A Summary of the Economic Evaluation of the Effect of UWB on Broadband Fixed Wireless Access in the 3.4 GHz Band

A study completed by Indepen and Quotient

Background

A new technology called ultra wideband (UWB) has been proposed for a wide range of applications including in-home networks, ad-hoc linkage of devices and short range radar systems. UWB works by transmitting at very low power levels across a wide range of frequencies already in use by others. In some cases the power levels are sufficiently low that interference seems unlikely, while in others there are grounds for concern. It is a matter for the regulator to decide whether to allow UWB transmissions.

At present use of UWB is not permitted in the UK though it is permitted in the United States. If use of UWB was permitted this would be on a licence exempt basis and would be confined to some or perhaps all of the frequency bands in the range 3-10 GHz.

Ofcom has been carefully studying and consulting on UWB in order to develop the body of evidence and understand the views of all affected stakeholders. An important element of this evidence was a study by Mason and Dotecon (the "Mason report") which assessed the net cost-benefit of UWB to the UK economy. The Mason report concluded that UWB has the potential to make a substantial contribution to the UK economy, generating billions of pounds of value over the next 15 years, and recommended that the draft ETSI mask (or a variant of it) be supported rather than the mask permitted by the US Federal Communications Commission (FCC). The scope for further investigations into the cost impact of the interference of UWB on broadband fixed wireless access (BFWA), systems not yet deployed and aeronautical radar was noted. As a result, Ofcom has commissioned further studies into each of these areas. This note summarises the work on BFWA.

Ofcom has since undertaken a consultation on UWB[1]. Of particular relevance to this study, several respondents noted the potential interference problems that UWB may cause to BFWA services and suggested possible mitigation measures.

Publication of a summary alone

Ofcom normally publishes work performed on its behalf in full. However, in this case, we are publishing only a summary of the results and, separately, the technical analysis. This is due to of the amount of confidential information that was needed. Because BFWA networks are only in the early stages of deployment in the UK, the consultants needed information such as deployment plans and technological input from the BFWA operators to complete their work. We therefore consider the full report to be confidential.

Summary of results

The study is primarily concerned with estimating the economic cost of any potential harmful interference caused by the use of UWB for personal area networks to BFWA services at 3.4 to 4.2 GHz. The results from this study together with the results from Mason report and a further study on the impact of UWB on services at 2.6 GHz will be used to revise the overall estimate of the net benefits of UWB.

The main issues addressed by the study are

- What interference might UWB cause to BFWA?
- What actions might be taken to mitigate this interference?

[1] Ultra Wideband, Consultation document, Ofcom, January 2005.

- What are the costs of these actions?
- What are the costs of any remaining harmful interference?
- What are the knock-on costs of interference on the broadband market?

The approach to the study has been conservative, in the sense that the assumptions used in the modelling are chosen such that they are likely to result in more rather than less interference. This means they assume that if UWB causes harmful interference to BFWA systems then there could be a net economic cost. They assume that consumers do not seek to mitigate the interference by moving or shielding equipment or using a wired connection instead of UWB or BFWA. While it might be argued that where the consumer has discretion over UWB use there is no net economic impact because the effect is internalised. However, this assumes that

1. Subscribers are fully aware of the potential impact of interference generated by UWB devices
2. If interference is experienced, that they judge whether to continue to subscribe to BFWA services or discontinue the BFWA service in favour of UWB capability (and perhaps subscribe to a fixed operator with some loss of service capability).
3. The impact of interference is experienced by individuals using both UWB and BFWA devices. However, in some circumstances where the BFWA network is able to compensate for the interference by devoting additional resources, other BFWA subscribers (who do not use UWB) may experience service degradation.

Furthermore consumers would still be prevented from maximising the value they obtain from both services (i.e. subscribers so affected would not be able to adopt both BFWA and UWB). This is important because BFWA systems have potential to provide capabilities not available from fixed wired service platforms e.g. nomadic use outside the home environment.

The other main area in which conservative assumptions are made concerns the market forecast for BFWA. The provision of broadband services is presently undergoing a period of rapid growth, particularly through the provision of wired DSL services, however, there is currently relatively little provision of BFWA and its future share of the market is uncertain. The consultants' forecasts for BFWA are generally optimistic and so give a number of "worst case" interference scenarios. Three scenarios for UWB were adopted, corresponding to optimistic, pessimistic and most likely cases.

The consultants have produced forecasts for the period 2005-2020 to be consistent with the approach taken by Mason and Dotecon and have modelled the impact of UWB on the performance of BFWA systems, using both UTRA TDD technology and WiMAX certified products.

High and moderate forecasts for BFWA take-up are derived, informed by the existing operators' usage forecasts, for the period to 2020. These were used, together with assumptions about internet usage patterns and the low, central and high UWB forecasts developed by Mason and Dotecon, in Monte Carlo simulations of the impact of UWB interference.

It is assumed that BFWA is used in fixed and portable (or nomadic) modes in the home or office and in other locations (e.g. cafes or transport terminals) where there is BFWA coverage but that the consumer's primary motivation for subscribing to BFWA is to receive a fixed broadband service. UWB devices are expected to be deployed extensively in a wide range of electronic products found in both home and office environments. Although the level of

emissions will be very low, the interference suffered by a BFWA terminal can be large enough to affect the reception of weak signals when the terminal is in close proximity to a transmitting UWB device.

In the presence of UWB interference a number of effects can be expected to occur:

- The additional interference will require UTRA TDD systems to increase power and/or change modulation and coding to maintain the link. This will result in *more* capacity resources being demanded;
- The additional interference will require WiMAX systems to change modulation and coding to maintain the link. This will result in *more* capacity resources being demanded;
- If the modulation and coding scheme required to support the subscriber's instantaneous data rate cannot be supported, then transactions will be blocked and the system will require *less* capacity. However, the levels of outage will increase.

Which of these effects occurs depends upon the severity of UWB interference at that instant, therefore the results of the simulation need to show both the total capacity demanded and the levels of outage.

The consultants found that UWB interference is substantial compared to the received signal powers associated with BFWA access systems. Without mitigation, it renders BFWA signals unusable for those subscribers that are also UWB users. The primary impact on BFWA networks is not on the capacity required, but rather on the outage experienced by BFWA subscribers. The impact on a BFWA network is most pronounced when a network is lightly loaded (either in early years of network operation or in the more lightly loaded urban and suburban areas). In congested areas, the cell ranges are naturally shorter due to higher capacity demands. Overall without mitigation, the hypothetical costs faced by BFWA operators to fully mitigate against UWB interference by upgrading infrastructure would range from £0[2] to £40 billion under the high BFWA market forecast, and £0 to £36 billion under the moderate BFWA market conditions. Under the central and high UWB market forecasts, the consultants consider that the most likely outcome for BFWA operators resulting from unmitigated UWB interference is business failure.

They then considered a number of possible mitigation methods. They found that

- The use of power control and capping of duty cycles are not effective means of mitigating UWB interference;
- Inhibiting UWB applications that are associated with the primary PC has potential to substantially reduce the levels of UWB interference, however, there is still a significant residual impact on BFWA performance. This option relies on an effective means of detecting BFWA activity;
- Switching UWB devices to higher frequency bands either as a complete regulatory measure or in response to detection of BFWA activity has potential to reduce the outage substantially. However, reducing interference by the readily achievable 20 or 30dB still results in a significant residual interference impact on BFWA networks.

[2] The zero cost corresponds with the assumed low UWB market forecasts. Central and high UWB forecasts lead to higher costs.

- By attenuating UWB emissions by 40dB, the interference impact can be reduced significantly. However, a residual impact would remain costing around 4% of network site costs for the high BFWA market forecast and 1% of network site costs for the moderate BFWA market forecast.

The consultants estimated the net costs to the economy of interference from UWB to BFWA services to be of the order of £300m, although there is considerable uncertainty in this figure. Given that the Mason report predicted a net benefit of £4bn from UWB then it is clear that UWB offers net benefits (subject to the conclusions of the impact study on the 2.5 - 2.69 GHz band), even if the interference caused leads to the failure of BFWA. The consultants were of the view that the only mitigation technique that might avoid BFWA failure is that where the UWB device moves to a higher band (say 4.2-4.7 GHz) when BFWA activity is detected and filtering is applied that would allow at least a 40dB attenuation of the UWB transmission at the BFWA frequencies (the "detect & avoid" approach). An upper bound on the costs of this mitigation is given by a strategy which involves limiting UWB to frequencies above 6GHz. No chipsets are being designed only for this band yet, but it is possible that they could be on the market in five years time particularly if all of Europe moved to use only the upper band. Assuming a five-year delay to the introduction of UWB, the net benefits from UWB would be reduced by over 70%.

Implications for UWB strategy

This report suggests that even if UWB were deployed, and the result was the business failure of the BFWA operators, that there would still be net economic benefits to the UK in proceeding in this direction. However, both this report and the responses to the Ofcom consultation on UWB raise the possibility that a "detect & avoid" mechanism might provide a mechanism to both allow UWB while mitigating interference to BFWA. If achievable, this is clearly an outcome that would increase the benefit to the UK and is Ofcom's preferred approach. If not achievable, a possible alternative is to limit UWB transmissions to above 4.2GHz. Further study would be required to understand the impact of such a strategy.

Standardisation of the operating parameters for UWB within Europe is taking place under EC direction within the CEPT. In June 2005 Ofcom indicated to CEPT its preference for detect & avoid and is now actively participating in meetings in order to inform other members of CEPT as to our work. Ofcom's hope is that as a result CEPT will agree with this view and reflect it back to the EC, which will then include detect & avoid or other mitigation approaches within any Decision it might issue concerning UWB. In this case, and depending on the exact parameters developed within CEPT, Ofcom would expect there to be minimal impact on licensed BFWA deployments.