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The τ Law: An Engineering Answer, Not a Scientific One

Wenzhu Hou, Lei Tian*

Data Research Center, China Academy of Information and Communications Technology, Beijing, China
**Corresponding author*

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Abstract: As the guiding principle for the semiconductor industry over the past sixty years, Moore's Law has been shaken as geometric miniaturization approaches physical limits. In May 2026, Huawei officially proposed the τ Law at ISCAS 2026, advocating for time micro sampling instead of geometric micronation, and establishing the characteristic time constant τ as a unified optimization goal across twelve orders of magnitude from transistor switches to data center workloads. Through a systematic review of Huawei's practice and theory, this paper reveals a core proposition: the τ law is not about discovering nature's laws, but about engineering sustained performance under resource scarcity. It is not only a theoretical innovation but also a conscious practice of industrial knowledge production, providing a pioneering methodological framework for China to build an independent knowledge system in the integrated circuit field.

1. Introduction

In the post-Moore era, chip process compression toward 3nm, 2nm and below faces four dilemmas: physical limit lockdown, soaring cost index, yield cliff decline, and zero marginal returns. Public industry data points out that the design cost per chip for advanced 3nm/2nm processes exceeds $1 billion. The global monopoly of EUV equipment, high procurement and operation costs, and the increase in transistor density for geometric microsacs below 7nm have narrowed year by year, with unit transistor costs shifting from decreasing to rising. Against this backdrop, on May 25, 2026, He Tingbo, Director and President of Huawei's Semiconductor Business Unit, delivered a keynote speech titled "Exploring and Implementing New Paths for Semiconductors" at the International Circuit and Systems Symposium (ISCAS 2026), officially proposing a new principle guiding the development of the semiconductor industry: the Tao(τ) Law. The core concept is to replace "geometric micronization" with "time microsampling," continuously compressing signal propagation delay through innovative technologies such as logical folding to improve overall system efficiency. The paper was then published in SCIENCE CHINA Information Sciences, systematically elaborating the time-scaling theory of this multilayer electronic system. [1]

This news quickly attracted global attention. People’s Daily gave a special report, calling it "China's first guiding principle in the global semiconductor field," and overseas media quickly followed suit. At the same time, two opposing interpretations emerged in the public sphere: one saw it as a scientific revolution challenging or even subverting Moore's Law, while the other saw it as a summary of engineering experience, failing to reach the level of a law. [2-5]

The difference between these two interpretations essentially marks the fundamental distinction between scientific and engineering issues. This article attempts to answer: What kind of question does the τ Law answer?

2. Scientific vs. Engineering Problem: An Essential Distinction

2.1 Scientific Problem: In Search of Nature's Laws

A hallmark of scientific problem is their assumption of an objective world, which researchers strive to discover, describe, and explain. Newtonian mechanics answers why objects fall, relativity answers the relationship between gravity and spacetime, and Schrödinger equations answer how microscopic particles move. These questions point to a natural reality independent of human will. Even without scientists researching it, the law of universal gravitation still exists; Without physicists to derive them, the electromagnetic laws described by Maxwell's equations still operate. Therefore, the answers to scientific questions are universal and unchangeable， which do not depend on the researcher's goals, resources, or preferences.

2.2 Engineering Problem: The ability to construct never existed

The paradigm of engineering problems is completely different. Engineering does not answer what is in nature? But answer Can we construct a certain capability under given constraints? The starting point of engineering is goal orientation, with core constraints including resource endowment, cost structure, technical conditions, and time windows. Elon Musk won't ask why can rockets fly? But can we build reusable rockets? ASML will not ask, Why can light engrave patterns? But rather can we build lithography machines with a wavelength of 13.5 nanometers? There is no one-way answer to engineering problems-all roads lead to Rome; the key lies in which road works under given constraints. More importantly, the answers to engineering problems can be surpassed, replaced, and overturned; it does not claim how the world works, but only claims we have found a viable path.

2.3 The dual properties of Moore's Law

Moore's Law has held a central place in semiconductor narratives for over half a century precisely because it has undergone a shift in identity from engineering observation to empirical laws. Gordon Moore's original statement from 1965 was an empirical observation of semiconductor industry trends and lacked the binding force of "laws" in physics. However, as the entire industry treats it as an "industry contract" for R&D rhythm, it gradually gains normative power-not only "the industry is developing this way," but "the industry should develop at this pace." This is a typical process of engineering knowledge evolving into the construction force of industrial order.

Moore's Law later evolved into an engineering goal contract observed by the entire industry chain, while the τ Law actively established a brand-new engineering optimization coordinate system from its inception. Their evolutionary paths are completely different, confirming that most well-known laws in the semiconductor field are engineering rules rather than strictly scientific ones. [6]

3. Engineering problem attributes of the τ law

3.1 Constraints Determine Direction: A typical engineering problem

Currently, the industry faces three rigid constraints: first, equipment constraints, with limited supply of high-end EUV lithography machines, leading the industry to shift to DUV multiple exposure processes; Second, physical constraints: the physical benefits of geometric miniatures below 7nm continue to decay; Third, commercial constraints: advanced processes require huge investments and extend payback cycles. The τ Law's primary contribution is to frame a pivotal engineering question: given the unavailability of state-of-the-art EUV lithography and advanced fabrication processes, what options remain for China's semiconductor industry to enhance chip performance when traditional node-shrinking iteration is no longer viable? [7]

This is a typical engineering problem. It is not a theoretical physics problem-"Where are the limits of a transistor?" nor a purely materials science problem-"How to construct new semiconductor materials," but rather a construction problem of "how to achieve the goal given constraints." It's not just lithography machines that are being constrained, but also R&D budgets (advanced node chip design budgets have exceeded a billion dollars per chip), cost curves (unit transistor costs no longer decrease, and at some nodes even rise), and physical limits (geometric scaling gains below 7nm are flattening). The τ law is precisely the engineering answer to finding alternative paths under these constraints. [8]

3.2 Target Substitution: From Making Transistors Smaller to Making Signals Run Faster

As an engineering pathway, the τ law completes a fundamental replacement of the goal. The core pursuit of Moore's Law is the continuous reduction in transistor size; The τ Law systematically states: the chip race is no longer about who is smaller, but about who makes the signal run faster. [9]

The significance of this replacement is that it no longer makes constraints a bottleneck deadlock. When the target is shrinking size, the most advanced lithography machines are the only path; But when the goal is replaced by shortening signal time, lithography machines are just one of many means; system-level innovations such as logic folding, 3D stacking, advanced packaging, interconnect optimization, and compute-in-memory integration can all contribute to τ reduction. Moore's Law belongs to a single-dimensional optimization model, while τ Law establishes a multidimensional optimization system with four layers of collaboration: devices, circuits, chips, and systems, greatly enriching the technical implementation path. This reflects the typical characteristic of engineering wisdom-changing the definition of goals and opening new paths under conditions where constraints cannot be altered.

3.3 Engineering Construction: Logical Folding, Multi-layer Collaboration, and Diachronic Verification

The three engineering constructs of the τ law further prove the essence of its engineering problems.

First, the physical foundation is not a new discovery, but a reuse of existing physical quantities. τ itself is a fundamental physical quantity in circuit theory-the time constant, equal to resistance multiplied by capacitance, representing the time required for signal switching, and has existed in textbooks for decades. Huawei has elevated τ from local parameters to a unified optimization goal spanning four levels: devices, circuits, chips, and systems. This is essentially no different from engineering thinking methods such as optimizing loss functions or shortening delivery cycles.

Second, core innovation logic folding is an engineering method for topological reconfiguration of logical distributions in three-dimensional space. By distributing logic gates on critical paths vertically across the upper and lower layers, vertical short connections replace horizontal detours, shortening physical transmission distances and thereby reducing latency. This is a structural reconstruction of two-dimensional layout in three-dimensional space, rather than a discovery of natural laws. This technology is fundamentally different from mainstream industry 3D stacking technologies such as TSMC SoIC, Intel Foveros, and AMD 3D V-Cache: the logical folding of the τ law belongs to a single die internally Circuit-level 3D reconstruction completes integrated layout during chip design, directly increasing the density of single dies and shortening core signal paths; In contrast, SoIC, Foveros, and 3D V-Cache are multi-die package-level stacks, where multiple dies are independently tape-out and then integrated through packaging technology without altering the internal structure of individual dies. The former delves deep into the chip itself, solving the design reconstruction problem of "circuit and logic architecture"; The latter mainly addresses the interconnection problem between chips at the physical packaging level. [10-12]

Third, the construction path of the τ law has undergone diachronic validation of engineering importance. From May 2020 to May 2026, Huawei has designed and mass-produced 381 chips based on τ scaling, covering multiple fields including mobile communications, AI, automotive, and industrial sectors. Mass production engineering practice shows that τ scaling has fundamentally restructured the optimization paradigm from devices and circuits to chips and systems, marking a key leap in industrial knowledge production from theoretical proposals to engineering reliability.

3.4 An Engineering Methodology Rather Than a Scientific Law

Based on the above analysis, the mainstream analysts' judgment-"The τ Law neither destroyed TSMC nor overturned Moore's Law; it is more like an engineering methodology, a new coordinate system"-is logical.

From the perspective of distinguishing empirical laws from scientific laws, Moore's Law is an empirical law based on the history of industry development. As the physical limit approaches, its predictive power naturally diminishes. The τ Law does not replace old empirical laws with new ones, but shifts industries from being experience-driven by historical observation to being law-driven by physical foundations. This further illustrates the engineering nature of the τ law: it is a conscious transformation about how to produce industrial knowledge. Both rely on mature semiconductor physics theories to propose unified engineering optimization rules for the entire industry, belonging to similar industry guidance frameworks and not major discoveries in basic science.

4. Bridging Scientific and Engineering Rigor

4.1 Measuring everything by time within a scientific foundation

Acknowledging the engineering nature of the τ Law does not mean denying its scientific validity. He Tingbo clearly states in the paper: The τ scaling is the first scaling principle since Dennard scaling to establish a unified optimization goal for the entire compute stack. Establishing τ as a unified optimization goal requires a high degree of abstraction ability-from picosecond-level latency of transistor switches, to nanosecond-level transmission within the chip, microsecond-level latency for inter-board interconnections, and then to second-level response times for data center services, spanning twelve orders of magnitude, abstracting "time" as a commensurable metric. This abstract ability is precisely the embodiment of scientific thinking. However, applying abstract thinking to industrial practice produces engineering knowledge, not scientific knowledge. The unified metric provided by τ scaling is essentially a global coordinate transformation for engineering optimization, rather than a revelation of new physical laws. [13]

4.2 Theorizing Engineering Knowledge with τ Scaling as an Industry Methodology

Acknowledging the engineering nature of the τ Law is precisely a more accurate grasp of its revolutionary significance. Its value lies not in discovering new physics, but in providing an industrial methodology for systematically thinking about problems under resource-limited conditions. It replaces the failure of single-dimensional competitions with a multi-level collaborative optimization system covering devices-circuits-chips-systems, enabling practitioners at all stages to communicate in the same language-time. The revolutionary value of the τ Law lies in revealing that industries can think this way, providing a new framework for action.

5. Paradigm Insights for Industrial Knowledge Production

5.1 The Leap from Rule Following to Paradigm Leadership

For a long time, China's semiconductor industry has been in a position of rule following: technology routes follow Moore's Law, evaluation standards follow process nodes in naming, and competitive strategies follow the pace of pioneers. As China's first new principle guiding industrial development in the global semiconductor field, the τ Law has achieved a dual breakthrough at the strategic level.

First, it defines new coordinates, using time instead of size as the measurement standard, changing the definition of the industry's development rhythm. It redefined the coordinate system for semiconductor performance evolution, shifted the optimization goal from transistor physical size to signal propagation time constant τ, and completed a complete closed loop from theory to mass production of 381 chips, fundamentally changing China's breakthrough focus in global technology competition. In the post-Moore's era, system latency optimization represented by the τ law has shifted global semiconductor competition from single-process competition to multi-track competition.

Second, it has opened up a new track, expanding the single process chase into a dual track of process pursuit + system innovation. τ scaling can be implemented to mature processes, using engineering methods such as logical folding to approach the performance level of advanced processes. The industry can no longer passively rely on EUV lithography machines; it can also proactively open up new competitive spaces through system architecture innovation.

5.2 Constructing an Independent Knowledge System

From the perspective of constructing China's independent knowledge system, the proposal of the τ law is an important theoretical conscious event. Previously, discussions in the semiconductor field often relied on Western academic frameworks: performance evolution followed Moore's Law, technical routes followed the node rhythm set by Western giants, and evaluation systems followed process numbers published by authoritative institutions. The proposal of the τ law consciously suspends these implicit frameworks, returning to the primary principles of industrial practice-cost, timeliness, energy consumption-for a reconstruction of the theory. This closed loop of "practice-abstraction-re-practice" is the classic paradigm for Chinese industry to contribute an independent knowledge system.

Huawei's six-year mass production testing based on the τ Law has essentially completed a complete process of industrial knowledge production: from identifying constraints and bottlenecks, to proposing innovative solutions, then to large-scale mass production verification, and finally to theoretically distilling it into a general methodology that guides the industry. This process fundamentally explains how industrial knowledge can be abstracted from practical experience into a reusable theoretical system.

6. Conclusion

The core issue of the τ Law is not What new physical properties τ has in the natural world, but whether we can systematically compress signal delay to sustain chip performance growth without relying on the most advanced EUV lithography machines. This is a typical engineering problem.

Acknowledging the engineering properties of the τ Law does not diminish its importance; on the contrary, it explains its revolutionary nature more accurately. It cannot replace the physical exploration significance of Moore's Law, but provides a coordinate system with different dimensions for the post-Moore era. It does not claim to have discovered a new world, but it reconstructs tools for understanding and transforming the world. This is the deepest value of industrial knowledge production-on resource-limited soil, through systematic engineering wisdom and theoretical self-awareness, a path to technological autonomy is blazed.

References

[1] He Tingbo. Time scaling theory of multilayer electronic systems [Time scale theory of multilayer electronic systems] [J]. Science China, Information Science, 2026.

[2] Daily Economic News. Huawei He Tingbo's paper reveals details about the market-stirring "Tao (τ) Law" [N]. 2026-05-25.

[3] Shanghai Securities News. Tao(τ) Law "Emerges Suddenly": What It Defines and Orients [N]. Shanghai Securities News, 2026-05-26.

[4] Shi Na, Song Weiping, Zheng Weihan. Tao(τ) Law "Emerges Suddenly": What It Defines and Orients [N]. China Economic Net, 2026-05-26.

[5] Negative review of XPIN. Has Huawei's newly released τ Law become a hit or have it been fully developed? [EB/OL]. Pacific Computer Network, 2026-05-27.

[6] Zhongguancun Online. Is the shift from Moore's Law to Tao's Law a shift from empirical laws to scientific laws? [EB/OL]. 2026-05-27.

[7] Fast Thought Slow Thought Research Institute. Interpretation of Tao's Law: China's Semiconductor Industry Moves from Rule-Following to Paradigm Leadership [R]. 2026.

[8] Huawei. Huawei Director He Tingbo proposes the τ law at ISCAS 2026 [EB/OL]. C114 Communication Network, 2026-05-26.

[9] Huawei Semiconductor Business Department. White Paper on Tao(τ)'s Law [R]. Huawei Technologies Co., Ltd., 2026.

[10] TSMC. The background and working principle of TSMC's SoIC™. 2024

[11] Intelligence. Foveros 2.5D packaging technology supports complex chip designs. 2025-7-31

[12] ByteTech Consulting. What is 3D V cache, and how does it enhance gaming performance? Technoidinc. 2025-6-11

[13] He Tingbo. Exploration and Practice of New Semiconductor Paths [C]//Proceedings of the 2026 International Circuit and Systems Symposium (ISCAS 2026), Shanghai, 2026.