

23rd June 2008

PATENTS ACT 1977

APPLICANT Intel Corporation

ISSUE Whether patent application number GB
0619968.1 complies with section 1(2)

HEARING OFFICER P Marchant

DECISION

- 1 Patent application number GB 06199868.1 entitled “Method and apparatus to vectorize multiple input instructions”, was filed as US PCT 2005/018444 on 25 May 2005 in the name of Intel Corporation claiming priority from an earlier United States application having a filing date of 24 June 2004. It entered the GB national phase on 10 October 2006.
- 2 The application concerns the optimisation of a trace of computer program instructions for use in a multi processing unit. The optimisation consists of receiving an input sequence of instructions from the trace, identifying two or more candidate instructions within the sequence suitable for replacement with a “single instruction with multiple data” and replacing the candidate instructions with the single instruction to produce an optimised trace of instructions. The applicant refers to this process as “vectorization”. The purpose is to replace suitable instances of multiple instructions in the trace with single instructions and thereby speed up the overall processing of program instructions.
- 3 The examiner objected in his examination reports of 7 March 2007, 27 July 2007 and 21 December 2007, that the subject matter of the application is excluded from patentability by section 1(2)(c) of the Act because it consists of a computer program. The applicant’s agent argued to the contrary in letters dated 28 June 2007, 27 November 2007 and 31 March 2008. He maintained that the patent should be allowed since the vectorization process goes beyond the mere programming of a computer, and provides an improved approach to the optimisation of the performance of a multi-processing unit, allowing it to achieve an increase in processing speed.
- 4 The examiner and the applicant were unable to resolve this disagreement, and the matter came before me at a hearing on 2 April 2008 at which the applicant

was represented by Dr Christopher Benson and Mr Alastair Lowe.

The Invention

5 Claim 1 was amended during prosecution, and now reads:

1. *A multi-processing unit capable of interacting with memory, storage and I/O devices and processing data therefrom and therefor, comprising an optimization unit including an input trace buffer, a sequencer, a vectorization unit and an output trace buffer, wherein:
said input buffer receives a trace of instructions,
said sequencer pulls instructions from said input buffer and provides a sequence of instructions to said vectorization unit,
and wherein
said vectorization unit is arranged:*

- *in a first stage, to search the sequence of instructions for two or more candidate instructions for vectorization by creating a dependency tree and storing said dependency tree in memory,*
- *in a second stage to search said memory for identical or similar instructions at a particular level in said dependency tree and replace the instructions with a single instruction with multiple data (SIMD), and finally to output a post-vectorization trace to the output trace buffer.*

6 Claims 2 to 5 are dependant on claim 1 and involve further minor limitations. Claim 6 was filed shortly before the hearing and reads:

6. *The apparatus of any of the preceding claims, wherein the vectorization unit is implemented in hardware.*

7 There are some features in claim 1 that it is necessary to explain further. The specification notes that a central processing unit of a computer may include multiple functional execution units for processing instructions in parallel. It is this to which the expression “multi-processing unit” in claim 1 refers. Where the claim refers to a “trace” of instructions, the specification explains for example on page 7 lines 9 – 10 that this simply means a sequence of instructions. The specification also states (in paragraph [0012]) that “vectorization” means “the process of merging operations that may be scheduled together for execution and require similar execution resources.”

8 The use of the term “unit” in relation to the optimization unit and the vectorization unit is taken to mean either a hardware unit or software unit that carries out the functions specified. This interpretation is necessary in view of the statement in paragraph [0021] that the invention may be implemented either in hardware or software.

9 Claim 1 also refers to the use of a “dependency tree”. The specification does not set out in detail what is meant by a dependency tree, but figure 3 and the relevant part of the description provide some information. According to the description and the figure, certain of the instructions making up the program are placed on a first level of a tree structure and others are placed on second and subsequent levels below the first level. The instructions on these different levels are shown by

arrows in the figure as being related to one another. It appears that the tree structure relates to the structure of the program, and shows in some sense how the instructions making up the program are dependent on one another. I presume the first stage of the vectorization unit analyses the program structure in order to identify these relationships, and from that analysis creates the dependency tree. Claim 1 requires that where multiple candidates are selected for vectorization by replacement with a single, SIMD, instruction, the candidates must all be on the same level of the dependency tree.

- 10 I understood from Dr Benson that while the use of SIMD instructions was known, the provision of a vectorization unit which can operate on existing programs, not already compiled or optimised for SIMD processing, was new.

The Law

- 11 The provisions in the Act relating to excluded matter are set out in section 1(2) which reads:

(2) It is hereby declared that the following (among other things) are not inventions for the purposes of this Act, that is to say, anything which consists of -

(a) a discovery, scientific theory or mathematical method;

(b) a literary, dramatic, musical or artistic work or any other aesthetic creation whatsoever;

(c) a scheme, rule or method for performing a mental act, playing a game or doing business, or a program for a computer;

(d) the presentation of information;

but the foregoing provision shall prevent anything from being treated as an invention for the purposes of this Act only to the extent that a patent or application for a patent relates to that thing as such.

- 12 These provisions are based on and are equivalent in their effect to those in Article 52(2) of the European Patent Convention. This area of the law was considered comprehensively by the Court of Appeal in *Aerotel Ltd v Telco Holdings Ltd* and *Macrossan's Application* [2006] EWCA Civ 1371, [2007] RPC 7. That judgment established a four-step test for the assessment of patentability, namely:

a) Properly construe the claim

b) Identify the actual contribution (or, per paragraph 44 of the judgment, the alleged contribution will do at the application stage)

- c) Ask whether it falls solely within the excluded subject matter
- d) Check whether the actual or alleged contribution is actually technical in nature.

- 13 Paragraph 46 of the judgment adds that the fourth step may not be necessary because the third step may already have covered the point.
- 14 Dr Benson and Mr Lowe referred me also to *Symbian Ltd v Comptroller General of Patents* [2008] EWHC 518 (Pat). In his judgment, Patten J took the view that it was necessary when applying the *Aerotel* test to computer program inventions, to ensure that the question whether the invention involves a technical effect is not overlooked. He said, in paragraph 58 of the judgment:

“Whether it is asked as part of Step 2, 3 or 4 matters much less than whether it is asked at all. In a case such as this where the only potential application of Art. 52 (2) is in relation to a computer program care needs to be taken not to pre-judge the issue of technical contribution or even to exclude it by concentrating too much on the fact that the invention is program based.”

- 15 Both the Court of Appeal in *Aerotel* and Patten J in *Symbian* explain that the *Aerotel* test is a reformulation of the approach originally adopted by the Court of Appeal in *Merrill Lynch’s Application* [1989] RPC 561 and *Fujitsu Limited’s Application* [1997] RPC 608, namely the “technical contribution approach with the rider” explained in paragraphs 83 to 85 of *Aerotel*. I understand from the remarks made by Patten J in *Symbian*, that in using the *Aerotel* test it is important to formulate the contribution made by the invention in step 2 correctly and to make the assessment as to whether the contribution is or is not excluded according to step 3 in an appropriate way.
- 16 In particular (as I understand the judgment to say) one should not look narrowly at the detail of the operation of the computer program, as this may lead incorrectly to the conclusion that the invention is for a computer program as such, but should have in mind factors such as “the problem said to be solved, how the invention works, what its advantages are” as set out in paragraph 43 of *Aerotel*. By assessing the contribution in this way, technical effects of the sort found to exist in the historical cases of *Vicom* (1986) T208/84, [1987] OJ 14, *Koch and Sterzel/X-ray method for optimum exposure* (1987) T 26/86, *IBM/Text processing* (1988) T 115/85 and *IBM/Data processor network* (1988) T6/83 will not be overlooked. I mention these cases since they are the ones referred to in paragraphs 86 to 88 of *Aerotel* as inventions found to be patentable consistently with the “technical effect with the rider” approach.
- 17 Dr Benson said accordingly that their argument was based on the technical contribution test. I don’t think I can go that far since the *Aerotel* approach is clearly set out and requires the contribution to be assessed and the question to be determined whether the contribution does or does not fall within an excluded category. I consequently need to apply *Aerotel* as explained in paragraphs 38 to 47 of the judgment. However I agree that it is appropriate to bear in mind the

value of assessing the contribution and addressing step 3 so as not inadvertently to produce results that are inconsistent with the previous approach, and will endeavour to do so.

Discussion

- 18 Applying the first step of the *Aerotel* test to the invention of claim 1; the scope of the claim can be broadly understood from its wording, taking into account the further explanations in paragraphs 7 to 9 above.
- 19 However I need to consider the matter set out in paragraph [0021] that “the optimization unit may be implemented in software, in hardware or in any suitable combination of software and hardware.” Dr Benson emphasised the importance of the vectorization unit as a separate part of the processor system, and indicated that it might be provided as hardware and its functionality by means of software. I take it that the intention is for the new claim 6 to cover that proposition.
- 20 The applicant argued that software and hardware implementations must be treated in the same way for the purposes of exclusion, but I do not think that is necessarily always the case. I agree it applies where the invention is said to consist of either the program itself or the program running on conventional hardware. That relates to the familiar “substance over form” proposition¹. It also seems to be a plausible argument where a computer implemented invention concerns new operation of a process or system wholly external to the computer. However I do not think it applies in a situation where the invention concerns the internal operation of a computer system which may be implemented either in software or by a new arrangement of hardware. I believe that such an invention can properly be found patentable when implemented in new hardware but not when implemented in software. There is support for this in the *Aerotel* judgment for example in which paragraph 53 refers to the idea of a new arrangement of hardware involving a “special exchange” as follows: “... *the contribution is a new system. It is true that it could be implemented using conventional computers, but the key to it is a new physical combination of hardware. It seems to us clear that there is here more than just a method of doing business as such.*”² It seems to me in fact that the idea of providing the functionality of the invention in new hardware is actually a different invention from its provision in software, requiring different considerations as to conception and execution on the part of the inventor, hence different considerations are likely to apply.
- 21 So much for the principle. Applying it to the present case, I need to consider the content of the specification in the light of paragraph [0021] to determine whether what is actually disclosed includes an invention consisting of a new arrangement of hardware. That requires teasing out a little. The software implementation is easy to understand. It requires the functional elements of claim 1 including the optimization unit and vectorization unit to be implemented in software on a

¹ As discussed for example in paragraphs 1.11 to 1.13 of the Manual of Patent Practice.

² It is true that the *Aerotel* patent has now been found invalid in the high court; see *Aerotel Ltd v Wavecrest Group Enterprises Ltd & Ors* [2008] EWHC B4 (Pat). That judgment reversed the finding in relation to the “special exchange” on the basis of prior art and expert evidence unavailable to the Court of Appeal, but I do not suppose that displaces the principle set out in the Court of Appeal judgment.

conventional processor.

- 22 The hardware only option evidently means that the invention may be implemented entirely in hardware with no software aspect at all. That is problematic since there is no explanation in the specification as to how it might be achieved. Claim 1 requires the creation of a dependency tree, the identification of candidate instructions and their replacement with SIMD instructions. It is not immediately obvious how such functions, which presumably require recursion and conditional loops etc, could be implemented only in hardware. If the applicant did wish to patent a hardware system for carrying out these operations, it would need to describe the arrangement and operation of the hardware in a manner “complete enough for the invention to be performed by a person skilled in the art”, as required by section 14(3). As it stands, I do not consider the skilled person would regard the specification as disclosing an arrangement of that kind. I imagine the addressee would take the suggestion that the invention be implemented (only) in hardware to signal a speculative possibility but recognise that there is no disclosure as to how it could be achieved. Since it would not be possible to define such an invention without adding subject matter contrary to section 76 of the Act, I will disregard this aspect.
- 23 A more practical possibility is the one emphasised by Dr Benson in which certain units are provided as hardware and their functionality provided in software. There is some difficulty in distinguishing such a system from the software only arrangement. Although a block diagram of the invention is provided in figures 1 and 2, there is no disclosure in the specification of any particular adaptation of hardware to carry out the functions constituting the invention. On the contrary, the disclosure is exclusively in terms of the functions and processes themselves. In the vectorization unit for example, the descriptions of the “first stage” and “second stage” refer simply to the processes carried out and not to any hardware arrangement. Paragraph [0028] explains that the first and second stages “may be described by an exemplary C-like pseudo code algorithm”. The skilled person would recognise that the description is actually of the first and second stages of the process rather than equipment for executing those processes. The only hardware that is described in the specification relates to conventional components such as processors and memory.
- 24 However, the description even at the rudimentary level of the block diagrams themselves shown in figures 1 and 2 might amount to new hardware. Claim 6 covers an arrangement in which the vectorization unit is provided in hardware performing the functions specified in claim 1. I do not think this of itself defines a different invention from that in claim 1 since clearly in a trivial sense all the functions constituting the invention must be implemented in hardware, and I do not consider that claim 6 as it stands requires anything more than that. However, if it were possible without adding subject matter to define a new arrangement of hardware in which the multi processing unit comprised a vectorization unit provided as a hardware entity separate from the main processor, where such an arrangement was new and inventive, I consider that it could avoid the computer program exclusion in the same way as did the “special exchange” in *Aerotel*.
- 25 I will consequently assess the excluded matter question firstly on the basis that the invention consists of software, or software running on conventional hardware

as is presently claimed, and secondly on the basis that the invention consists of a new arrangement of hardware.

Software implementation

- 26 Turning to step 2 of the *Aerotel* test in relation to the software invention, it is first necessary to identify what is already known in the art. This can only be a provisional view since the examiner had not finalised his assessment of novelty and inventive step by the time of the hearing, but it is sufficient for present purposes. A number of prior art disclosures were cited in the International Preliminary Examination Report on the parent PCT application, and in the examination of the equivalent US application, US 2005/0289529. The article “Fast Dependence Analysis in a Multimedia Vectorizing Compiler” by Patricio Bulić and Veselko Guštin, 11 February 2004, indicates that the idea of using SIMD vectorization involving an assessment of dependency for parallel processing in media processing applications was already known at the priority date. Dr Benson agreed at the hearing that the principle was known, but said that the invention was intended to apply the vectorization process to programs that have not been compiled or optimised for use on a SIMD processor. To put it another way, the invention is capable of vectorizing “on the fly” rather than at a pre-processing stage.
- 27 Mr Lowe in his letter of 27 November 2007 proposed that the contribution should be identified as: “a device that replaces identical or similar instructions with a single faster SIMD instruction” or alternatively: “a method of replacing identical or similar instructions with a SIMD instruction to speed up execution”. The examiner accepted either definition in his report of 21 December 2007. Mr Lowe reformulated his statement of the contribution in his letter of 31 March 2008 shortly before the hearing, as: “a device that includes means for replacing identical or similar instructions with a SIMD instruction to improve performance of the device when executing instructions”. I agree broadly with these various assessments but consider it necessary to specify the context in which the invention operates and to make clear that the system operates as part of the process of running a computer program, since that is what is said to distinguish it from the prior art. I consequently take the contribution to consist of a device for processing computer program instructions by replacing identical or similar instructions with SIMD instructions while executing those instructions, so as to improve the performance of the device.
- 28 The third *Aerotel* step is to determine whether this contribution consists solely of excluded matter. Dr Benson’s and Mr Lowe’s main contention at the hearing was that the contribution should be regarded as patentable because it produced, at least potentially, an increased speed of data processing. Clearly not all increases in the speed of operation of a program confer patentability; Mr Lowe and Dr Benson said that an increase in speed arising simply from a program up and running did not. That must be so otherwise any skilful use of a programming language or concept to speed up software would be allowable. What makes an increase in speed patentable, they said, is where it involves a technical improvement in the operation of the computer. Dr Benson went on to explain that a technical improvement lay in the provision of hardware SIMD registers and better utilisation of the hardware by the processing set out in the specification. I

note that this argument relates to a system implemented partly in new hardware, so does not assist with the consideration of the software implementation. It may help point the way to patentable claims as discussed above, but I should caution that there seems to be no mention in the specification of a “SIMD register” as such.

- 29 Returning to the discussion of the software implementation, I do not consider that an increase in the speed of processing computer program instructions by the application of the SIMD process amounts to a patentable improvement. The process consists of taking an existing computer program, analysing the instructions that make up the program and applying SIMD substitutions so that the program will operate more quickly. In particular the contribution involves performing this process while the program is running rather than at a pre-processing stage. It seems to me that this relates to the generation of more efficient program code rather than an improvement in the operation of the computer system.
- 30 Similar questions relating to the internal operation of a computer were addressed in *Gale*³, *Vicom* and the other precedent cases mentioned in paragraphs 86 to 88 of *Aerotel*. Having due regard to the necessary caveats that a different test was applied in those cases, and that each case must be assessed on its own merits, it may nevertheless be instructive to compare those findings with the present case. *Gale* involved a more efficient method of getting from one point to another in the operation of a computer program and was found to be excluded. On the other hand, the examples accepted as patentable all involve the operation of the program producing some tangible effect beyond the more efficient operation of the program itself. *Koch and Sterzel* involved better control of an X-ray machine, *IBM/Text processing* provided visual indications about the condition of the input/output device of a text processor and *IBM/Data processor network* concerned improved operation of a network of processors. In *Vicom* a computer programmed to process image data by a digital filtering method was found to be patentable but the decision pointed out that the digital filtering method itself would not be.
- 31 The present contribution, it seems to me, involves improving the way the program operates, as in *Gale*, rather than a tangible effect going beyond the more efficient operation of the program. Mr Lowe referred me to paragraph 92 of *Aerotel* discussing in the light of *Gale* the need for an additional effect, such as increased speed, to confer patentability. Clearly the increased speed⁴ of the square root algorithm in *Gale* itself was not of the necessary character. I consequently consider the reference to increased speed in paragraph 92 must refer back to circumstances such as those in *Vicom*, discussed in paragraph 83, where a speed increase appears in the manipulation of something tangible (image data in the case of *Vicom*) other than the program itself.

³ *Gale's Application* [1991] RPC 191

⁴ Although Mr Gale's specification does not state in terms that his invention operates more quickly than prior algorithms, I believe the characterisation by Nicholls LJ, quoted in paragraph 90 of *Aerotel*, of Mr Gale's invention as “expediting” calculations is consistent with the disclosure in the specification of the more efficient operation of a hitherto “relatively slow” process.

- 32 I note in that respect that the present claim does not specify an improved method of processing audio or image data, notwithstanding that SIMD processing is said in paragraph [0001] to be “exceptionally productive” for this sort of data. As described, the instructions upon which the system operates are said to be op-codes. No doubt such op-codes could, in an operational system, act on media data and the system could then operate to produce some particular effect in relation to the media data; but there is no description of such possibilities in the specification. What is described appears to relate to the operation of any computer program. It does not appear to be possible to formulate a claim, on the basis of the present disclosure, involving the manipulation of media data in some particular way by the device of the invention without adding new subject matter. If I had thought that might be feasible, I would have suggested that the applicant might file amended claims to that end, but I do not think such a possibility exists.
- 33 In an additional argument, Mr Lowe said that the invention in *Gale* took an everyday function of a computer and improved it, whereas the present invention provided a new function, the vectorization unit, which changes the way the processor itself operates. Dr Benson put the same argument in a different way when he said that the invention solved the question of a technical shortcoming in the computer by providing an improved program.
- 34 It seems to me that, for the software implementation at least, it is not so much the operation of the processor that is changed by the invention as the preparation of program instructions. The vectorization unit provides a rules-based system for converting the original code into more efficient code. The end result of the operation of the system of the invention is more efficient code. Notwithstanding that the vectorized program when substituted for the original instructions allows a processor to run more quickly, it seems that the improvement is in the area of programming rather than the operation of the processor.
- 35 In conclusion, I find that the invention in claim 1 relates solely to excluded subject matter because it consists of a program for a computer as such. Claims 2 to 5 add further minor limitations and are likewise excluded from patentability. I said in paragraph 24 above that claim 6 imposes no further limitation of substance and I consequently find that it is also excluded for the same reason.
- 36 I do not need to apply step 4 of the test since the question has already been dealt with in steps 1 to 3.

New hardware implementation

- 37 As discussed in paragraph 24 above, I note that the specification discloses an arrangement of components which can be interpreted in the light of paragraph [0021] as an arrangement of hardware, and consider that a claim limited to a new arrangement of hardware could avoid the computer program exclusion. The need for such a claim to avoid disclosing new subject matter and to meet the novelty and inventive step provisions are not trivial ones since the disclosure of hardware elements is relatively limited. And as I have said, the examiner has not yet completed his assessment of the prior art. I should consequently caution that the applicant may ultimately be unable to formulate valid claims. However, the possibility of doing so remains and I will consequently invite the applicant to file

amendments and remit the application to the examiner to continue with the examination.

Summary

- 38 I have found that the present claims are excluded from patentability because they relate to a computer program as such, contrary to section 1(2)(c) of the Act.
- 39 However it appears that it may be possible for the applicant to draft allowable claims relating to a new arrangement of hardware. I consequently order that the application be remitted to the examiner to continue his examination.
- 40 The applicant, if it does not appeal this decision, should within 2 months of the date of this decision either signal that it does not wish to file amendments, or file amendments omitting the present claims 1 to 6 and introducing claims relating to new hardware implementations of the invention in suitable terms.

Appeal

- 41 Under the Practice Direction to Part 52 of the Civil Procedure Rules, any appeal must be lodged within 28 days.

P MARCHANT

Deputy Director acting for the Comptroller