IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

HULU, LLC;
AMAZON.COM, INC., and
NETFLIX, INC.,
Petitioners

v.
REALTIME ADAPTIVE STREAMING LLC,
Patent Owner.

Case No. Unassigned
Patent 8,934,535

DECLARATION OF JAMES A. STORER, PH.D.

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I, James A. Storer, declare as follows:

1. My name is James A. Storer. I am a Professor of Computer Science at Brandeis University and a member of the Brandeis Center for Complex Systems. I have prepared this report as an expert witness retained by Hulu, LLC ("Petitioner"). In this report I give my opinions as to whether certain claims of U.S. Patent No. 8,934,535 ("the '535 Patent") are invalid. I provide technical bases for these opinions as appropriate.

2. This report contains statements of my opinions formed to date and the bases and reasons for those opinions. I may offer additional opinions based on further review of materials in this case, including opinions and/or testimony of other expert witnesses. I make this declaration based upon my own personal knowledge and, if called upon to testify, would testify competently to the matters contained herein.

I. BACKGROUND AND QUALIFICATIONS

3. I have summarized in this section my educational background, career history, publications, and other relevant qualifications. My full curriculum vitae is attached as Appendix 1 to this declaration.

4. I am an expert in the field of computer algorithms, including data communications and network computing, data compression, data and image retrieval, storage and processing of large data sets, and image / video processing. I

have studied, taught, practiced, and researched in the field of Computer Science for over thirty years. Currently, I am Professor of Computer Science at Brandeis University in Waltham, Massachusetts, where I have been on the faculty since 1981.

5. I received my Doctor of Philosophy (Ph.D.) degree in the field of Computer Science from Princeton University in 1979. I received my Masters of Arts (M.A.) degree in Computer Science from Princeton University and my Bachelor of Arts (B.A.) degree in Mathematics and Computer Science from Cornell University.

6. After receiving my Ph.D. degree, I worked in industry as a researcher at AT&T Bell Laboratories from 1979 to 1981 before joining the faculty of Brandeis University.

7. I have been involved in computer science research since 1976. My research has been funded by a variety of governmental agencies, including the National Science Foundation (NSF), National Aeronautics and Space Administration (NASA), and Defense Advanced Research Projects Agency (DARPA). In addition, I have received government Small Business Innovation Research (SBIR) funding, as well as numerous industrial grants.

8. I regularly teach courses in software and hardware technology for data compression and communications (including text, images, video, and audio) at both the undergraduate and graduate level, and in my capacity as co-chair of the

Annual Data Compression Conference, I regularly referee academic papers in these areas. In addition, much of my consulting activity has been in the areas of software and hardware for consumer electronic devices, including cell phones/PDAs (including cellular technology), smartphones, digital cameras, digital video and audio recorders, and personal computers ("PCs"), as well as devices for communications over the Internet.

9. I am the author of two books: *An Introduction to Data Structures and Algorithms* and *Data Compression: Methods and Theory*. Both books have been used as references for undergraduate level computer science courses in universities. I am the editor or co-editor of four other books, including *Hyperspectral Data Compression* and *Image and Text Compression*.

10. I have three issued U.S. patents that relate to computer software and hardware (two for which I am sole inventor and one for which I am co-inventor). I am the author or co-author of well over 100 articles and conference papers.

11. In 1991, I founded the Annual Institute of Electrical and Electronics Engineers (IEEE) Data Compression Conference (DCC), the first major international conference devoted entirely to data compression, and have served as the conference chair since then. This conference continues to be the world's premier venue devoted to data compression research and development.

12. I routinely serve as referee for papers submitted to journals such as, for example, JACM, SICOMP, Theoretical CS, Computer Journal, J. Algorithms, Signal Processing, JPDC, Acta Informatica, Algorithmica, IPL, IPM, Theoretical CS, J. Algorithms, Networks, IEEE J. Robotics & Automation, IEEE Trans. Information Theory, IEEE Trans. Computers, IEEE Trans. Image Processing, Proceedings of the IEEE, IBM J. of R&D, and J. Computer and System Sciences.

13. I have served as guest editor for a number of professional journals, including Proceedings of the IEEE, Journal of Visual Communication and Image Representation, and Information Processing and Management. I have served as a program committee member for various conferences, including IEEE Data Compression Conference, IEEE International Symposium on Information Theory, Combinatorial Pattern Matching (CPM), International Conference on String Processing and Information Retrieval (SPIRE), Conference on Information and Knowledge Management (CIKM), Conference on Information Theory and Statistical Learning (ITSL), Sequences and Combinatorial Algorithms on Words, Dartmouth Institute for Advanced Graduate Studies Symposium (DAGS), International Conference on Language and Automata Theory and Applications (LATA), DIMACS Workshop on Data Compression in Networks and Applications, and Conference on Combinatorial Algorithms on Words.

A. Compensation

14. For my efforts in connection with the preparation of this declaration I have been compensated at my standard rate for this type of consulting activity. My compensation is in no way contingent on the results of these or any other proceedings relating to the above-captioned patent.

B. Materials and Other Information Considered

15. I have considered information from various sources in forming my opinions. I have reviewed and considered each of the exhibits listed in the attached Appendix 2 (Appendix of Exhibits) in forming my opinions.

II. UNDERSTANDING OF THE LAW

16. I have applied the following legal principles provided to me by counsel in arriving at the opinions set forth in this report.

A. Legal Standard for Prior Art

17. I am not an attorney. I have been informed by attorneys of the relevant legal principles and have applied them to arrive at the opinions set forth in this declaration.

18. I understand that the petitioner for *inter partes* review may request the cancelation of one or more claims of a patent based on grounds available under 35 U.S.C. § 102 and 35 U.S.C. § 103 using prior art that consists of patents and printed publications.

1. Anticipation and Prior Art

19. I understand that § 102 specifies when a challenged claim is invalid for lacking novelty over the prior art, and that this concept is also known as "anticipation." I understand that a prior art reference anticipates a challenged claim, and thus renders it invalid by anticipation, if all elements of the challenged claim are disclosed in the prior art reference. I understand the disclosure in the prior art reference can be either explicit or inherent, meaning it is necessarily present or implied. I understand that the prior art reference does not have to use the same words as the challenged claim, but all of the requirements of the claim must be disclosed so that a person of ordinary skill in the art could make and use the claimed subject-matter.

20. In addition, I understand that § 102 also defines what is available for use as a prior art reference to a challenged claim.

21. Under § 102(a), a challenged claim is anticipated if it was patented or described in a printed publication in the United States or a foreign country before the challenged claim's date of invention.

22. Under § 102(b), a challenged claim is anticipated if it was patented or described in a printed publication in the United States or a foreign country more than one year prior to the challenged patent's filing date.

23. Under § 102(e), a challenged claim is anticipated if it was described in published patent application that was filed by another in the United States before the challenge claim's date of invention, or was described in a patent granted to another that was filed in the United States before the challenged claim's date of invention.

24. I understand that a challenged claim's date of invention is presumed to be the challenged patent's filing date. I also understand that the patent owner may establish an earlier invention date and "swear behind" prior art defined by § 102(a) or § 102(e) by proving (with corroborated evidence) the actual date on which the named inventors conceived of the subject matter of the challenged claim and proving that the inventors were diligent in reducing the subject matter to practice.

25. I understand that the filing date of patent is generally the filing date of the application filed in the United States that issued as the patent. However, I understand that a patent may be granted an earlier effective filing date if the patent owner properly claimed priority to an earlier patent application.

26. I understand that when a challenged claim covers several structures, either generically or as alternatives, the claim is deemed anticipated if any of the structures within the scope of the claim is found in the prior art reference.

27. I understand that when a challenged claim requires selection of an element from a list of alternatives, the prior art teaches the element if one of the alternatives is taught by the prior art.

B. Obviousness

28. I understand that even if a challenged claim is not anticipated, it is still invalid if the differences between the claimed subject matter and the prior art are such that the claimed subject matter would have been obvious to a person of ordinary skill in the pertinent art at the time the alleged invention.

29. I understand that an obviousness must be determined with respect to the challenged claim as a whole.

30. I understand that one cannot rely on hindsight in deciding whether a claim is obvious.

31. I also understand that an obviousness analysis includes the consideration of factors such as (1) the scope and content of the prior art, (2) the differences between the prior art and the challenged claim, (3) the level of ordinary skill in the pertinent art, and (4) "secondary" or "objective" evidence of non-obviousness.

32. Secondary or objective evidence of non-obviousness includes evidence of: (1) a long felt but unmet need in the prior art that was satisfied by the claimed invention; (2) commercial success or the lack of commercial success of the

claimed invention; (3) unexpected results achieved by the claimed invention; (4) praise of the claimed invention by others skilled in the art; (5) taking of licenses under the patent by others; (6) deliberate copying of the claimed invention; and (7) contemporaneous and independent invention by others. However, I understand that there must be a relationship between any secondary evidence of non-obviousness and the claimed invention.

33. I understand that a challenged claim can be invalid for obviousness over a combination of prior art references if a reason existed (at the time of the alleged invention) that would have prompted a person of ordinary skill in the art to combine elements of the prior art in the manner required by the challenged claim. I understand that this requirement is also referred to as a "motivation to combine," "suggestion to combine," or "reason to combine," and that there are several rationales that meet this requirement.

34. I understand that the prior art references themselves may provide a motivation to combine, but other times simple common sense can link two or more prior art references. I further understand that obviousness analysis recognizes that market demand, rather than scientific literature, often drives innovation, and that a motivation to combine references may come from market forces.

35. I understand obviousness to include, for instance, scenarios where known techniques are simply applied to other devices, systems, or processes

to improve them in an expected or known way. I also understand that practical and common-sense considerations should be applied a proper obviousness analysis. For instance, familiar items may have obvious uses beyond their primary purposes.

36. I understand that the combination of familiar elements according to known methods is obvious when it yields predictable results. For instance, obviousness bars patentability of a predictable variation of a technique even if the technique originated in another field of endeavor. This is because design incentives and other market forces can prompt variations of it, and predictable variations are not the product of innovation, but rather ordinary skill and common sense.

37. I understand that a particular combination may be obvious if it was obvious to try the combination. For example, when there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, a person of ordinary skill has good reason to pursue the known options within his or her technical grasp. This would result in something obvious because the result is the product not of innovation but of ordinary skill and common sense. However, I understand that it may not be obvious to try a combination when it involves unpredictable technologies.

38. It is further my understanding that a proper obviousness analysis focuses on what was known or obvious to a person of ordinary skill in the art, not just the patentee. Accordingly, I understand that any need or problem known in the

field of endeavor at the time of invention and addressed by the patent can provide a reason for combining the elements in the manner claimed.

39. It is my understanding that the Manual of Patent Examining Procedure §2143 sets forth the following as exemplary rationales that support a conclusion of obviousness:

40. Combining prior art elements according to known methods to yield predictable results;

41. Simple substitution of one known element for another to obtain predictable results;

42. Use of known technique to improve similar devices (methods, or products) in the same way;

43. Applying a known technique to a known device (method, or product) ready for improvement to yield predictable results;

44. Choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success;

45. Known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the art;

46. Some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

47. A person of ordinary skill in the art looking to overcome a problem will often use the teachings of multiple publications together like pieces of a puzzle, even though the prior art does not necessarily fit perfectly together. Therefore, I understand that references for obviousness need not fit perfectly together like puzzle pieces. Instead, I understand that obviousness analysis takes into account inferences, creative steps, common sense, and practical logic and applications that a person of ordinary skill in the art would employ under the circumstances.

48. I understand that a claim can be obvious in light of a single reference, if the elements of the challenged claim that are not explicitly or inherently disclosed in the reference can be supplied by the common sense of one of skill in the art.

49. I understand that obviousness also bars the patentability of applying known or obvious design choices to the prior art. One cannot patent merely substituting one prior art element for another if the substitution can be made with predictable results. Likewise, combining prior art techniques that are interoperable with respect to one another is generally obvious and not patentable.

50. In sum, my understanding is that obviousness invalidates claims that merely recite combinations of, or obvious variations of, prior art teachings using understanding and knowledge of one of skill in the art at the time and motivated by the general problem facing the inventor at the time. Under this analysis, the prior art references themselves, or any need or problem known in the field of endeavor at the time of the invention, can provide a reason for combining the elements of or attempting obvious variations on prior art references in the claimed manner.

C. Legal Standard for Claim Construction

51. I understand that before any invalidity analysis can be properly performed, the scope and meaning of the challenged claims must be determined by claim construction.

52. I understand that a patent may include two types of claims, independent claims and dependent claims. I understand that an independent claim stands alone and includes only the limitations it recites. I understand that a dependent claim depends from an independent claim or another dependent claim. I understand that a dependent claim includes all the limitations that it recites in addition to the limitations recited in the claim (or claims) from which it depends.

53. In comparing the challenged claims to the prior art, I have carefully considered the patent and its file history in light of the understanding of a person of skill at the time of the alleged invention.

54. I understand that to determine how a person of ordinary skill would have understood a claim term, one should look to sources available at the time of the alleged invention that show what a person of skill in the art would have understood disputed claim language to mean. It is my understanding that this may include what is called "intrinsic" evidence as well as "extrinsic" evidence.

55. I understand that, in construing a claim term, one should primarily rely on intrinsic patent evidence, which includes the words of the claims themselves, the remainder of the patent specification, and the prosecution history. I understand that extrinsic evidence, which is evidence external to the patent and the prosecution history, may also be useful in interpreting patent claims when the intrinsic evidence itself is insufficient. I understand that extrinsic evidence may include principles, concepts, terms, and other resources available to those of skill in the art at the time of the invention.

56. I understand that words or terms should be given their ordinary and accepted meaning unless it appears that the inventors were using them to mean something else or something more specific. I understand that to determine whether a term has special meaning, the claims, the patent specification, and the prosecution history are particularly important, and may show that the inventor gave a term a particular definition or intentionally disclaimed, disavowed, or surrendered claim scope.

57. I understand that the claims of a patent define the scope of the rights conferred by the patent. I understand that because the claims point out and distinctly claim the subject matter which the inventors regard as their invention, claim construction analysis must begin with and is focused on the claim language itself. I understand that the context of the term within the claim as well as other claims of the patent can inform the meaning of a claim term. For example, because claim terms are normally used consistently throughout the patent, how a term is used in one claim can often inform the meaning of the same term in other claims. Differences among claims or claim terms can also be a useful guide in understanding the meaning of particular claim terms.

58. I understand that a claim should be construed not only in the context of the particular claim in which the disputed term appears, but in the context of the entire patent, including the entire specification. I understand that because the specification is a primary basis for construing the claims, a correct construction must align with the specification.

59. I understand that the prosecution history of the patent as well as art incorporated by reference or otherwise cited during the prosecution history are also highly relevant in construing claim terms. For instance, art cited by or incorporated by reference may indicate how the inventor and others of skill in the art at the time of the invention understood certain terms and concepts. Additionally,

the prosecution history may show that the inventors disclaimed or disavowed claim scope or further explained the meaning of a claim term.

60. With regard to extrinsic evidence, I understand that all evidence external to the patent and prosecution history, including expert and inventor testimony, dictionaries, and learned treatises, can also be considered. For example, technical dictionaries may indicate how one of skill in the art used or understood the claim terms. However, I understand that extrinsic evidence is considered to be less reliable than intrinsic evidence, and for that reason is generally given less weight than intrinsic evidence.

61. I understand that in general, a term or phrase found in the introductory words or preamble of the claim, should be construed as a limitation if it recites essential structure or steps, or is necessary to give meaning to the claim. For instance, I understand preamble language may limit claim scope: (i) if dependence on a preamble phrase for antecedent basis indicates a reliance on both the preamble and claim body to define the claimed invention; (ii) if reference to the preamble is necessary to understand limitations or terms in the claim body; or (iii) if the preamble recites additional structure or steps that the specification identifies as important.

62. On the other hand, I understand that a preamble term or phrase is not limiting where a challenged claim defines a structurally complete invention in

the claim body and uses the preamble only to state a purpose or intended use for the invention. I understand that to make this determination, one should review the entire patent to gain an understanding of what the inventors claim they invented and intended to encompass in the claims.

63. I understand that 35 U.S.C. § 112 ¶ 6 created an exception to the general rule of claim construction called a "means plus function" limitation. These types of terms and limitations should be interpreted to cover only the corresponding structure described in the specification, and equivalents thereof. I also understand that a limitation is presumed to be a means plus function limitation if (a) the claim limitation uses the phrase "means for"; (b) the "means for" is modified by functional language; and (c) the phrase "means for" is not modified by sufficient structure for achieving the specified function.

64. I understand that a structure is considered structurally equivalent to the corresponding structure identified in the specification only if the difference between them are insubstantial. For instance, if the structure performs the same function in substantially the same way to achieve substantially the same result. I further understand that a structural equivalent must have been available at the time of the issuance of the claim.

III. LEVEL OF ORDINARY SKILL IN THE ART

65. In determining the characteristics of a hypothetical person of ordinary skill in the art of the ’535 Patent at the time of the claimed invention,[1] I considered several things, including various prior art techniques relating to data compression, the type of problems that such techniques gave rise to, and the rapidity with which innovations were made. I also considered the sophistication of the technologies involved, and the educational background and experience of those actively working in the field. I also considered the level of education that would be necessary to understand the ’535 Patent. Finally, I placed myself back in the relevant period of time and considered the engineers and programmers that I have worked with and managed in the field of video coding and decoding. I came to the conclusion that a person of ordinary skill in the field of art of the ‘535 Patent would have been a person with a bachelor’s degree in mechanical engineering, electrical engineering, computer science, or a similar field with at least two years of experience in data compression or a person with a master’s degree in mechanical engineering, electrical

[1] I considered the level of ordinary skill in the art on February 13, 2001, the earliest claimed priority date for the ’535 Patent. I understand that Petitioners are not aware of any claim by the Patent Owner that the ’535 Patent is entitled to an earlier priority date.

engineering, computer science, or a similar field with a specialization in data compression. A person with less education but more relevant practical experience may also meet this standard.

IV. OVERVIEW OF THE TECHNOLOGY

A. Overview of the ’535 Patent

66. The ’535 Patent describes an arrangement of existing data compression algorithms for “compressing and decompressing based on the actual or expected throughput (bandwidth) of a system employing data compression.” Ex. 1001 9:11-14, Abstract. The ’535 Patent describes “bottlenecks” in the throughput of a system and purports to address them by activating or deactivating different compression algorithms applied to data input to or output from a compression system. Ex. 1001 9:55-59. For example, the ’535 Patent changes between what it refers to as “asymmetric” and “symmetric” algorithms, and notes that asymmetric algorithms provide “a high compression ratio (to effectively increase the storage capacity of the hard disk) and fast data access (to effectively increase the retrieval rate from the hard disk).” Ex. 1001 13:29-34. I note that the specification states that an asymmetrical algorithm is “one in which the execution time for the compression and decompression routines differ significantly.” Ex. 1001 9:63-66. Asymmetric algorithms are discussed in opposition to symmetric algorithms, which “compris[e] a fast compression routine.” Ex. 1001 14:17-20. I note that the specification states

that a symmetrical algorithm is "one in which the execution time for the compression and the decompression routines are substantially similar." Ex. 1001 10:5-8.

67. FIG. 1 depicts one embodiment of the '535 Patent:

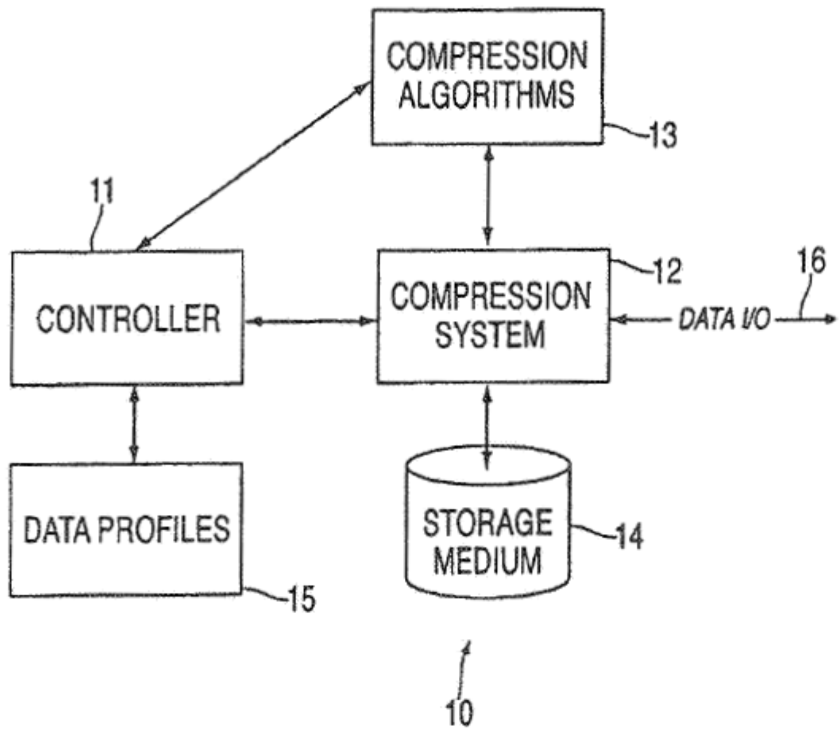

FIG. 1

Here, the data compression system operates "to compress data to be stored on the storage device 14 and to decompress data that is retrieved from the storage device 14." Ex. 1001 10:61-64. The controller 11 "tracks and monitors the throughput . . . of the data compression system 12," while data profiles 15 "enable the controller 11 to select a suitable compression algorithm based on the data type." Ex. 1001 10:38-43; 11:31-35. When the throughput of the system falls below a predetermined threshold, the system generates control signals to enable/disable different compression algorithms. Ex. 1001 10:38-43. In this regard, the ’535 Patent claims to be “bandwidth sensitive.” Ex. 1001 8:58-65; 13:15-17.

68. The ’535 Patent also describes applying “predetermined access profiles [to] different data sets, which enables the controller [] to select a suitable compression algorithm based on the data type.” Ex. 1001 11:32-36. Each “access profile” is assigned based on the type of data being stored (*e.g.*, application programs or operating system files). Ex. 1001 14:27-42. The following table in column 12 of the ’535 Patent is said to “summarize[] the three data access profiles and the type of compression algorithm that would produce optimum throughput":

Access Profile	Example Data Types	Compression Algorithm	Compressed Data Characteristics	Decompression Algorithm
1. Write few, Read many	Operating systems, Programs, Web sites	Asymmetrical (Slow compress)	Very high compression ratio	Asymmetrical (Fast decompress)
2. Write many, Read few	Auto-matically updated inventory database	Asymmetrical (Fast compress)	Very high compression ratio	Asymmetrical (Slow decompress)
3. Similar number of Reads and Writes	User generated documents	Symmetrical	Standard compression ratio	Symmetrical

Ex. 1001 12:50-65.

69. I understand that the "Background" of a patent application typically describes the relevant field and the prior art available at the time surrounding the filing of a patent application, and thus, that the Applicant has admitted that those systems are in the prior art. I note that the '535 Patent specification admits that some of the independent claim limitations, such as selecting a compression algorithm based on a parameter or attribute of a data block, were already known in the prior art. Specifically, the "Description of the related art" section of the '535 Patent identifies specific prior art references that disclose a "plurality of encoders [that] are preferably selected based on their ability to effectively encode different ***types*** of input data." Ex. 1001 5:46-47. In those prior art systems, blocks from an input data stream are tested against different compression encoders to determine the ability of each encoder to effectively encode the different data types in the data stream. Ex. 1001 5:42-48. The effectiveness of the encoder in the prior art system is judged based on factors such as the optimal compression ratio obtained by each of the compression encoders for each input data "block." *Id.* at 5:46-52. It is my opinion that a POSITA would have appreciated this as a teaching of using a parameter or attribute of a data block because the content of the data block may determine the effectiveness of the compression achieved by a particular encoder. The most effective encoder is selected and used to compress the input

block. Ex. 1001 5:48-55. This entire concept is admitted as prior art in the ’535 Patent specification.

70. I note that the ’535 Patent also describes a second prior art configuration that selects a compression algorithm based on a parameter or attribute of the data, and admits it was well-known in the prior art. I understand that the ’535 Patent incorporates into its specification the disclosure of US Patent No. 6,195,024 (“the ’024 Patent”)—a patent with an application filing date in 1998. Ex. 1001 5:33-38; Ex. 1015 Face. The ’024 Patent admits that “there are many conventional content dependent” compression techniques in the prior art and presents the below “diagram of a content dependent high-speed lossless data compression and decompression system/method according to the prior art.” Ex. 1015 at 5:54-56, 2:41-45.

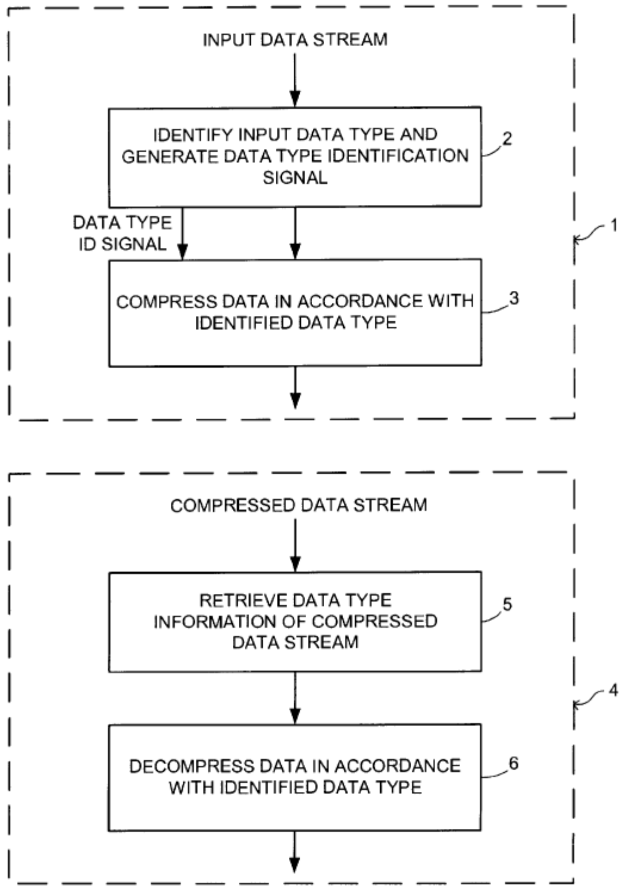

FIG. 1
PRIOR ART

Ex. 1015 FIG. 1. The ’024 Patent describes a system that identifies an input data type, which is a parameter or attribute of the input data and compresses the data in accordance with the identified data type. Ex. 1015 2:42-45. Thus, the ’535 Patent, through the incorporated disclosure of the ’024 Patent, admits that yet another configuration embodying its claim limitations was in the “PRIOR ART.”

71. I also note that the ’535 Patent admits that storing compressed data blocks is well-known in the prior art and is widely used. Ex. 1001, 2:44-46, cl. 15.

72. I also note here that the Examiner found the concept of selecting a compression algorithm based on a parameter or attribute to be anticipated during prosecution. *See infra* §V.B; Ex. 1002 at 274-77 (Office action rejecting claims directed to the same as anticipated).

B. Observations on the '535 Patent

73. I note that the '535 Patent is directed to managing and applying existing compression algorithms, which the '535 Patent describes as "popular" and were universally known and well understood before the earliest priority date of the '535 Patent. *See* Ex. 1001 5:1-10. For example, the '535 Patent names general categories of well-known algorithms such as dictionary-based algorithms like Lempel-Ziv, table-based algorithms like Huffman coding, as well as other well-known algorithms like run-length and arithmetic coding. Ex. 1001 10:2-9; 5:1-10. It is my opinion that each of these algorithms were commonly known and in near universal use at the relevant time.

74. The '535 Patent also describes basic properties of these well-known algorithms. These basic properties would have been routinely considered by a POSITA charged with designing any compression system. For example, the '535 Patent divides its compression algorithms into two well-known and generally understood categories of compression algorithms:

> In the following description of preferred embodiments, two categories of compression algorithms

are defined—an "asymmetrical" data compression algorithm and a "symmetrical” data compression algorithms. An asymmetrical data compression algorithm is referred to herein as one in which the execution time for the compression and decompression routines differ significantly. In particular, with an asymmetrical algorithm, either the compression routine is slow and the decompression routine is fast or the compression routine is fast and the decompression routine is slow. Examples of asymmetrical compression algorithms include dictionary based compression schemes such as Lempel-Ziv.

On the other hand, a "symmetrical" data compression algorithm is referred to herein as one in which the execution time for the compression and the decompression routines are substantially similar. Examples of symmetrical algorithms include table-based compression schemes such as Huffman. For asymmetrical algorithms, the total execution time to perform one compress and one decompress of a data set is typically greater than the total execution time of symmetrical algorithms. But an asymmetrical algorithm typically achieves higher compression ratios than a symmetrical algorithm.

Ex. 1001 9:60 – 10:14.

75. I note that this information would have been well-known to a POSITA. Specifically, a POSITA would have understood the performance characteristics of at least these compression algorithms and would have experience in leveraging these properties in designing compression systems. For example, Huffman coding was introduced in the 1950's and has been widely known and used since then as both a stand-alone compression method and as part of well-known and widely used data compression standards such as JPEG, H.261, H.263, MPEG1, and MPEG2. Similarly, Lempel-Ziv based compression methods have been well known since the late 1970's and have been incorporated into well-known and widely used data compression standards such as V.42bis, PKZIP, LZW, GZIP. A POSITA would also have a core understanding of asymmetry and would attempt to leverage asymmetric coding principles in algorithm implementations when appropriate. For example, a person of ordinary skill in the art would have been well aware for example, that MPEG2 compression is asymmetric when the encoder performs substantial computation for motion compensation that is not done by the decoder, and that Lempel-Ziv compression is asymmetric when the encoder performs substantial computation to search a history buffer that is not done by the decoder.

76. A POSITA would have understood that audio and video compression/encoding is one application of compression that involves asymmetries between the compression/encoding process and decompression/decoding process.

For example, compressing/encoding video is generally much more computationally complex (and slower to execute) than decompressing/decoding for several reasons. Motion prediction is typically used, which involves determining pixel movement between the current frame and a reference frame (or frames). The search for the location of a best possible match of a particular block in the current frame to a block in a reference frame (possibly at the 1/2 pixel resolution) can be computationally expensive (as compared to the decoder simply receiving this information). Motion prediction is useful for video compression/encoding because less data may be needed to represent moving of pixels between frames than is needed to encode two frames in their entirety. Video compression is typically lossy, where there is a tradeoff between the visual quality of the video after it has been decompressed and the size of its compressed representation. Another example of asymmetry in video encoding/compression is when, after residual pixel data from motion compensation is transformed using a mathematical function (*e.g.*, MPEG2 uses the DCT – discrete cosine transform), the resulting transformed values are quantized by the encoder (the lossy step of the video compression computation). This quantization step may employ significant computation in order to optimize the quantization choices in a way that best preserves quality/appearance while also providing data that can be best compressed by the final lossless step (*e.g.*, in MPEG2 that final step is a combination of run-length and Huffman coding) to minimize the size of the data.

77. A POSITA would have appreciated the benefits of using asymmetric compression techniques in video applications for several reasons. For example, in traditional producer-consumer video applications, the producer compresses and transmits the video and the consumer receives, decompresses, and views the video. In such an application, the consumer may have significantly more limited processing capability than the producer. In addition, the producer may wish to distribute the video to many consumers, and hence it may be desirable to have available and devote the computational resources to make the best possible compressed representation to minimize transmission and/or decoding time. A POSITA therefore would have appreciated that a reduction in decoding complexity would have been desirable in these fields in particular. *See* Ex. 1008 (Spanias Book) at 92; Ex. 1009 (Westwater Book) at 8.

78. I find this notable because the '535 Patent claims the basic use of these well-known properties of compression algorithms as somehow novel. After reviewing the file history of the '535 Patent, I understand that the Applicant relied on limitations directed to asymmetric compression algorithms to overcome anticipatory prior art, and that the Examiner allowed the case after those limitations were incorporated to the independent claims. Ex. 1002 at 435-443, 468-480. But, as discussed above, asymmetric compression would have been obvious to a POSITA at the relevant time, particularly in the context of video and audio compression. It

is my opinion that mere use of asymmetric algorithms would not have been a patentable distinction at the relevant time.

79. The ’535 Patent does not describe or claim any new or novel compression algorithms, encoders, or the like, and instead only makes use of well-known generic data compression encoders. Selection of well-known compression algorithms based on various conditions such as the bandwidth of a communication channel, parameters or attributes of data, and frequency of access of the data were routine and conventional considerations that were well-known in the field. *see generally* Ex. 1005; Ex. 1007; Ex. 1008 (Spanias Book) at 23 (stating the goal of audio coding is to obtain a compact digital representation for efficient transmission or storage).

80. Despite the general thrust of the subject matter of the ’535 Patent—making a selection from prior art compression algorithms based on well-known principles—I find it notable that the detailed description of the ’535 Patent only discusses 3 compression algorithms (Huffman, run-length, and Lempel-ziv)[2]. Arithmetic compression is discussed only in the “Description of Related Art” section of the specification. The ’535 Patent does not describe how any of the compression

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[2] I note that arithmetic coding is only discussed in the background description of the related art and is not mentioned in the detailed description.

algorithms are implemented or how to connect the compression algorithms to each other or any other component of a system.

81. It is also notable that the Title and Claims of the ’535 Patent both predominantly target both video and audio data (*e.g.*, the Title of the ’535 Patent is “System and Methods for Video and Audio Data Storage and Distribution”), but the detailed description is bereft of any disclosure regarding compressing video or audio data, much less how a compression algorithm might be selected for those types of data. In fact, “video” data is only mentioned twice in the detailed description, where it is only referenced in discussing a user interface. Ex. 1001 19:60-64. However, video data is recited (either directly or by claim dependency) in 16 claims of the ’535 Patent.

82. Similarly, audio data and its constituent data categories are barely discussed in the ’535 Patent. “Audio” and “speech” data are not referenced at all in the detailed description. “Music” data is referenced just twice in the detailed description in discussing a user interface. Ex. 1001 19:61-64. Yet, audio data is recited (either directly or by claim dependency) in 16 claims of the ’535 Patent.

83. I understand that certain claims of the ’535 Patent describe retrieving compressed and stored data based on factors such as the utilized capacity of a central processing unit (CPU) (Claim 18) and the utilized capacity of a memory

device. I note that the ’535 Patent is completely devoid of any disclosure regarding operation of its compression system in such a manner as described by the claims.

84. I note that the detailed description of the ’535 Patent amounts to a mere five and a half pages of text and just 5 Figures. Ex. 1001 Cols. 9-18, FIGs. 1-4B (showing start of the detailed description in column 9 and ending in column 18). I find it particularly notable that this disclosure has supported issuance of 205 claims in eight U.S. Patents, and there is at least one patent application currently pending. *See also* US Patent Nos. 7,386,046, 8,054,879, 8,073,047, 8,553,759, 8,897,356, 8,929,442, 8,867,610 (issued Patents related to the ’535 Patent and claiming priority to common US Provisional Patent Application 60/268,394).

V. THE ’535 PATENT

A. Challenged Claims

85. The ’535 Patent issued on January 13, 2015. Ex. 1001. I understand that Petitioners are challenging the validity of claims 1-14 of the ’535 Patent in the Petition for *Inter Partes* Review to which this declaration will be attached. Those claims are reproduced in Appendix 3 attached hereto. While this Petition and declaration are directed to the challenged claims, I have considered Claims 1-30 of the ’535 Patent, as well as portions of the ’535 Patent prosecution history in forming my opinions.

B. ’535 Patent Prosecution History

86. I reviewed the prosecution file history of the ’535 Patent (Ex. 1002) and am aware of the following facts. On September 20, 2013, the ’535 Patent application was filed as a U.S. Patent Application that claimed priority to U.S. Provisional Patent Application No. 60/268,394, which was filed February 13, 2001. Ex. 1001.

87. I note that during prosecution, the claims of the ’535 Patent were allowed after amendment to overcome rejections under 35 U.S.C. §§ 112(a) and 102 in response to one Office Action. Applicant amended each independent claim to include limitations directed to an asymmetric algorithm that the Examiner indicated as being allowable. Ex. 1002 at 435-443. The claims were allowed after these amendments. Ex. 1002 at 468. As discussed further below, it is my opinion that asymmetric compression algorithms were known in the art and of near universal use well-before the February 13, 2001 priority date of the ’535 Patent.

88. I understand that Imai was not cited or considered during prosecution of the ’535 Patent because neither the Japanese patent application or corresponding U.S. Patent are listed on the face of the ’535 Patent. In addition, I am not aware of Imai being discussed in any office action.

89. I also understand that Ishii was only referenced in an Information Disclosure Statement (“IDS”) submitted September 20, 2013 that listed 566 different

US Patent documents, 848 different non-patent literature documents, and 27 different foreign patent documents. Ex. 1002 at 74-196. While Ishii was cited in that voluminous IDS, the Examiner did not demonstrate any consideration of Ishii in any Office Action. *see generally* Ex. 1002.

VI. CLAIM CONSTRUCTION

90. For purposes of this inter partes review, I have considered the claim language, specification, and portions of the prosecution history, to determine the meaning of the claim language as it would have been understood by a person of ordinary skill in the art at the time of the invention. I understand that traditionally there have been two different standards for claim construction that may be applied by the Patent Trial and Appeal Board. The "broadest reasonable interpretation" is the standard that has traditionally been applied to claim construction issues when considering claims during prosecution and in post-grant proceedings. Under a BRI approach, a claim term is given its broadest reasonable interpretation in view of the specification from the view point of a person of ordinary skill in the art. The "plain and ordinary meaning" or *Phillips* standard has traditionally been applied in district court litigation and in post-grant proceedings (when the claims will expire before the post-grant proceedings are completed) Under a plain and ordinary meaning approach, a claim term is given its plain and ordinary meaning in view of the specification from the view point of a person of ordinary skill in the art.

91. I understand that the BRI approach may give a claim term a broader meaning than its plain and ordinary meaning. I have been asked to consider the claim terms and analyze invalidity using the broadest reasonable interpretation of the claims and the plain and ordinary meaning of the claims. Having considered the prior art grounds presented in this petition for the challenged claims, it is my opinion that there are no material differences between the BRI and plain and ordinary meaning of the claim language as applied to these prior art grounds.

A. "asymmetric compressors" / "compressors using asymmetric data compression"

92. Based on my review of the claims and specification of the '535 Patent, it is my opinion that a POSITA would have understood that the terms "asymmetric compressor(s)" (Claims 12, 15, 16, and 24-26) and "compressors using asymmetric data compression" (Claims 1, 10, and 27) mean "a compression algorithm in which the execution time for compression and decompression differ significantly." I note that the term "asymmetric" is used in Claims 1, 10, 12, 15, 16, and 24-27 in reference to compressors or data compression. I note that the specification provides a definition for these terms as: "[a]n asymmetrical data compression algorithm is referred to herein as one in which the execution time for the compression and decompression routines differ significantly." Ex. 1001 9:63-10:8.

93. I also note that the specification gives examples of asymmetric and symmetric algorithms, stating that "dictionary-based compression schemes such as Lempel-Ziv" are asymmetric, while "table-based compression schemes such as Huffman" are symmetric. Ex. 1001 10:1-3 & 10:8-9. Based on my review of the claims and specification of the '535 Patent, it is my opinion that a POSITA would have understood the terms "asymmetric compressors" and "compressors using asymmetric data compression" to mean "a compression algorithm in which the execution time for compression and decompression differ significantly."

B. "data block"

94. Based on my review of the claims and specification of the '535 Patent, it is my opinion that a POSITA would have understood "data block" to mean "a unit of data comprising more than one bit." I note that Claims 1-17, 19-28, and 30 of the '535 Patent consistently use the phrase "data block" to refer to a unit of data that is compressed by a compression algorithm. I also note that the specification explains that "[d]ata compression is widely used to reduce the amount of data required to process, transmit, or store a given quantity of information." Ex. 1001 2:40-46. This statement would have indicated to a POSITA that a data block must be a unit large enough for there to be a chance to realize a reduction in size through compression Ex. 1001 2:40-46. It would have been generally understood that the smallest unit of digital data representation is a bit, and the information contained in

a single bit cannot be represented through compression with fewer bits. It is therefore my opinion that a data block must be more than one bit in length so that it can be compressed as claimed.

95. My opinion regarding the construction of this phrase is also supported by the specification of the '535 Patent. I note the specification contains disclosures that describe "block structured disk compression" as operating on blocks of data that are either "fixed" or "variable in size." Ex. 1001 7:3-7. The specification also states that data blocks can represent files, and that "[a] single file usually is comprised of multiple blocks, however, a file may be so small as to fit within a single block." Ex. 1001 7:5-7. I also note that the specification discusses the pros and cons of smaller and larger data block sizes. Ex. 1001 7:12-23. A POSITA would have further understood that the specification contemplates units of data that comprise more than one bit that are stored in its system, such as with reference to FIG. 4B which states that "2 bits" are reserved for a sector map "type" definition, and "3 bits" are reserved for "c type". Ex. 1001 FIG. 4B. The specification's discussion of various data block sizes, including file-sized data blocks and data units as small as 2 bits, are consistent with my opinion regarding this construction. Ex. 1001 7:5-7, FIG. 4B.

96. I understand that the '535 Patent incorporates by reference U.S. Patent No. 6,195,024 ("the '024 Patent"). It is my opinion that the disclosure of the

’024 Patent uses the term “data block” in a manner that supports and is consistent with the construction proposed above:

> It is to be understood that the system processes the input data streams in data blocks that may range in size from individual bits through complete files or collections of multiple files. Additionally, the data block size may be fixed or variable. The counter module [] counts the size of each input data block (i.e., the data block size is counted in bits, bytes, words, any convenient data multiple or metric . . . .

Ex. 1015 at 7:9-15.

97. I understand that the Patent Owner has twice stipulated to a similar, but narrower construction of this term in District Court litigation proceedings. Ex. 1013 at 34; Ex. 1014 at 40. Particularly, I understand that Patent Owner twice stipulated to a construction of “data block” as “a single unit of data, which may range in size from individual bits through complete files or collection of multiple files.” It is my opinion that Patent Owner’s prior constructions of this phrase in the prior litigations also support this proposed construction.

C. “access profiles”

98. A POSITA would have understood that the term “access profile” means “information regarding the number or frequency of reads or writes.” I note that the term “access profile” appears in independent Claims 1 and 14, which both

recite "determining a parameter or attribute of at least a portion of a data block" and then "selecting an *access profile* from among a plurality of *access profiles* based upon the determined parameter or attribute." Ex. 1001 cls.1, 14. In these claims, information from a portion of a data block is used to select an *access profile*, and the "selected *access profile*" contains information regarding *accesses*, or a number or frequency of reads or writes, that is used to select the compression algorithm used to compress the portion of the data block. Ex. 1001 at cls. 1, 14. Thus, Petitioners' construction is supported by the claim language.

99. Furthermore, the '535 Patent depicts each "access profile" as a description of the number or frequency of reads or writes of data:

Access Profile	Example Data Types	Compression Algorithm	Compressed Data Characteristics	Decompression Algorithm
1. Write few, Read many	Operating systems, Programs, Web sites	Asymmetrical (Slow compress)	Very high compression ratio	Asymmetrical (Fast decompress)
2. Write many, Read few	Automatically updated inventory database	Asymmetrical (Fast compress)	Very high compression ratio	Asymmetrical (Slow decompress)
3. Similar number of Reads and Writes	User generated documents	Symmetrical	Standard compression ratio	Symmetrical

See Ex. 1001 8:4-13; 11:38-39, Tables on Columns 11 and 12.

100. In specific examples, the specification makes clear that the "access profile" is used in conjunction with the detection of a data type:

> Alternatively, ***the system can detect the type of data being installed or stored to disk (via file extension, etc.) and automatically select an appropriate algorithm using the Access Profile information*** as described above. For instance, the user could indicate to the controller that the data being installed ***comprises an application program which the controller would determine falls under Access Profile 1***. The controller would then command the compression engine to utilize an asymmetric compression algorithm employing a slow compression routine and a fast decompression.

Ex. 1001 14:36-45. It is therefore my opinion that Petitioners' construction is consistent with the intrinsic evidence.

VII. SUMMARY OF THE PRIOR ART

101. There are a number of patents and publications which constitute prior art to the '535 Patent. I have reviewed and considered the following prior art patent publication and patents.

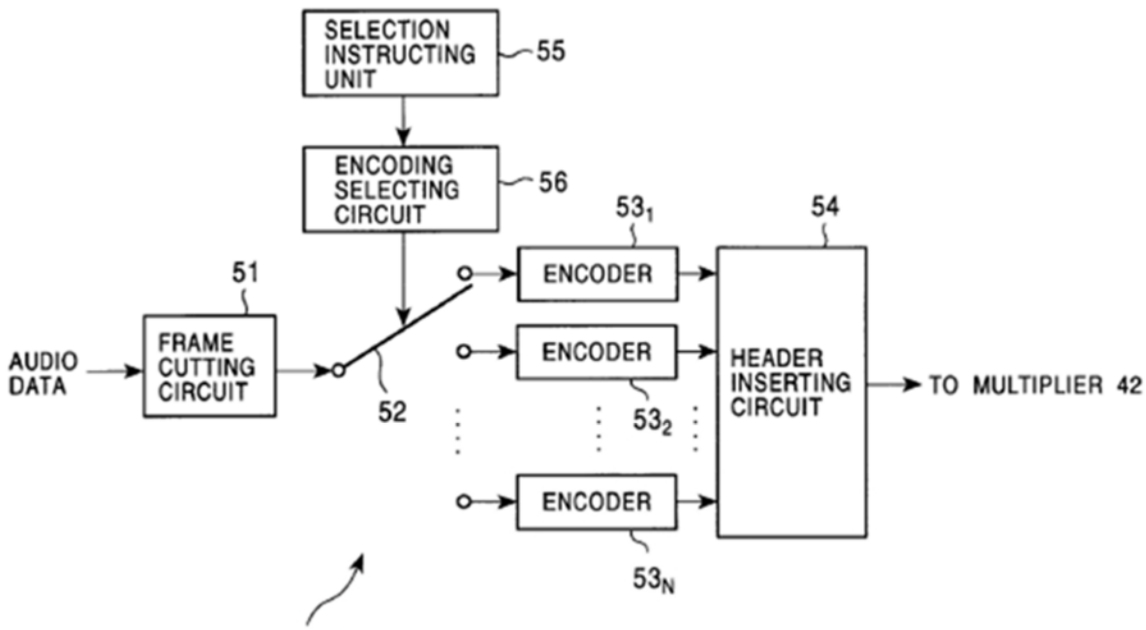
A. Imai (Exhibit 1004)

102. I understand that Exhibit 1004 is Japanese Patent Application Publication No. H11331305 to Imai *et al.* ("Imai"), which published November 30, 1999. I understand that Exhibit 1005 is a certified English translation of Imai, and

that Exhibit 1006 is U.S. Patent No. 6,507,611, which is an English-language counterpart of Imai. I have reviewed both the translated Japanese Patent Application to Imai as well as the U.S. Patent to Imai. I found the technical disclosures in each reference to be substantively the same, and I believe every portion that I cite from the translated Japanese Patent Application also appears in the U.S. Patent. I understand that Imai was not cited or considered during prosecution of the '535 Patent, based primarily on the fact that Imai is not cited on the face of the patent, nor have I seen the reference discussed in the prosecution history.

103. Imai describes encoding digital data including audio and video data for transmission in a manner that enables real time decompression and reproduction at a client. Ex. 1005 [0001], [0006], [0172]. After receiving a request for digital data from a client, Imai's "frame cutting circuit" cuts the requested digital data into "units of frame" having a length that is suitable for coding or for transmission on a network. Ex. 1005 [0130], [0066]. Imai's "units of frame" are units of data bits or digital data blocks on which Imai's compression and transmission system operates. For example, Imai teaches that the data input may be "data," which in this context would mean binary data, or it may be a digitized audio input, which would also be data in binary format.

FIG. 5



Encoding unit 41m

104. Switch 52 supplies each individual digital data "frame" output from the frame cutting circuit to a selected one of a plurality of available encoders 53_1 to 53_N. Ex. 1005 [0066]. Selection instructing unit 55 selects an appropriate "one from a plurality of coding methods corresponding to the encoders 53_1 to 53_N . . . and then instructs the encoding selecting circuit 56 to select the decided coding method." Ex. 1005 [0070]. Imai's encoders comprise asymmetric compression algorithms including the MPEG layer 1, MPEG layer 2, and MPEG layer 3 compression algorithms, as well as the ATRAC and ATRAC2 compression algorithms. Ex. 1005 [0067]; *see* Ex. 1008 (Spanias Book) at 92 (stating that the underlying MPEG and ATRAC "architectures" are similar in that they are both asymmetric); Ex. 1009

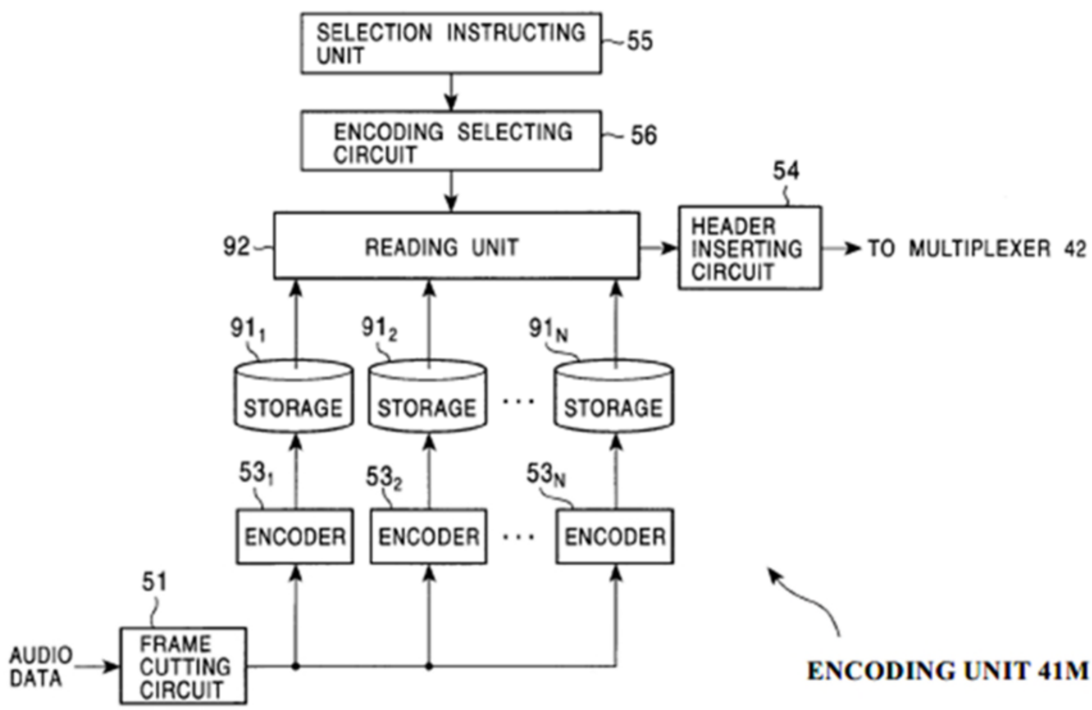
(Westwater Book) at 8 (stating that the MPEG standard uses asymmetric compression algorithms); Ex. 1010 (Salomon Book) at 11 (stating that MPEG layer 3, or MP3, is an asymmetric algorithm). I am personally familiar with the MPEG layer 1, MPEG layer 2, MPEG layer 3, ATRAC, and ATRAC 2 algorithms, and know that each is a compression algorithm.

105. Imai's selection instructing unit analyzes various factors to decide which compression algorithm to select and apply to each individual data frame. For example, Imai teaches assessing client processing ability by analyzing the client's processing of "dummy data packets" to determine client resources that are "employed for [] other process[es]" and resources that are available. Ex. 1005 [0099]-[0100]. Imai's selection instructing unit also determines characteristics of the uncompressed data and selects a compression algorithm accordingly. For example, in the context of audio data, Imai's processor identifies portions of the digital data that has instrument sounds, and other portions that have vocal sounds. Ex. 1005 [0102]. The selection instructing unit accounts for these variations in selecting a suitable coding method. *Id.* Imai additionally describes a detailed process for deriving a transmission rate of a network communication channel by timing the transmission and receipt of data packets between the client and server. Ex. 1005 [0149]-[0150]. Thus, Imai teaches assessing at least (1) the processing ability of the client (Ex. 1005 [0088]-[0100]), (2) the transmission rate of the network (Ex. 1005

[0149]-[0160]), and (3) parameters or attributes of the requested data (Ex. 1005 [0102]) in selecting the compression algorithm to apply.

106. Imai also teaches another variation of its compression system with reference to FIG. 16:

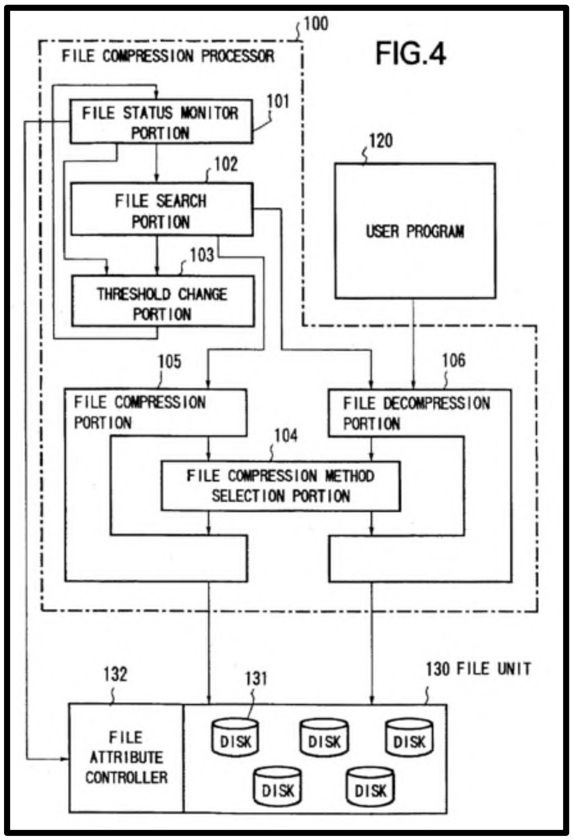
FIG. 16



Here, Imai teaches that the output of encoders 53_1 to 53_N are stored at the server in order to increase the processing "scale" of Imai's server by eliminating the need to encode in response to each request. Ex. 1005 ¶¶ [0165], [0167], [0170]. In this embodiment, data blocks are compressed with each compression algorithm once and then retrieved and transmitted multiple times according to the throughput of the channel and client processing constraints. Ex. 1005 ¶¶[0165], [0167], [0169].

B. Ishii (Ex. 1007)

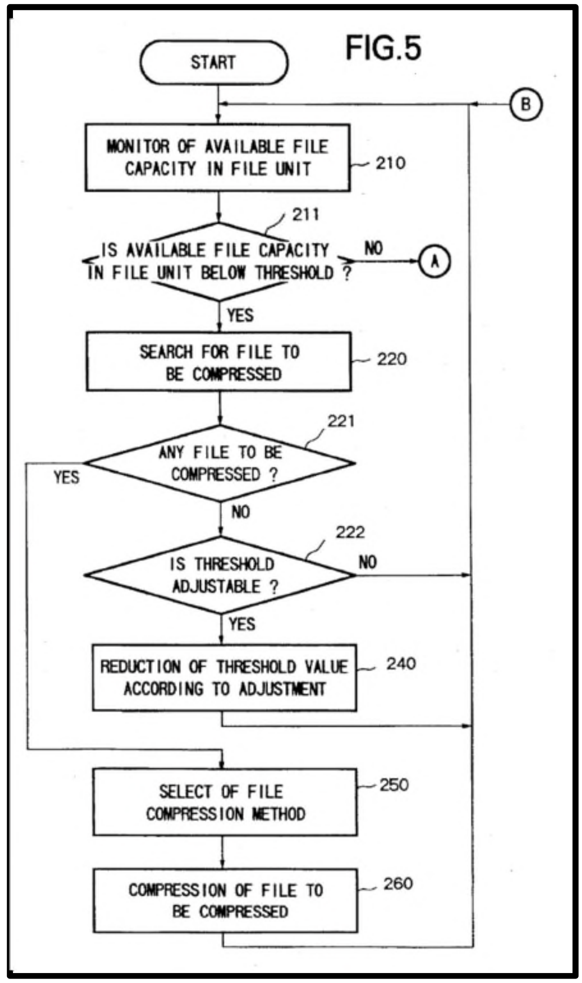
107. Ishii is a U.S. Patent that teaches a file compression processor that enables effective file utilization by selecting a "suitable compression method corresponding to the access frequency and the type of the file." Ex. 1007 1:50-55.



108. Ishii describes a problem where data storage devices (which Ishii calls "databases") were confronted with an "extremely large volume of data" to store on "large capacity storage media." Ex. 1007 1:17-27. To increase the "virtual capacity" of the data bases, "conventional file compression systems" were used. Ex. 1007 1:24-27. But Ishii recognized that prior art systems compressed "all files" with the same compressor, without considering whether the storage device was full or

that different files may require different compression types (or even no compression at all). Ex. 1007 1:32-46.

109. Ishii's solution "monitors the available file capacity, determines whether or not the file decompression is required depending on the difference between the available capacity and the threshold, and selects the suitable compression method for a file corresponding to the access frequency and data attribute of the file." Ex. 1007 10:27-32. To do this, Ishii includes a "file status monitor" that continuously tracks the current available file capacity of a file unit. Ex. 1007 5:37-41; *see* FIGS. 2, 5-7. When the current available file capacity is below a threshold level ("Yes" at step 211), a "file search portion" searches for files to compress in order to increase available capacity over the threshold. Ex. 1007 5:43-45.[3] Specifically, Ishii looks for files that have a



[3] The steps in FIGS. 5-7 that share the same number as those in FIG. 2 are described with respect to FIG. 2. Ex. 1007 8:43-45.

relatively low access frequency relative to other files. Ex. 1007 5:45-50, 7:24-31. Factors used to "select[] an appropriate data compression method for compression" of each file include the "access frequency" of the file to be compressed. Ex. 1007 5:60-65. Specifically, "[t]he file compression method with a shorter decompression time is selected for files with higher access frequency and the file compression method with a higher compression ratio is selected for files with lower access frequency." Ex. 1007 7:25-34.

110. When the file status monitor finds that the available file capacity has risen above the threshold again (*e.g.*, by deletion or reduction of files), the file search portion searches "for files with high access frequency" to decompress. Ex. 1007 8:35-42; 9:40-45; *see* FIG. 7. The process of monitoring the available file capacity to determine which files should be compressed and decompressed is a continuous one. Ex. 1007, FIGS.5-7 (depicting the monitoring loop that always returns to step 210). Thus, files may be compressed, uncompressed, and recompressed as the file storage device is used.

VIII. INVALIDITY

111. Based on my review and analysis of the materials cited herein, my opinions regarding the understanding of a person of ordinary skill in the art before February 2001, and my training and experience, it is my opinion that Claims

1-14 of the ’535 Patent are rendered obvious in view of the combination of Imai and Ishii. The reasons for my conclusions are explained more fully below.

112. For the purposes of my analysis, I have assumed that Imai and Ishii are prior art to the ’535 Patent.

113. With respect to each claim, I have considered the limitations of the claim as a whole, and did not simply determine whether each limitation can be found in the prior art. For dependent claims, this means that I have considered how the additional limitations recited by the dependent claim fit with the limitations recited in the parent claim. In this declaration, I have included headings that recite the relevant claim language as an aid to the reader. However, I have considered the claims as they appear in the patent, and any errors in the headings or recitations of the claim language or unintentional and do not affect my analysis.

114. Furthermore, I have analyzed obviousness from the standpoint of a POSITA at the time of the invention, which is February 2001. I am not aware of any reasons for why my analysis would change if the date of invention is found to have been within a few years of that date.

A. Ground 1: Claims 1-14 are Rendered Obvious by Imai and Ishii

115. It is my opinion that each of Claims 1-14 is rendered obvious in view of the combined teachings of Imai and Ishii. A POSITA would recognize the benefits of combining Imai and Ishii into a combined system that would draw upon

the teachings of Imai's compress and transmit embodiment (FIG. 5 and corresponding disclosure) and Imai's compress and store embodiment (FIG. 16 and corresponding disclosure). A POSITA would have found it obvious to do so in light of the general knowledge of a POSITA, which would suggest the combination of these embodiments, as well as Imai's teachings to do so which include, for example, using the same components in each embodiment. Ex. 1005 [0165] (acknowledging Imai's intentional decision to use the same components in the FIG. 5 and FIG. 16 embodiments and thereby importing the capabilities and functionality of those components into each embodiment). It is my opinion that the combined system would improve upon Imai's system by adding the capability to track the frequency with which Imai's digital signals are requested by the client as taught by Ishii and would further allow for modification of Imai's compression algorithm selection logic to consider the frequency of access as taught by Ishii.

116. It is my opinion that a POSITA would have had ample motivation to build such a combined system. I would point to the fact that Imai and Ishii are both directed to systems and methods of data compression which would have alone suggested to a POSITA that their teachings could be considered together. Ex. 1005 [0177]; Ex. 1007 1:11-15. I would also note that Imai and Ishii are also both directed to: (a) systems that select a compression algorithm from a plurality of compression algorithms (*e.g.,* Ex. 1005 [0067]; Ex. 1007 6:8-17), (b) systems that

include asymmetric compression algorithms (*e.g.,* Ex. 1005 [0067]; Ex. 1007 7:35-36), and (c) systems that account for the type of data to be compressed in their compression selection process (*e.g.,* Ex. 1005 [0068]; Ex. 1007 5:62-65). Thus, the teachings of Imai and Ishii are interrelated in that they would have been readily available to and considered together by a POSITA at the relevant time.

117. It is also my opinion that a POSITA would have been motivated to combine the compression algorithm selection teachings of Imai and Ishii because it involves combining prior art elements (the selection criteria in Imai with the selection criteria of Ishii) in similar devices (data compression/decompression systems) to create an improved system with predictable results (a data compression system that is better at optimizing compression algorithm selection). Imai teaches a data compression system that selects among available compression algorithms to allow for compressing, transmitting, and decompressing digital signal data in real-time or storing compressed digital signals for later transmission. Ex. 1005 [0051], [0167]. In Imai, a variety of factors, such as the content of the data and data type (Ex. 1005 [0101]-[0102]), the processing ability of the client (Ex. 1005 [0088]-[0100]), and the throughput of a communications channel (Ex. 1005 [0149]-[0160]), can be used to determine which compression algorithm is suitable for a set of data..

118. As explained above, Ishii similarly teaches a data compression system that selects among compression algorithms to compress data. Like Imai,

Ishii teaches using multiple criteria to select a suitable compression algorithm. Ex. 1007 6:7-17. Those factors include a "data attribute (whether it is text data or binary data)" and "access frequency." Ex. 1007 5:66-6:6. It is my opinion that a POSITA would have recognized these similarities, and sought to combine advantageous features of each system.

119. It is my opinion that a POSITA would have been aware of the advantages of combining these teachings. For example, the combined system would have yielded the predictable result of having a more complete set of compression algorithm selection criteria that will improve the system's ability to choose the most suitable algorithm for compressing a given data set. A POSITA would be aware that considering and combining additional considerations in selecting a compression algorithm to apply would be advantageous because it would make the system more intelligent and attuned to the current conditions on the system.

120. A POSITA would have had reason to combine Ishii's frequency of access of teachings with Imai because, using the POSITA's ordinary skill and creativity, a POSITA would have considered using a broad variety of selection criteria, and would not merely limit herself to Imai's specifically enumerated factors. A POSITA would have looked to another compression algorithm selection reference like Ishii, to learn of additional criteria for selecting a suitable compression algorithm. It is my opinion that a POSITA reading Ishii would have been motivated

to use the number of read/writes of the data in question to allow for selection of an algorithm for frequency accessed files versus infrequently accessed files. This would be the case because as a POSITA would have known, and Imai in fact teaches, one of the limiting factors in compression systems would have been the processing capacity of the overall system. Ex. 1005 [0167]. Using the number of read/writes of data file for selection of a more symmetric/less symmetric algorithm would assist in this goal by reducing the scale necessary for the server and the overall workload of the system. Ex. 1005 [0170].

121. A POSITA would recognize this benefit because Ishii teaches that "[t]he data compression methods selection portion 104 selects, from some data compression methods . . . the one with shorter data compression/decompression time for a file with higher access frequency and the one with a higher compression ratio for a file with lower access frequency." Ex. 1007 6:12-17. It is therefore my opinion that a POSITA would be motivated to incorporate Ishii's general teaching – that the number of reads of a data block (or file) is a factor to be considered in deciding which compressor to apply to that data block – into Imai's decision of which encoder to apply to Imai's data blocks.

122. It is my opinion that a POSITA given the teachings of Imai and Ishii would have found it obvious to try the proposed combination and had a reasonable expectation of success. A POSITA using the implementation of Imai

would have recognized that certain files were being requested repeatedly, and that Imai's server would not have been optimizing the compression selection strategy to account for the frequency of access. This problem would manifest in several ways, such as, for example, determining that Imai's server was selecting a compression method that was taking too long for clients to reproduce in real time. This problem would be exacerbated for frequently accessed files. There would have been a finite number of predictable solutions – chiefly considering the access frequency in the compression algorithm selection teachings of Imai would have been the primary solution and focus of the POSITA. Moreover, the combination would have been simple since it would not require incorporating any new compression algorithms into the system of Imai, although it does not prohibit doing so. It is my opinion that a POSITA would have pursued such a strategy and had a reasonable expectation of success because the advantages of the combination would be apparent given Ishii's teachings to "select[], from some data compression methods . . . the one with the shorter data compression/decompression time for a file with higher access frequency and the one with a higher compression ratio for a file with lower access frequency." Ex. 1007:613-17. Ishii's teachings would have therefore been a guide for frequently accessed files to only consider certain algorithms that reduce the server and/or client processing load, while enabling a wider set of compression algorithms for use with less frequently accessed files. A POSITA would have a reasonable expectation of success in the form of increased server processing capacity and more guidance in the compression algorithm selection process (or the selection of stored compressed data formats) for frequently accessed files. The POSITA, thus, would have been well-aware of the benefits and success that could be expected from incorporating these teachings. It is therefore my opinion that it would have been obvious to combine the teachings of Imai and Ishii in a manner that renders the challenged claims obvious.

1. Independent Claim 1 is Obvious

1. A method, comprising: **determining a parameter or attribute of at least a portion of a data block having audio or video data;** **selecting an access profile from among a plurality of access profiles based upon the determined parameter or attribute; and** **compressing the at least the portion of the data block with one or more compressors using asymmetric data compression and information from the selected access profile to create one or more compressed data blocks, the information being indicative of the one or more compressors to apply to the at least the portion of the data block.**

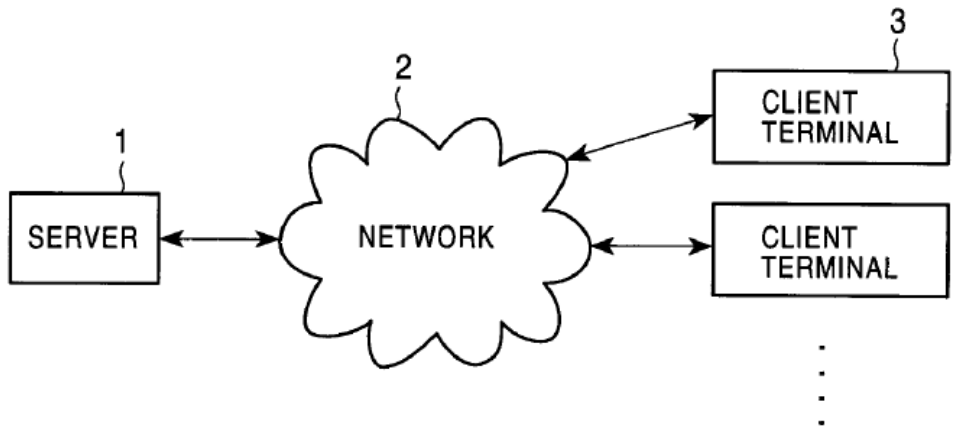
123. I understand that independent Claim 1 includes a preamble that recites "a method." I note that Imai teaches "methods" for compressing data by selecting one of a plurality of different coding methods for application. Ex. 1005 [0001], [0067], [0171]. Ishii also discloses methods for compressing data. Ex. 1005, 2:16-47. Accordingly, it is my opinion that Imai and Ishii render the preamble of Claim 1 obvious.

1[a] determining a parameter or attribute of at least a portion of a data block having audio or video data;

124. It is my opinion that the combination of Imai and Ishii teach this limitation. I note that Ishii describes a file compression processor that enables effective file utilization by selecting a "suitable compression method corresponding to the access frequency and the type of the file." Ex. 1007 1:52-55. I also note that a POSITA would have understood that each of Ishii's files is a collection of at least one or more data blocks because, as discussed in my opinion above, a POSITA would have understood a data block to be "a unit of data comprising more than one bit." It is my opinion that a data block would have been a common unit for representing digital data, and a POSITA would have understood that Ishii's files contain one or more data blocks.

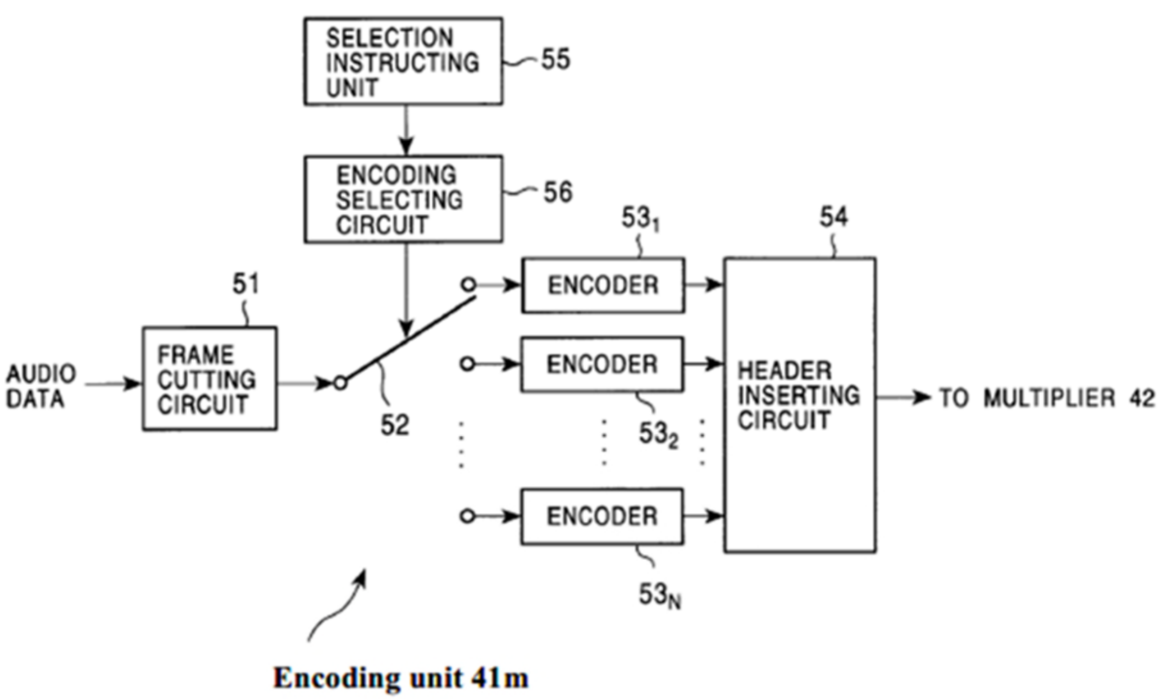
125. It is my opinion that Imai also teaches data blocks. Specifically, in Imai, a client requests signals from a server. Ex. 1005 [0086]. This basic configuration is shown in FIG. 1:

FIG. 1



Imai's FIG. 5 depicts the compression system at the server:

FIG. 5



126. After receiving a request for signals, Imai describes forming data blocks containing audio or video data from the data input into Imai's server. Ex. 1005 [0066]. I note that Imai teaches that the frame cutting circuit:

> cuts the audio signal (audio data) from the audio signal input circuit 31 in units of frame having a predetermined length (e.g., a length suitable for coding made by encoders 53_1 to 53_N, or a length suitable for packet (network packet) transmission via the network 2), and then supplies resulting frames to a switch 52.

Ex. 1005 [0066]. Thus, Imai's frame cutting circuit receives digital data requested by the client and "cuts" the digital data into data blocks of a length suitable for either compressing or for creating network transmission packets.

127. It is my opinion that a POSITA would have understood that each of Imai's "units of frame" are a data block. Ex. 1005 [0066]. This is because a "frame" was a commonly used and understood term in the digital audio field that refers to a digital unit of audio data. (The term is also used in video as well.) Imai's use of this term is consistent with that generally understood meaning because Imai states that digital audio data is "cut" or partitioned into "units of frame." A POSITA would have understood this is a common practice that would make the digital data easier to work with, such as units having a length suitable for coding and suitable for network packet transmission. It is also my opinion that Imai's "units of frame"

would meet any conceivable definition or construction of the term data block, whether or not the construction proposed above is adopted.

128. It is my opinion that Imai also teaches "determining a parameter or an attribute of a portion of a data block." Imai explains that it examines "portions" of data blocks to determine parameters or attributes of that data block. In one example, Imai considers the level of the voice as compared to a level of the instrument sounds in a portion of a data block:

> when the audio signal requested [by] the client terminal 3 has ***one portion in which a level of the voice is relatively high*** and the ***other portion in which a level of the instrument sounds is relatively high***, the ***coding method suitable for the voice is selected*** for one portion in which a level of the voice is relatively high, and ***the coding method suitable for the instrument sounds is selected*** for the other portion in which a level of the instrument sounds is relatively high.

Ex. 1005 [0102].

129. It is my opinion that Imai's example regarding analyzing the various levels of and types of sounds within a "portion" of an audio signal discloses determining a parameter or an attribute of a data block. A POSITA would have understood that Imai's audio signal analysis is performed on data blocks of the audio signal as cut by the "frame cutting circuit." Imai's analysis works on "portions" of

the audio signal. A POSITA would have understood a "portion" of the audio signal would be, at the minimum a part of a data block, or one data block, or more than one data block. Imai's analysis of the level of voice sounds, instrument sounds, and the like discloses determining a parameter or an attribute of the data. For example, the level of various sounds may be characterized by different attributes or parameters of a digital audio signal such as frequency, amplitude, and other properties of relevant transforms. Thus, Imai's analysis of the level of different sounds in a portion of an audio signal teaches determining a parameter or attribute of at least a portion of a data block.

130. I would also note that Ishii also teaches determining a parameter or attribute of a data block. Specifically, Ishii maintains a "file ***attribute*** controller" to "control information on the files recorded on the disks 131." Ex. 1007 5:30-31. This file attribute controller maintains "***information for each file*** including file size, ***data attribute (text data file, program file or image data file)***, identifier of compression prohibition, whether the file is already compressed or not yet compressed (compression/non-compression information), compression method, the last access date, the ***number of accesses***, and file size after compression (for already compressed files)." Ex. 1007, 6:20-31. All of the information stored for each file (particularly the "data attribute" and "number of accesses") is a parameter or attribute of Ishii's data blocks.

131. I note that Imai teaches compression of audio data (*e.g.,* Ex. 1005 [0067]) and also teaches that its system could be used for video. *See* Ex. 1005 [0067], [0102], [0172]. I understand that when a claim provides a list of alternatives, the prior art teaches the limitation even if only one of the alternatives is taught by the prior art. Here, I note that the foregoing passage expressly refers to audio data but not video data. Nevertheless, it is my opinion that Imai renders the claim obvious because audio data is one of the alternatives listed by this limitation.

132. It is also my opinion that a POSITA's general knowledge would have encompassed performing this limitation using data blocks containing video in view of Imai's express teaching that video signals could be substituted for audio signals. Specifically, I note that Imai states that "while ***audio signals*** are processed in the illustrated embodiment, the present invention is also applicable to other signals, such as ***video signals***, other types of time-series signals, and signals being not in time series." Ex. 1005 [0172]. This teaching of Imai would have suggested to a POSITA what was already obvious—that while the embodiments in Imai use digital audio data as an example, Imai's teachings present a framework for compressing many types of digital data. A POSITA would have understood that video, image, or other data-specific compression algorithms could be included with or in place of the various generic audio encoders and compression algorithms that Imai teaches. As I previously noted, the '535 Patent does not discuss any

implementation details for any encoder/compressor, or any of the many steps necessary to process an incoming audio signal or data and turn it into compressed data blocks, other than at a high-level. This further confirms that low-level implementation details were within the skill of a POSITA at the time of the invention.

133. In my opinion, it would have been a well-known common practice to a POSITA at the relevant time to be knowledgeable on and readily apply the teachings from audio, video, and image data compression fields to various applications. This is in part because audio, video, and image compression techniques were intrinsically related. For example, advances in audio compression often lead to advantages in video compression. Moreover, standard video compression encoders included audio compression encoders since audio is an integral part of most video content. For example, MPEG audio layers 1, 2, and 3, which are audio compression algorithms explicitly referenced by Imai, were developed as a part of a video compression standard projects that pre-date the ’535 Patent (the MPEG1 standard). A POSITA would thus necessarily be familiar with the audio compression techniques. It is my opinion that it would have been common for a POSITA to readily consult and utilize teachings from these related techniques, even without Imai’s explicit suggestion to do so.

134. I note that Ishii is compatible with Imai's approach because Ishii presents a file compression processor for compressing data and storing data generally, "whether it is text data or binary data such as programs and image data." Ex. 1007 1:11-15; 6:1-6. I would note that while Ishii is perfectly capable of storing both audio or video data, which are both types of binary data, Ishii does not specifically disclose that feature. It is my opinion that it would have been obvious for a POSITA to use Ishii's teachings to store audio or video data for several reasons.

135. Audio and video files have long been known as a form of binary data. Ex. 1008 (Spanias Book) at 4-5 (describing the ubiquity of digital audio formats in the late 1980s on). It is my opinion that a POSITA would be motivated to look to Ishii to store audio and video files because Ishii provides a solution to increase "efficient use of disk storage capacity by compressing files that have not been recently accessed 'asynchronously with the user program,' or in the background, in order to free up disk space when needed." Ex. 1007 5:43-49, 6:49-62, 7:3, 17-20, 46-49. For files like audio and video files that may take up a lot of disk space, a POSITA would look for solutions that provided efficient use of disk storage capacity in order to maximize available capacity, total storage, and storage headroom. In total, it is my opinion that the use of Ishii to store audio or video files is well within the capabilities of a POSITA and a POSITA has many good reasons to use Ishii in that way.

136. It is therefore my opinion that Imai and Ishii teach this limitation.

1[b]	**selecting an access profile from among a plurality of access profiles based upon the determined parameter or attribute; and**

137. Ishii teaches that its file compression portion "selects an appropriate data compression method for compression" based on the "***access frequency*** and ***file type***" of the file to be compressed. Ex. 1007 5:60-65. The "access frequency of a file is determined based on the last access date and the ***number of accesses*** for that file." Ex. 1007 5:54-56.

138. I would also note that the "access frequency … is given as high, medium and low" and is "set in the file search portion." Ex. 1007 5:54-59. It is therefore my opinion that Ishii's use of a "***file type***" and "***number of accesses***" (which are each an "attribute or parameter") of a file to select an "***access frequency***" (which is an "access profile") of either high, medium, or low satisfies the limitation of "selecting an access profile from among a plurality of access profiles based on the determined parameter or attribute."

139. It would have been obvious to a POSITA that the teaching in Ishii regarding using the access frequency of data to select a suitable compression algorithm would have been both compatible and useful to combine with Imai's own approaches for selecting a suitable compression algorithm (data type, throughput, etc.) because a POSITA would have recognized that using Ishii's general teaching –

that the number of reads of a data block (or file) can be a factor to consider in deciding which compressor to apply to that data block – would be another useful factor to utilize in Imai's decision of which encoder to apply to Imai's data blocks. A POSITA would have understood that combining the additional consideration of frequency of access from Ishii into Imai's decision logic would increase the intelligence of the system and would result in increased performance and better disk usage.

140. It is therefore my opinion that Imai and Ishii teach this limitation.

1[c]	**compressing the at least the portion of the data block with one or more compressors using asymmetric data compression and information from the selected access profile to create one or more compressed data blocks, the information being indicative of the one or more compressors to apply to the at least the portion of the data block.**

141. I note that Ishii states that when a determination is made that a file needs to be compressed it is "subject to data compression processing (Step 250)." Ex. 1007 7:16-17. In that step, "[t]he file compression method selection portion 104 . . . selects the method with suitable compression ratio and compression/decompression speed ***depending on the file access frequency*** and data attribute." Ex. 1007 7:17-20. In particular:

> In selecting a data compression method, the file compression method selection portion 104 selects the one suitable for the applicable data attribute by checking the data attribute held by the file attribute controller 132. Next,

> the access frequency is determined from the last access date and the number of accesses at the file attribute controller 132. The ***file compression method with a shorter decompression time is selected for files with higher access frequency*** and the ***file compression method with a higher compression ratio is selected for files with lower access frequency***.

In the next step, "[f]iles are compressed by the data compression method thus selected (Step 260)." Ex. 1007, 7:66-67.

142. I would also note that Ishii's access frequencies are categorized as "high, medium and low." Ex. 1007 5:55-57. Here, Ishii stores information regarding how to classify a file as having "high, medium [or] low" access frequency in the file search portion 102 and then that access frequency classification is used in Step 250 to pick the specific compressor to use. I would note that in order for Ishii to determine that some data blocks must be compressed with a specific compressor because those data blocks are classified with a certain access frequency, while other data blocks should be compressed with a different compressor because they are classified with a different access frequency, the access frequency must include "information … indicative of the one or more compressors to apply." This is because the information indicative of the compressors is instructive of which compressor to apply given the access scenario (high, medium, or low). It is therefore my opinion

that a POSITA would have understood Ishii teaches this portion of the limitation because it looked at access frequency information and data type to select a suitable compression algorithm.

143. A POSITA would have found it obvious to use Ishii's access profile information to select the compression algorithm in the combination of Imai and Ishii because: (1) Ishii uses access profile information to select compression algorithms, and (2) Imai would only require a modification to its selection instructing unit to utilize the access profile information in the same manner as Ishii. It is therefore my opinion that it would have been obvious to combine Ishii's access profile teachings with Imai's system.

144. I note that both Ishii and Imai teach asymmetric compression. Ishii states that the system may use "known compressors." Ex. 1007 7:31-32. Specifically, Ishii identifies a number of exemplary compressors, including: static Huffman coding, dynamic Huffman coding, arithmetic coding, Lempel-Ziv, run-length coding, and differential mapping. Ex. 1007 7:35-55. Out of this group, the '535 Patent expressly identifies Lempel-Ziv as an asymmetric compression algorithm. Ex. 1001 10:2-4. Indeed, it would have been well-known to a POSITA that Lempel-Ziv was an asymmetric compression algorithm. *See* Ex. 1001 10:2-4 ("Examples of asymmetrical compression algorithms include dictionary-based compression schemes such as Lempel-Ziv"). It is therefore my opinion that Ishii

teaches "compressing the at least the portion of the data block with one or more compressors using asymmetric data compression."

145. I would also note that Imai also teaches one or more asymmetric compressors. Imai explains that its encoders $53_{1\text{-}N}$ are comprised of "different coding methods from each other," such as:

> . . . Linear PCM (Pulse Code Modulation), ADPCM (Adaptive Differential PCM), Layers 1, 2, 3 of MPEG (Moving Picture Experts Group), ATRAC (Adaptive Transform Acoustic Coding), ATRAC 2, and HVXC (Harmonic Vector Excitation Coding).

Ex. 1005 [0067], [0068]-[0071].

146. Of these coding methods, MPEG layers 1, 2, and 3, ATRAC, and ATRAC 2, are each audio compression algorithms. I note that each of these algorithms would have been well-known to a POSITA as audio compression algorithms. My opinions are supported by at least the Spanias book on audio compression, which states the following:

> ***Audio coding or audio compression algorithms*** are used to obtain ***compact digital representations of high-fidelity (wideband) audio signals*** for the purpose of efficient transmission or storage. The ***central objective in audio coding is to represent the signal with a minimum number of bits*** while achieving transparent signal reproduction.

Ex. 1008 (Spanias Bok) at 23. Thus, although Imai refers generally to "encoders" and "coding methods," a POSITA would have understood that Imai teaches using compression encoders because coding is a term of art in the industry that encompasses compression algorithms, and Imai states that at least ATRAC 2 and MPEG layer 3 are examples of coding methods that "provide[] a high compression rate" and thus compress input data. Ex 1005 [0068]. With respect to ATRAC and MPEG layers 1 and 2, it was commonly known in the field that these were all compression algorithms. *See* Ex. 1012 2:25-34 (describing ATRAC compression); Ex. 1011 at 4:19-21 (describing MPEG layers 1, 2, and 3 compression).

147. Moreover, it was generally accepted in the field of data compression that "the central objective in audio coding is to represent the signal with a minimum number of bits," which is another way of expressing compression. Ex. 1008 (Spanias Book) at 23. Thus, it is my opinion that Imai's teachings regarding selecting from a plurality of encoders that implement coding methods including MPEG layers 1, 2, and 3, ATRAC, and ATRAC 2 teaches selecting one or more compression algorithms from among a plurality of compression algorithms.

148. A POSITA would have understood that audio codecs in general rely on asymmetric encoding principles, and particularly that the emphasis in audio encoding applications would be on reducing decoder complexity. Ex. 1008 (Spanias Book) at 28-29 ("Usually, most of the audio codecs rely on the so-called asymmetric

encoding principle. This means that the codec complexity is not evenly shared between the encoder and the decoder (typically, encoder 80% and decoder 20% complexity), with more emphasis on reducing the decoder complexity."). Like the MPEG family, ATRAC compression algorithms are asymmetric compression algorithms because the execution time for the compression and decompression of these algorithms differ significantly. Ex. 1008 (Spanias Book) at 92 ("Like the MPEG family, the ATRAC architecture decouples the decoder from psychoacoustic analysis and bit-allocation details. Evolutionary improvements are therefore possible without modifying the decoder structure. An added benefit of this architecture is asymmetric complexity, which enables inexpensive decoder implementations."); Ex. 1009 (Westwater Book) at 8. The ATRAC family of compression algorithms, including ATRAC 2, use an asymmetric architecture that separates the implementation details of the encoder from the decoder, such as psychoacoustic analysis and bit-allocation. Ex. 1008 (Spanias Book) at 92. This architecture allows for more sophisticated encoding strategies which are performed with access to higher performance computing resources (*e.g.*, a computing device or special purpose recording/encoding device) without modifying the complexity of the decoding strategies, which are typically performed with less sophisticated implementations. Ex. 1008 (Spanias Book) at 92. This architecture additionally provides for the release of more complex or enhanced "evolutions" of compression or encoding methods without requiring a reciprocal update to the decoding hardware or software. Ex. 1008 (Spanias Book) at 92.

149. The asymmetric architecture is also advantageous for "write-once, read-many" applications. These aspects of asymmetric algorithms in general, and specifically the ATRAC compression algorithm, is advantageous for, and contributes to their use in, inexpensive decoder implementations such as the Sony MiniDisc player. Ex. 1008 (Spanias Book) at 91-92 ("The ATRAC algorithm, developed by Sony for use in its rewriteable Mini-Disc system, combines subband and transform coding to achieve nearly CD-quality coding of 44.1 kHz 16-bit PCM input data at a bit rate of 146 kb/s per channel . . . . An added benefit of [the ATRAC] architecture is asymmetric complexity, which enables inexpensive decoder implementations.").

150. ATRAC 2 is also built on this asymmetric architecture and is therefore also an asymmetric compression algorithm. The MPEG family of audio

compression algorithms, including MPEG layers 1, 2, and 3, is also built on a similar architecture where the compressor executes a slow, complex algorithm and the decompressor is simple and fast. Ex. 1008 (Spanias Book) at 92 ("Like the MPEG family, the ATRAC architecture decouples the decoder from psychoacoustic analysis and bit-allocation details. Evolutionary improvements are therefore possible without modifying the decoder structure. An added benefit of this architecture is asymmetric complexity, which enables inexpensive decoder implementations."); Ex. 1010 (Salomon Book) at 11 ("A compression method where the compressor executes a slow, complex algorithm and the decompressor is simple is a natural choice when files are compressed into an archive, where they will be decompressed and used very often, such as mp3 audio files on a CD."). This explains why MPEG layer 3 is "a natural choice when audio files are compressed into an archive, where they will be decompressed and used very often." Ex. 1010 (Salomon Book) at 11. Thus, Imai teaches that at least one of the plurality of compression algorithms is asymmetric.

151. It is therefore my opinion that Imai's configuration of a plurality of different coding methods includes one or more asymmetric compression algorithm. Ex. 1005 [0067].

152. It is therefore my opinion that the combination of Imai and Ishii teaches this element and renders this element obvious.

2. Independent Claim 14 is Obvious

14.	**A method, comprising:** **determining a parameter or attribute of at least a portion of a data block;** **selecting an access profile from among a plurality of access profiles based upon the determined parameter or attribute; and** **compressing the at least the portion of the data block with one or more compressors utilizing information from the selected access profile to create one or more compressed data blocks, the information being indicative of the one or more compressors to apply to the at least the portion of the data block,** **wherein the one or more compressors utilize at least one slow compress encoder and at least one fast decompress decoder, and** **wherein compressing the at least the portion of the data block with the at least one slow compress encoder takes more time than decompressing the at least the portion of the data block with the at least one fast decompress decoder if the time were measured with the at least one slow compress encoder and the at least one fast decompress decoder running individually on a common host system.**

153. It is my opinion that the combination of Imai and Ishii renders obvious Claim 14.

14[a]	**determining a parameter or attribute of at least a portion of a data block;**
14[b]	**selecting an access profile from among a plurality of access profiles based upon the determined parameter or attribute; and**
14[c]	**compressing the at least the portion of the data block with one or more compressors utilizing information from the selected access profile to create one or more compressed data blocks, the information be-ing indicative of the one or more compressors to apply to the at least the portion of the data block,**

154. As discussed in my opinion above, the combination of Imai and Ishii teaches the first three limitations of Claim 14. Specifically, I note that these

limitations are similar to limitations 1[a]-1[c], except that: (1) limitation 14[a] does not require that the portion of the data block to have "audio or video data"; and (2) limitation 14[c] removes the requirement that the compressors "us[e] asymmetric data compression."

14[d]	**wherein the one or more compressors utilize at least one slow compress encoder and at least one fast decompress decoder, and**
14[e]	**wherein compressing the at least the portion of the data block with the at least one slow compress encoder takes more time than decompressing the at least the portion of the data block with the at least one fast decompress decoder if the time were measured with the at least one slow compress encoder and the at least one fast decompress decoder running individually on a common host system.**

155. It is also my opinion that the combination of Imai and Ishii teaches the next two limitations of Claim 14. I note that while limitation 14[c] does not require that the compressors "us[e] asymmetric data compression" as in limitation 1[c], limitations 14[d] and 14[e] require one particular type of asymmetric process to be used where at least one slow compress encoder and at least one fast decompress decoder are used. It is my opinion that Ishii teaches this.

156. Ishii states that the system may use "known compressors" and Ishii uses as an example "Lempel-Ziv." Ex. 1007 7:31-55. I would also note that the '535 Patent expressly identifies Lempel-Ziv as an asymmetric compression algorithm, which the '535 Patent describes as "one in which the execution time for the compression and decompression routines differ significantly," and, as discussed

at length above, a POSITA would have understood this to be the case. Ex. 1001 10:2-4. It would have been well-known that a Lempel-Ziv method may use more time for compression than for decompression because of additional expensive steps necessary in the encoding that are not required in the decoding; for example, when the encoder must search a history window for a longest match to incoming input compared to the decoder performing a simple string copy when the position of the match is received. It is therefore my opinion that Ishii teaches a compressor that satisfies these limitations.

157. Imai teaches this as well. As discussed in my opinion above in the context of asymmetric data compression, Imai explains that its encoders $53_{1\text{-}N}$ are comprised of "different coding methods from each other," such as:

> . . . Linear PCM (Pulse Code Modulation), ADPCM (Adaptive Differential PCM), Layers 1, 2, 3 of MPEG (Moving Picture Experts Group), ATRAC (Adaptive Transform Acoustic Coding), ATRAC 2, and HVXC (Harmonic Vector Excitation Coding).

Ex. 1005 [0067], [0068]-[0071].

158. A POSITA would have understood that audio codecs in general rely on asymmetric encoding principles, and particularly that the emphasis in audio encoding applications would be on reducing decoder complexity. Ex. 1008 (Spanias Book) at 28-29 ("Usually, most of the audio codecs rely on the so-called asymmetric

encoding principle. This means that the codec complexity is not evenly shared between the encoder and the decoder (typically, encoder 80% and decoder 20% complexity), with more emphasis on reducing the decoder complexity."). Like the MPEG family, ATRAC compression algorithms are asymmetric compression algorithms because the execution time for the compression and decompression of these algorithms differ significantly. Ex. 1008 (Spanias Book) at 92 ("Like the MPEG family, the ATRAC architecture decouples the decoder from psychoacoustic analysis and bit-allocation details. Evolutionary improvements are therefore possible without modifying the decoder structure. An added benefit of this architecture is asymmetric complexity, which enables inexpensive decoder implementations."); Ex. 1009 (Westwater Book) at 8. The ATRAC family of compression algorithms, including ATRAC 2, use an asymmetric architecture that separates the implementation details of the encoder from the decoder, such as psychoacoustic analysis and bit-allocation. Ex. 1008 (Spanias Book) at 92. This architecture allows for more sophisticated encoding strategies which are performed with access to higher performance computing resources (*e.g.*, a computing device or special purpose recording/encoding device) without modifying the complexity of the decoding strategies, which are typically performed with less sophisticated implementations. Ex. 1008 (Spanias Book) at 92. This architecture additionally provides for the release of more complex or enhanced "evolutions" of compression or encoding methods without requiring a reciprocal update to the decoding hardware or software. Ex. 1008 (Spanias Book) at 92.

159. A POSITA would have understood that each of the ATRAC and MPEG compression algorithms take a longer time for compression that decompression due to this asymmetric architecture. Ex. 1008 at 92 (Spanias Book) at 92 ("Like the MPEG family, the ATRAC architecture decouples the decoder from psychoacoustic analysis and bit-allocation details. Evolutionary improvements are therefore possible without modifying the decoder structure. An added benefit of this architecture is asymmetric complexity, which enables inexpensive decoder implementations."); (Salomon Book) at 5 ("A compression method where the compressor executes a slow, complex algorithm and the decompressor is simple is a natural choice when files are compressed into an archive, where they will be decompressed and used very often, such as mp3 audio files on a CD."). It is therefore my opinion that Imai teaches using an algorithm with "at least one slow compress encoder and at least one fast decompress decoder," and meeting the limitations of Claim 14.

160. It is also my opinion that the combination of Imai and Ishii render these limitations obvious.

3. Dependent Claim 2 is Obvious

2	**The method of claim 1, wherein the data block is from among a plurality of data blocks, and wherein the compressing comprises: compressing the plurality of data blocks to create the one or more compressed data blocks.**

161. I understand that Claim 2 depends from Claim 1, and that in order to disclose or render obvious this claim, each limitation of any base claim and any intervening claim must be met in addition to the instant claim limitation. It is my opinion that the combination of Imai and Ishii renders this claim obvious and teaches this limitation.

162. Specifically, as discussed in my opinion above, Imai teaches forming data blocks from data input into Imai's server. Ex. 1005 [0066]. In particular, Imai teaches that the frame cutting circuit:

> cuts the audio signal (audio data) from the audio signal input circuit 31 in units of frame having a predetermined length (e.g., a length suitable for coding made by encoders 53_1 to 53_N, or a length suitable for packet (network packet) transmission via the network 2), and then supplies resulting frames to a switch 52. The switch 52 will select one of the encoders 53_1 to 53_N under control of an encoding selecting circuit 56; accordingly, each frame outputted from the frame cutting circuit 51 is supplied to one of the encoders 53_1 to 53_N through the switch 52.

Ex. 1005 [0066]. Thus, Imai's frame cutting circuit receives digital data requested by the client and "cuts" the digital data into a plurality of data blocks of a length suitable for either compressing or for creating network transmission packets. As discussed at length above, each of Imai's "units of frame" are a data block. Ex. 1005 [0066]. Those "units of frame," or data blocks, are then compressed by one of Imai's encoders. It is therefore my opinion that Imai's units of frame teach a plurality of data blocks that are each then compressed to create compressed data blocks.

163. I note that Ishii also teaches systems and methods for compressing a plurality of files, which comprise one or more data blocks. Ex. 1007, 5:23-50, 7:66-4. Specifically, Ishii teaches that "[w]hen ***files*** to be compressed are picked up, they are subject to data compression processing (Step 250)." Ex. 1007 5:43-50. It is my opinion that a POSITA would have understood that Ishii's files would typically be more than one data block because data blocks would have been understood by a POSITA as a basic unit of representing digital data that a file would be represented in. Thus, a POSITA would have understood that when Ishii is compressing a file that is more than one data block in length, that Ishii would produce more than one compressed data block because Ishii teaches compressing each file separately. It is therefore my opinion that the combination of Imai and Ishii teaches this limitation and renders the limitation obvious.

4. **Dependent Claim 3 is Obvious**

3	**The method of claim 2, wherein the plurality of data blocks comprises: one or more files.**

164. I understand that Claim 3 depends from Claims 2 and Claim 1, and that in order to disclose or render obvious this claim, each limitation of any base claim and any intervening claim must be met in addition to the instant claim limitation. It is my opinion that the combination of Imai and Ishii renders this claim obvious and teaches this limitation.

165. It is indisputable that applying compression to files was well known in the art. I note that the background of the '535 Patent confirms that files and file management systems were known. Ex. 1001 5:56-63. I would also note that Ishii expressly teaches compressing a on file basis: "Files are compressed by the data compression method thus selected (Step 260)." Ex. 1007 7:66-67.

166. I note that Imai does not use the term "file." However, it is my opinion that a POSITA would have found it obvious to use files with Imai because Imai teaches use of "data" as an input and storing data in the form of a file was a well-known technique. Ex. 1005 [0061] (teaching use of "MIDI (Music Instrument Digital Interface) data"), [0066]. I would also note that Imai also teaches that "the present invention is also applicable to other signals such as video signals" and it was well-known and conventional to store video in a file format. Ex. 1005 [0172]. It

would have been common for a POSITA to have used video files in order to store digital video data, and a POSITA would have understood that those video files would have comprised more than one data block.

167. It is therefore my opinion that it would have been obvious for the combination of Imai and Ishii to compress a plurality of data blocks that comprise one or more files.

5. Dependent Claims 10 and 11 are Obvious

10	**The method of claim 1, wherein the at least the portion of the data block is from among a plurality of data blocks; and** **wherein the compressing comprises: compressing at least a portion of the plurality of data blocks with the one or more compressors using the asymmetric data compression and the information to create the one or more compressed data blocks.**
11	**The method of claim 10, wherein the plurality of data blocks or the one or more compressed data blocks comprise: at least a portion of a file.**

168. I note that Claim 10 is similar to Claim 2. However, instead of having to ***compress the plurality*** of data blocks to create compressed data blocks as required by Claim 2, Claim 10 only requires ***compressing at least a portion of the plurality*** of data blocks. I understand that Claim 10 depends from Claim 1 and that Claim 11 depends from Claims 10 and 1. I further understand that in order to disclose or render obvious this claim, each limitation of any base claim and any intervening claim must be met in addition to the instant claim limitation. It is my opinion that

the combination of Imai and Ishii renders these claims obvious and teaches these limitations.

169. As explained in my opinion above for Claims 1 and 2, the combination of Imai and Ishii renders obvious the limitations of Claim 10 because Imai and Ishii teach compressing all of the plurality of data blocks. Moreover, it was well within the skill of a POSITA to compress only a portion of a plurality of data blocks.

170. I note that Claim 11 depends from Claim 10 and adds the limitation that "the plurality of data blocks ***or*** the one or more compressed data blocks comprise: at least a portion of a file." It is my opinion that Claim 11 would have been obvious for at least the reasons discussed in my opinion above with respect to Claim 3, which requires that the plurality of data blocks comprise one or more files. This is because the limitations of Claim 10 do not change the application of the teachings identified for Claim 3.

171. It is therefore my opinion that the combination of Imai and Ishii render these limitations obvious.

6. <u>Dependent Claim 6 is Obvious</u>

6	**The method of claim 1, further comprising: storing at least a portion of the one or more compressed data blocks.**

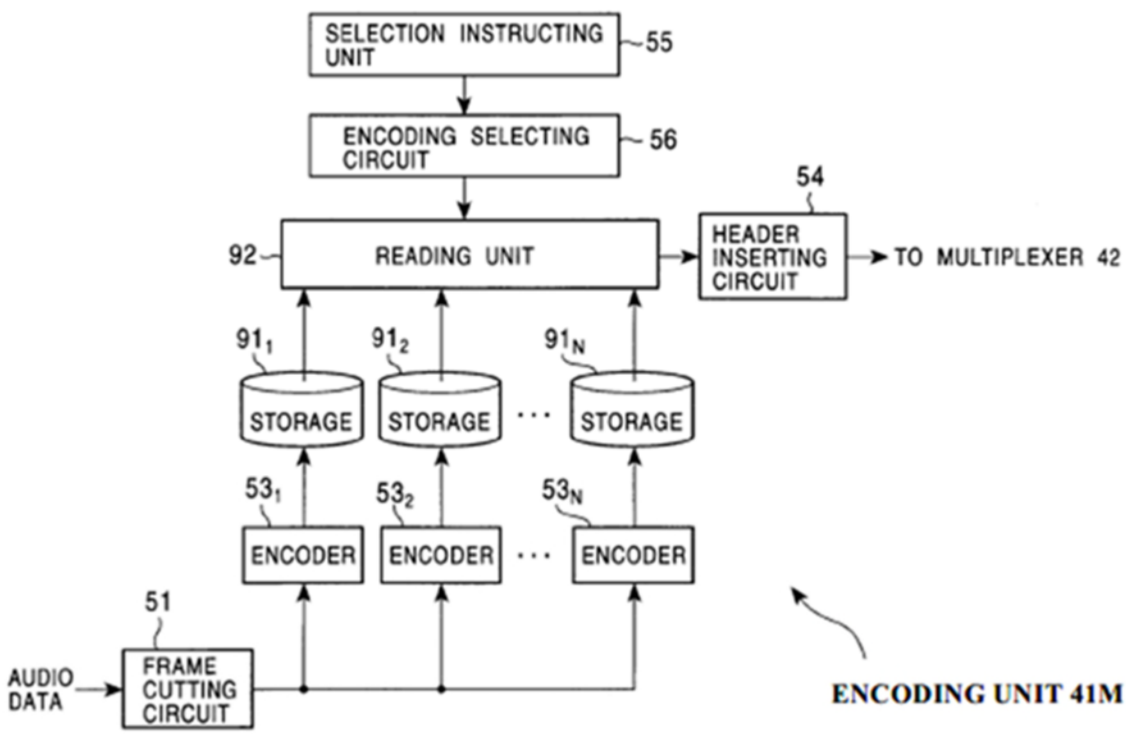
172. I understand that Claim 6 depends from Claim 1, and that in order to disclose or render obvious this claim, each limitation of any base claim and any intervening claim must be met in addition to the instant claim limitation. It is my opinion that the combination of Imai and Ishii renders this claim obvious and teaches this limitation.

173. I note that Ishii expressly teaches storing the compressed data blocks: "The file compression portion 105 actually compresses data of the searched file to be compressed, ***so as to record it on the disk 131 in the file unit 130***." Ex. 1007, 5:60-62.

174. I would also note that Imai teaches this limitation in multiple ways. As shown with reference to Imai's FIG. 16 and the accompanying disclosures, Imai teaches a second embodiment that is variant of the embodiment depicted in FIG. 5. For the second embodiment, Imai teaches storing at least a portion of the compressed data blocks in a storage medium. Ex. 1005 [0167- 0168], FIG. 16. Specifically, Imai teaches storing compressed data blocks in storages 91_1 to 91_N. Moreover, the compressed data blocks are stored in a variety of compressed formats

to simplify the transmission process by eliminating the need to compress data blocks in real time and in response to every request. Ex. 1005 [0165]-[0168].

FIG. 16

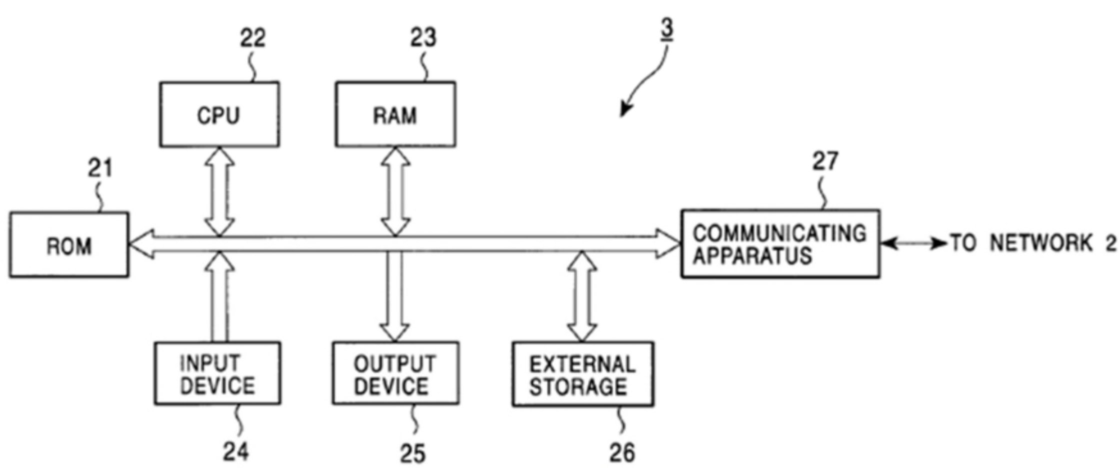


175. Imai explains that this embodiment is fully compatible with and improves the operation of the FIG. 5 configuration by "making the [server] processing simpler" "while the need of encoding [] in response to each request [] is eliminated." Ex. 1005 [0165], [0167], [0170]. Imai teaches that its real time transmission system can be improved by storing the compressed data blocks at the server. Ex. 1005 [0167]. It is notable that Imai teaches that this embodiment is largely a rearrangement of the functionality that used for FIG. 5. For example, Imai

explains that "the components corresponding to those [used] in the case of FIG. 5 are denoted by the same reference numerals." Ex 1005 [0165]. This means, for example, that the same selection instructing unit 55 is used to implement either embodiment. The primary additions to the FIG. 16 embodiment are the storage devices, and the "reading unit."

176. It is my opinion that a POSITA would have found it obvious in view of Imai's teachings to store compressed data blocks after compressing them with a selected compression algorithm at the client as well. Imai describes multiple storage devices at the client. Ex. 1005 [0054], [0055]. For example, Imai FIG. 3 shows that its client includes RAM 23 and external storage 26, which are both storage devices capable of storing compressed digital data blocks.

FIG. 3



Client terminal 3

177. Imai explains that data blocks compressed with the selected compression algorithm are transmitted to the client terminal, and that the client terminal decodes the coded data and reproduces the original uncompressed data. Ex. 1005 [0051]. A POSITA would have understood that the client process of receiving and decoding compressed data would typically involve the use of a storage medium, such as RAM 23, at the client to store the compressed data. For example, it would have been well-known to a POSITA at the relevant time that the output of a CPU is buffered and/or stored in RAM at least temporarily due to the limited storage capacity of CPU's and the known latency of transmission channels.

178. I also note that Imai teaches that encoded compressed data can be transmitted to a client and stored for later access "when real-time reproduction is not required". Ex. 1005 [0171]. While this embodiment of Imai describes transmitting the compressed output from "all" of Imai's compression algorithms Ex. 1005 [0171], it is my opinion that it would have been obvious to a POSITA to select the most appropriate encoder based on the bandwidth of the communication channel and parameters or attributes of the data and to compress and store that data at the client in order to facilitate non-real time reproduction at the client. For example, since, in this embodiment, Imai contemplates that the compressed data is being transmitted and will not be reproduced in real time, a POSITA would necessarily understand that the client would need some buffer or memory to store the

compressed data until reproduction time. This would require the use of a storage to store the compressed data.

179. A POSITA would also have found it obvious to store compressed data at the client when the client desires to reproduce the requested digital data more than once, and such a configuration would have been well within the knowledge of a POSITA given the teachings of Imai regarding non-real time reproduction. In other words, it would have been obvious to include a "replay" or "rewind" feature at the client terminal. A POSITA would have known how to build an apparatus that implements the storage functionality included in Imai in connection with the embodiment shown in Imai's FIG. 5 and would have been motivated to do so to achieve the predictable results of facilitating non-real time reproduction at the client.

180. As discussed above with reference to Imai's FIG. 16, Imai teaches a configuration in which the output of encoders 53_1 to 53_N are stored at the server in order to increase the processing capacity of Imai's server by eliminating the need to encode in response to each request. Ex. 1005 [0165], [0167], [0170]. In this embodiment, data blocks are compressed with each compression algorithm once and then retrieved and transmitted multiple times according to the throughput of the channel and client processing constraints. Ex. 1005 [0165], [0167], [0169]. Imai also teaches numerous criteria for narrowing the available universe of compression algorithms 53_1 to 53_N, such as not selecting compression algorithms designed for

"voice" data when the actual data comprises "instrument sounds," and not selecting compression algorithms designed for high throughput transmission channels when the detected throughput of the network is low. Ex. 1005 [0102], [0146]. Imai further teaches that in some embodiments the bandwidth of the communication channel is reserved prior to data transmission, such as by using the Resource Reservation Protocol (RSVP). Ex. 1005 [0145]. Thus, Imai would have suggested to a POSITA that certain compression algorithms can be eliminated from consideration based on parameters or attributes of data and/or a known or reserved bandwidth of a communication channel.

181. Given these teachings, a POSITA would have had no reason to compress a given data block with compression algorithms that Imai teaches are inappropriate and would have had even less reason to store the erroneous output of those inappropriate algorithms because Imai aims to transmit data compressed with the most "suitable" compression algorithm. Ex. 1005 [0067], [0068], [0102]. It is my opinion that compressing using those inappropriate algorithms and storing the output would have only increased processing and storage demands on the server with no benefit.

182. It is my opinion that a POSITA would have found it obvious as a matter of common sense to eliminate those clearly inappropriate compression algorithms 53_1 to 53_N in Imai's FIG. 16 so as to store the output of only one or more

selected encoders that are selected based on parameters or attributes of a data block and the bandwidth of a communication channel. A POSITA would have understood that storing only the output of the most appropriate encoder(s) would be advantageous in conserving server disk capacity and saving server processing capacity, both at the time of encoding and when a request for data is eventually received.

183. A POSITA would have been motivated to store the output of the selected compression algorithm from the configuration shown in Imai's FIG. 5 to achieve the very same goals of conserving server disk capacity and saving server processing capacity, both at the time of encoding and when a request for data is received. I note that an additional benefit of this configuration is storing data on an as-needed basis, so that content compressed with compression algorithms is already compressed in those formats and available for retrieval upon subsequent requests. At the same time, the storage of data compressed in formats that are not selected is reduced or eliminated. This technique is well-known in the field, and is analogous to "caching." Caching is the simple idea that a recently requested item is somewhat likely to be requested again and, if storage is available, it makes sense to store a recently produced result so that it can be reused if the same request is made again.

184. It is therefore my opinion that the combination of Imai and Ishii renders this limitation obvious.

7. Dependent Claims 4 and 5 are Obvious

4	**The method of claim 1, wherein the one or more compressed data blocks comprise: one or more files.**
5	**The method of claim 1, further comprising: storing at least a portion of the one or more compressed data blocks in one or more files.**

185. I understand that Claims 4 and 5 both depend from Claim 1, and that in order to disclose or render obvious this claim, each limitation of any base claim and any intervening claim must be met in addition to the instant claim limitation. It is my opinion that the combination of Imai and Ishii renders this claim obvious and teaches this limitation.

186. I note that Ishii teaches compression of files for storage on a disk. Ex. 1007, 5:60-62. And Ishii expressly refers to the output of the compression as "compressed ***files***." Ex. 1007 3:65-4:54, 8:34-41, 9:49-52.

187. As for Imai's storage of compressed data block as "files," as discussed in my opinion above with respect to Claim 6, Imai teaches an additional mode of operation where the compressed data blocks are stored for later usage at both the server side and the client side. *See supra* §{claim 6 discussion}. On the server side, data is stored in either "magnetic disks (hard disks), MOes (magneto-optical disks), optical disks, magnetic tapes, or phase change disks." Ex. 1005 [0167].

188. A POSITA would have found it obvious to use a file to store the compressed data blocks because organizing data into files for storage has long been well-known and standard in the art and there are a finite number of identified, predictable solutions to this problem. A POSITA had good reason to pursue this known option within her technical grasp. Indeed, using files to store compressed data would have been a well-known and commonly used practice for storing compressed digital formatted data at the time.

189. It is therefore my opinion that the combination of Imai and Ishii renders these claims obvious.

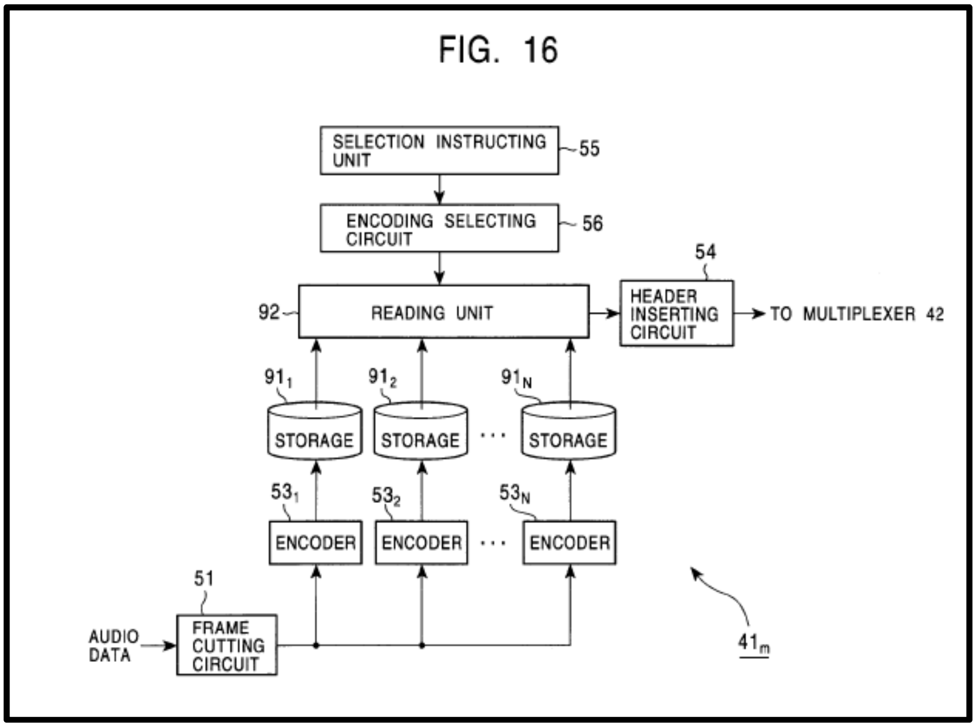
8. Dependent Claim 7 is Obvious

7	**The method of claim 6, further comprising:**
7[a]	**retrieving at least a portion of the at least stored portion of the one or more compressed data blocks;**
7[b]	**transmitting the at least retrieved portion of the at least stored portion of the one or more compressed data blocks over the Internet; and**

190. I understand that Claim 7 depends from Claims 6 and 1, and that in order to disclose or render obvious this claim, each limitation of any base claim and any intervening claim must be met in addition to the instant claim limitation. It is my opinion that the combination of Imai and Ishii renders this claim obvious and teaches this limitation.

191. I note that Imai teaches retrieving and transmitting. As discussed in my opinion above, Imai FIG. 16 and the corresponding disclosure teaches storing

at least a portion of the compressed data blocks in a storage medium. Ex. 1004 at [0167- 0169], FIG. 16.



And, as discussed above, a POSITA would have also found it obvious to build an apparatus that would store the output of one or more selected compression algorithms at the server of Imai.

192. I note that in the configuration of Imai where Imai stores compressed data blocks in the storage medium, a "read-out unit 92" is also provided to read the compressed data from storage prior to any transmission:

> [T]he ***read-out unit 92 will select one of the storages 91_1 to 91_N corresponding to the instruction from the selection instructing unit 55 and reads the coded data out of the selected storage***. The read-out coded data is supplied to

> the header inserting circuit 54, ***followed by being transmitted*** as described above.

Ex. 1005 [0169]. A POSITA would have understood that "reading" the coded data from storage retrieves it. Thus, Imai teaches "retrieving at least a portion of the at least stored portion of the one or more compressed data blocks."

193. I would also note that, with respect to transmission, Imai teaches transmission of compressed data blocks (including over the Internet) throughout. Imai teaches a system "related to a transmitting apparatus and method" for transmitting compressed (encoded) data to a receiving apparatus. Ex. 1005 [0001]. Imai describes its system as such:

> In this ***transmission system***, when a request for time series digital signals, e.g., digital audio signals, is issued from a client terminal 3 to a server 1 via a network 2 such as ***Internet***, ISDN (Integrated Service Digital Network) or PSTN (Public Switched Telephone Network), ***the server 1 encodes the requested audio signals with a predetermined coding method***, and resulting ***coded data is transmitted to the client terminal 3 via the network 2***.

Ex. 1005 [0051]. Transmission of compressed data blocks is achieved by a transmitting circuit 33. Ex. 1005 [0063- 0064]. In the context of Imai's storage of compressed data blocks, as shown in FIG. 16, the retrieved compressed data blocks are disclosed as "being transmitted as described above." Ex. 1005 [0169]; *see id.*

FIG. 9, 10A-C and corresponding text. Thus, Imai discloses transmitting its stored data to a client in fulfillment of its stated purpose of delivering content for reproduction at a client. Ex. 1005 [Abstract].

194. It is therefore my opinion that the combination of Imai and Ishii teaches and renders these limitations obvious.

7[c]	**decompressing the at least transmitted portion of the at least stored portion of the one more compressed data blocks.**

195. It is also my opinion that Imai teaches this limitation. In addition to a transmitting apparatus, as discussed above, Imai describes a corresponding "receiving apparatus and method." Ex. 1005 [0001]. In particular, Imai teaches that the client terminal receives compressed data blocks transmitted from a server and that "[a]fter receiving the coded data from the server 1, the client terminal 3 decodes the coded data and reproduces the original audio signals in real time, for example, (so-called streaming reproduction)." Ex. 1005 [0051]. This is depicted by FIGS. 7 and 8 of Imai. Describing FIG. 7, Imai discloses:

> After receiving the coded bit stream, the receiving circuit 61 performs format conversion on the received bit stream corresponding to the format conversion made in the transmitting circuit 33 in the FIG. 4, and then supplies resulting data to a decoding circuit 62 for decoding thereof.

Ex. 1005 [0078]; *see* Ex. 1005 [0079]-[0084]. Once the data arrives at a decoding unit, it "***decodes the coded data from the separating unit 71 into the original digital audio signal*** which is supplied to an audio signal output circuit 63." Ex. 1005 [0081].

196. It is therefore my opinion that the combination of Imai and Ishii teaches and renders this limitation obvious.

9. Dependent Claim 8 is Obvious

8	**The method of claim 1, further comprising: selecting the one or more compressors to compress the at least the portion of the data block to create at least a second compressed data block based upon a number of reads of at least a portion of a first compressed data block that was created from the at least the portion of the data block.**

197. I understand that Claim 8 depends from Claim 1, and that in order to disclose or render obvious this claim, each limitation of any base claim and any intervening claim must be met in addition to the instant claim limitation. It is my opinion that the combination of Imai and Ishii renders this claim obvious and teaches this limitation.

198. As discussed in my opinion above, Imai in view of Ishii teaches selecting a compressor to compress a data block to create a second compressed data block based on a number of reads of a first compressed data block. Specifically, Ishii teaches:

> The access frequency of a file is used for selecting a data compression method with shorter data compression/decompression time. The data compression methods selection portion 104 selects, from some data compression methods selected according to the data attribute, the one with shorter data compression/decompression time for a file with higher access frequency and the one with a higher compression ratio for a file with lower access frequency.

Ishii Ex. 1007 6:9-17. Thus, Ishii teaches using the frequency of access (reads) as a basis to select a compression algorithm.

199. It is my opinion that a POSITA would have understood that the frequency of access of a particular file will likely vary over time. For example, while an operating system file may remain relatively frequently accessed, individual user data files (e.g., an audio file or word processing document) may be less frequently accessed when the user moves on to other tasks (e.g., grows tired of a particular song or moves on to a new project). Ishii appreciated this same concern, and teaches using the frequency of access (reads) of compressed files (i.e. data blocks) to identify frequently accessed files that system should decompress to provide quicker access:

> The file search portion 102 is provided with an additional function to search for files with high access frequency from the files compressed already. According to this embodiment, when the file status monitor portion 101

> judges that the threshold value is the initial value and that the available file capacity is over the threshold, the file search portion 102 searches the already compressed files for files with high access frequency so that the file decompression portion 106 decompresses such files.

Ex. 1007 8:32-41.

200. I note that Ishii teaches decompressing a previously compressed file to improve system performance. It is my opinion that a POSITA would have appreciated that a further optimization of Ishii's system was possible. Specifically, a POSITA would understand that the system could receive the benefits of a file compression by switching to a less intensive compression algorithm that provides some amount of compression benefit but with a lower execution time, instead of decompressing a frequently accessed file. A POSITA would have been motivated to apply Ishii's teachings to compressed data blocks to tailor or update the compression to an updated number of reads of the data. Moreover, this is consistent with Ishii's teaching that access frequency should be classified as "high, medium, or low" and that these classifications may be set by the file search portion 102 itself. Ex. 1007 5:54-59.

201. It is my opinion that a POSITA would have appreciated that the frequency of access for a file may change with time and that the system's performance could be optimized by adjusting the level of compression to account

for this change in file access, instead of simply eliminating compression altogether. In this way, the benefits of compression could be tailored to the particular circumstances of file access frequency.

202. It is therefore my opinion that it would be obvious in view of Ishii to select among the asymmetric algorithms in Imai based upon frequency of access.

10. Dependent Claim 9 is Obvious

9	**The method of claim 1, wherein the determining of the parameter or attribute of the at least the portion of the data block excludes determining based only upon reading a descriptor of the at least the portion of the data block.**

203. I understand that Claim 9 depends from Claim 1, and that in order to disclose or render obvious this claim, each limitation of any base claim and any intervening claim must be met in addition to the instant claim limitation. It is my opinion that the combination of Imai and Ishii renders this claim obvious and teaches this limitation.

204. I note that Ishii's "number of accesses" is a "parameter or attribute" that Ishii maintains for each file in the file attribute controller. Ex. 1007, 6:20-31. In order for Ishii to operate as intended – to "select[] the suitable compression method corresponding to the access frequency and the type of the file" – the "number of accesses" of a file must be incremented when that file is accessed.

Where the "number of accesses" is maintained as a running count of the number of times that a file has been accessed, it is not "determin[ed] based only upon reading a descriptor of the at least the portion of the data block." It is therefore my opinion that Ishii teaches this limitation.

205. It is also my opinion that Imai teaches this limitation. As discussed in my opinion above with respect to limitation 1[a], Imai teaches determining a parameter or an attribute of a portion of a data block. In particular, I note that Imai considers the level of voice as compared to instrumental sounds in a portion of a data block:

> when the audio signal requested [by] the client terminal 3 has one portion in which a level of the voice is relatively high and the other portion in which a level of the instrument sounds is relatively high, the coding method suitable for the voice is selected for one portion in which a level of the voice is relatively high, and the coding method suitable for the instrument sounds is selected for the other portion in which a level of the instrument sounds is relatively high.

Ex. 1005 [0102]. This determination of the "level of the voice" and the "level of instrument sounds" in a portion of an audio signal (which has been cut into data blocks) is not described as being based on "reading a descriptor" at all, but on an evaluation of the data block itself. It is therefore my opinion that Imai satisfies this limitation as well.

206. It is my opinion that the combination of Imai and Ishii teaches and renders this limitation obvious.

11. Dependent Claim 12 is Obvious

12.	**The method of claim 1, wherein the compressing comprises:** **compressing the at least the portion of the data block with the selected one or more asymmetric compressors to create one or more portions of the one or more compressed data blocks, the at least the portion of the data block having been compressed with the selected one or more asymmetric compressors to create the one or more portions of the one or more compressed data blocks, and** **further comprising:** **storing at least the one or more portions of the one or more compressed data blocks.**

207. I understand that Claim 12 depends from Claim 1, and that in order to disclose or render obvious this claim, each limitation of any base claim and any intervening claim must be met in addition to the instant claim limitation. It is my opinion that the combination of Imai and Ishii renders this claim obvious and teaches this limitation.

12[a]	**compressing the at least the portion of the data block with the selected one or more asymmetric compressors to create one or more portions of the one or more compressed data blocks, the at least the portion of the data block having been compressed with the selected one or more asymmetric compressors to create the one or more portions of the one or more compressed data blocks, and**

208. The combination of Imai and Ishii teach this limitation. As discussed in my opinion above with respect to claim limitation 1[c], Imai and Ishii each teach compressing data blocks (including all portions of those data blocks) with one or more asymmetric compressors to create one or more compressed data blocks. I note that where Imai and Ishii disclose compressing whole data blocks (including all portions of those data blocks), they also teach and render obvious "compressing the ***at least the portion*** of the data block with the selected one or more asymmetric compressors to create one or more ***portions*** of the one or more compressed data blocks, the at least the portion of the data block having been compressed with the selected one or more asymmetric compressors to create the one or more portions of the one or more compressed data blocks." This is true for the same reasons identified in my opinion above for limitations 1[c].

12[b]	**storing at least the one or more portions of the one or more com-pressed data blocks.**

209. Imai and Ishii also teach this limitation. As discussed in my opinion above with respect to Claim 6, both references teach storing the compressed data blocks. It is my opinion that because Imai and Ishii each teach storing multiple

compressed data blocks, they also satisfy the limitation of storing "one or more *portions*" of compressed data blocks because a POSITA would have recognized that storing a data block includes storing portions of that data block. It is therefore my opinion that in view of the discussion and cited portions of Imai and Ishii with respect to Claim 6, Imai and Ishii render obvious this limitation.

12. Dependent Claim 13 is Obvious

13.	**The method of claim 12, further comprising:**
13[a]	**retrieving at least a portion of the at least stored one or more portions of the one or more compressed data blocks;**
13[b]	**transmitting the at least retrieved portion of the at least stored one or more portions of the one or more compressed data blocks over the Internet; and**
13[c]	**decompressing the at least transmitted portion of the at least stored one or more portions of the one or more compressed data blocks in real-time.**

210. I understand that Claim 13 depends from Claims 12 and 1, and that in order to disclose or render obvious this claim, each limitation of any base claim and any intervening claim must be met in addition to the instant claim limitation. It is my opinion that the combination of Imai and Ishii renders this claim obvious and teaches this limitation.

211. I note that Claim 13 contains all limitation of Claim 7, but also has a limitation requiring real-time decompression. As explained in my opinion above with respect to Claim 7, the combination of Imai and Ishii teaches retrieving compressed data blocks that have been stored, transmitting those retrieved

compressed data blocks over the Internet, and decompressing the transmitted compressed data blocks.

212. I would also note that Imai also teaches that the decompression of the transmitted compressed data blocks occurs in "real-time." In particular, Imai discusses that the problem it was aimed to solve was "[t]o decode and reproduce the digital audio signals in ***real time***" and presents an invention "to decode and reproduce digital signals in ***real time***." Ex. 1005 [0006]. And in accordance with Imai's system, the client terminal "decodes the coded data and reproduces the original audio signals in ***real time***, for example, (so-called streaming reproduction)." *Id*. at [0051]; *see id*. at [0094- 0095]; [0100]; [0122- 0123]; [0160]; [0180-0181] (all discussing ways that Imai achieves "real time" decompression or decoding).

213. It is therefore my opinion that Imai and Ishii render obvious these limitations.

IX. RESERVATION OF RIGHTS

My opinions are based upon the information that I have considered to date. I am unaware of any evidence of secondary considerations with respect to the '535 Patent that would render any of the challenged claims non-obvious. I reserve the right, however, to supplement my opinions in the future to respond to any arguments raised by the owner of the '535 Patent and to take into account new information that becomes available to me.

I declare that all statements made herein of my knowledge are true, and that all statements made on information and belief are believed to be true, and that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Executed on June 1, 2018.

By: ______________________

JAMES A. STORER, PH.D.

APPENDIX 1: CURRICULUM VITAE OF JAMES A. STORER

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Brandeis University, Professor of Computer Science (1993 - present)
Brandeis University, Associate Professor of Computer Science (1986 - 1992)
Harvard University, Visiting Professor of Computer Science (1987 - 1988)
Brandeis University, Assistant Professor of Computer Science (1981 - 1986)
Bell Laboratories at Murray Hill, MTS (1979 - 1981)

Research Interests:

Computer algorithms, communications and internet related computing, data compression and archiving (including text, images, video, and multi-media), storage and processing of large data sets, image retrieval, object recognition, text, image, and video processing, parallel

computing, applications of deep learning to image analysis.

Professional Activities:

- In 1991 I founded the Annual IEEE Data Compression Conference (DCC), the first major international conference devoted entirely to data compression, and have served as the conference chair since then.
- I am a member of the ACM and IEEE Computer Society. I routinely serve as referee for papers submitted to journals (JACM, SICOMP, Theoretical CS, J. Algorithms, Algorithms, *Signal Processing*, JPDC, Acta Inf., Algorithmicia, IPL, IPM, Theoretical CS, J. Alg., Networks, IEEE J. Rob. & Aut., IEEE Trans. Inf. Theory, IEEE Trans. Comp., IEEE Trans. Image Proc., Proceedings of the IEEE, IBM J. of R&D, JCSS, etc.). I have served as an editor for *Information Processing and Management, Journal of Visual Communication and Image Representation*, and the *Proceedings of the IEEE*. I have served as a program committee member for various conferences, including *IEEE Data Compression Conference*, *Combinatorial Pattern Matching* (CPM), *International Conference on String Processing and Information Retrieval* (SPIRE), *Conference on Information and Knowledge Management* (CIKM), *Sequences* and *Combinatorial Algorithms on Words*, *DAGS*.
- I consult in the areas of computer algorithms, data compression and communications (including text, image, and video), data storage and backup, cell phone, digital camera, and

DVR technology, image and video processing, information and image retrieval, including providing expert services for computing technology related litigation.

- I have obtained patents and SBIR funding to engage in research projects (such as high speed data compression hardware) that were not possible within the university environment, but which complemented my academic research and provided practical experience on which to base research directions

Books

Hyperspectal Data Compression

G. Motta, F. Rizzo, and J. A. Storer, Editors
Springer-Verlag, www.springer.com, November 2006
(425 pages, 6" x 9", hard-bound)
ISBN: 0-387-28579-2

This book provides a survey of recent results in the field of compression of remote sensed 3D data, with a particular interest in hyperspectral imagery. This material is intended to be of interest to researchers in a variety of areas, including multi dimensional data compression, remote sensing, military and aerospace image processing, homeland security, archival of large volumes of scientific and medical data, target detection, and image classification.

The interest in remote sensing applications and platforms (including airborne and spaceborne) has grown dramatically in recent years. Remote sensing technology has shifted from panchromatic data (a wide range of wavelengths merged into a single response), through multispectral (a few possibly overlapping bands in the visible and infrared range with spectral width of 100-200*nm* each), to hyperspectral imagers and ultraspectral sounders, with hundreds or thousands of bands. In addition, the availability of airborne and spaceborne sensors has increased considerably, followed by the widespread availability of remote sensed data in different research environments, including defense, academic, and commercial.

Remote sensed data present special challenges in the acquisition, transmission, analysis, and storage process. Perhaps most significant is the information extraction process. In most cases accurate analysis depends on high quality data, which comes with a price tag: increased data volume. For example, the NASA JPL's *Airborne Visible/Infrared Imaging Spectrometer* (AVIRIS, http://aviris.jpl.nasa.gov) records the visible and the near-infrared spectrum of the reflected light of an area 2 to 12 kilometers wide and several kilometers long (depending on the duration of the flight) into hundreds of non overlapping bands. The resulting data volume typically exceeds 500 Megabytes per flight and it is mainly used for geological mapping, target recognition, and anomaly detection. On the other hand, ultraspectral sounders such as the NASA JPL's *Atmospheric Infrared Sounder* (AIRS, http://www-airs.jpl.nasa.gov), which has recently become a reference in compression studies on this class of data, records thousands of bands covering the infrared spectrum and generates more than 12 Gigabytes of data daily. The major application of this sensor is the acquisition of atmospheric parameters such as temperature, moisture, clouds, gasses, dust concentrations, and other quantities to perform weather and climate forecast.

Chapter 1 addresses compression architecture and reviews and compares compression methods. Chapter 2 through 4 focus on lossless compression (where the decompressed image must be bit for bit identical to the original). Chapter 5 (contributed by the editors) describes a lossless algorithm based on vector quantization with extensions to near lossless and possibly lossy compression for efficient browsing and pure pixel classification. Chapters 6 deals with near lossless compression while Chapter 7 considers lossy techniques constrained by almost perfect classification. Chapters 8 through 12 address lossy compression of hyperspectral imagery, where there is a tradeoff between compression achieved and the quality of the decompressed image. Chapter 13 examines artifacts that can arise from lossy compression.

An Introduction to Data Structures and Algorithms

James A. Storer
Birkhäuser / Springer, www.springer.com, February 2002
(600 pages, 7" x 10", hard-bound)
ISBN 0-8176-4253-6, ISBN 3-7643-4253-6

A highly a highly accessible format presents algorithms with one page displays that will appeal to both students and teachers of computer science. The thirteen chapters include: Models of Computation (including Big O notation), Lists (including stacks, queues, and linked lists), Induction and Recursion, Trees (including self-adjusting binary search trees), Algorithms Design Techniques, Hashing, Heaps (including heapsort and lower bounds on sorting by comparisons), Balanced Trees (including 2-3 trees, red-black trees, and AVL trees), Sets Over a Small Universe (including on-the-fly array initialization, in-place permutation, bucket sorting, bit-vectors, and the union-find data structure), Discrete Fourier Transform (including an introduction to complex numbers, development of the FFT algorithm, convolutions, the DFT on an array of reals, the discrete cosine transform, computing the DCT with a DFT of n/2 points, 2D DFT and DCT, and an overview of JPEG image compression), Strings (including lexicographic sorting, KMP / BM / Rabin-Karp / Shift-And string matching, regular expression pattern matching, tries, suffix tries, edit distance, Burrows-Wheeler transform, text compression examples), Graphs (including DFS / BFS, biconnected and strongly connected components, spanning trees, topological sort, Euler paths, shortest paths, transitive closure, path finding, flow, matching, stable marriage, NP-complete graph problems), Parallel Models of Computation (including the PRAM, generic PRAM simulation, the hypercube/CCC/butterfly, the mesh, and hardware area-time tradeoffs).

- Concepts are expressed clearly, in a single page, with the least amount of notation, and without the "clutter" of the syntax of a particular programming language; algorithms are presented with self-explanatory "pseudo-code".
- Each chapter starts with an introduction and ends with chapter notes and exercises that promote further learning.
- Sorting, often perceived as rather technical, is not treated as a separate chapter, but is used in many examples (including bubble sort, merge sort, tree sort, heap sort, quick sort, and several parallel algorithms). Lower bounds on sorting by comparisons are included with the presentation of heaps in the context of lower bounds for comparison based structures.
- Chapters 1-4 focus on elementary concepts, the exposition unfolding at a slower pace. Sample exercises with solutions are also provided. These chapters assume a reader with only some basic mathematics and a little computer programming experience. An introductory college-level course on data structures may be based on Chapters 1 -4 and the first half of Chapters 5 (algorithms design), 6 (hashing), and 12 (graphs).
- Chapters 5-13 progress at a faster pace. The material is suitable for undergraduates or graduates who need only review Chapters 1-4. A more advanced course on the design and analysis of algorithms may be based on these chapters.
- Chapter 13 on parallel models of computation is something of mini-book itself. The idea is to further teach fundamental concepts in the design of algorithms by exploring exciting models of computation, including the PRAM, generic PRAM simulation, HC/CCC/Butterfly, the mesh, and parallel hardware area-time tradeoffs (with many examples). A sampling of this chapter can be a fun way to end a course based on earlier portions of the book. In addition, a seminar style course can spends its first half covering this chapter in detail and then study papers from the literature.
- Apart from classroom use, this book serves as an excellent reference text on the subject of data structures, algorithms, and parallel algorithms. Its page-at-a-time format makes it easy to review material that the reader has studied in the past.

Data Compression: Methods and Theory

James A. Storer
Computer Science Press (a subsidiary of W. H. Freeman Press), 1988
(419 pages, 6" x 9", hard-bound)
ISBN 0-88175-161-8

The first two chapters contain introductory material on information and coding theory. The remaining four chapters cover some of my data compression research performed in the period 1977 - 1987 (including substantial material that has not been reported elsewhere). Chapter 3 considers on-line textual substitution methods that employ "learning" heuristics to adapt to changing data characteristics. Chapter 4 considers massively parallel algorithms for on-line methods and their VLSI implementations. Chapter 5 considers off-line methods (including the NP-completeness of certain methods). Chapter 6 addresses program size (Kolmogorov) complexity. The appendices present source code and empirical results.

Image and Text Compression

James A. Storer, Editor
Kluwer Academic Press (part of Springer), 1992
(354 pages, 6" x 9", hard-bound)
ISBN 0-7923-9243-4

This is an edited volume of papers by leading researchers in the field; topics include: vector quantization, fractals, optical algorithms, arithmetic coding, context modeling, LZ methods, massively parallel hardware (the chapter I contributed), bounds on Huffman codes, coding delay, and 2D lossless compression. Also included is a 75 page bibliography of data compression research that I compiled specifically for this book.

Proceedings Compression and Complexity

B. Carpentieri, A. De Santis, U. Vaccaro, and J. A. Storer, Editors
IEEE Computer Society Press, 1998
(400 pages, 6" x 9", hard-bound)
ISBN 0-8186-8132-2

This is an edited volume of the papers presented at the *International Conference on Compression and Complexity of Sequences*, held in Positano, Italy in 1997.

Papers address the theoretical aspects of data compression and its relationship to problems on sequences, and include contributions from the editors.

Proceedings of the Data Compression Conference

James A. Storer, Co-Chair
IEEE Computer Society Press
1991 - present (approximately 500 pages hard-bound)

I have chaired DCC since it was founded in 1991; starting in 2013 the conference leadership has been expanded; I am currently co-chair (with M. Marcellin, formally committee chair).

The DCC proceedings are co-edited with the DCC program committee chair(s), which over the years has been J. Reif (1991), M. Cohn (1992-2006), M. Marcellin (2007-2012), Ali Bilgin & Joan Serra-Sagrista (2013-present).

Each volume has ten page extended abstracts of the presentations at technical sessions and one page abstracts of presentations at the posters session. The call for papers states that topics of interest include but are not limited to:

> An international forum for current work on data compression for text, images, video, audio, and related areas. Topics of interest include but are not limited to: Lossless and lossy compression algorithms for specific types of data (text, images, multi-spectral and hyper-spectral images, palette images, video, speech, music, maps, instrument and sensor data, space data, earth observation data, graphics, 3D representations, animation, bit-maps, etc.), source coding, text compression, joint source-channel coding, multiple description coding, quantization theory, vector quantization (VQ), multiple description VQ, compression algorithms that employ transforms (including DCT and wavelet transforms), bi-level image compression, gray scale and color image compression, video compression, movie compression, geometry compression, speech and audio compression, compression of multi-spectral and hyper-spectral data, compression of science, weather, and space data, source coding in multiple access networks, parallel compression algorithms and hardware, fractal based compression methods, error resilient compression, adaptive compression algorithms, string searching and manipulation used in compression applications, closest-match retrieval in compression applications, browsing and searching compressed data, content based retrieval employing compression methods, minimal length encoding and applications to learning, system issues relating to data compression (including error control, data security, indexing, and browsing), medical imagery storage and transmission, compression of web graphs and related data structures, compression applications and issues for computational biology, compression applications and issues for the internet, compression applications and issues for mobile computing, applications of compression to file distribution and software updates, applications of compression to files storage and backup systems, applications of compression to data mining, applications of compression to information retrieval, applications of compression to image retrieval, applications of compression and information theory to human-computer interaction (HCI), data compression standards including the JPEG, JPEG2000, MPEG (MPEG1, MPEG2, MPEG4, MPEG7, etc.), H.xxx, and G.xxx families.

Patents

In-Place Differential File Compression

United States patent number: 7,079,051
INVENTORS: James A. Storer and Dana Shapira
FILED: March 18, 2004
GRANTED: July 18, 2006
(23 claims, 6 of them independent)

Addresses in-place differential file compression methods that can be used in software update and backup systems.

Method and Apparatus for Data Compression

United States patent number: 5,379,036
INVENTOR: James A. Storer
FILED: April 1, 1992
GRANTED: January 1, 1995
(23 claims, 3 of them independent)

Addresses high speed parallel algorithms and hardware for data compression.

System for Dynamically Compressing and Decompressing Electronic Data

United States patent number: 4,876,541
INVENTOR: James A. Storer
FILED: October 15, 1987
GRANTED: October 24, 1989
(55 claims, 5 of them independent)

Addresses dictionary based adaptive data compression.

Computational Modeling of Rotation and Translation Capable Human Visual Pattern Recognition

U.S. Provisional Patent Application No. 60/712,596
INVENTORS: John Lisman, James A. Storer, Martin Cohn, Antonella DiLillo
FILED: August 29, 2005
(assigned to Brandeis University)

Addresses rotation and translation invariant recognition.

Mechanical puzzle with hinge elements, rope elements, and knot elements

United States Patent 8,393,623
INVENTOR: James A. Storer
FILED: October 29, 2009
GRANTED: March 12, 2013
(8 claims, 3 of them independent)

Addresses designs for a mechanical puzzle that may be realized as a puzzle game.

Papers

"Deflecting Adversarial Attacks with Pixel Deflection", to appear CVPR 2018 (coauthored with A. Prakash, N. Moran, S. Garber, A. DiLillo).

"Protecting JPEG Images Against Adversarial Attacks", IEEE Data Compression Conference 2018, 139-148 (coauthored with A. Prakash, N. Moran, S. Garber, A. DiLillo).

"Visual Lecture Summary Using Intensity Correlation Coefficient", FIE - Frontiers in Education Conference, Indianapolis, IN, 2017 (coauthored with S. Garber, L. Milekic, A. Prakash, N. Moran, A. DiLillo).

"A Two Tier Approach To Blackboard Video Lecture Summary", IMVIP - Irish Machine Vision and Image Processing Conference, Maynooth University, Ireland, 2017, pages 68-75 (coauthored with S. Garber, L. Milekic, A. Prakash, N. Moran, A. DiLillo); see http://eprints.maynoothuniversity.ie/8841/1/IMVIP2017_Proceedings.pdf.

"Semantic Perceptual Image Compression using Deep Convolution Networks", IEEE Data Compression Conference 2017, 250-259 (coauthored with A. Prakash, N. Moran, S. Garber, A. DiLillo).

"Highway Networks for Visual Question Answering", VQA Workshop, CVPR 2016 (coauthored with A. Prakash).

"Accurate Location in Urban Areas", CPVIR Workshop 2013 (coauthored with K. Thomas).

"Compression-Based Tools for Navigation with an Image Database", *Algorithms* 5, 2012, 1-17 (coauthored with A. DiLillo, A. Daptardar, K. Thomas, G. Motta)

"Edit Distance With Block Deletions", *Algorithms* 4, 2011, 40-60 (coauthored with D. Shapira).

"Applications of Compression to Content Based Image Retrieval and Object Recognition", *Proceedings International Conference On Data Compression, Communication, and Processing* (CPP 2011), Palinuro, Italy, 179 - 189 (coauthored with Antonella Di Lillo, Ajay Daptardar, Giovanni Motta, and Kevin Thomas)

"A Rotation And Scale Invariant Descriptor For Shape Recognition", *Proceedings International Conference On Image Processing* (ICIP), Hong Kong, 2010, MA-L9:1, 257-260 (coauthored with A. DiLillo and G. Motta).

"Shape Recognition, With Applications To A Passive Assistant", Proceedings *PETRA - PErvasive Technologies Related to Assistive Environments*, Samos, Greece, June 23-25; to appear *ACM International Conference Proceedings Series* (coauthored with A. DiLillo, G. Mota, and K. Thomas), 2010.

"Shape Recognition Using Vector Quantization", *Proceedings Data Compression Conference*, IEEE Computer Society Press, March 2010, 484-493 (coauthroed with A. Di Lillo and G. Motta).

"Network Aware Compression Based Rate Control for Printing Systems", Proceedings 10th International Symposium on Pervasive Systems (ISPAN 2009), Kaohsiung, Taiwan, December 2009, 123-128 (coauthored with Chih-Yu Tang).

"VQ Based Image Retrieval Using Color and Position Features", *Proceedings Data Compression Conference*, IEEE Computer Society Press, March 2008, 432-441 (coauthored with A. Daptardar).

"Multiresolution Rotation-Invariant Texture Classification Using Feature Extraction in the Frequency Domain and Vector Quantization", *Proceedings Data Compression Conference*, IEEE Computer Society Press, March 2008, 452-461 (coauthored with A. DiLillo and G. Motta).

"Edit Distance with Move Operations", *Journal of Discrete Algorithms* 5:2, June 2007, 380-392 (coauthored with D. Shapira).

"Texture Classification Based on Discriminative Feature Extracted in the Frequency Domain", *Proceedings IEEE International Conference on Image Processing* (ICIP), September 2007, II.53-II.56 (coauthored with A. DiLillo and G. Motta).

"Supervised Segmentation Based on Texture Signature Extracted in the Frequency Domain", *Third Iberian Conference on Pattern Recognition and Image Analysis* (IbPRIA), June 2007 (coauthored with A. DiLillo and G. Motta).

"Texture Classification Using VQ with Feature Extraction Based on Transforms Motivated by the Human Visual System", *Proceedings Data Compression Conference*, IEEE Computer Society Press, 392, 2007 (coauthored with A. DiLillo and G. Motta).

"Reduced Complexity Content-Based Image Retrieval using Vector Quantization", *Proceedings Data Compression Conference*, IEEE Computer Society Press, 342-351, 2006 (coauthored with A. H. Daptardar).

"In-Place Differential File Compression", *Computer Journal* 48:6, 677-691, November 2005 (coauthored with D. Shapira).

"Compression of Hyper/Ultra-Spectral Data", *Proceedings of SPIE, Optics and Photonics, Satellite Data Compression, Communication and Archiving*, Jul. 2005, Vol. 5889, pp. 588908-1--588908-10 (coauthored with G. Motta and F. Rizzo).

"Content-Based Image Retrieval Via Vector Quantization", In *Advances in Visual Computing - Springer Lecture Notes in Computer Science* 3804/2005 (ISBN 3-540-30750-8), 502-509; also appeared in *International Symposium on Visual Computing*, December 5-7, 2005 (coauthored with A. Daptardar).

"Low Complexity Lossless Compression of Hyperspectral Imagery via Linear Prediction", *IEEE Signal Processing Letters* 12:2, 138-141, 2005 (coauthored with F. Rizzo, B. Carpentieri, and G. Motta).

"Overlap and Channel Errors in Adaptive Vector Quantization for Image Coding", *Information Sciences* 171:1-3, 125-143, 2005 (coauthored with B. Carpentieri and F. Rizzo).

"Compression of Hyperspectral Imagery", *Proceedings International Conference on E-Business and Telecommunications* (ICETE), Sebutal, Portugal, 2004; an extended version of this paper is a chapter in the book *E-Business and Telecommunication Networks*, Edited by J. Ascenso, L. Vasiu, C. Belo, and M. Saramago, Kluwer / Springer, 317-324 (coauthored with B. Carpentieri, G. Motta, and F. Rizzo).

"Real-Time Software Compression and Classification of Hyperspectral Images", *Proceedings]]th SPIE International Symposium on Remote Sensing Europe*, X. L. Bruzzone, Ed., Maspalomas, Gran Canaria, Spain, Sept. 13-17, 2004, Vol. 5573, 182-192, (coauthored with B. Carpentieri, G. Motta, and F. Rizzo).

"Lossless Compression of Hyperspectral Imagery: A Real Time Approach", *Proceedings]]th SPIE International Symposium on Remote Sensing Europe*, X. L. Bruzzone, Ed., Maspalomas, Gran Canaria, Spain, Sept. 13-17, 2004, Vol. 5573, 262-272, (coauthored with B. Carpentieri, G. Motta, and F. Rizzo).

"High Performance Compression of Hyperspectral Imagery with Reduced Search Complexity in the Compressed Domain", *Proceedings Data Compression Conference*, IEEE Computer Society Press, 2004, 479-488 (coauthored with B. Carpentieri, G. Motta and F. Rizzo).

"In-Place Differential File Compression of Non-Aligned Files With Applications to File Distribution and Backups", *Proceedings Data Compression Conference* (DCC), IEEE Computer Society Press, 2004, 82-91 (coauthored with D. Shapira).

"Report of the National Science Foundation Workshop on Information Theory and Computer Science Interface", produced by workshop of 20 invited participants (Chicago, Il. 2003), report completed and submitted to the NSF in November 2004.

"Finding Non-Overlapping Common Substrings in Linear Time", *Proceedings Symposium on String Processing and Information Retrieval* (SPIRE), 2003, *Lecture Notes on Computer Science*, Volume 2857/2003 ISBN: 3-540-20177-7, Springer-Verlag, 369-377 (coauthored with M. Meyerovich and D. Shapira).

"In-Place Differential File Compression", *Proceedings Data Compression Conference* (DCC), IEEE Computer Society Press, 263-272, 2003 (coauthored with D. Shapira).

"Compression of Hyperspectral Imagery", *Proceedings Data Compression Conference*, IEEE Computer Society Press, 333-342, 2003 (coauthored with G. Motta and F. Rizzo).

"Partitioned Vector Quantization: Application to Lossless Compression of Hyperspectral Images", *Proceedings International Conference on Acoustics, Speech, and Signal Processing* (ICASSP), IMSP-P2.2-III, 241-244, 2003; also presented at *IEEE International Conference on Multimedia and Expo* (ICME2003), 2003, 553-556 (coauthored with G. Motta and F. Rizzo).

"Generalized Edit Distance with Move Operations", *Thirteenth Annual Symposium on Combinatorial Pattern Matching* (CPM), 85-98, 2002 (coauthored with D. Shapira).

"A Lossless Data Compression Algorithm for Electro-Cardiograms", Technical Report, Computer Science Department, Brandeis University (coauthored with G. Motta and M. Hosang); see also senior honors thesis of M. Hosang.

"LZ-Based Image Compression", *Information Sciences* 135, 107-122, 2001 (coauthored with F. Rizzo and B. Carpentieri).

"Optimal Encoding of Non-Stationary Sources", *Information Sciences*, 87-105, 2001 (coauthored with J. Reif).

"Overlap in Adaptive Vector Quantization", *Proceedings Data Compression Conference*, IEEE Computer Society Press, 401-410, 2001 (coauthored with F. Rizzo).

"Lossless Image Coding via Adaptive Linear Prediction and Classification", *Proceedings of the IEEE 88:11*, 1790-1796 (coauthored with G. Motta and B. Carpentieri), November 2000.

"Optimal Frame Skipping for H263+ Video Encoding", *Proceedings 11th Annual International Conference on Signal Processing Applications and Technology*, Dallas, TX October 2000, 373-377 (coauthored with G. Motta).

"Digital Image Compression", *Encyclopeda of Computer Science*, 4th Edition, John Wiley and Sons, 836-840, 2003 (coauthored with G. Motta and F. Rizzo). Also in *Concise Encyclopedia of Computer Science*, John Wiley & Sons, 5th edition, 2004, 379-382.

"Error Resilient Dictionary Based Compression", *Proceedings of the IEEE 88:11*, 1713-1721, 2000.

"Improving Scene Cut Quality for Real-Time Video Decoding", *Proceedings Data Compression Conference*, IEEE Computer Society Press, 470-479, 2000 (coauthored with G. Motta and B. Carpentieri).

"On Sequence Assembly", Technical Report, Computer Science Department, Brandeis University (coauthored with F. Mignosi, A. Rivesto, and M. Sciortino), 2000.

"Adaptive Linear Prediction Lossless Image Coding", *Proceedings Data Compression Conference*, IEEE Computer Society Press, 491-500, 1999 (coauthored with G. Motta and B. Carpentieri).

"Experiments with Single-Pass Adaptive Vector Quantization", *Proceedings Data Compression Conference*, IEEE Computer Society Press, 546, 1999 (coauthored with F. Rizzo and B. Carpentieri).

"Improving Single-Pass Adaptive VQ", *International Conference on Acoustics, Speech, and Signal Processing* (ICASSP), IMDSP2.10, Phoenix, Arizona, 1999 (coauthored with F. Rizzo and B. Carpentieri).

“The Prevention of Error Propagation in Dictionary Compression with Update and Deletion”, *Proceedings Data Compression Conference,* IEEE Computer Society Press, 1998, 199-208.

“Optimal Lossless Compression of a Class of Dynamic Sources”, *Proceedings IEEE Data Compression Conference*, 1998, 501-510 (coauthored with J. Reif).

“Error Resilient Data Compression with Adaptive Deletion”, in *Compression and Complexity of Sequences,* IEEE Press, 285-294, 1998.

“Lossless Image Compression by Block Matching”, *The Computer Journal 40:2/3*, 137-145, 1997 (coauthored with H. Helfgott).

"Error Resilient Optimal Data Compression", *SIAM Journal of Computing 26:4* , 934-939, 1997 (coauthored with J. Reif).

“Low-Cost Prevention of Error-Propagation for Data Compression with Dynamic Dictionaries”, *Proceedings Data Compression Conference,* IEEE Computer Society Press, 171-180, 1997 (co-authored with J. Reif).

“Generalized Node Splitting and Bi-Level Image Compression”, *Proceedings Data Compression Conference,* IEEE Computer Society Press, 443, 1997 (co-authored with H. Helfgott).

“Selective Resolution for Surveillance Video Compression”, *Proceedings Data Compression Conference,* IEEE Computer Society Press, 468, 1997 (co-authored with I. Schiller, C. Chuang, and S. King).

"A Video Coder Based on Split-Merge Displacement Estimation", *Journal of Visual Communication and Visual Representation 7:2*, 137-143, 1996; an abstract of this paper appeared in *Proceedings DCC 1993*, 492 (co-authored with B. Carpentieri).

"On-Line versus Off-Line Computation in Dynamic Text Compression", *Information Processing Letters 59*, 169-174, 1996 (co-authored with S. DeAgostino).

“Lossless Image Compresssion using Generalized LZ1-Type Methods”, *Proceedings Data Compression Conference,* IEEE Computer Society Press, 290-299, 1996.

“High Performance Adaptive Data Compression”, *Proceedings DAGS: Electronic Publishing and the Information Superhighway*, Boston, MA, 29-38, 1995 (co-authored with C. Constantinescu and B. Carpentieri).

“Single-Pass Adaptive Lossy Compression with Pattern Matching”, *Twenty-Fourth Annual IEEE Communication Theory Workshop*, Santa Cruz, CA, April 23-26, 1995.

“Near Optimal Compression with Respect to a Static Dictionary on a Practical Massively Parallel Architecture”, *Proceedings Data Compression Conference,* IEEE Computer Society Press, 172-181, 1995 (co-authored with D. Belinskaya and S. DeAgostino).

"Application of Single-Pass Adaptive VQ to BiLevel Images", *Proceedings Data Compression Conference,* IEEE Computer Society Press*,* 423, 1995 (co-authored with C. Constantinescu).

"Classification of Objects in a Video Sequence", *Proceedings SPIE Symposium on Electronic Imaging*, San Jose, CA, 1995 (co-authored with B. Carpentieri).

"Optimal Inter-Frame Alignment for Video Compression", *International Journal of Foundations of Computer Science 5:2*, 65-177, 1994 (co-authored with B. Carpentieri).

"Improved Techniques for Single-Pass Vector Quantization", *Proceedings of the IEEE 82:6*, 933-939, 1994; an extended abstract of this paper appeared in the *Proceedings DCC 1994,* 410-419 (co-authored with C. Constantinescu).

"Split-Merge Video Displacement Estimation", *Proceedings of the IEEE 82:6*, 940-947, 1994; an extended abstract of this paper appeared as "A Split and Merge Parallel Block-Matching Algorithm for Displacement Estimation", *Proceedings DCC 1992,* 239-248 (co-authored with B. Carpentieri).

"On-Line Adaptive Vector Quantization with Variable Size Codebook Entries", *Information Processing and Management 30:6*, 745-758, 1994; a preliminary version of this paper appeared as "On-Line Adaptive Vector Quantization with Variable Size Vectors", *Proceedings DCC 1993*, 32-41 (co-authored with C. Constantinescu).

"Design and Performance of Tree-Structured Vector Quantizers", *Information Processing and Management 30:6,* 1994, 851-862; a preliminary version of this paper appeared in the *Proceedings DCC 1993*, 292-301 (co-authored with J. Lin).

"Shortest Paths in the Plane with Polygonal Obstacles", *Journal of the ACM 41:5,* 982-1012, 1994 (co-authored with J. Reif).

"A Single-Exponential Upper Bound for Finding Shortest Paths in Three Dimensions" *Journal of the ACM 41:5,* 1013-1015, 1994 (co-authored with J. Reif).

"Image Compression", Encyclopedia of Computer Science and Technology, Volume 29, 231-256, 1994 (co-authored with J. Lin).

"On the Design and Implementation of a Lossless Data Compression and Decompression Chip", *IEEE Journal of Solid-State Circuits*, 948-953, 1993 (co-authored with D. M. Royals, T. Markas, N. Kanopoulos, and J. H. Reif).

"On Parallel Implementations and Experimentations of Lossless Data Compression Algorithms", *Proceedings Picture Coding Symposium*, Lausanne, Switzerland, Section 5.3, March 1993; a preliminary version of this paper appears in *Proceedings DCC 1992*, (coauthored with J. Reif and T. Markas).

"High Performance Compression of Science Data", *NASA Science Information Systems 29,* September 1993, 1-6.

"Split Merge Displacement Estimated Video Compression", *Proceedings 7th International Conference on Image Analysis and Processing*, Bari, Italy, September, 1993 (co-authored with B. Carpentieri).

"A Video Coder Based on Split-Merge Displacement Estimation", *Proceedings Data Compression Conference,* IEEE Computer Society Press, 492, 1993 (co-authored with B. Carpentieri).

"Design and Performance of Tree-Structured Vector Quantizers", *Proceedings Data Compression Conference,* IEEE Computer Society Press, 292-301, 1993 (co-authored with J. Lin).

"On-Line Adaptive Vector Quantization with Variable Size Codebook Entries", *Proceedings Data Compression Conference,* IEEE Computer Society Press, 32-41, 1993 (co-authored with C. Constantinescu).

“Adaptive Lossless Data Compression over a Noisy Channel", *Methods in Communication, Security, and Computer Science*, Springer-Verlag, 104-117, 1993; a preliminary version of this paper appeared in *Proceedings Sequences 91*, Positano, Italy 1991 (co-authored with J. Reif).

"Improving Search for Tree-Structured Vector Quantization", *Proceedings Data Compression Conference,* IEEE Computer Society Press, 339-348, 1992 (co-authored with J. Lin).

“Parallel Algorithms for Optimal Compression Using Dictionaries with the Prefix Property", *Proceedings DCC '92,* 152-61 (co-authored with S. DeAgostino).

"Parallel Algorithms for Data Compression", invited presentation, 1992 ALGOFEST symposium, Bristol, RI.

“Summary of Data Compression Splinter Group”, Proceedings AISRP Workshop, Boulder Colorado, August, 1992.

“Massively Parallel Systolic Algorithms for Real-Time Dictionary-Based Text Compression", *Image and Text Compression*, Kluwer Academic Press, 159-178, 1992.

“Data Compression Bibliography”, *Image and Text Compression*, Kluwer Academic Press, 277-349, 1992.

“Optimal Pruning for Tree-Structured Vector Quantization", *Information Processing and Management 28:6*, 723-733, 1992; a preliminary version of this paper appeared as "On the Complexity of Optimal Tree Pruning for Source Coding", *Proceedings DCC 1991*, 63-72, 1991 (co-authored with E. Lin and M. Cohn).

“Data Compression", *Information Processing and Management* 28:6, 1992 (co-authored with A. Bookstein).

"A Split and Merge Parallel Block-Matching Algorithm for Displacement Estimation", *Proceedings Data Compression Conference,* IEEE Computer Society Press*,* 239-248, 1992 (co-authored with B. Carpentieri).

"On Parallel Implementations and Experimentations of Lossless Data Compression Algorithms", *Proceedings Data Compression Conference,* IEEE Computer Society Press*,* 425, 1992 (co-authored with J. Reif and T. Markas).

“A Report on Sequences91”, SIGACT News, 1991.

“A Parallel Architecture for High Speed Data Compression", J*ournal of Parallel and Distributed Computing 13*, 222-227, 1991; a preliminary version of this paper appeared as "A Parallel Architecture for High Speed Data Compression", *Third Symposium on the Frontiers of Massively Parallel Computation*, College Park, Maryland, IEEE Press, 1990, 238-243 (co-authored with J. Reif).

“Processor-Efficient Algorithms for the Knapsack Problem", *Journal of Parallel and Distributed Computing 11*, 332-337, 1991; a preliminary version of this paper appeared as "A New Parallel Algorithm for the Knapsack Problem and its Implementation on the Hypercube", *Third Symposium on the Frontiers of Massively Parallel Computation*, College Park, Maryland, 1990, 2-7 (co-authored with J. Lin).

“Resolution Constrained Tree Structured Vector Quantization for Image Compression", *Proceedings IEEE Symposium on Information Theory*, Budapest, Hungary, 1991 (co-authored with J. Lin).

“The Worst-Case Performance of Adaptive Huffman Codes", *Proceedings IEEE Symposium on Information Theory*, Budapest, Hungary, 1991.

"On the Complexity of Optimal Tree Pruning for Source Coding", *Proceedings Data Compression Conference,* IEEE Computer Society Press, 63-72, 1991 (co-authored with E. Lin and M. Cohn).

“Adaptive Lossless Data Compression over a Noisy Channel", *Proceedings Sequences 91*, Positano, Italy, 1991 (co-authored with J. Reif).

“A Massively Parallel VLSI Design for Data Compression using a Compact Dynamic Dictionary", *Proceedings IEEE VLSI Signal Processing Conference*, San Diego, CA, 329-338, 1990 (co-authored with J. H. Reif and T. Markas).

“Quantization Techniques for Image Compression", *Microcomputers 14*, 139-164 (co-authored with J. Lin).

“Reliable Dynamic Compression for Bandwidth Reduction of Noisy Data Sent from Space", *Proceedings CESDIS Conference*, Greenbelt, MD, 1990.

“Lossy On-Line Dynamic Data Compression", *Combinatorics, Compression, Security and Transmission* , Springer-Verlag, 348-357, 1990; a preliminary version of this paper was presented as "Lossy Data Compression", *Proceedings Sequences 88*, Positano, Italy, 1988.

"A New Parallel Algorithm for the Knapsack Problem and its Implementation on the Hypercube", *Third Symposium on the Frontiers of Massively Parallel Computation*, College Park, Maryland, 2-7, 1990 (co-authored with J. Lin).

"A Parallel Architecture for High Speed Data Compression", *Third Symposium on the Frontiers of Massively Parallel Computation*, College Park, Maryland, IEEE Press, 238-243, 1990 (co-authored with J. Reif).

“The Amalfi and Maratea Conferences”, SIGACT News, 1988.

“Parallel Algorithms for On-Line Dynamic Data Compression", *Proceedings IEEE International Conference on Communications Philadelphia*, PA, 385-389, 1988.

“Real-Time Dynamic Compression of Video on a Grid-Connected Parallel Computer", *Proceedings Third International Conference on Super-Computing*, Boston, MA, 453-462, 1988.

“3-Dimensional Shortest Paths in the Presence of Polyhedral Obstacles", *Mathematical Foundations of Computer Science 3:24*, 85-92, 1988 (co-authored with J. Reif).

“Science Data Management", *Proceedings NASA Conference on Scientific Data Compression*, Snowbird, Utah, 1988 (co-authored with R. B. Miller).

"Lossy Data Compression", *Proceedings Sequences 88*, Positano, Italy, 1988.

“Minimizing Turns for Discrete Movement in the Interior of a Polygon", *IEEE Journal of Robotics and Automation 3:3*, 182-193, 1987 (co-authored with J. Reif).

“Parallel Algorithms for Data Compression", *Journal of the ACM 32:2*, 344-373, 1985 (co-authored with M. Gonzalez).

“Textual Substitution Techniques for Data Compression", *Combinatorial Algorithms on Words*, Springer-Verlag, 111-129, 1985.

“Uniform Circuit Placement", *VLSI Algorithms and Architectures 1*, 255-273, 1985 (co-authored with A. J. Nicas and J. Becker).

“On Minimal Node Cost Planar Embeddings", *Networks 14:2*, 181-212, 1984; a preliminary version of this paper appeared as "The Node Cost Measure for Embedding Graphs on the

Planar Grid", *Proceedings Twelfth Annual ACM Symposium on the Theory of Computing*, Los Angles, CA, 201-210, 1980.

"On the Complexity of Chess", *Journal of Computer and System Sciences 27:1*, 77-100, 1983; a preliminary version of this paper appeared as "A Note on the Complexity of Chess", *Proceedings Thirteenth Annual CISS* , 160-166, 1979.

"An Abstract Theory of Data Compression", *Theoretical Computer Science 24* , 221-237, 1983; a preliminary version of this paper appeared as "Toward an Abstract Theory of Data Compression", *Proceedings Twelfth Annual CISS*, 391-399, 1978.

"Data Compression Via Textual Substitution", *Journal of the ACM 29:4*, 928-951, 1982; a preliminary version of this paper appeared as "The Macro Model for Data Compression", *Proceedings Tenth Annual ACM Symposium on the Theory of Computing*, San Diego, CA, 30-39, 1978 (co-authored with T. G. Szymanski).

"Constructing Full Spanning Trees for Cubic Graphs", *Information Processing Letters 13:1*, 8-11, October, 1981.

"On Finding Minimal Length Superstrings", *Journal of Computer and System Sciences 20*, 50-58, 1980; a preliminary version of this paper appeared as "A Note on the Complexity of the Superstring Problem", *Proceedings Twelfth Annual CISS*, 52-56, 1978 (co-authored with D. Maier).

"The Node Cost Measure for Embedding Graphs on the Planar Grid", *Proceedings Twelfth Annual ACM Symposium on the Theory of Computing*, Los Angles, CA, 201-210, 1980.

"A Note on the Complexity of Chess", *Proceedings Thirteenth Annual CISS* , 160-166, 1979.

"The Macro Model for Data Compression", *Proceedings Tenth Annual ACM Symposium on the Theory of Computing*, San Diego, CA, 30-39, 1978 (co-authored with T. G. Szymanski).

"A Note on the Complexity of the Superstring Problem", *Proceedings Twelfth Annual CISS*, 52-56, 1978 (co-authored with D. Maier).

"Toward an Abstract Theory of Data Compression", *Proceedings Twelfth Annual CISS*, 391-399, 1978.

"Data Compression: Methods and Complexity Issues", Ph.D. Thesis, Dept. of Electrical Engineering and Computer Science, Princeton University Princeton, NJ, 1979.

Technical Reports (not published elsewhere)

"Edit Distance with Move Operations", Technical Report (coauthored with D. Shapira).

"Longest Common Substrings and Edit Distance", Technical Report, Computer Science, Brandeis University, Waltham, MA (co-authored with M. Meyerovich and D. Shapira); see also Senior Honors thesis of M. Meyerovich.

"Parallel Implementation of Single-Pass Adaptive VQ", Technical Report, Department of Computer Science, Brandeis University, Waltham, MA (co-authored with C. Constantinescu).

“Application of Single-Pass VQ to Mixed Images”, Technical Report, Department of Computer Science, Brandeis University, Waltham, MA (co-authored with C. Constantinescu).

"Geometric Clustering to Minimize the Mean-Square Error" Technical Report, Department of Computer Science, Brandeis University, Waltham, MA (co-authored with J. Lin).

"Optimal Resolution-Constrained Tree-Structured Vector Quantization" Technical Report, Dept. of Computer Science, Brandeis University, Waltham, MA (co-authored with J. Lin).

“Computing Range Sets, with applications to Automatic Worst-Case Asymptotic Analysis of Programs", Technical Report CS-85-123, Department of Computer Science, Brandeis University, Waltham, MA, August, 1985.

“A Note on the 2-Dimensional Channel Assignment Problem”, manuscript, 1984.

“Combining Trees and Pipes in VLSI", Technical Report CS-82-107, Dept. of Computer Science, Brandeis University, Waltham, MA, June, 1982.

“The Page-Control Macros for UNIX troff Typesetting”, Technical Report CS-82-106, Dept. of Computer Science, Brandeis University, Waltham, MA, September, 1982.

“Bridge: A Unix Experiment for Home Computer Services”, Technical Report 80-1352-13, Bell Laboratories Murray Hill, NJ, April, 1980.

"Improved Lower Bound for On-Line Two Dimensional Packing with Decreasing Width", Technical Report 79-1352-8, Bell Laboratories Murray Hill, NJ, July, 1979; also: "A Further Note Concerning On-Line Two Dimensional Bin Packing With Decreasing Width", Technical Report 80-1352-18, Bell Laboratories, Murray Hill, NJ, August, 1980.

“PLCC: A Compiler-Compiler for PL/1 and PL/C Users", Technical Report 236, Dept. of Electrical Engineering and Computer Science, Princeton University, Princeton, NJ, December, 1977.

“NP-Completeness Results Concerning Data Compression", Technical Report 234, Dept. of Electrical Engineering and Computer Science, Princeton University, Princeton, NJ, November, 1977.

“Non-Deterministic Switching Circuits”, manuscript, 1975.

APPENDIX 2: MATERIALS CONSIDERED IN THE PREPARATION OF THIS DECLARATION

Exhibit No.	Description
1001	U.S. Patent No. 8,934,535 to Fallon *et al.* ("'535 Patent")
1002	Prosecution File History for the '535 Patent
1003	Intentionally Omitted
1004	Japanese Patent Application Publication No. H11331305 to Imai *et al*. ("Imai").
1005	Certified English Translation of Imai
1006	U.S. Patent No. 6,507,611 to Imai *et al.* ("Imai")
1007	U.S. Patent No. 5,675,789 to Ishii *et al.* ("Ishii")
1008	Excerpt from Andreas Spanias *et al*., Audio Signal Processing and Coding (John Wiley & Sons, Inc., 2007)
1009	Excerpt from Raymond Westwater *et al*., Real-Time Video Compression Techniques and Algorithms (Kluwer Academic Publishers, 1997)
1010	Excerpt from David Salomon, A Guide to Data Compression Methods (Springer-Verlag New York, Inc., 2002)
1011	International PCT Application Publication WO 00/51243 to Park.
1012	U.S. Patent No. 5,873,065 to Akagiri et al.
1013	Memorandum Opinion and Order, *Realtime Data, LLC v. Rackspace US, Inc. et al.*, No. 6:16-CV-00961, Dkt. 183 (E.D. Tex. April 14, 2017)
1014	Memorandum Opinion and Order, *Realtime Data, LLC v. Actian Corp. et al.*, No. 6:15-CV-00463, Dkt. 362 (E.D. Tex. July 28, 2016)
1015	U.S. Patent No. 6,195,024 to Fallon (incorporated by reference into the '535 Patent)
1016	Notice of Interested Parties, Realtime Adaptive Streaming, LLC v. Hulu LLC, No. 2:17-CV-07611, Dkt. 18 (C.D. Cal. October 24, 2017)

APPENDIX 3: CHALLENGED CLAIMS

1. A method, comprising: determining, a parameter or an attribute of at least a portion of a data block having video or audio data; selecting one or more compression algorithms from among a plurality of compression algorithms to apply to the at least the portion of the data block based upon the determined parameter or attribute and a throughput of a communication channel, at least one of the plurality of compression algorithms being asymmetric; and compressing the at least the portion of the data block with the selected compression algorithm after selecting the one or more, compression algorithms.

2. The method of claim 1, further comprising: storing at least a portion of the compressed data block.

3. The method of claim 2, further comprising: retrieving at least a portion of the at least stored portion of the compressed data block based upon a user command or the throughput of the communication channel.

4. The method of claim 1, wherein selecting comprises: selecting the one or more compression algorithms to apply to the at least the portion of the data block based upon the determined parameter or attribute, the throughput of the communication channel, and a frequency of access of at least a portion of a second compressed or uncompressed data block.

5. The method of claim 1, wherein compressing comprises: compressing the at least the portion of the data block with the selected one or more compression algorithms based upon a user command.

6. The method of claim 1, wherein each compression algorithm from among the plurality of compression algorithms is asymmetric.

7. The method of claim 1, further comprising: determining the throughput of the communication channel by utilization of a portion of a memory device.

8. The method of claim 2, further comprising: retrieving at least a portion of the at least stored portion of the compressed data block based upon a utilization of one or more central processing units (CPUs).

9. An apparatus, comprising: a controller configured to: determine a parameter or an attribute of at least a portion of a data block having video or audio data, and select one or more compression algorithms from among a plurality of compression algorithms to determine a plurality of compression algorithms to apply to the at least the portion of the data block based upon the determined parameter or attribute and a throughput of a communication channel, at least one of the plurality of compression algorithms being asymmetric; and a data compression system configured to compress the at least the portion of the data block with the selected one or more compression algorithms.

10. The apparatus of claim 9, further comprising: a storage medium configured to store a portion of the at least compressed portion of the data block.

11. The apparatus of claim 10, wherein the data compression system is further configured to retrieve at least a portion of the at least stored portion of the at least compressed portion of the data block based upon the throughput of the communication channel or a user command.

12. The apparatus of claim 10, wherein the data compression system is further configured to: retrieve at least a portion of the at least stored portion of the at least compressed portion of the data block based upon the throughput of the communication channel; and retrieve at least a portion of a second compressed data block, compressed with one or more second compression algorithms from among the plurality of compression algorithms, based upon a second throughput of the communication channel, wherein at least one of the one or more second compression algorithms are different from at least one of the selected one or more compression algorithms, and wherein the second throughput of the communication channel is different from the throughput of the communication channel.

13. The apparatus of claim 12, wherein the controller is further configured to retrieve at least a portion of a third compressed data block that was compressed with one or more third compression algorithms from among the plurality compression algorithms based upon a third throughput of the communication channel, the third throughput of the communication channel differing from the first or the second throughputs of the communication channel.

14. The apparatus of claim 9, wherein the controller is configured to select the one or more compression algorithms to apply to the at least the portion of the data block based upon the determined parameter or attribute, the throughput of the communication channel, and a frequency of access of at least the portion of a second compressed or uncompressed data block.

15. The apparatus of claim 9, wherein the data compression system is configured to compress the at least the portion of the data block with the selected one or more compression algorithms based upon a user command.

16. The apparatus of claim 9, wherein each compression algorithm from among the plurality of compression algorithms is asymmetric.

17. The apparatus of claim 9, wherein the controller is further configured to determine the throughput of the communication channel by utilization of a portion of a memory device.

18. The apparatus of claim 10, wherein the data compression system is further configured to retrieve at least a portion of the at least stored portion of the compressed data block based upon a utilization of one or more central processing units (CPUs).

19. A method, comprising: determining a plurality of compression algorithms; selecting one or more compression algorithms from among the determined plurality of compression algorithms based upon a frequency of access of at least a portion of a compressed or uncompressed data block, at least one of the plurality of compression algorithms being asymmetric; and compressing, at least a portion of a second data block with the selected one or more compression algorithms.

20. The method of claim 19, further comprising: storing at least a portion of the at least compressed portion of the at least the portion of the second data block.

21. The method of claim 20, further comprising: retrieving at least a portion of the at least compressed portion of the at least the portion of the second data block based upon a throughput of a communication channel or a user command.

22. The method of claim 19, further comprising: selecting one or more second compression algorithms from among the determined plurality compression algorithms to apply to at least a portion of the second data block based upon a throughput of a communication channel.

23. The method of claim 19, wherein compressing comprises: compressing the at least the portion of the second data block with the selected one or more compression algorithms based upon a user command.

24. The method of claim 19, wherein each compression algorithm from among the plurality of compression algorithms is asymmetric.

25. An apparatus, comprising: a controller configured to: determine a plurality of compression algorithms, at least one of the plurality of compression algorithms being asymmetric, and select one or more compression algorithms from among the determined plurality of compression algorithms based upon a frequency of access of at least a portion of a compressed or uncompressed data block; and a data compression system configured to compress at least a portion of a second data block with the selected one or more compression algorithms.

26. The apparatus of claim 25, further comprising: a storage medium configured to store at least portion of the compressed portion of the at least the portion of the second data block.

27. The apparatus of claim 26, wherein the data compression system is further configured to retrieve a portion of the stored portion of the at least compressed portion of the at least the portion of the second data block based upon a throughput of a communication channel or a user command.

28. The apparatus of claim 25, wherein the controller is further configured to select one or more second compression algorithms from among the determined plurality compression of algorithms to apply to the at least the portion of the second data block based upon a throughput of a communication channel.

29. The apparatus of claim 25, wherein the data compression system is configured to compress the at least the portion of the second data block with the selected one or more compression algorithms based upon a user command.

30. The apparatus of claim 25, wherein each compression algorithm from among the plurality of compression algorithms is asymmetric.

APPENDIX 4: MAPPING BETWEEN IMAI U.S. PATENT AND IMAI (ENGLISH TRANSLATION OF JP PUBLICATION)

Ex. 1006 - Imai U.S. Patent (Col. No.)	**Ex. 1005 – Imai English Translation of JP Pub. (Paragraph Range)**
Abstract	[Abstract], [Problem to be Solved], [Solution Means]
1	[0001] – [0006]
2-4	No direct mapping. *See generally* [0007] – [0049]
4-5 (Brief Description of Drawings)	Page 55 [Brief explanation of the figures]
5	[0050] – [0056]
6	[0057] – [0067]
7	[0067] – [0073]
8	[0073] – [0083]
9	[0083] – [0090]
10	[0091] – [0096]
11	[0096] – [0103]
12	[0103] – [0110]
13	[0110] – [0118]
14	[0119] – [0125]
15	[0126] – [0133]
16	[0133] – [0140]
17	[0141] – [0145]
18	[0146] – [0153]
19	[0154] – [0162]
20	[0162] – [0172]
21	[0173] – [0181]
Claims	No direct mapping. *See generally* Pages 2-20 [Claim 1] – [Claim 99].