Executive Summary

1.0   Orange welcomes the opportunity to respond to Ofcom's third consultation[1] on its proposals for future regulation of Mobile Voice Call Termination (MVCT).

1.1   Given that Orange does not accept there are separate markets for wholesale MVCT on each individual network and we do not accept that Orange is dominant in respect of MVCT, Orange believes, based on Ofcom's view, that Ofcom has arrived at well considered charge controls for MVCT.

1.2   On the above basis, we support Ofcom's overall position in relation to the proposals for charge control regulation of MVCT, particularly Ofcom's proposal to address the current anomaly, where H3G is unregulated, by ensuring that all MVCT is regulated in a proportionate manner for all operators. However, it is incumbent upon Ofcom to be satisfied that its proposals will withstand a reasonable level of scrutiny. Orange agrees with Ofcom that, with a view to promoting regulatory certainty, the need for any (continuing) regulatory intervention arising from this market review should again be revisited in four years (ie 2010/ 2011).

1.4   Orange fully supports the technology neutral application of regulation to MVCT which will remove the asymmetry in the application of regulation between the four UK combined 2G/ 3G operators and H3G and we commend Ofcom's decision. In our view, it brings all mobile voice under a single framework of regulation and reflects the development in technology and the market since the last market review. In addition, Ofcom's approach brings the benefit of capturing future changes in technology.

1.5   However, whilst Orange supports the implementation of a technology neutral rate, we do not support the stance Ofcom has taken with regards to a single charge control for 2G/ 3G MNOs by the end of 2010/ 11. The charge control should take appropriate account of any legitimate and efficiently incurred costs in the methodology and calculation of the charge control, such as the exogenous spectrum difference.

1.6   Despite the view asserted by Ofcom that the efficient charges for a combined 900/ 1800 operator are consistently lower than an 1800 only network, Orange is extremely surprised to note that Ofcom believes that the cost differential will not have a material impact on competition. Moreover the fact that 1800 only operators will be allowed to recover their costs, means that combined 900/ 1800 operators will recover in excess of their costs, placing them at a competitive advantage. Not only is this unfair and discriminatory but it is also inconsistent with comments made by Ofcom in it's consultation document about the risks of adverse competitive effects for FNOs of mobile operators (in general) being allowed to charge excessive pricing.

1.7   Orange strongly believes that the difference has a material impact of the profit performance of the MNOs and must be maintained and reflected over the entire charge period. Therefore Orange fully supports the smooth glide path but with the differential maintained at the end of the proposed period of regulation – "smooth glide path +" - to ensure a fair and consistent approach is maintained whilst the exogenous factors remain.

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[1] Ofcom Mobile Call Termination consultation (Issued 13 September 2006)

Orange response to Ofcom consultation: Mobile Call Termination

Orange response to Ofcom consultation: Mobile Call Termination

Introduction

2.0 Orange welcomes the opportunity to respond to Ofcom's third consultation[2] on its proposals for future regulation of Mobile Voice Call Termination (MVCT). For purposes of clarity we firstly identify our main issues and discuss these in more detail. We then respond to each of the specific questions as set out in Ofcom's consultation in Annex A.

2.1 Given the following factors;

- level of uncertainty in technology and market development;
- uncertainty over future traffic volumes, and
- migration of traffic from 2G to 3G

and subject to Ofcom taking due account of our concerns in relation to:
- the cost of capital;
- recovery of efficiently incurred costs, and
- the difference in costs related to the spectrum utilised,

2.2 Orange believes that given Ofcom's view on market definition and market power Ofcom has arrived at well considered charge controls for MVCT. While Orange believes the Ofcom proposals are generally well considered, we have put forward some amendments that would suggest higher costs of approximately 13% should be taken into account for the determination of MTR in the medium case scenario. We welcome Ofcom's overall position in relation to the proposals for charge control regulation of MVCT, particularly Ofcom's proposal to address the current anomaly, where H3G is unregulated, in regulation by ensuring that all MVCT is regulated in a proportionate manner for all operators. However, it is incumbent upon Ofcom to be satisfied that its proposals will withstand a reasonable level of scrutiny.

2.3 However, whilst Orange supports the implementation of a technology neutral rate, we do not support the stance Ofcom has taken with regards to a single charge control for 2G/ 3G MNOs by then end of 2010/ 11. The charge control should take appropriate account of any legitimate and efficiently incurred costs in the methodology and calculation of the charge control, such as the exogenous spectrum difference.

Designation of Significant Market Power (SMP)

2.4 Within this response, we refer Ofcom to and reiterate the points made in our response to the Preliminary Consultation where we expressed our view on Market Definition and SMP.

2.5 The Orange position remains that we do not accept that there are separate markets for wholesale MVCT on each individual mobile network and we do not accept that Orange is dominant in respect of MVCT. Orange firmly believes that MVCT services are properly defined within a cluster market for mobile services. As Ofcom is aware, Orange is subject to bilateral interconnection agreements, which act as a constraint on Orange's ability to

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[2] Issued on 13 September 2006

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alter its charges without the <u>consent</u> of the other party. This has the effect of preventing Orange from setting MVCT charges at a monopolistic, profit maximising level aligned with Ofcom's Market Definition and proposed designation of SMP.

2.6   We observe that as a charge control is a highly interventionist mechanism Ofcom must ensure that the form and scope of regulation must be objectively justified and proportionate. Ofcom must also ensure that the level of the charge control does not remove the appetite for, or undermine, investment in an evolving and dynamic sector of the communications market.

2.7   However, taking into account Ofcom's definition of the relevant product market and the conclusions that Ofcom reaches in this consultation, it appears to Orange, that of the range of options presented by Ofcom and of the ones that it considers to be suitable, the least worst option for regulation is likely to be a charge control.

2.8   Ofcom also indicates[3] that there could exist a situation where there is no operator with SMP but the market is not "sufficiently competitive". We are not clear what the basis for the use of this terminology is. The existence of this market position is not recognised on the EU regulatory framework[4] which clearly identifies two states of a market – a market where there are one or more SMP operators and a market which is effectively competitive. That is the EU framework recognises that, where there is no SMP, the market must be effectively competitive. We are keen to understand Ofcom's apparent divergence from the established EU framework.

Alternatives to a charge control

2.9   Notwithstanding Ofcom's proposals Orange wishes to consider the alternative remedy of relying upon Ofcom's dispute resolution powers.

2.10   It appears that Ofcom is overly dismissive of relying upon this as a solution and in particular this is based upon Ofcom's overextension of the CAT's view about the definition of SMP. The consideration that Ofcom must make is once SMP has been found is how the dispute resolution could be effectively utilised. Ofcom has not made clear, or fully reasoned that in a situation where all MNOs are found to have SMP, why the optimum remedy is not to rely on Ofcom's dispute resolution powers.

2.11   The fair and reasonable test provides a robust test and therefore its potential under the dispute resolution must not be underestimated.

2.12   We seek to gain a better understanding from Ofcom of its reasons for departing from reliance on its dispute resolution powers, particularly as Ofcom's view is that this framework could deliver cost based charges.

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[3] Paragraph 7.9
[4] Paragraph 19 of the SMP Guidelines and Art. 16 of the Framework Directive

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Regulatory certainty and duration of a charge control

2.13   Given Ofcom's view that where SMP is present the appropriate remedy is that of a charge control, we agree with Ofcom that this will reduce uncertainty and the possibility of future legal and regulatory challenges. This in turn will provide a more stable commercial and regulatory environment for the industry to operate within.

2.14   **Orange agrees with Ofcom that, with a view to promoting regulatory certainty, the need for any (continuing) regulatory intervention arising from this market review should again be revisited in four years (ie 2010/ 2011).**

The provision of MVCT using new technologies and spectrum awards

2.15   Orange fully supports the technology neutral application of regulation to MVCT which will remove the asymmetry in the application of regulation between the four UK combined 2G/ 3G operators and H3G and we commend Ofcom's decision. In our view, it brings all mobile voice under a single framework of regulation and reflects the development in technology and the market since the last market review. In addition, Ofcom's approach brings the benefit of capturing future changes in technology.

2.16   In relation to operator neutrality we also believe this is the correct approach although an allowance for differences in costs must be maintained.

2.17   Ofcom suggests that enabling a common charge for MVCT would have a number of benefits. It implies, though not explicitly, that new competitors entering this market using Wimax or 4G wireless solutions, would be subject to the same regulation. However, under Ofcom's current proposals, there would be a difference in the end point between the 2G/ 3G and 3G only operators, so there is no common charge at this point. To this end, Orange believes that it is appropriate that a new entrant into the voice call termination market should be subject to SMP designation and consequently subject to a regulated charge. Without such clarification to the market, it is highly likely we could end up in the inequitable position where, existing UMTS operators could purchase spectrum at 2500MHz for the provision of 3G and be subject to MVCT regulation whilst a new entrant could enter the market to provide exactly the same service and not be subject to any regulation. Existing operators will never be able to compete on the same basis which is likely to be to the detriment of consumers, as suggested by Ofcom.

2.18   **Orange's view is that all operators entering the market offering MVCT should be subject to the same regulation.**

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Consideration of the regulatory principles and the LRIC model

Maintaining the 900/ 1800 cost differential

3.0 Orange wholly supports Ofcom's statement that exogenous cost differences (due to the reliance of an MNO on the use of different spectrum allocations) exist when determining the appropriate level of charge controls[5]. However, Orange is wholly unable to support Ofcom's proposal to remove this differential between the combined 900/ 1800 and 1800 only operators by the end of the charge control period in 2010/ 11.

3.1 It is clear that Ofcom relies on EU precedent[6] to set a charge control for call termination, particularly with respect to symmetry. However, Orange believes that spectrum differences are outside the control of the operator and that symmetry is not an appropriate objective in this case. In fact, the European Commission has written to ARCEP[7] supporting this point:

> *The Commission considers that MTRs should normally be symmetric and that asymmetry requires an adequate justification. It is recognized that, in certain exceptional cases, an asymmetry might[8] be justified by objective cost differences which are outside the control of the operators concerned, for instance owing to cost differences between the operation of a GSM900 network and a DCS1800 network or to substantial differences in the date of market entry.*

3.2 It seems to Orange that the above statement aptly describes the situation of the MNOs in the UK regarding the exogenous cost difference that should therefore be applied to the charge control.

The appropriate differential to be applied between 900/ 1800 and 1800 networks

3.3 Despite the view asserted by Ofcom that the efficient charges for a combined 900/ 1800 operator are consistently lower[9] than an 1800 only network, Orange is extremely surprised to note that Ofcom believes that the cost differential will not have a material impact on competition[10]. Ofcom seeks to justify its approach on the basis that the cost differential is narrowing as a result of blending in the 3G component charge and that, in any case, 1800 operators will still be permitted to cover their costs. However, the cost differential still exists so there is absolutely no reason to remove it. Moreover the fact that 1800 only operators will be allowed to recover their costs, means that combined 900/ 1800 operators will recover in excess of their costs, placing them at a competitive advantage. Not only is this unfair and discriminatory but it is also inconsistent with earlier comments made by Ofcom in it's consultation document about the risks of adverse competitive effects for FNOs of mobile operators (in general) being allowed to charge excessive pricing. It would be more reasonable to ensure the cost savings

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[5] Paragraph 9.58

[6] Paragraph 2.36

[7] http://forum.europa.eu.int/Public/irc/infso/ecctf/library?l=/commissionsdecisions/2006_0261_e npdf/_EN_1.0_&a=d

[8] *However, the Commission expects the differences related to technology to be inexistent in metropolitan France.*

[9] Paragraph A13.36

[10] Paragraph 9.72

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enjoyed by Vodafone and O2 as a result of their spectrum holdings were to be passed onto customers rather than bolster their profits through unreasonable regulation.

3.4   The cost difference has a material impact on the profit performance of the MNOs and must be maintained and reflected over the entire charge control period.

3.5   In the consultation document, Ofcom states that the difference in the number of required base stations of the combined 900/ 1800 and the 1800 only operators has narrowed over time. It believes that this is due to the requirement to meet traffic demand ie capacity, rather than provide coverage which then becomes the binding constraint on base station deployment. Whilst, to some extent, Orange would support this view, we would question whether the costs of an 1800 operator would ever become as low as a combined 900/ 1800 operator. Even with mature 2G networks, the 1800 only operators still have significantly more base stations in rural areas than the combined 900/ 1800 operators. As noted by Ofcom, we will still have to carry out repairs and maintenance to a larger number of base stations than the combined 900/ 1800 operators.

3.6   Ofcom goes onto to presume that there will be a decreasing number of 2G voice call termination minutes relative to the number of 3G termination minutes. Orange strongly believes that Ofcom is making presumptions which will benefit the combined 900/ 1800 operators (as opposed to 1800 operators) and Ofcom's proposal will not bring about parity in relation to the differential that exists in allocated spectrum.

3.7   Whilst Orange is pleased that an ongoing difference in cost is modelled, to reflect this exogenous difference, we believe the level of the cost is understated. The current outputs are demonstrating a difference of 0.3p by 2010/11 – this reflects the impact of the weighting of 2G and 3G traffic on the blended rates. In our view, a more realistic view of the differences would show a difference in 2G rates of 0.6p, and hence a blended rate difference of 0.4ppmin (in 2010/11 in 2006/7 prices). In Annex B[11], we set out the reasoning why we believe a more appropriate differential in the blended rate is 0.4ppm.

3.8   Orange believes a more appropriate differential between the combined 900/ 1800 and the 1800 only operators is 0.4ppm.

The introduction of spectrum trading and liberalisation

3.9   Ofcom states that *'absent 3G spectrum costs, 3G costs are lower than those of 2G such that 2G/ 3G operators will be incentivised to migrate to the lower-cost 3G technology in the future*[12]. It is well recognised in the industry, by manufacturers , telecom operators and regulators, that UMTS 900 is far more developed and that handsets, and other equipment, will be available far sooner than UMTS1800. Despite lobbying at European and international standards fora by 1800 only operators, there is still little appetite for the development of UMTS1800 equipment by the manufacturers. In any event,

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[11] Orange submission to Ofcom on the new mobile LRIC model
[12] Paragraph 9.61

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development is at least 18 months to 2 years behind that of UMTS 900, which means that the 1800 operators will be even further handicapped even if there is appetite to rollout UMTS 1800. There are very few 1800 only operators in Europe so inevitably much of the focus and development is for the benefit of 900 operators.

3.10   To this end, it is therefore disingenuous of Ofcom to presume that the 1800 only operators will be reducing the number of the 2G termination voice calls. It is far more likely that that voice calls will be shared between both the 2G and 3G networks and to this end, our 2G sites will need to be maintained and repaired.

3.11   In addition, from a physical perspective, UMTS1800 is very close in the spectrum range to the core band at 2100 MHz. The value of deployment of UMTS at 1800 is questionable as the disadvantages for rural coverage of UMTS1800 will be similar to the ongoing disadvantages for the rural coverage at 2G. To this end, the proposed cost differential between the combined 900/ 1800 and 1800 only operators is likely to increase with the advent of spectrum refarming unless there is further regulatory intervention.

3.12   Ofcom's current proposal to ignore the exogenous cost difference by 2010/ 11 will only lead to further inequity between the combined 900/ 1800 and 1800 only operators if 900MHz operators are allowed to rollout UMTS 900.

3.13   Ofcom also presumes that the advent of trading and spectrum liberalisation will cause spectrum differences between combined 900/ 1800 and 1800 only operators to cease to be exogenous. This seems a naïve presumption to Orange. Internal analysis completed by Orange, and presented to Ofcom demonstrates that a combined 900/ 1800 operator rolling out UMTS 900 has <u>significant</u> CapEx & OpEx savings giving a real cost advantage over an 1800 only operator rolling out a UMTS 1800 network. To date, there has been absolutely no indication that either Vodafone or O2 would be willing to trade their spectrum holdings, or allow access, with any of the other UK MNOs. In addition, an operator with a UMTS900 network will, by the very nature of UMTS technology, be able to manage many more voice calls per channel than a GSM 900 operator, leading to even greater spectrum advantages.

3.14   Without further regulatory intervention, Orange does not believe that the introduction of trading and liberalisation will cause spectrum differences to cease to be exogenous.

Mobile Number Portability (MNP)
3.15   Ofcom is proposing to change how the termination charges for ported calls are determined and proposes that the relevant termination charge is strictly included in the common pricing constraint. Ofcom seeks to do this by including all ported in subscribers in the same market as the network operator to which they currently subscribe.

3.16   We strongly believe that this is not an appropriate regulatory solution. An MVCT solution must not be implemented to resolve issues that occur as a direct result of the MNP framework including the indirect routing system that

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exists. In Orange's view, Ofcom is correctly reviewing the MNP arrangements[13] and processes and it is there that viable solutions must be sought and implemented.

3.17 A suitable and proportionate response from Ofcom is that the status quo should remain, and calls to ported-in numbers are not included in the common pricing constraint. (We assume Ofcom is not proposing that the donor operator will be obliged to pay a higher rate to the donee than is received by the originator.) If there is evidence of inconsistent treatment of calls to ported numbers, which leads to the undermining of the charge control accompanied by significant disadvantages to consumers, then Ofcom retains the ability to take relevant action in relation to the charge control.

Ensuring the correct externality factor

3.18 It is now widely accepted that an appropriate figure for externality must be taken into account when considering the appropriate charge for call termination. The exclusion of customer acquisition and retention and service costs (CARS) from the charge control[14] serves to strengthen the case for an externality surcharge. To this end, Orange supports Ofcom's inclusion of a reasonable externality factor but takes this opportunity to make a few comments with regard to the Rohlfs-Griffin factor and the handset cost assumption.

3.19 To reach its proposed externality surcharge 0.3, Ofcom has modeled two scenarios[15] and selected a reasonable mid-way point between the two estimates. Both scenarios are modeled with a traffic sensitivity and the conclusion is based on the low traffic scenario. The key assumptions in the model include:
- Size of the network externalities ie the R-G factor
- The degree of price discrimination
- The degree of leakage
- The handset cost
- The number of marginal consumers
- The demand for termination; and
- The level of retail termination prices without the externality surcharge

Leakage and Price Discrimination

3.20 In practice, we accept that leakage occurs. A low-cost subsidised handset may be taken up by an existing subscriber moving to a lower cost package or by a subscriber moving from another network. It is clearly impossible to prevent the subscriber taking up the offer. Leakage will be limited when operators are able to effectively price discriminate between users.

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[13] Ofcom consultation: Review of General Condition 18 – Number portability (http://www.ofcom.org.uk/consult/condocs/gc18/)
[14] Section A15.14 of the consultation document states that the "network externality surcharge can be interpreted as an allowance in termination charges of a contribution to the recovery of CARS costs."
[15] Scenario 1: R-G=1.3, perfect price discrimination and no leakage; Scenario 2: R-G=1.7, no price discrimination and 75% leakage

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3.21   Similarly it is difficult to price discriminate between marginal consumers. This is because marginal consumers typically select the lowest cost, lowest usage package available on the market although they may move onto another higher cost package later. This means that they can benefit to the same extent from the subsidy as another consumer with a much lower willingness to pay.

3.22   Orange believes that leakage and price discrimination have been incorporated in the model to an acceptable degree and that there is no need to adapt these assumptions under the current outcome.

3.23   Whilst we are not uncomfortable with the approach taken or the proposal of 0.3, it is our view that Ofcom must consider the following in relation to its key assumptions of the model - The Rohlfs-Griffin factor and the handset cost.

The appropriate Rohlfs-Griffin factor

3.24   Orange maintains the RG factor should be reset to 2 on the basis that any value below 2 does not adequately capture the network and option externalities for the reasons set out below.

3.25   The Rohlfs-Griffin factor is one of the key drivers of the model and represents the extent to which the social benefit from owning and using a mobile phone exceeds private benefit. Orange believes that there are strong arguments to support a Rohlfs-Griffin factor of at least 2. As we have argued extensively in the past, this is because mobile is a two-sided market. There are two beneficiaries to a call – the originator and the receiver. The Rohlfs-Griffin factor measures the extent to which the benefit of mobile phone ownership *and use* is external to the individual user. We believe that the Rohlfs-Griffin factor should be used to capture the network and option externality effects. Mobile phones create the option of being able to contact and being contactable at any time in a manner that fixed line communications do not[16]. There has been lengthy debate about the value of the Rohlfs-Griffin factor, but we maintain that any value below 2 does not capture the combined network and option externalities, crucially because there are two parties to a call and it is impossible to judge which party actually benefits more from the call, as only one party pays for the call.

3.26   By setting the R-G factor at 1.7, Ofcom sets out its view that one side (assumed to be the receiver) benefits less than the other side of the call. There is no empirical basis that the R-G factor should be set at 1 or indeed that it should take on a value any less than 2. It is agreed that externalities exist and therefore that the R-G factor is greater than 1, but in our view, Ofcom has not provided evidence to demonstrate that the value of the R-G factor should be any less than 2, or in other words, that one side of the call benefits any less than the other side. The operation of receiving party pays in the US demonstrates that the receiving end of the call may benefit to the value of the maximum price of the call and it is the co-existence of receiving

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[16] Orange strongly maintains that the network externality is a mobile specific factor that can be taken into account when setting the appropriate MVCT charge. Fixed line telephony already benefits from an implicit externality surcharge through the universal service obligation which is self-funded as BT enjoys benefits which offset the cost of providing universal service.

party pays and calling party pays that proves that both sides of the call can benefit equally or at least as much as the value of the call.

3.27   We therefore strongly urge Ofcom to reconsider its value set for the Rolhfs-Griffin factor and to reset it at 2.

The appropriate level of handset cost

3.28   The cost of subscription has a significant effect on the surcharge. Ofcom has estimated the cost of a handset provided to a marginal subscriber to be £70. Based on the confidential information we provide below, we believe Ofcom's estimate to be within a reasonable range of the actual cost. The average cost of a handset provided to a marginal consumer is presented below based on Orange figures.

[✂

✂]

3.29   Therefore we believe Ofcom's estimate of handset cost is of the right magnitude.

CAPM Parameters

3.30   On the whole, Orange is comfortable with the parameters estimated in the cost of capital calculation except for the estimation of the nominal risk free rate.

Updating the risk free rate

3.31   Ofcom sets out the parameters used in the Capital Asset Pricing Model (CAPM) in Annex 18 of the Consultation Document and proposes a value of 4.6% for the nominal risk-free rate. This is calculated from the real risk free rate of 2% and inflation at 2.5%. At the time Ofcom drafted the consultation document (26 July 2006) 4.6% was a reasonable reflection of the nominal average of nominal and real gilt rates. However, we believe that since then, market conditions have changed and that Ofcom should reassess its data set to re-estimate the nominal risk free rate.

3.32   We therefore believe that:
a)   The real risk free rate is not 2% but is actually 2.5%
b)   The nominal risk free rate is therefore 5% and this is backed up empirically by the market rates observed.

3.33   **Orange therefore suggests that the risk free rate is amended to 2.5% leading to a nominal risk free rate of 5% (backed up by observed market rates).**

3.34   Ofcom's approach has historically been to base its estimate of the RFR on recent market data, using longer-term averages as a cross-check. We agree that this is approach is a sound one. As set out in it's document "Ofcom's approach to risk in the assessment of the cost of capital – Second Consultation in relation to BT's equity beta 23 June 2005" :

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"As described in previous Ofcom publications, Ofcom base future estimates of the risk free rate on prevailing market rates at the time of publication (using a number of months' data in order to avoid very short-term fluctuations), but taking other factors into account if it considers that current rates may not be a reliable proxy for future rates (see the Bank of England's inflation report, May 2005).

In the PPC charge control statement, Ofcom used a value of 5% for the nominal risk free rate which reflected a 3 month average of the then most recently available data for 5-year gilts, and at the same time was reasonably aligned with a view of the longer term rate for 5-year gilts. As Figure 1 below shows, the nominal rate for 5-year gilts has fallen over the last year and mechanistically applying a 3 month average of the most recent data would lead to a risk free rate of 4.5% or less. Such an estimate would, however, be low by historic standards, and Ofcom believes that some weight should be given to a longer-term perspective, suggesting that the use of a slightly higher risk free rate would be more appropriate. Taking account of both the most recent and longer-term evidence, Ofcom proposes to use a value of 4.7% for the nominal risk free rate, which is consistent with a real risk free rate of about 2.0% and a rate of inflation of about 2.6-2.7%."

3.35   Based on the above, Orange therefore believes that the value of 4.6% suggested in the consultation document is inappropriately low as it puts too much weight on the very low rates prevailing mid 2005 to early 2006. We acknowledge that arriving at a single estimate based on constantly fluctuating market values is administratively difficult, but it is striking that as of the 16 November 2006 in the time that has elapsed since the cut-off point for Ofcom's analysis of the risk free rate (26 July), the market rate on five year gilts had not once been as low as 4.6, and had been as high as 4.87, with an average of 4.72.[17]. The market rate is currently on a clear upward trend. Whilst market rates will no doubt have changed again (in either direction) in the period following the production of these figures, this uncertainty and tendency for market rates to frequently exceed Ofcom's estimate of 4.6 is a sign that Ofcom has not struck an appropriate balance between current market rates and a more conservative approach.

3.36   We believe that the starting assumption that the real risk free rate of 2% is therefore wrong. Wright and Mason in the recent Smithers & Co[18] report recommends that (if the term premium is close to zero) the *"best current market based estimate of the forward looking real interest rate is the nominal yield on medium dated bonds less the Bank of England inflation target of 2%."* The nominal yield on medium dated bonds is more in the region of 4.5 – 4.75 than 4% and so the risk free rate should be 2.5-2.75. This would give a nominal risk free rate of 5%.

3.37   Orange wants Ofcom to look again at prevailing market rates and update their assumptions on the real and nominal risk free rates accordingly. Orange recommends that the risk free rate is amended to 2.5% leading

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[17] http://213.225.136.206/statistics/yieldcurve/uknom05.xls
[18]

http://www.ofgem.gov.uk/temp/ofgem/cache/cmsattach/16853_smithers_co.pdf?wtfrom=/ofgem/work/index.jsp&section=/areasofwork/transpcr

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to a nominal risk free rate of 5%. The charge controls should therefore
be re-stated with the cost of capital moving from 11.3% to 11.8%.

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Consideration of the proposed remedies

The proposed glide path

4.0   This section of the response highlights Orange's view on Ofcom's glide path proposals.

4.1   In its consultation document, Ofcom indicates its view that the 2G/ 3G MNOs should be required to reduce their charges in line with a smooth glide path of four equal percentage reductions. For H3G, Ofcom suggests three alternative glide path proposals.

<u>Consideration of the glide path for the 2G/3G</u>

4.2   Orange is pleased that Ofcom acknowledges that cost differences persist for the period of the proposed charge control. However, the suggestion that this cost difference should be ignored and a uniform charge control is preferable on the basis of consumer interest is not justified. We agree that consumers may be unaware or indifferent on which operators' network a call terminates and even though there may be an argument that supports this contention, there is not sufficient justification to support a conclusion of uniform charge controls.

4.3   Indeed, when looking at all of MVCT regulation, Ofcom have not proposed a uniform charge control. A different charge control is being proposed for the regulation of H3G – on the basis of cost differences. Ofcom must be consistent in its approach to the treatment of cost differentials.

4.4   Innovative retail pricing for packages and bundles is based on a wider set of factors than just wholesale voice call termination and therefore Ofcom's assumption that " *wholesale pricing may also translate to simplified retail charges*"[19] is, at best a "*may*". There is no justification or evidence provided by Ofcom as to how wholesale pricing could be reflected in retail charges. We would welcome Ofcom's views.

4.5   Based on the above and other considerations discussed in our response we do not believe a single charge control should be applied to all four 2G/ 3G operators. We acknowledge the fact that Ofcom has attempted to reconcile and demonstrate the differences in costs recognised in the earlier parts of the glide path, but the policy reasons do not support the conclusion whereby all four 2G/ 3G operators ultimately end up at the same charge control at the end of the proposed period.

4.6   Orange suggests that the equitable and sustainable position for Ofcom would be to ensure that the glide paths allow for all efficiently incurred costs to be recovered and for a differential to be maintained. Ofcom must not make the simplification of using the 1800 only operator's costs for setting the charge control for all four of the 2G/3G operators.   The 900/1800 operator's glide path should be based on the mid-point of cost modelling calculations for a 900/1800 operator.   The effect of this would be to maintain a differential of 0.4p in relation to O2 and Vodafone. To do otherwise would unduly discriminate against Orange (and T-Mobile) in favour of Vodafone and 02. In Orange's view this would be a proportionate response.

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[19] Paragraph 9.64

4.7   Orange strongly believes that the differential is highly material and cannot be dismissed or set aside. Indeed, for it ever to be removed would need to be substantiated with a robust level of evidence and to date, the evidence to remove the differential has not been provided. This approach ensures that the risk of regulation is not borne by those being regulated and ensures that a balanced and proportionate approach is taken.

4.8   Therefore Orange fully supports the smooth glide path but with the differential maintained at the end of the proposed period of regulation – "smooth glide path +" - to ensure a fair and consistent approach is maintained whilst the exogenous factors remain.

Consideration of the glide path for H3G
4.9   In relation to H3G we believe that Option 3, a cost based glide path is the most appropriate form of charge control to apply at this time. As Ofcom states, H3G's charges are significantly in excess of the cost-based range to which Ofcom is proposing H3G's charges should fall by 2010/11 (and have been for some time) supporting the implementation of Option 3.

4.10   This will primarily have the effect of aligning H3G with other regulated MNOs, who, to date have been regulated for their 2G networks, and looking forward will be regulated for 3G. In addition, this also sends the correct market signals for investment in the market as a whole, as opposed to being leveraged towards any individual operator.

4.11   It is evident that H3G's business plan[20] assumes that its termination rate will decrease on an annual basis. However, this has clearly not been the case. If we accept Ofcom's analysis, it shows that H3G has maintained a higher termination rate since 2002 (originally based on the highest 2G MNO rate when set).

4.12   It is also true that the market dynamics have appreciably changed since the last market review - H3G's subscriber base and its market share have rapidly increased.

4.13   Given the above substantive and appreciable changes Orange believes it is now appropriate to align regulation and the impact of regulation of MNOs by implementing Option 3 – the cost based glide path.

Consideration of current and proposed regulatory interventions
4.14   The current mobile regulation obligations are around:
- Requirement to provide network access on reasonable terms and conditions
- Requirement not to unduly discriminate
- Control of fixed to mobile interconnection charges
- Control of mobile to mobile interconnection charges
- Requirement to publish access contracts

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[20] As indicated in Ofcom's Assessment of whether H3G holds a position of SMP in the market for wholesale mobile voice call termination on its network Consultation - para 4.68   13 Sept 06

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- Requirement to notify charges

Ofcom's consultation response proposes the following mobile regulations:
- A charge control on mobile to mobile MCT to apply until 31 March 2011
- A charge control on fixed to mobile MCT to apply until 31 March 2011
- A prohibition of undue discrimination
- An obligation to meet reasonable requests for MCT on fair and reasonable terms
- An obligation to publish access contracts
- An obligation to publish charges and notify call volumes

4.15 In relation to the proposed new obligations that will replace the existing obligations we have the following comments to make:

MA3 and MA4 – application of charge control via two Conditions
4.16 We do not see the necessity or continuing need for two obligations relation to MVCT i.e. one for fixed origination and another for mobile origination. They should be simplified into a single, absolute obligation relating to MVCT.

4.17 Ofcom's view[21] that MNOs could discriminate within a single control basket against FNOs and their customers is incorrect. The existence of general provisions against discriminatory behaviour and the proposed inclusion of condition MA2 (Requirement not to unduly discriminate) means that there is no opportunity for MNOs to seek to discriminate in this way.

4.18 In proposing an additional unnecessary licence condition to be imposed on MNOs, Ofcom has failed to meet its own Regulatory Principles which state (inter alia) that *"Ofcom will always seek the least intrusive regulatory mechanisms to achieve its policy objectives"*.

[✂

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4.19 Therefore, proposed conditions MA3 and MA4 should be merged into one single condition covering the control of interconnection charges for mobile termination.

Scope of conditions (Network Access)
4.20 In the consultation document "Access Contract" is defined as a means for the provision of *Network Access* (emphasis added). However, the term "Network Access" definition does not make clear what is intended to be captured and therefore there is ambiguity and uncertainty in its interpretation. We would welcome Ofcom's clarification that "Network Access" is intended as Interconnection between two operators for the purpose of regulated MVCT.

4.21 The scope of the proposed new conditions is unclear and needs to be reconsidered. Proposed conditions MA1.1 and MA2.1 both refer to "Network Access" rather than mobile voice call termination services. "Network Access" is defined in Part 1 of the proposed conditions as:

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[21] Paragraph 9.96

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"Network Access means the provision of Interconnection to the Public Electronic Communications Network provided by the Dominant Provider, together with any services, facilities or arrangements which are necessary for the provision of Electronic Communications Services over that Interconnection"

4.22 Since "Interconnection" is defined very widely in the General Conditions of Entitlement[22], there is a serious risk that the terms of the conditions proposed by Ofcom impose obligations on the MNOs going far beyond the intention of regulating charges for mobile voice call termination. For example, MA1.1 could be interpreted as meaning that MNOs should be obliged to offer "network access" for forms of wholesale mobile outgoing services or access to value added service platforms. Such an extension of the remit of this consultation and investigation by Ofcom would be wholly unwarranted and is, no doubt, unintentional. As a result, it seems clear that the term "Network Access" currently used in the proposed conditions should be replaced by wording more clearly and more directly relating solely to regulated mobile voice call termination services.

MA 3.7

4.23 The effect of this proposed condition is to penalise any MNO which undershoots the target average charge in any year (because it will not be allowed to recover the revenue lost). This seems unfair and counter-productive in terms of regulatory incentives. Assuming Ofcom is correct in asserting that the market provides insufficient incentives for any MNO to reduce its charges on commercial grounds, the effect of this condition is to ensure that any charges set below the target average charge will generate losses for an MNO. Therefore, a rational MNO would naturally be cautious and would set charges which are likely to exceed the target average charge in order to avoid any such unrecoverable losses. While any charges which exceed the target average charge would be clawed back in the next charging period, the effect will have been to delay the benefits to consumers sought by the regulation. In effect, therefore this condition perversely incentivises MNOs to set charges higher than the regulated target average charge, and based on this it is misconceived and should be deleted.

MA 3.8

4.24 MA3.8 proposes that 'The Dominant Provider shall comply with any direction Ofcom may make from time to time under this Condition'.

4.25 This condition is too widely drawn and is, in any case, unnecessary, given Ofcom's standard enforcement powers.

Publication of charges and notification of call volumes

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[22] "Interconnection means the linking (whether directly or indirectly by physical or logical means, or by a combination of physical and logical means) of one Public Electronic Communications Network to another for the purpose of enabling the persons using one of them to be able:
  (a)   to communicate with users of the other one; or
  (b)   to make use of services provided by means of the other one (whether by the provider of that network or by another person)"

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4.26   Further, as the more interventionist approach of charge controls is proposed we do not see that an obligation to publish charges is required. We can see how this would be of utility in a regulated environment absent charge controls i.e. the visibility this would provide. However, by virtue of having established charge controls set by Ofcom, there will be transparency in the market of the regulated rates. The rates will also be published in the BT price list and available to all PECNs so it would appear that publication of charges is an unnecessary administrative burden on the MNOs.

4.27   Further clarification is required on the obligation to notify call volumes. Clarification is required that this information is only to be notified to Ofcom. Further clarification is required of the frequency of notification.

4.28   We welcome Ofcom's views on the above points.

Pass through of mobile regulation

4.29   In considering any regulation of MVCT, Orange is keen to ensure that the benefit of any regulation aimed at reducing prices for consumers, should indeed be received by consumers. To this extent we acknowledge BT's voluntary commitment to pass through the majority of these benefits (but not the totality) to its customers whose calls terminate on mobile, but this behaviour is not demonstrated across the market as evidenced by Ofcom's view that only two thirds[23] of the savings of MVCT regulation were passed through from fixed operators to mobile callers.

4.30   Given the above, Ofcom must accept that its intervention will create the same problem of inequitable distribution and market distortion that it views will occur in the mobile market. Ofcom's analysis in 7.5 of the consultation highlights the risks of a transfer of rents from fixed to mobile operators if termination charges are excessive. However, the consultation fails to consider the related and corresponding analysis of the risks of a transfer of rents from mobile to fixed operators if savings resulting from regulated reductions in MVCT rates are not passed through to fixed retail customers calling mobiles.

4.31   Further, while Ofcom objects on the grounds of efficiency and distributional equity to the mobile operators' flexibility to reduce prices based on the waterbed effect, it freely offers fixed operators that very flexibility[24] on the basis that this could be more efficient than targeting price reductions on fixed calls to mobile. This indicates an inconsistent position by Ofcom in that pricing flexibility practised by mobile operators represents market distortion whereas pricing flexibility as practised by fixed operators represents market efficiency.

4.32   For the above reasons, and also due to BT's voluntary commitment ending even before the current charge control comes to an end, we are keen to see Ofcom takes the necessary balancing steps to ensure that consumers do indeed receive the benefits of Ofcom's proposed regulation. Orange would fully support voluntary commitments from all relevant market participants. However, should this not be forthcoming, we recommend Ofcom takes the

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[23] Paragraph 3.12
[24] Paragraph 7.19

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necessary formal steps to gain the relevant undertakings to ensure a pass through.

4.33   The evidence clearly shows that benefit of MVCT regulation is not being fully received by (fixed) consumers and Ofcom should clearly take action to remedy this defect.

4.34   **Ensuring pass through of regulation will deliver the result that consumers of fixed services do indeed receive the benefits of regulation of MVCT as intended by Ofcom.**

Consideration and future application of Real Options

5.0   Orange submitted its paper on Real options[25] to Ofcom in August 2006 and is disappointed to the extent to which the issues raised have not been taken into account by Ofcom. In Annexes C and D we expand on the use of real options and the utility it provides in the assessment of the interaction of uncertainty with irreversibility of investment.

5.1   Recent discussions with Ofcom demonstrate that Ofcom recognises the merits of the real options approach which seeks to accurately measure and address the incremental cost created through the interaction of uncertainty with irreversibility in investment. Ofcom has stated (although not explicitly illustrated in any of its responses) that the current LRIC model, all be it in a relatively crude manner, does take into account the issues of decisions of inherently (irreversible) investment and uncertainty, although it is not responsive to changes in the market. Orange believes that a more sophisticated method could be developed which would capture the true economic cost of investment. The objective is that termination charges are set in a way that ensure efficient investment in mobile networks.

5.2   The problem is that the current LRIC model ignores the opportunity cost of investment. The termination charge is set, therefore, based on an incomplete measure of the costs of investment. As a result, the current charge does not give MNOs incentives to invest efficiently.

5.3   The purpose of raising this issue, developed more fully in Annexes C and D, is not to advocate a particular increment: clearly, more extensive consideration is required to determine with accuracy the efficient termination charge. The objective is merely to assess whether real options would have a material impact on the regulated termination charge. Our calculations suggest that incorporating real options would increase the network cost element of the termination charge significantly over the current level.

5.4   We see three major lessons that should be drawn from this calculation. The first is that, on current evidence, real options appear to have a significant effect on the termination charge that is required for efficient investment. The second is that, while the analysis is not always straightforward, it is feasible to incorporate real options into regulatory decisions. The theory of real options is well-developed. Real options are now used extensively by businesses to evaluate investment opportunities. While regulators have, on the whole, been slower to recognise the importance of real options, there are now several examples of regulators including real options in their decisions.[26] Finally, the real options approach indicates what future regulatory discussions should focus on. Large amounts of time and resources have been spent on arriving at precise estimates of particular parameters in the cost modelling (e.g., the cost of capital). The real options approach suggests a re-focussing of the discussion towards the extent of uncertainty looking forward.

<u>Where do we go from here?</u>

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[25] Real Options and Investment in Mobile Networks, Mason and Weeds 2006.
[26] The Irish Regulator, ComReg are currently looking at real options in the context of Bitstream and LLU pricing. In addition GlaxoSmithKline has used real options analysis to evaluate R&D investment in antibiotics.

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5.5   Including a real options element in the MTR provides the right incentives to operators to undertake risky investment so that this investment only occurs if it is efficient. Orange recognises that it is difficult and costly to collate the information necessary to calculate the full economic cost and hence the MTR. Instead, we propose that there is recognition of the increased cost of investment due to uncertainty and irreversibility and that when intervening, regulators should act to minimise that uncertainty.

5.6   At this stage in the consultation, we believe that it is important for Ofcom to recognise the increased cost of investment due to uncertainty and irreversibility and the fact that operators looking forward will face real options. We accept that Ofcom may not be comfortable with overhauling their established LRIC methodology at this stage. However, we suggest that Ofcom, without having undertaken a thorough analysis of real options thus far, should investigate how the interaction between uncertainty and irreversibility in investment might be easily incorporated into the model and look to include an allowance for the real options factor in future price control reviews.

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ANNEX A: QUESTIONS AND ANSWERS

Market Definition (s3)
Q1: Do you agree with Ofcom's market definition?

Definition:
- Wholesale mobile voice call termination provided to other Communications Providers by O2 in the UK
- Wholesale mobile voice call termination provided to other Communications Providers by Orange in the UK
- Wholesale mobile voice call termination provided to other Communications Providers by T-mobile in the UK
- Wholesale mobile voice call termination provided to other Communications Providers by Vodafone in the UK
- Wholesale mobile voice call termination provided to other Communications Providers by H3G in the UK

RESPONSE

As asserted by Orange in previous responses we do not accept that there are separate markets for wholesale Mobile Voice Call Termination (MVCT) on each network. Again, we disagree with Ofcom's view in this consultation and believe that MVCT services are correctly defined within a cluster market for mobile services – a wider definition which encompasses a basket of services.

We observe that the logic of Ofcom's approach with regard to the relevant market definition implies that each and every network operator offering MVCT or indeed any form of voice call termination is likely to be found to operate in a separate voice call termination market and therefore to be dominant in that market. As Ofcom continues with this approach it must therefore establish a clear policy statement on the regulatory regime that will apply to any new network operators delivering MVCT or any other form of voice call termination services.

The prospect of new entrants in MVCT is high given that Ofcom has awarded spectrum in the DECT guard band spectrum range which is suitable for use by GSM equipment and given possible future developments in respect of spectrum trading.

Ofcom must consider all potential service/market developments over the period of proposed regulation to avoid an undue discriminatory approach being taken and therefore applied. Orange is keen to ensure that any regulation is applied both consistently and fairly and, to deliver these results, it must be technology neutral in its approach. At its simplest, there must be the same regulation for the same service. Ofcom must develop the regulatory regime so that it is clear to all market participants when regulation will crystallise. We are keen to ensure Orange is not disadvantaged as a result of regulation not being applicable to similar services.

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Market power (s4)
Q2: Do you agree that each of the five MNOs has SMP in the market for wholesale mobile voice call termination provided by it to other Communications Providers in the UK?

RESPONSE

Notwithstanding Ofcom's stated view of market definition, Orange does not accept that it, or indeed any MNO, holds Significant Market Power (SMP) within the market. As stated in the previous question's response, we believe that mobile voice call termination is part of a wider cluster market for mobile services.

All businesses have stakeholder objectives and are <u>incentivised</u> to maximise profits, but in relation to SMP, the crux of the matter is whether an organisation has the <u>ability</u> to actually profit maximise i.e. can a business act in such a manner that it is able to behave independently of its competitors, customers and consumers? It seems clear for a number of reasons (summarised below) that, in the context of the competitive market for mobile services and the existing regulatory framework (i.e. regardless of whether Ofcom chooses to impose any specific regulation on call termination), Orange does not enjoy such a position.

The reasons for this have been well documented in past Calls to Mobile (CTM) submissions. As a result of Ofcom's rejection of our reasoned arguments, Orange does not propose to revisit in detail the justification for the SMP designation within this response.

Even with Ofcom's view of market definition, there are a range of factors and market developments that do or could in future act to constrain termination charges to efficient levels. Ofcom must take into account any and all factors that may be relevant during the proposed period of regulation when considering the need for regulatory intervention and when developing any remedy that may be required. In some cases, Ofcom seems to have taken the view that uncertain and unquantifiable market developments can be discounted; we do not find such an approach to be reasonable or acceptable. All relevant impacts must be taken into account, even if these are dependent upon future developments, changes in technology and potential new market entry. While such impacts are affected by uncertainty, this is a factor which is common to all forward looking regulation, including the proposed regulation of MVCT. A failure to take all relevant impacts into account could lead to the development of regulation which is disproportionate and which unfairly places unreasonable market risk on Orange and the other existing MNOs – this is not the purpose of regulation, nor should it be a side effect.

There are an increasing number of substitutes for mobile voice call termination being brought to market, and an increasing number of converged products being made available in the market by different companies. The communications market is developing, driven by competition to offer new services that offer alternatives to simple MVCT. In relation to fixed mobile convergence Orange has launched new mobile/ home based handsets that will operate on the GSM network where mobile, and via a wireless hub at fixed locations[27]. These type of offerings by Orange, other converged products by new competitors in the mobile market (including MVNOs and other MNOs), and based on alternative technologies (e.g. wi-fi and wimax) are increasing competitive pressures which lead to a downward ratchet-effect on mobile

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[27] 'Unique'

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termination charges. Even though Ofcom is sceptical of such an effect, the market is continuously evolving and products that are now being offered will provide increasing opportunity for customers to avoid entirely (e.g. VOIP) or achieve lower termination charges.

On this basis Ofcom could and should ensure that regulation of mobile voice call termination does not become an enduring feature. Therefore, Orange is fundamentally concerned at the proposals for an EU Regulation on roaming prices that would tie roaming prices to the regulated mobile voice call termination rate. Quite apart from the risk of market distortion arising from such retail tying, this approach carries the significant risk of embedding price control regulation of MVCT permanently, an outcome which would be highly damaging for the future development of the mobile market and arguably ultra vires. The UK is often considered as one of the most competitive mobile markets in Europe, if not the world.

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Q3: Do you agree that it is appropriate to impose the following SMP conditions on each of the five MNOs:

- A charge control on mobile to mobile MCT to apply until 31 March 2011
- A charge control on fixed to mobile MCT to apply until 31 March 2011
- A prohibition of undue discrimination
- An obligation to meet reasonable requests for MCT on fair and reasonable terms
- An obligation to publish access contracts
- An obligation to publish charges and notify call volumes

RESPONSE

MA 3 and MA4 - application of charge control via two Conditions
It is not clear why Ofcom suggests that a single Condition to meet a charge control would not be sufficient. As a charge control is recognised as being strongly interventionist, Orange believes that it would be appropriate for Ofcom to set a single Condition as an appropriate remedy. If required, Ofcom could produce guidelines that would support a simplified, single and absolute obligation relating to MVCT. We would welcome Ofcom's views on taking this approach and if not considered appropriate to indicate why.

Further, Orange is further concerned in having two MCT obligations i.e. one for fixed origination and one for mobile origination especially when coupled with reporting obligations. Orange would welcome Ofcom's reasoning for the two separate requirements as having two requirements seem to be disproportionate when considered with reporting of call volumes, as explained below.

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An obligation to meet reasonable requests for MCT on fair and reasonable terms
We welcome the addition to meet only "reasonable requests". However, practically it is not always clear what a reasonable request is and Ofcom may be required to provide guidance on this issue.

We note that in addition to meet reasonable requests on reasonable "terms" the obligation also inserts "fair".

On the basis that the interventionist approach of a charge control is proposed it is not clear why these changes are necessary and indeed the obligation could remain unchanged.

Scope of conditions (Network Access)
In the consultation document "Access contract is defined as a means for the provision of "Network Access". "Network Access" *means the provision of Interconnection to the Public Electronic Communications Network provided by the Dominant Provider, together with any services, facilities or arrangements which are necessary for the provision of Electronic Communications Services over that connection.*

Orange suggests that as the scope of the new condition is unclear it should be reconsidered. The proposed conditions MA 1.1 and MA 2.1 both refer to Network Access as opposed to MVCT.

Our concern stems from the definition of "Interconnection" in the General Conditions of Entitlement –

Interconnection means the linking (whether directly or indirectly by physical or logical means, or by a combination of physical and logical means) of one Public Electronic Communications Network to another for the purpose of enabling the persons using one of them to be able:
  (a) to communicate with users of the other one; or
  (b) to make use of services provided by means of the other one (whether by the provider of that network or by another person).

This is defined widely and could lead to wider interpretation than intended in the context of the proposed condition.

There is a serious risk that the terms of the conditions proposed by Ofcom impose obligations on MNOs that go far beyond the purpose of regulating charges for mobile voice call termination. For example, MA1.1 could be interpreted as meaning that MNOs should be obliged to offer "network access" for forms of wholesale mobile outgoing services or access to value added service platforms. Orange does not believe that any such extension of remit is warranted or intended by Ofcom.

However, if Ofcom's intention is different we require clarity from Ofcom as to the exact nature of this Condition

MA 3.7
The effect of this proposed condition is to penalise any MNO which undershoots the target average charge in any year (because it will not be allowed to recover the revenue lost). This seems unfair and counter-productive in terms of regulatory incentives. Assuming Ofcom is correct in asserting that the market provides insufficient incentives for any MNO to reduce its charges on commercial grounds, the effect of this condition is to ensure that any charges set below the target average charge will generate losses for an MNO. Therefore, a rational MNO would naturally be cautious and would set charges which are likely to exceed the target average charge in order to avoid any such unrecoverable losses. While any charges which exceed the target average charge would be clawed back in the next charging period, the effect will have been to delay the benefits to consumers sought by the regulation. In effect, therefore this condition perversely incentivises MNOs to set charges higher than the regulated target average charge, and based on this it is misconceived and should be deleted.

MA 3.8
This condition is too widely drawn and is, in any case, unnecessary, given Ofcom's standard enforcement powers.

Obligation to publish access contracts
As a result of the issues in relation to the Network Access definition, it is not clear what is intended to be captured by this obligation to publish access contracts. We would welcome Ofcom's clarification that the obligation for MNOs is to publish their (reference) interconnect agreement and provide this to Ofcom and to anyone who reasonably requests it.

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<u>Obligation to publish charges and notification of call volumes</u>
Ofcom's proposal is to apply charge controls we do not see that an obligation to publish charges is required. In a regulated environment absent of charge controls this would provide visibility and therefore transparency. However, regulated charge controls established by Ofcom will be transparent. In addition the rates will be published in the BT price list and available to all PECNs. So, on balance we do not believe this obligation is required.

In relation to notification of call volumes we would like clarity on what the purpose of this is and how the information will be utilised. It is not clear on what basis this information will provided and to whom it will made available.

<u>Orange definition</u>
Also please note the reference to Orange should mean Orange Personal Communications Services Ltd, company number 02178917 (and not Orange Ltd).

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Q4: Do you agree that the appropriate level of the target average charge to apply to mobile to mobile MCT and fixed to mobile MCT in 2010/11 in respect of H3G is 6ppm (2006/7 charges), and in respect of the 2G/3G MNOs is 5.3ppm (2006/7 charges)?

RESPONSE

As we state in our main response, overall, as Ofcom believes a charge control remedy is required, then generally and subject to our comments below Ofcom have arrived at a considered set of charge controls.

However, we are keen to ensure that a proportionate and fair approach is taken by Ofcom in relation to the charge controls set for each MNO. Specifically, our key concern is over the treatment of the differences in costs incurred by the 900/1800 and 1800 operators.

The scope, manner and application of regulation must consider all relevant and efficiently incurred costs. To do otherwise will mean that the risk of regulation is unfairly placed on some of the entities to be regulated. We consider the main issues to Orange specifically and the main issues around MVCT below.

Maintaining the 900/ 1800 spectrum differential

Orange fully supports Ofcom's view that exogenous cost differences exist (based on the different spectrum allocations to MNOs), when considering an appropriate charge control. However, Orange is wholly unable to support Ofcom's proposal to remove this differential between the combined 900/1800 and 1800 only operators by the end of the charge control period in 2010/ 11.

As per our main response it is evident that Ofcom relies on EU precedent[28] to set a charge control for call termination, particularly with respect to symmetry. However, Orange believes that spectrum differences are outside the control of the operator and that symmetry is not an appropriate objective in this case. In fact, the European Commission has written to ARCEP[29] supporting this point. Where they state *". . . It is recognized that . . . asymmetry might [30]be justified by objective cost differences which are outside the control of the operators concerned, for instance owing to cost differences between the operation of a GSM900 network and a DCS1800 network...."*

Orange's view is that the above is of direct relevance to this issue and the cost differential must be maintained.

The appropriate differential to be applied between 900/ 1800 and 1800 networks

Orange is extremely surprised to note that Ofcom believes that the differential will not have a material impact on competition[31]. Ofcom accepts from its own analysis that there will continue to be a significant cost differential in the provision of MVCT between the 1800 only and the 900/1800 MNOs. Ofcom also argues strongly that

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[28] Paragraph 2.36

[29] http://forum.europa.eu.int/Public/irc/infso/ecctf/library?l=/commissionsdecisions/2006_0261_e npdf/_EN_1.0_&a=d

[30] However, the Commission expects the differences related to technology to be inexistent in metropolitan France.

[31] Paragraph 9.72

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excessive earnings by the MNOs could seriously distort the competitive market between the MNOs and the FNOs but seems to discount altogether (without any detailed analysis) the same probability as between the 1800 MNOs and the 900/1800 MNOs. This part of Ofcom's analysis seems to us deeply flawed and incorrect. Therefore, the 900/1800 differential must be retained throughout the period of the proposed price control.

Ofcom seeks to justify its approach on the basis that the cost differential is narrowing as a result of blending in the 3G component charge and that, in any case, 1800 operators will still be permitted to cover their costs. However, the cost differential still exists so there is absolutely no reason to remove it.

Moreover the fact that 1800 only operators will be allowed to recover their costs, means that combined 900/ 1800 operators will recover in excess of their costs, placing them at a competitive advantage. This is unfair and discriminatory

The difference has a material impact on the profit performance of the MNOs and must be maintained and reflected over the entire charge period.

Ofcom states that the differential between the number of required base stations of the 900/ 1800 and the 1800 only operators has narrowed over time and this is due to the requirement to meet traffic demand i.e. capacity, rather than provide coverage.

Orange questions whether the costs of an 1800 operator would ever become as low as a combined 900/ 1800 operator. Even with mature 2G networks, the 1800 operators still have significantly more base stations in rural areas than the combined 900/ 1800 operators. Orange will still have to carry out repairs and maintenance to a larger number of base stations than compared to 900/ 1800 operators.

Ofcom also presumes that there will be a decreasing number of 2G voice call termination minutes relative to the number of 3G termination minutes. This presumption only benefits the combined 900/ 1800 operators (as opposed to 1800 operators).

Whilst Orange is pleased that an ongoing difference in cost is modelled, to reflect this exogenous difference, we believe the level of the cost is understated. The current outputs are demonstrating a difference of 0.3p by 2010/11 – this reflects the impact of the weighting of 2G and 3G traffic on the blended rates. In our view, a more realistic view of the differences would show a difference in 2G rates of 0.6p, and hence a blended rate difference of 0.4ppmin (in 2010/11 in 2006/7 prices). In Annex B[32], we set out the reasoning why we believe a more appropriate differential in the blended rate is 0.4ppm.

Orange believes that the appropriate differential between the combined 900/ 1800 and the 1800 only operators is 0.4ppm.

The introduction of spectrum trading and liberalisation
Ofcom states that '*absent 3G spectrum costs, 3G costs are lower than those of 2G such that 2G/ 3G operators will be incentivised to migrate to the lower-cost 3G technology in the future*[33]. However, it is widely acknowledged that UMTS 900 is far more developed and that handsets, and other equipment, will be available far sooner

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[32] Orange submission to Ofcom on the new mobile LRIC model
[33] Paragraph 9.61

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than UMTS1800. There appears to be little appetite for the development of UMTS1800 equipment by the manufacturers and at best development is at least 18 months to 2 years behind that of UMTS 900.

There are very few 1800 only operators in Europe so inevitably much of the wider commercial focus and development is for the benefit of 900 operators.

Therefore Ofcom should not presume that the 1800 operators will be reducing the number of the 2G termination voice calls. It is likely that that voice calls will be on both the 2G and 3G networks, so our 2G sites will need to be maintained and repaired.

In addition, spectrum refarming will bring its own issues. UMTS1800 is very close in the spectrum range to the core band at 2.1MHz. The value of deployment of UMTS at 1800 is questionable as the disadvantages for rural coverage of UMTS1800 will be similar to the ongoing disadvantages for the rural coverage at 2G.

The proposed cost differential between the 900/ 1800 and 1800 only operators is likely to increase with the advent of spectrum refarming unless there is further regulatory intervention.

Ofcom must take account of the exogenous cost differences detailed above. Otherwise this will lead to further inequity between the combined 900/ 1800 and 1800 only operators rollout networks using UMTS 900.

Ofcom also presumes that the advent of trading and spectrum liberalisation will cause spectrum differences between 900/ 1800 and 1800 only operators to cease to be exogenous. Our evidence and analysis presented to Ofcom, demonstrates that a 900/ 1800 operator rolling out UMTS 900 has a significant cost advantage over an 1800 operator rolling out a UMTS 1800 network.

This is over and above the likely lack of available UMTS1800 equipment with respect to availability of UMTS 900 equipment as discussed above. To date, there has been absolutely no indication that either of the UK 900/ 1800 operators would be willing to trade their spectrum holdings, or allow access, with any of the other UK MNOs.

Without further regulatory intervention, Orange does not believe that the introduction of trading and liberalisation will cause spectrum differences to cease to be exogenous.

Mobile Number Portability (MNP)
With the MNP arrangements and processes that exist, under current MVCT regulation, an MNO charges a different termination charge (i.e. the donor networks termination charge) from its own, for customers that port in to that network. This is a result of the indirect routing system in place.

Ofcom is proposing to change how the termination charges for these calls are determined and propose that these termination charges are strictly included in the common pricing constraint[34]. Ofcom seeks to do this by including all ported in

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[34] *The common pricing constraint applies to all voice call termination to all subscribers on one network. This is because MNOs do not charge different prices for termination depending on which subscriber is being called.*

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subscribers in the same market as the network operator to which they currently subscribe.

We strongly believe that this is not an appropriate regulatory solution in these circumstances. An MVCT solution must not be implemented to resolve issues that occur as a direct result of the MNP framework including the indirect routing system that exists. In Orange's view, Ofcom is correctly reviewing the MNP arrangements and processes and it is there that viable solutions must be sought and implemented.

We assert that a suitable and proportionate response from Ofcom is that the status quo should remain, and calls to ported-in numbers are not included in the common pricing constraint. If there is evidence of inconsistent treatment of calls to ported numbers, which leads to the undermining of the charge control accompanied with significant disadvantages to consumers, then Ofcom can monitor the situation and retains the ability to take relevant action in relation to the charge control.

The review of MNP arrangements is the correct policy area to address the issues that flow from the indirect routing system that exists for ported traffic. If the forthcoming review of the MNP arrangements does not bring about a suitable solution to address concerns of potential abuse due to the indirect routing arrangements when coupled with the regulation of MVCT, then Ofcom should take appropriate action once that assessment has been made.

LRIC Model
Within Annex B, Orange has set out the key changes it considers are required to the cost model in order to derive robust costings for the proposed charge control. Whilst we are generally supportive of the costing work Ofcom has undertaken, the issues raised (traffic forecasts, administrative costs and other modelling points) lead us to suggest that increases of around 12-13% would still be reasonable as the mid-point of the medium scenario ranges used.

Cost of Capital
The cost of capital is an important component in setting the appropriate MTR and it is crucial to estimate this as accurately as possible. As explained in the main response, we do not feel that Ofcom has used the correct nominal risk free rate to calculate the cost of capital. We strongly urge Ofcom to update its data set used to estimate the nominal risk free rate and to update the WACC calculation accordingly. We suggest that with a risk free rate of 5%, the WACC should be set at 11.8%.

Externalities
Orange is comfortable with the analysis of externalities put forward by Ofcom. We accept that the externality factor is a difficult area to estimate accurately. The important point is that the external benefit from mobile phone ownership is taken into account and feeds into an increment in the MTR to subsidise handset costs for marginal subscribers. We have argued in the main body of our response for a Rohlfs-Griffin factor of 2 and would strongly urge Ofcom to reconsider this value. We also provide supporting evidence for the assumption on handset costs used in the Ofcom model, in general support of the overall analysis presented and the final figure recommended. We do not accept that the externality increment should be any lower than the current value set. We believe that Ofcom has selected the appropriate balance between conflicting interests when opting for 0.3 as the externality increment.

Real options

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We are disappointed that Ofcom has not taken the real options factor into account in setting the appropriate MTR. However, at this stage we urge the real options debate to progress further as outlined in the main body of our response and Annex C and D. Without having undertaken a detailed analysis of the quantification of the real options increment, we trust that Ofcom will err on the side of caution in the final rate set.

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Q5: Which of the following glide path options should be used to define H3G's target average charge in each of the first three years of the charge control:

- **Option 1 – A smooth glide path with charges reducing at a constant percentage rate in each of the four years from today's average charge aligns with the target determined for the final year of the charge control**

- **Option 2 – A one-off partial cut to 8.5ppm (2006/7 prices) for the first year followed by a smooth glide path to ensure that the maximum average charge aligns with the target determined for the final year of the charge control**

- **Option 3 – A cost based glide path with charges reducing immediately to align with the 3G-only operator cost benchmark for 2007/8, and then set equal to the forecast path thereafter, such that in 2010/11 the maximum average charge aligns with the target determined for that year**

RESPONSE

In relation to H3G we believe that Option 3, a cost based glide path is the most appropriate form of charge control to apply at this time. As Ofcom states, H3G's charges are significantly in excess of the cost-based range to which Ofcom is proposing H3G's charges should fall by 2010/11 (and have been for some time) supporting the implementation of Option 3.

This will primarily have the effect of aligning H3G with other regulated MNOs, who, to date have been regulated for their 2G networks, and looking forward will be regulated for 3G. In addition, this also sends the correct market signals for investment in the market as a whole, as opposed to being leveraged towards any individual operator.

It is evident that H3G's business plan[35] assumes that its termination rate will decrease on an annual basis. However, this has clearly not been the case. If we accept Ofcom's analysis, it shows that H3G has maintained a higher termination rate since 2002 (originally based on the highest 2G MNO rate when set).

Also, there have been appreciable changes in the market since the last market review - H3G's subscriber base has rapidly increased and its market share continues to rapidly increase.

Given the above substantive and appreciable changes Orange believes it is now appropriate to align regulation and the impact of regulation of MNOs by implementing Option 3 – the cost based glide path.

We do not believe that such an approach would be unreasonable or unduly onerous for H3G, in the context of similar previous regulatory interventions on mobile call termination. As we demonstrate below as a comparison, there is clear evidence which supports intervention such as currently proposed by Ofcom.

The table below shows that previous regulation sets precedent for price controls that impose cuts in termination rates that support decrease of around 30%+

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[35] As indicated in Ofcom's Assessment of whether H3G holds a position of SMP in the market for wholesale mobile voice call termination on its network - para 4.68   13 Sept 06

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		Q303	Q403	Q404
900/1800 operator	Ofcom Final - June 04 pp min	10.80	9.28 -14%	6.31 -32%
		2006/07	**2007/08**	**2008/09**
H3G	Ofcom proposals - Sep pp min	11	9.5 8.3 6.8 -14% -25% -38%	8.1 7.4 6.5 -15% -11% -4%

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Q6: Do you agree that the 2G/3G MNOs should be required to reduce their charges in line with a smooth glide path of constant percentage rate in each year of the charge control such that average charges in the fourth year (2010/11) align with the target determined for that year?

RESPONSE

Orange is pleased that Ofcom acknowledges that cost differences between 900/1800 and 1800 only operators persist, but is disappointed to note that Ofcom's proposal for regulation does not reflect this cost differential for the period of the proposed charge control. The suggestion that a uniform charge control is preferable on the basis of consumer interest is not justified. We agree that consumers may be unaware or indifferent on which operators' network a call terminates and even though there may be an argument that supports this contention, there is not sufficient justification to support a conclusion of uniform charge controls.

Innovative retail pricing for packages and bundles is based on wider set of factors than just wholesale voice call termination and Ofcom's assumption that " *wholesale pricing may also translate to simplified retail charges*"[36] is, at best a "*may*". Ofcom does not explain the basis of this assumption, nor how it has arrived at this position. We welcome Ofcom's view on how it validates its view.

Based on the above and other considerations discussed in our response we do not believe a single charge control should be applied to all four 2G/ 3G operators which does not take into account the exogenous cost differences. We acknowledge the fact that Ofcom has attempted to reconcile and demonstrate the differences in costs recognised in the earlier parts of the glide path, but the policy reasons do not support the conclusion whereby all four 2G/ 3G operators ultimately end up at the same charge control at the end of the proposed period.

Orange suggests that the equitable and sustainable position for Ofcom would be to ensure that the glide paths allow for all efficiently incurred costs to be recovered and for a differential to be maintained. To this extent Orange suggests that slight amendment to Orange's smooth glide path be made. The effect of which would be to maintain a differential of 0.4ppm in relation to O2 and Vodafone.

To do otherwise would unduly discriminate against Orange (and T-Mobile) in favour of Vodafone and 02. Indeed we contest Ofcom's proposal for the removal of the differential whilst cost differentials continue to exist. Maintaining the differential ensures that the risk of regulation is not borne by those being regulated and ensures that a balanced and proportionate approach is taken.

Please also refer to our response to Q4 where we detail our issues on the exogenous cost differences that arise as a result of the use of different spectrum allocations between the 900/1800 v 1800 only operators.

Orange has concerns over the implementation of the one-off cut option. With the consideration of the profile with indexation included, the rates over the 4 year period may indeed rise[37]. It is more commercially acceptable to implement rate decreases than rate increases.

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[36] Paragraph 9.64
[37] For the graph shown below, we have assumed RPI to be 2.5% per annum.

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Therefore Orange fully supports the smooth glide path but with the differential maintained at the end of the proposed period of regulation – "smooth glide path +" - to ensure a fair and consistent approach is maintained whilst the exogenous factors remain.

ANNEX B: DETAILED COMMENTS ON THE LRIC MODEL

Executive summary

Issues:

1) Traffic forecasts
2) Treatment of on net calls between 2G and 3G
3) 1800MHz and 900/1800MHz differential and LRIC model calibration
4) MEA Indices
5) Data Down-lift Factor
6) Unit costs have not been included for all assets
7) Non-network costs (1)
8) Non-network costs (2)
9) 3G Licence Fee Treatment
10) Orange's proposals for appropriate charge control rates

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Executive summary

Introduction and overview
This paper provides a critique of Release 3 of Ofcom's new mobile LRIC model (September 2006) which has provided the basis for the proposed charge control rates for the four year period from April 2007.

Ofcom's approach throughout has been to determine a range of cost estimates taking into account various plausible scenarios with regards to the development of the mobile industry. While it is impossible to determine one specific rate for voice termination services with any degree of accuracy, the choosing of a rate from within a reasonable range of costings is a pragmatic solution to address the complex issue.

The LRIC Model
Orange has reviewed the model, and has identified some further areas that require amendment in order to improve the robustness and calibration of the model. Our comments are deliberately limited, as Ofcom has taken into account previous points Orange has submitted in the development of the current model. Our key comments are focused on:
- The choice of traffic forecasts. The aggressive voice forecast growth in the over the charge control period is out of line with Orange's view of the market, and
- The calibration of the model with respect to the different radio propagation properties of 900 and 1800MHz spectrum.

Conclusion
Orange has contributed comments and improvements through the development process to improve the robustness of the LRIC model, and will continue to do so.

The way in which Ofcom has interpreted the model outputs, making use of the ranges from the scenarios and varying parameters, has enabled a more prudent approach to be taken. This cautious approach is critical to ensure the continued investment in future technologies.

Taking into account the proposed amendments within this appendix, Orange proposes the following unit charge levels as the end points for the next charge control period (2010/11 rates in real 2006/7 terms).

	900/1800MHz Operator	1800MHz Operator
Medium - Ranges	5.1-6.2ppm	5.5-6.6ppm
Mid Point	5.6ppm	6.0ppm

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1. **Traffic Forecasts**
   The voice traffic forecasts used within the model are overly aggressive, and as such, put the burden of risk of under recovery of costs more firmly on the mobile operators.

   1.1. Detail
   One of the LRIC model's main sensitivities is to the traffic forecasts - both the absolute levels of the traffic and the relative levels of the different services within the total forecast. Ofcom recognises this, and have used various scenario analyses to determine the ranges of the impact.

   While Orange welcomes Ofcom's approach to using a range of traffic forecasts, we still have concerns over the traffic levels within these forecasts and how representative these are of future scenarios.

   For voice traffic, CAGR for the Low, Medium and High scenarios were set at 0%, 9% and 16% respectively for the key period of 2005/6 to 2010/11. Ofcom's sources were analyst reports and other operator forecasts.

   Subscriber growth itself is limited due to market saturation and increased competition eroding modelled market shares. The increase in voice traffic going forward is driven by increased per subscriber usage. However, the profiles included show significantly higher growth than previously experienced. No reasoning has been given to support this drive in minutes of usage (MoU) per subscriber, and it is not a trend that Orange has forecast within its own view of the market (Figure 1).

Usage per subscriber per month		2005	2006	2007	2008	2009	2010	2011	CAGR
Outgoing voice	Mins	92	94	104	111	116	118	120	105%
Incoming Voice	Mins	50	94	54	57	59	60	60	104%
Data	Mbytes	0.3	0.5	0.9	1.5	2.4	3.4	4.5	157%
SMS	Messages	64	75	81	83	85	87	88	103%

Figure 1: Orange's usage per subscriber forecasts

While the industry has seen substantial traffic growth in the last few years (as reflected in the LRIC model), this has been in part due to increased penetration of the potential mobile market.

Orange has reviewed the forecasts from IDC which illustrate a 9% CAGR for mobile voice in the period[38]. This is driven from a transfer of usage from fixed line telephony – the voice market as a whole is forecast to show a decline in traffic of 1%. This movement of traffic from fixed to mobile telephony has been ongoing for sometime, with a steady transfer of traffic. There is no change in factors to force a surge that has been forecast in the report. This throws open to debate where the areas of growth will actually arise.

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[38] IDC: Western European Mobile Voice and Data Forecast Q1 2006. Published May 2006.

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Another forecast from IDC[39] from October 2006 illustrates the traffic growth on a per subscriber basis – this shows much more conservative growth of only 2% CAGR.

	2005	2006	2007	2008	2009	2010	(CAGR %)
MOU per subscriber - contract	207	211	213	217	222	228	2%
MOU per subscriber - pre-paid	57	58	59	60	61	63	2%

Figure 2: MOU of voice and circuit-switched data traffic per user per month

Broker and analyst are notoriously buoyant when it comes to predicting the future – we wish it were true more often! However, in the light of Ofcom's responsibility to use a prudent range of views, the voice forecasts should be revised downwards.

In summary, with the approach that Ofcom has taken with regards to basing the proposed charge control level on the Medium scenario range, the focus intensifies on this particular forecast. Therefore we believe the voice forecasts should be revised down to a central case CAGR of between 4-5% (for the period between 2005/6 to 2010/11).

1.2. Financial Impact
The revision to the medium traffic forecast increases the 2010/11 blended termination rate by 6.6%.

2. Treatment of on net calls between 2G and 3G

The re-balancing of on net calls, to take into account the availability of 2G and 3G networks, has the impact of increasing the number of incoming minutes in the model. While the treatment may be appropriate for capturing the cost impact on the network of these traffic routings, it overstates the number of minutes terminating from a subscriber perspective and therefore spreads the relevant costs over an inflated customer traffic volume, understating the efficient charge for a mobile terminating minute.

2.1. Detail
Ofcom's treatment of on-net calls crossing between an operators' 2G and 3G networks (as described in A5.38 of the Consultation Document) raises some concern. Ofcom has decided to treat such calls as an outbound call on one network and an incoming call on the other network in order to accurately capture their costs. The "Network Traffic" demand within the model captures this treatment, and its impact is illustrated in Figure A5.6 of the Consultation Document which shows a demand peak in 2010/11.

However, by treating on-net calls as incoming calls, Ofcom has over-estimated the total volume of inbound calls over which to recover the relevant costs. This is particularly key as the temporary demand peak takes place in 2010/11 (the date when the charge control is set) so artificially lowering the charge.

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[39] IDC: Western Europe Mobile Voice and Data Forecasts Q3 2006 - October 2006

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Clearly, as such calls are truly on-net from and do not attract mobile termination charges, they should be excluded from the volume of calls over which the network costs are recovered.

2.2. Financial Impact

The impact on Ofcom's version of the LRIC model is approximately 0.5% increase to the blended termination rate in 2010/11 (0.03ppm).

3. 1800MHz and 900/ 1800MHz differential and LRIC model calibration

The LRIC model understates the differential in MTR due to the radio propagation properties of 900 and 1800MHz spectrum.

3.1. Detail

The issue of the LRIC model calibration with regards to the impact of different spectrum holdings of the mobile operators has been an ongoing area of debate throughout the regulation of MVCT.

Both Orange and T-Mobile, as 1800MHz operators, have put forward robust evidence demonstrating the different network roll out and costs associated with achieving coverage with 1800 instead of 900MHz spectrum in all previous responses.

While Orange is pleased that an ongoing difference in cost is modelled, to reflect this exogenous difference, we believe the level of the cost is understated. The current outputs are demonstrating a difference of 0.3p by 2010/11 – this reflects the impact of the weighting of 2G and 3G traffic on the blended rates. In our view, a more realistic view of the differences would show a difference in 2G rates of 0.6p, and hence a blended rate difference of 0.4ppmin (in 2010/11 in 2006/7 prices).

Coverage site counts
The T-Mobile[40] paper sets out how on a practical level, an 1800MHz network would require between 1.2 and 1.8 times as many sites as a 900MHz operator for the equivalent service. The choice of parameters within the LRIC model has delivered a difference in site counts at the bottom of this range.

Some of the key parameters influencing this network roll out with regards to coverage are the cell radii and the traffic split by geotype. Orange does not accept the low ratio included in the LRIC model with regards to the rural cell radii for 900MHz and 1800MHz, and hence the difference in site numbers required for coverage. To better demonstrate the coverage properties of the different frequencies, a higher ratio should be used. Whilst reserving its position in relation to inappropriateness the rural cell radii chosen, Orange believes that a figure of 1.25 should be included within the model. This ratio still delivers consistency of site count and cost for the model calibration, but reduces the distortion of the current modeling of 900MHz and 1800MHz differences. From a review of 2G coverage site requirements, this delivers a ratio of approx. 136% difference between 900/1800MHz and 1800MHz site counts.

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[40] T-Mobile paper (Annex B "A Technical Review of GSM900 and GSM 1800 Radio Networks" 21 Nov 2005, Section 8.

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The coverage and capacity arguments are interlinked in the LRIC model. The artificial adjustment of the cell sizes that have been included ends up taking into account capacity requirements in urban areas, so deriving better value coverage for the 900/1800MHz operators. (The urban cell sizes are smaller than would be required under a coverage only scenario, so additional capacity is built in). By making the changes suggested above, a more realistic reflection of the spectrum properties is given and some of the distortion included within Ofcom's model regarding coverage and capacity is removed.

Operator	Sites	2002/3	2003/4	2004/5	2005/6
Ofcom - Medium					
1800MHz	2G Coverage	5,728	5,765	5,776	5,795
1800MHz	2G coverage and capacity	9,957	11,069	11,780	12,224
900/1800MHz	2G Coverage sites	4460	4486	4493	4508
900/1800MHz	2G coverage and capacity	8,572	9,265	9,941	10,359
Ratio	**Coverage**	**128%**	**129%**	**129%**	**129%**
	Coverage and capacity	**116%**	**119%**	**118%**	**118%**
Orange adjustments – Medium					
1800MHz	2G Coverage	6,039	6,079	6,090	6,112
1800MHz	2G coverage and capacity	10,205	11,154	11,444	11,466
900/1800MHz	2G Coverage	4,460	4,486	4,493	4,508
900/1800MHz	2G coverage and capacity	8,148	8,504	8,757	8,778
Ratio	**Coverage**	**135%**	**136%**	**136%**	**136%**
	Coverage and capacity	**125%**	**131%**	**131%**	**131%**

Figure 3: Site counts for 900/1800MHz and 1800MHz operators

Ofcom's approach to the model calibration appears to have been somewhat different to that taken by the Competition Commission. Instead of merely averaging the actual information supplied by 1800MHz operators and the 900/1800MHz MNOs respectively to use as calibration points for the networks at different frequencies, a more "global" view has been taken. While for Ofcom this delivers a model which takes an overall view as to how the issues of differences are treated, (e.g. variations in operators retail strategies impact on network roll out; differences in investment choice impacting categorisation of costs to opex and capex), it by default leads to a lack of visibility to the operators, reducing our ability to scrutinise and challenge the assumptions.

While we are mindful that Ofcom has visibility of more information than a single operator has access to for overall calibration, it puts the onus on Ofcom to ensure that the model reflects correctly the differences in spectrum properties through robust parameters in a clear way.

3.2. Financial Impact
In our view, a more realistic view of the differences between 900MHz and 1800MHz operators would show a difference in 2G rates of 0.6p, and hence a blended rate difference of 0.4ppmin (in 2010/11 in 2006/7 prices).

4. MEA Indices

These have been applied on an inconsistent basis

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4.1. Detail

We have reviewed the parameters included within the LRIC model and consider that some amendments are required:

- **Remote switching sites.** The MEA profile for investment has been included as 0% throughout. In order to be consistent with other categories, this should have the same profile as Main Switch Sites.
- **Backhaul** MEA profile for investment is shown as having a decline in the years before the extended period (the steady trend of -5% changes to -3% and -1% for 2019/2020 and 2020/21). There is no justification for the change in steady profile, and so it would be more appropriate to keep -5% for these two additional years.
- **2G equipment.** The investment profiles for these asset classes show steady profiles across the time periods until the key time of the charge control period. Orange assumes that the change in profile is to illustrate the steady state of prices that will result when the technology enters its final years before switch off. Possible alternatives to these indices are:
  - Profile 1: The decline profile should be pushed out by several years, reflecting a more plausible timescale for 2G switch off (Table A); or
  - Profile 2: The steady profile should be retained, as there is an assumption within the model that 2G will not be switched off entirely.

Cost categories	2008/09	2009/10	2010/11	2011/12	2012/13
Per Release 3					
2G cell site equipment/2G TRXs/2G MSCs	-5%	-3%	-2%	0%	0%
2G BSCs/2G MSC ports/GSN/NMS	-4%	-3%	-1%	0%	0%
Orange estimates					
2G cell site equipment	-5%	-5%	-5%	-3%	-2%
2G BSCs	-4%	-4%	-4%	-3%	-1%

Figure 4: MEA indices profiles

4.2. Financial Impact

0.4% increase to the MTR within the Medium band (approx 0.02ppmin) - Profile 1
0.6% increase to the MTR within the Medium band (approx 0.08ppmin) - Profile 2

5. Data Down-lift Factor

The Down Lift Factor for Voice and Data has been understated, and as such under allocates costs to voice services.

5.1. Detail

In A5.47 of the Consultation Document, Ofcom discuss how the relative efficiency of carrying voice and data services on the radio network are modelled. Ofcom has determined that on theoretical grounds, a factor of two is appropriate, but that from practical experience from operators, a factor of three is valid.

Ofcom appears to have taken the half-way house approach to determining this value. The previous submissions that Orange have made on this subject, have shown that from practical experience a factor of four is reasonable for a comparison of voice to 384kbps data service. An even higher factor would be appropriate if faster data rates were used. (While the LRIC model does not

specifically model HSPDA, the traffic forecasts do show high levels of take up of data services which are only likely if high-data rate services are available).

The factor of four is relevant to the practical operation of networks. This adjustment still delivers results that are well within the benchmark cost from the voice only scenario analysis.

5.2. Financial Impact
Increasing the factor to four allocates additional costs to voice termination services of c2% for 1800MHz operator, or 0.01p/min.

6. Unit costs have not been included for all assets

6.1. Detail
A range of specific points require remedy within the model

- Unit cost for a 2Mbit/s microwave link has not been included - opex or capex, and yet assets are purchased and commissioned on the network. This understates the cost of backhaul.
- Interconnect Interface and switching support plants are included as assets needing to be purchased but no unit costs are included

6.2. Financial Impact
Costs for the particular assets classes will be understated.

7. Non-network costs (1)
Ofcom has not made an allowance for the financing cost of non-network assets within the determination of Administration costs. This is inconsistent with the treatment of network assets within the LRIC model. This has understated the level of costs allocated to be recovered on voice termination.

7.1. Detail
Orange believes, and has raised previously, the issue of allowing for the financing cost of non-network assets within the administration cost. This would be consistent with the cost for WACC included for network assets within the LRIC model.

From Orange accounting submissions	2005 £m	2004 £m	2003 £m	2002 £m
GBV	738	791	775	680
Depreciation	(414)	(424)	(403)	(304)
NBV	324	366	372	377
Cost of capital (pre-tax nominal)[41]	14.10%	14.10%	14.10%	14.10%
Cost per annum	46	52	52	53

7.2. Financial impact

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[41] Cost of capital is as per the Consultation Document 13th September 2006

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Using as a proxy Orange's level of non-network assets, an additional £52m (19%) should be included within administration costs. For inclusion within the LRIC model in 2006/7 terms, this would give a revised administration cost of £133m. On the Medium case used, this would give increase the level of mark up for a 2G/3G operator from 0.18ppmin to give a revised mark up of 0.21ppm.

(This figure may need to be revised if Ofcom accepts the changes put forward by Orange to the risk free rate, and hence the cost of capital.)

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8. Non-network costs (2)

There are inconsistencies in how particular non-network costs are treated within the Ofcom analysis of accounting information.

8.1. Detail
Within the CTM Annex 9 Orange 13 09 06.xls, Ofcom has included Brand Fees within CARS and Brand Income within Other. This treatment is not consistent, and in fact both items should be included within "Other", so reducing the CARS value by £60m and £59m in 2004 and 2003 respectively.

9. 3G Licence Fee Treatment

A range of scenarios have been considered by Ofcom in determining the appropriate level of cost recovery of the 3G Licence within the charge control. Orange's position remains that this cost should be allocated on the basis of 3G radio traffic (not total traffic).

9.1. Detail
The most logical way of allocating the 3G licence cost to mobile services is based upon the radio traffic cost driver. The licence allows the use of the 2.1GHz spectrum band, and the relative usage of the services across the access network is best described in the model by radio traffic.

Orange would like to see the option of the total traffic allocation driver excluded from the analysis. The cost recovery of the licence fee is very sensitive to this parameter and Ofcom has not put forward a strong argument as to why this option should be considered. The analysis of licence treatment can then be presented with more clarity as to how it contributes to the overall charge control.

All other costs within the model have been allocated in proportion to the cost driver – it would seem inconsistent to change tack and allocate only this cost on the basis of consumer demand or even revenue.

10. Orange's proposal for appropriate charge control rates

Orange has applied the above amendments to the LRIC model and determined the percentage changes required to Ofcom's proposed. As Ofcom has put forward proposals based on the Medium outputs, these amendments are illustrated for the medium scenario.

In summary these changes are:
- Increase in cost of capital to 11.8% (as described in the main part of the response) due to the increase in the risk-free rate
- Change in voice traffic profile to 5% CAGR for the medium scenario
- Down-lift factor between 3G voice and data services increased to 4
- Minor changes to MEA indices on 2G assets
- Changes to the 2G cell radii in rural areas
- Split of traffic by cell types changed to reflect higher macrocell traffic profile, impacting on 2G coverage calibration

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- Administrative costs increased to £133m

	900/1800MHz Operator	1800MHz Operator
Medium - Ranges	5.1-6.2ppm	5.5-6.6ppm
Mid Point	5.6ppm	6.0ppm

Figure 5: Ranges for unit charge levels in 2010/11 (in real 2006/7 prices)

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ANNEX C: REAL OPTIONS OVERVIEW

What are real options?
Real options relate to the decisions operators face over investment under uncertainty. Investment in mobile networks is inherently subject to irreversibility and uncertainty. So operators must make decisions over:

- Whether it is efficient to invest
- When is the most efficient time to invest
- What is the most efficient technology to invest in

Prior to making an irreversible investment under uncertainty, a firm holds an "option" on whether and when to invest; once it invests, the firm forfeits the option. When the returns to investing are certain, the option to delay and learn more about the market is unimportant. Similarly, if a firm can costlessly reverse its investment decisions, then the delay option is valueless. In the typical case, however, firms face both uncertainty and irreversibility. These factors can make profound differences to the way in which efficient investment should occur.

Network investments are largely irreversible as recovery of the cost of investment through resale is simply not possible, for example large costs to installation which cannot be recovered. In addition, returns from network investments are uncertain as future demand for telecoms services and products, and hence future revenue, is highly uncertain. Uncertainty is greater still for products that are yet to be introduced to the market, for which demand is especially difficult to forecast. Technological innovation, as discussed above, also acts to make the returns from an investment unpredictable, as the costs of delivering services may change in the future.

Today operators face real, and more complicated, decisions about what technology to invest in to continue to provide voice services as newer technologies such as UMTS and Wimax become the prevalent technologies for non-voice services. Operators have less control over the timing of significant investments such as the expansion band auction planned to take place in 2007. Real options help operators to think about their investments more clearly in the context of when the optimal time to invest is and what to invest in. They also allow the regulator to set the correct termination charge to ensure efficient investment.

How real options are considered in the LRIC model
The LRIC model is a forward-looking model, forecasting a world with certainty. Traffic is treated as deterministic and investment is built in on the basis of traffic forecasts. Within the model, annualised costs are allocated to services and the termination rate is the annualised cost of termination services. The current LRIC model provides only a rough proxy for the uncertainty that operators face by including a number of scenarios. The model accounts only partially for the irreversibility of investment – the sunk nature of mobile investment – through depreciation profiles.

Orange believes that a major flaw in the LRIC methodology is that it does not recognise how an operator might try to manage risk through the optimal timing and type of investments. The current LRIC model is a cashflow-based model. It ensures that investments break even on a net present value (NPV) basis. This does not recognise that, for example, it might be more efficient for an operator to wait to see if has access to the GSM900 band to roll out further UMTS infrastructure rather than

proceeding with upgrades to its current 2G infrastructure in the GSM1800 band. The opportunity cost of investing in further GSM1800 infrastructure might be the investment in GSM900 infrastructure that could be lower cost and higher quality, as discussed above.

The real options approach deals explicitly with all of these factors. It recognises that uncertainty is intrinsic to business, and must be at the centre of any investment model, rather than added in the form of scenarios at the end. It treats irreversibility in the correct way, by allowing for the full economic costs (which include opportunity costs) of sunk investments which depreciation profiles cannot do. The approach also allows for the important interactions that occur between uncertainty and irreversibility. Finally, it considers MNOs' efficient responses to uncertainty and irreversibility, in terms of the timing, amount and type of investment.

The key insight of the real options approach is that there is an opportunity cost to investing when investments are irreversible and the returns are uncertain. When a firm makes an irreversible investment, it exercises its option to invest. It gives up the possibility of waiting for new information to arrive that might affect the desirability or timing of the expenditure; it cannot disinvest should market conditions change adversely. This lost option value is an opportunity cost that must be included as part of the total cost of the investment. As a result, the NPV rule "Invest when net present value of cash flows from an investment is positive" must be modified. The cost of investment must be increased by an amount equal to the value of keeping the investment option alive.

Adapting the LRIC model to take account of real options

A simplistic response to this shortcoming in the LRIC model would be to add an *ad hoc* increment to MNOs' cost of capital, although this approach fails to recognise the full complexity of the situation. MNOs can affect their exposure to uncertainty and irreversibility by adjusting when they invest, how much they invest, and what types of investment they make. Some detailed analysis is required, therefore, to arrive at the final value of the opportunity cost of investment. The reward for the extra effort is that the resulting regulated termination charge reflects correctly the riskiness of sunk investment, and gives MNOs efficient incentives for investment.

Annex D illustrates in more detail how the current framework could be extended to incorporate real options. As in the current LRIC model, traffic volumes are the fundamental driver of network investment and costs. We depart from the current LRIC model by assuming that traffic volumes vary randomly over time. This has major consequences for investment behaviour. We show how efficient investment can be determined. The efficient pattern of investment takes into account the full economic cost of investment, which includes both the cost of capital and the opportunity cost (the option value lost on investment). We show how to calculate the full economic cost of investment when investment occurs efficiently. The size of the opportunity cost is affected by a number of different factors. One of the most important is the degree of uncertainty faced by MNOs. The efficient termination charge is then set equal to the full economic cost of the capacity installed for termination.

The purpose of this analysis is not to advocate a particular increment: clearly, more extensive consideration is required to determine with accuracy the efficient termination charge. The objective is merely to assess whether real options would have a material impact on the regulated termination charge. Our calculations

Orange response to Ofcom consultation: Mobile Call Termination

suggest that incorporating real options would increase the termination charge significantly over the current level.

ANNEX D: REAL OPTIONS AND INVESTMENT IN MOBILE NETWORKS
(Robin Mason/ Helen Weeds)

REAL OPTIONS AND INVESTMENT IN MOBILE NETWORKS

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28th October 2006

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Chapter 1

Introduction

1.1 Investment in mobile networks is inherently subject to irreversibility and uncertainty. These two factors have a crucial impact on the *timing* and *type* of investments that are efficient.

1.2 For some types of investment, recovery of the cost of investment through resale is simply not possible. An example is infrastructure such as masts. A mobile mast has little value outside of the industry. As a result, its resale value is closely correlated to the economic conditions of the industry. So, if conditions turn out to be unfavourable (e.g., because industry-wide demand for mobile services is low), a firm wishing to disinvest by removing and reselling the equipment would find many other firms also wanting to resell. The economic value of the equipment therefore moves up or down with the economic conditions of the industry, making the investment effectively irreversible.

1.3 In addition, a large portion of the initial cost of mobile masts is the cost of erecting the mast. This cost cannot be recovered at all. Further costs will be incurred in recovering the mast for resale; these too cannot be recouped. (In some cases recovery costs will exceed the second-hand value of the mast itself; in this case abandonment, if this can be done at no cost, would be preferable to recovery of the mast.)

1.4 There is considerable uncertainty surrounding mobile investments. Future demand for telecoms services and products, and hence future revenue, is highly uncertain. Uncertainty is greater still for products that are yet to be introduced to the market, for which demand is especially difficult to forecast. Technological innovation also acts to make the returns from an investment unpredictable, as the costs of delivering

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services may change in the future. Any source of uncertainty affecting future revenues is relevant for investment planning.

1.5 Operators are occasionally faced with a situation where even before recouping their investments in existing infrastructure, they embark on further investment in a new generation of networks. This phenomenon is common in the mobile sector, particularly in the context of 3G services, where the high cost of licensing and equipment have left operators facing substantial investment requirements at the early stage of network deployment.

1.6 The combination of irreversibility and uncertainty creates *real options*. This phrase is intended to reflect two facts. First, prior to making an irreversible investment under uncertainty, a firm holds an "option" on whether and when to invest; once it invests, the firm forfeits the option. Secondly, the option involves *real*, rather than financial assets.

1.7 There is now a considerable literature on the theory and practice of incorporating real options into investment analysis. The earlier literature is summarised well in Dixit and Pindyck (1994). More recent developments can be found in e.g., Schwartz and Trigeorgis (2004). The general lessons from this literature are that the opportunity cost of investing (and so forfeiting a real option) can be very large, and investment rules (such as the classical net present value, or NPV, rule) that ignore it can be grossly in error. Regulation that ignores the opportunity cost will lead to inefficient investment.

1.8 Regulators have been somewhat slower than academics and the business community to allow for real options. In its 1999 report on charges made by Cellnet and Vodafone for terminating calls from fixed-line networks, the Competition Commission stated that

> "[t]he value of the delay option could well be a factor in decision-making in many industries. How far it applies to mobile telephony is less clear. ... We are therefore not persuaded that there is a quantifiable addition that we should make to the cost of capital ..." (para. 2.288).

Real options were not considered in the 2003 report on mobile termination charges. Most recently, Ofcom has recognised in principle that real options should be included in investment decisions:

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> "Ofcom concludes that, going forward, its analysis should take account of the value of real options where appropriate."[1]

1.9 Ofcom has suggested that, if real options are to be incorporated, they should be reflected in the *cost of capital* used for calculating long-run incremental costs (LRICs). This is only partially correct; in fact, a proper treatment of the real options that arise in capacity investment requires more than a simple adjustment to the cost of capital.

1.10 In this report, we consider how real options should be included in investment decisions and cost calculations, taking into account the different types of option that arise. The type of option that occurs depends on the nature of the investment decision being undertaken:

1.10.1 When to invest.

1.10.2 How to invest.

1.11 The real option approach broadens the issue of investment beyond the "now-or-never" decision implicit in the NPV rule to include the question of when investment should occur. When the opportunity cost of investment is included in the investment decision, efficient investment typically occurs later (in some sense) than when the opportunity cost is ignored. One consequence of this is that efficient investment occurs at a point when it appears that super-normal profits are earned. A natural (and frequent) policy response is to infer that there is market power, and to regulate to limit the market power and super-normal profits. This response would cause, however, inefficient investment. In order to determine efficient regulation in this situation, it is necessary to include the opportunity cost of the investment. This requires the details of the investment to be specified: the extent to which the cost is sunk; and the nature of uncertainty surrounding the investment. More particularly, the setting of regulated prices for mobile network operators (MNOs) needs to take into account the opportunity cost of investment for the MNOs, as well as the direct capital and operating expenditures. This is true even when the regulated prices are set in order to mimic perfect competition in the sector.

1.12 The real options approach also recognises that investment can itself generate further options, the value of which should also be included

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[1] Ofcom, 18 August 2005: "Ofcom's approach to risk in the assessment of the cost of capital—Final Statement." Available at http://www.ofcom.org.uk/consult/condocs/cost_capital2/statement/

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in an assessment of the investment. It can be efficient to undertake now a more costly investment, if that investment allows more flexibility in the future should conditions change. In short, flexibility has to be considered in the investment decision; the value of flexibility—or, conversely, the opportunity cost of not having flexibility—has to be included in the investment calculation. For example, it may be efficient for MNOs to build mobile base sites that can be more easily upgraded in the event that demand for 3G services exceeds forecasts. The investment may appear excessive in the base-case scenario of traffic growth. When uncertainty is included explicitly in the calculation, however, the investment can be efficient.

1.13 Our objective in this report is to indicate how the existing LRIC model used by Ofcom can be adapted to take account of real options. In the course of the assessment, we arrive at rough estimates of the quantitative impact of real options. For example, we find that allowing for real options when making network capacity investments increases the LRIC by around 35%. Necessarily, this estimate is approximate. More generally, we establish

- How real options can be taken into account within the broad framework of the existing LRIC model.

- That real options can have a significant quantitative effect on the termination charge that should be applied.

- That real options will increase the effective LRIC of termination of MNOs. The increase arises in order to yield adequate returns on investments that are irreversible and inherently risky, so that investment occurs efficiently.

Chapter 2

The option of when to invest

2.1 In this section, we consider how to incorporate real option factors in the decision of when to invest in a mobile network. We start with a brief review of the current LRIC model; we then suggest how this model could be revised to allow for real options.

2.2 In broad outline, the current LRIC model works as follows:

2.2.1 Demand is forecast: traffic (minutes of voice, bytes of data) and subscribers.

2.2.2 The network is built to meet forecast demand.

2.2.3 Operating and capital expenses are annualised, using the appropriate depreciation method and allowing for cost of capital.

2.2.4 Costs are allocated to services.

2.2.5 Mark-ups are applied to the estimated LRIC of the service to recover fixed and common costs, plus other factors (such as network externalities).

2.3 The calculation of LRIC is intrinsically forward-looking. This means that forecasts play a key role in the calculation. Forecasts are, of course, inherently uncertain. To a limited extent, the current model allows for forecast uncertainty. Three different scenarios (low, medium and high) are calculated for different aspects of demand (e.g., average voice traffic per subscriber; outgoing messages per average subscriber).

2.4 The current LRIC model incorporates the irreversibility of investment though its depreciation assumptions. LRIC uses forward-looking costs, setting rates based on current or expected future equipment costs, rather than the historical costs actually paid for the equipment.

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2.5 So, the current LRIC model includes, to a limited extent, both uncertainty and irreversibility. It does not, however, allow for *interaction* between the two. And so it does not incorporate the real options that arise because of the combination of uncertainty and irreversibility.

2.6 In order to demonstrate how to adapt the LRIC model, and to assess the effect of incorporating real options, we use a simplified model of mobile pricing and investment decisions. Our model has the following features:

2.6.1 The degree of uncertainty is explicitly parameterised, rather than being captured partially in alternative scenarios.

2.6.2 The degree of irreversibility is explicitly parameterised, rather than being captured partially by depreciation profiles.

2.6.3 Investment takes place in many stages, rather than once-and-for-all.

2.7 We present two versions of the model. The first version is a simplified version of the current model; the aim is to provide a benchmark against which we can measure the effect of including real options. The second version allows for uncertainty and irreversibility.

2.8 Following the current LRIC model, in both versions of the model, we concentrate on *traffic* as the main driver of investment decisions and costs; we ignore changes in the number of subscribers. The main justification for this assumption is to simplify the analysis. Not too much is lost by the assumption, however, since (according to the LRIC model) around 90% of total costs can be attributed to traffic.

2.9 There are five traffic flows that are relevant for an individual MNO.

2.9.1 on-net: originates and terminates on the same network. Denote the volume of this traffic (in minutes) by x.

2.9.2 off-net to fixed: originating traffic that terminates on a fixed network. Denote this traffic volume by $x_{\to F}$.

2.9.3 off-net to mobile: originating traffic that terminates on a mobile network. Denote this traffic volume by $x_{\to M}$.

2.9.4 from fixed: terminating traffic that originates on a fixed network. Denote this traffic volume by $x_{F\to}$.

2.9.5 from mobile: terminating traffic that originates on a mobile network. Denote this traffic volume by $x_{M\to}$.

2.10 We make the following assumptions about the balance of traffic:

2.10.1 Traffic between mobile networks is balanced: $x_{\to M} = x_{M\to}$, which we relabel as x_M. While this is not completely correct, it is not a bad approximation of the current situation.

2.10.2 Traffic between fixed and mobile networks is imbalanced, with the traffic volume from mobiles to fixed being roughly 1.5 times the volume from fixed to mobile. (The factor of 1.5 is taken from the 2003 Competition Commission report on mobile termination.)[1] If $x_{F\to}$ is relabelled as x_F, this means that $x_{\to F} \approx 1.5x_F$.

2.11 The total traffic terminating on the MNO is $X = x + x_M + x_F$. Due to our traffic balance assumptions, the total originating traffic is $x + x_M + 1.5x_F$. We assume that the proportions of terminating traffic are constant over time: that a proportion a is on-net, b is off-net to mobile, and the remainder $1 - a - b$ is off-net to fixed. Hence we assume that

$$\frac{x}{x + x_M + x_F} = a, \quad \frac{x_M}{x + x_M + x_F} = b.$$

(The current LRIC model uses approximately the same assumption: in the medium term, a is roughly 30% and b is roughly 20%.) The fraction of total traffic arising from termination is then

$$\frac{2}{5 - a - b}.$$

2.1 Investment under certainty: a benchmark

2.12 In this benchmark version of the model, X can change over time, but does so *deterministically* i.e., there is no uncertainty about traffic forecasts.

2.13 The variable (annual) profit of an MNO from origination is

$$\pi^O = (p - c^O)(x_M + x + 1.5x_F) - \bar{t}x_M - 1.5fx_F. \tag{2.1}$$

In this expression, p is the retail price charged per minute by the MNO. We are ignoring, therefore, non-linear pricing. c^O is the marginal cost

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[1] In table 5.20 in Chapter 5, the Competition Commission state traffic volumes for the year 2001/2002 to be 23.26 billion minutes mobile to fixed, and 15.22 billion minutes fixed to mobile.

of origination, assumed to be constant. $\bar{t}$ is the regulated termination charge for traffic between mobiles. f is the termination charge for traffic that terminates on fixed networks.

The variable (annual) profit of an MNO from termination is

$$\pi^T = (\bar{t} - c^T)(x_M + x_F) - c^T x \tag{2.2}$$

where c^T is the marginal cost of termination, assumed to be constant. Hence the total variable profit of an MNO, which is the sum of variable profits from origination and termination, is

$$\pi = \pi^O + \pi^T = (x + x_M)(p - c^O - c^T) + x_F(1.5(p - c^O - f) + \bar{t} - c^T)$$
$$= X\left[p - c^O - c^T + \left(\frac{1 - a - b}{2}\right)(p + 2\bar{t} - 3f - c^O)\right]. \tag{2.3}$$

The MNO therefore earns a margin of $p - c^O - c^T$ (the retail price minus the total marginal cost of origination plus termination) on on-net traffic, and off-net traffic between mobile networks. On off-net traffic to and from fixed networks, the MNO earns a margin that has two parts: from origination, which earns a margin of $p - c^O - f$; and from termination, with a margin of $\bar{t} - c^T$.

2.14 The variables c^O, c^T, f and p are *parameters* in our analysis. c^O and c^T are determined by mobile technologies. f is determined (predominantly) by regulation of the major fixed network. p is determined by competition in the mobile retail market. Our focus is on $\bar{t}$, set by the regulator according to the amount of capacity investment.

2.15 The total volume of traffic carried by the MNO (the sum of originating and terminating traffic) is $(5 - a - b)X/2$, and hence is proportional to the volume of terminating traffic X. In order to carry this total volume of traffic, investment in network capacity is required. In this first version of the model, we suppose that capacity investment occurs to match exactly (forecast) traffic volumes. That is, we do not allow for the possibility of delayed investment. This is entirely reasonable in a model with no uncertainty. To make the model as straightforward as possible, suppose that network capacity is measured in minutes of traffic.

2.16 The actual calculation of LRIC is complicated, but the basic idea is straightforward: the investing firm is reimbursed for its capital cost through an annual annuity payment that reflects the firm's cost of

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capital. The LRIC also includes payment for one-time set-up costs and direct and indirect ongoing fixed costs, which we ignore (for simplicity). We also assume that capacity utilisation and MEA prices are constant, for simplicity. Let the cost of capital be ρ; and the life-time of assets be T (e.g., 15–20 years). Let the unit cost of capacity be κ.[2] Then the LRIC of an amount of capital K is

$$\frac{\rho(1+\rho)^T}{(1+\rho)^T-1}\kappa K \equiv \delta\kappa K$$

where

$$\delta \equiv \frac{\rho(1+\rho)^T}{(1+\rho)^T-1}.$$

For example, if the cost of capital is 15% and the asset lifetime is 15 years, then $\delta = 0.171$. If capital is infinitely lived, then $\delta = \rho$.

2.17 Suppose that the regulated termination charge $\bar{t}$ is set equal to the LRIC of the installed capacity required for termination. When the volume of terminating traffic is X, the LRIC of termination is $\delta\kappa X$. The termination charge per unit of traffic is then

$$\bar{t} = \delta\kappa. \tag{2.4}$$

2.18 This completes the first version of the model. Traffic volumes, and particularly termination volumes X, are the primary drivers. Investment occurs in order to carry the traffic volumes. The termination charge $\bar{t}$ is set at the LRIC of invested capacity relating to termination.

2.2 Investment under uncertainty

2.19 We now suppose that there is uncertainty in demand forecasts. Specifically, the traffic volume X varies stochastically. Let the volume of termination traffic at time t be X_t. Following e.g., Dixit and Pindyck (1994), suppose that X_t follows a Geometric Brownian Motion (GBM):

$$dX_t = \mu X_t dt + \sigma X_t dz_t \tag{2.5}$$

where dz_t is the increment of a Wiener process. Hence *percentage changes* in traffic volumes are assumed to follow a *Normal distribution*.

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[2]κ can be viewed as an exchange rate, to 'convert' capacity expressed in minutes to pence. The units of κ are therefore pence per minutes (ppm).

$\mu \geq 0$ is known as the *drift* parameter; on average, traffic volumes increase in percentage terms at a rate μ. $\sigma \geq 0$ is the volatility parameter, and measures the degree of uncertainty. If σ is zero, then we are back to the first version of the model, in which there was no uncertainty. A higher σ corresponds to higher levels of uncertainty. (We discuss below how the drift and volatility parameters, μ and σ, can be estimated.)

2.20 In this second version of the model, we do not assume that capacity investment occurs to ensure that traffic volumes can be carried. Instead, we allow the MNO to delay investment until traffic volumes are 'sufficiently' high. We shall determine the extent to which the MNO delays investment; and how the extent of delay depends on the various parameters—in particular, σ.

2.21 An immediate implication of delayed investment is that the MNO can carry the lower of actual traffic volumes, X_t, and the capacity of its network. If X_t rises above the network's capacity K, say, and no investment occurs, then the network is able to carry only K minutes of traffic. This is a simplifying assumption used mostly for convenience. We do not think that an MNO will actually refuse to serve traffic over its capacity K. In practice, as traffic volumes increase for a fixed capacity, the traffic will be carried but service quality (such as bandwidth and blocking probabilities) will degrade. We capture this in this simple model by supposing that volume over capacity is not served at all.

2.22 The MNO's variable (flow) profit is

$$\pi = \left[p - c^O - c^T + \left(\frac{1 - a - b}{2} \right)(p + 2\bar{t} - 3f - c^O) \right] \min\{X_t, K\}$$
$$\equiv \theta \min\{X_t, K\}, \tag{2.6}$$

where $\theta = p - c^O - c^T + (1 - a - b)(p + 2\bar{t} - 3f - c^O)/2$ is the margin per unit.

2.23 There are three important regions to consider.

2.23.1 Region 1: X_t is less than the MNO's capacity; hence no investment is necessary.

2.23.2 Region 2: X_t is greater than the MNO's capacity; but is not sufficiently high to trigger investment by the MNO.

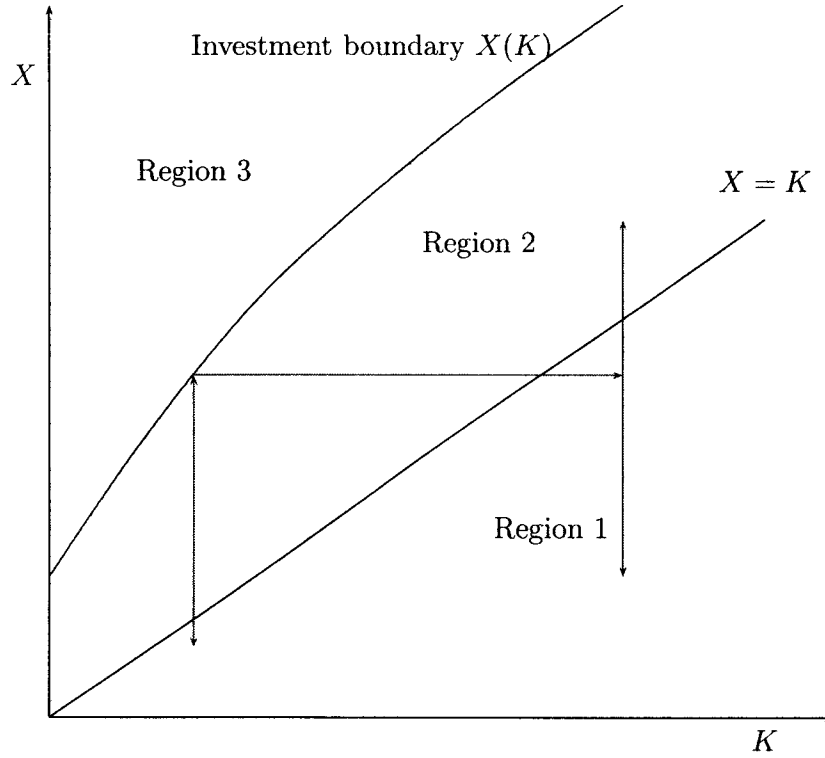2.23.3 Region 3: X_t is greater than the MNO's capacity, and is high enough to trigger investment.

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Figure 2.1: Investment and non-investment regions

2.24 We illustrate these regions in figure 2.1. The network's capacity is shown on the horizontal axis; the current traffic volume X_t is shown on the vertical axis. The vertical lines in the figure illustrate how X_t changes over time, for a given level of network capacity. Of course X_t may go down as well as up. Eventually, however, it will rise to hit the third region (having passed through the second region). At this point, the network invests: movement occurs according to the horizontal arrows that are shown.

2.25 The task now is to determine the boundary of the third region, at which investment is triggered. The current value (i.e., the expected present

discounted value of future profits) of the MNO depends on two factors: the current traffic volume, X_t; and current capacity K. So, we denote the current value of the MNO by $V(X_t, K)$. It is straightforward to show (see e.g., Dixit and Pindyck (1994)) that $V(X_t, K)$ must satisfy the following differential equation for combinations of X_t and K in regions 1 and 2:

$$\frac{1}{2}\sigma^2 X_t^2 \frac{\partial^2 V(X_t, K)}{\partial X_t^2} + \mu X_t \frac{\partial V(X_t, K)}{\partial X_t} - \rho V(X_t, K) + \theta \min\{X_t, K\} \tag{2.7}$$

where ρ is the cost of capital.

2.26 This differential equation can be solved to give the general solution

$$V(X_t, K) = \begin{cases} A(K)X^\beta + \frac{\theta}{\rho - \mu} X_t & X_t < K, \\ A(K)X^\beta + \frac{\theta}{\rho} K & X_t \geq K. \end{cases} \tag{2.8}$$

The firm's value therefore has two components. The first component, $A(K)X^\beta$, is an option value anticipating future capacity investment. The second component is the expected net present value of revenue from the MNO's current capacity. If current capacity exceeds current traffic, this is $X/(\rho - \mu)$; otherwise, it equals K/ρ.

$A(K)$ is a coefficient which is not of primary interest. β is a constant, given by

$$\beta = \frac{1}{2} - \frac{\mu}{\sigma^2} + \sqrt{\left(\frac{1}{2} - \frac{\mu}{\sigma^2}\right)^2 + \frac{2\rho}{\sigma^2}} > 1. \tag{2.9}$$

2.27 We now determine the investment boundary between regions 2 and 3. As soon as X_t hits this boundary, the MNO invests, increasing its capital from K to K'. Since investment is irreversible, $K' \geq K$. Immediately after investment, the firm's value is $V(X_t, K')$. Three conditions must hold.

2.27.1 Since value functions are forward-looking, anticipating future movements in X and investments in capacity, the firm's value just before investment must be equal to its value just after investment. Hence

$$V(X_t, K) = V(X_t, K') - \kappa(K' - K). \tag{2.10}$$

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2.27.2 The amount of investment, $K' - K$, is chosen optimally by the MNO, so that the marginal return from investment equals the marginal cost of investment. Hence

$$\frac{\partial V(X_t, K')}{\partial K} = \kappa.$$ (2.11)

2.27.3 There is a further, more technical optimality condition, known as *smooth pasting*. This requires not only that the firm's values immediately pre- and post- investment are equal, but also that they are *smoothly* equal. Hence

$$\frac{\partial V(X_t, K)}{\partial X} = \frac{\partial V(X_t, K')}{\partial X}.$$ (2.12)

2.28 These three conditions can be solved simultaneously to give the investment boundary, which we denote $X(K)$, and the optimal amount of investment, which we denote $K'(X)$. The investment boundary is given by

$$X(K) = \frac{\beta}{\beta - 1}\left[K + \frac{\rho\kappa}{\theta}(K' - K)\right].$$ (2.13)

Investment does not occur as soon as the traffic volume X hits network capacity K. The expression in equation (2.13) shows the two ways in which this arises. First, uncertainty and irreversibility causes delay. This is reflected in the term $\beta/(\beta - 1) > 1$. As figure 2.2 shows, this term is increasing in the degree of uncertainty, σ: greater uncertainty gives a higher investment threshold, all other things equal. (We return below to what other things may change.)

2.29 Uncertainty therefore seems to appear in a simple way, via the 'markup' term $\hat{\beta} = \beta/(\beta - 1)$. Thus, it might appear that real options can be dealt with simply by adjusting upwards the cost of capital by a factor that, if not equal exactly to $\hat{\beta}$, is at least greater than 1. This might be appropriate when a single investment decision is under consideration. But as equation (2.13) makes clear, it is not appropriate for multi-stage investments—which is the relevant case for MNOs. Instead, there is an additional term,

$$\frac{\rho\kappa}{\theta}(K' - K)$$

which depends on a number of factors. First, investment delay is greater when the following investment is larger (that it, $X(K)$ increases
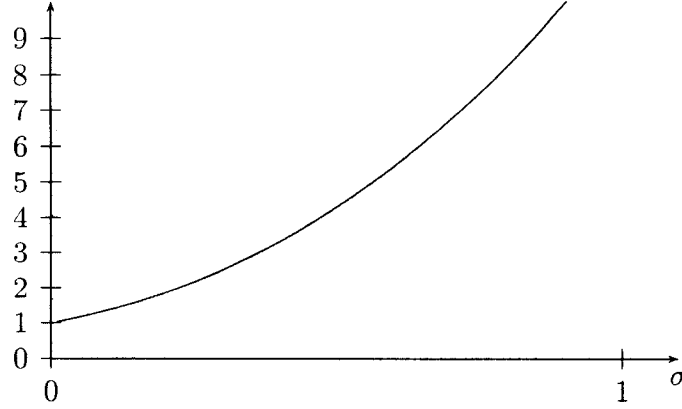
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Figure 2.2: Uncertainty factor $\beta/(\beta - 1)$

in the size of the investment increment $K' - K$). It is also increasing in the normalised annualised cost of investment. κ is the unit cost of capital. On an annual basis, adjusting for the cost of capital, this cost is $\rho\kappa$. After investment, the MNO earns a return θ on each unit of traffic. Hence the unit cost of investment must be adjusted by the factor $1/\theta$.

2.30 There are a number of possibilities for the amount of investment that occurs.

    2.30.1 $K' < X(K)$: investment does not meet the current volume of traffic.

    2.30.2 $K' = X(K)$: investment meets exactly the current volume of traffic.

    2.30.3 $K' > X(K)$: investment increases capacity above the current volume of traffic.

We shall discuss in more detail the third case (of 'over-investment') in chapter 3. In the appendix, we argue that, in the absence of fixed costs to investment, the optimal amount of investment is $K' = X(K)$: that is, investment occurs so that capacity equals the current traffic volume.

2.31 In this case,

$$X(K) = K' = \frac{\hat{\beta}(1 - \phi)}{1 - \hat{\beta}\phi}K > K \tag{2.14}$$

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where

$$\hat{\beta} \equiv \frac{\beta}{\beta - 1}, \qquad \phi \equiv \frac{\rho\kappa}{\theta}. \tag{2.15}$$

It is then easy to see that $X(K)$ increases in both

2.31.1 σ, the degree of uncertainty, and

2.31.2 ϕ, the adjusted unit cost of investment.[3]

2.32 The remaining task is to determine the level of the termination charge $\bar{t}$. The termination charge $\bar{t}$ set by the regulator should now reflect the option values inherent in investment. If it does not, then MNOs would invest inefficiently: the regulated charge would not offer sufficient reward for the risk involved in investment, and MNOs would undertake too little investment. Manipulation of equation (2.13) shows that the correct LRIC in this situation is

$$\rho\kappa + \theta - \hat{\beta}\rho\kappa > \rho\kappa.$$

This can be contrasted with the LRIC that would result if uncertainty and real options were ignored: $\rho\kappa$. (The LRIC is $\rho\kappa$ since, implicitly, we have assumed that assets are infinitely-lived. A standard adjustment applies for assets with finite lives.) Hence the LRIC with real options should be increased by an amount

$$\lambda \equiv \theta - \hat{\beta}\rho\kappa.$$

This can be solved for the implied termination charge $\bar{t}$ *per unit of capital*

$$\bar{t} = \frac{p - c^O - c^T + \left(\frac{1-a-b}{2}\right)(p - 3f - c^O) - (\hat{\beta} - 1)\rho\kappa}{a + b}. \tag{2.16}$$

2.33 This completes the second version of the model. Traffic volumes, and particularly termination volumes X, are the primary drivers. Investment occurs whenever traffic volumes are sufficiently high, hitting an investment boundary (which is above the current capacity). The amount of delay is determined by a number of factors, including the degree of uncertainty. The termination charge $\bar{t}$ is set at the LRIC of invested capacity relating to termination (which includes option values).

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[3]In order for the model to be consistent, it must be that $\hat{\beta}\phi < 1$.

2.34 We can now compare the benchmark model, with no uncertainty, with the model in which real options are considered. In many ways, the two versions of the model are conceptually very similar, as paragraphs 2.18 and 2.33 indicate. The key difference between the models lies in the investment behaviour of the MNO. In the first version, without uncertainty, investment occurs to match traffic volumes (which are assumed to increase at the trend rate). In the second version, the combination of irreversibility and uncertainty causes the MNO to delay investment until traffic volumes are sufficiently high.

2.35 The investment delay that occurs with uncertainty is *efficient*: it is not something that a regulator should attempt to correct. In fact, the investment pattern in the benchmark model (with no uncertainty) is inefficient when traffic volumes are uncertain.

2.36 Finally, note that the determination of the termination charge $\bar{t}$ in the case of uncertainty requires additional parameters to be used, compared to the 'certainty' termination charge. Equation (2.16) involves not only ρ and κ, the two key parameters for the 'certainty' termination charge, but also p, c^O, f, a and b. The reason is that, with real options, we have to determine the *timing* as well as the *amount* of investment. When traffic volumes change deterministically, the timing of investment is straightforward: subject to the 'lumpiness' of investment, capacity should be expanded to match volume increases. When traffic volumes change stochastically, there is investment delay, as we have shown. In order to determine when investment occurs, we have to consider the returns to investment. That means in turn that we must consider the margin that MNOs earn on each unit of capacity. As a result, the additional parameters appear in the appropriate LRIC of investment, and hence the termination charge.

2.3 Quantifying the effect of uncertainty on the LRIC

2.37 In order to compare the termination charge $\bar{t}$ with and without uncertainty, we have to estimate the relevant parameters. There are ten parameters in the model, summarised in table 2.1. The estimates that we use for the parameters are not intended to be definitive. For example, we use a historical and average figure for the cost of capital. A more comprehensive study would update this estimate using more

recent market data. The objective of the exercise is to illustrate how the various parameters would be used to set the LRIC for termination.

Parameter	Meaning	Estimate
p	retail price (ppm)	10
c^O	marginal cost of origination (ppm)	0
c^T	marginal cost of termination (ppm)	0
f	termination charge on fixed networks (ppm)	1
a	on-net traffic proportion	0.3
b	off-net to mobile traffic proportion	0.2
γ	deflator (%)	2.5
ρ	cost of capital (nominal, pre-tax %)	11.3
μ	drift (%)	9.5
σ	volatility	14.1
κ	unit cost of capacity (ppm)	43.5

Table 2.1: Model parameters

2.38 Two crucial parameters for our analysis are μ (the drift rate of traffic volume) and σ (the volatility parameter). There are two sources for estimating these parameters. The first is historical traffic figures. Figure 2.3 shows quarterly percentage changes in total traffic volumes (outgoing plus incoming) for all UK mobile networks over the period July 1993 to July 2001.[4] From these historical figures, the annual drift rate can be estimated at 42.87%, and the annual standard deviation is 7.71%.

2.39 One criticism of this approach is that it may underestimate the true volatility, because it is backward looking and does not account for the uncertainties over the future of mobile growth. It may also overestimate the future growth rate, as the period analysed corresponds to rapid penetration of mobile services from a very low base. Share prices, on the other hand, might provide a more forward-looking estimate of volatility. At issue is how to relate the volatility of share prices to the underlying volatility of traffic volumes.

2.40 Denote the value of an MNO by V. Share price data can be used to

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[4]The traffic figures are taken from the April 2002 Analysys model of LRIC for mobile networks.
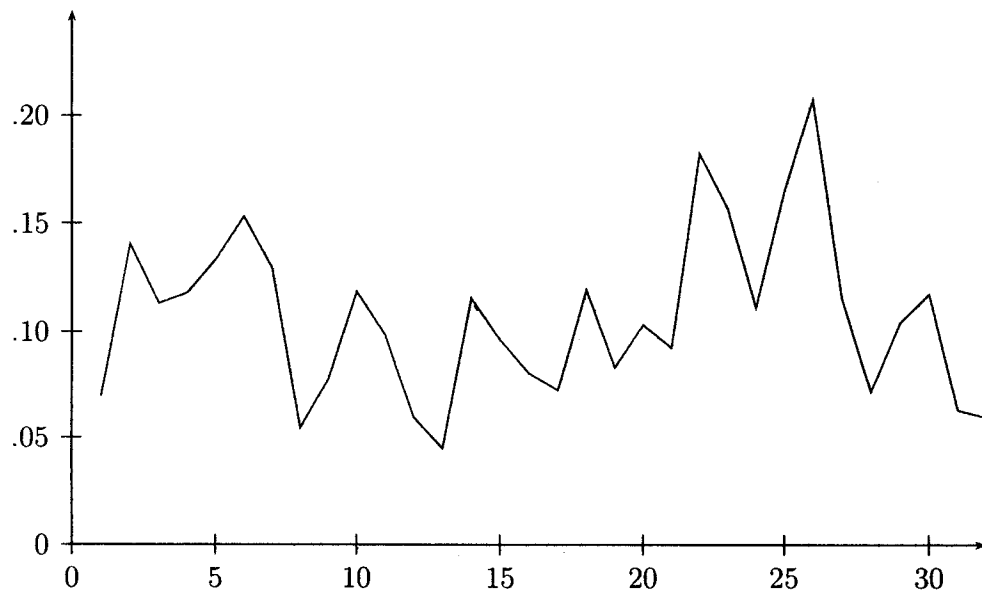
Figure 2.3: Quarterly percentage changes in traffic volumes, July 1993–July 2001
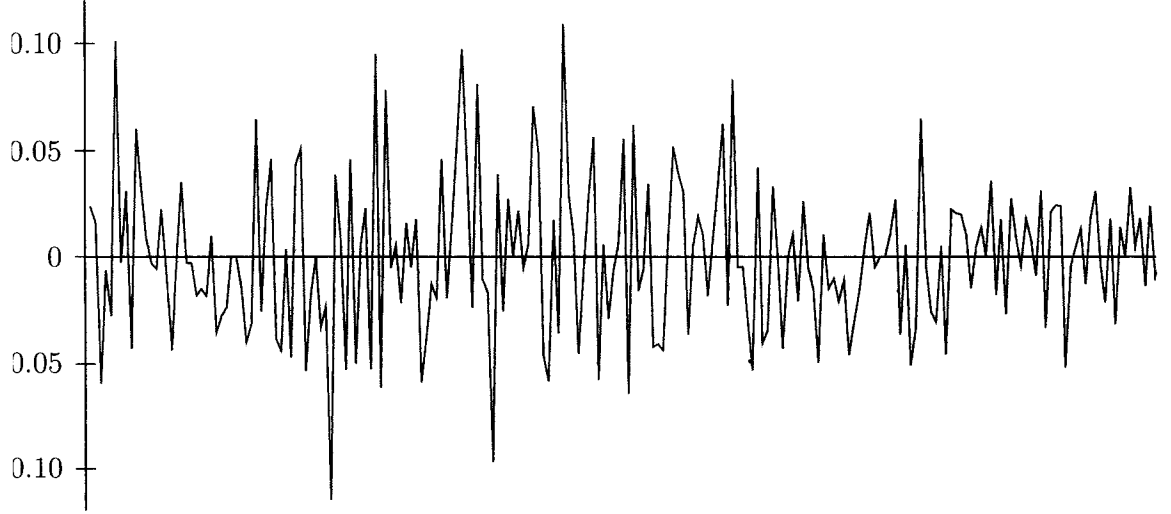
Figure 2.4: Percentage change in O_2 daily share price, 20/11/2001–07/03/2006

estimate the parameters μ_V and σ_V in the equation

$$dV = \mu_V V dt + \sigma_V V dz. \qquad (2.17)$$

There are difficulties in isolating returns from UK mobile telephony. The easiest MNO to study for this exercise is, therefore, O_2, for whom the majority of business is in the UK. Daily share price data were obtained from the O_2 website, and plotted in figure 2.4 for the period 20th November 2001 to 7th March 2006. To complete the calculation, *unlevered* figures should be used, adjusting for the level of gearing over the period. We were not able to obtain detailed data on gearing, however. Hence, for the current exercise, we use raw share price data. The annualised percentage rate of change in these data is 29.17%; the annualised standard deviation is 43.51%.

2.41 In order to relate these figures to the drift and volatility of traffic volumes, we need to relate the dynamics of the MNO's value to the dynamics of traffic volumes. From Ito's lemma,

$$dV = \frac{\partial V}{\partial X} dX + \frac{1}{2} \frac{\partial^2 V}{\partial X^2} (dX)^2.$$

We are concerned only with the stochastic components of dV and dX,

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and so can ignore the second order term. That implies that

$$\mu = \Omega(X)\mu_V, \qquad \sigma = \Omega(X)\sigma_V$$

where

$$\Omega(X) \equiv \frac{V(X)}{X\frac{\partial V}{\partial X}}.$$

Our previous calculations have given us an expression for $V(X, K)$ (see equation (2.8)). Things are particularly simple when $X \geq K$; in this case, $\Omega(X) = 1/\beta$. This then means that

$$\frac{\mu}{\sigma} = \frac{\mu_V}{\sigma_V} = 0.6705. \tag{2.18}$$

2.42 This means that we cannot derive separate estimates of μ and σ: they are coupled by equation (2.18). If, however, we specify an estimate for μ, the annual percentage change in traffic volumes, then equation (2.18) supplies us with the corresponding estimate of σ, using share price data (which, by hypothesis, is forward-looking). We use the traffic forecasts in the latest LRIC model to estimate μ. The average annual percentage growth rate over the period 2005/06–2039/40 is 9.5%. Equation (2.18) then implies that the traffic volatility parameter is 14.1%.

2.43 Other parameters in table 2.1 are estimated in a rough-and-ready way. The (nominal, pre-tax) retail price p is set at 10ppm, based on figures from the 2003 Competition Commission report for total origination revenues and traffic minutes for the four operators. Marginal costs of origination and termination are set to zero (since they are likely to be small). The figure for f is taken from the 2003 Competition Commission report, and is intended to be an average for all fixed networks. The cost of capital ρ is taken as 11.3% in pre-tax, real terms. We use an inflator, γ, with a central value of 2.5%, so that the central nominal pre-tax cost of capital is 13.8%.

2.44 κ is a tricky parameter to estimate accurately. One method is to base the estimate directly on the LRIC model, using capital expenditure and the volume of forecast traffic for each year over the period 2006–2021. In order to match the outcome of real options model as closely as possible to current calculations, we choose instead to set κ so that the termination charge with deterministic traffic growth, given in equation (2.4), is roughly equal to the average recommended charge over the next review period, of about 6ppm. This then implies that $\kappa = 43.5$.

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2.45 Finally, we allow operators' margin per unit of traffic to decline over time, at an annual rate equal to the deflator γ. A full treatment of a time-varying margin is very complicated;[5] We approximate this factor by adjusting downwards the annual percentage growth rate of traffic, so that the *effective* growth rate is $\mu - \gamma$.

2.46 With these parameter values, the termination charge (per unit of traffic) for the model without uncertainty is 6ppm (by design). Recall that the termination charge (per unit of traffic) for the model with uncertainty is

$$\frac{p - c^O - c^T + \left(\frac{1-a-b}{2}\right)(p - 3f - c^O) - (\hat{\beta} - 1)\rho\kappa}{a + b}.$$

At the central inflator figure of 2.5%, this gives a termination charge of 8.14ppm, some 36% higher than the corresponding charge under certainty. This higher value reflects directly the need to reward investing firms for the risk that irreversibility presents. The reward is not a 'monopoly rent', but a necessary increment to the standard LRIC to ensure efficient investment.

2.47 We have performed a sensitivity analysis for these calculations. The estimates are most sensitive to the parameters μ, σ and ρ (and particularly the gap $\rho - \mu$). This sensitivity is caused by the simplicity of the model, in which a high degree of linearity is assumed. For example, the profit function in equation (2.6) is a linear function of traffic, since we have not modelled demand in a detailed way. A consequence of this feature is that the termination charge under uncertainty depends linearly on the uncertainty factor $\hat{\beta}$. Since this factor is sensitive to parameter values (see figure 2.2, for example), so is the implied termination charge.

2.48 As a result, and given the approximate nature of the exercise, we want to emphasise the following main points (rather than a specific figure):

- Real options can be taken into account within the broad framework of the existing LRIC model.

- Real options can have a significant quantitative effect on the termination charge that should be applied.

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[5]It turns the ordinary differential equation (2.7) in to a partial differential equation, in which the value function $V(\cdot)$ depends on both the state and time.

- At the central parameter values that we have used, real options increase the effective LRIC of termination of MNOs. The increase arises in order to yield adequate returns on investments that are irreversible and inherently risky, so that investment occurs efficiently.

2.4 Summary

2.49 Our primary aim in this chapter has been to indicate how the existing LRIC model can be adapted to take into account the real options that are inherent in investment decisions for mobile networks.

2.50 Our model works as follows:

2.50.1 The primary driver (i.e., the 'state' variable) is the volume of traffic.

2.50.2 The existing LRIC model treats traffic volumes as changing *deterministically*, and assumes that investment decisions follow traffic volumes. (Any lags that occur are due to the 'lumpiness' of network capacity.)

2.50.3 In contrast, we assume that traffic volumes vary *stochastically*: future changes in volumes are inherently uncertain. This uncertainty, combined with the irreversibility of investment, means that MNOs will not invest immediately when traffic volumes rise. Instead, they will wait until volumes are sufficiently high, relative to current capacity, before investing. This investment delay is entirely *efficient*.

2.50.4 We determine when and how much investment will occur.

2.50.5 Given the simple structure of our model, that allows us to compute an LRIC, and hence a regulated termination charge, per unit of capital. These are calculated to ensure that MNOs face efficient incentives towards investment.

2.50.6 Estimates of the model parameters indicate that allowing for real options raises the regulated termination charge by around 35%.

Chapter 3

The option for flexibility

3.1 In the previous chapter, we considered when and how MNOs will invest in network capacity when faced with irreversibility and uncertainty. Since there were no fixed costs to investment, we argued that investment, when it occurs, increases capacity up to current traffic volumes.

3.2 It is more realistic, however, to allow for fixed costs to investment. That is, when network capacity is expanded, there are costs that have to be borne by the MNO that are independent of the scale of investment. For example, when a new site is prepared, there are labour and other costs that have to be incurred regardless of the number of masts and the amount of capacity installed at the site.

3.3 An immediate implication of these fixed costs is that MNOs may, *efficiently*, over-invest in capacity. When traffic volumes rise to hit the investment boundary, the investment that is triggered brings capacity *above* the current volume of traffic. This is illustrated in figure 3.1. (The exact amount of investment can be determined using the approach described in the appendix.)

3.4 This behaviour can be viewed as a form of *flexibility*. Traffic volumes vary stochastically. It is not optimal or even possible, given irreversibility and uncertainty, simply to match capacity to traffic at each moment. If traffic volumes fall, then it is not possible to sell capacity and recover the cost of investment. If traffic volumes rise by a small amount, the fixed cost of investment (as well as real options considerations) mean that it is efficient to wait before investing in capacity. Once traffic volumes hit the investment boundary, then it is efficient to bring capacity *above* the current traffic volume, to economise on future fixed investment costs. The extra capacity gives the network the flexibility to take
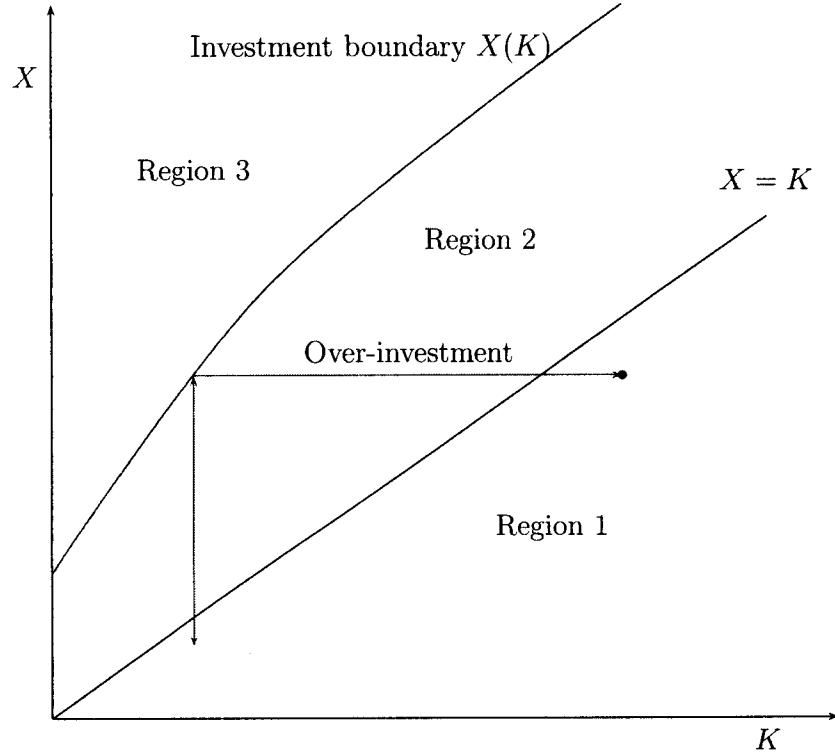
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Figure 3.1: Over-investment for flexibility

on additional traffic without having to incur more fixed investment costs.

3.5 Equation (2.13) tells us that the investment boundary $X(K)$ increases in the size of the investment increment $K' - K$. This make sense: when optimal investment calls for a greater increment in capacity, then, with irreversibility and uncertainty, the traffic volume that triggers investment should be higher. Following this fact through the calculations in the previous chapter shows that, as a consequence, the regulated termination charge $\bar{t}$ should also rise. The logic is simple. Efficiency calls for MNOs to wait for higher traffic volumes before investing, and

to make larger capacity increments when investing. This effectively exposes the MNOs to additional risk, which has to be reflected in the regulated charge. The point of raising the termination charge is not to be, in some sense, 'fair' to the MNOs. Rather, it is to ensure that the MNOs face efficient incentives towards investment.

Chapter 4

Conclusions

4.1 Our objective in this report has been to show how the current LRIC model for mobile termination can be adapted to incorporate the real options that arise when investment is irreversible and subject to uncertainty.

4.2 We have followed the current structure of the LRIC model by treating traffic volumes as the fundamental driver. We depart from the current LRIC model by assuming that traffic volumes vary stochastically. This, we have shown, has major consequences for investment behaviour, LRICs, and the level of the regulated termination charge.

4.3 We have considered two different types of options created when traffic volumes are stochastic. They relate to the option of when to invest; and the option of flexibility (or how much to invest).

4.4 In both cases, our objective has been to determine the form of *efficient investment*. We show that

4.4.1 MNOs will wait until traffic volumes are sufficiently high before investing.

4.4.2 When investment occurs, it can lead to over-capacity: the investment increment exceeds current traffic volumes.

Both types of behaviour are efficient. Moreover, the regulated termination charge should be set to ensure that MNOs behave in exactly this way.

4.5 We show in some detail how the regulated termination charge should be set to take into account the real option of when to invest. The termination charge must be increased from the level that ignores real

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options, in order to reflect the risk involved in irreversible, uncertain investments. A rough calibration of the model indicates that the increase in the termination charge is around 35%.

4.6 More important than this approximate quantitative effect is the framework that is developed to incorporate real options in regulatory decision for mobile networks.

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Chapter 5

Appendix: Optimal investment under uncertainty

5.1 Three conditions determine when and how much investment occurs:

$$V(X_t, K) = V(X_t, K') - \kappa(K' - K) - F; \tag{5.1}$$

$$\frac{\partial V(X_t, K')}{\partial K} = \kappa; \tag{5.2}$$

$$\frac{\partial V(X_t, K)}{\partial X} = \frac{\partial V(X_t, K')}{\partial X}. \tag{5.3}$$

These are, respectively, value matching (VM), optimal investment (OI), and smooth pasting (SP) conditions. $F \geq 0$ is the fixed cost of investment, which is unrelated to the scale of investment $K' - K$. The OI condition supposes that there is a non-zero but finite amount of investment. If

$$\frac{\partial V(X_t, K')}{\partial K} < \kappa$$

then no investment occurs (the marginal benefit from investment is outweighed by the marginal cost). If

$$\frac{\partial V(X_t, K')}{\partial K} > \kappa$$

then investment does not stop at K': capacity is increased to the point at which equality occurs between the marginal benefit from investment and the marginal cost.

5.2 We know that the value function $V(X_t, K)$ takes the form

$$V(X_t, K) = \begin{cases} A(K)X^\beta + \frac{\theta}{\rho-\mu}X_t & X_t < K, \\ A(K)X^\beta + \frac{\theta}{\rho}K & X_t \geq K. \end{cases} \tag{5.4}$$

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5.3 Suppose first that $F = 0$ (there are no fixed costs of investment). Is it possible that $K' < X(K)$ i.e., that investment, when it occurs, leaves capacity below the current traffic volume? The VM, OI and SP conditions would then be

$$A(K)X(K)^\beta + \frac{\theta}{\rho}K = A(K')X(K)^\beta + \frac{\theta}{\rho}K' - \kappa(K' - K); \quad (5.5)$$

$$\frac{dA(K')}{dK}X(K)^\beta + \frac{\theta}{\rho} = \kappa; \quad (5.6)$$

$$\beta A(K)X(K)^{\beta-1} = \beta A(K')X(K)^{\beta-1}. \quad (5.7)$$

The third equation implies that $A(K) = A(K')$. The first equation then implies that $\theta/\rho = \kappa$ (which of course cannot hold in general). The second equation then gives the marginal return from investment as

$$\frac{dA(K')}{dK}X(K)^\beta.$$

This is zero (and hence investment non-zero but finite) if and only if $dA(K')/dK = 0$ for all K'.

5.4 In summary: optimal investment will be such that $K' < X(K)$ if and only if $\theta/\rho = \kappa$. Since θ, ρ and κ are parameters of the model, this is a very special case that will not arise in general. In fact, in the model calibrations in section 2.3, we find that $\theta/\rho = 78$ while $\kappa = 30$.

5.5 This leaves the other case, of $K' \geq X(K)$: investment occurs so that capacity at least matches the current volume of traffic. In the absence of fixed costs of investment ($F = 0$), it cannot be optimal for investment to bring capacity *above* the current volume of traffic: the additional capacity would earn no immediate return; and, in the event that the volume of traffic rises, the MNO can invest with constant returns to scale. Hence the only case to consider, when there are no fixed costs to investing, is $K' = X(K)$.

5.6 When there are fixed costs to investing, the three conditions are

$$A(K)X(K)^\beta + \frac{\theta}{\rho}K = A(K')X(K)^\beta + \frac{\theta}{\rho - \mu}X(K) - \kappa(K' - K) - F; \quad (5.8)$$

$$\frac{dA(K')}{dK}X(K)^\beta + \frac{\theta}{\rho} = \kappa; \quad (5.9)$$

$$\beta A(K)X(K)^{\beta-1} = \beta A(K')X(K)^{\beta-1} + \frac{\theta}{\rho - \mu}. \quad (5.10)$$

These can be solved to give the optimal K', which will be greater than $X(K)$ due to the fixed cost F.