

Validation and Scope of the Three-Layer Model

A Post-June Review of the Three-Part Framework and Its Extension

Validation Report

Version 1.0 - 29 August 2026

Abstract

This report documents the post-publication validation of the Three-Layer Model developed across The Semantic Scaling Problem, Meaning Under Conditions of Scale, and From Structure to Action, together with the extension paper Distinction and Representation. The validation began with an attempt to determine whether distributed energy coordination could provide a technically demanding test of the model rather than a merely illustrative application.

The investigation tested a series of progressively stronger contribution candidates: a universal mathematical realizer of the Semantic Layer, distinct validity domains, improved fault localization, a previously unrecognized intermediate functional position, a new generic information-to-action architecture, and additional analytical information beyond established models. The tests did not support those stronger claims. Domain-specific mechanisms remained mathematically heterogeneous; formal methods already provide specification and monitoring of validity boundaries; and OODA distinguishes contextual orientation, decision, and action at least as finely as the Three-Layer Model in the examined grid case.

The negative results did not invalidate the Three-Layer Model. They clarified its legitimate contribution. The model remains a descriptive and integrative analytical framework that classifies representation, interpretation, operation, and cross-layer stabilization across heterogeneous information-processing ecosystems. The validation further confirmed that analytical layers are not identical to technical components, mathematical object types, or mandatory implementation stages. Following the audit, the four papers were revised to version 1.1 to calibrate several absolute scaling, recursion, agent-participation, and stabilization claims. The core architecture remains unchanged.

1. Purpose and Status of This Report

This document is a post-publication validation report. It is not Part IV of the original paper sequence, not a second extension paper, and not a replacement for any element of the existing corpus. Its purpose is to preserve the outcome of an adversarial examination conducted after the June 2026 publication sequence and the subsequent extension.

The report distinguishes three questions that had become entangled during the validation process:

- Whether the Three-Layer Model can be reconstructed in a demanding real technical system.
- Whether that reconstruction exposes a mechanism or mathematical object not already present in the relevant disciplines.
- Whether the model nevertheless provides a coherent integrative language whose analytical scope can be stated precisely.

The first question received a positive answer in the distributed-grid case. The second did not. The third remains the defensible contribution of the framework.

Core status: retained

Strong mechanistic novelty: not supported

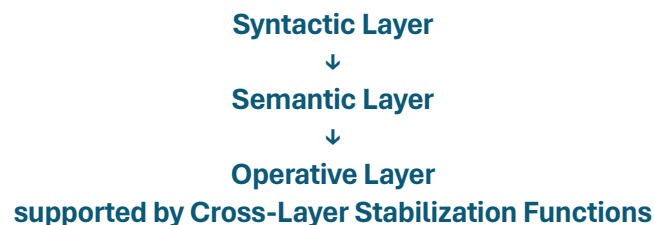
Integrative analytical contribution: retained

2. The Existing Research Corpus

The primary research program consists of three papers and one later extension. The extension clarifies a logical precondition of the Syntactic Layer without altering the architecture.

Status	Document	Function in the program
Part I	The Semantic Scaling Problem	Introduces semantic scaling as an analytical problem and empirical question.
Part II	Meaning Under Conditions of Scale	Examines semantic disequilibrium and stabilization demand under scaling conditions.
Part III	From Structure to Action	Introduces the Syntactic, Semantic, and Operative layers with cross-layer stabilization.
Extension	Distinction and Representation	Clarifies distinction as a logical precondition of representation; adds no new layer.

The canonical architecture remains:



The arrows express analytical transformation and dependency. They do not require a rigid technical pipeline, a one-to-one mapping to software or organizational components, or a universal mathematical type for each layer.

3. The Validation Question

The validation did not begin by asking whether representation, interpretation, and action exist. Such a question would be too weak and historically preoccupied. It asked whether applying the Three-Layer Model to a technically mature domain reveals a reproducible distinction that established domain models do not already expose.

Validation question

Does the Three-Layer Model provide analytical information beyond a relabeling of established mechanisms?

A positive result required more than a plausible mapping. The model would have to distinguish a function, boundary, or failure condition that could not already be reconstructed through control theory, optimization, formal specification, runtime verification, or generic decision architectures. A negative result would not show that the model is unusable. It would show that its contribution lies at a higher integrative level rather than in a newly discovered domain mechanism.

4. The Distributed-Grid Test Case

4.1 Origin of the test

The inquiry originated in an attempted SmartSupplyNetwork research framing. The terminology itself did not qualify as a new core research object. The underlying technical problem, however, remained suitable: distributed flexibility must be represented, constrained, coordinated, committed, and executed across organizational and technical boundaries. The grid case therefore continued as a falsification-oriented test within Applied Interoperability, not as a new energy theory.

The selected case was distributed-energy-resource flexibility activation under network constraints. It was chosen because it resists a convenient narrative. Real grid coordination combines forecasts, resource states, feasibility constraints, optimization, dispatch, local control, communication, and physical feedback. The same functions may be centralized, hierarchical, or distributed.

4.2 Neutral process structure

A network-aware DER aggregation framework provides a concrete technical sequence. Resource flexibility is first evaluated so that the resulting flexibility is feasible within the relevant operational domain. Optimal setpoints are then calculated from the determined flexibility and transmitted through a hierarchy of utility, aggregator, and local controllers [5]. The neutral analytical structure can be expressed as:

R → D → C → E

represented conditions → feasible possibilities → committed dispatch → execution

This four-part representation was deliberately kept neutral. It prevented the Three-Layer Model from determining the result in advance.

4.3 Mapping to the Three-Layer Model

The TLM reconstruction placed represented grid and resource conditions in the Syntactic Layer, the determination of contextually feasible operational possibilities in the Semantic Layer, and dispatch commitment plus execution in the Operative Layer. This mapping was coherent:

$$\text{TLM: R | D | (C + E)}$$

The case therefore supports applicability. It does not by itself demonstrate novelty. Feasible regions, optimal setpoints, model-predictive control, and hierarchical coordination are established technical mechanisms. The TLM does not replace or rederive them.

4.4 Centralized, distributed, and direct-response configurations

The same functional organization can be realized in different architectures. A centralized optimizer may determine feasibility and dispatch within one computational locus. A hierarchical system may distribute those functions across utility, aggregator, and local controllers. A decentralized or direct-response configuration may couple local measurements and actions without a clearly isolated intermediate component.

The direct-response counterexample was decisive. It rejected a mandatory implementation sequence in which every system must first instantiate a discrete Semantic-Layer module and only afterward enter an Operative-Layer module. What remained was an analytical distinction among functions and validity conditions, not a universal component topology.

5. Tested Contribution Candidates

The validation proceeded by testing stronger candidate contributions one at a time. Each candidate was retained only until an established counterpart or counterexample removed its novelty.

Candidate	Test result	Reason
Universal semantic object D	Rejected	Grid feasibility, authorization sets, abstractions, and other realizers have different established mathematical types.
New validity domains	Not unique	Specifications, contracts, and formal methods already distinguish assumptions, guarantees, admissibility, and execution properties.
Unique fault localization	Not supported	Runtime verification and process architectures can distinguish and monitor failure boundaries at equal or finer resolution.
New intermediate functional position	Not unique	Orientation, cognition, deliberation, feasibility analysis, and policy evaluation already occupy related positions.
New information-to-action architecture	Rejected	Sense-Plan-Act, OODA, BDI, and related architectures predate the model.
Additional information beyond OODA in the grid case	Not demonstrated	OODA separates Orient, Decide, and Act; the TLM groups commitment and execution in the Operative Layer.

6. Formal Methods and Runtime Verification Countertest

A possible rescue claim was that the Three-Layer Model uniquely exposes validity boundaries: representation validity, semantic validity, and operative validity. This route did not survive comparison with formal methods. Contracts can specify assumptions and guarantees across component boundaries. Runtime verification analyzes executions against formal properties and can monitor whether relevant events and states satisfy those properties [6][7].

The TLM can still organize the questions asked of a system. It can prompt an analyst to examine whether a failure originates in representation, interpretation, or operation. But the layer labels do not themselves constitute a formal specification language, monitor synthesis method, or fault-localization algorithm.

Analytical guidance ≠ formal verification method
Layer distinction ≠ unique fault-localization mechanism

This negative result protects the framework from an inflated technical claim. It also clarifies a productive relationship: formal methods may instantiate or test boundaries identified through the TLM, while the TLM supplies a broader cross-domain classification of the function being stabilized.

7. Generic Architecture Countertest

7.1 Sense-Plan-Act

Sense-Plan-Act already organizes a progression from environmental input through planning to action. Historical robotic architectures further combine planning with reactive monitoring and exception handling rather than implementing a simple rigid pipeline [8]. The generic idea that represented information is processed before action is therefore not new.

7.2 OODA

OODA provides the stronger counterexample: Observe, Orient, Decide, Act. Orientation contextualizes and interprets observed information, while Decide selects among options and Act implements the choice [9][10]. In the grid case the mapping is direct:

Observe = R
Orient = D
Decide = C
Act = E

The comparison showed that the Three-Layer Model does not uniquely discover contextual interpretation before decision. For the examined process, OODA is also more granular because it separates decision from execution, whereas both lie within the TLM Operative Layer.

This does not make the models identical. OODA is a decision-action cycle. The TLM is an ecosystem-oriented classification of representation, meaning, behavior, and stabilization. The relevant conclusion is narrower: difference in scope and vocabulary does not automatically produce additional analytical information in a given case.

8. Confirmed Findings

After the stronger claims were removed, five findings remained stable.

1. The Three-Layer Model can be reconstructed coherently in a mature technical domain without replacing its established mechanisms.
2. A functional layer is not identical to a technical component. One component may realize multiple functions, and one function may be distributed across multiple components.
3. A functional layer is not a universal mathematical object type. Domain-specific realizers may be mathematically unrelated while occupying comparable analytical roles.
4. The arrows between layers express transformation and dependency, not a mandatory chronological or implementation sequence.
5. Verification, provenance, evaluation, alignment, control boundaries, and knowledge structures remain appropriately classified as cross-layer stabilization functions rather than a fourth layer.

functional role ≠ mathematical object ≠ component

These findings preserve the architecture while preventing it from expanding into an unsupported universal mechanism.

9. Scope of the Three-Layer Model

The validated contribution is integrative rather than mechanistic. The Three-Layer Model offers a common analytical language for relating phenomena that are often discussed separately: structures and representations, contextual interpretation, behavioral consequences, and the mechanisms that preserve coherence across their transformation.

The model may legitimately claim	The model may not claim
A descriptive layered lens for heterogeneous information-processing ecosystems.	A universal physical, mathematical, or computational law.
Cross-domain functional comparison of representation, interpretation, operation, and stabilization.	A shared mathematical type behind all domain-specific realizers.
A common vocabulary connecting fragmented discussions.	The first generic architecture linking information to action.
Guidance for locating analytical questions across a transformation.	A unique formal verification or fault-localization method.
A conceptual framework requiring further empirical validation.	Predictive certainty or proven superiority over established architectures.

TLM contribution = cross-domain integrative functional classification

10. Revision of the Corpus to Version 1.1

The post-June audit found that the core architecture was more cautious than many claims generated during the later exploration. It nevertheless identified several sentences in the original papers whose wording was stronger than the evidential status declared in their abstracts, limitations, and conclusions. The four documents were therefore revised to version 1.1 on 29 August 2026.

Correction family	Calibration in v1.1
Scaling laws	Absolute exponential-versus-incremental claims were replaced by conditional relative-scaling hypotheses.
Information and interpretation	Additional information may expand plausible interpretations; it does not necessarily do so.
Recursive amplification	Interpretive and agentic recursion may amplify complexity but may also consolidate it.
Structural and semantic dynamics	Representations and meanings may change at different rates; semantic entropy need not increase continuously.
Agent participation	Agents may participate across Syntactic, Semantic, and Operative functions.
Behavior and stabilization	Sufficient stabilization is required for persistent and coordinated behavior, not for every isolated behavior.

The revisions did not introduce a new layer, alter the status of cross-layer stabilization, or convert the framework into a prescriptive architecture. Each v1.1 paper contains a revision note identifying the calibrated claim group and confirming that its central function remains unchanged.

11. Research Status

Research item	Status after validation
Three-layer architecture	Retained
Cross-layer stabilization	Retained
Extension: distinction before representation	Retained as a logical clarification
Cross-domain applicability	Retained as an analytical hypothesis
Universal mathematical realizer	Not supported
New generic information-to-action architecture	Rejected
Unique diagnostic or verification gain	Not demonstrated
Integrative common analytical language	Retained as the central contribution
Empirical explanatory power	Open; requires further domain testing

The report therefore closes the post-June novelty search without closing the research program. Future work may test whether the common vocabulary produces reproducible comparative value in additional domains. Such work must begin from the v1.1 corpus and the scope boundaries documented here.

12. Conclusion

The adversarial tests did not invalidate the Three-Layer Model. They clarified what kind of contribution it can legitimately claim.

The distributed-grid case demonstrated that the model can organize a real transformation from represented conditions through contextual feasibility to operative commitment and execution. It did not reveal a new control mechanism, a universal semantic object, or a unique verification boundary. Comparisons with formal methods and OODA further showed that validity monitoring, contextual orientation, decision, and action are already represented in established frameworks.

What remains is neither trivial nor unlimited. The Three-Layer Model provides an integrative analytical classification of heterogeneous mechanisms according to their roles in representation, interpretation, operation, and cross-layer stabilization. Its value lies in connecting these functions across information-processing ecosystems without claiming that their domain-specific realizations are technically or mathematically identical.

The v1.1 revision aligns the wording of the four papers with this validated scope. The architecture remains Syntactic, Semantic, and Operative, supported by Cross-Layer Stabilization Functions. Distinction remains outside the architecture as a logical precondition of representation. Strong mechanistic novelty claims are closed. The integrative research contribution remains open to further empirical testing.

Core architecture retained
Claim scope calibrated
Integrative contribution preserved

Primary Corpus

[P1] The Semantic Scaling Problem. Rights of Robots Research Program. Version 1.1, revised 29 August 2026.

[P2] Meaning Under Conditions of Scale. Rights of Robots Research Program. Version 1.1, revised 29 August 2026.

[P3] From Structure to Action. Rights of Robots Research Program. Version 1.1, revised 29 August 2026.

[P4] Distinction and Representation. Rights of Robots Research Program. Version 1.1, revised 29 August 2026.

External References

- [5] K. Utkarsh, F. Ding, X. Jin, M. Blonsky, H. Padullaparti, and S. P. Balamurugan. “A Network-Aware Distributed Energy Resource Aggregation Framework for Flexible, Cost-Optimal, and Resilient Operation.” *IEEE Transactions on Smart Grid* 13(2), 2022. Open manuscript: <https://www.osti.gov/servlets/purl/1833350>
- [6] K. Havelund and G. Rosu. “Runtime Verification - 17 Years Later.” 2018. NASA Technical Reports Server: <https://ntrs.nasa.gov/citations/20210005928>
- [7] E. Bartocci and Y. Falcone, eds. *Lectures on Runtime Verification: Introductory and Advanced Topics*. 2018. Open editor version: <https://inria.hal.science/hal-01762298/file/rv-book-editor-version.pdf>
- [8] R. Simmons. “Structured Control for Autonomous Robots.” 1994. NASA Technical Reports Server: <https://ntrs.nasa.gov/api/citations/19940026056/downloads/19940026056.pdf>
- [9] Air University. “Finding the Right Model: The Joint Force, the People’s Liberation Army, and Information Warfare.” 2023. <https://www.airuniversity.af.edu/JIPA/Display/Article/3371164/finding-the-right-model-the-joint-force-the-peoples-liberation-army-and-informa/>
- [10] Air University. “Space, Maritime Security, and Geopolitics in the South China Sea.” 2025. <https://www.airuniversity.af.edu/JIPA/Display/Article/4266924/space-maritime-security-and-geopolitics-in-the-south-china-sea/>