TIW Asia's response to

OFTA Third Generation Mobile Services Consultation Paper of March 21, 2000

TIW Asia through its TIW sponsorship, a committed player in the next generation of new information services in the mobile telecommunications market, is pleased to submit this document in response to the Telecom Authority consultation on UMTS.

It is a daunting task to determine the future viability of UMTS, be it from the point of view of the technology, the applications and services that will be offered with the technology, pricing or assessment of demand. Policy makers must, therefore, be aware of the uncertainties and huge risk surrounding the implementation of this new generation of wireless mobile services. The tremendous success of GSM does not necessarily ensure the success of UMTS. The potential to transmit data at speeds of up to 2 Mbit/s is a significant advancement on existing wireless technology but the long-term viability of UMTS will depend on the ability of vendors and operators to offer services to the public that are of real value.

Despite this uncertainty, our approach to this paper has been to make concrete proposals or suggestions wherever possible. It is our view that UMTS holds huge promise and it is, therefore, in the interest of the Hong Kong public for the Telecom Authority (TA) to adopt an implementation policy that will ensure that UMTS services are made available to the Hong Kong public as soon as possible. It is this view that drives the recommendations set out below. We have constructed this document where we first answer the specific questions raised by TA and then include in appendix some thoughts on technical issues.

2.09 Should the TA dictate a specific IMT-2000 standard?

TIW Asia believes that a technological neutral approach provides maximum flexibility to both new entrants and incumbent 2G operators alike. This flexibility will translate into a better deal for the HK consumers as companies can optimize their service offerings by adopting an IMT standard that best suits the HK marketplace.

Historically, when left to their own devices, HK operators have realized the advantages from having a network that is open to as many consumers as possible. Roaming revenues are playing an ever important role in the profitability of the operations. TIW Asia believes the market itself is the most suitable driver to determine the optimal standard.

We have included in the Appendix some elements on technical standards challenges that TA may want to consider in its license “packaging”.

3.12 Should the TA adopt a 3G band plan that is in compliance with the ITU IMT-2000 allocation?

Yes, TIW Asia believes that TA adopt a 3G band plan that is in compliance with the ITU IMT-2000 allocation, to allow for the economies scale when purchasing equipment as well as to maximize roaming revenues and highlight Hong Kong accepted position as a hub for international trade.

3.19 Is 2x15 MHz for new entrants and 2x10MHz for incumbents, sufficient minimum paired spectrum?

It is TIW Asia's view that such a spectrum allocation plan is sufficient for essential 3G services offerings. While it is still uncertain as to the day to day spectrum requirements of all 3G services, our preliminary research indicates that the above mentioned allocation is adequate.

There are alternative options that can be adopted for the amount of spectrum allocated to operators as illustrated in the appendix.

3.21 Should the TA immediately decide on the allocation of the TDD spectrum?

This approach raises the question of the importance of knowing how much paired and unpaired spectrum is required to make the business case for the deployment of a 3G network and its services. A operator seeking spectrum needs to consider how to differentiate itself from other networks. Will their 3G network offer a range of services at different bit rates, or specialize in high quality services, or only high bit rate services, or handle asymmetric traffic, etc? More importantly, the TA must allocate unpaired spectrum wisely to decrease the adjacent channel interference experienced by network operators.

There is also the choice between allocating licensed unpaired spectrum and allocating unlicensed 'public' unpaired spectrum.

TIW Asia believes that unlicensed spectrum is an appropriate approach in the domestic 'cordless' environment and also in the office wireless PABX environment. However, in public scenarios, eg, a shopping mall, the capacity of a system operating in an unlicensed band could be significantly less than that of a system operating in its own licensed band. Therefore, if operators are interested in using TDD systems to provide localized coverage in public areas, such as shopping malls, acquiring a licensed unpaired frequency band could prove beneficial.

4.04 Should the TA allow incumbent to bid on 3G licences, and/or be given priority over new entrants?

TIW Asia shares the TA's preliminary view that incumbents should be allowed to bid on 3G licences, but that they would not be given priority other than licence band spectrum allocation which would support incumbents. While the current level of competition in the Hong Kong market has been intense, TIW Asia feels there is room for one additional operator with international 3G experience.

4.06 Which of the four proposed scenarios in best suited for the HK market?

TIW Asia believes that a revised Option 2 is preferable whereby six 2x10 MHz licences will be awarded. Another 5 MHz unpaired spectrum should be awarded at the same time as discussed in the technical section. This scenario permits for the greatest amount of competition.

4.14 Which is the best-suited method of licence award; Auction or Based on Merit?

Evaluation based on Merit or "Beauty Contest" is the best method for awarding 3G licences in Hong Kong. This method has served the TA well in the past, and fears of spectrum inefficiencies have failed to materialize as market forces have ensured that operators make the best use of this finite resource to serve the greatest amount of customers.

In addition, control rests wit the TA to ensure grade of service GOS targets are adhered to over the course of the licence.

An auction forces operators to seek additional funds to pay for the higher upfront fees. This places unnecessary financial burdens on all aspects of the companies operations, forcing some of them to try to recoup the investment at a quicker pace and potentially forcing a lower grade of service in the Hong Kong consumers.

5.07 Should the TA regulate 3G services under a similar framework as that of present mobile services?

TIW Asia believes that no additional regulatory frameworks are necessary for 3G services.

5.12 Should the TA maintain a regulatory distinction between fixed and mobile services?

Yes, the current distinction is view as necessary by TIW Asia as focus is maintained and operators concentrate on each business unit as profit centers. These are distinct services each with there own set of unique challenges. Clear segmentation limits the temptation to neglect key areas of business that may not be as profitable as others. A distinct regulatory body will ensure fixed licences requirements are met.

5.14 Should the TA mandate 2G to 3G roaming? What are the technical & operational difficulties involved?

As a new entrant domestic roaming could be mandated for relatively a short period of time to provide incentive for new entrant to rollout. However, several technical issues must be addressed as illustrated in the appendix.

5.18 Should the TA separate service provision from network operation?

Service providers (SPs) provide services to subscribers and currently are usually associated with one network operator. The network bills an SP who passes the bill plus extras to the subscribers. A mobile virtual network operator (MVNO) is somewhat different from an SP, as defined by some, in that an SP buys airtime and re-sells it to its customers. A MVNO may have some network equipment, eg, a home location register (HLR) containing subscription information for its own users. However, the original simplistic idea of an SP will merge into that of an MVNO, and we will use the terms SP and MVNO synonymously.

Given the possibility that there would be a limited number of licences compared to the number of incumbent operators, some incumbent operators could become 3G SPs. A SP could be associated with one 3G network operator, or offer services on many or all of the 3G networks. A MVNO does not require a spectrum licence, but could build and operate parts of a 3G network to furnish the type and standard of specific services.

In the long term we may expect to have many more SPs than there are network operators. If they operate across networks, the SP's MVNO would provide total roaming. It may be that the profitability of SPs will exceed that of operators. In the UK the railway lines are owned by one company (analogous to an operator), while supporting many different train companies (service providers). The customer only deals with the train companies.

The situation in which there are operators who are also SPs having other SPs creating a MVNO on their networks is commercially complex but doable. An approach might be to regulate against operators being SPs on other network, and not prevent them from participating as partners in MVNO businesses.

In general, TIW Asia welcomes the concept of separating service provision from network operation.

Appendix - Technical Issues

1. Introduction

The OFTA consultation paper consults industry and other interested parties prior to the finalisation of the regulatory framework for third generation (3G) mobile services in Hong Kong. Applications for 3G licenses will be invited by the TA during the last quarter of 2000.

There are five public mobile radiotelephone services (PMRS) in Hong Kong, and the systems used are GSM900, IS-136 and IS-95. In addition there are six licensed PCS operators and they all employ the GSM1800 technology. To these eleven, second generation (2G) networks will be added a number of 3G licenses that may be awarded to incumbent operators, or to new operators. The 3G technologies to be deployed will depend on the evolving 2G technologies, the available 3G systems, the available spectrum and the customer benefits. The TA shouldn't mandate the use of a single 3G standard. The TA would like customers to be able to migrate to other networks and obtain similar services without having to replace their terminals. Further, users should not need to change their handset when they travel.

This goal of interoperability among different 3G systems is inherent in the concept of a family of systems under IMT-2000. This family has five systems: IMT-DS, IMT-MC, IMT-TC, IMT-SC and IMT-FT, which are better known as UTRA FDD, cdma2000, UTRA TDD, UWC-136 and DECT, respectively. DECT is a 2G cordless system, while UWC-136 is an evolution of IS-136 towards GSM Phase 2+. cdma2000 is an evolution of cdmaOne and is a 3G system, while UTRA FDD and UTRA TDD are new 3G systems. Consequently cdma2000 and the two modes of UTRA will be able to offer a wider range of services than the other two systems. Work is under way to provide dual mode UTRA and cdma2000 terminals, as exemplified by ETSI changing the chip rate of UTRA to be more in accordance with that of cdma2000. Hence we conclude that the requirements of the TA will be satisfied if it selects cdma2000 and/or UTRA.

We also note that GSM900 and GSM1800 will evolve to GSM Phase 2+, and thereby be able to offer some 3G services.

2. Adopting a Band Plan in Compliance with IMT-2000

There are currently two main 3G band plans in existence around the world. In the USA the '3G' spectrum in the 1.9 GHz band has already been allocated to the PCS operators. There are three technologies deployed in this band, namely, cdmaOne, GSM1900 and IS-136 (TDMA). The second main 3G band plan is based on the IMT-2000 spectrum allocation and this has been adopted in a number of regions throughout the world, including Europe and Japan. The USA PCS band plan and the up-link portion of the UTRA FDD band plan (which is based on the IMT-2000 band plan) are shown in Figure 1 along with part of the GSM1800 down-link band.

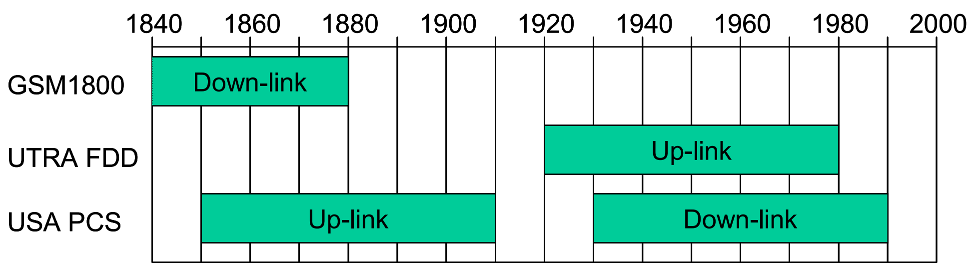

Figure 1 The USA and IMT-2000 frequency bands.

The figure shows that the USA PCS down-link band overlaps with the UTRA FDD up-link band. If the TA chose to adopt a 3G band plan that could accommodate systems designed to operate in both the USA PCS spectrum, eg, cdma2000, and the IMT-2000 spectrum, eg, UTRA FDD, then the situation could arise whereby the transmissions from one MS could generate a high level of interference in the receive band of another nearby MS. The problem is demonstrated in Figure 2 below, in which MS A is operating on a cdma2000 system and it is receiving the down-link transmissions from BS A on frequency f1. Nearby, there is a UTRA FDD MS (MS B) that is transmitting to the UTRA FDD BS (BS B) on frequency f2. Since the distance between MS A and MS B is much smaller than the distances between MS A and BS A and between MS B and BS B, the transmissions from MS B will arrive at MS A at a much greater power than the transmissions from BS A. If frequencies f1 and f2 are adjacent, as shown in Figure 2, then the interference caused by the transmissions from MS B 'spilling' into MS A's receive band could prevent MS A from demodulating the transmissions from BS A. This problem can only be mitigated by introducing guard bands between the spectrum bands allocated to the different systems to limit the amount of interference that one system can inflict on the other.

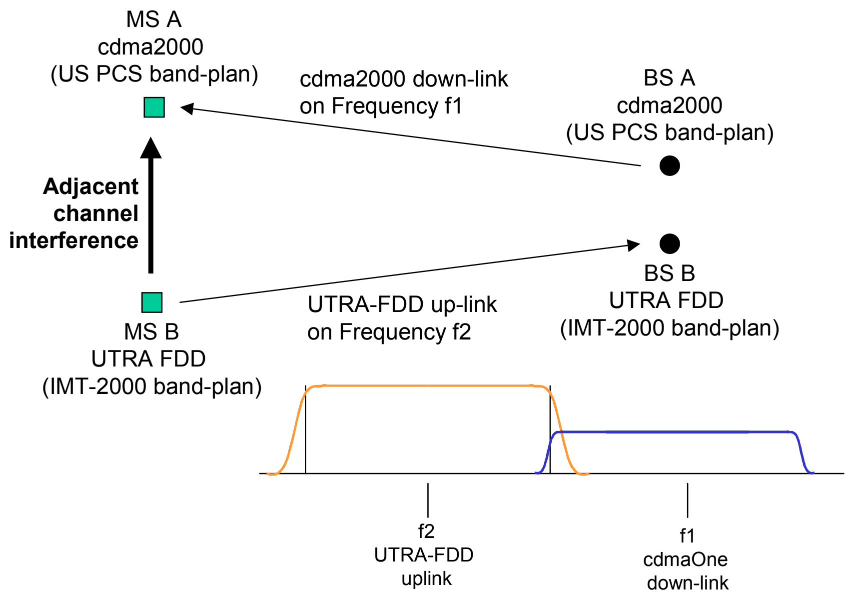

Figure 2 The problem of non-harmonised frequency bands.

The problem of non-harmonised frequency bands may also occur on the UTRA FDD up-link transmissions. Consider the example of co-located cdma2000 and UTRA FDD BTSs, with the cdma2000 BTS transmitting on a carrier frequency that is adjacent to one of the UTRA FDD receive frequencies. The level of adjacent channel interference inflicted on the UTRA FDD BTS receiver from the cdma2000 BTS transmitter could be very large and this could significantly reduce the capacity of the UTRA FDD system.

However, even with a harmonised band plan, there is still the possibility of a MS attempting to demodulate the transmissions from a distant BS in the face of interference from a nearby BS transmitting on an adjacent carrier frequency. This means that guard bands will still be required between different networks to limit the amount of interference that they inflict on each other. It is unclear whether the guard bands would need to be significantly larger in the non-harmonised case, although intuitively we would expect this to be the case. The key difference between the two is that, in the harmonised case, co-location of BS sites will tend to mitigate the problem, whereas in the case of non-harmonised bands, co-location could make the problem significantly worse.

If the TA allows systems based on the USA PCS bands and the UTRA FDD bands (see Figure 1) to operate in Hong Kong, then the frequency allocation plan will be complex. For example, from 1920 MHz to 1930 MHz could be the UTRA FDD up-link band, from 1930MHz to 1940MHz could be the cdma2000 down-link band. This pattern of 10 MHz of UTRA FDD followed by 10 MHz of cdma2000 could be repeated. Although co-channel interference between UTRA FDD and cdma2000 is avoided, adjacent channel interference will occur. With this in mind, let us consider the adjacent channel interference problem.

The UKTAG Guard Bands Sub-Group has studied the carrier spacings of UTRA FDD, UTRA TDD, and the situation in which there are adjacent FDD and TDD carriers [i]. The sub-group recommends that, for FDD, the inter-operating carrier spacing should be 5 MHz, the inter-layer carrier spacing for the same operator should also be 5 MHz, while the intra-operator intra-layer carrier spacing should be 4.8 MHz. The meaning of these terms is as follows. Inter-operator carrier spacing is the spacing of two adjacent CDMA carriers, in which each carrier is used by a different operator. Intra-operator, inter-layer applies to an operator having a hierarchical cellular network, and we are concerned with the carrier spacing between one carrier in one layer (eg, a macrocellular layer) and another in a different layer (eg, a microcellular layer). Intra-operator, intra-layer applies when an operator deploys adjacent carriers on the same layer, and the carriers are co-sited.

The curve of adjacent channel interferences ratio (ACIR) *versus* carrier spacing shows that the ACIR is relatively constant until about 3.5 MHz and then decreases rapidly to 5 MHz, and then the curve falls slowly thereafter. In other words the gains are small if the adjacent carrier is more than 5 MHz, and the performance is unacceptable for a carrier spacing of 4 MHz.

Simulations to show the effect of ACIR on capacity, defined as kbits/sec/MHz/cell, have been made for two operators, 44 base stations, a cell radius of 500m, a minimum coupling loss (the minimum expected path loss between a MS and a BS) of 60dB, an E_b/N_o threshold of 6dB corresponding to a MS speed of 33m/s and a probability of outage P_o of 5%, a power control dynamic range of 80dB [i]. Both up-link and down-link, as well as 32 kb/s and 144 kb/s services were considered. Changes in high values of ACIR have little effect on capacity, but then the capacity falls quite rapidly for decreasing ACIR. The knee of the curves seems to be about an ACIR of 25dB, but this figure may be different if the target E_b/N_o is changed. We note that an ACIR of 25dB corresponds to a carrier spacing of about 4.5 MHz.

When the simulations were made for a hexagonal layer of macrocells and a layer of microcells on a Manhattan grid; in which the capacity is in terms of all of the 91 cells, a minimum coupling loss of 60 dB, a P_o of 5% and E_b/N_o of 6dB (33 m/s) for the macrocells and 4.5dB (0.8 m/s) for pedestrians in microcells, and a 32 kb/s service rate; then again the results suggest that it would be wise to have ACIR > 25dB.

Similar simulations have been performed in which an operator co-locates carriers, namely the intra-operator, intra-layer condition [i]. Again the same basic conclusion applies, namely, that the ACIR should exceed 25dB.

We now display a series of curves from Reference [i] to illustrate why the carrier spacings to which we have previously referred have been adopted. Figure 3 and Figure 4 show the effect of carrier spacing on the normalised capacity for voice, 32 kb/s and 144 kb/s services for the up-link and down-link performances, respectively, when the adjacent carrier is another operator and both operators have deployed FDD. Figure 5 and Figure 6 apply to the intra-operator, inter-layer FDD system, while Figure 7 Figure 8 are for the intra-operator, intra-layer scenario. It is evident from all these graphs that a good choice of carrier spacing is 5 MHz. The results appear to be less comprehensive for the TDD/TDD adjacent carrier situation, but the conclusion is again for an adjacent carrier spacing of 5 MHz. The most difficult situation is when the carrier of a FDD network is adjacent to a TDD carrier of a different network. The ACIR needs to be in excess of 35dB to ensure that the reduction in capacity due to adjacent carrier transmission is not excessive. This means a carrier spacing of at least 5 MHz. For example, for an ACIR of 30 dB, a TDD base station will have zero capacity, ie, a dead zone, when it is operated in a TDD cell, and will suffer a capacity reduction when it is three TDD cell radii away. A TDD base station cannot be operated within a FDD cell that is fully loaded.

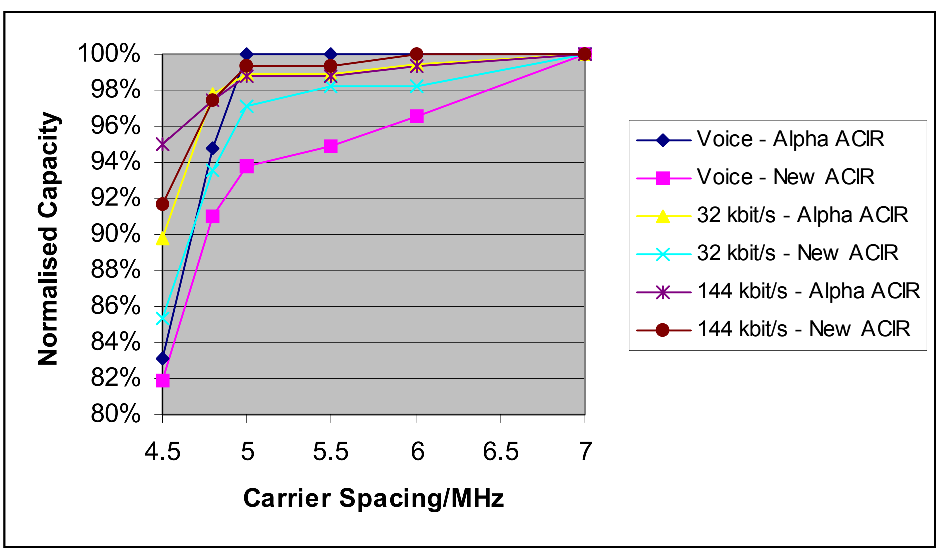

Figure 3 Up-link inter-operator carrier spacing (from [2]).

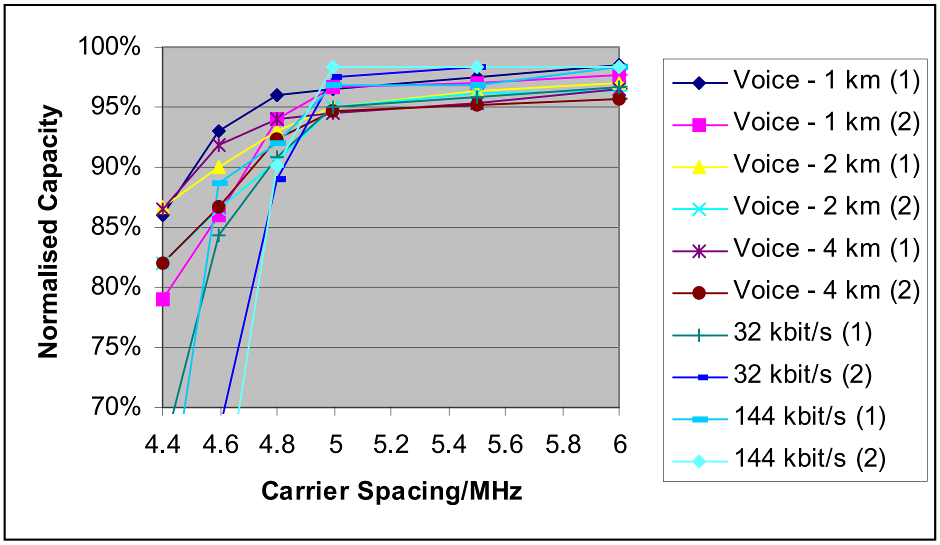

Figure 4 Down-link inter-operator carrier spacing (from [2]).

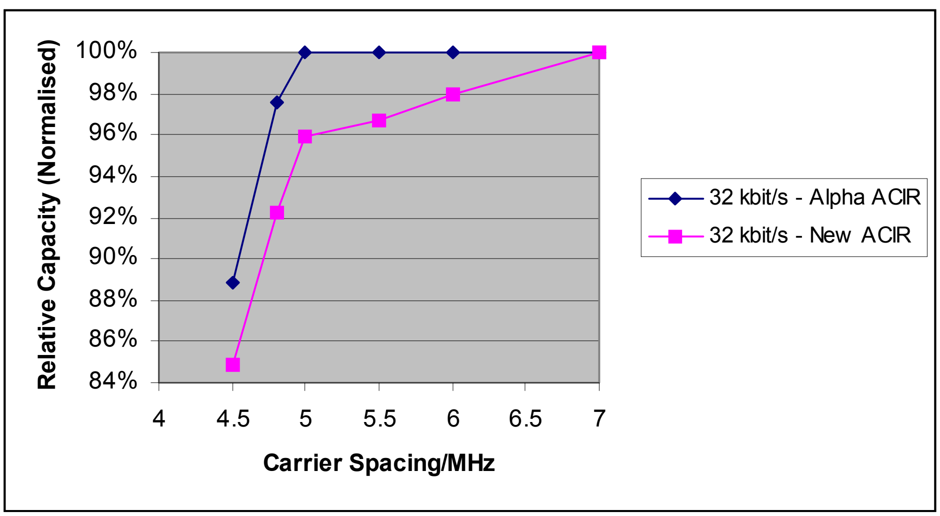

Figure 5 Impact of up-link carrier spacing (intra-operator/inter-layer) - from [2].

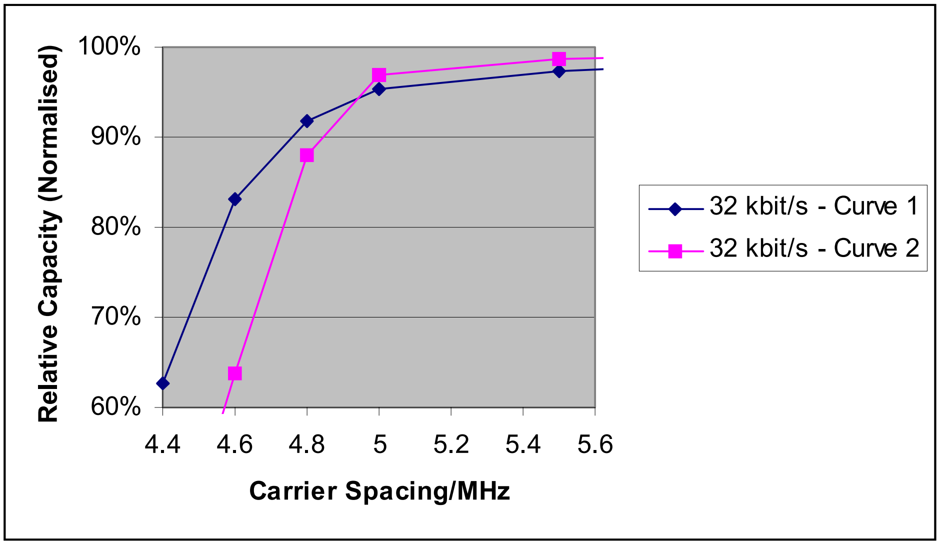

Figure 6 Impact of down-link carrier spacing (intra-operator/inter-layer) - from [2].

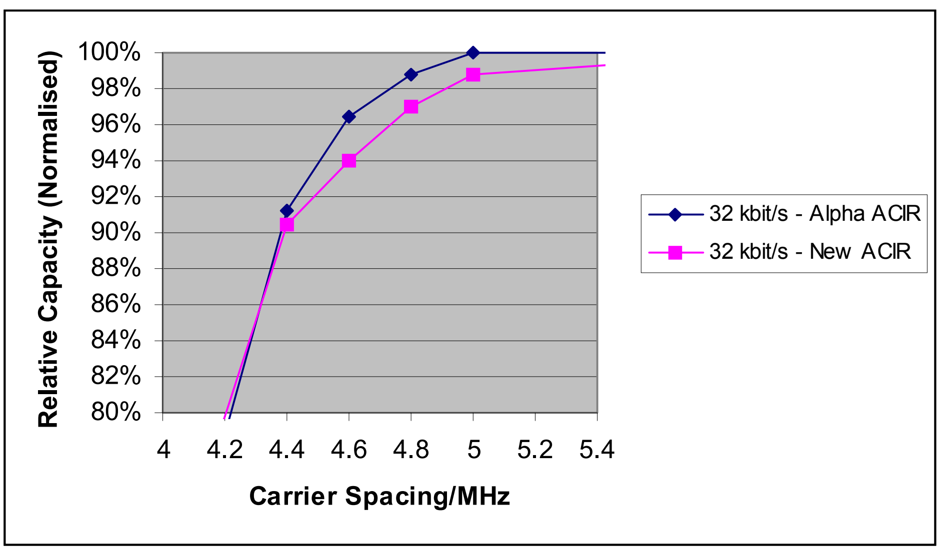

Figure 7 Impact of up-link carrier spacing (intra-operator/intra-layer) - from [2].

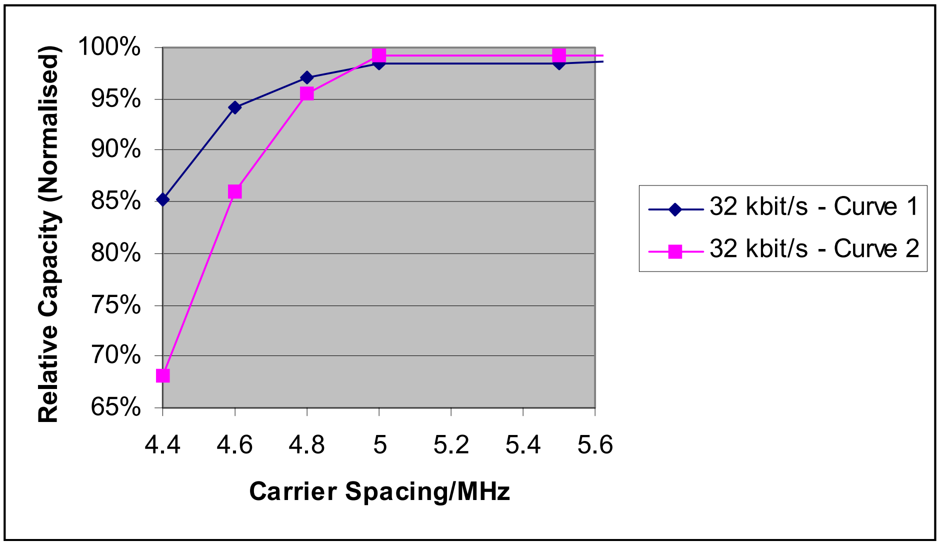

Figure 8 Impact of down-link carrier spacing (intra-operator/intra-layer) from [2].

Dead-zones are a serious consequence of adjacent channel interference when conventional frequency planning cannot be used because of the lack of carriers, itself a consequence of 3G systems having wideband signals. Ericsson's analysis for voice services using 1 km cells and an ACIR of 40 dB indicates that, within 100 m of the interfering base station, the probability of outage is very high. Lucent examined dead zones along a motorway that were assumed to account for only 0.5% of the area of the 1 km cells. For mobiles travelling at 25m/s, the mean time for 50% of the calls to drop was 372 seconds, ie, comparable with the mean holding time of voice call.

A UTRA FDD test-bed consisting of two BTSs, MSs and a mobile communications control centre simulator acting as a radio network controller (RNC) and a mobile switching centre (MSS), was employed to evaluate adjacent channel interference [ii]. Worst-case up-link adjacent channel interference conditions were examined in which the interfering MS has a line-of-sight (LOS) with a BTS. When the interfering MS was within 200 m of the BTS, the reduction in E_b/I_o was between 2.5 to 4.5 dB, and the E_b/I_o could decrease by a 1 dB at 900 m. The situation was significantly worse for the down-link, when the decrease in E_b/I_o was as much as 12 dB at 700 m. It is considered that operator coordination may be required to ensure that those large reductions in E_b/I_o are avoided.

The packaging of the spectrum by the TA in terms of the location of unpaired and paired spectrum, as well as the amount of spectrum, is crucially dependent on the adjacent channel interference levels that might be expected. It is imperative that the TA provides an excellent packaging plan.

3. 3G operator bandwidth allocation

There are alternative options that can be adopted for the amount of spectrum allocated to operators. As the IMT-2000 spectrum available is fixed, allowing operators more spectrum means that there will be fewer licenses. Here are some options that have been proposed.

Allocated paired spectrum, MHz	Allocated unpaired spectrum, MHz	Number of licenses	Country
2 × 20		3	Japan
2 × 15 (new entrants) 2 × 15 2 × 10	5 0 5	1 1 3 } = 5	UK
2 × 15	5	4	Finland
2 × 15	5	4	France
2 × 10 2 × 15	5 5	3 2	Germany
2 × 10 2 × 15		6, or 4	Singapore
2 × 15 (new) 2 × 10 (new) 2 × 10 (existing) 2 × 5 (existing)	0 5	not decided	Australia

Table 1 Some proposed 3G spectrum allocations from around the world.

The TA considers that new 3G operators will need 2x15 MHz, and incumbent 2G operators 2x10 MHz. This means four operators with 2x15 MHz, but then they would all be new entrants; or six 2x10 MHz allocations, ie, existing 2G operators. The other mixed scenarios are [one]-[two] 2x15 MHz and [four]-[three] 2x10 MHz.

Notice that if only existing operators are allowed 3G licenses of 2x10 MHz and they are allowed to migrate their spectrum, then there will be six 3G operators each having some 2x20 MHz. This spectrum will be the same as that advocated by the Japanese, and has the virtue that more high bit rate services will be supported.

If there is one new entrant with 2x15 MHz, and existing 2G operators have 2x10 MHz of 3G spectrum, plus 2x10 MHz of 2G spectrum converted to 3G use, then the existing operators could be in a good position.

4. TDD spectrum

The TA considers that there may be no immediate need to allocate TDD spectrum at the same time they allocate paired spectrum. However, the TA will reserve the unpaired spectrum for licensed 3G operators.

This approach raises the question of the importance of knowing how much paired and unpaired spectrum is required to make the business case for the deployment of a 3G network and its services. An organisation seeking spectrum needs to consider how to differentiate itself from other networks. Will their 3G network offer a range of services at different bit rates, or specialise in high quality services, or only high bit rate services, or handle asymmetric traffic, etc? More importantly, the TA must allocate unpaired spectrum wisely to decrease the adjacent channel interference experienced by network operators.

There is also the choice between allocating licensed unpaired spectrum and allocating unlicensed 'public' unpaired spectrum. We concluded that unlicensed spectrum is an appropriate approach in the domestic 'cordless' environment and also in the office wireless PABX environment. However, in public scenarios, eg, a shopping mall, the capacity of a system operating in an unlicensed band could be significantly less than that of a system operating in its own licensed band. Therefore, we conclude that if an operator is interested in using TDD systems to provide localised coverage in public areas, such as shopping malls, acquiring a licensed unpaired frequency band could prove beneficial.

5. Roaming between 2G and 3G networks

Roaming from UTRA FDD to GSM1800 requires a dual receiver, or the use of compressed mode, whereby a UTRA FDD mobile is able to address the suitability of a GSM base station. Other than the problem of service compatibility, ie, the mobile must be engaged in the type of service that a 2G network can support, there are technical difficulties in UTRA-to-GSM handovers. The dual receiver consumes more battery power than the single receiver, whereas the execution of the compressed mode involves complexity. Roaming from a GSM1800 network to an UTRA network means the service compatibility ought to be realised. It is noted that a mobile switching from a narrowband signal to a wideband signal will need dual-mode baseband receivers, but only one RF front-end.

Right from the outset we may expect the availability of dual-mode UTRA FDD/GSM handsets as incumbent GSM and new operators who obtain a 3G licence will most likely start their 3G infrastructure roll-out with 3G islands in a sea of GSM cells. Interoperability of 2G and 3G is therefore a prerequisite for a successful 3G deployment.

6. Summary

There are concerns relating to dead zones due to adjacent channel interference. The idea that a MS could lose service if it comes within, say, 100m, of a competitor's BTS is likely to be unacceptable in a dense urban environment like Hong Kong. This issue needs serious attention and it is important that the TA is aware of the limitations when designing the 3G spectrum packages.

The 3G spectrum packages offered by the TA need to be carefully considered, both in terms of the amount of spectrum offered and its position in the band, particularly with reference to the unpaired spectrum. For example, a FDD carrier frequency that is located directly adjacent to a TDD carrier frequency could prove to be less valuable (ie, it will receive greater levels of adjacent channel interference) than a FDD carrier that is only adjacent to other FDD carriers. In the UK the spectrum packages were designed in such a way to ensure that the same operator would be allocated the FDD carrier and the TDD carrier on either side of the FDD/TDD spectrum division. This allows the operator a degree of control over the TDD/FDD adjacent channel interference. This approach will only be possible in Hong Kong if the TA decides to allocate the paired and unpaired frequencies at the same time. It is recommended that the TA allocate both the paired and unpaired frequencies at the same time.

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i UKTAG Guard Bands Sub-Group: Update Report, document 43/99, Issue 1, 16 June 1999.

ii R.M.Joyce, T.Griparis, M.Swinburne and A.Rouz, 'Orange/Fujitsu wideband cdma field trials – system overview', 3G 2000 Conference, London, 27-29 March 2000, pp 6-10.