SYNESTRA

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The Physical Fabric Problem

How fiber failures create silent economic loss. And why no existing tool can see them.

ABSTRACT

At 2025 cluster scale, fiber infrastructure sustains a silent, disqualifying event every 48 seconds. A link reports healthy. A GPU training job slows. No alarm fires. No ticket opens. The consequence chain runs from the physical layer through the network layer to the compute layer to an economic output gap, and it crosses three domain boundaries that no single existing monitoring tool can observe. Meta's LLaMA 3 training experienced 419 job interruptions in 54 days. ByteDance logged over 38,000 failures in three months. The industry's response was checkpointing — a recovery mechanism that consumes 12 to 43% of total training time. This paper documents the ghost problem, the commissioning gap, the checkpoint tax, and the cross-domain blind spot. It establishes why physical fabric intelligence is not a network operations feature. It is an Economic Availability imperative.

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A link that reports healthy is not a link that is healthy.

The physical fabric of a modern AI factory is not passive infrastructure. It is the layer that converts provisioned GPU capacity into delivered AI output. When it degrades, it does not fail loudly. It fails silently. The link reports up. The GPU appears available. The training job slows. No alarm fires. The industry has a name for this: a ghost.

At 2025 AI cluster scale, the optical fabric contains over 10 million individual links. Borrill (2026) documents that, at this scale, a ghost event — a link reporting healthy while dropping or corrupting traffic — occurs somewhere in the fabric every 48 seconds. Not once per outage. Every 48 seconds, somewhere in your cluster, a GPU is underperforming because of a fiber problem that no monitoring tool can see.

10M+	48 sec	43%
OPTICAL LINKS IN A 2025-SCALE AI TRAINING CLUSTER	FREQUENCY OF GHOST EVENTS — BORRILL 2026, PRODUCTION DATA	PEAK CHECKPOINT TAX — SHARE OF TRAINING TIME LOST TO RECOVERY

The ghost problem is not a new discovery. It has been observed in production at Meta, Google, Microsoft, and ByteDance. It is documented in peer reviewed research. The knowledge exists. The system to act on it continuously, across the full fabric, at production scale, does not.

> *The ghost problem is not a networking problem. It is an economic output problem. The training job that slows is revenue that does not arrive. The checkpoint that fires is engineering time that disappears. Physical fabric intelligence is not a feature. It is the difference between what your cluster is provisioned to produce and what it actually produces.*

Ghost events are one mechanism. There are three more.

The physical fabric problem is not limited to ghost events in production. It begins at commissioning, accumulates through operational life, and becomes visible in the economic output record. Four distinct mechanisms contribute to physical fabric economic loss.

The commissioning gap

Polarity errors, end-face contamination, and microbending from improper cable routing are introduced during the commissioning process and persist for the life of the facility. A single miswired trunk connecting 96 GPU ports can silently degrade performance across an entire training cluster. Most commissioning processes test pass or fail. They do not test degradation trajectory. The contamination that passes commissioning at 0.4dB loss will not pass commissioning at 3.2dB loss eighteen months later. The standard process never goes back to look.

The checkpoint tax

The industry's primary response to physical fabric failures is checkpointing. When a training job is interrupted, the system saves its state and restarts. Meta's LLaMA 3 training experienced 419 interruptions over 54 days of training. ByteDance logged over 38,000 job failures in three months. Checkpointing works. It also consumes 12 to 43% of total training time depending on cluster size and failure rate. That is not a recovery mechanism. That is a normalized economic loss that the industry has accepted because no alternative existed.

The cross-domain blind spot

Network monitoring tools observe link state: up, down, or flapping. Compute monitoring tools observe GPU utilization: active, idle, or underperforming. No existing domain tool correlates a degraded NVLink connection with the reduction in training throughput it causes, or traces that throughput reduction to its economic consequence in the revenue model. The domain boundary between the network layer and the compute layer is precisely where physical fabric loss hides from every existing monitoring system.

> *ByteDance's published analysis identified 38,000 failures across a 3-month training run. The paper is titled "Towards Efficient and Reliable LLM Serving." Efficiency and reliability are the stated goals. The unstated one is economic: every failure that is not caught early is a checkpoint that is not prevented, a GPU that is not producing, and a revenue period that cannot be recovered.*

The consequence chain. And the only layer that can see it.

The physical fabric consequence chain spans four domain boundaries. Each domain has its own monitoring system. None of them is designed to trace a consequence that runs across all four. Synestra is the first intelligence layer built to observe the complete chain.

FIBER LINK	NETWORK	COMPUTE	ECONOMIC
Degrades below alarm threshold. Reports healthy. Ghost created.	Traffic routed to degraded path. Packet loss below alarm. No ticket.	GPU throughput drops. Training job slows. Utilization appears normal.	Checkpoint fires or job completes late. Revenue-producing capacity not delivered.

Current tools can see one step in this chain. BMS sees the physical layer. NMS sees the network layer. DCIM sees the asset layer. GPU schedulers see the compute layer. No existing tool sees all four simultaneously. Synestra's Edge Data Intelligence module is the first system designed to correlate across all four layers in real time.

What Synestra adds to commissioning

Synestra establishes an optical baseline at commissioning. Not pass or fail. Degradation trajectory per link. That baseline is the reference against which every future measurement is compared. The first sign of contamination progression is visible months before it crosses any alarm threshold.

What Synestra adds to operations

Ghost events that are invisible to NMS become visible in the cross-domain correlation. A GPU that underperforms without a declared fault generates a signal. Synestra traces that signal backward to the fiber segment responsible. The mean time to identify is measured in minutes. Without Synestra, it is measured in days.

What Synestra adds to the economic record

Every physical fabric event is captured in the operational memory layer with its full consequence chain. The economic cost of each event is calculated and attributed. Over time, that record produces an accurate picture of how much Economic Availability is being lost to physical fabric failures. That picture does not exist anywhere today.

The non-transferable advantage

A facility that has operated Synestra for 24 months has a physical fabric history that cannot be replicated. Every ghost event, every degradation sequence, every commissioning anomaly is documented. The facility knows exactly which fiber segments are trending toward failure. A new operator does not. That knowledge is the asset.

The physical fabric is not background infrastructure. It is the physical layer that converts provisioned GPU capacity into delivered AI output. A facility that treats fiber monitoring as a network operations task and not an economic availability imperative will lose between 1 and 3 percentage points of Economic Availability to physical fabric failures every year. At \$200 to \$380 million per EA point at 1GW scale — the conservative to base range in the Synestra commercial model — that is \$200 million to \$1.1 billion in annual recoverable economic output that no alarm will ever flag.