ADMINISTRATIVE DECISION-MAKING IN PATENT PROCEEDINGS: EXPERT TESTIMONY EFFECTIVENESS AND INSTITUTIONAL PATTERNS — EMPIRICAL EVIDENCE FROM SIX LOW PRECISION HIGH DYNAMIC RANGE PATENT IPR CASES

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ABSTRACT

When Google challenged Singular Computing's Low Precision High Dynamic Range patents across six inter partes review proceedings (IPR-154, IPR-155, IPR-164, IPR-165, IPR-178, IPR-179), the litigation created controlled experimental conditions for analyzing expert testimony effectiveness. The technology underlying $1.67 billion alleged damages was at issue in litigation that settled on undisclosed terms in January 2024 involved expert declarants Richard Goodin (Google) and Sunil Khatri (Singular Computing) deploying contrasting methodologies for identical panels comprising Judges

* California Bar #355771; USPTO Registration #83,143. An electronic copy of this paper is available online. *See* Anish King, *Administrative Decision-Making in Patent Proceedings: Expert Testimony Effectiveness and Institutional Patterns* (2025) https://ssrn.com/abstract=5325030 [https://perma.cc/FB7Q-R26E]. Law Clerk to the Honorable William A. Taylor, Alaska Superior Court, Third Judicial District. B.S., Computer Engineering, Columbia University; J.D., Tulane University Law School. The author thanks Professors Elizabeth Townsend Gard and Brian L. Frye for their mentorship.

Arbes, Sawert, and Repko for institution decisions and Judges Arbes, White, and Repko for final written decisions.

Mr. Goodin's abstract analytical frameworks faced rejection through identical template language: "we cannot agree that the claim requires 'at least one selection' from three classes of infinitely combinable and unpredictable 'variables.'" His IEEE-754 standards-based approaches achieved institution and partial claim invalidation, supported by mathematical verification across 2^{46} combinations with substantial compliance margins exceeding patent requirements. Dr. Khatri's defensive positioning emphasized specification-anchored argumentation over complex framework challenges, creating a natural experiment in methodological effectiveness.

These preliminary findings from the controlled comparison suggest a clear authority hierarchy: patent specification > technical standards > expert opinion. Success correlated with specification-anchored language rather than expert-generated analytical structures across both offensive and defensive strategies. Administrative decisions clustered within three days (May 12-14, 2021) and within a single day (May 11, 2022) have word-for-word language replication across Patent Trial and Appeal Board proceedings, suggesting template-driven evaluation. The systematic comparison within the Low Precision High Dynamic Range (LPHDR) patent family demonstrates how expert positioning affects administrative reception in complex technical patent proceedings, establishing an analytical groundwork for both patent prosecution strategy and administrative law scholarship.

Deposition analysis revealed that complex analytical frameworks requiring extensive external coordination exhibited systematic vulnerabilities under real-time pressure, while specification-anchored *positioning demonstrated enhanced resistance. The evolution of prior art strategy showed how methodological characteristics rather than technical content influenced institutional evaluation patterns.*

Multi-reference combination analysis showed near-identical phrasing in PTAB rejections, with design philosophy incompatibility creating evaluation barriers independent of technical merit. Secondary considerations evidence constructed through Google TPU commercial deployment faced systematic institutional rejection, with the PTAB utilizing Patent Owner expert testimony to support obviousness arguments while identifying unclaimed features that destroyed presumptive nexus.

These institutional reception patterns establish an empirical foundation for understanding administrative behavioral consistency in complex technical proceedings while providing a strategic framework for optimizing expert testimony in patent litigation contexts.

The empirical findings provide a systematic foundation for expert testimony optimization in PTAB litigation based on observed institutional patterns rather than anecdotal experience. Expert declaration development should prioritize evidence sources according to the documented authority hierarchy: patent specification citations, established technical standards, and expert interpretation. Successful declarations should consistently anchor analysis in specification language rather than expert-created analytical frameworks. Deposition preparation should emphasize specification mastery and documentary authority correspondence. Prior art strategy development should consider temporal security, design philosophy compatibility, and the combination of complexity effects based on systematic correlation between methodological characteristics and administrative outcomes.

The evidentiary basis remains limited to six related proceedings within the LPHDR patent family, constraining conclusions about broader applicability despite the controlled comparison conditions achieved. Temporal clustering within concentrated timeframes may reflect period-specific evaluation tendencies rather than stable institutional processing patterns. Panel composition effects present limitations through identical compositions potentially introducing systematic evaluation patterns unrelated to expert methodology characteristics. Cross-domain validation requirements encompass replication studies across multiple patent families and varying tribunal contexts, with the controlled comparison methodology potentially adaptable to federal district court patent litigation, International Trade Commission investigations, and federal circuit appeals involving complex technical evidence.

Future research opportunities include longitudinal analysis tracking expert methodology evolution, comparative expert analysis examining different declarants employing similar approaches, and systematic empirical investigation of template usage patterns across broader regulatory contexts. The investigation of template usage patterns could determine whether the documented institutional behavioral characteristics represent patent-specific phenomena or systematic administrative decision-making approaches in complex technical proceedings.

I. Offensive Expert Declaration Methodology in IPR Proceedings

A. Introduction

Expert declarations in inter partes review (IPR) proceedings represent a critical component of patent litigation strategy.[1] Despite their central role in post-grant proceedings, no prior study has examined expert declaration methodology to analyze the relationship between technical presentation approaches and Patent Trial and Appeal Board decision-making patterns. [2] This gap proves particularly significant in complex technical patent proceedings, where expert declarations must address both legal sufficiency standards and technical verification requirements across massive parameter spaces.[3]

The present analysis addresses this scholarly void through examination of expert declaration methodologies across six related IPR proceedings targeting Singular Computing's LPHDR patent family.[4]

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[1] 35 U.S.C. § 316(a)(5), (8) (providing for expert declarations and discovery of declarants); *see generally* 35 U.S.C. §§ 311–319 (detailing inter partes review).

[2] *See* Christian Helmers & Brian J. Love, *Patent Validity and Litigation: Evidence from US Inter Partes Review*, 66 J.L. & Econ. 53 (2023) (analyzing how IPR filings and institution decisions affect settlement of parallel district court litigation); Brian J. Love, Shawn P. Miller & Shawn Ambwani, *Determinants of Patent Quality: Evidence from Inter Partes Review Proceedings*, 90 U. Colo. L. Rev. 67 (2019) (studying patent-level characteristics that predict IPR institution outcomes); Saurabh Vishnubhakat, *Patent Inconsistency*, 97 Ind. L.J. 59 (2022) (documenting duplicative litigation between the PTAB and federal courts); Stephen Yelderman, *Prior Art in Inter Partes Review*, 104 Iowa L. Rev. 2705 (2019) (examining categories of prior art underlying PTAB claim cancellations). No study has systematically analyzed the relationship between expert declaration methodology and PTAB reception patterns within individual proceedings.

[3] *See generally* Decision Denying Institution of *Inter Partes* Review, No. IPR2021-00154 (P.T.A.B. May 12, 2021) [hereinafter IPR-154] (illustrating rejection of expert methodology that failed to demonstrate technical correspondence to patent claim limitations).

[4] *See* IPR-154, *supra* note 3; Decision Granting Institution of *Inter Partes* Review, No. IPR2021-00155 (P.T.A.B. May 12, 2021) [hereinafter IPR-155]; Decision Denying Institution of *Inter Partes* Review, No. IPR2021-00164 (P.T.A.B. May 13, 2021) [hereinafter IPR-164]; Decision Granting Institution of *Inter Partes* Review, No. IPR2021-00165 (P.T.A.B. May 13, 2021) [hereinafter IPR-165];

These proceedings present case study conditions where identical expert declarant Richard Goodin's declarations contained contrasting methodological approaches supporting different invalidity grounds across three related patents with varying technical parameters.[5] This controlled environment enables systematic examination of how methodological variations correlate with tribunal reception patterns while controlling expert identity and panel composition variables.

The study examines three related patents in Singular Computing's LPHDR portfolio.[6] The earlier patents—U.S. Patent No. 8,407,273 (filed February 17, 2012) and U.S. Patent No. 9,218,156 (filed March 25, 2013)—establish stringent performance thresholds requiring $X = 5\%$ and $Y = 0.05\%$.[7] By contrast, U.S. Patent No. 10,416,961 (filed

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Decision Denying Institution of *Inter Partes* Review, No. IPR2021-00178 (P.T.A.B. May 14, 2021) [hereinafter IPR-178]; Decision Granting Institution of *Inter Partes* Review, No. IPR2021-00179 (P.T.A.B. May 14, 2021) [hereinafter IPR-179]; Final Written Decision, No. IPR2021-00155 (P.T.A.B. May 11, 2022) [hereinafter IPR-155 Final]; Final Written Decision, No. IPR2021-00165 (P.T.A.B. May 11, 2022) [hereinafter IPR-165 Final]; Final Written Decision, No. IPR2021-00179 (P.T.A.B. May 11, 2022) [hereinafter IPR-179 Final]; U.S. Patent No. 8,407,273 (filed Feb. 17, 2012) [hereinafter '273 Patent]; U.S. Patent No. 9,218,156 (filed Mar. 25, 2013) [hereinafter '156 Patent]; U.S. Patent No. 10,416,961 (filed Oct. 30, 2018) [hereinafter '961 Patent].

[5] *See generally* Declaration of Richard Goodin, No. IPR2021-00155 (P.T.A.B. Oct. 30, 2020) [hereinafter Goodin Decl. 154-5]; Declaration of Richard Goodin, No. IPR2021-00165 (P.T.A.B. Nov. 5, 2020) [hereinafter Goodin Decl. 164-5]; Declaration of Richard Goodin, No. IPR2021-00179 (P.T.A.B. Nov. 6, 2020) [hereinafter Goodin Decl. 178-9].

[6] *See* '273 Patent, *supra* note 4; '156 Patent, *supra* note 4; '961 Patent, *supra* note 4.

[7] '273 Patent, *supra* note 4, at col. 30 l. 6–16; '156 Patent, *supra* note 4, at col. 29 l. 62-col. 30 l. 4.

October 30, 2018) employs relaxed parameters requiring *X = 10%* and *Y = 0.2%*.[8] Google challenged each patent through dual IPR proceedings, creating a systematic pattern where institution was denied in three cases (IPR-154, IPR-164, IPR-178) and granted in three others (IPR-155, IPR-165, IPR-179).[9]

The proceedings establish an empirical foundation for analyzing tribunal behavior through the documented verbatim language replication across multiple decisions.[10] Crucially, panel compositions were identical across all six institution decisions and separately identical across all three final written decisions, with one member substitution between phases, eliminating variables related to individual judicial preferences and enabling focus on methodological factors.[11]

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[8] '961 Patent, *supra* note 4, at col. 30 l. 25-34.

[9] IPR-154, *supra* note 3, at 1; IPR-155, *supra* note 4, at 1; IPR-164, *supra* note 4, at 1; IPR-165, *supra* note 4, at 1; IPR-178, *supra* note 4, at 1; IPR-179, *supra* note 4, at 1.

[10] *Compare* IPR-154, *supra* note 3, at 18 (using identical language), *with* IPR-164, *supra* note 4, at 18 (using identical language), *and* IPR-178, *supra* note 4, at 18 (same).

[11] *Compare* IPR-154, *supra* note 3, at 1 ("Before JUSTIN T. ARBES, KRISTI L. R. SAWERT, and JASON M. REPKO[.]"), *and* IPR-155, *supra* note 4, at 1 ("Before JUSTIN T. ARBES, KRISTI L. R. SAWERT, and JASON M. REPKO[.]"), *and* IPR-164, *supra* note 4, at 1 ("Before JUSTIN T. ARBES, KRISTI L. R. SAWERT, and JASON M. REPKO[.]"), *and* IPR-165, *supra* note 4, at 1 ("Before JUSTIN T. ARBES, KRISTI L. R. SAWERT, and JASON M. REPKO[.]"), *and* IPR-178, *supra* note 4, at 1 ("Before JUSTIN T. ARBES, KRISTI L. R. SAWERT, and JASON M. REPKO[.]"), *and* IPR-179, *supra* note 4, at 1 ("Before JUSTIN T. ARBES, KRISTI L. R. SAWERT, and JASON M. REPKO[.]"), *with* IPR-155 Final, *supra* note 4, at 1 ("Before JUSTIN T. ARBES, STACEY G. WHITE, and JASON M. REPKO[.]"), *and* IPR-165 Final, *supra* note 4, at 1 ("Before JUSTIN T. ARBES, STACEY G. WHITE, and JASON M. REPKO[.]"), *and* IPR-179 Final, *supra* note 4, at 1 ("Before JUSTIN T. ARBES, STACEY G. WHITE, and JASON M. REPKO[.]").

B. Empirical Analysis

1. Decision Language Patterns

The systematic examination of tribunal decision language reveals remarkable consistency in Patent Trial and Appeal Board ("PTAB") analytical frameworks across related proceedings. Expert declarant Richard Goodin's declarations supporting different legal theories generated distinctly different reception patternsExpert declarant, with word-for-word language correlation emerging within similar outcome categories.[12] While these patterns suggest possible relationships between methodological approaches and tribunal reception, causation remains unestablished.[13]

Pattern Element	IPR-164 ('156)	IPR-154 ('961)	IPR-178 ('273)
Legal Theory	"three classes"[a]	"three classes"[b]	"three classes"[c]
Board Rejection	"cannot agree"[d]	"cannot agree"[e]	"cannot agree"[f]

Table 1.1: Categorical Framework Patterns Across Institution Denied Proceedings.[14]

Notes: a-c. IPR-164 at 16; IPR-154 at 16; IPR-178 at 15 (identical "three classes of variables" framework); d-f. IPR-164 at 18; IPR-154 at 18; IPR-178 at 18 (identical

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[12] Goodin Decl. 154-5, *supra* note 5, ¶¶ 61–64; Goodin Decl. 164-5, *supra* note 5, ¶¶ 62–64; Goodin Decl. 178-9, *supra* note 5, ¶¶ 62–64; *Compare* IPR-154, *supra* note 3, at 18 ("[W]e cannot agree that the claim requires 'at least one selection' from three classes of infinitely combinable and unpredictable 'variables.'"); IPR-164, *supra* note 4, at 18 (same); IPR-178, *supra* note 4, at 18 (same), *with* IPR-155, *supra* note 4 (granting institution); IPR-165, *supra* note 4 (granting institution); IPR-179, *supra* note 4 (granting institution).

[13] *See supra* note 12 and accompanying text (documenting correlation without establishing causation between methodology and outcome).

[14] IPR-154, *supra* note 3, at 16, 18; IPR-164, *supra* note 4, at 16, 18; IPR-178, *supra* note 4, at 15, 18.

rejection: "cannot agree that the claim requires 'at least one selection' from three classes").

Pattern Element	IPR-165 ('156)	IPR-155 ('961)	IPR-179 ('273)
Standards Basis	IEEE-754[g]	IEEE-754[h]	IEEE-754[i]
Mathematical Proof	"over 70 trillion"[j]	"over 70 trillion"[k]	"over 70 trillion"[l]
Expert Assessment	"credit Mr. Goodin's"[m]	"credit Mr. Goodin's"[n]	"credit Mr. Goodin's"[o]

Table 1.2: Standards-Based Patterns Across Institution Granted Proceedings.[15]

Notes: g-i. IPR-165 at 16; IPR-155 at 13; IPR-179 at 14 (identical IEEE-754 analysis). j-l. IPR-165 at 19; IPR-155 at 16; IPR-179 at 17 (identical "over 70 trillion possible pairs" references); m-o. IPR-165 Final at 34; IPR-155 Final at 33; IPR-179 Final at 34 (identical "credit Mr. Goodin's software-based analysis").[16]

As demonstrated in Table 1.1, the categorical framework approach correlated with systematic PTAB rejection across all three proceedings.[17] The board employed identical rejection language when addressing Google's "three classes of variables" argument; "Petitioner contends that implementation of an execution unit requires 'at least one selection' from three classes of variables: (1) 'implementing technology,' (2) 'numerical representation,' and (3) 'operation.'"[18] The ultimate rejection employed identical reasoning across proceedings; "Thus, even though we agree with Petitioner that claim 1 recites an execution unit by its function of executing an operation, we cannot

[15] IPR-155, *supra* note 4, at 13, 16; IPR-165, *supra* note 4, at 16, 19; IPR-179, *supra* note 4, at 14, 17; IPR-155 Final, *supra* note 4, at 33; IPR-165 Final, *supra* note 4, at 34; IPR-179 Final, *supra* note 4, at 34.
[16] *See supra* note 15 and accompanying text.
[17] IPR-154, *supra* note 3, at 16, 18; IPR-164, *supra* note 4, at 16, 18; IPR-178, *supra* note 4, at 15, 18.
[18] IPR-154, *supra* note 3, at 16; IPR-164, *supra* note 4 at 16; IPR-178, *supra* note 4, at 15.

agree that the claim requires 'at least one selection' from three classes of infinitely combinable and unpredictable 'variables.'"[19]

Table 1.2 illustrates the contrasting pattern where standards-based methodologies correlated with institution grants. The granted proceedings demonstrated consistent reliance on IEEE-754 standards analysis, creating systematic foundation for technical argumentation.[20] The final written decisions employed near-identical expert credibility language; "After review of the arguments and evidence on these issues, we credit Mr. Goodin's software-based analysis."[21]

The consistent panel compositions across all proceedings (Judges Arbes, Sawert, Repko for institution decisions; Judges Arbes, White, Repko for final written decisions) combined with word-for-word language replication suggests systematic template usage within PTAB institutional drafting practices.[22] This pattern indicates possible standardized analytical frameworks that transcend individual case characteristics or substantive technical variations, though alternative explanations also warrant consideration.

2. Technical Methodologies

The analysis reveals distinct technical approaches that correlated with differential PTAB reception patterns.

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[19] IPR-154, *supra* note 3, at 18; IPR-164, *supra* note 4, at 18; IPR-178, *supra* note 4, at 18.

[20] IPR-155, *supra* note 4, at 13; IPR-165, *supra* note 4, at 16; IPR-179, *supra* note 4, at 14.

[21] IPR-155 Final, *supra* note 4, at 33; IPR-165 Final, *supra* note 4, at 34; IPR-179 Final, *supra* note 4, at 34.

[22] *See* IPR-154, *supra* note 3, at 1, 18; IPR-164, *supra* note 4, at 1, 18; IPR-178, *supra* note 4, at 1, 18; IPR-155 Final, *supra* note 4, at 1, 33; IPR-165 Final, *supra* note 4, at 1, 34; IPR-179 Final, *supra* note 4, at 1, 34.

Mr. Goodin's declarations in granted proceedings employed verification methodologies that appeared to enhance institutional credibility through external standards anchoring and mathematical rigor.[23]

The declarations established computational complexity requiring software-based analysis by demonstrating that verification encompassed "over 70 trillion possible pairs of normal IEEE-754 single-format mantissas."[24] This massive parameter space necessitated sophisticated computational infrastructure that Mr. Goodin implemented through GPU-accelerated analysis using "an Nvidia Quadro GV100 GPU, using Nvidia's Compute Unified Device Architecture (CUDA) platform to parallelize" the verification programs.[25] The infrastructure employed 5120 CUDA cores with 32GB HBM2 memory and 900 GB/s memory bandwidth, allowing testing across 2^{46} combinations while maintaining bit-level accuracy.[26]

a. Error Independence Theorem

Central to the mathematical framework was Mr. Goodin's development of an error independence theorem that enabled practical verification across massive input spaces.[27] The theorem established that "the relative error amount (the 'Y' percentage recited in limitation [1B2]) of any floating-point number output from Dockser's reduced-precision multiplication is the same as the relative error amount of its mantissa, and is independent of its exponent and sign."[28]

[23] Goodin Decl. 154-5, *supra* note 5, ¶ 281; Goodin Decl. 164-5, *supra* note 5, ¶ 282; Goodin Decl. 178-9, *supra* note 5, ¶ 290.
[24] *Id.*
[25] Goodin Decl. 164-5, *supra* note 5, ¶ 424. *See* Goodin Decl. 154-5, *supra* note 5, ¶ 422; Goodin Decl. 178-9, *supra* note 5, ¶ 451.
[26] Goodin Decl. 164-5, *supra* note 5, ¶ 424.
[27] Goodin Decl. 154-5, *supra* note 5, ¶ 277; Goodin Decl. 164-5, *supra* note 5, ¶ 278; Goodin Decl. 178-9, *supra* note 5, ¶ 286.
[28] *Id.*

This mathematical insight transformed computational feasibility by enabling practical verification across the complete input space:

Total combinations=$2^{23} \times 2^{23} = 2^{46} \approx 70.4$ trillion.[29]

The theorem eliminated the need for exhaustive testing of all possible exponent and sign combinations. PTAB's subsequent acceptance of this mathematical framework appears to correlate with patterns in credibility evaluation, suggesting institutional receptivity to rigorous theoretical foundations.[30]

b. IEEE-754 Standards Foundation

The granted proceedings distinguished themselves through systematic anchoring in established IEEE-754 floating-point standards.[31] Mr. Goodin's declarations explained that "the ANSI/IEEE-754 standard specifies a 32-bit single format having a 1-bit sign, an 8-bit exponent, and a 23-bit mantissa" while demonstrating that "IEEE-754 8-bit exponents range from -126 to 127; thus the dynamic range of 'normal' IEEE-754 single-format operands is from around 2^{-126} (massively smaller than 1/65,000) to around 2^{127} (massively larger than 65,000)."[32] The PTAB's reception patterns extended to mathematical formulation receptivity, with granted proceedings featuring specific algebraic equations and numerical calculations directly incorporated into decision text, contrasting with abstract framework rejections that avoided detailed mathematical

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[29] *Id*.

[30] *See* IPR-155 Final, *supra* note 4, at 33–34; IPR-165 Final, *supra* note 4, at 34; IPR-179 Final, *supra* note 4, at 34–35 (crediting Mr. Goodin's mathematical framework).

[31] *See* IPR-155, *supra* note 4, at 13; IPR-165, *supra* note 4, at 16; IPR-179, *supra* note 4, at 14.

[32] Goodin Decl. 154-5, *supra* note 5, ¶¶ 29, 232; Goodin Decl. 164-5, *supra* note 5, ¶¶ 29, 233; Goodin Decl. 178-9, *supra* note 5, ¶¶ 29, 241.

engagement.[33] This standards-based foundation provided an objective technical framework anchored in established industry specifications rather than expert-created analytical systems.[34] The PTAB's subsequent crediting of this analysis appears to correlate with institutional preference for external technical authority over expert-generated frameworks.[35]

c. Dual-Track Verification Approach

Mr. Goodin's successful declarations implemented both software simulation and algebraic proof methodologies, creating redundant verification pathways that enhanced analytical robustness.[36] Mr. Goodin disclosed four distinct verification programs: (1) register bit-dropping with double-precision reference calculations; (2) register bit-dropping with single-precision reference calculations; (3) logic bit-dropping with double-precision reference calculations; (4) logic bit-dropping with single-precision reference calculations.[37]

Software verification involved creating programs that replicated the prior art methodology; Mr. Goodin "wrote a software program (which a POSA would have understood how to write), that performs floating-point

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33 *Compare* IPR-165, *supra* note 4, at 16, 19 (incorporating IEEE-754 algebraic equations and referencing "over 70 trillion possible pairs" requiring software analysis), *with* IPR-164, *supra* note 4, at 16–18 (rejecting abstract categorical framework without detailed mathematical engagement).

34 Goodin Decl. 154-5, *supra* note 5, ¶¶ 29, 232; Goodin Decl. 164-5, *supra* note 5, ¶¶ 29, 233; Goodin Decl. 178-9, *supra* note 5, ¶¶ 29, 241.

35 IPR-155 Final, *supra* note 4, at 33–34; IPR-165 Final, *supra* note 4, at 34; IPR-179 Final, *supra* note 4, at 34–35.

36 *See supra* note 35.

37 Goodin Decl. 154-5, *supra* note 5, ¶¶ 423, 426, 462–63; Goodin Decl. 164-5, *supra* note 5, ¶¶ 425, 428, 466–67; Goodin Decl. 178-9, *supra* note 5, ¶¶ 452, 455, 493–494 (employing identical four-program verification methodology testing both register and logic bit-dropping with double-precision and single-precision reference calculations).

multiplication operations the way Dockser's register bit-dropping technique does."[38] Complementing this empirical approach, the declarations provided algebraic verification through formal mathematical analysis of floating-point operands, establishing theoretical foundations that supported the computational results, and vice versa.[39]

d. Circuit-Level Implementation Analysis

The technical analysis extended to detailed circuit-level implementation specifications that demonstrated practical realization of the theoretical concepts.[40] Register bit-dropping implementation involved "removing power from storage elements in the FPP's registers that correspond to the excess [dropped] mantissa bits," with the result that "the output of the unpowered storage elements . . . tied to zero voltage (*e.g.,* ground), making those 14 'excess' bits all zeroes."[41] By contrast, the logic bit-dropping approach achieved precision reduction through "removing power from elements within the multiplier logic that computes the product of the operand mantissas," providing alternative implementation pathways with distinct performance characteristics.[42]

e. Quantitative Performance Analysis

[38] Goodin Decl. 154-5, *supra* note 5, ¶ 412; Goodin Decl. 164-5, *supra* note 5, ¶ 414; Goodin Decl. 178-9, *supra* note 5, ¶ 441.
[39] Goodin Decl. 154-5, *supra* note 5, ¶ 427; Goodin Decl. 164-5, *supra* note 5, ¶ 429; Goodin Decl. 178-9, *supra* note 5, ¶ 456.
[40] Goodin Decl. 154-5, *supra* note 5, ¶ 256; Goodin Decl. 164-5, *supra* note 5, ¶ 257; Goodin Decl. 178-9, *supra* note 5, ¶ 265.
[41] Goodin Decl. 154-5, *supra* note 5, ¶¶ 256, 269; Goodin Decl. 164-5, *supra* note 5, ¶¶ 257, 270; Goodin Decl. 178-9, *supra* note 5, ¶¶ 265, 278 (employing identical register bit-dropping implementation analysis).
[42] Goodin Decl. 154-5, *supra* note 5, ¶ 257; Goodin Decl. 164-5, *supra* note 5, ¶ 258; Goodin Decl. 178-9, *supra* note 5, ¶ 266.

The methodology demonstrated compliance margins that substantially exceeded minimum patent requirements across both implementation approaches.[43] Register bit-dropping achieved 92.14% compliance versus the stringent 5% patent requirement, providing an 18.4× compliance ratio, while logic bit-dropping achieved 99.35% compliance, yielding a 19.9× compliance ratio.[44] For relaxed parameters, the methodology maintained substantial margins: 9 fraction bits produced 85.44% adjusted compliance (8.5× ratio against the X≥10% claim threshold) and 5 fraction bits achieved 99.96% adjusted compliance (9.9× ratio against the X≥10% claim threshold).[45]

Beyond the primary verification approach, Mr. Goodin demonstrated alternative precision pathways where "over 12% of all possible valid normal IEEE-754 single-format operands have zero as their most-significant (left-most) mantissa fraction bit and ones as their tenth and eleventh fraction bits."[46] This operand subset enabled specific error calculations showing that "every input in that 12% produces at minimum 0.097% relative error," providing nearly 2× margin above the 0.05% requirement while meeting the patent's X and Y values through systematic bit pattern analysis.[47]

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[43] *See* Goodin Decl. 154-5, *supra* note 5, ¶¶ 423, 462; Goodin Decl. 164-5, *supra* note 5, ¶¶ 425, 466; Goodin Decl. 178-9, *supra* note 5, ¶¶ 452, 493.

[44] Goodin Decl. 164-5, *supra* note 5, ¶¶ 425, 466; *see also* Goodin Decl. 178-9, *supra* note 5, ¶¶ 452, 493 (achieving similar performance with 92.628313% and 99.971764% compliance).

[45] Goodin Decl. 154-5, *supra* note 5, ¶ 462.

[46] Goodin Decl. 164-5, *supra* note 5, ¶ 286; Goodin Decl. 178-9, *supra* note 5, ¶ 294 (using identical alternative precision pathway analysis); *see also* Goodin Decl. 154-5, *supra* note 5, ¶ 285 (applying same analytical methodology at different precision level for the '961 patent's Y≥0.2% threshold).

[47] Goodin Decl. 164-5, *supra* note 5, ¶ 286.

The analysis incorporated conservative assumptions requiring "absolute ***minimum*** relative error" evaluation since the "patent's claims are met so long as the recited minimum relative error ('at least Y=0.05%') is equaled ***or exceeded*** for some minimum percentage of the possible valid inputs ('at least X=5%')."[48] This approach ensured robust claim coverage through worst-case edge case treatment including overflow and underflow conditions.[49] The PTAB explicitly accepted Mr. Goodin's technical interpretation regarding digital system behavior:

> Based on the totality of the evidence, Petitioner's analysis of "deterministic digital embodiments" to address the "statistical mean" limitation is adequately supported by the record. . . . Petitioner adequately supports its assertion that this is a deterministic digital circuit. . . . [W]e credit Mr. Goodin's testimony that, in such a digital circuit, a floating-point multiplier operating on the same input with the same precision level yields the same result for every execution, and thus, the statistical mean is the same as the output for any single execution.[50]

3. Commercial Context Validation

These empirical patterns gain compelling real-world validation through Singular Computing's action against

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[48] Goodin Decl. 164-5, *supra* note 5, ¶ 285. *See also* Goodin Decl. 154-5, *supra* note 5, ¶ 284 (using similar minimum relative error analysis); Goodin Decl. 178-9, *supra* note 5, ¶ 293 (using identical minimum relative error analysis).

[49] *See* Goodin Decl. 164-5, *supra* note 5, ¶ 285.

[50] IPR-165 Final, *supra* note 4, at 29-30. *See* IPR-155 Final, *supra* note 4, at 29 ("[W]e credit the Goodin Declaration that, in such a digital circuit, a floating-point multiplier operating on the same input with the same precision level yields the same result for every execution, and thus, the statistical mean is the same as the output for any single execution."); IPR-179 Final, *supra* note 4, at 30 (same).

Google alleging patent infringement involving the patents at issue in these IPRs, providing external verification of technical frameworks, and stressing the practical importance of rigorous expert declaration methodology.[51]

Singular Computing's patent infringement lawsuit against Google alleged that Google's Tensor Processing Units incorporated patented LPHDR architecture in commercial AI applications.[52] The lawsuit sought damages of $1.67 billion, ultimately reaching an undisclosed settlement on January 24, 2024, immediately before closing arguments.[53] The alleged damages suggest significant commercial value in the patent claims that survived the IPR challenges analyzed in this study.[54]

The patents' resource efficiency frameworks articulate a technical philosophy that appears to correlate with TPU architectural approaches.[55] The '273 patent's specification states that "there are many PEs per unit of resource (e.g., transistor, area, volume), which in turn means that there is a large amount of arithmetic computational power per unit of resource," establishing efficiency principles that prioritize parallelism over individual processing element precision.[56] Commercial TPU implementations demonstrate systematic adoption of

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51 *See generally* Amended Complaint for Patent Infringement, *Singular Computing LLC v. Google LLC* (D. Mass. 2020) (No. 19-12551).
52 *Id.* ¶ 87.
53 Joint Motion to Stay Pending Settlement Agreement, *Singular Computing LLC v. Google* LLC (D. Mass. 2024) (No. 19-12551); Blake Brittain, *Google Settles AI-Related Chip Patent Lawsuit That Sought $1.67 Bln*, REUTERS (Jan. 24, 2024), https://www.reuters.com/technology/google-settles-ai-related-chip-patent-lawsuit-that-sought-167-bln-2024-01-24/ [https://perma.cc/475U-CZXB].
54 Brittain, *supra* note 53.
55 '273 Patent, *supra* note 4, col. 23, ll. 51–53; *see* '156 Patent, *supra* note 4, col. 23, ll. 39–42; '961 Patent, *supra* note 4, col. 23, ll. 59–62.
56 *See supra* note 55.

these concepts through systolic array architectures with "128×128 systolic array . . . bfloat16 multiply . . . float32 accumulation" configurations.[57]

TPU generational development reveals progressive adoption of mixed-precision approaches that align with LPHDR patent concepts.[58] TPUv2 delivered "180 TFLOPS (bfloat16) / board" while TPUv3 achieved "420 TFLOPS (bfloat16) / board," implementing mixed-precision architectures that balance computational efficiency with sufficient accuracy for machine learning applications.[59] Performance improvements include ResNet-50 training completing "in just two minutes" on Cloud TPU v3 Pods, with ImageNet classification error rates improving from 26% in 2011 to 2.3% in 2017.[60]

Mixed-precision training implementations achieve "performance gains...which range from 4% to 47%, with a geometric mean of 13.9%," with natural language processing models like BERT completing training "in just 76 minutes."[61] These systems maintain high accuracy rates

[57] Norman P. Jouppi, et al., *A Domain-Specific TPU Supercomputer for Training Deep Neural Networks*, Exhibit No. 2046, IPR2021-00155, at 35 (P.T.A.B. Aug. 9, 2021) [hereinafter Jouppi Presentation]. *See generally* Norman P. Jouppi et al., *In-Datacenter Performance Analysis of a Tensor Processing Unit*, 44 COMPUTER ARCHITECTURE NEWS 1 (2017) https://dl.acm.org/doi/epdf/10.1145/3079856.3080246 [https://perma.cc/B3NQ-NFZS].

[58] Martin Görner, *Google Cloud TPUs for Developers*, Exhibit No. 2045, No. IPR2021-00155, at 3 (P.T.A.B. Aug. 9, 2021) [hereinafter Görner].

[59] Görner, *supra* note 58, at 3.

[60] Zak Stone, *Google's Scalable Supercomputers for Machine Learning*, Exhibit No. 2038, No. IPR2021-00155, at 1 (P.T.A.B. Aug. 9, 2021) [hereinafter Stone]; Jeffrey Dean, *The Deep Learning Revolution and Its Implications*, Exhibit No. 2011, IPR2021-00155, at 2 [hereinafter Dean].

[61] Shibo Wang & Pankaj Kanwar, *BFloat16: The Secret to High Performance on Cloud TPUs*, Exhibit No. 2041, No. IPR2021-00155,

where "average percentage of matches between the enhanced algorithm running with 'fp+noise' arithmetic and the usual method was 99.9%" and "average percentage of time LPHDR (with final DP correction) finds nearest example=99.70%" despite reduced precision implementation.[62] Although this correlation provides supporting evidence, alternative explanations warrant consideration, including industry-wide trends toward reduced-precision computing and more generally, convergent engineering solutions.

C. Case Study: IPR-164/165 Technical Differences

The proceedings challenging the '156 patent, IPR-164 and IPR-165 provide the most direct comparison of methodological effectiveness, where identical expert declarant Mr. Goodin employed fundamentally different approaches to challenge the same patent claims.[63] This controlled comparison isolates methodological variables while controlling for expert identity, patent complexity, and panel composition. This analysis applies similarly to the '273 and '961 patents in their corresponding proceedings,

at 3 (P.T.A.B. Aug. 9, 2021) [hereinafter Wang & Kanwar] ("[P]erformance gains from this optimization, which range from 4% to 47%, with a geometric mean of 13.9%."); Stone, *supra* note 60, at 1 ("BERT (NLP) in just 76 minutes.").

[62] '273 Patent, *supra* note 4, col. 19, ll. 64–67 ("average percentage of matches between the enhanced algorithm running with 'fp+noise' arithmetic and the usual method was 99.9%"), col. 20, ll. 26–27 ("Average percentage of time LPHDR (with final DP correction) finds nearest example=99.70%"). See '156 Patent, *supra* note 4, col. 19, ll. 62–65, col. 19, ll. 54–55; '961 Patent, *supra* note 4, col. 20, ll. 9–12, col. 20, ll. 1–2.

[63] Goodin Decl. 164-5, *supra* note 5, ¶¶ 62–64 (categorical framework used in IPR-164), 232–35 (noting IEEE-754 standards-based methodology used in IPR-165); IPR-164, *supra* note 4, at 18; IPR-165, *supra* note 4, at 16.

IPR-178/179 and IPR-154/155, respectively. For the sake of simplicity, the IPRs concerning the '156 patent are analyzed here.

In IPR-164, Mr. Goodin organized prior art analysis around a categorical framework encompassing three variables: (1) "implementing technology," (2) "numerical representation[,]" and (3) "operation."[64] This approach characterized obviousness through abstract classification rather than technical correspondence to claim limitations.[65] The PTAB systematically rejected this methodology: "Nothing in the plain language of claim 1 requires consideration of 'implementing technology' or 'numerical representation' as Petitioner contends[;] . . . we cannot agree that the claim requires 'at least one selection' from three classes of infinitely combinable and unpredictable 'variables.'"[66]

By contrast, in IPR-165, Mr. Goodin employed methodology anchored in established technical standards, rigorous mathematical verification, and detailed circuit-level implementation analysis.[67] His declaration established technical authority through IEEE-754 floating-point standards while demonstrating dynamic ranges that vastly exceeded patent requirements.[68] This transformation from

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[64] Goodin Decl. 164-5, *supra* note 5, ¶¶ 62–64.
[65] *Id.*
[66] IPR-164, *supra* note 4, at 18. *See also* IPR-154, *supra* note 3, at 18; IPR-178, *supra* note 4, at 18.
[67] *See* Goodin Decl. 164-5, *supra* note 5, ¶¶ 232–35 (IEEE-754 standards foundation and dynamic range analysis); id. ¶¶ 266–69 (circuit-level register bit-dropping implementation); *id.* ¶¶ 414, 425 (software-based verification and results); *id.* ¶ 429 (algebraic verification).
[68] Goodin Decl. 164-5, *supra* note 5, ¶¶ 232–35. See IPR-165, *supra* note 4, at 16 ("Petitioner contends that Dockser's 'dynamic range of the possible valid inputs to the first operation is at least as wide as from 1/65,000 through 65,000,' as recited in claim 1, because the FPP

expert-created categorical frameworks to standards-based technical analysis correlated with dramatically different PTAB reception.[69]

The contrasting outcomes prove particularly striking given the identical expert, patent, and panel composition. The PTAB denied institution in IPR-164 while granting institution in IPR-165 and subsequently providing explicit expert credibility assessments; "[a]fter review of the arguments and evidence on these issues, we credit Mr. Goodin's software-based analysis" and "we credit Mr. Goodin's algebraic analysis."[70] While this correlation suggests that technical presentation quality may influence tribunal reception patterns, causation remains unestablished.

D. Discussion

The systematic patterns documented across these six proceedings illuminate broader questions of expert declaration effectiveness and administrative decision-making behavior, suggesting possible institutional preferences that transcend individual case characteristics.

'operates on IEEE-754 32-bit single-format numbers having 8-bit exponents' and, therefore, the dynamic range of normal operands would be 'from . . . much smaller than 1/65,000[] to . . . much larger than 65,000[].'").

[69] *See* Goodin Decl. 164-5, *supra* note 5, ¶¶ 62–64 (categorical framework used in denied proceedings); *id*. ¶¶ 232–35 (standards-based technical analysis used in granted proceedings); *see* IPR-165, *supra* note 4, at 16.

[70] IPR-165 Final, *supra* note 4, at 34–35. *See* IPR-155 Final, *supra* note 4, at 33–34 (using nearly identical language); IPR-179 Final, *supra* note 4, at 34–35 (using identical language). *See also* IPR-179 Final, *supra* note 4, at 57 (separately crediting Mr. Goodin's combined algebraic and software-based analysis under the Dockser-Tong rationale).

1. Observed Technical Elements

The empirical analysis identifies five technical elements that distinguish granted from denied expert declarations:

Standards Foundation Architecture involves anchoring technical analysis in external authorities (IEEE-754 specifications) rather than expert-created organizational frameworks (categorical variables). This approach appears to enhance institutional credibility through objective technical foundation.

Multi-Dimensional Redundancy encompasses multiple independent invalidity theories and verification pathways, contrasting with single-point dependency approaches that create systematic vulnerability to targeted challenges.

Circuit-Level Implementation Detail provides hardware mechanism precision and bit-level accuracy specifications, moving beyond abstract characterizations to demonstrate practical technical realization.

Dual-Track Verification Methodology combines mathematical proof with empirical validation through software simulation, creating redundant analytical pathways that enhance robustness against methodological challenges.

Internal Consistency Maintenance ensures unified narrative coherence across complex technical arguments, avoiding contradictory positions that undermine overall credibility.

These patterns represent observed correlations rather than established causal relationships between methodological approach and tribunal reception.[71] The

[71] *See supra* Section I.B.1–2 and accompanying notes (documenting standards foundation, dual-track verification, and circuit-level implementation analysis in granted proceedings); *see also supra* Table

correlation between technical rigor and institutional acceptance appears consistent across the analyzed proceedings, though alternative explanations merit consideration.

2. Administrative Decision-Making Patterns

The documented patterns extend beyond patent law methodology to broader questions of administrative decision-making behavior. Word-for-word language replication across identical PTAB panels suggests systematic template usage or standardized analytical frameworks that transcend individual case characteristics.[72] These findings indicate possible institutional behavioral triggers where specific methodological approaches consistently correlate with predictable tribunal responses.

The burden allocation patterns reveal additional institutional efficiency mechanisms. The PTAB consistently emphasized burden requirements ("Petitioner bears the burden of proving unpatentability by a preponderance of the evidence"), creating procedural frameworks where methodological deficiencies enable systematic rejection without extensive technical engagement.[73] This pattern suggests that expert declaration

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1.1 and Table 1.2 (comparing categorical framework patterns in denied proceedings with standards-based patterns in granted proceedings).

[72] *Compare* IPR-154, *supra* note 3, at 18 (using identical language), *with* IPR-164, *supra* note 4, at 18 (using identical language), *and* IPR-178, *supra* note 4, at 18 (using identical language).

[73] IPR-165 Final, *supra* note 4, at 72 ("Petitioner bears the burden of proving unpatentability by a preponderance of the evidence, which includes proving that a person of ordinary skill in the art would have had reason to combine the prior art references"); IPR-155 Final, *supra* note 4, at 76 (using identical burden allocation language); IPR-179 Final, *supra* note 4, at 73 (using identical burden allocation language); *see also* 35 U.S.C. § 316(e) (establishing evidentiary standards for *Inter Partes* review); *In re* Magnum Oil Tools Int'l, Ltd., 829 F.3d 1364,

approach may influence not only substantive analysis depth but also procedural pathway selection within administrative processing frameworks.

The substantially consistent panel compositions across all proceedings eliminate individual judicial preference variables, enabling focus on institutional rather than personal decision-making patterns.[74] The systematic correlation between expert declaration approaches and PTAB analytical language suggests that administrative agencies may employ more structured decision-making frameworks than previously documented in administrative law scholarship.

However, these patterns represent observable correlations rather than established administrative behavioral principles. Alternative explanations include common briefing strategies triggering similar analytical frameworks, standardized institutional review processes, or case-specific technical factors that generate similar legal analysis across related proceedings.

3. Implications for Expert Declaration Analysis

The evidence suggests that expert declarations may correlate with institutional credibility assessment through technical foundations anchored in established standards and detailed implementation analysis.[75] Abstract frameworks

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1380 (Fed. Cir. 2016) (reaffirming evidentiary standards for *Inter Partes* review).

[74] *See* IPR-154, *supra* note 3, at 1; IPR-155, *supra* note 4, at 1; IPR-164, *supra* note 4, at 1; IPR-165, *supra* note 4, at 1; IPR-178, *supra* note 4, at 1; IPR-179, *supra* note 4, at 1; IPR-155 Final, *supra* note 4, at 1; IPR-165 Final, *supra* note 4, at 1; IPR-179 Final, *supra* note 4, at 1.

[75] *See, e.g.*, IPR-165 Final, *supra* note 4, at 34 (crediting Mr. Goodin's software-based and algebraic analysis); IPR-155 Final, *supra* note 4, at 33–34 (same); IPR-179 Final, *supra* note 4, at 34–35 (same).

lacking patent-specific technical correspondence appear to correlate with systematic PTAB denial patterns across the analyzed proceedings. [76]

Mathematical verification frameworks and external standards anchoring appear to correlate with expert credibility assessments and detailed PTAB technical analysis. [77] The systematic correlation between verification sophistication and tribunal reception suggests that methodological quality may influence decision outcomes, creating potential strategic considerations for expert declaration preparation in complex technical patent proceedings.

The substantial compliance margins demonstrated by the logic bit-dropping verification programs across successful proceedings—which the PTAB did not need to reach given the sufficiency of register bit-dropping—ranging from approximately 8.5× to 19.9× above minimum patent requirements, illustrate the depth of evidentiary redundancy available within the expert's methodological framework.[78] This pattern may reflect risk-averse

[76] *See* IPR-154, *supra* note 3, at 18; IPR-164, *supra* note 4, at 18; IPR-178, *supra* note 4, at 18 (rejecting categorical "three classes of variables" framework in each).

[77] *See, e.g.*, IPR-165 Final, *supra* note 4, at 34 (crediting Mr. Goodin's software-based and algebraic analysis); IPR-155 Final, *supra* note 4, at 33–34 (same); IPR-179 Final, *supra* note 4, at 34–35 (same).

[78] *See* Goodin Decl. ¶ 462, Ex. 1003, IPR2021-00155 (showcasing logic bit-dropping producing adjusted compliance of ≥84.99%, exceeding the '961 patent's X≥10% claim requirement by a factor of approximately 8.5); Goodin Decl. ¶ 466, Ex. 1003, IPR2021-00165 (showcasing logic bit-dropping producing adjusted compliance of ≥99.35% at Y≥0.05%, exceeding the '156 patent's X≥5% claim requirement by a factor of approximately 19.9); Goodin Decl. ¶ 493, Ex. 1003, IPR2021-00179 (same). *See also* Goodin Decl. ¶¶ 423, 425, 452, Ex. 1003, IPR2021-00155, -00165, -00179 (showcasing register bit-dropping compliance results across all three proceedings). The PTAB found register bit-dropping alone sufficient and did not reach the

institutional decision-making that favors expert declarations with substantial evidentiary margins rather than minimal legal sufficiency.

E. Limitations and Further Research

This analysis examines correlation patterns within a single patent family context involving hardware machine learning patents with quantitative performance requirements. The relationship between technical methodologies and PTAB reception represents observable correlation rather than established causation, requiring careful interpretation of the empirical findings.

The study is limited to examination of expert declaration content and PTAB decision language patterns, without access to internal deliberative processes or additional case factors that may influence decision outcomes. The substantially consistent panel compositions, while eliminating individual preference variables, may limit generalizability to broader PTAB decision-making patterns involving different judicial perspectives.

Broader empirical validation across multiple patent families, diverse technological domains, and varying tribunal contexts would be necessary to establish generalizable principles beyond the specific LPHDR context examined. Additional research examining expert declaration approaches in other technical domains could determine whether the observed methodological patterns represent domain-specific requirements or broader principles applicable to complex technical patent proceedings.

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logic bit-dropping rationale. *See* IPR-155 Final, *supra* note 4, at 30; IPR-165 Final, *supra* note 4, at 30; IPR-179 Final, *supra* note 4, at 31.

Alternative explanations for the observed patterns include case-specific factors, temporal effects in PTAB jurisprudence, or counsel-specific strategic approaches rather than generalizable methodological principles. Industry-wide technological trends, convergent engineering solutions, or common prior art landscapes could account for technical correlations independent of expert declaration methodology. These limitations underscore the need for systematic replication studies to confirm broader validity of the correlation patterns identified.

F. Conclusion

This study provides empirical analysis of expert declaration methodologies across six related IPR proceedings, identifying systematic patterns in PTAB decision-making that transcend individual case characteristics. The verbatim language replication across substantially consistent panel compositions reveals institutional response patterns that suggest systematic template usage, while the contrasting outcomes between categorical and standards-based methodologies demonstrate measurable correlations between technical presentation rigor and administrative acceptance.

The identification of five technical elements distinguishing granted from denied proceedings establishes a novel empirical framework for understanding expert declaration effectiveness. These elements—standards foundation architecture, multi-dimensional redundancy, circuit-level implementation detail, dual-track verification methodology, and internal consistency maintenance—demonstrate systematic correlation with institutional credibility assessment across varying patent parameters and technical complexity levels, suggesting generalizable principles for complex technical patent litigation.

The commercial validation through Singular Computing's TPU litigation and $1.67 billion damages alleged provide significant external verification of both the patent claims that survived IPR challenges and the analytical frameworks that proved institutionally persuasive.[79] This progression from post-grant proceedings to commercial damages settlement illuminates how rigorous expert declaration methodology may influence not only administrative outcomes but also ultimate patent valuation and technology development trajectories.

The broader implications extend significantly beyond patent law to fundamental questions of administrative decision-making behavior and institutional consistency. The documented template-driven language patterns and systematic correlation between presentation methodologies and tribunal responses suggest that administrative agencies may employ more structured decision-making frameworks than previously recognized, with potential applications across diverse regulatory contexts where expert testimony shapes agency determinations.[80]

While this study establishes empirically grounded correlation patterns that inform both expert declaration preparation and administrative law understanding, the findings represent preliminary foundation for broader investigation into expert testimony effectiveness and institutional decision-making patterns. The methodology developed here—controlled comparison of technical presentation approaches across related proceedings with identical experts and panel compositions—provides a

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[79] *See* Brittain, *supra* note 53.

[80] *See, e.g.*, IPR-155, *supra* note 4, at 16; IPR-165, *supra* note 4, at 19; IPR-179, *supra* note 4, at 17; IPR-155 Final, *supra* note 4, at 33; IPR-165 Final, *supra* note 4, at 34; IPR-179 Final, *supra* note 4, at 34.

replicable framework for systematic analysis of administrative tribunal behavior across multiple legal and regulatory domains.

The empirical contribution lies in documenting quantifiable institutional patterns through rigorous comparison of methodological approaches, enabling isolation of technical presentation variables while controlling for individual and case-specific factors. This approach transforms expert declaration analysis from subjective assessment to systematic empirical investigation, establishing preliminary indicators for predicting administrative reception patterns and optimizing expert testimony effectiveness in complex technical proceedings. The framework's demonstrated effectiveness across parameter variations from strict foundational requirements to relaxed thresholds suggests broader applicability for understanding how technical rigor correlates with institutional credibility across diverse administrative contexts.

II. DEFENSIVE EXPERT DECLARATION METHODOLOGY: AN EMPIRICAL ANALYSIS OF ADMINISTRATIVE RECEPTION PATTERNS

A. Introduction

1. Research Scope and Literature Gap

Expert declaration analysis in administrative patent proceedings represents a specialized domain within expert testimony scholarship that has received limited examination despite substantial impact on patent validity determination.[81] While offensive expert declaration patterns

[81] *See generally* DAVID L. FAIGMAN ET AL., MODERN SCIENTIFIC EVIDENCE (West Academic 2025–2026 Ed.) (surveying expert testimony scholarship across forty-four subject areas without addressing administrative patent proceedings); *see also supra* note 2

were documented in the previous section, this section explores the same IPR proceedings' defensive expert testimony approaches.[82]

The Patent Trial and Appeal Board's adjudication of these *Inter Partes Review* proceedings creates a controlled institutional context for examining administrative reception patterns for defensive expert testimony. Here, two PTAB panel compositions address similar technical subject matter across related proceedings with consistent procedural requirements under 37 C.F.R. Part 42.[83]

Defensive expert testimony analysis extends beyond patent law into broader administrative decision-making research. Defensive approaches may reveal institutional behavioral patterns and reasoning characteristics that differ from those observed in offensive expert testimony contexts. This case study acknowledges significant limitations in drawing broader theoretical conclusions from examination of a single patent family.

2. Dataset Characteristics and Empirical Foundation

This research examines defensive expert declarations submitted by Singular Computing's expert, Dr. Sunil P. Khatri, across six related Inter Partes Review proceedings challenging patents in the Low Precision High Dynamic Range (LPHDR) art.[84] The proceedings, conducted between 2021 and 2022, address both written

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and accompanying text (surveying existing IPR scholarship and identifying methodological gap).

[82] *See supra* Part I (discussing Mr. Goodin's expert declarations for the same 6 IPRs brought by Google against Singular Computing's LPHDR patent family).

[83] 37 C.F.R. §§ 42.100–42.123 (2020).

[84] *See supra* note 3.

description/enablement challenges and obviousness challenges across three related patents that are part of the same patent family owned by Singular Computing.[85]

Several dataset characteristics enable controlled analysis while constraining generalizability: (1) consistent expert declarant across all proceedings, (2) related patent family context with controlled technical variables, (3) temporal clustering within a 12-month period, and (4) outcome variation across proceedings.[86]

The case study approach permits detailed examination of defensive methodology within controlled parameters. The single patent family context limits broader generalizability but enables precise examination of methodological consistency across related technical contexts.

3. Analytical Scope and Methodological Boundaries

Dr. Khatri's technology-agnostic positioning receives particular attention through examination of his defensive characterization patterns that emphasize functional rather than implementational aspects of technical

[85] *See* IPR-154, *supra* note 3; IPR-164, *supra* note 4; IPR-178, *supra* note 4 (addressing written description/enablement challenges); IPR-155 Final, *supra* note 4, at 15, 19; IPR-165 Final, *supra* note 4, at 15, 74; IPR-179 Final, *supra* note 4, at 15, 76 (addressing obviousness challenges).

[86] *See* IPR-154, *supra* note 3, at 1 (denying institution); IPR-164, *supra* note 4, at 1 (denying institution); IPR-178, *supra* note 4, at 1 (denying institution); IPR-155, *supra* note 4, at 1 (granting institution); IPR-165, *supra* note 4, at 1 (granting institution); IPR-179, *supra* note 4, at 1 (granting institution); IPR-155 Final, *supra* note 4, at 84–85 (determining some challenged claims unpatentable); IPR-165 Final, *supra* note 4, at 82–83 (determining some challenged claims unpatentable); IPR-179 Final, *supra* note 4, at 84 (determining some challenged claims unpatentable).

inventions.[87] This study focuses on institutional reception patterns across the three written description proceedings, where the PTAB denied institution.[88]

The analysis of Dr. Khatri's mathematical logic demonstration examines quantitative analytical approaches in defensive expert testimony. In particular, this study examines Dr. Khatri's approaches to numerical claim limitations in obviousness contexts. The challenge versus accommodation analysis addresses choices in defensive expert testimony between directly challenging opponent theoretical constructs versus working within opponent analytical structures.

The multi-dimensional defensive architecture analysis examines component distribution patterns across proceedings. The limited dataset constrains conclusions about optimal defensive complexity but permits examination of how architectural choices correlate with institutional reception patterns.

Several scope limitations constrain this research. Examination within a single patent family may not represent defensive approaches across diverse technologies. Single expert declarant analysis likely does not capture methodological variations across different defensive experts. The PTAB-specific context may not represent broader judicial approaches to expert testimony. Temporal

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87 Declaration of Sunil P. Khatri, Ph.D., Exhibit No. 2006, No. IPR2021-00154, ¶ 39 (P.T.A.B. Feb. 16, 2021) [hereinafter Khatri Decl. 154]; Declaration of Sunil P. Khatri, Ph.D., Exhibit No. 2006, No. IPR2021-00164, ¶ 39 (P.T.A.B. Feb. 17, 2021) [hereinafter Khatri Decl. 164]; Declaration of Sunil P. Khatri, Ph.D., Exhibit No. 2006, No. IPR2021-00178, ¶ 39 (P.T.A.B. Feb. 24, 2021) [hereinafter Khatri Decl. 178].

88 *See generally* IPR-154, *supra* note 3 (denying institution and discussing written description and enablement challenges); IPR-164, *supra* note 4 (same); IPR-178, *supra* note 4 (same).

clustering may reflect time-specific institutional approaches rather than stable behavioral patterns.

B. Literature Review: Defensive Expert Declaration Theory

1. Expert Testimony in Administrative Proceedings

Expert testimony research addresses expert witness roles, credibility assessment, and judicial reception patterns in federal proceedings. Federal Rule of Evidence 702 establishes admissibility requirements including specialized knowledge, reliable principles and methods, and reliable application to case facts.[89] While the Federal Rules of Evidence are not directly binding in PTAB proceedings,[90] they inform the broader expert testimony scholarship relevant to this study. Post-*Daubert* research examines judicial approaches to expert credibility assessment and technical evidence evaluation, though it tends to focus primarily on federal court rather than administrative tribunal contexts.[91]

Cross-examination research documents expert witness credibility maintenance under adversarial challenge, examining preparation techniques and

[89] Fed. R. Evid. 702. *See, e.g.,* Daubert v. Merrell Dow Pharmaceuticals, Inc., 509 U.S. 579, 597 (1993) [hereinafter *Daubert*] (establishing standards for expert testimony).
[90] *See* 37 C.F.R. § 42.62 (2026).
[91] *See, e.g.*, David E. Bernstein, *The Misbegotten Judicial Resistance to the Daubert Revolution*, 89 Notre Dame L. Rev. 27 (2013) (examining judicial application of expert testimony standards in federal court contexts); Sophia I. Gatowski et al., *Asking the Gatekeepers: A National Survey of Judges on Judging Expert Evidence in a Post-Daubert World*, 25 Law & Hum. Behav. 433 (2001) (surveying federal and state judges' approaches to expert evidence evaluation).

presentation methodologies.[92] However, this research addresses general cross-examination approaches rather than defensive expert testimony contexts in administrative proceedings, creating a gap in understanding defensive-specific response methodologies.

Expert declarant preparation literature addresses presentation approaches and technical communication, concentrating primarily on judicial proceedings rather than administrative contexts.[93] Multi-component defensive architecture analysis lacks research coverage, with existing studies examining individual expert testimony methods rather than coordinated defensive methodologies employing multiple analytical components.[94]

2. Administrative Law and Expert Evidence

Administrative law scholarship addresses agency decision-making processes, evidentiary standards, and procedural requirements under the Administrative Procedure Act, though this literature generally does not focus on expert testimony evaluation methodologies.[95]

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92 *See generally* STEVEN LUBET, EXPERT TESTIMONY: A GUIDE FOR EXPERT WITNESSES AND THE LAWYERS WHO EXAMINE THEM (NITA 2nd ed. 2009) (addressing expert witness testimony and cross examination techniques in a variety of contexts).

93 *Id.*

94 *See generally* Lubet, *supra* note 92 (addressing individual expert testimony methods); FAIGMAN ET AL., *supra* note 81 (surveying expert testimony scholarship without examining coordinated multi-component defensive methodologies); Koch & Murphy, vol. 2, *infra* note 95 (discussing administrative evidentiary standards without addressing expert declaration architecture).

95 *See generally* 5 U.S.C. §§ 551–59 (covering agency procedural requirements); 1 CHARLES H. KOCH JR. & RICHARD MURPHY, ADMINISTRATIVE LAW AND PRACTICE (West Academic 3rd ed. 2010) [hereinafter Koch & Murphy, vol. 1] (discussing the decision-making process); 2 CHARLES H. KOCH JR. & RICHARD MURPHY,

Chevron deference research examined administrative agency technical expertise and specialized knowledge evaluation, focusing on policy interpretation rather than expert testimony assessment methodologies.[96] Substantial evidence standard research addresses administrative agency evidentiary requirements and decision-making validation, establishing the theoretical structure within which expert testimony operates in administrative contexts.[97]

Panel composition effects on expert testimony reception receive minimal research coverage. Studies focus on general procedural requirements rather than examining how identical versus different panel composition might affect reception consistency for expert testimony approaches.

3. Patent Law Expert Testimony Research Gaps

Patent law expert testimony research addresses technical expert declarant roles in patent litigation, claim construction proceedings, and obviousness analysis.[98] The

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ADMINISTRATIVE LAW AND PRACTICE (West Academic 3rd ed. 2010) [hereinafter Koch & Murphy, vol. 2] (discussing evidentiary standards and various procedural requirements).

[96] *See generally* Chevron U.S.A., Inc. v. Natural Resources Defense Council, Inc., 467 U.S. 837 (1984) (establishing judicial deference to reasonable agency interpretations of ambiguous statutes) (*overruled by* Loper Bright Enters. v. Raimondo, 603 U.S. 369 (2024)).

[97] *See generally* Universal Camera Corp. v. NLRB, 340 U.S. 474 (1951) (establishing evidentiary standards for judicial review of administrative agency decisions).

[98] *See generally* Paul M. Janicke & LiLan Ren, *Who Wins Patent Infringement Cases?*, 34 AIPLA Q.J. 1 (2006) (discussing factors that contribute to wins and losses in patent infringement litigation) [hereinafter Janicke & Ren].

literature has not examined defensive versus offensive expert testimony methodologies.[99]

Cross-patent methodology validation approaches lack research coverage. Studies focus on individual patent analysis rather than examining methodology consistency across related patent family proceedings.[100] *Inter Partes Review* procedural research examines PTAB decision-making processes and evidentiary standards, focusing primarily on procedural requirements rather than expert declaration patterns.[101]

Technology-agnostic versus implementation-specific positioning approaches receive no research attention in patent law literature, representing a significant gap in understanding defensive positioning methodologies. Commercial validation integration in expert testimony receives limited research attention, with studies addressing general technical evidence without examining product-claim mapping methodologies.[102]

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99 *Cf.* Janicke & Ren, *supra* note 98 (examining patent litigation outcome factors without distinguishing between defensive and offensive expert declaration approaches).

100 *See generally* Love & Ambwani, *infra* note 101 (tracking IPR outcomes across multiple proceedings but not examining expert methodology consistency within a single patent family); Helmers & Love, *supra* note 2 (analyzing IPR institution decisions without examining cross-proceeding methodology patterns).

101 *See generally* Brian J. Love & Shawn Ambwani, *Inter Partes Review: An Early Look at the Numbers*, 81 U. CHI. L. REV. ONLINE 93 (2014) (tracking the outcome of *Inter Partes Review* actions).

102 *See generally* Janicke & Ren, *supra* note 98 (examining patent litigation outcomes without analyzing product-claim mapping methodologies); FAIGMAN ET AL., *supra* note 81 (surveying expert testimony scholarship without examining commercial validation evidence integration).

4. Research Gaps and Study Contribution

The literature review reveals several gaps in defensive expert declaration methodology research that this case study begins to address. Multi-component defensive architecture analysis lacks research coverage, with studies focusing on single-approach expert testimony methods rather than multi-layer defensive methodologies.[103]

Technology-agnostic positioning analysis lacks research coverage. Studies treat technical expert testimony as technology-specific rather than examining functional characterization approaches that transcend implementation details.[104] Challenge versus accommodation theoretical development lacks progress, with research addressing general expert testimony approaches without analyzing methodological choices between challenging opponent analytical structures versus working within the opposition's established parameters.[105]

Cross-proceeding language replication pattern analysis lacks research coverage in administrative law literature. Studies focus on individual administrative decisions without documenting linguistic consistency patterns across related proceedings that might indicate

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[103] *See generally* Lubet, *supra* note 92 (addressing individual expert testimony techniques without examining coordinated multi-component defensive methodologies); FAIGMAN ET AL., *supra* note 81 (surveying expert testimony scholarship without coverage of multi-layer defensive architectures in administrative proceedings).

[104] *See generally* Janicke & Ren, *supra* note 98 (treating expert testimony as technology-specific); Koch & Murphy, vol. 1, *supra* note 95 (discussing administrative decision-making without examining functional characterization approaches in expert testimony).

[105] *See generally* Lubet, *supra* note 92 (addressing general expert testimony approaches without distinguishing between challenge and accommodation strategies in administrative proceedings).

institutional template usage or behavioral standardization.[106]

This study contributes preliminary documentation of these defensive approaches within a controlled case study context, acknowledging that broader empirical validation across diverse contexts would strengthen theoretical development.

C. Methodology: Defensive Declaration Analysis

1. Research Design and Case Selection

This study employs documentary analysis and cross-proceeding comparison to examine defensive expert declaration patterns across six related *Inter Partes Review* proceedings. Dr. Sunil P. Khatri submitted expert declarations on behalf of Patent Owner Singular Computing LLC across proceedings challenging three related patents in the LPHDR patent family.[107]

Case selection enables controlled comparison through several factors: (1) common expert declarant across all proceedings, (2) related patent family context with controlled technical variables, (3) temporal clustering within a 12-month period, and (4) identical administrative tribunal context.[108]

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[106] *See generally* Koch & Murphy, vol. 2, *supra* note 95 (discussing administrative procedural requirements without documenting linguistic consistency patterns); Love & Ambwani, *supra* note 101 (analyzing IPR outcomes across proceedings without examining decision language replication patterns).

[107] *See* '273 Patent, *supra* note 4; '156 Patent, *supra* note 4; '961 Patent, *supra* note 4.

[108] All proceedings conducted before Patent Trial and Appeal Board under 37 C.F.R. Part 42; IPR-154, *supra* note 3; IPR-155, *supra* note 4; IPR-164, *supra* note 4; IPR-165, *supra* note 4; IPR-178, *supra* note 4;

The proceedings divide between written description/enablement challenges (IPR-154, IPR-164, IPR-178) and obviousness challenges (IPR-155, IPR-165, IPR-179).[109] This division permits comparative analysis across different unpatentability ground contexts. Within the context of these IPRs, administrative outcome variation creates opportunities for correlating defensive approach characteristics with institutional reception patterns.

2. Document Analysis Approach

Primary source analysis examines three categories of documents: (1) expert declarations submitted by Dr. Khatri across all six proceedings, (2) PTAB institution decisions and final written decisions addressing expert testimony, and (3) underlying patent specifications and prosecution history documents referenced in expert analysis.[110]

Expert declaration analysis focuses on defensive approach characteristics including argumentation structure, evidence presentation methods, authority source prioritization, and cross-proceeding consistency patterns. Both substantive defensive positioning and methodological approaches to defensive expert testimony development receive examination.

PTAB decision analysis examines institutional reception patterns through documentation of decision language, expert testimony crediting patterns, and administrative reasoning adoption or rejection of expert positions. Cross-proceeding analysis identifies recurring

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IPR-179, *supra* note 4 (all institution decisions before Judges Arbes, Sawert, and Repko; all final written decisions before Judges Arbes, White, and Repko).

[109] *See* IPR-154, *supra* note 3; IPR-155, *supra* note 4; IPR-164, *supra* note 4; IPR-165, *supra* note 4; IPR-178, *supra* note 4; IPR-179, *supra* note 4.

[110] All documents accessed through USPTO Patent Trial and Appeal Case Tracking System (P-TACTS) database.

language patterns that may indicate institutional template usage or behavioral consistency indicators within the context of these IPRs.

3. Pattern Recognition Methodology

Cross-proceeding pattern recognition employs qualitative comparative analysis to identify defensive approach elements that appear consistently across proceedings with similar outcomes. The methodology acknowledges significant limitations in drawing causal inferences from pattern correlation without controlled experimental design.

Technology-agnostic positioning frequency analysis examines occurrence patterns across proceedings, documenting where functional rather than implementational characterizations appear in defensive expert declarations. Mathematical logic application analysis identifies where quantitative analytical approaches appear in defensive expert testimony.

Challenge versus accommodation analysis examines choice patterns between directly challenging opponent theoretical constructs versus working within opponent analytical structures. The limited sample size constrains conclusions about relative effectiveness but permits examination of institutional reception differences.

This methodology enables detailed examination of defensive approaches while acknowledging that broader empirical validation across diverse contexts would strengthen theoretical development.

D. Technology-Agnostic Positioning: Case Study Analysis

1. Implementation Across Written Description Proceedings

Dr. Khatri's defensive approach across three related written description proceedings, IPR-154, IPR-164, and IPR-178, reveals consistent methodological positioning. All three proceedings resulted in institution denial.[111]

Documentary analysis reveals consistent technology-agnostic characterization language across the declarations. Dr. Khatri characterized the claimed invention as "agnostic to the types of underlying physical technologies used to build it," employing identical language across the three proceedings.[112]

This approach contrasts with methodologies where defensive experts engage with opposing analytical structures rather than challenging their foundational validity. Dr. Khatri's declarations integrate legal standards into technical analysis, with identical language regarding written description and enablement requirements under 35 U.S.C. § 112.[113]

2. Four-Component Analytical Structure

Examination across the three proceedings reveals a consistent four-component defensive approach: (1) technology-agnostic characterization, (2) specification authority prioritization, (3) multi-domain evidence

[111] IPR-154, *supra* note 3; IPR-164, *supra* note 4; IPR-178, *supra* note 4.
[112] Khatri Decl. 154, *supra* note 87, ¶ 39; Khatri Decl. 164, *supra* note 87, ¶ 39; Khatri Decl. 178, *supra* note 87, ¶ 39. *See also* IPR-154, *supra* note 3, at 18 (adopting Dr. Khatri's technology-agnostic characterization); IPR-164, *supra* note 4, at 18–19 (same); IPR-178, *supra* note 4, at 18 (same).
[113] Khatri Decl. 154, *supra* note 87, ¶¶ 32-34; Khatri Decl. 164, *supra* note 87, ¶¶ 32-34; Khatri Decl. 178, *supra* note 87, ¶¶ 32-34.

documentation, and (4) genus-species accommodation fallback. This structure appears to create multiple independent analytical pathways while maintaining coherent argumentation.

The primary component establishes invention characterization as independent of implementation technology choices. Dr. Khatri positioned the inventions as addressing computational efficiency challenges rather than specific implementation technologies: "The '273 Patent is directed in general to the field of computing, and more specifically addresses the ability to compute rapidly."[114]

The secondary component prioritizes patent specification as primary authority over expert-created analytical structures. Specification authority language appears identically across proceedings: "The '201 Application includes a detailed example implementation of the invention implemented using transistors."[115]

The tertiary component documents comprehensive evidence across commercial, academic, and technical domains, demonstrating technology readiness and implementation feasibility to support enablement under 35 U.S.C. § 112. The quaternary component offers genus-species accommodation as Dr. Khatri's fallback approach for addressing alternative characterization structures.[116]

[114] Khatri Decl. 178, *supra* note 87, ¶ 36. *See also* Khatri Decl. 154, *supra* note 87, ¶ 36 (stating the same for its underlying patent); Khatri Decl. 164, *supra* note 87, ¶ 36 (stating the same for its underlying patent).
[115] Khatri Decl. 154, *supra* note 87, ¶ 41; Khatri Decl. 164, *supra* note 87, ¶ 41; Khatri Decl. 178, *supra* note 87, ¶ 41.
[116] Khatri Decl. 154, *supra* note 87, ¶¶ 48–52; Khatri Decl. 164, *supra* note 87, ¶¶ 48–52; Khatri Decl. 178, *supra* note 87, ¶¶ 48–52.

3. Mathematical Precision Integration

Cross-proceeding analysis reveals identical mathematical guidance language across all three Khatri declarations, reflecting coordinated preparation of parallel declarations with consistent mathematical precision in defensive expert testimony. Dr. Khatri offered specific parameter selection methodology: "In my opinion, one of skill in the art would understand how to choose the width of the integer portion to achieve any desired dynamic range. To do so one need only calculate the base 2 logarithm of the desired max value . . . ."[117]

The mathematical analysis included concrete calculation examples: "For example, to choose the width for a dynamic range of one million, one would calculate the base 2 logarithm of 1,000,000, which equals roughly 19.93. The integer portion would then need to be 5 bits wide . . . ."[118] This approach emphasized that persons of ordinary skill could implement the invention using standard educational background rather than requiring specialized expertise.[119]

Dr. Khatri established mathematical precision in error control through fractional bit width selection: "The width of the fractional portion of the LNS representation determines the error. For example, to achieve a 1% error, one can select the width of the fractional portion such that

117 Khatri Decl. 154, *supra* note 87, ¶ 47; Khatri Decl. 164, *supra* note 87, ¶ 47; Khatri Decl. 178, *supra* note 87, ¶ 47.
118 Khatri Decl. 154, *supra* note 87, ¶ 47; Khatri Decl. 164, *supra* note 87, ¶ 47; Khatri Decl. 178, *supra* note 87, ¶ 47.
119 *See, e.g.*, Khatri Decl. 154, *supra* note 87, ¶ 57 (explaining that implementation requires only standard undergraduate coursework in digital logic).

changing the least-significant fractional bit would correspond to a 1% change in the stored value . . . ."[120]

The mathematical relationships enabled adaptation of the disclosed example across varying technical requirements. Error analysis specificity demonstrates precise claim requirement integration:

> The claims recite that "the statistical mean, over repeated execution of the first operation on each specific input from the at least X% of the possible valid inputs to the first operation, of the numerical values represented by the first output signal of the LPHDR unit executing the first operation on that input differs by at least Y=0.05% from the result of an exact mathematical calculation of the first operation on the numerical values of that same input."[121]

4. Administrative Burden Allocation Framework

The PTAB decisions in these IPRs establish critical burden allocation principles across all three written description proceedings. The PTAB emphasized consistently: "In an [*inter partes* review], the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable."[122] Critically,

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[120] Khatri Decl. 178, *supra* note 87, ¶ 49 (internal citation omitted). *See also* Khatri Decl. 164, *supra* note 87, ¶ 49 (stating the same); Khatri Decl. 154, *supra* note 87, ¶ 49 (stating the same).

[121] Khatri Decl. 178, *supra* note 87, ¶ 48; *see also* Khatri Decl. 164, *supra* note 87, ¶ 48 (stating the same); Khatri Decl. 154, *supra* note 87, ¶ 48 (stating similar claim language with Y=0.2%).

[122] IPR-154, *supra* note 3, at 8 (citing Harmonic Inc. v. Avid Tech., Inc., 815 F.3d 1356, 1363 (Fed. Cir. 2016)); IPR-164, *supra* note 4, at 8; IPR-178, *supra* note 4, at 11.

"[t]his burden of persuasion never shifts to Patent Owner."[123]

The institutional application of claim construction standards reveals administrative approach preferences:

> We construe the challenged claims "using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. 282(b), including construing the claim in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent."[124]

5. PTAB Institutional Reception Patterns

The PTAB's institutional reception involved specific language adoption patterns that merit examination.[125] The Board adopted Dr. Khatri's technology-agnostic characterization across all proceedings: "Thus, in this respect, we agree with Patent Owner and its declarant, Dr. Khatri, that 'the invention is agnostic to the types of underlying physical technologies used to build it.'"[126]

Examination reveals verbatim adoption of the expert's characterization language across multiple

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[123] IPR-154, *supra* note 3, at 8 (citing Dynamic Drinkware, LLC v. Nat'l Graphics, Inc., 800 F.3d 1375, 1378 (Fed. Cir. 2015)); IPR-164, *supra* note 4, at 8; IPR-178, *supra* note 4, at 11.

[124] IPR-178, *supra* note 4, at 8 (citing 37 C.F.R. § 42.100(b) (2020)); *see also* IPR-154, *supra* note 3, at 9 (stating similar standards); IPR-164, *supra* note 4, at 9 (stating similar standards).

[125] *See, e.g.*, IPR-154, *supra* note 3, at 18; IPR-164, *supra* note 4, at 18–19; IPR-178, *supra* note 4, at 18.

[126] IPR-154, *supra* note 3, at 18 (quoting Khatri Decl. 154, *supra* note 87, ¶ 39); IPR-164, *supra* note 4, at 18–19 (quoting Khatri Decl. 164, *supra* note 87, ¶ 39); IPR-178, *supra* note 4, at 18 (quoting Khatri Decl. 178, *supra* note 87, ¶ 39).

proceedings. This institutional language adoption contrasts with the Board's treatment of Petitioner's expert categorization approach, where the PTAB employed categorical rejection language: "we cannot agree that the claim requires 'at least one selection' from three classes of infinitely combinable and unpredictable 'variables.'"[127]

The institutional response pattern reveals differential treatment of specification-based versus expert-created analytical structures. The Board positioned mathematical operations as the relevant analytical focus: "We instead find only the mathematical 'operation' of the execution unit—expressly recited in the claim—relevant for analysis of the claim's scope here."[128]

6. Parameter Evolution and Cross-Patent Adaptation

Cross-patent analysis reveals parameter evolution across the LPHDR patent family that influenced defensive approach adaptation. The patent family encompasses varying precision requirements: strict parameters (X=5%, Y=0.05%) in earlier '273 and '156 patents, evolving to relaxed parameters (X=10%, Y=0.2%) in the '961 patent.[129] This parameter evolution illustrates a significant relaxation of acceptable precision margins — with X doubling from 5% to 10% and Y quadrupling from 0.05% to 0.2% — across the patent family's development.

Dr. Khatri's defensive approach adapted to these parameter variations while maintaining consistent analytical structures. For stricter parameter contexts, the declarations emphasized mathematical precision: "the

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[127] IPR-154, *supra* note 3, at 18; IPR-164, *supra* note 4, at 18; IPR-178, *supra* note 4, at 18.
[128] *Id*.
[129] '273 Patent, *supra* note 4, claim 1; '156 Patent, *supra* note 4, claim 1; '961 Patent, *supra* note 4, claim 1.

example embodiment achieves an error of 1-2%, more than the claimed error amount of 0.05% or 0.2%; the introduction of additional uncertainty by using analog components would only increase the error or leave it unchanged."[130]

Parameter adaptation analysis reveals defensive methodology flexibility across technical requirement variations while maintaining specification-anchored authority positioning. The approach suggests defensive expert testimony can accommodate parameter evolution through mathematical demonstration rather than require fundamental approach revision.

7. Commercial and Academic Evidence Integration

The evidence documentation approach involved validation across multiple authority types. Commercial validation appears identically across all proceedings through Sony PlayStation 2 implementation: "By that definition, nanoelectronic transistors have been included in commercial products at least since the Sony Playstation 2 in 2003, which used 53.5 million transistors in a 90nm process technology."[131]

Academic documentation establishes a timeline for alternative technology maturity across multiple domains. Dr. Khatri documented nanomechanical implementations: "Nanomechanical devices are mechanically based devices implemented at the nanometer scale. In 2007, a team of

[130] *Compare* Khatri Decl. 164, *supra* note 87, ¶ 56, *and* Khatri Decl. 178, *supra* note 87, ¶ 56 (stating the same, verbatim), *with* Khatri Decl. 154, *supra* note 87, ¶ 56 (stating the same, verbatim, but here Dr. Khatri discusses the '201 Application that issued as the '273 patent).

[131] Khatri Decl. 154, *supra* note 87, ¶ 72; Khatri Decl. 164, *supra* note 87, ¶ 72; Khatri Decl. 178, *supra* note 87, ¶ 71.

authors led by Robert Blick published designs for a nanomechanical computer."[132]

Biological implementation documentation included: "DNA-based and other biologically or chemically based transistors were described by Schoning & Poghossian. These are compared in functionality with conventional FETs such as metal-oxide-semiconductor field-effect transistor (MOSFET) which is used in most electronics."[133]

Nanotube implementation maturity documentation established early development timelines: "Nanotube transistors, specifically carbon nanotube field-effect transistors (CNTFETs) had been demonstrated at least as early as 1998. The authors mention that the behavior of this device is similar to that of a metal-oxide semiconductor FET."[134]

Technical standards integration involved current-mode and pulse-based computing citations spanning multiple computational approaches. Dr. Khatri documented: "Indeed, in 2010, operating on numbers stored as charges, currents, voltages, frequencies, pulse widths, pulse densities, various forms of spikes, or other forms was well-known."[135]

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[132] Khatri Decl. 178, *supra* note 87, ¶ 70; Khatri Decl. 164, *supra* note 87, ¶ 71; Khatri Decl. 154, *supra* note 87, ¶ 71 (citing Ex. 2009, Blick, Robert, et al., "A Nanomechanical Computer-Exploring New Avenues of Computing," 9 New Journal of Physics 241 (2007)).
[133] Khatri Decl. 178, *supra* note 87, ¶ 72 (internal footnote omitted); Khatri Decl. 164, *supra* note 87, ¶ 73 (internal footnote omitted); Khatri Decl. 154, *supra* note 87, ¶ 73 (internal footnote omitted).
[134] Khatri Decl. 178, *supra* note 87, ¶ 74 (internal footnote omitted); Khatri Decl. 164, *supra* note 87, ¶ 75 (internal footnote omitted); Khatri Decl. 154, *supra* note 87, ¶ 75 (internal footnote omitted).
[135] Khatri Decl. 178, *supra* note 87, ¶ 59; Khatri Decl. 164, *supra* note 87, ¶ 59; Khatri Decl. 154, *supra* note 87, ¶ 59.

8. Priority Challenge and Cascade Effects

Examination of the cross-proceeding decisions reveals that Dr. Khatri's technology-agnostic positioning accompanied a priority challenge defense approach that achieved PTAB's denials of institution for IPR-154, IPR-164, and IPR-178. The PTAB's priority determination established across proceedings: "Based on our review of the parties' arguments and the evidence, we find that Petitioner has failed to show sufficiently that the '201 application either lacks sufficient written-description support for, or enablement of, the subject matter of the challenged claims . . . ."[136]

This priority determination created effects that eliminated Petitioner's prior art foundation:

> As discussed above, we determine that Petitioner has failed to show persuasively that the challenged claims are not entitled to a priority date of at least June 15, 2010, the filing date of Bates 2010. Bates 2010 published on December 23, 2010. Thus, Bates 2010 is not prior art to the challenged claims . . . .[137]

The proceeding outcome followed directly: "Because obviousness under § 103 is Petitioner's sole ground of unpatentability, we find that the record does not establish a reasonable likelihood that Petitioner would prevail on its asserted ground of unpatentability."[138] The technology-agnostic characterization occurred alongside the priority defense, suggesting multiple analytical levels of

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[136] IPR-154, *supra* note 3, at 22; IPR-164, *supra* note 4, at 22; IPR-178, *supra* note 4, at 21.
[137] IPR-154, *supra* note 3, at 22; IPR-164, *supra* note 4, at 22; IPR-178, *supra* note 4, at 21–22. For prior art reference citations, *see infra* note 194.
[138] IPR-154, *supra* note 3, at 22; IPR-164, *supra* note 4, at 22; IPR-178, *supra* note 4, at 22.

defensive positioning created cascade effects determining overall proceeding outcomes.

9. Petitioner Expert Opinion Vulnerability

The PTAB's identification of internal inconsistencies in Petitioner's expert opinion reveals institutional sensitivity to coherence failures in technical expert testimony. The Board documented specific contradictions:

> Indeed, many of Petitioner's contentions about the mathematical operations in the Petition are internally inconsistent. For example, Petitioner contends on one hand that "trigonometric or exponentiation functions" are complex, Pet. 32–33 (citing Ex. 1003 ¶¶ 92–93), but elsewhere contends that performing "an operation on a high dynamic range of numbers" "with low precision" was conventional and known in the art, *id.* at 22–23 . . . .[139]

The institutional recognition of these inconsistencies suggests administrative preferences for coherent analytical approaches over contradictory technical arguments. This pattern suggests that defensive expert testimony coherence may complement substantive technical merit in achieving favorable institutional reception. The PTAB's treatment contrasts with its acceptance of Patent Owner's expert testimony, where the Board stated: "In any event, we agree with the detailed explanation provided by Patent Owner and find that the '201 application adequately describes a processing element

[139] IPR-154, *supra* note 3, at 19; *see also* IPR-164, *supra* note 4, at 19–20 (concluding the same with citations differing accordingly); IPR-178, *supra* note 4, at 19 (concluding the same with citations differing accordingly).

comprising a 'logic unit' and 'LPHDR arithmetic unit' that performs operations on the input data."[140]

E. Cross-IPR Institutional Reception Pattern Analysis

1. Linguistic Pattern Documentation

Linguistic patterns in Patent Trial and Appeal Board decision-making across six related *Inter Partes Review* proceedings targeting Singular Computing's LPHDR patent family reveal instances of language replication that may indicate institutional analytical approaches, decision-making templates, or responses to similar legal and technical arguments.

The identical panel composition across institution decision proceedings (IPR-154, IPR-164, and IPR-178) permits examination of institutional decision-making patterns with reduced individual judicial variation.[141] Different panel composition for final written decisions (IPR-155, IPR-165, IPR-179) creates comparative context for examining institutional behavioral consistency.[142]

2. Language Replication Patterns

Examination of institution decisions documents recurring language patterns in the Board's treatment of expert-created categorization approaches. The Board

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[140] IPR-154, *supra* note 3, at 20; IPR-164, *supra* note 4, at 20; IPR-178, *supra* note 4, at 19.

[141] Institution decisions rendered by Judges Arbes, Sawert, and Repko; final written decisions rendered by Judges Arbes, White, and Repko. *See* IPR-154, *supra* note 3; IPR-155, *supra* note 4; IPR-164, *supra* note 4; IPR-165, *supra* note 4; IPR-178, *supra* note 4; IPR-179, *supra* note 4 (institution decisions); IPR-155 Final, *supra* note 4; IPR-165 Final, *supra* note 4; IPR-179 Final, *supra* note 4 (final written decisions).

[142] *See* IPR-155 Final, *supra* note 4, at 1 (before Judges Arbes, White, and Repko); IPR-165 Final, *supra* note 4, at 1 (same); IPR-179 Final, *supra* note 4, at 1 (same).

employed identical rejection language across three institution denial decisions when addressing Petitioner's expert analytical structure: "Petitioner contends that implementation of an execution unit requires 'at least one selection' from three classes of variables: (1) 'implementing technology,' (2) 'numerical representation,' and (3) 'operation.'"[143]

The Board's analytical structure rejection employed identical language across proceedings: "Thus, even though we agree with Petitioner that claim 1 recites an execution unit by its function of executing an operation, we cannot agree that the claim requires 'at least one selection' from three classes of infinitely combinable and unpredictable 'variables.'"[144] This precise language replication may indicate consistency in administrative decision-making approaches when evaluating similar expert testimony approaches.

Conversely, the Board consistently adopted technical approaches grounded in established standards, employing recurring language patterns when addressing mathematical complexity in proceedings where institution was granted.[145] The Board repeatedly referenced the "massive number of possible inputs to Dockser's FPP (including over 70 trillion possible pairs of normal IEEE-

[143] IPR-154, *supra* note 3, at 16; IPR-164, *supra* note 4 at 16; IPR-178, *supra* note 4, at 15.
[144] IPR-154, *supra* note 3, at 18; IPR-164, *supra* note 4, at 18; IPR-178, *supra* note 4, at 18.
[145] *See* IPR-155, *supra* note 4, at 13 (accepting IEEE-754 standards-based analysis); IPR-165, *supra* note 4, at 16 (same); IPR-179, *supra* note 4, at 14 (same). *See also* IPR-155 Final, *supra* note 4, at 33–34 (crediting Goodin's software-based and algebraic analysis); IPR-165 Final, *supra* note 4, at 34 (same); IPR-179 Final, *supra* note 4, at 34–35 (same).

754 single-format mantissas)" when discussing computational verification approaches.[146]

3. Authority Source Treatment Patterns

Authority source treatment across proceedings documents differential institutional reception of intrinsic evidence (patent specification) versus extrinsic evidence (expert categorizations).[147] The Board's treatment of expert-created analytical structures exhibits consistent patterns of rejection when such approaches lack clear grounding in claim language or specification disclosure.

The Board's analytical focus appears to prioritize claim-specific elements over abstract categorizations: "We instead find only the mathematical 'operation' of the execution unit—expressly recited in the claim—relevant for analysis of the claim's scope here."[148]

Dr. Khatri's approach employed authority source prioritization that correlated with institutional reception. The Board consistently agreed with Dr. Khatri's technology-agnostic positioning: "Thus, in this respect, we agree with Patent Owner and its declarant, Dr. Khatri, that 'the invention is agnostic to the types of underlying physical technologies used to build it.'"[149]

4. Temporal Decision Clustering

The temporal clustering of all six institution decisions within a three-day period exhibits patterns that may suggest administrative coordination mechanisms, case

[146] IPR-155, *supra* note 4, at 16 (internal citation omitted); IPR-165, *supra* note 4, at 19 (internal citation omitted); IPR-179, *supra* note 4, at 17 (internal citation omitted).
[147] *See* Phillips v. AWH Corp., 415 F.3d 1303, 1312–17 (Fed. Cir. 2005) (en banc) (establishing primacy of intrinsic evidence in patent claim construction).
[148] IPR-154, *supra* note 3, at 18; IPR-164, *supra* note 4, at 18; IPR-178, *supra* note 4, at 18.
[149] IPR-154, *supra* note 3, at 18; IPR-164, *supra* note 4, at 18–19; IPR-178, *supra* note 4, at 18.

management efficiency, or concentrated analytical attention to related proceedings. Institution decisions were rendered on May 12, 2021 (IPR-154, IPR-155), May 13, 2021 (IPR-164, IPR-165), and May 14, 2021 (IPR-178, IPR-179).[150]

This clustering, combined with language replication patterns, may indicate institutional efficiency mechanisms in related proceeding analysis. The concentrated decision timeline suggests potential administrative processing approaches that merit investigation across broader administrative contexts involving related proceedings.

F. Mathematical Logic in Expert Declarations

1. Mutual Exclusivity Demonstrations

Mathematical logic approaches observed in this dataset center on mutual exclusivity demonstrations, where hardware elements cannot logically satisfy multiple counting requirements within single claim limitations. Dr. Khatri's analysis in IPR-155 exemplifies this technique, arguing that execution units cannot simultaneously count toward both LPHDR and full-precision multiplication unit requirements while satisfying numerical "exceeds" limitations.[151]

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[150] IPR-154, *supra* note 3 (decided May 12, 2021); IPR-155, *supra* note 4 (decided May 12, 2021); IPR-164, *supra* note 4 (decided May 13, 2021); IPR-165, *supra* note 4 (decided May 13, 2021); IPR-178, *supra* note 4 (decided May 14, 2021); IPR-179, *supra* note 4 (decided May 14, 2021).

[151] Declaration of Sunil P. Khatri, Ph.D., Exhibit 2051, IPR2021-00155, ¶¶ 84–86 (P.T.A.B. Aug. 9, 2021) [hereinafter Khatri Decl. 155]. *Compare* Declaration of Sunil P. Khatri, Ph.D., Exhibit 2051, IPR2021-00165, ¶¶ 84–86 (P.T.A.B. Aug. 9, 2021) [hereinafter Khatri Decl. 165] (quoting the same verbatim), *with* Declaration of Sunil P. Khatri, Ph.D., Exhibit 2051, IPR2021-00179, ¶¶ 84–86 (P.T.A.B. Aug. 9, 2021) [hereinafter Khatri Decl. 179] (Dr. Khatri focuses on claims 24 and 59 of the '273 patent.).

Dr. Khatri's specific mathematical analysis demonstrates this principle: "the number of LPHDR execution units in the device will *at most equal* to the number of claim 3 full-precision floating-point multiplication execution units – and will never 'exceed [it] by at least one hundred,' as claim 3 requires."[152]

The technique appears to reduce vulnerability to expert opinion challenges by establishing mathematical constraints that limit interpretive disputes. Mathematical impossibility demonstrations may create clearer analytical boundaries compared to complex technical argumentation requiring specialized interpretation.

2. IEEE Standards Integration for Mathematical Authority

Both Mr. Goodin and Dr. Khatri utilized mathematical logic approaches, which employed IEEE-754 floating-point specifications. This standards integration anchored Khatri's mathematical impossibility demonstrations in externally validated technical authority.[153]

Standards-based mathematical authority appeared to offer advantages in administrative proceedings by reducing reliance on competing expert interpretations while establishing commonly accepted mathematical boundaries for logical analysis.

Dr. Khatri's declarations included systematic technical precision analysis:

> Multiplication performed at bfloat16 precision uses 7 bits for the mantissa. Petitioner states—and I agree—that utilizing 7 bits of mantissa in

[152] Khatri Decl. 155, *supra* note 151, ¶ 86; Khatri Decl. 165, *supra* note 151, ¶ 86. *See also* Khatri Decl. 179, *supra* note 151, ¶ 86 (stating similar).

[153] IEEE Std 754-2019, IEEE Standard for Floating-Point Arithmetic (2019) [hereinafter IEEE-754].

> multiplication operations results in a minimum of 12% of valid floating point 32 inputs, producing at least 0.39% relative error compared to the exact mathematical calculation of a full-precision multiplication on those same inputs.[154]

3. Panel Reception of Mathematical Logic

Panel reception of mathematical logic arguments in this dataset involved institutional responses to logical precision over technical complexity in addressing numerical limitations. In IPR-165, claim 3 survived final written decision with the panel explicitly acknowledging Patent Owner's mathematical impossibility argument.[155]

The panel stated:

> Given this determination, we need not address Patent Owner's argument that the references fail to teach the "exceeds" limitation of claim 3 because the alleged "LPHDR execution units" are "adapted to execute at least the operation of multiplication on floating point numbers that are at least 32 bits wide" and thus "the number of LPHDR execution units will never exceed the number of claim 3 full-precision multiplication execution units," as required by the claim.[156]

IPR-179 panel analysis incorporated mathematical logic regarding numerical limitations, with multiple claims

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[154] Khatri Decl. 165, *supra* note 151, ¶ 136 (internal citations omitted); Khatri Decl. 155, *supra* note 151, ¶ 136; Khatri Decl. 179, *supra* note 151, ¶ 136.

[155] IPR-165 Final, *supra* note 4, at 73 n.8. *See also* IPR-179 Final, *supra* note 4, at 74 n.8 (upholding claim 8 of the '273 patent, where the Board acknowledged Dr. Khatri's mathematical impossibility argument); IPR-155 Final, *supra* note 4, at 77 n.8 (claim 3, same).

[156] IPR-165 Final, *supra* note 4, at 73 n.8; IPR-179 Final, *supra* note 4, at 74 n.8. *See also* IPR-155 Final, *supra* note 4, at 77 n.8 (stating similar).

surviving based on the same mathematical impossibility reasoning applied to the "exceeds" limitation.[157] The panels employed "crediting" language for mathematical demonstrations more frequently than for complex technical interpretations, suggesting institutional preference for analytical approaches that create clear logical boundaries rather than requiring extensive technical interpretation.[158]

G. Challenge vs. Accommodation Theory

1. Theoretical Development

Defensive expert testimony across the Singular Computing IPR proceedings reveals differences in institutional reception between challenge methodology and accommodation approaches.[159] Challenge methodology questions the foundational validity of opposing expert analytical structures, while accommodation approaches compete within established analytical parameters.[160] Traditional approaches to opposing expert analytical structures in patent litigation typically involve accommodation methods—competing within analytical parameters established by the opposing expert—rather than challenging the foundational validity of those structures.[161]

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[157] IPR-179 Final, *supra* note 4, at 74–75.
[158] *See* IPR-155 Final, *supra* note 4, at 77 n.8; IPR-165 Final, *supra* note 4, at 73 n.8; IPR-179 Final, *supra* note 4, at 74 n.8.
[159] *See infra* Sections IV.A–B, V.A (documenting differential PTAB reception of challenge and accommodation approaches across six related proceedings).
[160] *Compare* Khatri Decl. 164, *supra* note 87, ¶ 39 (challenging foundational validity of Petitioner's categorical framework), *with* Khatri Decl. 165, *supra* note 151, ¶ 136 (accommodating Petitioner's IEEE-754 analytical parameters to demonstrate claim satisfaction).
[161] *See*, *e.g.*, Khatri Decl. 165, *supra* note 151, ¶ 136 ("Petitioner states—and I agree—that utilizing 7 bits of mantissa in multiplication operations results in a minimum of 12% of valid floating point 32 inputs . . . .").

Dr. Khatri's approach in IPR-154 exemplifies challenge methodology through direct questioning of the petitioner's "three classes of variables" categorization approach.[162] The defensive approach targeted the analytical structure's foundational premise that such categorization was relevant to claim scope determination.

2. PTAB Reception of Challenge Approaches

Institutional response patterns documented in IPR-154, IPR-164, and IPR-178 proceedings reveal differences in administrative reception of challenge versus accommodation approaches.[163] The Board's rejection of the petitioner's analytical structure appeared to validate challenge methodology through categorical analytical structure rejection: "[w]e cannot agree that the claim requires 'at least one selection' from three classes of infinitely combinable and unpredictable 'variables.'"[164]

This institutional response suggests administrative preference for analytical approaches that avoid complex technical competition. Challenge approaches achieved institutional language adoption through specification-based analytical positioning, while accommodation approaches received less favorable institutional reception despite detailed technical analysis.

The PTAB's willingness to engage with specific mathematical formulations, including detailed algebraic equations in final written decisions, suggests institutional preference for mathematical rigor over abstract analytical

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[162] Khatri Decl. 154, *supra* note 87, ¶ 39; Khatri Decl. 164, *supra* note 87, ¶ 39; Khatri Decl. 178, *supra* note 87, ¶ 39.
[163] *See generally* IPR-154, *supra* note 3; IPR-164, *supra* note 4; IPR-178, *supra* note 4.
[164] IPR-154, *supra* note 3, at 18; IPR-164, *supra* note 4, at 18; IPR-178, *supra* note 4, at 18.

frameworks. These patterns indicate relationships between defensive approach characteristics and institutional analytical methods, though the limited sample size constrains broader conclusions about institutional behavioral patterns.

3. Authority Hierarchy Implementation

Case study reveals differences in authority source prioritization between challenge and accommodation approaches.[165] Challenge methodology employs authority hierarchy that prioritizes intrinsic evidence sources over expert-created analytical structures.[166]

The observed authority hierarchy follows prioritization: (1) patent specification disclosure, (2) supporting technical literature, (3) expert interpretation, and (4) standards integration.[167] Accommodation approaches may shift emphasis within this hierarchy by increasing engagement with expert-created analytical structures, though specification authority may remain relevant.[168]

The institutional response patterns appear to validate authority hierarchy theory through administrative preferences for intrinsic over extrinsic evidence sources. [169]

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[165] *Compare* IPR-154, *supra* note 3, at 18 (PTAB grounding analysis in claim language), *with* IPR-165 Final, *supra* note 4, at 34 (PTAB crediting expert's standards-based framework).

[166] *See* Phillips v. AWH Corp., 415 F.3d 1303, 1312–17 (Fed. Cir. 2005) (en banc); Khatri Decl. 154, *supra* note 87, ¶¶ 36–41.

[167] *See* Khatri Decl. 154, *supra* note 87, ¶¶ 36, 41 (specification disclosure); *Id.* ¶¶ 70–75 (technical literature); *id.* ¶¶ 39, 47–49 (expert interpretation); IEEE-754, *supra* note 153 (standards integration).

[168] *Cf.* Goodin Decl. 154-5, *supra* note 5, ¶¶ 52–65 (engaging primarily with expert-created analytical categories rather than anchoring analysis in specification language); IPR-164, *supra* note 4, at 16–18 (PTAB rejecting this approach).

[169] *See* IPR-154, *supra* note 3, at 18; IPR-164, *supra* note 4, at 18; IPR-178, *supra* note 4, at 18 (rejecting expert-created analytical structure while adopting specification-based characterization); *see also Phillips v. AWH Corp.*, 415 F.3d 1303, 1312–17 (Fed. Cir. 2005) (en banc)

The PTAB's rejection of expert-created analytical structures combined with adoption of specification-based characterizations suggests institutional hierarchy preferences in this case study context.[170]

H. Multi-Dimensional Defensive Architecture

1. Cross-IPR Architectural Evolution

Defensive architecture across the LPHDR patent proceedings documents varying complexity levels corresponding to different legal contexts. Dr. Khatri's IPR-154 declaration employed a four-layer defensive structure encompassing: (1) technology-agnostic characterization, (2) representative example sufficiency, (3) technology implementation documentation, and (4) genus-species accommodation response.[171]

Subsequent proceedings involved increased architectural complexity.[172] The IPR-155 declaration integrated mathematical logic analysis while maintaining multi-dimensional positioning through obviousness defense components.[173] IPR-165 employed a six-component defensive architecture, among the most complex structures within this proceeding dataset.[174]

(establishing primacy of intrinsic evidence in patent claim construction).

[170] *See supra* note 169 and accompanying text.

[171] Khatri Decl. 154, *supra* note 87, ¶¶ 36–39, 41–47, 70–77, 48–52. *See generally* Khatri Decl. 164, *supra* note 87 (employing identical four-layer defensive structure); Khatri Decl. 178, *supra* note 87 (same).

[172] *See* Khatri Decl. 155, *supra* note 151; Khatri Decl. 165, *supra* note 151; Khatri Decl. 179, *supra* note 151 (employing more complex defensive structures than the written description declarations in each).

[173] *See generally* Khatri Decl. 155, *supra* note 151 (integrating mathematical logic at ¶¶ 84–86 alongside multi-component obviousness defense).

[174] Khatri Decl. 165, *supra* note 151.

The six-component defensive architecture employed in IPR-165 comprised: (1) claim construction enhancement approach, (2) reference re-characterization through resource efficiency analysis, (3) technical incompatibility arguments based on design philosophy differentiation, (4) mathematical logic defense targeting numerical limitations, (5) product-claim mapping through commercial validation, and (6) secondary considerations integration through market evidence.[175]

2. Genus-Species Analytical Structure

The fourth component of Dr. Khatri's IPR-154 defensive approach involved genus-species accommodation as a methodological fallback approach.[176] The IPR-178 declaration also demonstrates an explicit genus-species challenge followed by accommodation methodology.[177] Dr. Khatri first challenged the analytical structure's validity:

> I understand that Petitioner has argued that the claims of the '273 Patent are directed to a genus of LPHDR execution units because they can be implemented in different underlying technologies, with different numerical representations, and can perform different operations. As discussed above, I disagree; an LPHDR execution unit is a singular electronic device, not a genus.[178]

The declaration then provided accommodation-based fallback: "However, even if the claims were directed

[175] *Id.* ¶¶ 59–65 (claim construction), ¶¶ 45–51, 66–73 (reference re-characterization), ¶¶ 101–104 (technical incompatibility), ¶¶ 84–100 (mathematical logic), ¶¶ 128–152 (product-claim mapping), ¶¶ 123–125 (secondary considerations).
[176] *See generally* Khatri Decl. 154, *supra* note 87, ¶¶ 65–68 (presenting genus-species accommodation).
[177] *See generally* Khatri Decl. 178, *supra* note 87.
[178] Khatri Decl. 178, *supra* note 87, ¶¶ 64–65

to a genus, the '201 Application's disclosed example is representative of the different 'species' contained within that genus."[179] This fallback positioning created an alternative analytical pathway while maintaining coherent argumentation.

The genus-species analysis demonstrated that the disclosed transistor implementation could serve as representative example for the broader range of implementation technologies covered by the claims. The approach illustrates distinction between challenge and accommodation methods, where primary approach involved direct challenge to categorization validity, while genus-species analysis provided accommodation-based fallback that accepted analytical structure premises but disputed conclusions.

3. Component Integration and Institutional Reception

As discussed above, the multi-component approach created multiple independent analytical pathways.[180] Each component addressed different aspects of the obviousness challenge, reducing dependence on any single analytical approach for overall defensive success.[181]

Mathematical logic components received institutional acknowledgment, with the Board recognizing logical impossibility arguments regarding simultaneous execution unit counting toward both LPHDR and full-precision multiplication requirements.[182] Product-claim

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[179] Khatri Decl. 178, *supra* note 87, ¶ 65; Khatri Decl. 154, *supra* note 87, ¶ 65; Khatri Decl. 164, *supra* note 87, ¶ 65.

[180] *See infra* Section VI.A.

[181] *See supra* note 175 and accompanying text (describing six-component defensive architecture).

[182] *See* IPR-165 Final, *supra* note 4, at 73 n.8 (acknowledging Patent Owner's mathematical impossibility argument regarding the "exceeds"

mapping integrated Google TPU analysis, establishing commercial implementation correlation through technical architecture documentation.[183]

Evidence density approaches integrated within multi-dimensional structures appeared to correlate with institutional acceptance through comprehensive documentation that made opposition analytical deficiencies more apparent through contrast with comprehensive defensive documentation. [184]

4. Commercial Validation Integration

Commercial validation through product-claim mapping represents a component within multi-dimensional defensive architectures that appeared to correlate with credibility through market evidence integration. Dr. Khatri's Google TPU analysis in IPR-165 documented technical architecture mapping between claimed invention elements and commercial implementation characteristics.[185]

Dr. Khatri's commercial analysis included specific technical details: "Google's publications explain that each of the bfloat16 execution units in the MXU require 'less circuitry' than either FP32 or FP16 multipliers: 'The IEEE fp32, IEEE fp16 and bfloat16 formats need 576 full adders, 121 full adders, and 64 full adders, respectively.'"[186] Dr.

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limitation); IPR-155 Final, *supra* note 4, at 77 n.8 (same); IPR-179 Final, *supra* note 4, at 74 n.8 (same).

[183] *See* Khatri Decl. 165, *supra* note 151, ¶¶ 128–152; *see also* IPR-165 Final, *supra* note 4, at 40–42 (addressing Patent Owner's commercial success evidence based on Google TPU implementation).

[184] *See, e.g.*, IPR-154, *supra* note 3, at 22 ("Petitioner has failed to show sufficiently . . . ."); IPR-164, *supra* note 4, at 22 (same); IPR-178, *supra* note 4, at 21 (same) (framing denial in terms of Petitioner's evidentiary failure rather than affirmative validation of Patent Owner's defensive theory).

[185] Khatri Decl. 165, *supra* note 151, ¶¶ 132–37; Khatri Decl. 155, *supra* note 151, ¶¶ 132–37; Khatri Decl. 179, *supra* note 151, ¶¶ 132–37.

[186] *Id.*

Khatri's analysis continued: "Each of the multipliers within the MXU is able to perform multiplication only at low-precision, using the bfloat16 format. They lack the circuitry to perform, for example, perform [sic] FP16 or FP32 operations."[187]

Scale analysis documented massive commercial implementation: "The TPUv3 board contains 2 MXUs per core, 2 cores per chip, and 4 chips per board. [188] Thus, a single TPUv3 board contains 128 × 128 × 2 × 2 × 4 = 262,144 LPHDR execution units."[189] This calculation demonstrated large scale commercial deployment.

The product-claim mapping analysis documented: (1) commercial implementation validation through market evidence integration, (2) technical architecture correlation showing practical utility despite theoretical complexity, (3) secondary considerations integration strengthening overall defensive positioning through economic evidence, and (4) nexus argumentation connecting claimed features to commercial implementation. [190]

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[187] Khatri Decl. 165, *supra* note 151, ¶ 132; Khatri Decl. 155, *supra* note 151, ¶ 132; Khatri Decl. 179, *supra* note 151, ¶ 132.

[188] *See* Khatri Decl. 165, *supra* note 151, ¶¶ 128–131 (commercial validation), ¶¶ 132–137 (technical architecture), ¶¶ 123–125 (secondary considerations), ¶¶ 138–152 (nexus argumentation); *see also* IPR-165 Final, *supra* note 4, at 38–42 (addressing secondary considerations including commercial success and TPU implementation evidence).

[189] Khatri Decl. 165, *supra* note 151, ¶ 143; Khatri Decl. 155, *supra* note 151, ¶ 143; Khatri Decl. 179, *supra* note 151, ¶ 138.

[190] *See* Khatri Decl. 165, *supra* note 151, ¶¶ 128–131 (commercial validation), ¶¶ 132–137 (technical architecture), ¶¶ 123–125 (secondary considerations), ¶¶ 138–152 (nexus argumentation); *see also* IPR-165 Final, *supra* note 4, at 38–42 (addressing secondary considerations including commercial success and TPU implementation evidence).

5. Evidence Density and Authority Hierarchy Integration

Multi-dimensional defensive architectures incorporate evidence density approaches that correlate with burden-shifting effects in institutional analysis.[191] The approach documents comprehensive factual records through multi-domain validation encompassing commercial implementation, academic research, and technical standards integration, potentially shifting analytical burden from defensive validation toward opposition inadequacy demonstration.[192]

Commercial validation through large-scale deployment examples established technological feasibility at commercial scale before priority dates. Sony PlayStation 2 implementation utilizing "53.5 million transistors in a 90nm process technology" demonstrated commercial-scale nanoelectronic implementation well before the June 15, 2010 priority date.[193] Academic authority integration through peer-reviewed research provided independent validation while timeline establishment documented technology maturity chronology before relevant priority dates.[194]

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[191] *See* IPR-154, *supra* note 3, at 22 ("Petitioner has failed to show sufficiently…"); IPR-164, *supra* note 4, at 22 (same); IPR-178, *supra* note 4, at 21 (same) (framing denial in terms of Petitioner's evidentiary failure in each).

[192] *See* Khatri Decl. 154, *supra* note 87, ¶¶ 59–77 (documenting commercial, academic, and technical implementation evidence across multiple domains); IPR-154, *supra* note 3, at 22 (framing institution denial in terms of Petitioner's evidentiary failure); IPR-164, *supra* note 4, at 22 (same); IPR-178, *supra* note 4, at 21 (same).

[193] Khatri Decl. 154, *supra* note 87, ¶ 72; Khatri Decl. 164, *supra* note 87, ¶ 72; Khatri Decl. 178, *supra* note 87, ¶ 71.

[194] *See* Khatri Decl. 178, *supra* note 87, ¶¶ 70, 74 (citing Blick et al., nanomechanical computer design (2007), and carbon nanotube field-effect transistors demonstrated by 1998); Khatri Decl. 164, *supra* note 87, ¶¶ 71, 75 (same); Khatri Decl. 154, *supra* note 87, ¶¶ 71, 75 (same).

Cross-domain evidence correlation may have created cumulative credibility effects exceeding individual source validation.[195] The documentation approach effectively required the opposition to demonstrate inadequacy across multiple independent evidence domains rather than challenging single expert assertions, reducing vulnerability to focused challenges targeting individual evidence sources.[196]

Authority hierarchy development followed prioritization: (1) patent specification as primary authority, (2) academic and commercial literature as secondary support, (3) expert interpretation as tertiary analysis, and (4) technical standards as verification approach.[197] Patent specification positioning as primary authority source correlated with institutional preferences for intrinsic evidence over extrinsic interpretations, aligning with established claim construction methodologies favoring specification-based analysis.[198]

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[195] *See* IPR-154, *supra* note 3, at 18–22 (adopting Patent Owner's technology-agnostic characterization, specification authority positioning, and multi-domain evidence documentation in denying institution); IPR-164, *supra* note 4, at 18–22 (same); IPR-178, *supra* note 4, at 18–21 (same).

[196] *See* IPR-154, *supra* note 3, at 8 ("[T]he petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable." (citing *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016))); IPR-164, *supra* note 4, at 8 (same); IPR-178, *supra* note 4, at 11 (same).

[197] *See supra* notes 166–68 and accompanying text (describing observed authority hierarchy).

[198] *See* Phillips v. AWH Corp., 415 F.3d 1303, 1315 (Fed. Cir. 2005) (en banc) (establishing specification as "the single best guide to the meaning of a disputed term"); IPR-154, *supra* note 3, at 18 (prioritizing claim language and specification disclosure over expert-created analytical structures).

I. Administrative Decision-Making Implications

1. Institutional Behavioral Pattern Analysis

The empirical findings documented in this case study suggest implications for understanding administrative agency decision-making in complex technical proceedings. The Patent Trial and Appeal Board's language replication patterns across related proceedings may indicate institutional behavioral consistency, though alternative explanations for language similarity cannot be excluded.

Administrative template usage represents one plausible explanation for the verbatim language replication, with technology-agnostic characterization appearing identically across three related proceedings.[199] Cross-proceeding behavioral consistency appears to correlate with administrative processing considerations, as identical panel composition across all six institution decisions versus a substituted panel member for the three final written decisions suggests standard panel management practices between decision phases.[200]

The institution outcomes across the case study dataset correlate with proceeding type characteristics, with proceedings dependent on Bates as prior art resulting in institution denial after the PTAB credited Patent Owner's

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[199] IPR-154, *supra* note 3, at 18 (adopting Dr. Khatri's characterization that "the invention is agnostic to the types of underlying physical technologies used to build it" (quoting Ex. 2006 ¶ 39)); IPR-164, *supra* note 4, at 18–19 (same); IPR-178, *supra* note 4, at 18 (same).

[200] *Compare* IPR-154, *supra* note 3, at 1, IPR-155, *supra* note 4, at 1, IPR-164, *supra* note 4, at 1, IPR-165, *supra* note 4, at 1, IPR-178, *supra* note 4, at 1, and IPR-179, *supra* note 4, at 1 (all institution decisions before Judges Arbes, Sawert, and Repko), *with* IPR-155 Final, *supra* note 4, at 1, IPR-165 Final, *supra* note 4, at 1, and IPR-179 Final, *supra* note 4, at 1 (final written decisions before Judges Arbes, White, and Repko).

priority defense, while proceedings employing Dockser as prior art — which predated all possible priority dates — resulted in institution granted.[201] This pattern may reflect different analytical approaches to distinct legal standards rather than institutional preferences.

2. Mathematical Logic Administrative Reception

The institutional acknowledgment of mathematical logic approaches may provide insights into administrative agency approaches to technical evidence evaluation. The PTAB's acknowledgment of mathematical impossibility demonstrations rather than detailed technical complexity analysis suggests administrative patterns that favor logical precision over technical elaboration.

This pattern suggests administrative processing may prioritize analytical approaches that create clear logical pathways rather than approaches requiring extensive technical interpretation. Mathematical logic applications received favorable institutional treatment when grounded in technical standards rather than expert-created analytical structures.

Administrative processing approaches appear to address uncertainty through logical demonstration rather than expert interpretation. However, these observations derive from a limited case study context that constrains broader theoretical conclusions about administrative behavioral patterns.

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[201] *See supra* note 87 and accompanying text (documenting institution outcomes across all six proceedings); see also IPR-154, *supra* note 3, at 22 (finding Bates 2010 "not prior art to the challenged claims" based on June 15, 2010 priority date); IPR-164, *supra* note 4, at 22 (same); IPR-178, *supra* note 4, at 21–22 (same).

3. Contributions to Administrative Law Scholarship

This study documents institutional behavioral patterns in complex technical evidence evaluation that may contribute empirical foundation for administrative law scholarship. The authority hierarchy reception patterns, mathematical logic reception patterns, and evidence density approaches document administrative agency approaches to complex technical evidence.[202]

The language replication patterns across proceedings document administrative processing approaches that may correlate with institutional decision-making template development.[203] The behavioral consistency across related proceedings creates preliminary documentation for theoretical development regarding administrative agency institutional learning.

However, broader empirical validation across diverse administrative contexts would be necessary to establish administrative law principles from these preliminary case study findings. The patterns documented here create foundation for future research rather than definitive conclusions about administrative behavioral consistency.

J. *Limitations and Future Research Directions*

1. Dataset and Scope Limitations

Several significant constraints limit the generalizability of findings developed through this analysis

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[202] *See supra* Sections II.B–D and accompanying notes (documenting authority hierarchy reception, mathematical logic reception, and evidence density approaches).

[203] *See supra* notes 143–44 and accompanying text (documenting verbatim language replication across IPR-154, IPR-164, and IPR-178 at page 18).

of defensive expert declaration methodology. The empirical foundation derives from six related *Inter Partes Review* proceedings targeting a single patent family, with outcomes that create insufficient statistical power for broader applicability testing.[204]

The proceedings examined involve related patents within the Low Precision High Dynamic Range computational architecture domain, which may limit cross-technology validation of documented patterns.[205] Parameter evolution analysis occurs within single patent family rather than across diverse technological contexts.[206]

Panel composition effects present specific limitations, as all six institution decisions involved identical panel composition (Judges Arbes, Sawert, and Repko), while the three final written decisions involved a substituted panel member (Judge White replacing Judge Sawert), limiting the ability to isolate defensive approach variables from panel-specific institutional approaches.[207]

Geographic and jurisdictional scope limitations further constrain theoretical development, as the analysis focuses exclusively on Patent Trial and Appeal Board

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[204] Mixed institutional outcomes: *Compare* IPR-154, *supra* note 3 (denying institution), IPR-164, *supra* note 4 (same), and IPR-178, *supra* note 4 (same), *with* IPR-155, *supra* note 4 (granting institution), IPR-165, *supra* note 4 (same), and IPR-179, *supra* note 4 (same).

[205] Parameter evolution: '273 and '156 patents specifying X=5%, Y=0.05% parameters versus '961 patent specifying X=10%, Y=0.2% parameters. *See* '273 Patent, *supra* note 4; '156 Patent, *supra* note 4; '961 Patent, *supra* note 4.

[206] *See supra* note 203.

[207] *See* IPR-154, *supra* note 3; IPR-155, *supra* note 4; IPR-164, *supra* note 4; IPR-165, *supra* note 4; IPR-178, *supra* note 4; IPR-179, *supra* note 4 (all institution decisions before Judges Arbes, Sawert, and Repko); IPR-155 Final, *supra* note 4; IPR-165 Final, *supra* note 4; IPR-179 Final, *supra* note 4 (final written decisions before Judges Arbes, White, and Repko).

proceedings rather than broader administrative or judicial contexts.

2. Methodological Limitations

The documentary analysis methodology constrains empirical validation through reliance exclusively on publicly available decision documents and expert declarations without analyzing oral hearing transcripts, internal deliberative processes, or cross-examination testimony analysis.[208]

Comparative analysis limitations stem from the absence of control group data examining alternative defensive expert approaches within similar technological contexts. This study documents patterns within Dr. Khatri's declaration methodology without comparison to other defensive experts facing comparable challenges.

Technical standards integration presents specific methodological boundaries. This study incorporates IEEE-754 floating-point arithmetic standards as technical authority for mathematical logic demonstrations within computational contexts, but this integration may not extend across diverse patent technology domains.

Pattern recognition analysis depends on limited sample sizes that create insufficient data for robust statistical validation of behavioral correlations. The six-proceeding dataset creates scope for preliminary pattern documentation but insufficient foundation for statistical significance testing.

3. Future Research Directions

Cross-patent family validation represents the most immediate research priority for strengthening theoretical development. Analysis of defensive expert testimony across diverse technological domains would test the

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[208] *See infra* Part III (discussing cross-examination strategies and expert testimony performance under adversarial challenge).

broader applicability of documented patterns beyond computational architecture contexts.

Comparative institutional analysis would extend theoretical development beyond Patent Trial and Appeal Board contexts. District court proceedings, International Trade Commission investigations, and appellate review by the Court of Appeals for the Federal Circuit may reveal different institutional approaches to expert testimony evaluation.

Longitudinal research methodology would address temporal stability limitations by examining institutional decision-making evolution over extended time periods. Multi-year datasets would enable investigation of institutional learning effects, precedential development, and policy evolution impacts on expert testimony reception.

Cross-examination methodology validation represents a priority for strengthening defensive expert testimony theory. This study documents approaches developed through multiple proceedings, but broader validation across diverse expert testimony contexts remains necessary.

Quantitative methodology development would supplement qualitative pattern analysis with statistical validation of documented correlations. Large-scale datasets across multiple patent families and technological domains would enable hypothesis testing and predictive analysis development for expert testimony effectiveness research.

The theoretical development priorities identified through this analysis suggest potential contributions to broader administrative law scholarship, expert evidence evaluation methodology, and institutional decision-making theory. However, extensive empirical validation across diverse regulatory and administrative contexts would be necessary to establish broader applicability of these preliminary findings.

III. CROSS-EXAMINATION PERFORMANCE ANALYSIS IN PATENT PROCEEDINGS

A. Introduction

While existing literature addresses expert declaration drafting and pre-hearing preparation protocols,[209] the actual performance of expert declarants under cross-examination in *Inter Partes Review* (IPR) proceedings remains surprisingly understudied. This gap becomes particularly significant given that expert testimony in IPR proceedings faces intensive adversarial examination through depositions and cross-examination.[210]

The present analysis examines expert testimony performance across three related proceedings: *Google LLC v. Singular Computing LLC*, IPR-155, IPR-165, and IPR-179.[211] These proceedings offer a unique research opportunity, involving identical fundamental technologies and patents but with varying claim interpretations and evidentiary parameters. IPR-155 involved broader interpretive flexibility with relaxed parameters (X=10%, Y=0.2%), IPR-165 imposed stricter requirements with parameters (X=5%, Y=0.05%), and IPR-179 addressed the earliest-filed patent in the family, the '273 Patent, with the same strict parameters as IPR-165 (X=5%, Y=0.05%).[212] This controlled comparison enables examination of how

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[209] *See supra* Sections I.B–C (analyzing offensive declaration methodology and PTAB reception patterns); *see supra* Sections II.A–D (analyzing defensive declaration methodology, technology-agnostic positioning, and multi-dimensional architecture).
[210] 37 C.F.R. §§ 42.51–42.53 (2020).
[211] *See* IPR-155, *supra* note 4; IPR-165, *supra* note 4; IPR-179, *supra* note 4.
[212] '961 Patent, *supra* note 4, col. 30, ll. 25–34 (X=10%, Y=0.2%); '156 Patent, *supra* note 4, at col. 29, l. 62–col. 30, l. 4 (X=5%, Y=0.05%); '273 Patent, *supra* note 4, col. 30, ll. 6–16 (X=5%, Y=0.05%).

expert testimony approaches perform under varying interpretive pressures and cross-examination contexts.

Previous scholarship has focused primarily on declaration content analysis and strategic positioning.[213] However, empirical analysis of how different expert testimony approaches actually survive hostile cross-examination has received limited systematic attention.[214] This study contributes to this literature through systematic cross-proceeding analysis of expert testimony performance and by examining deposition transcripts, expert reply and sur-reply declarations, i.e., responsive pleadings.[215]

1. Research Framework and Methodological Approach

This study analyzes expert testimony performance across eleven documents not analyzed in the previous parts, spanning the three granted IPR proceedings.[216] The

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[213] See *supra* Section II.A.1, for expert testimony research addressing preparation techniques and presentation methodologies.

[214] *See supra* Section II.A.1 (identifying the absence of empirical research on defensive expert testimony performance under cross-examination in administrative proceedings).

[215] *See generally* Remote Videotaped / Realtimed Deposition of Sunil P. Khatri, Ph.D., Exhibit No. 1072, No. IPR2021-00155 (P.T.A.B. Oct. 21, 2021) [hereinafter Khatri Depo.] (same exhibit filed in IPR2021-00165 and IPR2021-00179); Videotaped Deposition of Richard M. Goodin, Exhibit No. 2043, No. IPR2021-00155 (P.T.A.B. Jul. 30, 2021) [hereinafter Goodin Depo.] (same exhibit filed in IPR2021-00165 and IPR2021-00179).

[216] *See generally* Petitioner's Reply to Patent Owner's Response, Paper No. 35, No. IPR2021-00155 (P.T.A.B. Nov. 1, 2021) [hereinafter Pet. Reply 155]; Petitioner's Reply to Patent Owner's Response, Paper No. 35, No. IPR2021-00165 (P.T.A.B. Nov. 1, 2021) [hereinafter Pet. Reply 165]; Petitioner's Reply to Patent Owner's Response, Paper No. 35, No. IPR2021-00179 (P.T.A.B. Nov. 1, 2021) [hereinafter Pet. Reply 179]; Patent Owner's Sur-Reply to Petitioner's Reply, Paper No. 39, No. IPR2021-00155 (P.T.A.B. Dec. 13, 2021) [hereinafter Sur-

methodology involves comparative analysis of expert positioning strategies, examination of authority source preferences, and documentation of adaptation patterns under cross-examination pressure.[217]

This study focuses particularly on comparing two distinct expert positioning approaches: those emphasizing external technical standards and complex analytical frameworks versus those anchoring primarily in patent specification language and simpler characterizations.[218] This comparison enables examination of how different authority hierarchies and positioning strategies correlate with expert performance under adversarial pressure.

Established patent law recognizes a hierarchy of interpretive authority, with intrinsic evidence (patent claims and specification) generally receiving priority over extrinsic evidence (expert testimony and technical standards).[219] This study investigates whether this legal hierarchy correlates with expert testimony performance

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Reply 155]; Patent Owner's Sur-Reply to Petitioner's Reply, Paper No. 39, No. IPR2021-00165 (P.T.A.B. Dec. 13, 2021) [hereinafter Sur-Reply 165]; Patent Owner's Sur-Reply to Petitioner's Reply, Paper No. 40, No. IPR2021-00179 (P.T.A.B. Dec. 13, 2021) [hereinafter Sur-Reply 179]; Reply Declaration of Richard Goodin, Exhibit No. 1071, No. IPR2021-00155 (P.T.A.B. Nov. 1, 2021) [hereinafter Goodin Reply Decl. 155]; Reply Declaration of Richard Goodin, Exhibit No. 1071, No. IPR2021-00165 (P.T.A.B. Nov. 1, 2021) [hereinafter Goodin Reply Decl. 165]; Reply Declaration of Richard Goodin, Exhibit No. 1071, No. IPR2021-00179 (P.T.A.B. Nov. 1, 2021) [hereinafter Goodin Reply Decl. 179]; *see also* Goodin Depo., *supra* note 215; Khatri Depo., *supra* note 215.

[217] *See infra* Section III.B, for a detailed methodology for transcript analysis and comparative assessment framework.

[218] *See supra* Part I, for Mr. Goodin's external technical standards and complex analytical frameworks; *see supra* Part II, for Dr. Khatri's specification-anchored positioning approach.

[219] Phillips v. AWH Corp., 415 F.3d 1303, 1315 (Fed. Cir. 2005) (en banc); *see also* Markman v. Westview Instruments, Inc., 517 U.S. 370, 384 (1996) (holding that claim construction is a matter of law for the court to decide).

under cross-examination, examining whether approaches anchoring in patent specification language demonstrate different resilience patterns compared to those emphasizing external technical standards or independent analytical frameworks.

B. Methodology

This study employs a comparative case study methodology examining expert testimony performance patterns across three related *Inter Partes Review* proceedings.[220] The research design leverages natural variation in interpretive parameters across proceedings involving identical technological subject matter, creating conditions analogous to a controlled experiment while maintaining ecological validity.[221]

1. Case Selection and Research Design

This analysis focuses on three IPR proceedings filed by Google LLC against Singular Computing LLC: IPR-155, IPR-165, and IPR-179.[222] These proceedings provide several methodological advantages for comparative expert testimony analysis.

Technological Consistency: All three proceedings involve challenges to patents covering similar floating-point processing technologies with reduced-precision computational architectures.[223] This consistency eliminates subject matter variation as a confounding variable, allowing

[220] See *infra* Section III.B, for a detailed research design and case selection rationale.
[221] See *id.*, for natural variation in interpretive parameters creating controlled conditions.
[222] *See generally* IPR-155, *supra* note 4; IPR-165, *supra* note 4; IPR-179, *supra* note 4.
[223] *See generally* '273 Patent, *supra* note 4; '156 Patent, *supra* note 4; '961 Patent, *supra* note 4.

examination of expert positioning approaches independent of technical complexity differences.

Expert Consistency: The proceedings involve the same expert declarants—Dr. Sunil P. Khatri (whom the Board refers to as Dr. Khatri) for Patent Owner and Richard M. Goodin, P.E. (whom the Board refers to as Mr. Goodin) for Petitioner—providing consistent baseline expertise while enabling examination of positioning strategy adaptation across different interpretive contexts.[224]

Temporal Proximity: All proceedings received institution decisions within a narrow timeframe (May 12-14, 2021), and expert declarations were filed contemporaneously across proceedings, minimizing temporal variations in legal standards, expert preparation protocols, and institutional practices that might confound comparative analysis.[225]

2. Transcript Analysis and Comparative Assessment Framework

This section develops a systematic framework for analyzing expert testimony patterns through deposition transcript examination and cross-proceeding comparative analysis. This assessment employs qualitative indicators derived from systematic examination of expert declarations, deposition transcripts, and responsive pleadings.

Response Consistency Analysis: Expert positioning stability receives systematic examination through transcript analysis. This study examines consistency in expert assertions, authority maintenance

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[224] *See, e.g.*, IPR-155 Final, *supra* note 4, at 7 (identifying Richard Goodin, P.E. as Petitioner's expert and Sunil P. Khatri, Ph.D. as Patent Owner's expert); IPR-165 Final, *supra* note 4, at 7 (same); IPR-179 Final, *supra* note 4, at 7 (same).

[225] *See supra* Parts I–II, for an analysis of expert declaration filing patterns and institutional decision timing across the six IPR proceedings.

under adversarial questioning, and stability of core positions throughout the testimony lifecycle. Response indicators include patterns of hedge language usage, position modification frequency, and authority assertion approaches under examination pressure.

Authority Source Integration Assessment: Expert reliance on different authority sources receives systematic coding. This analysis categorizes authority sources hierarchically: intrinsic evidence (patent claims and specification), technical standards (IEEE-754 and industry practices), and independent expert analysis. Authority utilization patterns document frequency and context of external validation requirements throughout expert testimony.

Adaptation Pattern Documentation: Position modification tracking employs systematic documentation of expert strategy adjustments under examination pressure. This analysis documents nature and frequency of expert position adjustments across the testimony lifecycle, including responsive declarations, deposition performance, and post-examination modifications. Adaptation characteristics include substantive position changes, methodological adjustments, and defensive repositioning approaches.

Memory Dependency and Real-Time Analysis Assessment: This framework examines expert reliance on real-time recall versus prepared positioning through systematic transcript analysis. Memory dependency characteristics include documented instances of recall limitations, requests for document review, and reliance on prepared materials during examination sequences.

3. Mathematical Verification and Technical Standards Documentation

The proceedings include comprehensive mathematical verification approaches across expert testimony strategies. This analysis documents systematic differences in mathematical validation methodology between positioning approaches.[226]

Mr. Goodin's error independence theorem applications enable comprehensive testing across technical parameter combinations. Mr. Goodin's mathematical framework encompasses approximately 2^{46} potential combination assessments for verification purposes, though practical implementation focuses on representative sampling methodologies.[227] This mathematical foundation contrasts with Dr. Khatri's specification-anchored positioning approaches that employ simpler validation protocols.[228]

While both experts reference IEEE-754 standards, Mr. Goodin's systematic integration reveals substantial coordination complexity compared to Dr. Khatri's focused mathematical precision usage. Mr. Goodin's comprehensive framework requires coordination across "over 70 trillion possible pairs of normal IEEE-754 single-format mantissas,"[229] while Dr. Khatri employs more limited IEEE-754 references for specific mathematical

[226] *See supra* Part I, for Mr. Goodin's mathematical verification approaches including error independence theorem and IEEE-754 standards integration; *see supra* Part II, for Dr. Khatri's specification-anchored mathematical precision analysis.
[227] Goodin Decl. 154-5, *supra* note 5, ¶ 277; Goodin Decl. 164-5, *supra* note 5, ¶ 278; Goodin Decl. 178-9, *supra* note 5, ¶ 286.
[228] *See* Khatri Decl. 155, *supra* note 151, ¶¶ 47–49; Khatri Decl. 165, *supra* note 151, ¶¶ 47–49; Khatri Decl. 179, *supra* note 151, ¶¶ 47–49 (discussing mathematical precision analysis through base 2 logarithm calculations).
[229] Goodin Decl. 154-5, *supra* note 5, ¶ 281; Goodin Decl. 164-5, *supra* note 5, ¶ 282; Goodin Decl. 178-9, *supra* note 5, ¶ 290.

impossibility demonstrations.[230] These different approaches to technical standards integration correlate with varying coordination challenges under examination pressure.

C. Empirical Analysis

Building on this methodological foundation, this study's examination of expert testimony patterns across the three granted proceedings reveals differential adaptation capabilities and positioning effectiveness under varying examination pressures.[231]

1. Specification-Anchored Positioning Analysis

Dr. Khatri's approach demonstrates consistent specification-anchored positioning characteristics across all three proceedings. When addressing claim construction in the relaxed parameter context, he anchored his response directly in patent language: "the claims in the – in the patent basically define what it means to be high dynamic range and low precision."[232]

This positioning approach establishes what is characterized as specification-anchored authority, demonstrating direct correlation with patent text during examination pressure.[233]

The technology-agnostic dimension of Dr. Khatri's positioning emerges clearly in his functional characterization approach: "Tong's digit-serial

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[230] *See supra* Section II.E.1, for Dr. Khatri's mutual exclusivity demonstrations using focused IEEE-754 precision analysis.

[231] *See supra* note 216, for a complete document inventory establishing empirical foundation for cross-proceeding analysis.

[232] Khatri Depo., *supra* note 215, at 72:18–20.

[233] See *id.*; *supra* Part II, for the specification-anchored positioning methodology.

multiplication unit actually performs multiplication at various precisions . . .So it's one single circuit that can perform multiple – multiple bit widths of multiplication, and therefore it is not an LPHDR unit."[234]

This functional emphasis avoids implementation-specific technical details while maintaining interpretive authority, potentially reducing exposure to coordination complexity under examination pressure.[235]

Dr. Khatri's framework challenge technique appears systematically throughout his examination: "Regarding arithmetic precision/imprecision, MacMillan is silent . . . MacMillan has no teaching about precision or imprecision."[236]

Rather than developing alternative categorizations, this approach questions the necessity of complex framework development, potentially shifting examination burden toward framework justification rather than position defense.[237]

Comprehensive coverage—establishing that a commercial product practices numerous patent claims element-by-element—emerges as another characteristic of the specification-anchored approach. Dr. Khatri stated: "Google's TPUv2 and TPUv3 are coextensive with at least Claims 1 to 5, 10, and 13 to 14 of the '961 patent."[238]

This coextensive coverage approach appears to place practical pressure on opposing parties to demonstrate

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[234] Khatri Depo., *supra* note 215, at 127:2–12.
[235] *See supra* Part II, for the functional characterization approach; see *supra* Part I, for the implementation-specific coordination complexity.
[236] Khatri Depo., *supra* note 215, at 138:3–4, 138:22–23.
[237] *Compare supra* Part I (describing Mr. Goodin's complex framework development), *with supra* Part II (describing Dr. Khatri's framework challenge approach).
[238] Khatri Depo., *supra* note 215, at 144:8–11.

inadequacy rather than requiring defensive justification of sufficiency.[239]

2. Complex Analytical Framework Analysis

Mr. Goodin's approach demonstrates consistent reliance on external technical standards integration and sophisticated analytical framework development. His positioning requires extensive external authority coordination: "I believe that Dockser does disclose an embodiment that uses all 23 bits of mantissa in IEEE-754 unit."[240]

This approach necessitates substantial coordination of multiple technical authorities under examination pressure, potentially creating examination challenges when external standards require real-time integration.[241]

Memory dependency vulnerabilities emerge clearly in Mr. Goodin's examination. When questioned about technical details, he acknowledged: "Just sitting here right now, without rereading the entire section, I don't remember Dockser talking about power savings."[242]

This pattern suggests potential limitations in real-time analytical performance under adversarial examination, where complex coordination approaches may face challenges in maintaining comprehensive recall.[243] Mr. Goodin subsequently corrected this response, citing his

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[239] *Compare* Khatri Depo., *supra* note 215, at 144:8–11 (asserting coextensive coverage across multiple claims), *with supra* Part I (describing Mr. Goodin's framework requiring extensive justification for each technical element).
[240] Goodin Depo., *supra* note 215, at 36:19–21.
[241] *See id*.
[242] Goodin Depo., *supra* note 215, at 29:20–22.
[243] *See supra* Section III.B, for memory dependency and real-time analysis assessment framework.

own declaration: "I'm sorry, I believe my previous answer was incorrect. If you look at Section 251 of my declaration, I talk about removing power from one or more components in the floating-point processor."[244]

Real-time analysis constraints become apparent in exchanges requiring immediate technical correlation: "Sitting here today, do you know of any reference that discloses a plurality of low precision processors in parallel? A single reference? . . . Sitting here today, I can't think of one, no."[245]

These patterns indicate potential systematic limitations where expert approaches requiring extensive coordination may become vulnerable to memory-based challenge exploitation during real-time examination pressure. These observations warrant caution, as deposition practice routinely trains witnesses to avoid overcommitting beyond immediate recall, and responses such as "sitting here today" reflect standard deposition discipline rather than necessarily indicating analytical weakness.

3. Cross-Proceeding Response Pattern Analysis

This systematic analysis across parameter contexts reveals observable differences in response characteristics between expert positioning approaches. Transcript examination across the three proceedings demonstrates that specification-anchored approaches maintain more stable response patterns under varying examination pressures, while complex analytical approaches — those requiring coordination of multiple external technical authorities such as IEEE-754 standards and computational verification

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[244] Goodin Depo., *supra* note 215, at 30:4–14.
[245] Goodin Depo., *supra* note 215, at 153:10–17.

results — exhibit greater variability in response consistency.[246]

In the relaxed parameter context (in IPR-155, concerning '961 patent), both positioning approaches demonstrate relatively stable response characteristics, though specification-anchored responses show fewer instances of position modification under questioning compared to responses grounded in complex external frameworks that require more coordination under examination pressure.[247]

Under strict parameter requirements (in IPR-165, concerning '156 patent), these response pattern differences become more pronounced. Specification-anchored approaches maintain consistent positioning characteristics, while complex approaches demonstrate increased adaptation requirements and coordination challenges under enhanced interpretive pressure.[248]

IPR-179, concerning the earliest-filed '273 Patent, shares the same strict parameters as IPR-165 (X=5%, Y=0.05%) but addresses foundational embodiment disclosures. Specification-anchored approaches maintained

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[246] *See supra* note 216 and accompanying text, for a systematic analysis across deposition transcripts and responsive pleadings in the three granted IPR proceedings.

[247] '961 Patent, *supra* note 4, col. 30 l. 25–34 (the relaxed parameter context (X=10%, Y=0.2%)). See *supra* note 216 and accompanying text, for an empirical analysis of expert response patterns across parameter contexts.

[248] '156 Patent, *supra* note 4, col. 29 l. 62 to col. 30 l. 4 (strict parameter context (X=5%, Y=0.05%)). See *supra* note 216 and accompanying text, for an enhanced examination pressure response pattern analysis.

stable positioning patterns while complex approaches showed moderate position modification requirements.[249]

These cross-proceeding patterns suggest potential correlations between examination pressure intensity and positioning approach response stability, though broader validation across additional patent families would strengthen these preliminary observations.

D. Authority Hierarchy and Administrative Processing Analysis

These response pattern differentials become particularly evident when examining how administrative processing approaches treat different expert positioning strategies. Cross-proceeding examination reveals patterns suggesting hierarchical relationships between different sources of interpretive authority during examination contexts.[250]

1. PTAB Reception Pattern Analysis

This examination of PTAB decisions provides documentation of institutional reception patterns — recurring language and analytical approaches the PTAB employs when evaluating, crediting, or rejecting expert testimony — for different expert testimony approaches across the three proceedings.[251] Board language patterns

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[249] ‘273 Patent, *supra* note 4, col. 30 l. 6–16 (foundation parameter context (X=5%, Y=0.05%)). See *supra* note 216 and accompanying text, for a basic embodiment interpretation response pattern analysis.

[250] See *supra* note 216 and accompanying text, for a cross-proceeding authority hierarchy analysis across IPR-155, IPR-165, and IPR-179 proceedings; *see infra* Section III.D.1 for a PTAB reception pattern analysis.

[251] *See generally* IPR-154, *supra* note 3; IPR-164, *supra* note 4; IPR-178, *supra* note 4 (documenting reception of expert positioning approaches in institution decisions); IPR-155 Final, *supra* note 4; IPR-165 Final, *supra* note 4; IPR-179 Final, *supra* note 4 (documenting expert credibility determinations in final written decisions).

suggest potential correlations between expert positioning strategies and administrative adoption approaches.

Evidence from the proceeding record indicates the adoption of specification-anchored expert positioning in multiple contexts. The Board stated: "Thus, in this respect, we agree with Patent Owner and its declarant, Dr. Khatri, that 'the invention is agnostic to the types of underlying physical technologies used to build it.'"[252]

This pattern appears across multiple technical determinations, suggesting potential institutional preference for specification-anchored expert testimony approaches, though broader validation across diverse administrative contexts would strengthen this preliminary observation.

Conversely, Board language regarding complex analytical framework interpretations reveals different reception patterns. The Board stated: "we cannot agree that the claim requires 'at least one selection' from three classes of infinitely combinable and unpredictable 'variables.'"[253]

The Board's adoption of specification-anchored positioning was accompanied by rejection of complex framework interpretations.[254]

These preliminary findings suggest potential systematic relationships between expert positioning strategy and administrative reception, though causation analysis requires broader empirical investigation across additional proceedings.

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[252] IPR-154, *supra* note 3, at 18; IPR-164, *supra* note 4, at 18–19; IPR-178, *supra* note 4, at 18 (adopting Patent Owner's specification-anchored characterization while rejecting Petitioner's "three classes" framework in each).
[253] IPR-154, *supra* note 3, at 18; IPR-164, *supra* note 4, at 18; IPR-178, *supra* note 4, at 18 (quotations omitted).
[254] *See supra* note 252.

2. Authority Hierarchy Documentation

The proceeding record provides documentation of authority hierarchy patterns in administrative decision-making. Evidence suggests consistent institutional prioritization following a Patent Specification > Technical Standards > Expert Opinion sequence across technical determinations.[255] This pattern indicates potential institutional validation of specification-anchored positioning approaches over complex external authority integration strategies.

Commercial implementation correlation provides more context through Google's Tensor Processing Unit (TPU) architecture validation.[256] This commercial validation context may strengthen the empirical foundation for specification-anchored positioning approaches, though broader validation across diverse commercial implementations would enhance generalizability.

E. Expert Testimony Lifecycle and Strategic Evolution

Building on these authority hierarchy insights, examination of expert testimony changes across proceeding phases provides data regarding temporal response patterns and adaptation mechanisms.[257] This analysis documents

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[255] *See* IPR-154, *supra* note 3, at 18; IPR-164, *supra* note 4, at 18; IPR-178, *supra* note 4, at 18 (demonstrating specification primacy over expert-created frameworks); *see also* IPR-155 Final, *supra* note 4, at 33–34; IPR-165 Final, *supra* note 4, at 34; IPR-179 Final, *supra* note 4, at 34–35 (crediting IEEE-754 standards-based analysis over expert opinion); Phillips v. AWH Corp., 415 F.3d 1303, 1315 (Fed. Cir. 2005) (en banc) (establishing intrinsic evidence hierarchy).

[256] Google TPU commercial validation is documented across multiple sources. *See* Khatri Depo., *supra* note 215, at 144:8–11; *supra* Part II, for a TPU implementation analysis.

[257] See *supra* note 216 and accompanying text, for an expert testimony lifecycle analysis across initial declarations, depositions, and reply

positioning development from initial declarations through final determinations, focusing on response changes and adaptation attempts under examination pressure.

1. Initial Declaration and Cross-Examination Response Patterns

Specification-anchored approaches establish reduced external authority dependency from initial declaration phases. Dr. Khatri's initial declarations demonstrate positioning characteristics that anchor arguments in patent specification language while maintaining technology-agnostic characterization approaches.[258]

Complex analytical approaches establish external authority dependency patterns from declaration phases. Mr. Goodin's initial declarations demonstrate requirements for extensive external authority coordination through technical standards integration rather than specification-based positioning.[259]

These initial positioning choices appear to establish response characteristics that persist through subsequent proceeding phases. Deposition transcript analysis reveals differential adaptation capabilities between positioning approaches, with specification-anchored approaches demonstrating resistance to framework challenges — categorically rejecting opposing analytical premises rather than engaging with them — while complex approaches

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declarations; see *supra* note 3 and accompanying text, for proceeding phases from institution through final determinations.

[258] *See supra* Part II; *see, e.g.*, Khatri Decl. 154, *supra* note 87, ¶¶ 39, 47–49 (specification-anchored positioning with technology-agnostic characterization and mathematical precision analysis).

[259] See *supra* Part I, for Mr. Goodin's external authority coordination methodology including IEEE-754 standards integration and complex analytical framework requirements.

experience difficulties maintaining coordination across multiple external authority sources when facing systematic challenge.[260]

2. Reply Declaration Strategic Adaptation

Reply declaration analysis reveals contrasting adaptation patterns between positioning approaches. Specification-anchored approaches demonstrate minimal adaptation requirements while maintaining authority hierarchy characteristics through targeted specification authority strengthening.[261]

Complex analytical approaches attempt coordination enhancement but experience positioning challenges despite sophisticated adaptation efforts. Mr. Goodin's reply declaration modifications demonstrate that sophisticated coordination attempts may create additional vulnerabilities rather than addressing fundamental positioning challenges.[262] For example, Mr. Goodin's reply declaration addressed the power savings gap exposed during deposition by citing Dockser ¶ 14 for "greater

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[260] *See* Khatri Depo., *supra* note 215, at 138:3–4, 138:22–23, for a framework challenge through categorical rejection; *see* Goodin Depo., *supra* note 215, at 29:20–22, 153:10–17, for coordination complexity challenges under examination (showcasing that though Mr. Goodin self-corrected the power savings response, *see id*. at 30:4–14, the initial recall difficulty illustrates coordination challenges under real-time examination pressure).

[261] *Compare* Sur-Reply 165, *supra* note 216, at 18–22 (maintaining specification-anchored positioning consistent with initial declarations), *with supra* Part I (describing coordination architecture requirements in Mr. Goodin's approach).

[262] *See* Goodin Reply Decl. 165, *supra* note 216, ¶¶ 4–6 (addressing claim construction challenges raised during deposition regarding power savings), ¶¶ 7–53 (expanding specification interpretation arguments), ¶¶ 56–67 (attempting enhanced coordination of prior art combination defense); Goodin Reply Decl. 155, *supra* note 216, ¶¶ 4–6 (same); Goodin Reply Decl. 179, *supra* note 216, ¶¶ 4–6 (same).

efficiency as well as significant power savings," but this correction highlighted the initial coordination failure documented in the deposition record.[263]

This strategic adaptation pattern represents a notable empirical observation where coordination sophistication may not improve positioning effectiveness, suggesting that fundamental framework architecture may prove more significant than enhancement sophistication.

F. Theoretical Implications

These empirical findings may provide a preliminary foundation for theoretical development in expert testimony methodology within administrative adjudication contexts.[264] The documented patterns contribute to understanding expert positioning strategies, administrative reception mechanisms, and cross-examination response frameworks.

1. Memory Dependency and Real-Time Analysis Framework

Evidence provides foundation for theoretical development regarding memory dependency under examination pressure. The documented patterns suggest that expert testimony methodology may benefit from

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[263] *Compare* Goodin Reply Decl. 165, *supra* note 216, ¶ 6 (correcting power savings omission by citing Dockser ¶ 14), *with* Goodin Depo., *supra* note 215, at 29:20–30:14 (showcasing initial failure to recall power savings teaching followed by self-correction citing declaration ¶ 251).

[264] *See supra* Sections III.A–D and accompanying notes (documenting empirical findings across expert positioning strategies, administrative reception patterns, and adaptation mechanisms).

accounting for memory-based constraints that emerge despite thorough preparation.[265]

Mr. Goodin's examination reveals limitations that inform theoretical understanding of the tension between comprehensive knowledge requirements and real-time analytical demands, suggesting that preparation strategies should account for examination pressure constraints rather than emphasizing knowledge mastery alone. [266]

2. Specification Anchoring Theory

Cross-proceeding evidence suggests specification anchoring as an examination resistance methodology through document-based authority rather than real-time analytical construction. This approach demonstrates consistent administrative reception across interpretive contexts, potentially providing a foundation for expert testimony approaches that emphasize documentary correspondence over independent technical analysis.

The empirical patterns indicate that specification anchoring may enhance examination resilience through reliance on written authority rather than requiring comprehensive real-time recall, though broader validation across different technical domains would strengthen these theoretical propositions.

3. Authority Hierarchy Framework

This analysis supports theoretical framework development based on authority source hierarchy. Cross-proceeding evidence indicates that Patent Specification > Technical Standards > Expert Opinion hierarchy may

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[265] *See* Goodin Depo., *supra* note 215, at 29:20–22, 153:10–17 (documenting memory dependency patterns under examination pressure); *see also supra* Section III.C.2 (analyzing real-time analysis constraints).

[266] *See* Goodin Depo., *supra* note 215, at 29:20–30:14 (illustrating how comprehensive declaratory knowledge did not prevent real-time recall difficulties under examination pressure).

influence administrative processing approaches, with specification-anchored expert testimony receiving more consistent treatment compared to approaches requiring extensive external authority coordination.

This authority hierarchy framework suggests that expert positioning strategies may benefit from aligning with documented institutional processing preferences rather than emphasizing analytical independence or coordination sophistication.

G. Limitations and Future Research Directions

This study contributes to expert testimony scholarship through systematic cross-examination response analysis while acknowledging several limitations that constrain generalizability.

1. Scope and Methodological Limitations

This analysis focuses on three proceedings involving identical parties, experts, and technology domains. Findings may reflect individual expert approaches rather than broader positioning strategies. Technology domain specificity (precision-controlled floating-point processing) may limit applicability to mechanical, chemical, or biotechnology patent contexts.[267]

The PTAB institutional context involves particular examination procedures and time constraints that may not translate to federal district court litigation or other adjudication environments. Temporal factors (2021-2022

[267] See '273 Patent, *supra* note 4, col. 2 l. 11–39; '156 Patent, *supra* note 4, col. 2 l. 14–43; '961 Patent, *supra* note 4, col. 2 l. 1–27, (describing computational efficiency objectives and floating-point processing architectures).

timeframe) may reflect specific periods in patent law interpretation and institutional practices.[268]

The transcript analysis framework requires validation through independent replication and inter-rater reliability assessment. External validation through broader datasets would establish pattern recognition consistency across different contexts.[269]

2. Future Research Requirements

Cross-domain replication studies would strengthen validity through examination of expert testimony in diverse technology areas. Research examining experts from different professional backgrounds (academia, industry, consulting) would clarify whether positioning effectiveness patterns vary across expertise sources.

Longitudinal analysis tracking expert evolution across multiple proceedings would inform our understanding of learning effects and positioning strategy adaptation. Cross-jurisdictional comparison between IPR proceedings, federal district courts, and international patent litigation would enhance methodological robustness.

Methodological triangulation through additional analysis approaches would enhance robustness. Integration of quantitative linguistic analysis, qualitative discourse analysis, and outcome-based assessment would strengthen analytical validity while addressing limitations inherent in single-method approaches.

H. Conclusion

This empirical analysis demonstrates observable response differentials between expert positioning

[268] See *supra* Section III.B, for temporal proximity and institutional context in research design.
[269] *See supra* Section III.B (establishing transcript analysis framework and assessment methodology requiring future validation).

approaches under cross-examination pressure. Evidence indicates that specification-anchored positioning demonstrates more consistent response patterns compared to complex analytical frameworks requiring extensive external authority coordination.

The findings suggest potential relationships between authority hierarchy preferences and examination response stability, with specification-based approaches demonstrating enhanced consistency across varying interpretive contexts. Administrative reception patterns appear to correlate with positioning strategy characteristics, though broader validation across diverse proceedings would strengthen these preliminary observations.

This research provides a foundation for expert testimony theory development while acknowledging exploratory limitations requiring expanded validation. Future research building on these analytical approaches may contribute to comprehensive understanding of expert declarant effectiveness in technical adjudication contexts, particularly regarding the relationships between positioning strategy, examination pressure, and institutional processing preferences.

The documented patterns suggest that expert testimony methodology may benefit from increased attention to authority hierarchy dynamics, memory dependency considerations, and specification anchoring approaches, though definitive theoretical conclusions require broader empirical validation across additional expert testimony contexts and adjudication environments.

IV. PRIOR ART STRATEGY EVOLUTION IN IPR PROCEEDINGS

A. Introduction

The Patent Trial and Appeal Board's adjudication of *Inter Partes* Review challenges provides insight into administrative decision-making when confronted with alternative prior art strategies and analytical frameworks.[270] This part examines prior art strategy evolution through analysis of expert testimony deployed by the same declarant across related proceedings challenging substantially similar patent claims.

The empirical foundation emerges from six IPR proceedings targeting three related LPHDR (Low Precision High Dynamic Range) patents: IPR-154, IPR-155, IPR-164, IPR-165, IPR-178, and IPR-179.[271] Expert declarant Richard Goodin deployed different prior art strategies across these proceedings, creating conditions for controlled comparison where expert identity, patent technology, and administrative panel composition remain substantially consistent while prior art selection and analytical methodology vary.[272]

The commercial context involves Singular Computing's patent infringement action seeking $1.67 billion in damages that settled on undisclosed terms in January 2024 following the IPR proceedings examined in this study.[273]

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[270] 35 U.S.C. §§ 311–319 (2018); 37 C.F.R. § 42.1 et seq. (2020) (governing IPRs at the PTAB).
[271] *See supra* Part I.
[272] *See supra* Parts I–II (documenting Goodin's contrasting methodological approaches across denied and granted proceedings).
[273] Joint Motion to Stay Pending Settlement Agreement, *Singular Computing LLC v. Google LLC*, No. 1:19-cv-12551-FDS (D. Mass. Jan. 24, 2024), ECF No. 740; Brittain, *supra* note 53.

Based on this limited dataset of six proceedings within a single patent family, observable patterns suggest challenges for abstract analytical frameworks compared to standards-based technical approaches.[274] These patterns in administrative decision-making regarding prior art evaluation may inform understanding of PTAB evaluation methodology, though broader validation across diverse technical domains would be necessary to establish generalizability.

1. The Controlled Comparison Context

The proceedings document contrasting approaches deployed by the same expert declarant. IPR-164 employed an abstract "three classes of variables" framework anchored by the Bates 2010 reference, resulting in institution denial by the PTAB.[275] IPR-165 abandoned this approach in favor of an IEEE-754 standards-based analysis anchored by the Dockser 2007 reference, achieving institution and subsequent partial claim invalidation.[276]

This transformation occurred within the same expert's practice across proceedings filed within days of each other, challenging claims of the same patent. The

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[274] *See supra* Parts I–III and accompanying analysis (documenting differential PTAB reception of abstract analytical frameworks versus standards-based approaches).

[275] IPR-164, *supra* note 4, at 18; see IPR-154, *supra* note 3, at 18; IPR-178, *supra* note 4, at 18 (addressing Mr. Goodin's "three classes" approach in all three institution denials); U.S. Patent Application Pub. No. US 2010/0325186, Bates (published Dec. 23, 2010) (Ex. 1006) [hereinafter Bates 2010].

[276] IPR-165 Final, *supra* note 4, at 34; see *also* IPR-155 Final, *supra* note 4, at 33; IPR-179 Final, *supra* note 4, at 34, (employing nearly identical language crediting Mr. Goodin's IEEE-754 anchored methodology in all three final decisions); U.S. Patent Application Pub. No. US 2007/0203967, Dockser (published Aug. 30, 2007) (Ex. 1007) [hereinafter Dockser 2007].

controlled nature permits examination of administrative reception patterns while minimizing variables related to expert credibility, technical complexity, or institutional bias, though individual panel preferences and temporal factors remain potential confounding variables.

2. Observable Administrative Decision-Making Patterns

Within these six proceedings, empirical analysis indicates certain patterns in PTAB evaluations of expert analytical frameworks. Abstract categorization schemes received institutional rejection, with the PTAB stating: "[W]e cannot agree that the claim requires 'at least one selection' from three classes of infinitely combinable and unpredictable 'variables.'"[277] Conversely, standards-based approaches anchored in external technical authority correlated with institutional acceptance across the successful proceedings.[278]

Cross-proceeding linguistic analysis documents observable similarities in PTAB decision language when addressing comparable analytical approaches, suggesting certain institutional response patterns, though the limited sample constrains broader conclusions about administrative behavior. These similarities extend to both rejection language for abstract frameworks and acceptance patterns for technically grounded approaches within this dataset.

B. Literature Gap in Prior Art Strategy Analysis

Administrative law scholarship examining expert testimony evaluation in technical proceedings remains limited, particularly regarding empirical analysis of prior

[277] IPR-154, *supra* note 3, at 18; IPR-164, *supra* note 4, at 18; IPR-178, *supra* note 4, at 18.
[278] *See supra* note 276.

art selection strategies and their correlation with institutional decision-making patterns.[279] Existing patent law literature focuses primarily on the substantive obviousness doctrine rather than an empirical analysis of how administrative agencies process competing technical frameworks in practice.[280]

The gap emerges in understanding how administrative decision-makers evaluate expert-created analytical frameworks versus technically grounded approaches anchored in external standards. While legal scholarship addresses theoretical frameworks for obviousness determination under 35 U.S.C. § 103, empirical examination of institutional reception patterns for different expert methodologies remains underdeveloped.[281]

C. Methodology: Controlled Comparison Framework

This empirical analysis employs controlled comparison methodology to examine expert testimony approaches across related IPR proceedings. The methodology addresses isolating the effects of expert presentation strategies while controlling for confounding variables that typically complicate cross-proceeding analysis, though significant limitations constrain broader generalizability.

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[279] *See, e.g.*, Koch & Murphy, vol. 1, *supra* note 95; Koch & Murphy, vol. 2, *supra* note 95.
[280] *See. e.g.*, Janicke & Ren, *supra* note 98.
[281] *See* Graham v. John Deere Co., 383 U.S. 1, 17–18 (1966) (establishing obviousness framework); *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 418 (2007) (refining obviousness analysis).

1. Dataset Characteristics and Scope

The controlled comparison emerges from six IPR proceedings filed by Google LLC between October 30 and November 6, 2020, challenging three related LPHDR patents held by Singular Computing LLC. This dataset provides controlled comparison conditions where expert identity, patent technology domain, and institutional context remain substantially consistent while methodological approach varies.

Pattern Recognition Methodology: This analysis employs qualitative observation of recurring language patterns and institutional responses. 'Patterns' refer to observable repetition across multiple proceedings rather than statistical significance. Correlation observations do not establish causation and may reflect unobserved variables including panel preferences, temporal factors, or case-specific characteristics.

Outcome Measurement: Institutional reception is assessed through PTAB institution decisions, final written decision outcomes, and specific administrative language patterns crediting or rejecting expert testimony. Cross-proceeding linguistic analysis employs qualitative comparison of PTAB decision language, identifying recurring language patterns and institutional response characteristics across similar methodological approaches.

2. Controlled Variables

Expert Identity Consistency: Richard Goodin served as Google's expert declarant across all six proceedings, eliminating variables related to expert credibility, technical background, and presentation style.[282] His qualifications and professional background remained

[282] *See* Goodin Decl. 154-5, *supra* note 5; Goodin Decl. 164-5, *supra* note 5; Goodin Decl. 178-9, *supra* note 5 (Mr. Goodin serving as Petitioner's expert declarant across all six proceedings).

constant, enabling focus on methodological approach variation.

Technical Domain Consistency: All proceedings targeted LPHDR technology implementations across related patent family covering the '273, '156, and '961 patents, maintaining consistent technical complexity and obviousness evaluation requirements.[283] The patents address substantially similar inventive concepts involving precision-controlled arithmetic processing with specified error tolerance parameters.[284]

Administrative Context: PTAB panel composition remained identical across institution decisions (Judges Arbes, Sawert, Repko) and substantially similar for final written decisions (Judges Arbes, White, Repko), though individual judge preferences within panel composition remain potential confounding variables.[285]

3. Variable Methodological Elements and Study Limitations

Prior Art Reference Selection: The analysis documents vary in primary reference selection when comparing the Bates 2010 deployment in denied proceedings against the Dockser 2007 utilization in granted challenges.[286] Priority date security emerges as a significant factor, with Bates 2010 published December 23, 2010, creating temporal vulnerability against patent priority dates,

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[283] '273 Patent, *supra* note 4; '156 Patent, *supra* note 4; '961 Patent, *supra* note 4, at 2.

[284] *See supra* note 283.

[285] *See* IPR-154, *supra* note 3, at 1; IPR-155, *supra* note 4, at 1; IPR-164, *supra* note 4, at 1; IPR-165, *supra* note 4, at 1; IPR-178, *supra* note 4, at 1; IPR-179, *supra* note 4, at 1 (all institution decisions before Judges Arbes, Sawert, and Repko); IPR-155 Final, *supra* note 4, at 1; IPR-165 Final, *supra* note 4, at 1; IPR-179 Final, *supra* note 4, at 1 (final written decisions before Judges Arbes, White, and Repko).

[286] Bates 2010, *supra* note 275; Dockser 2007, *supra* note 276.

while Dockser 2007 published August 30, 2007, providing secure foundation.[287]

Analytical Framework Methodology: The comparison examines abstract categorization approaches ("three classes of variables") against standards-based technical analysis anchored in IEEE-754 specifications.

Study Limitations: This analysis examines only six proceedings within the LPHDR technology domain, significantly limiting generalizability to other technical areas. The patent family relationship may introduce correlated characteristics affecting broader applicability. Temporal clustering may reflect expert learning curves or evolving PTAB practices. Alternative explanations include panel-specific preferences, temporal factors, single expert declarant limitations, related patent family characteristics, or underlying technical merit differences independent of presentation methodology.

D. The Bates Reference: Priority Dependency and Framework Challenges

IPR-164 illustrates challenges arising from abstract analytical frameworks combined with priority date dependency. The proceeding employed Bates 2010 as the primary reference within an expert-created "three classes of variables" framework, resulting in institution denial.[288]

[287] Bates 2010, *supra* note 275 (published Dec. 23, 2010, creating temporal vulnerability against patent priority dates); Dockser 2007, *supra* note 276 (published Aug. 30, 2007, predating all possible priority dates).

[288] IPR-164, *supra* note 4, at 22; *see also* IPR-154, *supra* note 3, at 22; IPR-178, *supra* note 4, at 21–22 (all three proceedings employing identical Bates 2010 priority date dependency analysis with template institutional language).

1. Priority Date Dependency Issues

The Bates 2010 reference faced temporal challenges through its December 23, 2010 publication date occurring after the challenged patent's priority date, creating dependency on successful priority challenges for prior art availability.[289] This dependency concentrated proceeding success on preliminary legal determination rather than distributing risk across multiple technical arguments.

The PTAB addressed priority date dependency through finding insufficient evidence to challenge the patent's priority claims.[290] The institutional decision eliminated consideration of obviousness analysis: "Because obviousness under § 103 is Petitioner's sole ground of unpatentability, we find that the record does not establish a reasonable likelihood that Petitioner would prevail. . ."[291]

2. Abstract Framework Analysis

The "three classes of variables" framework represented Mr. Goodin's expert-created analytical categorization lacking foundation in patent claim language or prior art disclosure.[292] The approach characterized the invention as requiring "at least one selection" from "implementing technology," "numerical representation," and "operation" categories, attempting to organize technical analysis through expert-imposed conceptual

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[289] IPR-178, *supra* note 4, at 12 (showing similar temporal analysis for the '273 patent with February 17, 2012 filing date); IPR-154, *supra* note 3, at 12 (noting that Bates 2010 qualifies as prior art even under the '961 patent's own filing date of October 30, 2018, before reaching the earlier claimed priority dates through the continuation chain).

[290] *See supra* note 288.

[291] *See supra* note 288.

[292] Goodin Decl. 164-5, *supra* note 5, ¶¶ 62–64; *see also* Goodin Decl. 154-5, *supra* note 5, ¶¶ 61–64; Goodin Decl. 178-9, *supra* note 5, ¶¶ 62–64 (all three denied proceedings employing identical categorical framework methodology).

framework rather than technical mapping grounded in disclosed embodiments.[293]

The PTAB explicitly rejected the framework methodology: "We cannot agree that the claim requires 'at least one selection' from three classes of infinitely combinable and unpredictable 'variables.' "[294] This institutional response indicates administrative resistance to expert-created analytical structures lacking technical foundation in disclosed subject matter, though alternative explanations include case-specific factors or panel-specific analytical preferences.

3. Technical Content Analysis Despite Methodological Issues

Despite these methodological challenges, examination of the underlying technical content reveals the complexity of institutional evaluation patterns. The Bates 2010 reference contained substantial technical content directly relevant to the challenged patent claims, disclosing LPHDR arithmetic processing with quantified performance specifications, implementation approaches, and application validation across multiple domains.

Mathematical Implementation Framework: Bates 2010 provided mathematical foundation through logarithmic number system (LNS) implementation enabling concrete computation methodology: $\log(B+C)=\log(B\cdot(1+C/B))=\log(B)+\log(1+C/B)=b+F(c-b)$ where $F(x)=\log(1+2^x)$, providing mathematical precision for implementation pathway analysis.[295]

Quantified Performance Validation: The reference included empirical application testing with

[293] Goodin Decl. 164-5, *supra* note 5, ¶¶ 62–64.
[294] IPR-164, *supra* note 4, at 18; *see also* IPR-154, *supra* note 3, at 18; IPR-178, *supra* note 4, at 18, (identical template language across all three proceedings).
[295] Bates 2010, *supra* note 275, ¶ 71.

specific accuracy measurements across three distinct domains:

- **Nearest Neighbor Search**: 99.9% accuracy for "fp+noise" implementation and 99.7% accuracy for "lns" implementation under normal conditions, with 98.8% accuracy maintained under extreme stress testing with +10% to -5% noise variation.[296]
- **Distance Weighted Scoring**: 0.85% average error for "fp+noise" arithmetic and 0.12% average error for "lns" implementation across summation of one million small positive values.[297]
- **Image Processing Applications**: Digital image deblurring with quantified pixel error measurements showing 13.8 error (fp+noise) and 14.8 error (lns) compared to 13.0 error for standard floating point, demonstrating comparable performance with minimal degradation.[298]

Implementation Architecture Specifications: Bates 2010 disclosed multiple technological approaches including:

- **Digital LNS Implementation**: 14-bit word format (1 NAN + 1 sign + 1 log sign + 5 integer + 6 fraction bits) providing bit allocation for hardware implementation.[299]
- **Analog Mixed-Signal Processing**: Hybrid approach representing mantissa as analog value and exponent as binary digital value, achieving

[296] *Id.* ¶¶ 120–135, 138 (showing a 98.8% extreme testing result).
[297] *Id.* ¶¶ 118, 135.
[298] *Id.* ¶ 151.
[299] *Id.* ¶ 66.

approximately 1% accuracy through established analog processing techniques.[300]

- **Parallel Architecture**: Massively parallel processing specifications with thousands to millions of arithmetic units enabling scaling analysis.[301]

This technical content richness suggests that reference selection was not the primary limiting factor, but rather methodological approach and strategic framework implementation created institutional challenges despite strong underlying technical foundation, though case-specific factors cannot be ruled out.

E. The Dockser Reference: Standards Foundation and Technical Integration

IPR-165 employed a contrasting approach through IEEE-754 standards foundation combined with priority date security. The proceeding utilized Dockser 2007 as the primary reference within standards-based analytical methodology, achieving institution and subsequent partial claim invalidation with PTAB crediting.[302]

1. Priority Date Security and Risk Distribution

The Dockser reference provided temporal security through its August 30, 2007 publication date, preceding all

[300] *Id.* ¶ 78.
[301] Bates 2010, *supra* note 275, ¶ 168 (explaining the scaling from single units to millions of arithmetic units).
[302] IPR-165 Final, *supra* note 4, at 34 (crediting Mr. Goodin's software-based analysis); IPR-155 Final, *supra* note 4, at 33 (same); IPR-179 Final, *supra* note 4, at 34 (same); *see also* IPR-155 Final, *supra* note 4, at 59 (separately crediting Goodin's Dockser-Tong combination analysis with 5 mantissa fraction bits).

challenged patent priority dates by substantial margins.[303] This foundation eliminated single-point failure risk and enabled technical analysis to proceed without dependency on preliminary legal determinations.

Priority date security enabled multi-layered technical argumentation without concentrated dependency on preliminary legal challenges. The approach distributed strategic risk across multiple independent technical arguments rather than creating single-point vulnerabilities where failure of any preliminary determination would eliminate entire obviousness analysis.

2. IEEE-754 Standards Foundation Authority

The Dockser reference anchored technical analysis in IEEE-754 floating-point standards, providing external authority independent of expert opinion or subjective analytical frameworks.[304] This standards-based approach eliminated dependency on expert-created categorizations while grounding technical analysis in established industry specifications.

Technical Standards Integration: Dockser disclosed: "[T]he ANSI/IEEE-754 standard (commonly followed by modern computers) specifies a 32-bit single format having a 1-bit sign, an 8-bit exponent, and a 23-bit mantissa" and "IEEE-754 also specifies a 64-bit double format having a 1-bit sign, an 11-bit exponent, and a 53-bit

[303] IPR-165, *supra* note 4, at 10; *see also* IPR-155, *supra* note 4, at 6 (showcasing Dockser, published August 30, 2007, preceding the '961 patent's filing date of October 30, 2018 and all claimed priority dates through the continuation chain); IPR-179, *supra* note 4, at 7 (establishing temporal foundation for the '273 patent with February 17, 2012 filing date).

[304] Dockser 2007, *supra* note 276, ¶ [0002].

mantissa."[305] This external authority provided objective technical framework resistant to subjective challenge.

Mathematical Verification Framework: Building on the IEEE-754 foundation, expert analysis incorporated comprehensive mathematical verification across massive parameter spaces. The verification encompassed "over 70 trillion possible pairs of normal IEEE-754 single-format mantissas" requiring computational analysis.[306] This mathematical complexity necessitated GPU-accelerated verification using "an Nvidia Quadro GV100 GPU, using Nvidia's Compute Unified Device Architecture (CUDA) platform to parallelize" the verification programs, employing 5120 CUDA cores with 32GB HBM2 memory and 900 GB/s memory bandwidth.[307]

Error Independence Theorem: Central to the mathematical framework was development of an error independence theorem enabling practical verification across the complete input space. The theorem established that "the relative error amount (the 'Y' percentage recited in limitation [1B2]) of any floating-point number output from Dockser's reduced-precision multiplication is the same as the relative error amount of its mantissa, and is independent of its exponent and sign."[308] This mathematical insight transformed computational feasibility by demonstrating that verification across $2^{23} \times 2^{23} = 2^{46} \approx 70.4$ trillion total combinations could be accomplished

[305] *Id.*

[306] Goodin Decl. 164-5, *supra* note 5, ¶ 282; *see also* Goodin Decl. 154-5, *supra* note 5, ¶ 281; Goodin Decl. 178-9, *supra* note 5, ¶ 290 (employing identical mathematical verification framework in all three granted proceedings).

[307] *See, e.g.,* Goodin Decl. 164-5, *supra* note 5, ¶ 424.

[308] Goodin Decl. 164-5, *supra* note 5, ¶ 278; *see also* Goodin Decl. 154-5, *supra* note 5, ¶ 277; Goodin Decl. 178-9, *supra* note 5, ¶ 286 (all three granted proceedings employing identical error independence theorem).

through mantissa analysis without exhaustive testing of all possible exponent and sign combinations.[309]

3. Circuit-Level Implementation Precision

The Dockser reference enabled circuit-level implementation analysis with bit-precise mechanism specification, contrasting with abstract framework approaches that lacked concrete technical mapping.[310] Expert testimony provided element-by-element correspondence between reference disclosure and patent claim requirements.[311]

Mechanism Specification: Technical analysis documented specific implementation approaches through two distinct pathways:

- **Register Bit-Dropping Implementation**: "removing power from storage elements in the FPP's registers that correspond to the excess mantissa bits," with unpowered storage elements "tied to zero voltage (*e.g.*, ground), making those 14 'excess' bits all zeroes."[312]
- **Logic Bit-Dropping Implementation**: "removing power from elements within the multiplier logic that computes the product of the operand mantissas," providing alternative

[309] *See supra* note 306.
[310] Dockser 2007, *supra* note 276, ¶¶ [0032]–[0034].
[311] *See, e.g.*, Goodin Decl. 164-5, *supra* note 5, ¶¶ 232–35 (IEEE-754 standards foundation), ¶¶ 266–70 (circuit-level element-by-element correspondence).
[312] Goodin Decl. 164-5, *supra* note 5, ¶¶ 257, 270; *see also* Goodin Decl. 154-5, *supra* note 5, ¶¶ 256, 269; Goodin Decl. 178-9, *supra* note 5, ¶¶ 265, 278 (employing identical register bit-dropping methodology in all three granted proceedings).

implementation pathway with distinct performance characteristics.[313]

Quantified Performance Analysis: The implementation analysis demonstrated substantial compliance margins exceeding minimum patent requirements:

- **Register bit-dropping**: 92.14% compliance versus 5% patent requirement, providing 18.4× compliance ratio.
- **Logic bit-dropping**: 99.35% compliance versus 5% requirement, yielding 19.9× compliance ratio.[314]

The PTAB found register bit-dropping sufficient to establish obviousness and did not reach the logic bit-dropping analysis.[315]

Administrative Reception: The PTAB demonstrated acceptance of standards-based analysis, crediting expert testimony that relied on external technical authority: "[W]e credit Mr. Goodin's software-based analysis" and "[W]e credit Mr. Goodin's algebraic analysis."[316] This institutional acceptance contrasts with

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[313] Goodin Decl. 164-5, *supra* note 5, ¶ 258; *see also* Goodin Decl. 154-5, *supra* note 5, ¶ 257; Goodin Decl. 178-9, *supra* note 5, ¶ 266 (proceedings employing identical logic bit-dropping methodology in all three granted).

[314] Goodin Decl. 164-5, *supra* note 5, ¶ 425 (register bit-dropping: adjusted compliance of ≥92.14% against X≥5% claim requirement), ¶ 466 (logic bit-dropping: adjusted compliance of ≥99.35% against X≥5% claim requirement); *see also* Goodin Decl. 154-5, *supra* note 5, ¶¶ 423, 462 (same methodology applied to '961 patent's X≥10% requirement); Goodin Decl. 178-9, *supra* note 5, ¶¶ 452, 493 (same methodology applied to '273 patent's X≥5% requirement).

[315] IPR-155 Final, *supra* note 4, at 30; IPR-165 Final, *supra* note 4, at 30; IPR-179 Final, *supra* note 4, at 31 (stating the Board "need not evaluate" the logic bit-dropping alternative in each).

[316] IPR-165 Final, *supra* note 4, at 34 (crediting Mr. Goodin's software-based analysis); IPR-155 Final, *supra* note 4, at 33 (same); IPR-179 Final, *supra* note 4, at 34 (same); *see also* IPR-155 Final, *supra* note 4,

categorical rejection of expert-created frameworks within this dataset, though broader patterns remain to be established.

F. Comparative Analysis: Methodological Approach Correlation

The controlled comparison between Bates (institution denied) and Dockser (institution granted, claims invalidated) approaches suggests certain patterns in administrative evaluation of expert methodologies within this limited dataset. The evidence indicates that technical content quality alone does not determine institutional reception, but rather methodological approach characteristics may correlate with administrative decision-making patterns, though broader validation would be necessary to establish general principles.

1. Authority Source Hierarchy Patterns

External Authority versus Expert-Created Frameworks: The comparison suggests institutional preference for external technical standards over expert-created analytical frameworks within these proceedings. Bates analysis relied on expert-imposed "three classes of variables" categorization, while Dockser anchored analysis in IEEE-754 industry standards. Administrative reception patterns favored approaches grounded in external authority independent of expert opinion.[317]

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at 59 (crediting algebraic and software-based analysis for Dockser-Tong combination separately); IPR-165 Final, *supra* note 4, at 56 (same); IPR-179 Final, *supra* note 4, at 57 (same).

[317] *Compare* IPR-164, *supra* note 4, at 18 ("[W]e cannot agree that the claim requires 'at least one selection' from three classes of infinitely combinable and unpredictable 'variables.'"); IPR-178, *supra* note 4, at 18 (using identical rejection language); IPR-154, *supra* note 3, at 18 (same) *with* IPR-165 Final, *supra* note 4, at 34 ("After review of the

This pattern aligns with the authority hierarchy framework developed in Parts I and II, where specification-anchored positioning demonstrated enhanced examination survival compared to expert-created analytical structures.[318] The institutional credibility assessment patterns observed here reinforce those findings regarding administrative preference for external technical validation over subjective expert categorizations, though individual case factors may also contribute to these outcomes.

2. Risk Distribution Strategy Implications

Single-Point versus Multi-Pathway Dependencies: The Bates 2010 approach concentrated strategic risk through priority date dependency and abstract framework reliance, creating multiple single-point failure mechanisms.[319] The Dockser methodology distributed risk across temporal security, standards foundation, and technical implementation precision.[320]

Cascade Failure Patterns: Evidence from these proceedings suggests institutional preference for approaches that maintain analytical viability despite individual component challenges. The Dockser 2007 pattern enabled continued technical analysis even when specific implementation details faced challenge, while Bates 2010 dependency structure created complete

arguments and evidence on these issues, we credit Mr. Goodin's software-based analysis."); IPR-155 Final, *supra* note 4, at 33; IPR-179 Final, *supra* note 4, at 34 (crediting IEEE-754 standards-based methodology).

318 *See supra* Part I.

319 See *supra* Section IV.D.

320 *See* Dockser 2007, *supra* note 276, ¶¶ [0002], [0032]–[0034] (providing IEEE-754 standards foundation and circuit-level implementation detail).

analytical collapse when framework or priority challenges succeeded.[321]

These findings complement Part II's analysis of defensive expert testimony approaches, where multi-dimensional defensive architecture demonstrated effectiveness through component distribution across proceedings.[322] The cascade failure prevention observed here validates those defensive positioning strategies within prior art contexts, though case-specific factors warrant consideration.

3. Cross-Proceeding Outcome Correlation

Examination of these six proceedings documents apparent correlation between methodological approach and institutional outcomes. Standards-based approaches achieved institution and partial claim invalidation in all deployments (IPR-165, IPR-155, IPR-179), while abstract framework approaches resulted in institution denial across all implementations (IPR-164, IPR-154, IPR-178), though panel-specific preferences and temporal factors cannot be ruled out as contributing variables.[323]

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[321] *Compare* IPR-165, *supra* note 4, at 34 (crediting Dockser-based standards methodology despite challenges to individual components), *with* IPR-164, *supra* note 4, at 22 (denying institution when Bates priority challenge failed, eliminating all obviousness grounds).

[322] *See supra* Part II.

[323] IPR-165, *supra* note 4, at 24; IPR-155, *supra* note 4, at 24; IPR-179, *supra* note 4, at 24 (all granted); IPR-164, *supra* note 4, at 22; IPR-154, *supra* note 3, at 22–23; IPR-178, *supra* note 4, at 22 (all denied). IPR-165 Final, *supra* note 4, at 34; IPR-155 Final, *supra* note 4, at 33; IPR-179 Final, *supra* note 4, at 34 (showing mixed outcomes with some claims invalidated). The panel composition remained consistent, with the institution decisions brought before Judges Arbes, Sawert, and Repko, and the final written decisions brought before Judges Arbes, White, and Repko. *See supra* note 285.

Linguistic Pattern Analysis: Qualitative analysis indicates recurring language usage characteristics, with PTAB rejection language for abstract frameworks appearing across proceedings: "[W]e cannot agree that the claim requires 'at least one selection' from three classes. . ."[324] Conversely, acceptance language for standards-based approaches demonstrates observable similarity in crediting expert testimony across successful proceedings.[325]

Technical Implementation Assessment: Element-by-element analysis indicates both references provided adequate technical content for most patent elements, yet administrative evaluation correlated with presentation methodology rather than coverage completeness within this dataset. This suggests that institutional reception patterns may prioritize methodological characteristics over technical content adequacy within patent obviousness analysis, though alternative explanations including panel preferences or temporal factors merit consideration.

G. Cross-Proceeding Validation and Pattern Replication

The methodological approach patterns identified through Bates-Dockser comparison appear across the complete IPR portfolio, providing some validation evidence for certain institutional behavioral tendencies within this dataset. Cross-proceeding analysis documents observable institutional reception patterns when similar methodological approaches encounter comparable administrative evaluation contexts.

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324 IPR-164, *supra* note 4, at 18; IPR-154, *supra* note 3, at 18; IPR-178, *supra* note 4, at 18.

325 *See* IPR-155 Final, *supra* note 4, at 33; IPR-165 Final, *supra* note 4, at 34; IPR-179 Final, *supra* note 4, at 34.

1. Standards-Based Approach Replication

IPR-155 Pattern Confirmation: This proceeding employed Dockser 2007 with IEEE-754 foundation, achieving partial claim invalidation with PTAB crediting language similar to IPR-165 outcomes.[326] Administrative decision documentation demonstrates linguistic similarity with crediting language appearing across multiple final written decisions involving standards-based approaches.

IPR-179 Cross-Patent Validation: The foundation patent proceeding replicated standards-based methodology with identical Dockser reference, achieving partial claim invalidation despite different patent context.[327] This cross-patent validation suggests methodological approach characteristics may transcend specific technical content or claim language variations within this related patent family, though broader generalizability remains unestablished.

2. Abstract Framework Pattern Consistency

Abstract framework approaches faced institutional rejection across IPR-154, IPR-164, and IPR-178, indicating consistent administrative behavioral patterns within this

326 IPR-155 Final, *supra* note 4, at 33 (crediting Goodin's software-based analysis); *cf.* IPR-165 Final, *supra* note 4, at 34 (nearly identical crediting language); IPR-179 Final, *supra* note 4, at 34 (same); *see also* IPR-155 Final, *supra* note 4, at 59 (crediting combined algebraic and software-based analysis under Dockser-Tong combination separately).

327 IPR-179 Final, *supra* note 4, at 34 ("After review of the arguments and evidence on these issues, we credit Mr. Goodin's software-based analysis."); *cf.* IPR-155 Final, *supra* note 4, at 33; IPR-165 Final, *supra* note 4, at 34 (showing consistent crediting across different patents: '961, '156, and '273 patents respectively, all employing identical Dockser + IEEE-754 methodology).

dataset.[328] The PTAB employed nearly identical rejection language across proceedings, suggesting potential template usage for categorical methodological evaluation.[329]

Institutional Language Analysis: Cross-proceeding analysis indicates recurring language usage patterns, with decision language similarity demonstrating observable consistency in core rejection phrases across different proceedings, judges, and time periods within this concentrated timeframe. Alternative explanations for this similarity include standardized legal analysis frameworks, common briefing strategies, or coordinated administrative processing approaches during this period.

Administrative Processing Patterns: The language replication extends beyond core rejection phrases to structural decision organization, with similar paragraph ordering, analytical framework, and conclusory language patterns appearing across denied proceedings.[330] This organizational consistency suggests potential administrative processing approaches for methodological evaluation, though broader dataset validation would strengthen these preliminary observations.

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[328] IPR-154, *supra* note 3, at 18 ("[W]e cannot agree that the claim requires 'at least one selection' from three classes of infinitely combinable and unpredictable 'variables.'"); IPR-164, *supra* note 4, at 18 (using identical rejection language); IPR-178, *supra* note 4, at 18 (showing template institutional processing with nearly identical wording across all three Bates-based proceedings).

[329] *See supra* note 328.

[330] *Compare* IPR-154, *supra* note 3, at 12–22 (following identical analytical sequence: claim construction, written description analysis, priority determination, conclusion), *with* IPR-164, *supra* note 4, at 12–22 (same structural organization), *and* IPR-178, *supra* note 4, at 11–22 (same, with one-page offset in preliminary sections).

H. Administrative Decision Patterns in Prior Art Evaluation

Examination of these six proceedings documents observable institutional patterns in prior art evaluation that appear independent of specific technical content, expert identity, or case-specific factors. These patterns suggest certain administrative decision-making characteristics within this limited context, though broader validation across diverse technical domains would be necessary to establish institutional behavior patterns.

1. Decision Language Pattern Analysis

Cross-proceeding PTAB decision analysis indicates language replication patterns, with identical or nearly identical phrases appearing across proceedings addressing similar methodological approaches. The consistency extends to both structural organization and specific analytical frameworks employed in evaluation of expert methodologies.

Recurring Language Indicators: For abstract framework rejection, the institutional language appears with minimal variation across the three denied proceedings.[331] For standards-based acceptance, crediting language demonstrates structural similarity across successful proceedings.[332]

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[331] *See supra* note 328.

[332] IPR-154, *supra* note 3, at 18; IPR-164, *supra* note 4, at 18; IPR-178, *supra* note 4, at 18 (using the following language in abstract framework rejections: "we cannot agree that the claim requires 'at least one selection' from three classes of infinitely combinable and unpredictable 'variables'"). IPR-155 Final, *supra* note 4, at 33; IPR-165 Final, *supra* note 4, at 34; IPR-179 Final, *supra* note 4, at 34 (crediting Mr. Goodin's software-based analysis in each); *see also* IPR-155 Final, *supra* note 4, at 59; IPR-165 Final, *supra* note 4, at 56; IPR-179 Final,

This linguistic consistency suggests potential administrative processing approaches for expert testimony evaluation, though individual case considerations and panel-specific preferences remain important variables. The recurring usage may reflect institutional efficiency mechanisms rather than categorical rejection of substantive analysis.

2. Methodological Evaluation Framework Evidence

Administrative decision patterns suggest institutional recognition of distinct expert methodology categories, with differential treatment based on approach characteristics rather than exclusive focus on specific technical content evaluation. Expert-created frameworks received heightened scrutiny and rejection within this dataset, while standards-based approaches achieved institutional acceptance regardless of technical complexity variations.[333]

Authority Source Assessment: Evidence from these proceedings indicates administrative preference for external technical standards over expert opinion and patent specification citation over expert-created analytical frameworks. This hierarchy appears consistent across proceedings and technical domains within the dataset, though broader validation would establish generalizability.[334]

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supra note 4, at 57 (crediting combined algebraic and software-based analysis under Dockser-Tong combination separately).

[333] *Compare* IPR-164, *supra* note 4, at 18 (rejecting expert-created "three classes" framework), IPR-154, *supra* note 3, at 18 (same), *and* IPR-178, *supra* note 4, at 18 (same), *with* IPR-165 Final, *supra* note 4, at 34 (crediting standards-based analysis), IPR-155 Final, *supra* note 4, at 33 (same), *and* IPR-179 Final, *supra* note 4, at 34 (same).

[334] *See supra* Parts I–II (developing authority hierarchy framework); *Phillips v. AWH Corp.*, 415 F.3d 1303, 1315 (Fed. Cir. 2005) (en banc) (establishing intrinsic evidence priority in claim interpretation).

Credibility Assessment Correlation: Cross-proceeding analysis documents apparent correlation between expert reliance on external authority and administrative credibility assessment outcomes within these proceedings. Approaches anchored in IEEE-754 standards, patent specification citations, and industry technical documentation received institutional acceptance, while expert-created categorizations faced rejection, though panel-specific factors may also contribute to these patterns.[335]

I. Implications for Administrative Decision-Making Analysis

The patterns documented through controlled comparison of expert methodologies within this limited dataset provide a preliminary foundation for understanding administrative decision-making processes in technical patent proceedings. The observable behavioral characteristics may inform both legal practice considerations and administrative law scholarship, though significant limitations constrain broader theoretical conclusions.

1. Administrative Law Theory Contributions

Institutional Behavioral Patterns: This empirical analysis indicates certain administrative behavioral patterns that appear independent of individual decision-maker characteristics within this context, suggesting institutional processing frameworks may transcend personal judge preferences or case-specific factors. This consistency enables preliminary theoretical development regarding

335 *See supra* note 333.

administrative agency evaluation of expert testimony in technical contexts, though broader validation across diverse administrative environments would strengthen conclusions.

Expert Methodology Evaluation Framework: The documented patterns suggest administrative agencies may apply evaluation criteria to expert methodologies based on: (1) authority source characteristics (external standards versus expert-created frameworks), (2) technical implementation specificity (circuit-level detail versus abstract categorization), and (3) risk distribution patterns (multi-pathway approaches versus single-point dependencies). This framework may inform preliminary assessment of expert approach characteristics within administrative proceedings while acknowledging significant scope limitations.[336]

Processing Approaches: The recurring language patterns and categorical evaluation characteristics provide limited evidence of administrative decision-making approaches that extend beyond individual case characteristics within this dataset. This potential processing standardization may promote consistency and efficiency, though categorical evaluation of expert methodologies based on framework characteristics rather than individualized substantive technical analysis raises questions about administrative process in technical proceedings that merit further investigation.

2. Patent Law Practice Considerations

Expert Methodology Development: Within these six proceedings, examination of expert testimony approaches suggests correlation between specific

[336] *See supra* Section I.B (authority source characteristics); *supra* Section IV.E.3 (technical implementation specificity through circuit-level Dockser analysis versus abstract Bates categorization); Part IV.D (risk distribution patterns through Bates single-point failure versus Dockser multi-pathway approach).

methodological characteristics and institutional reception patterns. Standards-based approaches anchored in external technical authority demonstrated advantages over expert-created analytical frameworks, though broader validation would establish applicability across diverse technical domains.[337]

Risk Assessment Framework: The patterns observed in this limited context may inform considerations regarding strategic risk assessment through multi-pathway approach development that avoids single-point failure dependencies. Priority date security, external authority grounding, and technical implementation precision provided independent strategic pathways that maintained analytical viability despite individual component challenges within this dataset.[338]

Integration with Broader Expert Testimony Strategy: These findings complement Part I's expert declaration methodology and Part II's defensive positioning strategies.[339] The authority hierarchy preferences documented here align with Part III's findings regarding specification-anchored positioning effectiveness under examination pressure.[340] This convergence across different aspects of expert testimony suggests certain patterns in administrative evaluation of technical evidence, though broader validation would establish generalizability.

3. Study Limitations and Alternative Explanations

Dataset Scope Constraints: This analysis examines only six proceedings within the LPHDR

[337] *See supra* note 332 and accompanying text.
[338] *See supra* Sections IV.D–E (documenting risk distribution across temporal security, standards foundation, and implementation precision).
[339] *See supra* Part I and II.
[340] *See supra* Parts I–III.

technology domain involving a single patent family, significantly limiting generalizability to other technical areas or administrative contexts. The patent family relationship introduces correlated characteristics that may affect broader applicability of observed patterns. Two-expert analysis within a single patent family may not capture methodological variations across different expert pairings or technology domains.

Temporal and Panel Factors: Proceedings filed within concentrated time periods may reflect expert learning curves, evolving PTAB practices, or panel-specific decision-making preferences unrelated to methodological effectiveness. The identical panel composition for institution decisions and overlapping composition for final written decisions may introduce institutional consistency patterns unrelated to expert methodology characteristics.

Alternative Explanations: Observed patterns may result from factors including: (1) patent-specific claim language variations affecting obviousness analysis, (2) individual judge preferences within panel composition, (3) temporal evolution in PTAB evaluation standards during 2021-2022, (4) underlying technical merit differences independent of presentation methodology, (5) case-specific factors not accounted for in this analysis, or (6) coordinated briefing strategies that influence institutional responses.

Causation versus Correlation: The documented correlations between methodological approaches and institutional outcomes do not establish causation. The patterns observed suggest relationships that warrant further investigation rather than definitive conclusions about expert testimony strategies. From a litigation strategy perspective, these patterns may inform practitioners’ considerations, though individual panel composition and case-specific factors may override general tendencies.

J. Conclusion: Methodological Evolution Within Administrative Context

The controlled comparison of prior art strategies across six related IPR proceedings provides preliminary evidence of how expert practice adapts within specific institutional contexts. The documentation suggests an evolution from abstract framework approaches toward standards-based methodologies within this limited dataset. However, this transformation occurred within identical expert practice across related proceedings filed within concentrated time periods, thus constraining broader conclusions about expert adaptation patterns.

Key Empirical Observations: Within this dataset, the analysis establishes apparent correlation between expert methodological characteristics and administrative reception patterns, indicating certain institutional tendencies for: (1) external technical standards over expert-created frameworks, (2) multi-pathway risk distribution over single-point dependencies, (3) circuit-level implementation precision over abstract categorizations, and (4) quantified technical specifications over theoretical framework organization. These patterns demonstrate observable consistency within the proceeding context while acknowledging significant limitations regarding broader applicability.

Administrative Pattern Documentation: The evidence documents certain institutional response patterns including: (1) recurring decision language usage with observable consistency for categorical rejection phrases, (2) potential evaluation framework application based on methodological characteristics rather than exclusive focus on technical content quality, and (3) hierarchical authority source assessment prioritizing external standards over expert opinion. This apparent standardization enables preliminary correlation between expert approach characteristics and institutional reception outcomes within this limited dataset.[341]

Expert Practice Evolution: The documented progression from the Bates 2010 abstract framework challenges to the Dockser 2007 standards-based success represents methodological adaptation based on institutional feedback patterns rather than technical content improvement. This transformation occurred within identical expert practice across related proceedings filed within days of each other, minimizing confounding variables related to expert identity or technical domain while acknowledging that learning effects across contemporaneous proceedings remain a potential factor .

Contributions to Administrative Law Understanding: This analysis provides preliminary foundation for understanding how administrative agencies evaluate competing expert methodologies in technical proceedings, establishing tentative assessment criteria for expert testimony approaches and institutional reception probability within patent contexts.[342] These preliminary findings may contribute to administrative law scholarship by documenting observable agency decision-making patterns while providing tentative guidance for expert testimony preparation in technical administrative contexts.

Research Limitations and Future Directions: The controlled experimental conditions documented in this analysis rarely occur in administrative law practice, significantly limiting generalizability beyond the LPHDR technology domain and six-proceeding dataset. Future research should examine whether these methodological patterns replicate across other technical administrative proceedings, different expert declarant categories, and

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[341] *See supra* note 332 and accompanying text (documenting differential reception patterns across methodological approaches).

[342] *See supra* Parts I–IV and accompanying analysis.

varying institutional contexts to establish broader theoretical frameworks for understanding administrative evaluation of expert testimony. The patterns identified here establish foundation for broader investigation of administrative agency behavior in technical evidence evaluation rather than definitive conclusions about expert testimony effectiveness or institutional decision-making principles.

The patterns identified through this research provide preliminary empirical foundation for both theoretical understanding and practical application of administrative law principles in complex technical proceedings, while acknowledging significant scope limitations that constrain broader theoretical conclusions about administrative behavior patterns.

V. Prior Art Reference Combination Analysis in Administrative Patent Proceedings

A. Introduction

Obviousness determinations under 35 U.S.C. § 103 frequently require combining multiple prior art references to demonstrate that claimed inventions would have been obvious to persons of ordinary skill.[343] While substantial scholarship addresses substantive obviousness doctrine, less attention has examined how combination complexity affects administrative evaluation patterns in practice.[344]

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[343] Graham v. John Deere Co., 383 U.S. 1, 17–18 (1966); KSR Int'l Co. v. Teleflex Inc., 550 U.S. 398, 418 (2007).

[344] *See generally* Helmers & Love, *supra* note 2; Love, Miller & Ambwani, *supra* note 2; Vishnubhakat, *supra* note 2; Yelderman, *supra* note 2 (analyzing IPR outcomes without examining how reference combination complexity affects administrative evaluation patterns in each).

This part analyzes six *Inter Partes* Review proceedings where expert declarant Mr. Richard Goodin, P.E. employed different reference combination approaches against related patent claims within the LPHDR technology family.[345]

Two-reference combinations (Dockser and Tong) resulted in institution and claim invalidation across three proceedings, while three-reference combinations adding MacMillan were rejected consistently.[346] The PTAB cited design incompatibility concerns between references when rejecting complex combinations.[347] These proceedings offer controlled comparison conditions where expert identity and technical domain remain constant while combination approaches vary.

This analysis extends Part I's examination of expert declaration methodology and Part IV's documentation of standards-based positioning versus abstract analytical frameworks by examining how reference integration complexity correlates with administrative reception patterns.

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[345] *See supra* Parts I, III, and IV.

[346] Dockser 2007, *supra* note 276, at [0015–16]; Jonathan Ying Fai Tong et al., *Reducing Power by Optimizing the Necessary Precision/Range of Floating-Point Arithmetic*, 8 IEEE Transactions on VLSI Systems 273, 274 (2000). *See also* IPR-155 Final, *supra* note 4, at 59 (crediting Dockser-Tong combination); IPR-165 Final, *supra* note 4, at 56 (same); IPR-179 Final, *supra* note 4, at 57 (same); U.S. Patent No. 5,689,677 (issued Nov. 18, 1997) [hereinafter MacMillan].

[347] IPR-165 Final, *supra* note 4, at 71 ("A person of ordinary skill in the art, reading MacMillan and understanding its emphasis on avoiding increased costs associated with added complexity and size, would not have been motivated to modify MacMillan's device by incorporating Dockser's FPP into the PEs."); IPR-155 Final, *supra* note 4, at 75; IPR-179 Final, *supra* note 4, at 72 (showing consistent rejection of three-reference combinations based on MacMillan's complexity avoidance objectives creating lack of motivation to combine).

B. Prior Art Reference Analysis

1. Dockser 2007: Primary Reference Foundation

U.S. Patent 8,595,279 to Dockser, filed in 2006 and issued in 2013, discloses floating-point processors with user-selectable precision controls.[348] The invention addresses power consumption by "removing power from one or more components which would otherwise be used to store or process one or more excess bits."[349]

Technical implementation involves "subprecision select bits" controlling arithmetic operations including addition and multiplication while maintaining IEEE-754 floating-point standard compliance.[350] This standards foundation proved significant for establishing technical authority consistent with patterns documented in Part IV where IEEE-754 anchored approaches demonstrated institutional advantages over expert-created analytical frameworks.[351]

2. Tong 2000: Academic Validation Reference

The Tong publication in IEEE Transactions on VLSI Systems documents "up to 66% reduction in multiplier energy/operation" through floating-point

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[348] U.S. Patent No. 8,595,279, col. 1, ll. 22–50 (filed Feb. 27, 2006, issued Nov. 26, 2013) (disclosing the issued patent corresponding to the Dockser 2007 application publication cited *supra* note 276 as Ex. 1007) [hereinafter Dockser Patent].

[349] *Id.* col. 1, l. 64–col. 2, l. 27.

[350] *Id.* col. 1, ll. 22–40 (arithmetic operations).

[351] *See supra* Part IV (analyzing prior art strategy evolution and institutional reception patterns for IEEE-754 standards-based approaches).

precision optimization.[352] Detailed power distribution analysis demonstrates that the "mantissa multiplier completely dominates the power" at 81.2%, with rounding unit accounting for 17.9%, exponent unit 0.833%, and other components 0.066%.[353]

The research validated reduced-precision approaches across a comprehensive five-application test suite encompassing diverse computational domains. Sphinx III speech recognition required "only 5 mantissa bits and 6 exponent bits to maintain 90% recognition accuracy—the same level of accuracy achieved with a 32-bit IEEE-standard FP representation."[354] ALVINN neural network training demonstrated that "the accuracy does not change significantly with as few as 5 mantissa bits."[355] Additional validation included PCASYS fingerprint classification, Bench22 image processing, and Fast DCT transform processing, all demonstrating maintained accuracy with reduced precision.[356]

Cross-application analysis established that no "noticeable degradation in accuracy when the mantissa bitwidth is reduced from 23 to 11 bits" occurred across the complete test suite.[357] This represents a 12-bit reduction (approximately 52% decrease) while maintaining application accuracy across diverse computational domains. These peer-reviewed findings provided empirical support for precision reduction approaches without creating design philosophy conflicts with Dockser's standards-based framework.

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[352] *See* Tong, *supra* note 346, at 273.
[353] *Id.* at 275.
[354] *Id.* at 273.
[355] *Id.* at 278.
[356] *Id.* at 281–82.
[357] *Id.* at 278.

3. MacMillan 1997: Complexity-Conflicting Reference

US Patent 5,689,677 to MacMillan describes SIMD processing architectures titled "Circuit for Enhancing Performance of a Computer for Personal Use."[358] The patent emphasizes cost considerations throughout, stating that "[t]he architecture replaces some or all of the personal computer's conventional main memory, resulting in a cost saving that helps offset the added cost of the new components."[359]

The SIMD architecture comprises "a SIMD Controller 252, one or more SIMD-RAM devices 254 and Interconnect Router 256."[360] Each SIMD-RAM device includes "a plurality of memory devices, in this case, dynamic random access memory (DRAM) 304, which are coupled to a plurality of processing elements (PE's) 302 via random access logic 306."[361] Processing elements contain a "32-bit wide data path" supporting "atomic operations on bits, bytes, 16-bit words, and 32-bit words."[362] The patent specifies that "[o]perations on 64-bit words and block operations could be performed by looping through two or more data values—these would not be atomic operations."[363]

The architecture emphasizes cost efficiency through shared memory approaches: "A first aspect of the present invention is that it provides shared memory for data and programs that can be used by both the host computer

[358] U.S. Patent No. 5,689,677 (issued Nov. 18, 1997) [hereinafter MacMillan].
[359] *Id.* col. 16, ll. 17–20.
[360] *Id.* col. 9, ll. 24–25.
[361] *Id.* col. 12, ll. 37–40.
[362] *Id.* col. 12, ll. 47–49.
[363] *Id.* col. 12, ll. 49–51.

system and the parallel SIMD system. The invention of this shared memory results in lower system cost and more flexibility."[364] Multiple passages emphasize complexity avoidance as a design priority: "The SIMD architecture can be scaled to tens of thousands of processors or more, with excellent processor utilization for many programs. Moreover, this scalability can generally be achieved without the need for reprogramming."[365] This systematic complexity avoidance creates fundamental incompatibility with sophisticated precision management approaches requiring technical complexity.

C. Two-Reference Combination Analysis

1. Expert Integration Methodology

Mr. Goodin characterized Dockser and Tong as complementary rather than competing references across the relevant proceedings. Expert declarations positioned Dockser as providing an implementation mechanism for precision-controlled floating-point processing, while Tong offered empirical validation through academic research. [366]

This positioning approach avoided competing design philosophies by emphasizing different aspects of compatible technical development. Both references prioritized performance optimization through distinct but reinforcing methodologies: Dockser through standards-based implementation and circuit-level precision control, Tong through algorithm-level optimization validated across

[364] MacMillan, *supra* note 358, col. 5, ll. 55–59.
[365] *Id.* col. 2, ll. 13–16.
[366] Goodin Decl. 164-5, *supra* note 5, ¶¶ 311–12, 321–23 (disclosing Section VII: Dockser-Tong two-reference combination, characterizing Tong's precision optimization as complementary to Dockser's selectable-precision FPP); Goodin Decl. 154-5, *supra* note 5, ¶¶ 322–23, 332–33 (same); Goodin Decl. 178-9, *supra* note 5, ¶¶ 333–35 (same).

multiple application domains. The academic authority of IEEE peer review enhanced rather than contradicted the standards-based technical authority established by IEEE-754 compliance.

2. PTAB Reception Patterns

Administrative evaluation focused on technical merit without raising design philosophy compatibility concerns. PTAB decisions analyzed whether references adequately disclosed claim elements and whether persons of ordinary skill would be motivated to combine the teachings.[367] No threshold compatibility assessment preceded substantive technical evaluation in two-reference contexts.

The Board generally credited Mr. Goodin's technical analysis across proceedings involving two-reference combinations, though specific elements of the combination rationale faced scrutiny. IPR-165 provides representative language: "We credit Mr. Goodin's software-based analysis" and "We credit Mr. Goodin's algebraic analysis."[368] Similar expert crediting appeared in IPR-155 and IPR-179 final written decisions.[369]

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[367] IPR-165 Final, *supra* note 4, at 56 (disclosing Dockser-Tong technical analysis: "Petitioner used a software program to determine the relative error when retaining 5 mantissa fraction bits"); IPR-155 Final, *supra* note 4, at 59 (crediting Goodin's algebraic and software-based analysis); IPR-179 Final, *supra* note 4, at 57 (crediting Mr. Goodin's algebraic analysis and software-based analysis).

[368] IPR-165 Final, *supra* note 4, at 34 ("After review of the arguments and evidence on these issues, we credit Mr. Goodin's software-based analysis."); *Id.* at 56 ("[W]e credit Mr. Goodin's algebraic analysis and software-based analysis.").

[369] IPR-155 Final, *supra* note 4, at 59 ("After review of the arguments and evidence on these issues, we credit the Goodin Declaration's algebraic analysis and software-based analysis."); IPR-179 Final, *supra*

Administrative language focused on technical correspondence between prior art disclosure and patent claim elements rather than evaluating reference compatibility or design philosophy consistency. The absence of "design incompatibility" language indicates direct progression to substantive technical analysis without preliminary screening for combination appropriateness.[370]

D. Three-Reference Combination Analysis

1. Design Philosophy Incompatibility Assessment

Mr. Goodin's addition of MacMillan to previously compatible Dockser-Tong combinations resulted in systematic rejection across all three proceedings where this approach was attempted. This represents a central empirical observation of this analysis: institutional recognition of design incompatibility as a threshold barrier that eliminates obviousness arguments before technical merit evaluation can occur.[371]

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note 4, at 57 ("[W]e credit Mr. Goodin's algebraic analysis and software-based analysis.").

[370] *Compare* IPR-165 Final, *supra* note 4, at 56, *and* IPR-155 Final, *supra* note 4, at 58, *and* IPR-179 Final, *supra* note 4, at 57 (demonstrating direct technical merit analysis of Dockser-Tong combinations without compatibility assessment), *with* IPR-165 Final, *supra* note 4, at 71, *and* IPR-155 Final, *supra* note 4, at 75, *and* IPR-179 Final, *supra* note 4, at 72 (including MacMillan complexity avoidance creating lack of motivation to combine in three-reference contexts). No PTAB language addressing reference compatibility appears in two-reference proceedings.

[371] IPR-165 Final, *supra* note 4, at 71; IPR-155 Final, *supra* note 4, at 75; IPR-179 Final, *supra* note 4, at 72 ("A person of ordinary skill in the art, reading MacMillan and understanding its emphasis on avoiding increased costs associated with added complexity and size, would not have been motivated to modify MacMillan's device by incorporating Dockser's FPP into the PEs.") (reaching this determination without

The PTAB identified fundamental incompatibility between MacMillan's cost reduction priorities and the technical sophistication required for precision-controlled processing. IPR-165 provides representative rejection language that was replicated across proceedings:

> Given the express teachings of MacMillan, however, we are not persuaded that an ordinarily skilled artisan would have been motivated to combine the two different approaches in that manner. Specifically, MacMillan's repeated statements that its approach is designed to avoid increased costs from added complexity and size (and thereby allow for many low-cost processors in the device) would have dissuaded a person of ordinary skill in the art from doing so.[372]

This design incompatibility analysis represents a systematic institutional approach to reference combination evaluation that operates independent of technical adequacy. The institutional analysis emphasized textual contradictions between explicit design priorities rather than technical inadequacy. Where Dockser 2007 and Tong emphasized technical sophistication through IEEE-754 standards compliance and peer-reviewed validation, MacMillan prioritized simplicity and cost reduction for personal computer applications.[373] These competing objectives

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evaluating substantive technical merit of the proposed three-reference combination in each).

[372] IPR-165 Final, *supra* note 4, at 72; *see also* IPR-155 Final, *supra* note 4, at 76; IPR-179 Final, *supra* note 4, at 73 (including identical rejection reasoning across all three proceedings based on MacMillan's explicit complexity avoidance objectives).

[373] MacMillan, *supra* note 358, col. 5, ll. 42–44 ("SIMD capabilities should not add significant complexity to the architecture of a computer system for personal use."); *cf.* Dockser 2007, *supra* note 276, ¶ 3

created incompatibility that prevented obviousness arguments from proceeding to substantive technical evaluation.

2. Template Administrative Language Analysis

Rejection of three-reference combinations employed nearly identical language across proceedings, revealing systematic institutional processing that indicates broader administrative behavioral patterns. IPR-155 and IPR-179 replicated the core IPR-165 rationale with minimal textual variation.[374] Cross-proceeding linguistic analysis reveals near-verbatim phrasing in core rejection rationale across the three proceedings.[375]

This template language consistency represents significant institutional behavioral evidence suggesting that PTAB processing may employ standardized analytical frameworks for recurring design philosophy conflicts. Rather than conducting individualized case-by-case analysis, the Board appears to recognize "design incompatibility" as a categorical basis for rejection that triggers template language application across multiple proceedings.

Recurring template elements included: (1) statement regarding lack of persuasion about motivation to combine

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(emphasizing selectable precision); Tong, *supra* note 346 (academic validation of precision optimization).

[374] *See supra* note 372 (documenting template replication of rejection reasoning across IPR-155 and IPR-179).

[375] IPR-165 Final, *supra* note 4, at 71–72; IPR-155 Final, *supra* note 4, at 75-76; IPR-179 Final, *supra* note 4, at 72–73 (including manual comparison that shows word-for-word replication of: (1) MacMillan complexity avoidance analysis, (2) "not persuaded that an ordinarily skilled artisan would have been motivated to combine" language, and (3) identical Federal Circuit case law citations (*Chemours, TriVascular, In re Gordon, Henny Penny*) with nearly identical explanatory parentheticals across all three decisions).

teachings, (2) specific citation to MacMillan's complexity avoidance statements, and (3) conclusion that such avoidance would dissuade persons of ordinary skill in the art. This linguistic consistency indicates institutional template usage for design philosophy incompatibility assessment that may reflect broader administrative efficiency mechanisms in patent validity determination.

Template application indicates PTAB recognition of design philosophy compatibility as a threshold requirement that can eliminate obviousness arguments before detailed technical analysis. The institutional significance extends beyond individual case outcomes to suggest systematic administrative approaches to complex reference combination evaluation that prioritize design philosophy compatibility over technical adequacy assessment.

E. Administrative Processing Framework Analysis

1. Sequential Evaluation Patterns

Administrative treatment suggests different analytical sequences for simple versus complex reference combinations. Two-reference combinations proceeded directly to technical merit evaluation, examining claim coverage, prior art correspondence, and motivation to combine. Three-reference combinations encountered preliminary compatibility screening that eliminated obviousness arguments before substantive technical analysis could occur.

This sequential approach may reflect institutional efficiency considerations, since design philosophy incompatibility provides clear grounds for rejection without requiring detailed claim-by-claim technical analysis or complex motivation assessment. The template language consistency across proceedings supports this interpretation, indicating standardized institutional protocols for recurring compatibility issues rather than case-specific individualized assessment.

Sequential evaluation creates threshold effects where combination complexity triggers different analytical pathways within administrative processing. Simple combinations with compatible design philosophies receive direct technical merit evaluation, while complex combinations undergo preliminary screening that can prevent substantive analysis regardless of underlying technical adequacy or claim coverage quality.

2. Authority Source Interaction Effects

Two-reference combinations maintained reinforcing authority relationships that enhanced rather than competed with each other. IEEE-754 standards (Dockser 2007) and peer-reviewed academic research (Tong) provided cumulative external validation through compatible but distinct credibility sources. Both emphasized technical excellence through recognized validation mechanisms: industry standards and academic peer review processes.[376]

Three-reference combinations introduced competing authority claims that undermined rather than enhanced overall credibility.[377] MacMillan's commercial market positioning and cost optimization priorities conflicted with the technical sophistication established by

[376] *Compare* Dockser 2007, *supra* note 276, ¶ [0002] (IEEE-754 standards foundation), *and* Tong, *supra* note 346 (peer-reviewed validation), *with* MacMillan, *supra* note 358, col. 5, ll. 42–44 (showcasing cost-focused design philosophy creating incompatibility with technical sophistication requirements).

[377] *See* IPR-165 Final, *supra* note 4, at 71–72 (rejecting Dockser-MacMillan combination based on design philosophy incompatibility despite adequate individual reference quality); IPR-155 Final, *supra* note 4, at 75–76 (same); IPR-179 Final, *supra* note 4, at 72–73 (same).

standards and academic authority.[378] Rather than providing additional validation sources, the third reference created internal contradictions that triggered institutional rejection mechanisms.

These authority interaction patterns align with findings documented in Part I regarding institutional preferences for external technical standards over expert-created analytical frameworks.[379] Combinations that maintain consistent authority hierarchies avoid triggering design philosophy incompatibility analysis, while combinations mixing incompatible authority sources face threshold rejection mechanisms regardless of individual reference technical quality.

F. Cross-Proceeding Pattern Analysis

1. Parameter Independence Documentation

Reference combination outcomes remained consistent across varying technical parameter requirements and patent contexts within this related family. Two-reference combinations achieved institution and claim invalidation under relaxed parameters (IPR-155: X=10%, Y=0.2%), strict requirements (IPR-165: X=5%, Y=0.05%), and the earliest-filed patent in the family (IPR-179: '273 Patent, X=5%, Y=0.05%).[380] Three-reference rejections

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[378] *Compare* MacMillan, *supra* note 358, col. 5, ll. 42–44 ("SIMD capabilities should not add significant complexity to the architecture of a computer system for personal use."), *with* Dockser 2007, *supra* note 276, ¶ [0002] (IEEE-754 standards requiring technical precision infrastructure), *and* Tong, *supra* note 346, at 273 (including academic validation of precision optimization techniques).

[379] *See supra* Part I.

[380] '961 Patent, *supra* note 3, col. 30, ll. 25–34 (X=10%, Y=0.2%); '156 Patent, *supra* note 4, col. 29, l. 62–col. 30, l. 4 (X=5%, Y=0.05%);

replicated across identical parameter variations, indicating parameter independence.

This parameter independence suggests that combination structure and design philosophy compatibility, rather than technical stringency or substantive patent differences, influenced administrative reception patterns. Outcomes correlated with combination complexity characteristics rather than claim requirements, parameter thresholds, or individual patent technical characteristics within this related family.

2. Temporal and Panel Consistency Analysis

All proceedings occurred within concentrated timeframes with overlapping administrative panels, creating both controlled comparison conditions and potential generalizability constraints. Institution decisions were rendered May 12-14, 2021, with identical panel composition (Judges Arbes, Sawert, Repko), while final written decisions appeared May 11, 2022, with overlapping composition (Judges Arbes, White, Repko).[381]

This consistency enables controlled comparison by minimizing panel-specific variation but constrains generalizability regarding broader institutional behavioral patterns. The concentrated temporal clustering and overlapping panel composition may reflect period-specific evaluation approaches, coordinated case management, or

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‘273 Patent, *supra* note 4, col. 30, ll. 6–16 (X=5%, Y=0.05%). *See also* IPR-155 Final, *supra* note 4, at 59 (crediting Dockser-Tong combination for ‘961 patent); IPR-165 Final, *supra* note 4, at 56 (same for ‘156 patent); IPR-179 Final, *supra* note 4, at 57 (same for ‘273 patent).

[381] *See* IPR-154, *supra* note 3, at 1; IPR-155, *supra* note 4, at 1; IPR-164, *supra* note 4, at 1; IPR-165, *supra* note 4, at 1; IPR-178, *supra* note 4, at 1; IPR-179, *supra* note 4, at 1 (institution panel); IPR-155 Final, *supra* note 4, at 1; IPR-165 Final, *supra* note 4, at 1; IPR-179 Final, *supra* note 4, at 1 (final decision panel).

individual judge preferences rather than stable institutional processing protocols that would apply across different time periods or panel compositions.

G. Implementation Validation Analysis

1. Algorithm Implementation Correlation

Two-reference combinations enabled practical algorithm validation that three-reference combinations could not achieve due to design philosophy conflicts. Tong's empirical validation demonstrated effectiveness across three distinct algorithmic domains that required both precision control capabilities (Dockser 2007) and empirical validation (Tong) without the complexity avoidance constraints imposed by MacMillan's design philosophy.[382]

Nearest Neighbor Search Implementation: The algorithm implementation places "Examples" into PE memories with test vectors "passed through all the PEs" for parallel distance computation using Euclidean distance metrics.[383] The implementation requires sophisticated error management across parallel processing elements for finding the closest vector using systematic distance calculation across processing element arrays.[384] Implementation validation achieved "average percentage of matches . . . was 99.9%" for reduced-precision arithmetic implementation and "99.7%" for logarithmic number

[382] Tong, *supra* note 346, at 274 (demonstrating precision optimization across multiple benchmark applications); *cf.* IPR-165 Final, *supra* note 4, at 72; IPR-155 Final, *supra* note 4, at 76; IPR-179 Final, *supra* note 4, at 73 (showing MacMillan's complexity avoidance creating systematic incompatibility with precision-controlled processing approaches).
[383] Bates 2010, *supra* note 275, ¶¶ 90, 95–96.
[384] *Id.* ¶ 98.

system implementation under normal conditions, with stress testing demonstrating "98.8%" accuracy maintained under extreme conditions with +10% to -5% noise variation.[385] This sophisticated validation required precision management capabilities that would be fundamentally incompatible with MacMillan's complexity avoidance design philosophy.

Distance Weighted Scoring Implementation: Technical implementation addresses sophisticated computational challenges involving "processing 1,000,000 Examples . . . sums were over one million small positive values" requiring advanced error management and computational precision maintenance.[386] The algorithm computes "a weighted sum of the scores . . . where the weights are a diminishing function of the distance from the Test to the respective Examples" involving normalization by dividing the "un-normalized weight . . . by the sum of all un-normalized weights" across massive datasets.[387] Performance validation demonstrated "0.85%" average error for reduced-precision implementation and "0.12%" average error for logarithmic arithmetic implementation.[388] The algorithm employed Kahan summation methods for precision maintenance across cumulative operations, requiring technical sophistication that directly conflicts with MacMillan's simplicity emphasis and cost reduction priorities.

Image Deblurring Implementation: Richardson-Lucy deconvolution algorithm implementation utilized 32-pixel linear blur kernel with "C programming language" specification for systematic camera motion blur removal across digital image processing applications.[389] The

[385] *Id.* ¶¶ 120, 134, 138.
[386] *Id.* ¶ 146.
[387] *Id.* ¶¶ 143–44.
[388] *Id.* ¶ 145.
[389] Bates 2010, *supra* note 275, ¶¶ 149–50.

implementation addresses linear blur kernel implementation with "pixels J through J+31" using 32-pixel linear blur kernel for systematic camera motion blur removal with "the Kahan method" for computational accuracy maintenance.[390] Performance validation showed restored images where "it is possible to recognize buildings, streets, parking lots, and cars" with quantified mean pixel errors of 13.8 (reduced precision) and 14.8 (logarithmic) compared to 13.0 (standard floating point) and 32.0 (blurred original).[391] This sophisticated image processing validation required precision management capabilities and algorithmic complexity that are fundamentally incompatible with cost reduction priorities and complexity avoidance requirements.

2. Combination Capability Correlation Analysis

The practical algorithm validation correlation provides empirical evidence of consequences beyond administrative reception patterns. Compatible reference combinations (Dockser 2007 + Tong) provided technical foundation enabling sophisticated algorithmic implementation through precision control mechanisms and empirical validation across diverse computational domains. Incompatible combinations failed to enable practical validation because MacMillan's complexity avoidance requirements created fundamental conflicts with algorithmic sophistication needs.[392]

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390 *Id.* ¶¶ 149–50.
391 *Id.* ¶ 151, tbl. 1.
392 *Id.* ¶¶ 90, 143, 148 (demonstrating sophisticated algorithm validation across nearest neighbor search, distance weighted scoring, and image processing domains requiring precision management); *cf.* MacMillan, *supra* note 358, col. 5, ll. 42–44 ("SIMD capabilities should not add significant complexity to the architecture of a computer

This implementation validation correlation demonstrates practical consequences of combination compatibility that extend beyond PTAB administrative processing patterns. Compatible reference combinations enable sophisticated technical implementation and practical algorithm validation, while incompatible combinations create design constraints that prevent advanced algorithmic validation even when individual references contain relevant technical content.

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system for personal use."). (The correlation between PTAB rejection and practical algorithmic incompatibility suggests alignment between institutional decision-making patterns and technical implementation realities).

H. Element-by-Element Mapping Analysis

1. Two-Reference Mapping Documentation

Analysis Category	Details
Claim Element: "processor or device"	
Dockser 2007 Disclosure	"floating-point processor (FPP) . . . with selectable subprecision"
Tong 2000 Validation	Performance validation across five applications
Mapping Quality	EXCELLENT
PTAB Reception	ACCEPTED
Claim Element: "processing elements"	
Dockser 2007 Disclosure	"floating-point operator configured to perform the floating-point operation"
Tong 2000 Validation	Empirical validation across multiple domains
Mapping Quality	STRONG
PTAB Reception	ACCEPTED
Claim Element: "arithmetic operations"	
Dockser 2007 Disclosure	"floating-point add and subtract . . . multiply . . . divide instructions"
Tong 2000 Validation	Cross-application effectiveness demonstration
Mapping Quality	EXCELLENT
PTAB Reception	ACCEPTED

Claim Element: "selectable precision"	
Dockser 2007 Disclosure	"selecting a subprecision less than the first precision"
Tong 2000 Validation	Quantified precision reduction validation
Mapping Quality	PERFECT
PTAB Reception	ACCEPTED
Claim Element: "power management"	
Dockser 2007 Disclosure	"removing power from one or more components in the floating-point processor that would otherwise be used to store or process the one or more excess bits"
Tong 2000 Validation	"66% reduction in multiplier energy/operation"
Mapping Quality	STRONG
PTAB Reception	ACCEPTED

Table 5.1 Two-Reference Combination Claim Element Mapping Analysis.[393] *Note: Mapping Quality assessments reflect the author's characterization based on analysis of expert declarations and PTAB decisions, not language used by the Board. PTAB Reception reflects actual Board outcomes.*

2. Three-Reference Mapping Failure Analysis

Analysis Category	Details
Design Aspect: Technical Sophistication	
Dockser + Tong Foundation	IEEE-754 standards + peer review validation
MacMillan Addition	Cost reduction emphasis
Compatibility	INCOMPATIBLE
PTAB Reception	REJECTED

393 Dockser Patent, *supra* note 348 (patent disclosure mapping); Tong, *supra* note 346, at 273–82 (showing empirical validation across application domains); IPR-155 Final, *supra* note 4, at 33, 59; IPR-165 Final, *supra* note 4, at 34, 56; IPR-179 Final, *supra* note 4, at 34, 57 (PTAB reception determinations).

Design Aspect: Performance Optimization	
Dockser + Tong Foundation	Precision control + empirical validation
MacMillan Addition	Cost reduction priority
Compatibility	CONFLICTING
PTAB Reception	REJECTED
Design Aspect: Implementation Approach	
Dockser + Tong Foundation	Standards compliance + academic research
MacMillan Addition	Personal computer simplicity
Compatibility	CONTRADICTORY
PTAB Reception	REJECTED
Design Aspect: Design Philosophy	
Dockser + Tong Foundation	Technical excellence emphasis
MacMillan Addition	Complexity avoidance emphasis
Compatibility	OPPOSING
PTAB Reception	REJECTED

Table 5.2: Three-Reference Combination Design Philosophy Conflict Analysis.[394] *Note: Compatibility assessments reflect the author's characterization based on PTAB reception patterns documented in the final written decisions, not language used by the Board. PTAB Reception reflects actual Board outcomes.*

The element-by-element analysis demonstrates that three-reference combination rejection occurred not due to inadequate claim element coverage but due to incompatible design philosophies that created threshold rejection before

[394] *See* IPR-165 Final, *supra* note 4, at 71–72; IPR-155 Final, *supra* note 4, at 75–76; IPR-179 Final, *supra* note 4, at 72–73 (rejecting three-reference combinations based on MacMillan design philosophy incompatibility in each); MacMillan, *supra* note 358, col. 5, ll. 42–44 (complexity avoidance design philosophy); Dockser Patent, *supra* note 348 (IEEE-754 standards foundation); Tong, *supra* note 346 (empirical validation).

technical merit evaluation could proceed. MacMillan provided relevant technical content for parallel processing and arithmetic operations, but introduced design philosophy conflicts that prevented advancement to substantive claim mapping analysis.

I. Study Limitations and Alternative Explanations

1. Dataset and Scope Constraints

This analysis examines six proceedings within the floating-point processing technology domain involving identical expert declarant, Mr. Goodin, and related patent family characteristics. Findings may reflect domain-specific characteristics, individual expert methodologies, or technology-specific administrative processing patterns rather than broader institutional behavioral characteristics. The LPHDR patent family involves quantifiable performance parameters that may enable clearer compatibility assessment compared to other patent technologies with different technical characteristics.[395]

Temporal clustering within a one-week petition filing period (October 30-November 6, 2020) and concentrated institutional decision timeframes (May 12-14, 2021) may indicate coordinated case management, specific institutional practices during this period, or panel-specific evaluation approaches rather than stable administrative processing protocols. The overlapping panel composition across multiple proceedings may introduce systematic evaluation patterns unrelated to combination strategy characteristics or reference compatibility assessment.

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[395] *See supra* Parts I–V and accompanying analysis (documenting empirical findings across six IPR proceedings within a single patent family and technology domain).

2. Alternative Explanations for Observed Patterns

Observed correlation between combination complexity and administrative rejection may result from factors including underlying technical merit differences between references independent of design philosophy considerations, expert presentation quality variations that correlate with combination complexity, claim construction differences that favor simpler versus complex obviousness theories, or reference-specific technical inadequacies beyond design philosophy conflicts.

MacMillan may have contained technical deficiencies independent of cost reduction emphasis that account for systematic rejection patterns. Alternative tertiary references with compatible design philosophies might demonstrate different outcomes, suggesting reference-specific rather than complexity-related effects. Individual PTAB panel preferences for particular analytical approaches during this specific time period may override general institutional processing patterns that would apply across different panels or time periods.

The concentrated dataset involving related patents within a single technology family and identical expert declarant constrains broader applicability to different technology domains, expert approaches, or temporal contexts. Different patent technologies, expert methodologies, or institutional time periods might yield different patterns, limiting theoretical generalizability beyond this specific administrative and technical context.

J. Conclusion

Analysis of reference combination approaches across six related proceedings reveals a correlation between combination complexity and administrative reception patterns within this limited dataset. Two-reference combinations achieved consistent outcomes through compatible technical positioning and reinforcing authority source relationships, while three-reference combinations were rejected due to design philosophy incompatibility identified through template institutional language application.

Administrative evaluation patterns suggest potential sequential processing frameworks where compatibility assessment may precede substantive technical analysis for complex reference combinations. Simple combinations with compatible design philosophies proceed directly to technical merit evaluation, while complex combinations encounter threshold compatibility requirements that can eliminate obviousness arguments independent of underlying technical adequacy or claim coverage quality.

These findings extend earlier sections' documentation of expert positioning approaches and administrative decision-making patterns. The authority hierarchy preferences observed here align with Part I's specification-anchored positioning effectiveness and Part IV's standards-based technical approaches, indicating potential consistency across multiple dimensions of expert testimony evaluation in administrative patent proceedings.[396]

The implementation validation correlation provides empirical evidence of practical consequences extending beyond administrative processing patterns. Compatible combinations enable sophisticated algorithmic implementation and validation, while incompatible combinations create design constraints that prevent advanced technical validation despite adequate individual

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[396] *See supra* Part I (analyzing expert declaration methodology and specification-anchored positioning strategies); *supra* Part IV (documenting IEEE-754 standards-based approaches and institutional reception patterns).

reference content. This suggests that combination complexity effects may influence not only administrative outcomes but also practical technical development capabilities.

The concentrated dataset enables controlled comparison while constraining broader generalizability to different institutional, temporal, or technological contexts. Future research examining combination strategies across diverse technology domains, different temporal periods, and varying expert approaches would determine whether these patterns reflect stable institutional processing approaches or context-specific factors affecting this particular set of proceedings. Such research might explore whether threshold compatibility requirements represent efficient administrative processing mechanisms or create systematic barriers to complex technical arguments in patent validity determination across different technological and administrative contexts.

VI. PRIOR ART NEUTRALIZATION THROUGH DESIGN PHILOSOPHY ANALYSIS

A. Introduction

Prior art challenges in complex technical proceedings may benefit from methodologies that extend beyond traditional claim coverage analysis. While conventional prior art evaluation typically focuses on element-by-element claim mapping and functional overlap between references and claimed inventions, some administrative proceedings involve prior art combinations that raise questions about design philosophy compatibility and inventive concept preservation.

Dr. Sunil P. Khatri's expert testimony across three related Inter Partes Review proceedings—IPR-155, IPR-

165, and IPR-179—suggests an analytical methodology that addresses fundamental design conflicts rather than technical adequacy alone. This method appears to focus on architectural incompatibility as a basis for challenging obviousness arguments, particularly when prior art combinations would require abandoning core design principles of the cited references.[397]

B. Architectural Principle Analysis Components

The analytical methodology observed in Dr. Khatri's declarations involves several recurring elements that address different aspects of prior art combination challenges. Based on the language patterns across the three proceedings, three primary analytical components emerge from this limited dataset, though broader validation would be necessary to establish general applicability.

1. Design Philosophy Identification and Objective Incompatibility

This component involves examining the fundamental objectives underlying each prior art reference to identify potential conflicts that may complicate rational combinations. Dr. Khatri's examination of the Dockser reference illustrates this methodology through emphasis on selectable precision capability as a core architectural principle.

The study characterized Dockser's design objectives as centered on providing "a general processor with selectable precision" that maintains full-precision

[397] *See* Khatri Decl. 155, *supra* note 151, ¶¶ 107–09 (arguing that "a POSA would not be motivated to combine the teachings of Dockser, MacMillan, and Tong" and characterizing petitioner's combination as "nothing but a hindsight-based modification of the references to meet the claims"); *accord* Khatri Decl. 165, *supra* note 151, ¶¶ 107–09; Khatri Decl. 179, *supra* note 151, ¶¶ 107–09.

capabilities while offering reduced-precision options for limited circumstances.[398] This characterization established a foundation for arguing that "Dockser's objectives are fundamentally directed away from Petitioner's proposed 'alternative' combination."[399]

The method suggests that when prior art references embody conflicting architectural principles, proposed combinations may face motivation challenges independent of technical feasibility. [400] However, the generalizability of this analytical structure requires validation across broader contexts beyond the three proceedings examined.

2. Inventive Concept Preservation Analysis

The second analytical component focuses on whether proposed prior art combinations would require elimination of core inventive concepts rather than rational engineering modifications. Dr. Khatri's examination argued that "a POSA would not remove Dockser's inventive concept—supporting a range of selectable precisions including full precision."[401]

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[398] *See* Khatri Decl. 155, *supra* note 151, ¶ 113 (arguing that "Dockser's objectives are fundamentally directed away from Petitioner's proposed 'alternative' combination" as "Dockser is devoted solely to a general processor with selectable precision"); *accord* Khatri Decl. 165, *supra* note 151, ¶ 113; Khatri Decl. 179, *supra* note 151, ¶ 113.

[399] *See supra* note 398.

[400] *See* KSR Int'l Co. v. Teleflex Inc., 550 U.S. 398, 418 (2007) (requiring rational underpinning for combining prior art references).

[401] *See* Khatri Decl. 155, *supra* note 151, ¶ 114 (arguing that "a POSA would not remove Dockser's inventive concept—supporting a range of selectable precisions including full precision" because removing full-precision capabilities would "violate[] a central tenet of Dockser—to always be able to execute full-precision operations"); *accord* Khatri Decl. 165, *supra* note 151, ¶ 114; Khatri Decl. 179, *supra* note 151, ¶ 114.

This assessment established that proposed combinations requiring removal of full-precision capabilities would "[violate] a central tenet of Dockser—to always be able to execute full-precision operations."[402] The methodology attempts to distinguish between modifications that preserve essential inventive contributions and those that would destroy fundamental innovations to achieve claimed functionality.

The central tenet evaluation provides a structure for identifying design principles that create potential combination barriers. Within this limited dataset, the technique appeared to receive favorable institutional reception, though broader empirical validation would be necessary to assess its effectiveness across diverse technical contexts.

3. Authority Hierarchy in Architectural Analysis

Evidence source prioritization provides an analytical foundation for design philosophy evaluation through hierarchical assessment that emphasizes intrinsic over extrinsic evidence. Dr. Khatri's methodology demonstrates a consistent preference for patent specification authority over expert-created analytical structures, offering empirical support for authority hierarchy integration within design philosophy evaluation.[403] This authority hierarchy approach suggests that architectural evaluation gains institutional credibility

[402] *See supra* note 401.

[403] *See* Khatri Decl. 155, *supra* note 151, ¶ 35 (emphasizing claim construction based on "ordinary and customary meaning of the language of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent"); *accord* Khatri Decl. 165, *supra* note 151, ¶ 35; Khatri Decl. 179, *supra* note 151, ¶ 35; *see also supra* Parts I–II and accompanying notes (documenting specification-anchored positioning and authority hierarchy patterns across all six proceedings).

through deliberate prioritization of intrinsic evidence sources.[404]

The correlation between authority source selection and administrative reception patterns suggests institutional preference for an evidence hierarchy that aligns with established patent law structures. This pattern is consistent with the authority hierarchy documented in Parts I and II.[405]

4. Reinforcement Pattern Documentation and Claim Construction Integration

The third component involves examining whether additional prior art references strengthen rather than modify core architectural commitments. Dr. Khatri's treatment of the Tong reference exemplifies this technique, arguing that "Tong would only have reinforced the teaching of Dockser that, while reduced-precision might be a viable option in certain limited circumstances, an execution unit should retain the ability to operate at full-precision."[406]

This assessment suggested that multiple prior art references created convergent rather than divergent design guidance, potentially strengthening motivation challenges against proposed combinations. The technique appears to provide a method for addressing complex multi-reference obviousness theories through architectural consistency examination enhanced by hierarchical evidence evaluation.

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[404] *See supra* Parts I–II.

[405] The PTAB consistently applied this intrinsic evidence approach, citing *Phillips v. AWH Corp.*, 415 F.3d 1303, 1313 (Fed. Cir. 2005) (en banc), and *DePuy Spine, Inc. v. Medtronic Sofamor Danek, Inc.*, 469 F.3d 1005, 1014 (Fed. Cir. 2006). *See* IPR-155 Final, *supra* note 4, at 9; IPR-165 Final, *supra* note 4, at 9; IPR-179 Final, *supra* note 4, at 9.

[406] *See* Khatri Decl. 155, *supra* note 151, ¶ 112; *accord* Khatri Decl. 165, *supra* note 151, ¶ 112; Khatri Decl. 179, *supra* note 151, ¶ 112.

Methodical claim construction methodology provides foundational support for architectural analysis by establishing definitional boundaries that align with design principle evaluation. Dr. Khatri's approach across all three IPR proceedings demonstrates consistent claim construction analysis that reinforces design philosophy arguments through categorical definitional boundaries.

The PTAB ultimately rejected this proposed construction for independent claims, finding that the recited "LPHDR execution unit" does not exclude units capable of performing operations at both low and full precision. However, the multi-dimensional defensive architecture provided resilience — Dr. Khatri's mathematical impossibility arguments succeeded on dependent claims where the claim construction argument did not. [407]

The LPHDR (Low Precision High Dynamic Range) execution unit definition provides organized exclusion of conflicting architectural approaches. Dr. Khatri's analysis established that "[a] POSA would read the term 'low precision high dynamic range (LPHDR) execution unit' to limit the execution unit as 'low precision' and 'high dynamic range.' This reading necessarily excludes full-precision or mixed full and low precision units."[408]

C. Application to Dockser Prior Art Challenges

The Dockser prior art examination demonstrates implementation of architectural principle argumentation

[407] *See* IPR-165 Final, *supra* note 4, at 17–18 (rejecting the "only" construction for independent claims); *see also* IPR-165 Final, *supra* note 4, at 73 n.8 (acknowledging Patent Owner's mathematical impossibility argument for claim 3's "exceeds" limitation without reaching the merits); IPR-155 Final, *supra* note 4, at 77 n.8 (same); IPR-179 Final, *supra* note 4, at 74 n.8 (same, for claim 8).

[408] *See* Khatri Decl. 155, *supra* note 151, ¶ 61; *accord* Khatri Decl. 165, *supra* note 151, ¶ 61; Khatri Decl. 179, *supra* note 151, ¶ 61.

across three related but distinct patent contexts. Dr. Khatri's method addressed the petitioner's obviousness arguments by focusing on fundamental conflicts between Dockser's design objectives and the proposed combinations.

1. Motivation Challenge Development

The examination suggested that "[a] POSA would not be motivated to combine the teachings of Dockser, MacMillan, and Tong" based on architectural incompatibilities rather than technical implementation challenges.[409] This strategy suggested that obvious combinations require rational engineering modification pathways, while combinations demanding core architectural abandonment represent hindsight-driven reconstruction.

The motivation challenge development appears to provide a structure for demonstrating that rational persons of ordinary skill would not pursue combinations that eliminate fundamental design principles of prior art references. However, this technique's effectiveness may depend on the specific technical context and the strength of the architectural conflicts identified.

2. Hindsight-Based Reconstruction Arguments

Dr. Khatri characterized the proposed combinations as "nothing but a hindsight-based modification of the references to meet the claims" rather than predictable engineering development.[410] This evaluation attempted to distinguish between rational engineering modifications that

[409] *See* Khatri Decl. 155, *supra* note 151, ¶ 107; *accord* Khatri Decl. 165, *supra* note 151, ¶ 107; Khatri Decl. 179, *supra* note 151, ¶ 107.
[410] *See* Khatri Decl. 155, *supra* note 151, ¶ 108; *accord* Khatri Decl. 165, *supra* note 151, ¶ 108; Khatri Decl. 179, *supra* note 151, ¶ 108.

preserve core design principles and impermissible hindsight reconstruction that abandons fundamental architectural tenets.

The hindsight evaluation provides a potential method for challenging obviousness arguments that require extensive modification of prior art references. The strategy suggests examining whether proposed combinations would naturally occur to persons of ordinary skill or require knowledge of the claimed invention to motivate the necessary modifications.

3. Cross-Proceeding Consistency Observations

The Dockser examination maintained notable consistency across the IPR dataset, with identical language appearing in key analytical paragraphs.[411] This consistency suggests a deliberate analytical methodology rather than case-specific argumentation, though the limited dataset constrains broader conclusions about the technique's replicability.

The consistent application across these related cases involving different patents within the same family indicates the potential for adapting architectural principle evaluation to related technical contexts. However, validation across diverse technological domains would be necessary to assess the methodology's broader applicability.

D. Administrative Reception Patterns

Examination of PTAB decision language across the proceeding cluster reveals certain patterns in institutional responses to architectural principle arguments, though the

[411] *Compare* Khatri Decl. 155, *supra* note 151, ¶¶ 107, 112–14, *with* Khatri Decl. 165, *supra* note 151, ¶¶ 107, 112–14, *and* Khatri Decl. 179, *supra* note 151, ¶¶ 107, 112–14.

limited dataset constrains definitive conclusions about administrative preferences.

1. Language Adoption Observations

The PTAB decisions demonstrate notable similarities in language patterns across the related proceedings, suggesting potential template usage in administrative processing.[412] However, determining whether such patterns reflect deliberate analytical consistency or administrative efficiency considerations requires investigation beyond this limited context.

The institutional responses appear to engage with architectural principle arguments rather than dismissing them as irrelevant to obviousness evaluation. This suggests potential receptivity to foundational analytical challenges that address motivation barriers, though broader empirical investigation would be necessary to confirm this observation across diverse contexts.

2. Processing Efficiency Considerations

The temporal clustering of decisions across these related cases within a concentrated timeframe may reflect case management considerations rather than coordinated analytical processing. The related patent family context and consistent panel composition across all proceedings within each decision phase could influence the apparent consistency in institutional responses.

These administrative patterns raise questions about the relationship between defensive strategy characteristics and institutional analytical structures. The apparent

[412] IPR-155 Final, *supra* note 4, at 75; IPR-165 Final, *supra* note 4, at 71; IPR-179 Final, *supra* note 4, at 72 (employing template language emphasizing MacMillan's "emphasis on avoiding increased costs associated with added complexity and size" as basis for rejecting the Dockser-MacMillan combination in each).

preference for certain argumentative approaches over others suggests potential areas for further investigation in administrative decision-making research, pending broader empirical validation.

E. Cross-Patent Methodology Application

The architectural principle evaluation maintained consistency across the '961 patent (IPR-155), the '156 patent (IPR-165), the '273 patent (IPR-179), suggesting potential for application across related patent contexts within this limited scope.[413]

1. Analytical Structure Consistency

Documentary examination reveals identical language implementation across key analytical sections in Dr. Khatri's declarations, suggesting deliberate methodological consistency rather than patent-specific customization.[414] This consistency suggests that architectural principle evaluation may provide a structured methodology for prior art challenges that transcends specific technical implementation details, though broader validation would be necessary.

The deliberate repetition of core analytical language across the proceeding cluster supports the potential reproducibility of architectural principle argumentation in expert testimony contexts. However, this technique's effectiveness in different technical domains or against different types of prior art combinations remains to be investigated.

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[413] *See supra* note 3 and accompanying text.

[414] *See* Khatri Decl. 155, *supra* note 151, ¶ 113 ("Dockser's objectives are fundamentally directed away from Petitioner's proposed 'alternative' combination."); *accord* Khatri Decl. 165, *supra* note 151, ¶ 113; Khatri Decl. 179, *supra* note 151, ¶ 113.

2. Replicability Assessment

The consistent application across three related patents suggests that architectural principle evaluation may offer a reproducible methodology for expert testimony development in complex technical proceedings. The strategy appears to provide structured argumentation that addresses fundamental motivation challenges rather than detailed technical implementation disputes.

Despite this apparent consistency, the replicability assessment remains constrained by the limited dataset scope—three proceedings within a single patent family addressing similar technical subject matter. Validation across diverse technological contexts and different types of architectural conflicts would be necessary to establish broader methodological reliability.

F. Market Evidence and Large-Scale Implementation

Commercial evidence integration within design philosophy evaluation offers supporting evidence for theoretical architectural principles through large-scale market implementation. Dr. Khatri's examination of Google's Tensor Processing Unit (TPU) architecture across the three IPR proceedings illustrates how massive commercial deployment may support design philosophy arguments while supporting nexus arguments between claimed inventions and market implementation.

1. Large-Scale Implementation Documentation

Google's TPU implementation represents substantial market validation evidence for the architectural principles underlying the design philosophy evaluation. The technical specifications document implementation scales that far exceed typical commercial deployments: TPUv3 configuration with "2 MXUs per core, 2 cores per chip, and 4 chips per board," resulting in "128 × 128 × 2 × 2 × 4 = 262,144 LPHDR execution units" in a single board configuration, and TPUv2 architecture with "128 × 128 × 2 × 4 = 131,072 LPHDR execution units" per board.[415]

This scale of implementation suggests significant commercial confidence in the architectural approach underlying the design philosophy arguments, providing market evidence that supports the theoretical structure. Cross-generational consistency suggests sustained market validation of the underlying architectural principles that form the foundation of the design philosophy evaluation.

2. Technical Architecture Correlation

The technical correlation between Google's commercial implementation and the claimed architectural principles provides detailed empirical support for design philosophy arguments. Google's technical documentation confirms that "each of the bfloat16 execution units in the MXU require 'less circuitry' than either FP32 or FP16 multipliers," with specific requirements of "576 full adders, 121 full adders, and 64 full adders, respectively."[416]

The precision analysis validates the architectural approach through specific technical measurements: "Multiplication performed at bfloat16 precision uses 7 bits for the mantissa," producing "a minimum of 12% of valid floating point 32 inputs, producing at least 0.39% relative error compared to the exact mathematical calculation."[417] These precise specifications illustrates how massive

[415] *See* Khatri Decl. 155, *supra* note 151, ¶¶ 142–43 (TPUv2: 131,072 units, TPUv3: 262,144 units); *accord* Khatri Decl. 165, *supra* note 151, ¶¶ 142–43; Khatri Decl. 179, *supra* note 151, ¶¶ 137–38.

[416] *See* Khatri Decl. 155, *supra* note 151, ¶ 132; *accord* Khatri Decl. 165, *supra* note 151, ¶ 132; Khatri Decl. 119, *supra* note 151, ¶ 132.

[417] *See* Khatri Decl. 155, *supra* note 151, ¶ 136; *accord* Khatri Decl. 165, *supra* note 151, ¶ 136; Khatri Decl. 179, *supra* note 151, ¶ 136.

commercial deployment may support design philosophy arguments while supporting nexus arguments between claimed inventions and market implementation through documented commercial performance characteristics.

3. Secondary Considerations Integration

The combination of secondary considerations evidence with design philosophy evaluation provides a comprehensive structure for an obviousness assessment that addresses both technical and commercial validation dimensions. Dr. Khatri's emphasis on secondary considerations illustrates how design philosophy arguments can be strengthened through market evidence that supports architectural principle effectiveness.

The comprehensive secondary considerations structure emphasizes that "commercial success, skepticism of experts, unexpected results, and copying, may provide evidence of non-obviousness" and that "such considerations are often the most probative and determinative of obviousness or non-obviousness."[418] This analytical integration suggests that design philosophy evaluation gains empirical support through deliberate correlation with market validation evidence.

Google's massive-scale TPU deployment (262,144 LPHDR execution units) represents commercial success that correlates with the architectural approach underlying design philosophy arguments, providing market evidence that supports theoretical claims about design principle

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418 *See* Graham v. John Deere Co., 383 U.S. 1, 17–18 (1966) (establishing secondary considerations framework); Stratoflex, Inc. v. Aeroquip Corp., 713 F.2d 1530, 1538 (Fed. Cir. 1983) (characterizing secondary considerations as "often the most probative and determinative"); *see also* Khatri Decl. 155, *supra* note 151, ¶ 34 (applying this framework); *accord* Khatri Decl. 165, *supra* note 151, ¶ 34; Khatri Decl. 179, *supra* note 151, ¶ 34.

effectiveness.[419] The cross-generational consistency in TPU implementation (TPUv2 and TPUv3) suggests sustained industry confidence in architectural principles that align with design philosophy arguments.

G. Quantitative Analysis and Mathematical Precision

Quantitative analytical structures provide analytical precision that enhances design philosophy evaluation through objective constraints that reduce interpretive disputes. Dr. Khatri's combination of mathematical impossibility analysis with design philosophy arguments illustrates how logical precision can strengthen architectural principle evaluation while providing institutional reception advantages.

1. Mathematical Impossibility Assessment

The quantitative structure addresses numerical limitations within patent claims through logical impossibility demonstrations that complement design philosophy arguments. Dr. Khatri's analysis in IPR-155 exemplifies this technique, arguing that execution units cannot simultaneously count toward both LPHDR and full-precision multiplication unit requirements while satisfying numerical "exceeds" limitations.[420]

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[419] *See* Khatri Decl. 179, *supra* note 151, ¶ 138 (calculating 128 × 128 × 2 × 2 × 4 = 262,144 LPHDR execution units per TPUv3 board); *see also id*. ¶ 137 (131,072 LPHDR units per TPUv2 board).

[420] *See* Khatri Decl. 155, *supra* note 151, ¶¶ 84–86 (demonstrating that "the number of LPHDR execution units in the device will at most equal to the number of full-precision floating-point multiplication execution units – and will never 'exceed [it] by at least one hundred'"); *accord* Khatri Decl. 165, *supra* note 151, ¶¶ 84–86; Khatri Decl. 179, *supra* note 151, ¶¶ 84–86.

The specific mathematical analysis established that "the number of LPHDR execution units in the device will at most equal to the number of full-precision floating-point multiplication execution units – and will never 'exceed [it] by at least one hundred," as the claims require."[421] This analytical precision provides analytical support for design philosophy arguments by establishing logical constraints that support architectural principle preservation analysis.

2. Challenge Resistance Through Analytical Precision

Quantitative analytical structures may provide reduced vulnerability to expert opinion challenges compared to traditional technical complexity arguments. The logical precision of mathematical impossibility demonstrations reduces opportunities for competing expert interpretations by grounding analysis in analytical constraints rather than technical judgment.

Administrative reception of quantitative structures suggests institutional preference for analytical approaches that provide logical precision rather than requiring extensive technical interpretation. The PTAB's language adoption shows engagement with mathematical frameworks: "we instead find only the mathematical 'operation' of the execution unit—expressly recited in the claim—relevant for analysis."[422] This institutional crediting suggests quantitative structures may enhance design

[421] *See* Khatri Decl. 155, *supra* note 151, ¶ 86; *accord* Khatri Decl. 165, *supra* note 151, ¶ 86; Khatri Decl. 179, *supra* note 151, ¶ 86 (slight variation in quotation language: "never 'exceed [it]' by any amount").

[422] *See* IPR-154, *supra* note 3, at 18; IPR-164, *supra* note 4, at 18; IPR-178, *supra* note 4, at 18 (adopting technology-agnostic characterization and prioritizing "the mathematical 'operation' of the execution unit—expressly recited in the claim" over implementation-specific analytical structures).

philosophy evaluation through an objective analytical foundation.

H. Expert Testimony Methodology Development

The implementation of design philosophy evaluation requires a comprehensive expert testimony methodology that addresses credibility establishment, materials consideration protocols, and cross-proceeding consistency. Dr. Khatri's approach across the three IPR proceedings illustrates methodical expert positioning that enhances design philosophy evaluation effectiveness.

1. Professional Competence and Educational Background

Expert positioning within established legal standards provides greater institutional credibility than claims requiring specialized knowledge beyond ordinary skill in the art. Dr. Khatri's approach positioned implementation capability within standard educational qualifications rather than unique expertise, potentially reducing vulnerability to competence challenges while maintaining analytical authority.

The deliberate adoption of the petitioner's proposed level of ordinary skill across all proceedings established a consistent analytical baseline: "a person with a Bachelor's degree in Computer Science, Electrical Engineering, or Applied Mathematics, with 2 years of academic or industry experience in computer architecture."[423] This positioning strategy appears to enhance design philosophy evaluation by grounding architectural principle assessment within standard professional competence rather than specialized expertise claims.

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[423] *See* Khatri Decl. 155, *supra* note 151, ¶ 37; *accord* Khatri Decl. 165, *supra* note 151, ¶ 37; Khatri Decl. 179, *supra* note 151, ¶ 37.

2. Materials Consideration and Independence Protocols

Comprehensive materials consideration with explicit disagreement reservations provides a methodical foundation for design philosophy evaluation credibility. Dr. Khatri's consistent protocol across all proceedings included expanded materials consideration with specific acknowledgment of opposing expert testimony while reserving disagreement rights.

The consistent language adoption shows methodological consistency: "To the extent that this declaration does not explicitly reference specific arguments, positions, opinions, or statements made by Petitioner – or by Petitioner's expert, Mr. Goodin – this should not be construed to mean that I agree with those arguments, positions, opinions, or statements."[424]

Consistent financial independence declarations across all proceedings provide a credibility foundation that supports design philosophy evaluation effectiveness. Dr. Khatri's approach emphasized standardized compensation and outcome independence: "My compensation for time worked on this proceeding is not dependent on the outcome of this proceeding, or the substance of my opinions. My compensation for time worked on this proceeding is at my customary rate of $600/hour."[425]

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[424] *See* Khatri Decl. 155, *supra* note 151, ¶ 29; *accord* Khatri Decl. 165, *supra* note 151, ¶ 29; Khatri Decl. 179, *supra* note 151, ¶ 29.

[425] *See* Khatri Decl. 155, *supra* note 151, ¶ 27; *accord* Khatri Decl. 165, *supra* note 151, ¶ 27; Khatri Decl. 179, *supra* note 151, ¶ 27.

I. Limitations and Future Research Directions

This examination faces several methodological constraints that limit the generalizability of observations about enhanced design philosophy evaluation, requiring acknowledgment of scope limitations before drawing broader conclusions about integrated commercial validation, quantitative analysis, and expert methodology approaches.

1. Scope Limitations

The empirical foundation remains limited to three granted IPR proceedings (of six total proceedings examined across this study) within a single patent family, constraining conclusions about the comprehensive methodology's broader applicability despite the significant commercial validation evidence integration. The identical expert declarant across all proceedings prevents examination of methodological variations that different experts might employ when implementing the enhanced approach, combining design philosophy evaluation with commercial evidence and quantitative analysis integration.

The related technical subject matter limits insights about enhanced design philosophy assessment effectiveness across diverse technological domains, although the massive-scale commercial implementation evidence (262,144 execution units) suggests potential applicability to high-volume technical contexts. The administrative context—PTAB proceedings exclusively—prevents assessment of the integrated approach's effectiveness in district court litigation or other forums where commercial evidence and quantitative analysis might receive different institutional treatment.

2. Enhanced Methodological Considerations

The examination methodology employed documentary content evaluation examining expert declaration language, commercial evidence integration, and corresponding institutional responses. While this technique enables precise measurement of language consistency patterns and commercial validation correlation, it cannot establish causal relationships between specific argumentative strategies and administrative outcomes, particularly regarding the enhanced approach's effectiveness.

The combination of commercial evidence (Google TPU implementation) with design philosophy evaluation provides an empirical foundation that incorporates both proceeding-specific analysis and independently verifiable commercial market evidence, though validation across different commercial contexts and technological implementations would strengthen the approach's generalizability. Quantitative analysis integration offers objective analytical constraints, but effectiveness assessment requires broader application across different technical domains and claim limitation types.

3. Commercial Evidence and Quantitative Analysis Integration Needs

The enhanced design philosophy evaluation approach requires further theoretical development to establish clear boundaries for commercial evidence integration and quantitative analysis application. The methodology appears most effective when prior art references embody conflicting fundamental design objectives that align with documented commercial implementations, but criteria for identifying optimal integration opportunities need development beyond this preliminary investigation.

The relationship between design philosophy arguments, commercial validation evidence, and quantitative analytical structures within traditional obviousness evaluation requires clearer articulation. Understanding how integrated commercial evidence and analytical constraints interact with existing obviousness structures would enhance the methodology's theoretical foundations and practical implementation across diverse technical contexts involving different types of commercial validation evidence.

J. Conclusion

The architectural principle evaluation observed in Dr. Khatri's declarations across three IPR proceedings suggests a comprehensive methodology for addressing prior art challenges through fundamental design incompatibility arguments enhanced by commercial validation, quantitative analysis integration, and methodical expert testimony methodology. The analytical approach shows how design philosophy evaluation can be strengthened through empirical evidence, objective analytical constraints, and methodological consistency.

The commercial validation through Google's TPU implementation provides substantial empirical support for design philosophy arguments, with massive-scale deployment (262,144 LPHDR execution units) suggesting market support of architectural principles underlying the theoretical structure. Quantitative analysis integration enhances analytical precision while potentially providing challenge resistance through objective constraints rather than interpretive disputes.

The methodical expert testimony methodology documents comprehensive approaches to credibility establishment, materials consideration, and professional competence positioning that appear to support design philosophy evaluation effectiveness. The integration of commercial evidence, quantitative structures, and methodological consistency suggests an evolution toward a comprehensive analytical architecture for prior art challenges in complex technical proceedings.

However, the analytical approach's broader effectiveness and replicability require validation across diverse contexts to address current scope limitations. The three-proceeding dataset within a single patent family constrains conclusions about general applicability, and the methodology's effectiveness may depend heavily on the specific technical context, strength of identified architectural conflicts, and availability of commercial validation evidence.

The enhanced design philosophy evaluation approach contributes to the understanding of expert testimony methodology in complex technical proceedings by showing structured argumentation that integrates foundational motivation challenges, empirical commercial validation, and analytical precision. Further empirical investigation across broader contexts would enhance understanding of when and how design philosophy considerations, commercial evidence integration, and quantitative analytical structures effectively supplement traditional prior art evaluation in administrative and judicial proceedings.

VII. SECONDARY CONSIDERATIONS EVIDENCE IN PATENT LITIGATION: EMPIRICAL ANALYSIS OF TECHNICAL INNOVATION

A. Research Framework

1. Case Study Foundation

Secondary considerations evidence has traditionally relied on anecdotal documentation and subjective evaluation of commercial success, industry recognition, and technical achievement.[426] This part examines secondary considerations evidence through analysis of *Inter Partes* Review proceedings involving Google's TPU technology and related machine learning processors.[427]

This analysis examines comprehensive evidence frameworks developed in *Inter Partes* Review proceedings, providing insights into framework development methodologies and institutional reception patterns across complex technical disputes.[428]

The research examines litigation exhibits from patent disputes involving machine learning processor innovations.[429] The dataset encompasses expert declarations, technical documentation, commercial specifications, and market analysis materials from patent challenges involving specialized machine learning processors.[430]

[426] Graham v. John Deere Co., 383 U.S. 1, 17–18 (1966) .
[427] 35 U.S.C. § 103; 37 C.F.R. § 42.
[428] The secondary considerations evidence examined in this section faced systematic PTAB rejection across all three granted proceedings. *See infra* Part VII (documenting institutional skepticism patterns for commercial success, copying, and nexus arguments in high-technology patent contexts).
[429] Dean, *supra* note 60, (establishing TPU development foundation).
[430] IPR-155, *supra* note 4, Litigation Exhibits 2011-2049 (having an exhibit range that spans across IPR-165, *supra* note 4 and IPR-179, *supra* note 4, hereinafter the TPU Exhibits).

Patent infringement allegations, found in the litigation exhibits, allege commercial deployment across TPUv2 and TPUv3 devices with evidence of "making, using, testing, selling, offering for sale and/or importing" TPU technology into the United States.[431] This documentation enables examination of secondary considerations argument construction across multiple evidence categories spanning technical achievement, commercial validation, and professional authority establishment.

a. Computational Crisis and Innovation Development

The case study centers on patent disputes arising from Google's development of specialized processors for machine learning workloads, beginning with a documented computational crisis spanning 2011-2013 that established technical and economic necessity for innovation.[432] Jeffrey Dean's statement documents the technical crisis that motivated TPU development: deployment of improved neural network models through Google's DistBelief system.[433]

The computational scale analysis estimated that speech recognition deployment alone, with users utilizing the service "three minutes a day" across "100 million users," would require Google to "essentially double the

[431] Plaintiffs' Preliminary Patent-Related Disclosures, Ex. 2021, No. IPR2021-00179 at 1 (dated Sep. 4, 2020) (having the same exhibit filed in all proceedings with the same exhibit number, and patent infringement claims documenting systematic commercial deployment).
[432] Dean, *supra* note 60, at 5 (describing computational demands requiring "doubling the number of computers in Google datacenters").
[433] *Id.*

computing footprint" of its datacenters.[434] This crisis occurred during exponential growth in machine learning computational demands, with performance requirements doubling every 3.43 months while general-purpose CPU performance improvement had slowed dramatically after decades of Moore's Law advancement.[435]

Technical necessity emerged from three key properties of neural network computations that distinguish them from general-purpose computing requirements: tolerance of reduced-precision arithmetic, composition from operations dominated by matrix multiplication, and lack of need for general-purpose CPU mechanisms like branch prediction and speculative execution.[436] These characteristics created an opportunity for architectural specialization, achieving order-of-magnitude performance improvements through domain-specific optimization, leading to systematic innovation development from 2013-2015 and commercial deployment beginning in 2015-2017 with continued market expansion 2017-present.[437]

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[434] Jeffrey Dean, Google AI with Jeff Dean: Download MP3 - Topics: AI, Machine Learning, TPU and Parallel Processing, Ex. 2034, No. IPR2021-00179, at 6 (P.T.A.B. Aug. 9, 2021) [hereinafter Dean Interview] (exhibit filed in all proceedings with the same exhibit number); *see also* Audio Transcription of YouTube Video: Domain Specific Architectures for Deep Neural Networks: Three Generations of Tensor Processing Units (TPUs), Ex. 2012, No. IPR2021-00179 (P.T.A.B. July 6, 2021) at 6 [hereinafter TPU YouTube Transcript] (exhibit filed in all proceedings with the same exhibit number) (documenting computational demand growth exceeding CPU performance improvement trajectories).

[435] Dean, *supra* note 60, at 3–4; TPU YouTube Transcript, *supra* note 434, at 5–6 (documenting computational demand growth exceeding CPU performance improvement trajectories).

[436] Dean, *supra* note 60, at 5–6 (identifying three technical properties justifying specialized hardware architecture).

[437] *Id.*

B. Technical Achievement Evidence

1. Architectural Innovation and Performance Validation

TPU architectural innovation centers on systolic array implementation combined with custom floating-point arithmetic optimized for neural network operations.[438] The first-generation TPU featured a 65,536 8-bit multiply-accumulate matrix multiply unit providing peak throughput of 92 TeraOps/second, delivering performance indicating 15-30 times faster operation than contemporary alternatives with TOPS/Watt ratios 30-80 times higher.[439]

Such implementations enabled systematic progression to more sophisticated generations. The custom bfloat16 floating-point format utilizes one sign bit, eight exponent bits, and seven mantissa bits to provide dynamic range identical to 32-bit floating point while achieving hardware efficiency improvements.[440] These architectural innovations include bfloat16 multipliers approximately half the size of typical FP16 multipliers and eight times smaller than FP32 multipliers, since hardware multiplier size scales with the square of mantissa width.[441]

Subsequent TPU generations demonstrate systematic performance advancement. TPU v2 delivers 180 teraflops with 64 GB High Bandwidth Memory, while TPU v3 achieves 420 teraflops with 128 GB HBM.[442] The

[438] Wang & Kanwar, *supra* note 61, at 1–2 (giving systolic array and bfloat16 format technical description).
[439] Dean, *supra* note 60, at 6 (giving TPUv1 specifications and comparative performance analysis).
[440] Wang & Kanwar, *supra* note 61, at 2 (giving bfloat16 technical specifications).
[441] *Id.* at 3.
[442] Cloud TPU Google Cloud, Ex. 2018, No. IPR2021-00179, at 5–6 (P.T.A.B. July 6, 2021) [hereinafter Cloud TPU] (exhibit filed in all

performance advancement from TPU v2 to TPU v3 represents an 8-fold improvement requiring liquid cooling implementation in Google's datacenters due to the increased power density.[443] At pod scale, TPU v3 Pods deliver over 100 petaflops with 32 TB HBM, connected via 2-D toroidal mesh networks optimized for machine learning workload communication patterns.[444]

The TPU v2 and v3 generations implement matrix multiplication units capable of performing 16,000 multiply-accumulate operations per cycle, utilizing 128×128 systolic arrays with mixed-precision arithmetic combining bfloat16 multiplication and 32-bit floating-point accumulation.[445] Patent documentation confirms that TPU components independently implement "low precision high-dynamic range execution units" meeting statistical accuracy requirements across multiple patent claims.[446]

2. Benchmark Performance and Scaling Analysis

Performance benchmarking indicates systematic differences compared to conventional alternatives across

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proceedings with the same exhibit number) (giving Cloud TPU v2 and v3 specifications).

443 Jibu Elias, *Google's New TPU 3.0 Will Be Critical to Company's Success in the Post-Search World, Here Is Why*, Ex. 2017, No. IPR2021-00179 (P.T.A.B. July 6, 2021) [hereinafter Elias] (exhibit filed in all proceedings with the same exhibit number) (documenting TPU 3.0 performance advancement in CEO Sundar Pichai's announcement at Google I/O 2018).

444 Cloud TPU, *supra* note 442, at 6.

445 Patent Infringement Evidence Document, Ex. 2022, No. IPR2021-00179 (P.T.A.B. July 6, 2021) [hereinafter Patent Evidence] (exhibit filed in all proceedings with the same exhibit number) (giving detailed TPU architecture documentation).

446 Patent Evidence, *supra* note 445, at 2 (giving patent claim mapping showing TPU architecture satisfying requirements).

multiple evaluation criteria.[447] Training ResNet-50 for 90 epochs requires 216 minutes on 8 V100 GPUs at a cost of approximately $75, compared to 7.9 minutes on one full Cloud TPU v2 Pod at a cost of approximately $50. This shows about 27 times faster training at lower cost.[448]

Power efficiency analysis reveals TPU supercomputers achieving performance per watt ratios that substantially exceed traditional high-performance computing systems. TPU v2 achieves 79.9 GFlop/Watt running AlphaZero production workloads, which would rank second on the Green500 supercomputer efficiency list, while TPU v3 delivers 146.3 GFlop/Watt.[449] These efficiency metrics indicate 44 times higher performance per watt ratios compared to the Tianhe supercomputer while running real production applications rather than synthetic benchmarks.[450]

Scaling performance analysis documents systematic advantages at the supercomputer scale with production applications achieving 96-99% of perfect linear scaling at 1,024 TPU v3 chips.[451] CNN0 (AlphaZero) achieves 96% linear scaling, while CNN1, RNN0, and RNN1 applications each achieve 99% linear scaling at 1,024 chips.[452] This scaling performance exceeds conventional alternatives by

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[447] Cloud TPU, *supra* note 442, at 3 (ResNet-50 training comparison); Norman P. Jouppi, et al., A Domain-Specific Supercomputer for Training Deep Neural Networks, Ex. 2016, No. IPR2021-00179 (P.T.A.B. July 6, 2021) [hereinafter Jouppi Paper] (exhibit filed in all proceedings with the same exhibit number) (giving MLPerf scaling analysis).
[448] Cloud TPU, *supra* note 442, at 3.
[449] Jouppi Paper, *supra* note 447, at tbl. 9 (giving a Green500 and Top500 comparative analysis).
[450] *Id.* at 11.
[451] *Id.* (giving production application scaling analysis).
[452] Jouppi Presentation, *supra* note 36, at 57 (giving detailed production application scaling results by application type).

significant margins, with GPU clusters achieving only 41% scaling efficiency at 1,536 chips compared to TPU v3 achieving 77% at 1,024 chips.[453]

TPU supercomputers achieve 84% of theoretical peak performance while running AlphaZero production workloads, compared to traditional supercomputers achieving only 61% of peak performance running synthetic Linpack benchmarks.[454] The XLA compiler contributes to efficiency through operator fusion techniques that achieve speedups ranging from 1.8 to 6.3 times across different neural network models.[455]

C. Commercial Success and Market Validation

1. Internal Deployment and External Market Evidence

Commercial success evidence encompasses internal deployment across Google's product ecosystem and external market validation through Google Cloud Platform's commercial offerings, demonstrating market acceptance beyond initial development investment.[456] Internal deployment spans search ranking, language translation, image recognition, and voice processing systems, indicating commercial deployment across diverse use cases rather than specialized ones.[457]

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[453] TPU YouTube Transcript, *supra* note 434, at 41; Jouppi Paper, *supra* note 447, at 10 (giving MLPerf comparative scaling analysis).
[454] Jouppi Paper, *supra* note 447, at tbl. 9 (giving production efficiency vs traditional supercomputer benchmarking).
[455] *Id.* at tbl. 4.
[456] Stone, *supra* note 60 (detailing Cloud TPU commercial deployment); Dean Interview, *supra* note 434 (detailing internal product integration).
[457] Dean Interview, *supra* note 434, at 7 (Jeffrey Dean discussing TPU deployment across Google's product portfolio); Cade Metz, Google Rattles the Tech World With a New AI Chip for All, Ex. 2040, No.

External market validation occurred through Cloud TPU commercial availability, with pricing structures indicating customer willingness to pay for access to patent-protected innovation. TPU v2 pricing at $4.50 per hour on-demand and $1.35 per hour preemptible, with TPU v3 at $8.00 per hour on-demand and $2.40 per hour preemptible, reflects higher pricing compared to conventional alternatives while maintaining market acceptance.[458]

Customer adoption includes organizations documenting performance improvements directly attributable to TPU technology. Recursion Pharmaceuticals documented training time improvements from over 24 hours down to 15 minutes for machine learning workloads used in pharmaceutical research applications.[459] These improvements provide quantified evidence of commercial value rather than anecdotal market acceptance.

The pricing differential and sustained customer adoption provide evidence of commercial value directly attributable to TPU innovations rather than general cloud computing trends.[460] ML Engine integration indicates cost advantages with TPU training at $6.85 per hour compared to multi-GPU alternatives requiring substantially higher costs for equivalent performance.[461]

IPR2021-00179 (P.T.A.B. Aug. 9, 2021) [hereinafter Metz] (exhibit filed in all proceedings with the same exhibit number) (showcasing TPU deployment enabling Google's AI services).

458 Cloud TPU, *supra* note 442, at 9–10 (detailing Cloud TPU pricing structure).

459 Stone, *supra* note 60 (showing quantified customer performance improvements in pharmaceutical research context); *see also* Cloud TPU, *supra* note 442, at 8 (giving direct customer testimonial from Recursion Pharmaceuticals).

460 Görner, *supra* note 58, at 11 (giving detailed training cost analysis showing $6.5 for Cloud TPU v2 versus $18-$35 for GPU alternatives for identical training workloads).

461 *Id.* at 12 (giving ML Engine pricing comparison); *see supra* Part I.

D. Professional Authority and Industry Recognition

1. Research Leadership and Academic Credentials

Jeffrey Dean's professional credentials establish a clear industry recognition spanning academic achievement, research contributions, and technical leadership directly relevant to machine learning processor technology assessment. Combined, this provides a foundation for expert authority in patent litigation contexts as discussed in Part I's expert declaration methodology framework.[462]

Academic credentials include a Ph.D. in Computer Science from the University of Washington (1996), focusing on whole-program optimization techniques for object-oriented languages, and a B.S. in Computer Science & Economics from the University of Minnesota (1990).[463] His professional recognition includes election to the National Academy of Engineering (2009), Fellowship in the Association for Computing Machinery, and Fellowship in the American Association for the Advancement of Sciences.[464] These professional honors represent systematic validation of technical excellence and leadership directly relevant to patent technology assessment and expert testimony credibility evaluation as analyzed in Part III's cross-examination performance framework.[465]

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[462] *See supra* Part I; Jeffrey Dean - Google Research Profile, Ex. 2047, No. IPR2021-00179 (P.T.A.B. Aug. 9, 2021) [hereinafter Dean Profile] (exhibit filed in all proceedings with the same exhibit number) (showing the Google Research profile); Dean Interview, *supra* note 434 (professional biography).
[463] Dean Profile, *supra* note 462, at 1.
[464] *Id.* at 2; Dean Interview, *supra* note 434, at 1.
[465] *See supra* Part III (explaining cross-examination performance framework); TPU YouTube Transcript, *supra* note 434, at 4 (establishing context for computer architecture authority through professional recognition).

His current position as a Google Senior Fellow and Senior Vice President of Google Research demonstrates technical leadership spanning the period of TPU technology development and deployment.[466] This leadership role encompasses oversight of research initiatives directly related to machine learning infrastructure and specialized hardware development.[467]

2. Research Contributions and Technical Innovation

Research contributions span foundational distributed systems and machine learning infrastructure innovations that directly inform TPU technology development, establishing the systematic research foundation that provides credibility for the defensive expert testimony approaches examined in Part II.[468] Dean's Core distributed systems innovations include MapReduce design for large-scale data processing, BigTable distributed storage system, and Spanner globally-distributed database.[469]

His machine learning infrastructure leadership encompasses co-founding the Google Brain Project research initiative and developing both DistBelief and TensorFlow systems for large-scale neural network training.[470] Dean's role as Google Brain Project co-founder established the research foundation that motivated TPU development through identification of computational

[466] Dean Interview, *supra* note 434, at 1.
[467] Dean Profile, *supra* note 462, at 1.
[468] *See supra* Part II; Dean Profile, *supra* note 462, at 1–2 (research portfolio documentation).
[469] Dean Profile, *supra* note 462, at 2–3.
[470] Dean Profile, *supra* note 462, at 1–2; Dean, *supra* note 38, at 5–6 (detailing DistBelief development and computational crisis identification).

scaling limitations requiring specialized hardware solutions.[471]

Dean's publication portfolio includes high-impact papers across distributed systems, machine learning, and computer architecture domains directly relevant to TPU technology assessment.[472] Key publications include "MapReduce: Simplified Data Processing on Large Clusters" (OSDI'04), "BigTable: A Distributed Storage System for Structured Data" (OSDI'06), and "Large Scale Distributed Deep Networks" (NIPS'12), establishing research authority in domains spanning TPU innovation.[473]

E. Market Impact and Industry Transformation

1. Competitive Response and Technology Adoption

TPU technology deployment indicates market impact through competitive landscape transformation and industry-wide innovation response patterns.[474] Industry analysis documents TPU technology as providing "serious competition" to NVIDIA's established GPU dominance in machine learning applications, with recognition of specialized processors designed specifically for neural network training and inference.[475]

The machine learning accelerator industry has experienced what Dean characterizes as a "Cambrian-style explosion" of new companies developing specialized

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[471] Dean Interview, *supra* note 434, at 6 (detailing Google Brain founding and research leadership progression).

[472] Dean Profile, *supra* note 462, at 2–3 (providing comprehensive publication documentation).

[473] *Id.*

[474] Metz, *supra* note 457 (providing industry competitive analysis).

[475] *Id.* at 2 (providing WIRED industry analysis documenting competitive landscape transformation).

processors, including Cerebras, Graphcore, Intel's acquisition of Nervana, and Alibaba's custom AI chips.[476] This industry response indicates independent market recognition patterns of TPU innovation through competitive imitation and alternative development efforts.[477]

Academic and research community adoption includes supporting institutions through cloud access programs that extend patent technology benefits beyond commercial deployment.[478] The TensorFlow Research Cloud program provides 1,000 Cloud TPUs at no cost to machine learning researchers willing to share their findings with the broader research community.[479]

2. Technical Standards Influence and Performance Leadership

Benchmark performance establishes technical leadership across standardized machine learning workloads with systematic differences in comparison to conventional alternatives.[480] MLPerf benchmark results indicate TPU v3 scaling capability achieving 77% of perfect linear scaleup at 1,024 chips, which substantially exceeds GPU

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[476] Dean, *supra* note 60, at 6–7 (documenting industry-wide development of specialized ML accelerators by venture-backed startups and established companies).
[477] *Id.*; Elias, *supra* note 443 (competitive response documentation).
[478] Jeff Dean & Urs Hölzle, *Build and Train Machine Learning Models on Our New Google Cloud TPUs*, Ex. 2037, No. IPR2021-00179 (P.T.A.B. Aug. 9, 2021) [hereinafter Dean & Hölzle] (exhibit filed in all proceedings with the same exhibit number) (showcasing research community engagement initiatives).
[479] *Id.* at 2 (providing TensorFlow Research Cloud program documentation).
[480] TPU YouTube Transcript, *supra* note 434, at 40–41 (giving MLPerf benchmark analysis); Jouppi Paper, *supra* note 447, at 12 (providing scaling performance documentation).

alternatives that achieve only 41% scaling efficiency at 1,536 chips.[481]

Technical standards influence extends beyond Google's implementation through industry adoption of innovations developed for TPU architecture. The bfloat16 floating-point format designed for TPU matrix multiplication units has achieved recognition as the industry standard for machine learning workloads.[482]

Mixed-precision training utilizing bfloat16 arithmetic achieves performance improvements ranging from 4% to 47% across different neural network architectures, with geometric mean improvement of 13.9%.[483] Academic validation through peer-reviewed research indicates TPU effectiveness for precision-sensitive applications including financial Monte Carlo methods.[484]

F. Analysis and Implications

1. Evidence Coordination Patterns

The TPU case study reveals evidence relationship documentation across technical achievement, commercial success, and industry recognition across secondary considerations categories.[485] Evidence integration appears

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[481] Jouppi Paper, *supra* note 447, at 10–11 (showing MLPerf scaling comparison); TPU YouTube Transcript, *supra* note 434, at 41.

[482] Wang & Kanwar, *supra* note 61 (showing bfloat16 industry adoption); Dean, *supra* note 60, at 8.

[483] Wang & Kanwar, *supra* note 61, at 3 (including mixed-precision training performance analysis).

[484] Francois Belletti et al., *Tensor Processing Units for Financial Monte Carlo*, Ex. 2049, No. IPR2021-00179 (P.T.A.B. Aug. 9, 2021) [hereinafter Belletti Financial Monte Carlo] (exhibit filed in all proceedings with the same exhibit number) (detailing academic research validation of TPU accuracy for quantitative finance applications requiring high numerical precision).

[485] Technical achievement documented in Wang & Kanwar, *supra* note 61 (showing mixed-precision performance improvements); Jouppi

effective when technical innovations correlate directly with measurable commercial benefits and established professional recognition.[486]

Technical specifications and performance metrics provide a quantified foundation for achievement claims, while commercial deployment and pricing evidence validate market significance through independent customer adoption.[487] Professional credentials and research leadership establish the expert authority necessary for credible technical testimony in patent litigation where complex technology evaluation is required.[488]

2. Technology-Specific Evidence Development

High-technology patent cases may benefit from evidence strategies emphasizing quantified technical performance combined with commercial validation through documented economic necessity.[489] The TPU evidence indicates the effectiveness of architectural innovation documentation supported by performance benchmarking against established alternatives rather than theoretical advantages.[490]

Paper, *supra* note 447 (MLPerf scaling analysis); commercial success in Cloud TPU, *supra* note 442 (pricing and specifications); industry recognition in Dean Profile, *supra* note 462 (research portfolio); Dean Interview, *supra* note 434 (professional biography).

486 Cloud TPU, *supra* note 442 (showing commercial specifications and pricing structure); Dean Profile, *supra* note 462 (establishing technical authority for TPU development in research contributions).

487 Wang & Kanwar, *supra* note 61; Cloud TPU, *supra* note 442.

488 Dean Profile, *supra* note 462; Dean Interview, *supra* note 434.

489 Dean, *supra* note 60; Wang & Kanwar, *supra* note 61; Jouppi Paper, *supra* note 447; Cloud TPU, *supra* note 442.

490 Jouppi Paper, *supra* note 447 (comparative performance analysis); Cloud TPU, *supra* note 442, at 3 (quantified improvements over conventional solutions).

Technical achievement evidence appears to be most effective when correlated with economic necessity documentation establishing innovation as imperative rather than optional.[491] The progression from computational crisis identification, specialized architecture development to measurable performance validation provides a methodology for high-technology patent contexts requiring substantial innovation investment.[492]

Industry recognition evidence requires documentation spanning academic credentials, research contributions, and professional honors across multiple recognition categories.[493] This comprehensive validation across recognition categories establishes credibility of expert testimony in patent disputes requiring expert interpretation of complex technologies and authority hierarchy considerations.[494]

Market impact evidence benefits from documentation combining direct commercial deployment with broader ecosystem influence and competitive response patterns.[495] Evidence of industry transformation provides additional validation extending beyond direct revenue correlation or market share metrics.[496]

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491 Dean, *supra* note 60, at 4–5 (establishing specialized hardware necessity in datacenter doubling requirements).

492 *Id.*

493 *E.g.*, Dean Profile, *supra* note 462 (demonstrating a comprehensive research portfolio); Dean Interview, *supra* note 434 (showing sustained professional recognition).

494 *See supra* Part III (discussing cross-examination analysis and authority hierarchy considerations); *See, e.g.,* TPU YouTube Transcript, *supra* note 434 (demonstrating technical authority breadth across TPU architecture, performance metrics, and industry analysis).

495 *E.g.,* Stone, *supra* note 60 (demonstrating commercial deployment of Cloud TPU pods); Metz, *supra* note 457 (demonstrating the competitive market transformation of Google's Cloud TPU pods).

496 Metz, *supra* note 457 (demonstrating industry transformation evidence extending beyond direct revenue correlation).

G. Limitations and Research Directions

This case study acknowledges methodological limitations affecting generalizability to other patent litigation contexts and technology domains. The focus on specialized processor technology for machine learning applications may limit direct applicability to other technology domains with different commercial characteristics and market structures.

The highly technical context with substantial research infrastructure and commercial deployment resources may not represent typical patent litigation scenarios involving individual inventors or smaller technology companies.[497] The research foundation and multi-year development timeline may require modification for technologies with different development characteristics.[498]

The methodology relies on litigation exhibit documentation rather than outcome correlation studies which limits empirical validation of evidence effectiveness in judicial decision-making processes. Future research might benefit from comparative analysis across multiple technology domains and correlation studies examining relationships between evidence patterns and litigation outcomes.

Additional research directions include longitudinal analysis of evidence pattern evolution across different litigation phases, integration studies examining

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[497] *See* Dean Interview, *supra* note 434 (documenting Google's research infrastructure advantages); *see also* Metz, *supra* note 457 (documenting resource scale enabling competitive transformation).

[498] *See generally* Dean, *supra* note 60, at 3–5 (documenting computational crisis beginning 2011-2013 leading to TPU development); Jouppi Presentation, *supra* note 57 (discussing the TPU development timeline through deployment phases).

coordination between secondary considerations and broader litigation strategy frameworks, and comparative effectiveness analysis across different patent technology categories.[499]

H. Conclusion

This analysis provides a foundation for understanding secondary considerations evidence construction in highly technical patent litigation through examination of technical achievement, commercial success, industry recognition, and market impact documentation spanning computational crisis resolution, specialized hardware innovation, and systematic market validation.[500] This case study indicates that evidence coordination across multiple categories provides support for patent validity while establishing foundation for expert testimony in highly technical fields requiring integration with expert declaration methodology and defensive expert testimony approaches.[501]

The documentation cited in this study, spanning from computational crisis identification to specialized hardware innovation and market validation, coordinates evidence preparation with litigation objectives and technology characteristics that promote secondary

[499] *See generally* Graham v. John Deere Co., 383 U.S. 1, 17–18 (1966) (establishing that secondary considerations including commercial success, long felt need, and industry acceptance may be used to determine obviousness); *see supra* Parts I–II (discussing broader litigation strategy frameworks).
[500] *See generally Graham*, 383 U.S. at 17–18 (establishing analytical framework for secondary considerations).
[501] *See supra* Part I (examining expert declaration methodology framework); *supra* Part II (analyzing defensive expert testimony approaches in IPR proceedings).

considerations.[502] The methodology reveals coordination between technical achievement evidence, commercial necessity documentation, and professional recognition establishment that may inform patent litigation strategy across highly technical fields requiring expert testimony approaches.[503]

The empirical approach offers practitioners a methodology for evidence development while establishing a framework for continued research in patent litigation evidence analysis and secondary considerations theory development across diverse technology domains and litigation contexts.[504]

VIII. INSTITUTIONAL RECEPTION OF SECONDARY CONSIDERATIONS EVIDENCE: EMPIRICAL ANALYSIS OF PTAB DECISION-MAKING PATTERNS

A. Introduction

Secondary considerations evidence has traditionally been viewed as a powerful defensive tool in patent validity challenges as the Federal Circuit considers such evidence "often the most probative and cogent . . . [on the issue of

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502 *See* Dean, *supra* note 60, at 3 (showing a foundational necessity for novel technology); Wang & Kanwar, *supra* note 61 (demonstrating technical achievement); Jouppi Paper, *supra* note 447, at 12 (demonstrating technical achievement); Cloud TPU, *supra* note 442 (demonstrating commercial success of the technology); Dean Profile, *supra* note 462, at 1–2 (establishing professional authority with a document listing career accomplishments).

503 *See supra* Part III (examining cross-examination performance analysis and authority hierarchy frameworks).

504 See *infra* Part VIII (analyzing the PTAB's reception of secondary considerations through an empirical analysis).

obviousness].”[505] However, an empirical analysis of Patent Trial and Appeal Board decision-making reveals systematic institutional skepticism toward secondary considerations arguments in patent disputes over complex technologies. Institutional skepticism in these contexts is particularly heightened where the commercial products contain significant unclaimed features.

This part examines PTAB reception patterns through an analysis of Dr. Sunil P. Khatri’s secondary considerations evidence across six related *Inter Partes* Review proceedings targeting Singular Computing’s Low Precision High Dynamic Range (LPHDR) patent family. The systematic rejection of comprehensive secondary considerations arguments provides an empirical foundation for understanding institutional behavioral patterns in highly technical patent disputes involving multi-generational commercial products with substantial unclaimed features.[506]

The analysis reveals a systematic rejection of secondary considerations arguments across all proceedings where institution was grantedwith the PTAB employing identical rejection language and utilizing the Patent Owner’s expert testimony to support obviousness arguments.[507] This comprehensive pattern represents systematic application of strict nexus requirements that severely limit secondary considerations effectiveness in cases involving complex technology.

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505 Stratoflex, Inc. v. Aeroquip Corp., 713 F.2d 1530, 1538 (Fed. Cir. 1983).

506 *See* IPR-155 Final, *supra* note 4, at 50; IPR-165 Final, *supra* note 4, at 50; IPR-179 Final, *supra* note 4, at 51.

507 *See* IPR-155 Final, *supra* note 4, at 12–13, 50; IPR-165 Final, *supra* note 4, at 12, 50; IPR-179 Final, *supra* note 4, at 51, 60.

B. Case Study Foundation

1. IPR Proceeding Distribution

Dr. Sunil P. Khatri served as the Patent Owner's expert declarant across six related IPR proceedings challenging Singular Computing's LPHDR patent family: IPR-154 ('961 patent), IPR-155 ('961 patent), IPR-164 ('156 patent), IPR-165 ('156 patent), IPR-178 ('273 patent), and IPR-179 ('273 patent).[508]

The PTAB denied institution in IPR-154, IPR-164, and IPR-178, preventing any secondary considerations analysis, and granted institution in IPR-155, IPR-165, and IPR-179, enabling comprehensive examination and subsequent systematic rejection of secondary considerations arguments.[509] This distribution provides a controlled and comparative context for analyzing institutional reception patterns across similar defensive strategies.

2. Expert Declaration and Deposition Evidence

Dr. Khatri's testimony was systematically coordinated across proceedings through Primary Declaration Ex. 2051 (used across IPR-155, IPR-165, and IPR-179) and Alternative Declaration Ex. 2006 (used in IPR-154, IPR-164, and IPR-178).[510] Deposition testimony

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[508] IPR-154, *supra* note 3, at 7; IPR-155 Final, *supra* note 4, at 7; IPR-164, *supra* note 4, at 7; IPR-165 Final, *supra* note 4, at 7; IPR-178, *supra* note 4, at 7; IPR-179 Final, *supra* note 4, at 7.

[509] *See* IPR-154, *supra* note 3, at 1; IPR-155 Final, *supra* note 4, at 1; IPR-164, *supra* note 4, at 1; IPR-165 Final, *supra* note 4, at 1; IPR-178, *supra* note 4, at 1; IPR-179 Final, *supra* note 4, at 1.

[510] *See* Khatri Decl. 155, *supra* note 151; Khatri Decl. 165, *supra* note 151; Khatri Decl. 179, *supra* note 151; Khatri Decl. 154, *supra* note 64; Khatri Decl. 164, *supra* note 64; Khatri Decl. 178, *supra* note 64.

(Ex. 1072) provided additional evidence base referenced across multiple proceedings.[511]

This coordinated declaration strategy enabled a systematic PTAB analysis of identical arguments across related proceedings which showed template-based institutional rejection patterns as documented in this analysis.[512]

C. Systematic Technical Argument Rejection

1. Mantissa Precision Analysis Failure

The PTAB systematically rejected Dr. Khatri's technical precision arguments despite detailed mathematical analysis of floating-point format specifications.[513] The central dispute involved Petitioner's argument that Dockser disclosed operations with five-bit mantissa precision versus Dr. Khatri's analysis claiming eleven-bit mantissa requirements.[514] The Board stated: "Patent Owner's argument about an 11-bit mantissa . . . does not squarely address Petitioner's obviousness rationale . . . . For this reason, we do not credit the Khatri Declaration on this point. Khatri Decl. ¶ 77."[515]

Dr. Khatri argued that persons of ordinary skill would not select five-bit mantissa implementations due to precision inadequacy because IEEE-754 standard specifications require twenty-three-bit mantissa for single precision floating-point format.[516] This institutional

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[511] *See* Khatri Depo., *supra* note 215, at 1.
[512] *See infra* Section VIII.G (discussing template-based institutional rejection patterns).
[513] *See* IPR-155 Final, *supra* note 4, at 58.
[514] *See id.*
[515] *See id.*
[516] *See* Khatri Decl. 155, *supra* note 151, ¶ 77; *accord* Khatri Decl. 165, *supra* note 151, ¶ 77; Khatri Decl. 179, *supra* note 151, ¶ 77 (regarding mantissa precision analysis and IEEE-754 standard comparisons).

rejection despite specification-based technical reasoning suggests that PTAB prioritizes legal obviousness framework over expert technical interpretation precision.

In his rejected analysis, Dr. Khatri specifically compared bfloat16 format (eight-bit exponent and seven-bit mantissa) and IEEE-754 standard implementations in arguing that the substantial precision reduction would discourage adoption by persons of ordinary skill seeking reliable computational results.[517]

2. X/Y Percentage Limitations Technical Dispute

Critical technical arguments regarding claimed X/Y percentage limitations suffered institutional rejection despite detailed mathematical analysis.[518] The patents claimed specific error tolerance requirements, with representative claim language requiring "at least Y=0.2% relative error for 99.03% of possible valid inputs" (IPR-155 Final at 58, '961 patent) and "at least Y=0.05% relative error for 99.45% of possible valid inputs" (IPR-165 Final at 33, '156 patent; IPR-179 Final at 57, '273 patent).[519]

Khatri argued that TPU bfloat16 implementations meet these specific percentage requirements by demonstrating copying of the claimed invention through

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[517] *See* Khatri Decl. 155, *supra* note 151, ¶¶ 77, 82, 134; *accord* Khatri Decl. 165, *supra* note 151, ¶¶ 77, 82, 134; Khatri Decl. 179, *supra* note 151, ¶¶ 77, 82, 134 (regarding mantissa precision analysis, Tong's experimental results demonstrating 5-bit precision inadequacy, and bfloat16 format comparison with IEEE-754 implementations).

[518] IPR-155 Final, *supra* note 4, at 58–59; IPR-165 Final, *supra* note 4, at 50; IPR-179 Final, *supra* note 4, at 51 (demonstrating systematic PTAB rejection of X/Y percentage limitation arguments across patents with varying error tolerance thresholds).

[519] IPR-155 Final, *supra* note 4, at 6; IPR-165 Final, *supra* note 4, at 6; IPR-179 Final, *supra* note 4, at 6 (reproducing challenged claim language specifying X/Y percentage parameters).

precision correlation analysis.[520] However, the PTAB rejected this analysis and noted that "Patent Owner does not explain, however, how the cited analysis of how Dockser teaches the X and Y percentage limitations applies to the TPUv2 and TPUv3 products."[521]

The institutional requirement for specific bit-manipulation technique correlation rather than format-level precision matching may demonstrate strict PTAB standards for copying evidence in highly technical patent disputes.[522]

3. Prior Art Combination Arguments

Motivation-to-combine arguments suffered systematic rejection across multiple IPRs with identical institutional language.[523] The PTAB stated, "[t]hus, we disagree with Patent Owner's arguments regarding the combination with Tong . . . . For the same reasons, we do not credit the Khatri Declaration on this point. Khatri Decl. ¶¶ 74–82."[524]

Dr. Khatri argued that persons of ordinary skill would not be motivated to combine Dockser and Tong references due to fundamental design philosophy conflicts

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[520] *See* Khatri Decl. 155, *supra* note 151, ¶¶ 135–36; *accord* Khatri Decl. 165, *supra* note 151, ¶¶ 135–36; Khatri Decl. 179, *supra* note 151, ¶¶ 135–36 (regarding X/Y percentage limitations and TPU implementation correlation).

[521] IPR-179 Final, *supra* note 4, at 51; IPR-155 Final, *supra* note 4, at 50; IPR-165 Final, *supra* note 4, at 50.

[522] *See supra* note 521.

[523] *See* IPR-155 Final, *supra* note 4, at 62; IPR-165 Final, *supra* note 4, at 60; IPR-179 Final, *supra* note 4, at 61 (demonstrating motivation-to-combine arguments getting rejected with similar institutional language).

[524] IPR-155 Final, *supra* note 4, at 62. *Cf.* IPR-165 Final, *supra* note 4, at 60; IPR-179 Final, *supra* note 4, at 61 (demonstrating similar rejection language with slight variation: "we find Patent Owner's arguments regarding the combination with Tong unavailing").

and implementation complexity requirements.[525] The consistent rejection across these IPRs may demonstrate institutional template usage for similar defensive arguments despite detailed technical reasoning.

4. Claim Construction Reception

Claim construction arguments regarding LPHDR execution unit requirements received systematic institutional skepticism.[526] The PTAB stated: "[t]hus, we disagree with Patent Owner and assign little weight to the Khatri Declaration on this issue. *See id.* at 15–17; Khatri Decl. ¶¶ 60–61."[527]

Dr. Khatri's argument that LPHDR execution units must demonstrate reduced transistor requirements compared to full precision alternatives failed institutional acceptance despite specification-anchored analysis addressing hardware implementation efficiency claims.[528]

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525 *See* Khatri Decl. 155, *supra* note 151, ¶¶ 74–82; *accord* Khatri Decl. 165, *supra* note 151, ¶¶ 74–82; Khatri Decl. 179, *supra* note 151, ¶¶ 74–82 (regarding motivation to combine Dockser and Tong).

526 *See* IPR-155 Final, *supra* note 4, at 12–13; IPR-165 Final, *supra* note 4, at 15; IPR-179 Final, *supra* note 4, at 15.

527 IPR-155 Final, *supra* note 4, at 12–13; *accord* IPR-165 Final, *supra* note 4, at 15 (using similar language: "we assign little weight to Dr. Khatri's testimony on this issue."); IPR-179 Final, *supra* note 4, at 15 (using similar language: "we assign little weight to Dr. Khatri's testimony on this issue").

528 *See* Khatri Decl. 165, *supra* note 151, ¶¶ 59–65; IPR-165 Final, *supra* note 4, at 15 ("[A]ssign[ing] little weight to Dr. Khatri's testimony on this issue."); *see also* Khatri Decl. 155, *supra* note 151, ¶¶ 59–65; Khatri Decl. 179, *supra* note 151, ¶¶ 59–65 (regarding LPHDR execution unit claim construction and transistor reduction requirements).

D. Secondary Considerations Comprehensive Rejection

1. Commercial Success Nexus Failures

Commercial success arguments based on Google's Tensor Processing Unit deployment suffered systematic nexus failures across all proceedings.[529] The PTAB concluded that "Patent Owner has not established a sufficient nexus between the alleged copying and commercial success of the TPUv2 and TPUv3 products and the Dockser/Tong-challenged claims" and that the evidence was "too speculative to reach a conclusion of commercial success."[530]

Dr. Khatri's commercial success evidence documented that "[TPU] v2 and v3 products released in 2017–2018 . . . 'use execution units designed to perform operations using a low-precision floating point format called bfloat16'" featuring eight-bit exponent and seven-bit mantissa specifications.[531] The argument emphasized substantial cost savings and performance improvements achieved through reduced-precision arithmetic implementations.[532]

However, the institutional focus on strict nexus requirements rather than commercial achievement magnitude demonstrates rigorous application of *Fox Factory* standards requiring co-extensiveness between

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[529] *See* IPR-155 Final, *supra* note 4, at 50; IPR-165 Final, *supra* note 4, at 49–50; IPR-179 Final, *supra* note 4, at 51.
[530] IPR-155 Final, *supra* note 4, at 50–51; IPR-165 Final, *supra* note 4, at 50–51; IPR-179 Final, *supra* note 4, at 51.
[531] IPR-179 Final, *supra* note 4, at 4; *accord* IPR-165 Final, *supra* note 4, at 45; IPR-155 Final, *supra* note 4, at 45 (regarding TPU commercial success arguments and bfloat16 technical specifications).
[532] IPR-179 Final, *supra* note 4, at 45–46; IPR-165 Final, *supra* note 4, at 45; IPR-155 Final, *supra* note 4, at 45.

commercial products and claimed inventions.[533] The PTAB additionally noted that supporting cost savings analysis "pertains to Petitioner's 'first' TPU, not the TPUv2 and TPUv3 products that use the bfloat16 format," which illustrates product-generation misalignment that undermines nexus establishment.[534]

2. Copying Arguments Technical Inadequacy

Copying arguments based on TPU bfloat16 format implementation failed systematically due to inadequate technical correlation demonstration.[535] The PTAB noted that "Patent Owner 'does not even attempt to demonstrate that [Petitioner's] TPUs perform the same bit-dropping techniques as Dockser.'"[536]

Dr. Khatri argued that TPU bfloat16 implementations demonstrate copying through correlation with claimed X/Y percentage limitations and emphasized that Google's selection of eight-bit exponent and seven-bit mantissa specifications precisely matches optimization approaches described in the challenged patents.[537]

The institutional rejection for failing to establish specific implementation correlation between accused

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533 IPR-155 Final, *supra* note 4, at 47–48; IPR-165 Final, *supra* note 4, at 48; IPR-179 Final, *supra* note 4, at 48–49 (citing Fox Factory, Inc. v. SRAM, LLC, 944 F.3d 1366 (Fed. Cir. 2019)).

534 IPR-155 Final, *supra* note 4, at 51; *accord* IPR-165 Final, *supra* note 4, at 51; IPR-179 Final, *supra* note 4, at 51.

535 *See* IPR-179 Final, *supra* note 4, at 50; IPR-165 Final, *supra* note 4, at 50; IPR-155 Final, *supra* note 4, at 49.

536 IPR-179 Final, *supra* note 4, at 51; IPR-165 Final, *supra* note 4, at 50; IPR-155 Final, *supra* note 4, at 50.

537 *See* Khatri Decl. 155, *supra* note 151, ¶¶ 134–36; *accord* Khatri Decl. 165, *supra* note 151, ¶¶ 134–36; Khatri Decl. 179, *supra* note 151, ¶¶ 134–36 (regarding copying arguments and TPU format correlation).

products and claimed bit-manipulation techniques illustrates a PTAB requirement for precise technical mapping rather than broad format similarity arguments.[538] This systematic failure demonstrates institutional standards requiring demonstration of specific claimed technique implementation rather than general technological approach similarity.[539]

3. Unclaimed Features Systematic Identification

The PTAB consistently applied strict nexus requirements under *Fox Factory* in finding that "a presumption of nexus is inappropriate with respect to the TPU products" across all proceedings due to significant unclaimed features identification.[540]

Dr. Khatri's deposition testimony provided institutional foundation for unclaimed features analysis through acknowledgment of sophisticated TPU architectural components, such as "a custom Inter-Core Interconnect that [Petitioner] did custom for this design; it's not some standard that you buy off the shelf" and "[a] systolic array idea . . . brought back from the past that probably cut the energy costs in half for the multiplier," arguing that Petitioner fails to demonstrate that these features impact TPU performance.[541]

The institutional emphasis on Custom Inter-Core Interconnect (ICI) architecture and systolic array implementations as significant non-claimed innovations demonstrates PTAB skepticism toward presumptive nexus in cases where commercial success may derive from

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538 *See* IPR-165 Final, *supra* note 4, at 50; *see also* IPR-179 Final, *supra* note 4, at 50–51; IPR-155 Final, *supra* note 4, at 50.
539 *See supra* note 538.
540 IPR-155 Final, *supra* note 4, at 47–48; *accord* IPR-165 Final, *supra* note 4, at 48; IPR-179 Final, *supra* note 4, at 48–49.
541 IPR-155 Final, *supra* note 4, at 46, 48; *accord* IPR-165 Final, *supra* note 4, at 46–48; IPR-179 Final, *supra* note 4, at 46–49.

substantial technological advances outside claimed invention scope.[542] The systematic identification of these unclaimed features across all proceedings establishes an institutional foundation for nexus rejection despite comprehensive commercial success evidence.[543]

E. Expert Testimony Strategic Backfire

1. Deposition Testimony Utilized for Obviousness

The PTAB's deployment of Patent Owner's expert testimony to support obviousness arguments illustrates critical strategic risks in comprehensive defensive approaches.[544] Dr. Khatri's deposition admission that "'exact computing . . . takes up a lot of resources, takes up a lot of power, takes up a lot of area, and takes up a lot of delay" was credited by the PTAB to establish motivation for reduced-precision alternatives rather than to support Patent Owner's secondary considerations framework.[545]

This institutional deployment demonstrates how expert acknowledgment of technical limitations can systematically undermine defensive positioning when utilized by opposing parties to establish obviousness

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[542] *See supra* note 541.

[543] *See* IPR-155 Final, *supra* note 4, at 46, 48; IPR-165 Final, *supra* note 4, at 46–48; IPR-179 Final, *supra* note 4, at 46–47, 49.

[544] IPR-155 Final, *supra* note 4, at 12–13 (quoting Khatri Depo., *supra* note 215, at 46:2–5); IPR-165 Final, *supra* note 4, at 13 (quoting Khatri Depo., *supra* note 215, at 46:2–5); IPR-179 Final, *supra* note 4, at 60 ("The record adequately supports Petitioner's reasoning here: Dr. Khatri testified that 'exact computing . . . takes up a lot of power.'").

[545] IPR-155 Final, *supra* note 4, at 12–13 (quoting Khatri Depo., *supra* note 215, at 46:2–5); IPR-165 Final, *supra* note 4, at 13 (quoting Khatri Depo., *supra* note 215, at 46:2–5); IPR-179 Final, *supra* note 4, at 60 ("The record adequately supports Petitioner's reasoning here: Dr. Khatri testified that 'exact computing . . . takes up a lot of power.'").

motivation in highly technical contexts.[546] The testimony intended to support technical achievement arguments was redirected to establish economic necessity for the innovations disclosed in prior art references.[547]

2. Product Complexity Acknowledgment

Dr. Khatri's testimony regarding TPU architectural sophistication provided additional institutional foundation for nexus rejection through acknowledgment of substantial non-claimed features. His statement that "the TPUs have the features that . . . are in these claims" combined with admission of "no opinion 'about what the TPUs . . . might have in addition'" enabled PTAB conclusions regarding unclaimed features significance.[548]

The testimony demonstrates how expert acknowledgment of commercial product complexity can systematically undermine nexus arguments in secondary considerations contexts involving sophisticated technological implementations.[549] The institutional use of this acknowledgment to support unclaimed features analysis illustrates coordination risks in multi-theory defensive strategies.[550]

F. Limited Technical Success Analysis

1. MacMillan Combination Crediting

Dr. Khatri's arguments achieved institutional acceptance exclusively on narrow prior art combination

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[546] *See supra* note 545.
[547] *See supra* note 545.
[548] IPR-155 Final, *supra* note 4, at 48 (citing Khatri Depo., *supra* note 215, at 147:15–149:2); IPR-165 Final, *supra* note 4, at 48 (citing Khatri Depo., *supra* note 215, at 147:15–149:2); IPR-179 Final, *supra* note 4, at 48–49 (citing Khatri Depo., *supra* note 215, at 147:15–149:2).
[549] *See supra* note 548.
[550] *See supra* note 548.

issues regarding MacMillan reference analysis.[551] The PTAB stated: "[w]e credit the testimony of Dr. Khatri on these points, as it is explained sufficiently and is consistent with the disclosures of the references. *See* Khatri Decl. ¶¶ 46–48, 107–115."[552]

The credited analysis argued that persons of ordinary skill in the art "would not have been motivated to re-engineer the FPP of Dockser" to eliminate thirty-two-bit floating-point capability due to backward compatibility requirements and software modification necessities.[553] This represents systematic institutional acceptance based on specification consistency and technical feasibility analysis rather than secondary considerations evidence.[554]

2. Success Limitation to Technical Analysis

The exclusive limitation of institutional success to technical obviousness analysis rather than secondary considerations evidence demonstrates PTAB distinction between specification-anchored technical interpretation and market-based validity arguments. The credited MacMillan analysis addressed prior art disclosure interpretation and motivation-to-combine requirements while comprehensive secondary considerations arguments suffered systematic rejection.[555]

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[551] *See* IPR-155 Final, *supra* note 4, at 83; IPR-165 Final, *supra* note 4, at 79; IPR-179 Final, *supra* note 4, at 81.
[552] *Id.*
[553] Khatri Decl. 179, *supra* note 151, ¶¶ 109–15; *accord* Khatri Decl. 165, *supra* note 151, ¶¶ 109–15; Khatri Decl. 155, *supra* note 151, ¶¶ 109–15 (regarding MacMillan combination analysis and FPP re-engineering limitations).
[554] *See supra* note 551.
[555] *Compare* IPR-165 Final, *supra* note 4, at 79 (crediting technical combination analysis), *with* IPR-155 Final, *supra* note 4, at 50 (rejecting secondary considerations arguments), and IPR-165 Final,

This pattern illustrates institutional receptivity to narrow technical analysis grounded in specification disclosure while maintaining systematic skepticism toward comprehensive market-based validity arguments in highly technical patent disputes.[556]

G. Cross-IPR Institutional Consistency Patterns

1. Language Replication Documentation

PTAB rejection patterns demonstrate systematic institutional approaches through identical language deployment across proceedings. The Board employed consistent formulations, stating that they "do not credit the Khatri Declaration on this point" for motivation-to-combine arguments and that they "assign little weight to the Khatri Declaration on this issue" for claim construction disputes.[557]

The systematic language replication across IPR-155 and IPR-165 for identical declaration paragraphs suggests institutional template development for processing repetitive defensive strategies which indicates administrative efficiency considerations in complex multi-IPR litigation contexts.[558]

2. Temporal Processing Evolution

Cross-IPR analysis reveals institutional processing evolution from comprehensive analysis to abbreviated cross-referencing methodology. IPR-155 provided detailed

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supra note 4, at 49–50 (rejecting secondary considerations arguments), and IPR-179 Final, *supra* note 4, at 51 (rejecting secondary considerations arguments).

[556] *See, e.g.,* IPR-165 Final, *supra* note 4, at 49–50, 79.

[557] IPR-155 Final, *supra* note 4, at 12–13, 62.

[558] *Compare* IPR-155 Final, *supra* note 4, at 62, *with* IPR-165 Final, *supra* note 4, at 60 (showing identical language patterns for identical declaration arguments).

paragraph-level examination of secondary considerations arguments while subsequent IPR-165 and IPR-179 decisions employed abbreviated treatments with extensive cross-references to prior analytical determinations.[559]

This temporal evolution suggests institutional learning and template development for similar defensive strategies with efficiency gains through precedential application of rejection rationales across related proceedings rather than duplicative comprehensive analysis.[560]

3. Institutional Template Application

The systematic application of identical nexus analysis across proceedings demonstrates institutional standardization of *Fox Factory* requirements in highly technical cases.[561] The consistent finding that "a presumption of nexus is inappropriate with respect to the TPU products" employed identical analytical framework addressing co-extensiveness failures and unclaimed features significance.[562]

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[559] *Compare* IPR-155 Final, *supra* note 4, at 50–62 (demonstrating a comprehensive secondary considerations analysis), *with* IPR-165 Final, *supra* note 4, at 49 (demonstrating an abbreviated analysis with cross-reference methodology), *and* IPR-179 Final, *supra* note 4, at 51 (demonstrating an abbreviated analysis with cross-reference methodology).

[560] *See, e.g.,* IPR-165 Final, *supra* note 4, at 49; IPR-155 Final, *supra* note 4, at 50–62.

[561] *See* IPR-155 Final, *supra* note 4, at 47–48; IPR-165 Final, *supra* note 4, at 48; IPR-179 Final, *supra* note 4, at 48–49.

[562] IPR-155 Final, *supra* note 4, at 48 ("We find that a presumption of nexus is inappropriate with respect to the TPU products."); *accord* IPR-165 Final, *supra* note 4, at 48 (showing identical analytical framework and conclusions); *accord* IPR-179 Final, *supra* note 4, at 48–49 (showing identical analytical framework and conclusions).

This institutional consistency indicates template-based decision-making approaches for secondary considerations evaluation in cases involving sophisticated commercial products with substantial non-claimed technological features.[563]

H. Strategic Implications for Patent Practice

1. Nexus Establishment Requirements

The systematic failure of TPU-based secondary considerations arguments illustrates critical strategic requirements for nexus establishment in complex technology cases.[564] The PTAB's identification of Custom Inter-Core Interconnect and systolic array architecture as significant unclaimed features demonstrates institutional scrutiny requiring precise claim-product correspondence rather than broad technological similarity.[565]

Future secondary considerations strategies must address unclaimed features challenges through detailed technical mapping demonstrating that commercial success derives specifically from claimed innovations rather than substantial non-claimed technological advances.[566] The institutional requirement for co-extensiveness analysis demands comprehensive product-claim alignment documentation addressing all significant commercial product features.

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[563] *See supra* note 562.
[564] *See* IPR-155 Final, *supra* note 4, at 50; IPR-165 Final, *supra* note 4, at 50; IPR-179 Final, *supra* note 4, at 51.
[565] *See* IPR-155 Final, *supra* note 4, at 46, 48; *accord* IPR-165 Final, *supra* note 4, at 46–48; IPR-179 Final, *supra* note 4, at 46–49*; see also supra* Section IV.C (discussing systematic nexus requirement failures and unclaimed features identification).
[566] *See supra* Section IV.C (discussing systematic nexus requirement failures and unclaimed features identification).

2. Expert Deposition Preparation Requirements

Dr. Khatri's deposition testimony utilization against Patent Owner's defensive arguments demonstrates critical coordination requirements in multi-theory litigation contexts.[567] Expert acknowledgment of technical limitations, product complexity, and unclaimed features can provide institutional foundation for obviousness arguments and nexus rejection.[568]

Strategic coordination requires careful limitation of expert testimony scope to avoid providing opposing parties with admissions supporting obviousness motivation or undermining secondary considerations nexus arguments through product complexity acknowledgment.[569] Expert preparation must anticipate cross-utilization of testimony across multiple legal theories and defensive strategies.

3. Multi-Generational Product Alignment

The PTAB's focus on product generation specificity illustrates strategic requirements for precise temporal and technical alignment in rapidly evolving technology domains. The institutional rejection based on TPU generation misalignment ("first TPU" versus "TPUv2 and TPUv3 products that use the bfloat16 format")

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[567] *E.g.,* IPR-155 Final, *supra* note 4, at 12–13 (quoting Khatri Depo., *supra* note 215, at 46:2–5); IPR-165 Final, *supra* note 4, at 13 (quoting Khatri Depo., *supra* note 215, at 46:2–5); IPR-179 Final, *supra* note 4, at 60 ("The record adequately supports Petitioner's reasoning here: Dr. Khatri testified that 'exact computing . . . takes up a lot of power.'").

[568] *See supra* Section VIII.G (discussing expert testimony strategic backfire and deposition utilization analysis).

[569] *See id.* (discussing expert testimony strategic backfire and deposition utilization analysis).

demonstrates requirements for exact product-claim correspondence.[570]

Secondary considerations evidence targeting the wrong commercial product generation undermines nexus establishment and enables institutional rejection based on relevance failures rather than substantive merit analysis.[571] Future arguments must ensure comprehensive alignment between secondary considerations evidence and specific commercial implementations practicing challenged claims during relevant timeframes.

4. Complex Technology Nexus Standards

The institutional application of strict *Fox Factory* standards in highly technical contexts demonstrates heightened scrutiny for secondary considerations evidence involving sophisticated commercial products. The systematic identification of unclaimed features and rejection of presumptive nexus demonstrates institutional skepticism requiring enhanced proof standards beyond traditional secondary considerations approaches.[572]

Practitioners developing secondary considerations strategies in highly technical cases must anticipate institutional requirements for detailed technical correlation analysis, comprehensive unclaimed features assessment, and enhanced nexus proof addressing sophisticated product architecture complexity.[573]

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[570] *See* IPR-155 Final, *supra* note 4, at 51 (rejecting Patent Owner's argument because it "pertains to Petitioner's 'first' TPU, not the TPUv2 and TPUv3 products that use the bfloat16 format").

[571] *See id.* at 50–51.

[572] *See* IPR-155 Final, *supra* note 4, at 47–48; IPR-165 Final, *supra* note 4, at 48; IPR-179 Final, *supra* note 4, at 48–49*; see also* Fox Factory, Inc. v. SRAM, LLC, 944 F.3d 1366, 1374 (Fed. Cir. 2019).

[573] *See, e.g.,* IPR-155 Final, *supra* note 4, at 47–48; IPR-165 Final, *supra* note 4, at 48; IPR-179 Final, *supra* note 4, at 48–49*; see also Fox Factory*, 944 F.3d at 1374.

I. Conclusion

This empirical analysis provides documentation of institutional skepticism toward secondary considerations evidence in highly technical patent disputes through systematic examination of PTAB reception patterns across six related IPR proceedings. Dr. Khatri's comprehensive strategy resulted in systematic rejection of secondary considerations arguments with institutional success limited exclusively to narrow technical obviousness analysis unrelated to market-based validity evidence.[574]

This systematic rejection across multiple IPR proceedings through paragraph-level analysis, identical cross-IPR language replication, and institutional utilization of Patent Owner's expert testimony against defensive arguments reveals consistent PTAB behavioral patterns with significant implications for secondary considerations strategy development in highly technical contexts. The empirical foundation provided by cross-IPR consistency documentation and institutional template analysis establishes a baseline understanding of PTAB approaches to market-based validity arguments involving sophisticated commercial products with substantial unclaimed features.

The strategic implications for practitioners include stricter nexus establishment requirements, expert testimony coordination limitations, multi-generational product alignment challenges, and heightened institutional scrutiny that distinguishes highly technical cases from traditional ones. The institutional preference for specification-anchored technical analysis over market-based validity

[574] *See* IPR-165 Final, *supra* note 4, at 79 (crediting technical combination analysis); IPR-155 Final, *supra* note 4, at 50 (rejecting secondary considerations arguments); IPR-165 Final, *supra* note 4, at 49–50 (rejecting secondary considerations arguments); IPR-179 Final, *supra* note 4, at 51 (rejecting secondary considerations arguments).

arguments demonstrates systematic application of strict legal standards that severely limit secondary considerations effectiveness in disputes involving complex technologies.

The documented rejection of detailed technical analyses including X/Y percentage limitations correlation, bfloat16 format specifications, and comprehensive commercial success evidence demonstrates institutional skepticism transcending argument sophistication or technical depth. The systematic utilization of expert deposition testimony against defensive positioning illustrates coordination risks requiring enhanced strategic preparation in multi-theory litigation contexts.

Future research directions include comparative analysis across different technology domains to determine generalizability of these institutional skepticism patterns, investigation of successful nexus establishment methodologies in complex product contexts, and longitudinal studies of PTAB decision-making evolution in secondary considerations. Additionally, examination of Federal Circuit review patterns on PTAB secondary considerations rejections could provide an appellate perspective on institutional standard application.

This analysis reveals patterns of institutional behavior in administrative patent law while providing an empirical foundation for secondary considerations strategy development in future patent litigation concerning complex technologies. The documented systematic rejection patterns establish a precedential baseline for practitioners developing defensive strategies in highly technical patent disputes involving sophisticated commercial products with substantial unclaimed technological features.[575]

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[575] *See* Graham v. John Deere Co., 383 U.S. 1, 17–18 (1966) (establishing secondary considerations analytical framework); *Fox Factory*, 944 F.3d at 1374 (establishing nexus requirements in highly technical contexts); Stratoflex, Inc. v. Aeroquip Corp., 713 F.2d 1530,

IX. CONCLUSION AND RESEARCH CONTRIBUTIONS

This study presents the first controlled empirical analysis of administrative decision-making patterns in patent proceedings. It reveals systematic institutional behaviors that transcend individual case characteristics through natural experimental conditions rarely available in administrative law research. The authority hierarchy patterns, template language usage, and methodological evaluation frameworks documented provide a preliminary empirical foundation for understanding how administrative agencies evaluate expert evidence in proceedings involving complex technologies.

The convergence of findings across multiple analytical dimensions provides evidence for institutional preferences within this dataset affecting expert testimony effectiveness through specification-anchored positioning, standards-based technical analysis, and methodological characteristics rather than solely analytical sophistication or technical complexity. Commercial validation through alleged $1.67 billion damages and subsequent undisclosed settlement demonstrates practical consequences extending beyond academic research to technology development and patent enforcement outcomes.[576]

The controlled comparison methodology developed by this study provides a replicable framework for systematic analysis of administrative decision-making patterns while establishing foundation for continued

1538 (Fed. Cir. 1983) (discussing secondary considerations probative value).

[576] *See* Blake Brittain & Nate Raymond, *Google Settles AI-related Chip Patent Lawsuit that Sought $1.67 Bln*, (Jan. 24, 2024, 11:10AM), https://www.reuters.com/technology/google-settles-ai-related-chip-patent-lawsuit-that-sought-167-bln-2024-01-24/ [https://perma.cc/KR5V-2L67].

empirical investigation of institutional behavioral patterns across diverse legal and regulatory contexts. The findings suggest expert testimony effectiveness correlates with authority hierarchy alignment and methodological characteristics which provides a preliminary framework for broader investigation of administrative evidence evaluation.

Administrative law implications extend to fundamental questions about due process, agency expertise, and algorithmic governance in regulatory contexts where template usage and systematic processing approaches may affect individualized case consideration requirements. The empirical approach offers a systematic foundation for understanding institutional behavioral patterns previously accessible only through anecdotal observation or theoretical frameworks.

Future research should prioritize cross-domain validation while building on controlled comparison methodology enabling these discoveries. The breakthrough lies in demonstrating that systematic empirical analysis of administrative behavior can illuminate institutional patterns within complex technical regulatory proceedings. This provides a foundation for both theoretical advancement and practical application improvement across diverse administrative and technological contexts. Broader replication studies across multiple regulatory domains could establish within three-to-five years whether the institutional patterns documented here represent patent-specific phenomena or systematic characteristics of administrative decision-making in technical proceedings.