

Alereon is one of the leading developers of integrated circuits for UWB; we are in a unique position to comment both the technical and economic merits of this consultation as developers of the first integrated UWB chipset capable of sending and receiving data at 480Mb/s. This chipset uses multiband OFDM technology, which is well suited to address the coexistence issues raised in the consultation document. The author of these comments was formerly the Chair of the IEEE 802.19 Coexistence Technical Advisory Group and has extensive experience in developing coexistence mechanisms between wireless systems.

The spectral mask for UWB proposed by Ofcom appears reasonable and achievable to Alereon; combined with sensible mitigation techniques, this proposal will allow the UK to reap the economic benefits of UWB while protecting the services of existing users. We appreciate the opportunity to contribute to this process and look forward to a rulemaking that allows this important technology to go forward.

Q1: Are these the appropriate topics to be consulting on?

A1: There has been much debate about the merits of UWB; we commend Ofcom for taking a leadership role in clarifying and focusing the debate so that rules can be made and the economic benefits described in the Mason report can be realized. It is easy to get trapped in an endless policy debate, especially concerning UWB; Ofcom are in a unique position to crystallize the issues and positively influence the ITU to strike a reasonable balance between the benefits of UWB (which are substantial), and the perceived interference risks of the technology (which are manageable).

Q2: Do you agree with this analysis of our statutory duties? Are there any important factors that have been omitted?

A2: This analysis matches Ofcom's statutory duties well, in our opinion, and the interests of Ofcom's constituency have been addressed in a reasonable and thoughtful way. In particular, the enlightened cost-benefit analysis described in the document is particularly comprehensive. UWB offers significant and unique economic benefits and can be made to achieve flexible spectral reuse, while maintaining adequate protection for incumbents.

Q3: Do you agree with the economic study? Are there other studies that Ofcom should be conducting?

A3: The econometric analysis of UWB deployment versus incumbent risk is appropriate and insightful. We also believe that the interference risk is likely to be less than even this analysis shows; the ambient noise environment due to other intentional and non-intentional radiators is such that we believe UWB will not adversely affect incumbents. In practice, many wireless systems both in and out of band with UWB are limited in performance by existing interference, not thermal noise. Thus, incumbents are unlikely to realize the costs due to UWB shown in the model because their systems are already provisioned to accommodate interference from Class B emissions and spectral sidelobes or spurs from other existing wireless emitters.

Q4: Is there a better way that future use of the spectrum could be taken into account?

A4: There is considerable research work being done in the area of cognitive and software defined radio. These technologies, as they mature, will allow intelligent wireless devices to manage the environment around them using combinations of temporal, spatial, spectral, and power control mechanisms, giving regulators much better tools for developing and maintaining regulatory policy. Such intelligent wireless systems would provide more reliable services to consumers, better

frequency reuse, and better coexistence between wireless systems. Some of the techniques for spectral adaptability that are being advocated by UWB proponents are important first steps in this process of deploying this new class of more intelligent wireless system.

Q5: What is the most appropriate solution to the potential interference from UWB to BFWA?

A5: There is a legitimate concern about coexistence between BFWA and UWB, if operated in the same band. Fortunately, many of the stakeholders in UWB also have a vested interest in BFWA. As a result, many effective mitigation techniques have already been proposed by Intel, Siemens, and others. They include:

- Dynamic frequency selection – multiband systems could sense the presence of a BFWA system and switch to another band
- Adaptive spectral shaping/nulling – using spectral sculpting techniques, the UWB system could suppress energy in BFWA bands in use. This knowledge could be gained through collaboration when the wireless systems share a common host, or by inference, if the UWB system has a spectral analysis capability.
- Temporal collaboration techniques – when BFWA and UWB devices share a common host
- Spatial techniques – if BFWA is operating indoors, which will imply non-line of sight operation and a commensurate decrease in link budget, it would be advantageous for it to use a directional antenna, which could provide additional UWB isolation in addition to improving its own link margin. If the BFWA antenna is located outdoors, there is less of a likelihood of UWB interference, since indoor usage of UWB is expected to be dominant.
- Transmit power control – UWB systems can employ transmit power control, which will lessen the interference probability.

Q6: Would it be possible to achieve sufficient isolation between radio astronomy and UWB through practical methods of physical separation?

A6: We believe the normal usage models for both UWB devices and radio astronomy systems (RAS) make interference unlikely. UWB devices will mostly be used indoors and will be highly attenuated by the time any possible signal could reach a RAS antenna¹; furthermore, existing interference in the bands of interest due to license exempt devices such as BFWA and RLAN appear to be significantly higher than UWB would be permitted to radiate under the proposed mask. RAS systems are generally pointed into deep space at high elevation angles so that coupling from terrestrial interference (existing or proposed) is minimized; RAS systems would want to be located away from urban centers and have antennas with minimal sidelobes to prevent coupling from any terrestrial source as a matter of course. UWB is only one source of potential interference to RAS, and we believe reasonable analysis shows that it is not the most significant one. UWB devices are personal area network systems that will be used in close proximity to human beings that operate other wireless systems which RAS antennas must already avoid. Thus, UWB devices will not be suspended in space near a RAS antenna beam but would be in the multifamily

¹ It has been shown that a UWB signal radiating in free space at -41.3dBm/MHz will be at the thermal noise floor of any potential victim receiver (having a 0dBi gain antenna) at a distance of 24.5 meters or less. While protection ratios beyond this 0dB SNR and geometric scenarios for main beam coupling can be debated, it is obvious that it is difficult to detect UWB at reasonable distances, and that any RAS system having significant gain in the direction of a UWB emitter will also acquire significant energy from other sources as well, since UWB devices are unlikely to be suspended in space.

dwelling filled with other radiators, while a BFWA transmitter could be on a tower that would be more likely to couple into a RAS antenna beam.

Q7: Are there any other options that we should consider?

A7: Attenuation versus frequency combined with a flat emission mask imply that the higher frequencies above 6GHz will have significantly reduced range², severely limiting the usefulness of the technology. In addition, there is significant risk to this nascent industry of the higher frequencies because of the increased cost of integrated solutions using current technology.

Q8: Are there any major technical studies that we have omitted?

A8: There have been a number of recent technical presentations in CEPT TG3 that were likely not available when the consultation was written; many of these studies refute the more pessimistic documents and paint a more reasonable and balanced view than the earliest studies.

Q9: Have we made an accurate assessment of the existing studies?

A9: Yes – we believe your assessment is fair and reasonable.

Q10: Do you agree that we should seek a common European framework for the introduction of UWB?

A10: Yes, absolutely. The economic benefit of a new technology such as UWB is maximized when applied across multiple markets, and a harmonized framework avoids a regulatory patchwork that inhibits deployment. The ideal would be to harmonize regulations worldwide, and perhaps Ofcom can help be the standard-bearer for this effort in CEPT and ITU.

Q11: Have we proposed the most appropriate mask? Will it be possible to deliver equipment conforming to this mask?

A11: We are very supportive of the in-band mask, and commend Ofcom for proposing the same -41.3dBm/MHz in-band limit as used by the FCC. We are also comfortable with the out of band limit of -85dBm/MHz at 2.1GHz, although there are open issues with how this would be tested. For example, this signal level cannot be measured at one meter in a radiated test, since it will be below the KTB noise floor. We would prefer a radiated test, however.

Q12: To what extent should we define parameters such as those listed above? What is the most appropriate definition for each of these parameters?

A12: We address your points individually:

- Should there be a minimum pulse repetition factor (PRF)? Low rates of PRF might make the interference less noise-like and potentially more problematic.
 - While the intent of this is correct, we believe the same objectives can be achieved by limiting peak power, average power, and specifying an integration interval over which to relate these two.
- Should devices that are not linked with other UWB devices ("non-associated device") limit their emissions? Non-associated devices might make emissions to alert other nearby devices to their presence. Limiting

² In free space, 6GHz would be attenuated by 6dB compared to 3GHz, resulting in approximately half the achievable range for a given data rate. If a path model with attenuation factor higher than free space were used, this reduction in range would be even greater.

these would result in less noise but potentially increase the length of time for nearby devices to "find" each other.

- We believe the current FCC rules that require a non-associated device to cease transmitting after a proscribed (10 second) scanning interval will achieve this objective.
- Should there be a mandated ability to turn UWB transmitters off? This might be valuable if users note that their UWB devices are interfering with other devices that they own (eg W-LANs) and wish to turn one off.
 - We expect that most UWB devices will be battery powered, and will have a power switch; we would agree that a power switch for all UWB devices is reasonable.
- Should UWB devices be required to use the minimum power for the data rate and range that they are trying to achieve? This might result in power levels lower than the maximum being used for many applications, with resulting reduction in potential interference.
 - In general, we believe transmit power control (TPC) is useful and enhances coexistence and spectral reuse. The parameters of this would need to be considered carefully to make sure they are reasonable, practical, and beneficial.
- Should there be any guidance provided to UWB users? The FCC issues detailed guidance about issues such as the use of UWB devices out of doors. If so, what should the instructions cover?
 - Instructions similar to those included with FCC Part 15 devices would be useful to the consumer.
- Should there be a minimum bandwidth for UWB? The FCC have required a bandwidth of at least 500MHz. Suggesting a minimum bandwidth would seem to provide technological constraints when they might not be necessary.
 - Alereon believes that the 500MHz minimum bandwidth restriction could and should be relaxed. This would allow UWB system developers more flexibility in spectral adaptation, and would also permit a variety of bandwidths to be used as appropriate.
- Are there are specific applications where the potential consequences of UWB outweigh the potential benefits, e.g. replacement of monitor cables due to high data rate combined with continuous operation? If so, would it be practical to limit the range of applications that UWB could be used for?
 - While we believe it is reasonable to limit duty the cycle of UWB to a figure that constrains aggregation potential while still allowing most usage models, it is not appropriate to place regulatory constraints on applications as a class. Thus, a compressed monitor signal should be allowed so long as it meets the duty cycle constraint.

Q13: Is our proposed approach to international bodies appropriate?

A13: We encourage Ofcom to stress to the international regulatory community that UWB represents an opportunity, not a problem. The UWB community will support Ofcom in conveying that message; we believe that reasonable analysis (and some of the analysis in CEPT and ITU has not been reasonable) will show that the benefits are compelling and the risks manageable.

Q14: How should we best deal with the precedent potentially set by our proposed approach to UWB?

A14: Weigh the analysis impartially and with a fair cost-benefit analysis, as you have done --- then issue clear rules that gives the technology community direction to develop products.

Q15: What should Ofcom's role be in setting and monitoring EMC standards?

A15: Ofcom have suggested EMC monitoring stations to provide ground truth of the interference environment and to observe whether new technologies raise the apparent noise/interference floor. This seems like a proper thing for a regulatory body to do, and will aid Ofcom in verification of the various interference models that have been put forward.