

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Mercedes-Benz USA, LLC,
Petitioner,

v.

Daedalus Prime LLC,
Patent Owner.

Case No. IPR2023-01333
Patent 10,049,080

**PETITIONER'S REPLY TO
PATENT OWNER'S RESPONSE**

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LIST OF EXHIBITS¹

Ex-1001	U.S. Patent No. 10,049,080 to George et al. (“the ’080 Patent”)
Ex-1002	Declaration of Dr. Trevor Mudge submitted in IPR2023-00567
Ex-1003	Curriculum Vitae of Dr. Trevor Mudge
Ex-1004	Prosecution History of the ’080 Patent (Application No. 15/431,527)
Ex-1005	U.S. Patent Pub. No. 2011/0213950 to Mathieson et al. (“Mathieson”)
Ex-1006	U.S. Patent Pub. No. 2009/0309243 to Carmack et al. (“Carmack”)
Ex-1007	U.S. Patent Pub. No. 2008/0288748 to Sutardja et al. (“Sutardja ’748”)
Ex-1008	U.S. Patent Pub. No. 2007/0083785 to Sutardja (“Sutardja ’785”)
Ex-1009	U.S. Patent Pub. No. 2011/0145615 to Rychlik et al. (“Rychlik”)
Ex-1010	Prosecution History of U.S. Patent No. 9,569,278 (“the ’278 Patent”)
Ex-1011	INTENTIONALLY LEFT BLANK
Ex-1012	INTENTIONALLY LEFT BLANK
Ex-1013	INTENTIONALLY LEFT BLANK
Ex-1014	INTENTIONALLY LEFT BLANK
Ex-1015	INTENTIONALLY LEFT BLANK

¹ Four-digit pin citations that begin with 0 are to the branded numbers added by Mercedes in the bottom right corner of the exhibits. All other pin citations are to original page, column, paragraph, or line numbers.

Ex-1016	INTENTIONALLY LEFT BLANK
Ex-1017	INTENTIONALLY LEFT BLANK
Ex-1018	INTENTIONALLY LEFT BLANK
Ex-1019	INTENTIONALLY LEFT BLANK
Ex-1020	Claim Mapping Table
Ex-1021	INTENTIONALLY LEFT BLANK
Ex-1022	U.S. Patent Pub. No. 2006/0095807 to Grochowski (“Grochowski”)
Ex-1023	U.S. Patent Pub. No. 2012/0317568 to Aasheim (“Aasheim”)
Ex-1024	Jeffrey C. Mogul et al., <i>Operating Systems and Asymmetric Single-ISA CMPs: The Potential for Saving Energy</i> , Hewlett-Packard Development Company, L.P. (2007)
Ex-1025	Juan Carlos Saez et al., <i>Operating System Support for Mitigating Software Scalability Bottlenecks on Asymmetric Multicore Processors</i> , ACM 978-1-4503-004-5/10/05 (2010)
Ex-1026	U.S. Patent No. 7,093,147 to Farkas et al. (“Farkas”)
Ex-1027	Charles Lefurgy et al., <i>Energy Management for Commercial Servers</i> , Computer 39 (Dec. 2003).
Ex-1028	Yushi Shen et al., <i>Enabling the New Era of Cloud Computing: Data Security, Transfer, and Management</i> (Information Science Reference 2014).
Ex-1029	Stefanos Kaxiras and Margaret Martonosi, <i>Computer Architecture Techniques for Power-Efficiency</i> , in Synthesis Lectures on Computer Architecture #4 (Morgan & Claypool 2008).
Ex-1030	Vasanth Venkatachalam and Michael Franz, <i>Power Reduction Techniques For Microprocessor Systems</i> , 37 ACM Computing Surveys 195 (2005).
Ex-1031	Euiseong Seo et al., <i>Energy Efficient Scheduling of Real-Time</i>

	<i>Tasks on Multicore Processors</i> , 19 IEEE Transactions on Parallel and Distributed Systems 1540 (Nov. 2008).
Ex-1032	Rakesh Kumar et al., <i>Single-ISA Heterogeneous Multi-Core Architectures: The Potential for Processor Power Reduction</i> , Proceedings of the 36 th International Symposium on Microarchitecture (MICRO-36 2003), IEEE Computer Society (2003).
Ex-1033	U.S. Patent No. 8,615,647 to Hum et al. (“Hum”)
Ex-1034	Declaration of Dr. Robert Horst
Ex-1035	<i>Curriculum Vitae</i> of Dr. Robert Horst
Ex-1036	Declaration of Damon M. Lewis
Ex-1037	Declaration of Jiaying (Kyle) Xu
Ex-1038	Brogioli Deposition Transcript

I. Introduction

Patent Owner's Response ("POR") bases its arguments on incorrect assumptions about the technologies disclosed in Sutardja and Mathieson. However, the correct reading of these references, as described in the Petition and confirmed at deposition by Patent Owner's expert, erases any alleged inconsistencies and deficiencies.

First, Patent Owner incorrectly describes Sutardja as failing to disclose an "operating system ... [to] control power management hardware" by muddying Petitioner's argument regarding Sutardja's disclosed "core switching module." To avoid it meeting the claim limitation, Patent Owner argues that Sutardja's "core switching module" is "software" (and thus cannot be power management *hardware*), and that Sutardja's "system call" from the operating system fails to enact "control." But Patent Owner misunderstands the Petition, which describes the power management hardware as the "hardware controlled by the core switching module", i.e., the hypervisor module 213. Petition at 32-33. Specifically, Sutardja discloses "power management hardware" in the form of a disclosed below-the-kernel (bare metal) "hypervisor module", which in turn, Sutardja discloses, "may be integrated with" the "core switching module." Sutardja's operating system "controls" a transition between cores when it sends a "system call" to the "power management hardware" to "trigger" the transition.

Second, Patent Owner argues that Mathieson's "controller" cannot be part of the "operating system" because it operates "transparently" to the operating system. But as Patent Owner's expert explains, a kernel of an operating system normally operates transparently to higher-level application software within the same operating system. The "controller" is part of such a kernel. Finally, contrary to Patent Owner's arguments, Mathieson's disclosure of cores which consume less power for the same applied frequency discloses that those cores consume less power for the same supply voltage.

II. Claim Construction and Level of Ordinary Skill in the Art

Patent Owner argues that the Petition's definition of a POSITA improperly encompasses people with more than ordinary skill in the art. POR, 12. This distinction is irrelevant. One with greater than "ordinary" skill necessarily meets the definition of a POSITA; the POSITA definition is a floor, not a ceiling.

Patent Owner next presents an alleged claim construction for "operating system." POR, 12-13. Because Patent Owner construes "operating system" "in its conventional sense" and cites its dictionary definition, Petitioner understands Patent Owner to concede that the term should be understood in accordance with its plain meaning. In other words, "operating system" does not require construction. POR, 12-13; Petition, 15.

III. The Petition's Arguments Regarding Sutardja Were not Considered During Prosecution of the '080 Patent

Patent Owner argues that both Sutardja '748 and its parent, Sutardja '324, were considered by the Examiner during prosecution. POR, 17, citing Ex. 1004 at 84. That Sutardja '748 and Sutardja '324 appear in the prosecution history of the '080 Patent does not mean that the Examiner considered the Sutardja references in the manner presented by the Petition. First, the prosecution history shows that the Examiner did not use either Sutardja reference to reject any of the independent claims. Petition, 8. Second, where Sutardja was used to reject dependent claims, the Applicant did not dispute any of Sutardja's disclosures. *Id.*, 8-9.

IV. Sutardja Discloses an Operating System which Controls Power Management Hardware

A. Independent Claim 1

Patent Owner presents two reasons to argue that Sutardja does not disclose the limitations of the '080 patent: that Sutardja's "operating system" does not "control" the "power management hardware;" and that Sutardja's "core switching module," *if it is mapped to* the "power management hardware," is not equivalent to that hardware. POR, 21-28.

Turning to the latter argument first, as noted in the Petition, Sutardja's "power management hardware" is the "*hardware controlled by* the core switching module," i.e. the "hypervisor" in which the "core switching module" can be integrated. Petition, 32-33; POR, 24; *see, e.g.* Sutardja, [0271-72]. Nowhere does Patent Owner dispute that these disclosures correspond to "power management hardware." POR,

22-28. In fact, by referencing both forms of Sutardja's underlying hardware later in its Response, Patent Owner implicitly concedes that they are "power management hardware." *Id.*, 25-28.

Patent Owner misunderstands the Petition,² instead correlating the "core switching module" *itself* to the power management hardware with that mis-mapping being allegedly "fatal" to the entirety of Sutardja's disclosures. POR, 25. This is not Petitioner's argument. Even if Patent Owner were correct (which it is not), this alternative mapping does not negate Petitioner's argument that that Sutardja discloses "power management hardware."

Next, Patent Owner argues that Sutardja's "core switching module" cannot correspond to the "power management hardware" because it is software. POR, 25-26. Yet the distinction between hardware and software is not as defined as Patent

² The Petition states that Sutardja's "operating system...controls the power management hardware (core switching module)." Petition, 35. The Patent Owner mistakes this as an inconsistency, POR, 25, but as the Petition notes, Sutardja discloses that the "core switching module" could be implemented either in a software hypervisor or a hardware hypervisor. Petition at 33 ("Sutardja teaches that the hypervisor may 'operate[] above the kernel' or it 'may operate below the kernel,'" indicating implementation on either of the hardware or in the operating system).

Owner insists. *Every time* the '080 Patent mentions “hardware,” it discloses “software” or “firmware” as an alternative means to accomplish the same function. '080 Patent, 4:47-53; 5:59-63. Furthermore, even if Sutardja’s “core switching module” is software, a POSITA reading Sutardja would understand that it could be implemented on the disclosed hardware hypervisor. Petition at 33 (hypervisor can be implemented in hardware or in the operating system); Horst Decl. ¶ 117 (a bare metal hypervisor “execute commands” against the hardware); *see also* Deposition Transcript of Dr. Michael Brogioli (“Brogioli Dep.”), 51:21-52:4 (conceding that logic, such as executable microcode, once implemented on a chip is “hardware”).

Second, Patent Owner argues that Sutardja’s operating system does not “control” the “power management hardware,” because its “PMS module” and “kernel module” merely send “system calls” to the “power management hardware,” instead of controlling it by manipulating it directly. POR, 27-28. Patent Owner asserts that a “system call to a hyper visor module 213 or a core switching module 212” does not equate to “control” of such structures, but provides no evidence to support this constrictive interpretation.³ *Id.* This argument is flawed. In Sutardja, the

³ The '080 Patent does not explain what it means by “control.” *See, e.g.,* '080 Patent, 5:56-63; *see also* Brogioli Dep., 84:3-12 (Dr. Brogioli is not aware of whether the '080 Patent explains the meaning of “control”).

PMS module/kernel module of the operating system “generate[s] *a system call* to the hypervisor module 213 or a core switching module 212 *to trigger a transition.*” Sutardja, [0253]; Petition, 35. In other words, the purpose of the system call is to effect the transition, and therefore, the system call *controls* the occurrence of the transition. Sutardja even refers to the call as “*a control message...*[sent from the PMS module] to the core switching module 212.” Sutardja, [0260-61].

In sum, Sutardja’s operating system *controls*, via “system calls,” various forms of *power management hardware* which execute the transition between cores: the “core switching module,” or the hardware underlying the “core switching module,” such as the “hypervisor.”

B. Claims 2-24

Patent Owner presents no separate arguments for the patentability of independent claims 9 and 17 over Sutardja. POR, 28-29.

Similarly, Patent Owner does not present separate arguments for the patentability of dependent claims 2-4, 7, 8, 10-12, 15, 16, 18-20, 23, or 24 over Sutardja; dependent claims 5, 6, 13, 14, 21, or 22 over Sutardja and Rychlik; or dependent claims 7, 15, and 23 over Sutardja and Carmack. POR, 29-30.

Therefore, Patent Owner’s arguments for the remaining limitations of claims 2-24 rise or fall with its arguments as to claim 1. *See* Petition, 35-53.

V. Mathieson and Sutardja Disclose Each Element of Claim 1

A. Mathieson's Controller Corresponds to the Claimed Operating System

Patent Owner first argues that Mathieson's "controller" cannot correspond to the claimed "operating system" because it functions "transparently to" the operating system. POR, 34-36. However, because operating systems have many layers, Brogioli Dep., 28:4-18, 30:8-15 (recognizing layers of an operating system), it is not inconsistent for the "controller" to both be *part of* a low level of the operating system and operate "transparently to" a higher level of the operating system. See Brogioli Dep., 31:2-21 (recognizing that low level kernel functions are transparent to high level applications on the operating system).

Typically, "[t]he lowest level of the operating system" is the kernel, and the kernel executes "modules" which "control processes and manage devices within the processor." Declaration of Dr. Robert Horst ("Horst Decl.") (EX. 1034), ¶217. As Patent Owner's expert put it, the kernel is "a piece of software that's rather low level that implements certain functionality that *other layers* -- software layers *of the operating system* interface with ...[and] rely upon." Brogioli Dep., 28:2-8. The kernel normally operates transparently to the higher-level layers of the operating system, such as the layers which run application software. Brogioli Dep., 30:18-32:25.

Mathieson's "controller" is an example of a "module" which would be executed by that layer of the operating system known as the kernel. Horst Decl., ¶217. Mathieson states that the "controller" functions "transparently to *higher level software*, such as the operating system." Mathieson, [0043]. As Patent Owner's expert confirmed at deposition, Mathieson uses the phrase "higher level software, such as the operating system" to refer, not to the *entire* operating system, but to *a level within* the operating system that is higher than the kernel. See Brogioli Dep., 89:23-92:13 (explaining that "higher level" in this context refers to upper layers of the software stack, such as application software). Therefore, the two concepts are not inconsistent: Mathieson's "controller" is both *part of* the kernel of the operating system and operating *transparently to* the operating system's higher levels.

**B. Mathieson Discloses Power Consumption Based on Both
Frequency and Voltage**

Next, Patent Owner argues that Mathieson does not disclose cores which consume less power for the same "supply voltage," because core power in Mathieson is only described in relation to operating frequency. POR, 38-43. However, as Dr. Horst explains, "the frequency of operation" for a core "is directly proportional to

the voltage (i.e., f is proportional to V).”⁴ Horst Decl., ¶48. “Thus, higher frequency requires a greater core voltage resulting in the consumption of much more power.” *Id.* When Mathieson’s cores consume less power for the same “operating frequency,” they also, necessarily, consume less power for the same “supply voltage.” Mathieson, [0076] (“vary the voltage and/**or** operating frequency of the active cores may cause the processor to operate at a lower total power consumption,” the permissive “or” allowing for consuming less power for the same supply voltage when altering the frequency). Contrary to Patent Owner’s argument, Mathieson does not need to *describe* core operation in terms of “voltage” for this to be true. POR, 42.

VI. Mathieson and Sutardja Disclose Each Element of Claims 2-24

Patent Owner presents no separate arguments for the patentability of independent claims 9 and 17 over Mathieson and Sutardja. POR, 43.

Similarly, Patent Owner does not present separate arguments for the patentability of dependent claims 2-4, 7, 8, 10-12, 15, 16, 18-20, 23, or 24 over

⁴ In a footnote, Dr. Horst explains that the voltage must be at a level proportional to the frequency *or higher*. Horst Decl., ¶48 n. 5. In other words, while voltage and frequency *are normally* proportional, if a core’s voltage becomes temporarily higher than the proportional voltage amount, the core can still function.

Mathieson and Sutardja; or for the patentability of dependent claims 5, 6, 13, 14, 21, or 22 over Mathieson, Sutardja and Rychlik. POR, 43-44.

Therefore, Patent Owner does not dispute that the Petition's proposed combinations of Mathieson, Sutardja, and Rychlik, disclose all remaining limitations of claims 2-24. See Petition, 35-53.

VII. Conclusion

For the reasons above and in the Petition, the Board should find the challenged claims unpatentable.

Dated: August 15, 2024

Respectfully submitted,

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Certificate of Word Count

The undersigned certifies, in accordance with 37 C.F.R. § 42.24(d), that the foregoing **PETITIONER'S REPLY TO PATENT OWNER'S RESPONSE** complies with the type-volume limitation of 5,600 words, comprising 2,029 words, excluding the parts exempted by § 42.24(c).

Dated: August 15, 2024

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Certificate of Service

The undersigned certifies that, in accordance with 37 C.F.R. § 42.6(e) and 37 C.F.R. § 42.105, the foregoing **PETITIONER'S REPLY TO PATENT OWNER'S RESPONSE** was served on August 15, 2024, electronically via e-mail upon the following parties:

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