltd, April 1997.

Summary

There are still a number of spectrum management issues to be resolved which could have a significant impact on the market for multiband and multimode equipment; however, we expect most of these to be resolved in the favour of the existing operators and, in particular, in the favour of the existing 900-MHz operators. We expect the following key decisions to be taken:

- DCS1800 spectrum will be reserved for 900-MHz operators who will not have to compete for this spectrum in any meaningful way and hence are unlikely to have to pay significant fees for it.
- Competition considerations in some countries will provide 1800-MHz operators with 900-MHz spectrum, but, in general, 1800-MHz operators will simply get more 1800-MHz spectrum.
- Operators with dual-mode GSM/DECT systems will be allowed access to unlicensed DECT spectrum at no cost and with few restrictions.
- Coverage obligations will not apply to additional spectrum provided in a different band.
- Efficient use of the additional spectrum will not be enforced by the spectrum manager.
- The requirement to use European standards will prevent dual-mode GSM/PHS and GSM/DCS1900 being adopted in Europe.

All this adds up to a good deal for the 900-MHz GSM operator.

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