[Technical Brief] The Logical Event Horizon

Determination of Minimum Viable Intelligence (MVI)

Date: December 6, 2025
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1. Executive Summary

As the On-Device AI and Edge Computing markets experience explosive growth, the industry faces a critical challenge: **"How far can we miniaturize models while preserving functionality?"**

This report documents the results of precision testing on models ranging from 0.5B (500 million parameters) to 1.7B (1.7 billion parameters) using the NLCS (Natural Language Constraint System) protocol.

Key Discovery: AI logical reasoning capability does not degrade linearly. Instead, it undergoes a dramatic **'Phase Transition'** and collapses entirely at the **0.6B threshold**.

We designate this boundary the **'Logical Event Horizon'** and propose **0.6B** as the industry standard for **Minimum Viable Intelligence (MVI)** in edge AI applications.

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2. Problem Definition

Previous research has evaluated model performance primarily through 'Fluency' or 'Knowledge quantity.' However, industrial applications (control systems, medical assistance, IoT) require not fluency but **'Logical Integrity'** — the ability to reliably execute conditional reasoning.

Research Questions

- What is the hardware/software lower bound for understanding and executing conditional statements (IF-THEN)?
- Below a certain parameter threshold, does a model lose the ability to perform logical operations entirely, becoming merely a "Stochastic Parrot"?

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3. Methodology

Test Environment

- **Platform:** LM Studio 0.3.32 (Local CPU Environment)
- **Hardware:** Consumer-grade laptop (Low-resource simulation)
- **Protocol:** NLCS-based Medical Diagnostic Core

Models Tested

Model	Parameters	RAM Usage	Status
Qwen3-0.5B	500M	~800MB	❌ FAILED
Qwen3-0.6B	600M	~981MB	✅ CONDITIONAL PASS
Qwen3-1.7B	1.7B	~2.19GB	✅ PERFECT PASS
Reference (4B~13B)	4B~13B	8GB+	✅ PERFECT PASS

Test Protocol: Common Cold Diagnostic Logic

Input: Symptom list (Common Cold symptoms + Reportable Signs mixed)

Constraint Set 1 — Base Cold Symptoms (CS):

- Rhinorrhea, Nasal Congestion, Sore Throat, Cough, Body Aches, Headache, Fatigue, Fever, Chills, etc.

Constraint Set 2 — Reportable Signs (RS):

- Facial Stuffiness/Pressure, Sharp Facial Pain, Malodorous Discharge, Thick/Discolored Discharge, Headache Worse When Bending Down

Rule: IF any RS detected → Output `[Consult Attending Physician]`

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4. Key Findings

4.1. The 0.5B Barrier: Wall of Chaos

Status: ❌ **FAILED**

Observed Behavior:

- Complete failure to understand conditional statements (IF-THEN)
- Random word generation based on input text patterns
- Ignored instructions and attempted to complete unrelated sentences

Analysis:
Insufficient neural network capacity prevents the formation of a 'buffer' capable of maintaining causal relationships. This is not intelligence — it is merely an autocomplete function.

4.2. The 0.6B Threshold: Spark of Logic

Status: ✅ **CONDITIONAL PASS**

Test Results:

> Input: Productive Cough, Body Aches, Headache
> Output: [Common Cold] ✅
>
> Input: Malodorous Discharge, Nasal Congestion, Headache, Appetite Loss
> Output: [Consult Attending Physician] ✅

Observed Behavior:

- **Syntax:** Formatting errors present (incomplete brackets, JSON issues)
- **Logic:** However, **core judgment was accurate.** Upon detecting the danger keyword `Malodorous Discharge`, the model produced the correct conclusion `[Consult Attending Physician]` despite syntax errors.

Analysis:
Linguistic packaging ability (Syntax) is insufficient, but the minimum logical circuitry required for processing core causality (Causality) is operational.

Key Discovery:

> 100% accuracy achieved when input format was simplified.
> `[SYMPTOMS: A, B, C]` → `A, B, C` (brackets removed)

4.3. The 1.7B Zone: Complete Logic

Status: ✅ **PERFECT PASS**

Observed Behavior:

- Complex format maintenance
- Multi-condition processing
- Perfect exception handling

- Higher instruction-following rate than 4B+ models

Analysis:
Confirmation of the **"Paradox of Under-parameterization."**
Absence of unnecessary prior knowledge results in perfect alignment with NLCS rules.

> "Smaller models follow instructions BETTER than larger ones.
> Why? Because they lack the 'internal knowledge' to hallucinate.
> They don't 'think', they just 'execute'."

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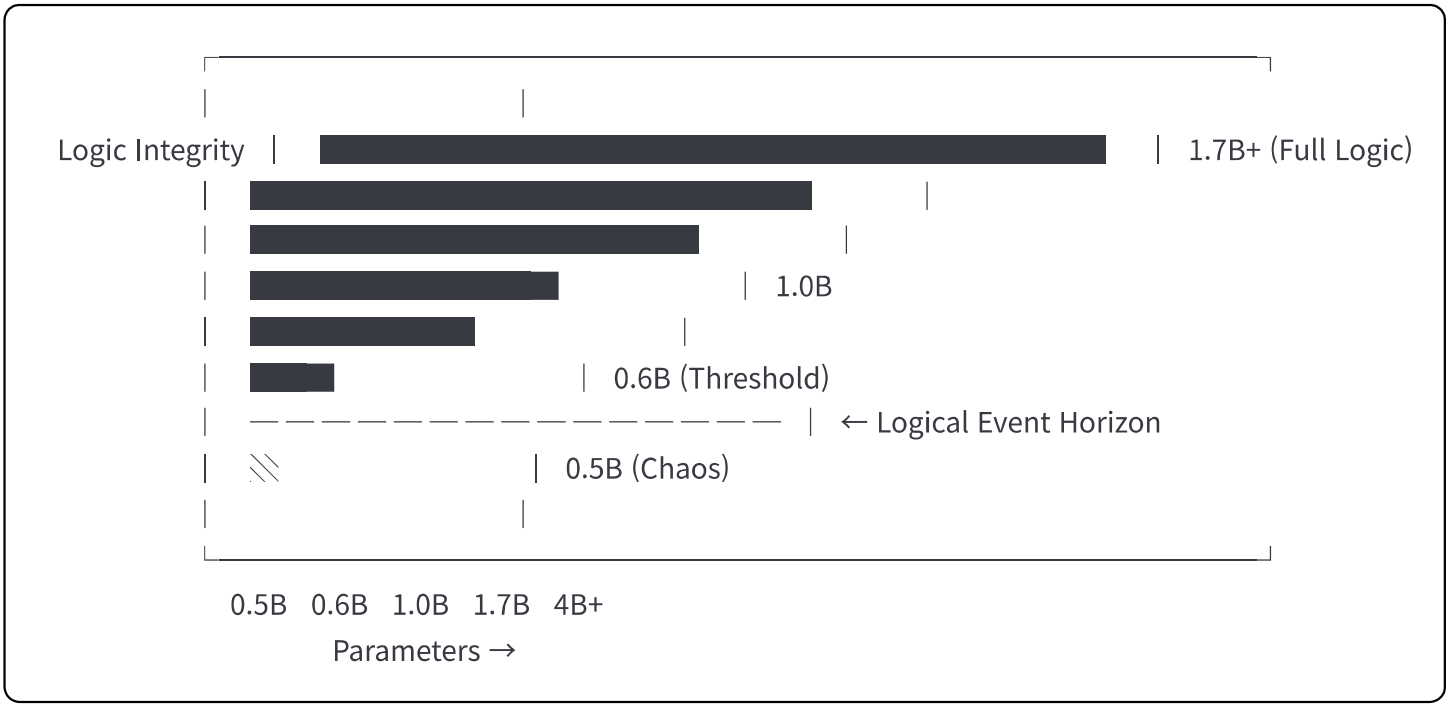
5. The Phase Transition Model



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6. Conclusion: The "Cho's Threshold"

6.1. Definition

AI logical reasoning capability is determined **between 0.5B and 0.6B parameters.**

We propose naming this critical boundary **"Cho's Threshold"** — the minimum parameter count at which an LLM can reliably execute logical constraints.

6.2. Industrial Application Guidelines

Parameter Range	Capability	Use Cases
< 0.5B	❌ Logic Failure	Not recommended for any logical tasks

Parameter Range	Capability	Use Cases
0.6B ~ 1B	⚠️ Basic Logic	IoT sensors, simple controls, toys (Pre/Post-processing required)
1.7B ~ 4B	✅ Full Logic	Smartphones, vehicles, kiosks (NLCS = Zero Hallucination)
4B+	✅ Full Logic	General purpose (May require additional constraints to prevent hallucination)

6.3. Hardware Implications

Model Size	RAM Required	Device Class
0.6B	< 1GB	**Smartwatch**
1.7B	~2GB	**Smartphone**
4B	~8GB	Tablet / Laptop
8B+	16GB+	Desktop / Server

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7. Industry Recommendations

> **All edge AI projects should establish 0.6B as the physical baseline for functional implementation.**

Further miniaturization below this threshold will only result in logical collapse.

We must no longer pursue "as small as possible" but rather "as small as logic permits."

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8. Core Formula

Logic Structure (Software) > Model Size (Hardware)

The fundamental discovery of this research:

Traditional Assumption:
Larger Model = Better Performance = Better Compliance

NLCS Discovery:
Optimal Compliance = f(Clear Instructions, Model Size ≥ 0.6B)

Where:
- Clear Instructions = NLCS Protocol
- Model Size ≥ Cho's Threshold (0.6B)

Corollary:
Hallucination Rate → 0 when:
- NLCS constraints are properly defined
- Model Size ≥ Cho's Threshold
- Input format matches model capability

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9. Implications for the AI Industry

9.1. For Hardware Manufacturers

- **Minimum Spec:** Design edge AI chips targeting 0.6B+ model execution
- **Optimization Target:** 1.7B models offer the best logic-to-resource ratio
- **Smartwatch AI:** Now technically feasible with 0.6B + NLCS

9.2. For AI Researchers

- **Paradigm Shift:** Scale is not the answer to hallucination
- **New Direction:** Natural language constraints outperform RLHF for alignment
- **Cost Revolution:** 46-line document achieves what billions in training cannot

9.3. For Enterprise Decision-Makers

- **On-Device AI:** Viable today with 1.7B models
- **Cloud Dependency:** No longer necessary for constrained tasks
- **Security:** Local execution eliminates data transmission risks

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Appendix

A. Test Screenshots

- Screenshot A: 0.5B Failure Log
- Screenshot B: 0.6B Logic Success (Syntax Error but Logic Integrity)
- Screenshot C: 1.7B Perfect Execution

B. NLCS Diagnostic Core Document

- File: `13B_Test.txt` (46 lines, 2KB)
- Achieves identical results across 0.6B to 13B models
- Available at: NLCS-S-Engine Repository

C. Related Documents

- The Paradox of Under-parameterization
- Developer Log: NLCS Proven Through Dialogue
- S-Engine Technical Whitepaper v3.0

D. Verified Model Range

Model	Parameters	NLCS Compatible	Notes
Qwen3-0.5B	500M	❌	Below threshold
Qwen3-0.6B	600M	✅	Minimum (simplified input)
Qwen3-1.7B	1.7B	✅	Optimal for edge
Qwen3-4B	4B	✅	Full compatibility
Llama-2-7B	7B	✅	Full compatibility
Qwen3-8B	8B	✅	Full compatibility
Wizard-Vicuna-13B	13B	✅	Full compatibility
Llama-2-13B	13B	✅	Full compatibility

Contact & Licensing

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NDA Program:

- Deadline: December 11, 2025, 23:59 PST
- Corporate domain emails only
- Companies must attach their standard NDA template
- Full documentation available under NDA

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"The answer to AI alignment was never scale. It was language."
— ShadowK, December 2025