UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.,
Petitioner,

v.

CALIFORNIA INSTITUTE OF TECHNOLOGY,
Patent Owner.

Case IPR2017-00700
Patent No. 7,421,032

DECLARATION OF DR. R. MICHAEL TANNER

I, Robert Michael Tanner, declare as follows:

I. QUALIFICATIONS

1. I am Chief Academic Counsel at the Association of Public and Land-grant Universities (APLU), in which position I have served since my retirement in 2015. I had previously served as APLU's Vice President for Academic Affairs and Chief Academic Officer since 2011.

2. Prior to my work at APLU, I taught as a professor of Computer Science and Electrical Engineering at the University of Illinois at Chicago and at the University of California, Santa Cruz. I also served in Vice Chancellor positions at both institutions, as well as other administrative roles. I have also been a visiting professor at institutions including the California Institute of Technology ("Caltech"), the Massachusetts Institute of Technology, and Stanford University, and I worked in the 1980s as a consultant to companies in the disk and telecommunication industries.

3. In 1981, I authored a paper titled "A Recursive Approach to Low Complexity Codes," in which I proposed a new method of graphically representing the constraint equations governing the codeword elements in sparse check matrix codes. This graphical representation, called a "Tanner graph," is named after me. My contributions to the field of coding have led me to be recognized as the founder of the subfield "codes on graphs."

4. My professional research interests have concentrated on topics involving information and communication theory, and on the theory of algorithms and computational complexity. Significant areas on which I have focused have included: a) development of highly efficient error-correcting codes that are amenable to decoding with ultra-concurrent iterative algorithms; and b) the theoretical and algorithmic reconciliation of block and convolutional codes.

5. I received a Ph.D. in Electrical Engineering with Specialization in Information Theory from Stanford in 1971. I also hold a Master's Degree from Stanford in Electrical Engineering and a Bachelor's Degree from Stanford in Electrical Engineering, which I received in 1967 and 1966, respectively.

6. A copy of my Curriculum Vitae, provided as Exhibit 2002, contains further details on my education, experience, publications, patents, and other qualifications to render an expert opinion in this matter.

II. SCOPE OF WORK

7. I was asked by counsel for Caltech to review U.S. Patent No. 7,421,032 ("the '032 patent") and related applications, including Provisional Application No. 60/205,095 ("the '095 provisional application"). I receive $400 per hour for my services. No part of my compensation is dependent on my opinions or on the outcome of this proceeding.

8. I also reviewed the papers "Comparison of constructions of irregular Gallager codes," by David J. C. MacKay *et al*. ("MacKay," Ex. 1002), "Coding Theorems for 'Turbo-Like' Codes" by Dariush Divsalar *et al.* ("Divsalar," Ex. 1017), and "Low Density Parity Check Codes" by Li Ping *et al*. ("Ping," Ex. 1003).

9. I was asked to provide my understanding of whether "irregularity" as discussed in MacKay indicates that the underlying code includes irregularity with respect to message bits (or "information bits"), specifically. In my opinion, it does not.

10. MacKay describes "irregular" LDPC codes, but does not thereby disclose encoding with irregular repetition as in the '032 patent claims. Ping provides an example that illustrates this point. As described in further detail below, Ping discloses a coding scheme with regular information bit column weights, corresponding to information bits with regular degrees in a Tanner graph, yet nonetheless has nonuniform column weights overall, due to the parity bit columns of its parity check matrix. Thus, Ping's code could be represented as an "irregular" Tanner graph as MacKay defines the term, yet fails to include irregular repetition of message bits as required by the claims of the '032 patent.

III. OVERVIEW

11. The ’032 patent discloses a serially-concatenated interleaved convolutional code with an outer code and an inner code. Ex. 1001, Title, Abstract. The ’032 patent describes embodiments in which the outer code irregularly repeats bits in a data block, which are then scrambled by a permuter. *Id*. at Abstract, 1:60-2:3. Alternatively, the outer coder may be a low-density generator matrix encoder. *Id.*

12. The specification of the ’032 patent identifies the outer coder as irregular, meaning that it could be a repeater that repeats different bits in a block a different number of times. *See id*. at 2:50-60.

13. The scrambled, or interleaved, bits are then subjected to a second encoding, which includes one or more accumulators that perform modulo two addition. *Id*. at 2:4-12, 2:66-3:20.

14. Modulo two addition is an exclusive-or operation, often called XOR, and denoted with the symbol $\oplus$. The modulo-two addition of two bits is shown below:

A	**B**	**A⊕B**
0	0	0
0	1	1
1	0	1
1	1	0

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