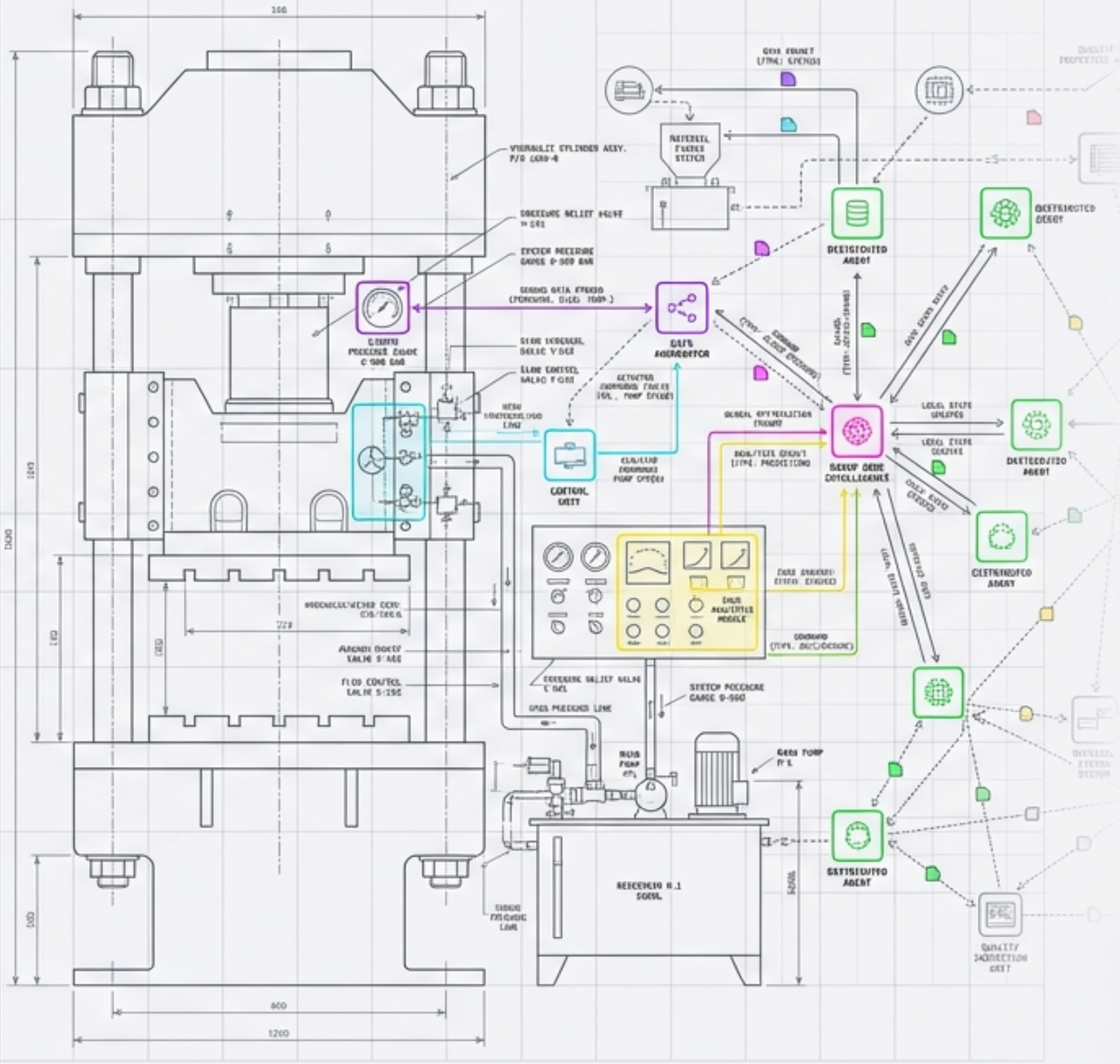
GHOST IN THE MACHINE: BUILDING THE SWARM

Session 2 – From Passive Monitoring to Active Intelligence

Faculty Development Program | MSRIT



Focus: Architecture. Integration. Resolution.

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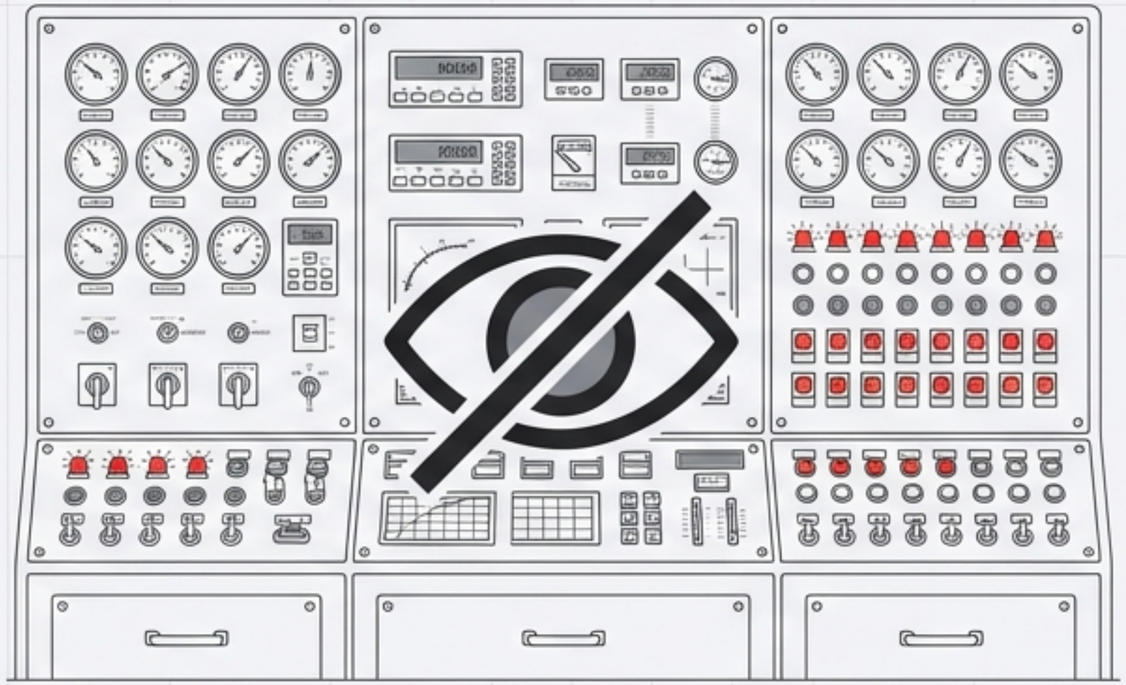
The Skeptic’s Question

The Objection

> “We have PLCs, SCADA, and DCS systems. We have threshold alarms and predictive maintenance algorithms. Why do we need AI agents?

Common Engineering Objection

The Context



The Gap: In Session 1, traditional tools failed Neel because they were siloed and static. PLCs alert on single variables. They do not reason across systems.

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Beyond Automation: The 7 Capabilities

Capability	Traditional Automation	AI Agent Swarm
Cross-Silo Reasoning	PLC sees pressure spike -> Alerts operator.	Correlates spike with upstream valve, ambient temp, and production batch.
Unstructured Data	Manuals in PDF format. Search is manual.	Reads manuals, parses notes, recalls incident reports.
Adaptive Pattern Recognition	Fixed Threshold (>85°C).	Contextual Threshold (82°C is normal in summer, concerning in winter).
Natural Language Interface	Codes, Menus & HMI screens.	Operator asks "Why is Unit 7 hot?" -> Agent explains reasoning.
Multi-System Orchestration	Siloed scheduling.	Checks inventory (ERP), finds window (MES), assigns tech (CMMS).

Also includes: Explainable Recommendations and Continuous Learning.

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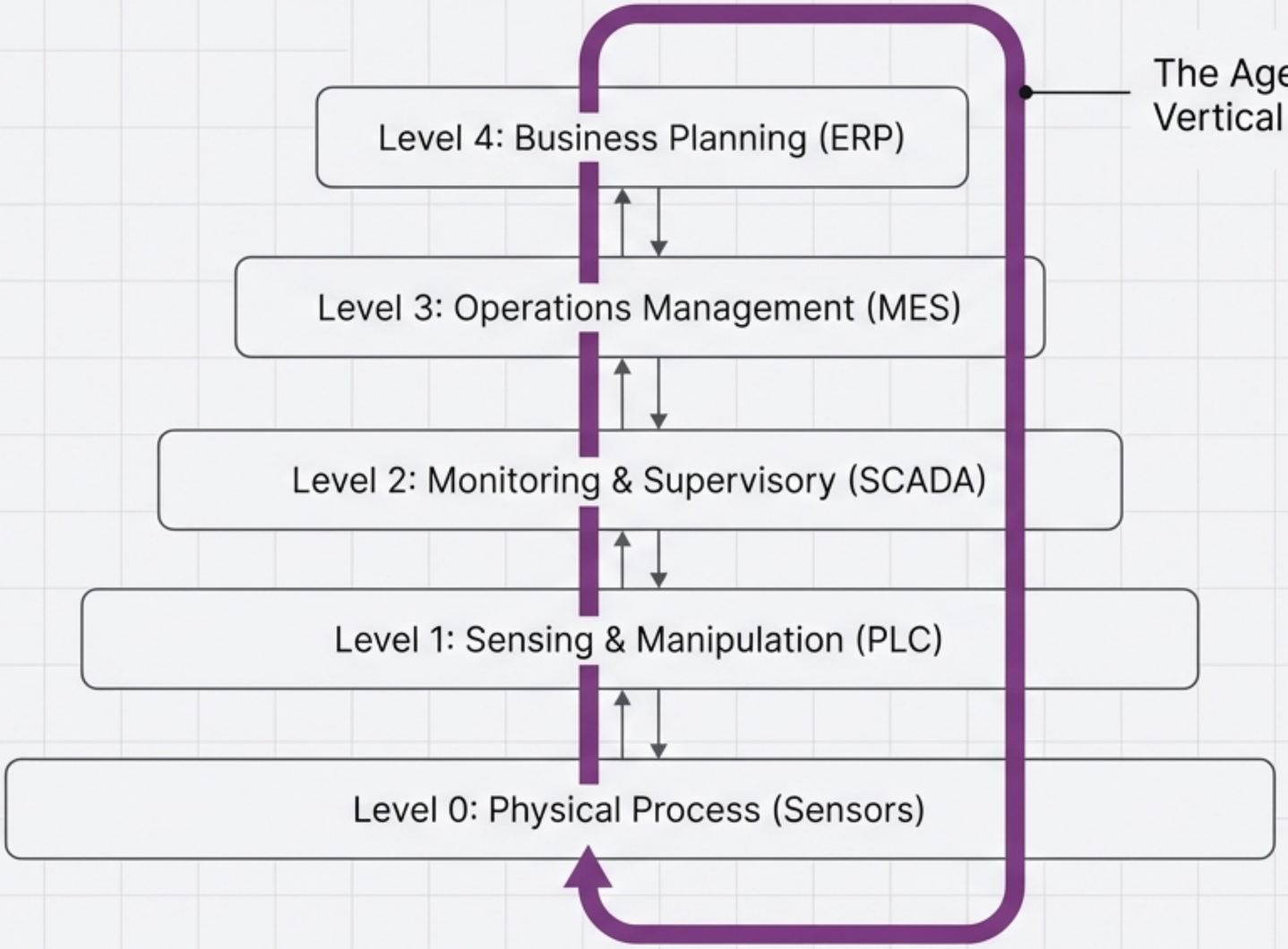
The Architectural Fit: ISA-95 Overlay



The Agent Swarm Layer:
Vertical Integration

The Swarm sits on top of the pyramid logic. It connects the sensor data (L1) directly to the maintenance schedule (L3) and inventory (L4) without requiring manual human data entry at every step.

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Meet the Swarm: Specialized Intelligence

Deployed Asset: Hydraulic Press Machine 7 (HYD_PRESS_07)

Name
DRISHTI

Role
The Watcher

Function
24/7 data watching, baseline tracking.

Name
JIBREEL

Role
The Judge

Function
Pattern recognition, deviation scoring.

Name
ATHENA

Role
The Brain

Function
Root cause analysis, diagnosis.

Name
VIDHAATA

Role
The Planner

Function
Resource optimization, work orders.

Name
HERMES

Role
The Voice

Function
Communication, escalation routing.

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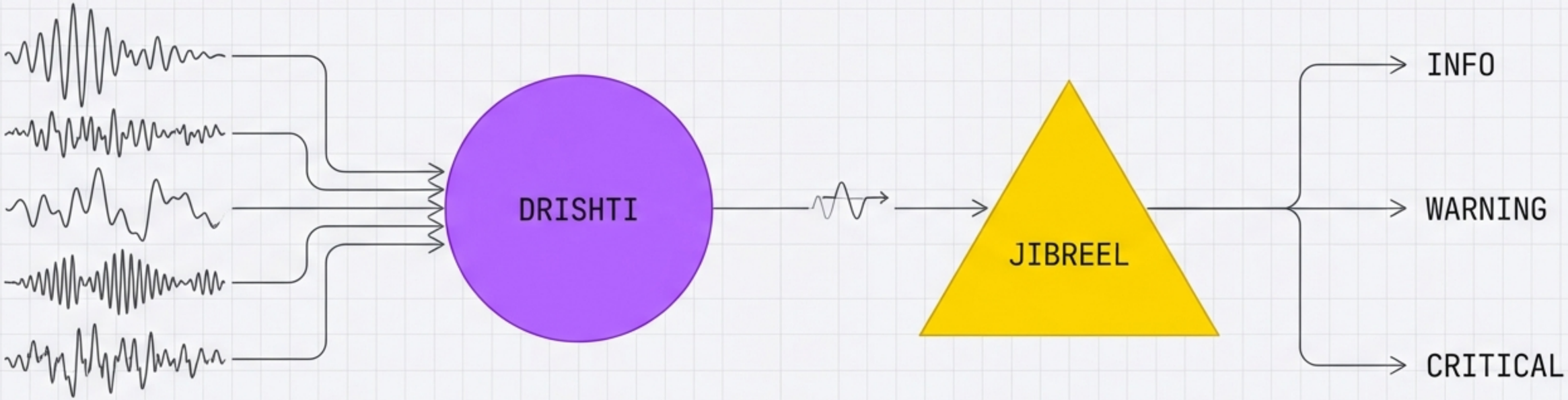
The Watchers: Ingestion & Detection



Sensor Streams

Drishti (Monitor)

- **Role:** Ingests sensor streams, maintains rolling baselines.
- **Trigger:** Flags statistical anomalies (z-score > 2.5).
- **Action:** Correlates multi-sensor patterns.

Jibreel (Detector)

- **Role:** Compares against known failure patterns.
- **Classifications:** BEARING_DEGRADATION, MOTOR_WINDING, BELT_WEAR, LUBRICATION_FAILURE.
- **Output:** Urgency Score.

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The Solvers: Analysis to Action

Athena (Analyzer)

- **Role:** Deep analysis & Hypothesis testing.
- **Logic:** 'Is this sensor error or real failure?' Correlates with historical incidents.

Vidhaata (Scheduler)

- **Role:** Logistics Engine.
- **Constraints:** Checks Production deadlines, Technician availability, Parts lead time.
- **Action:** Generates Work Order.

Hermes (Messenger)

- **Role:** Protocol Delivery.
- **SLA Protocols:**
  - **INFO:** Email/Dashboard (24h)
  - **WARNING:** SMS to Team (4h)
  - **CRITICAL:** Phone/Alarm (15m)

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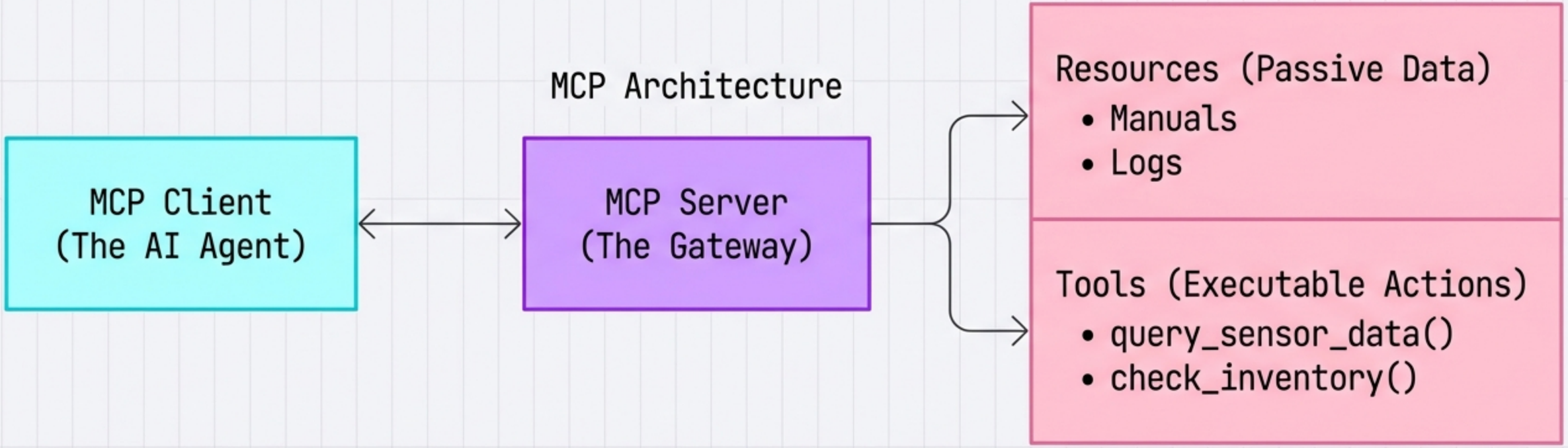
The Connectivity: Model Context Protocol (MCP)

MCP is an open standard connecting AI models to external tools and data.



Key Insight: Agents do not hallucinate data; they must query it via defined tools, exactly like a human engineer queries a database.

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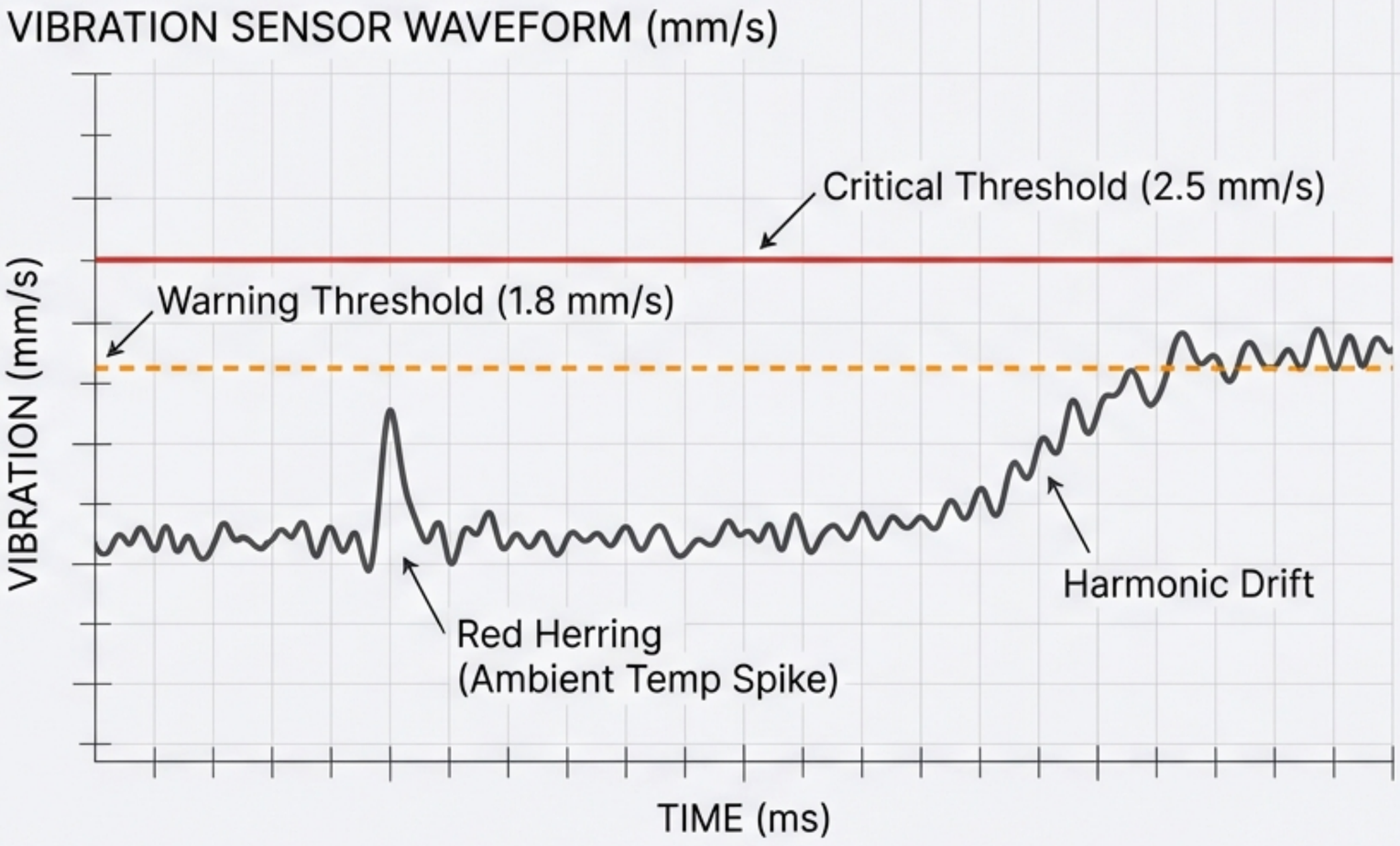
Tuning the Sensitivity: Signal-to-Noise Ratio

The Engineering Trade-off: **False Positives (Alert Fatigue)** vs. False **Negatives** (Missed Failures).



Configuration: Hydraulic Press 07

	Metric	Warning	Critical
1	Temperature	72°C	80°C
2	Vibration	1.8 mm/s	2.5 mm/s
3	Motor Current	+8%	+15%

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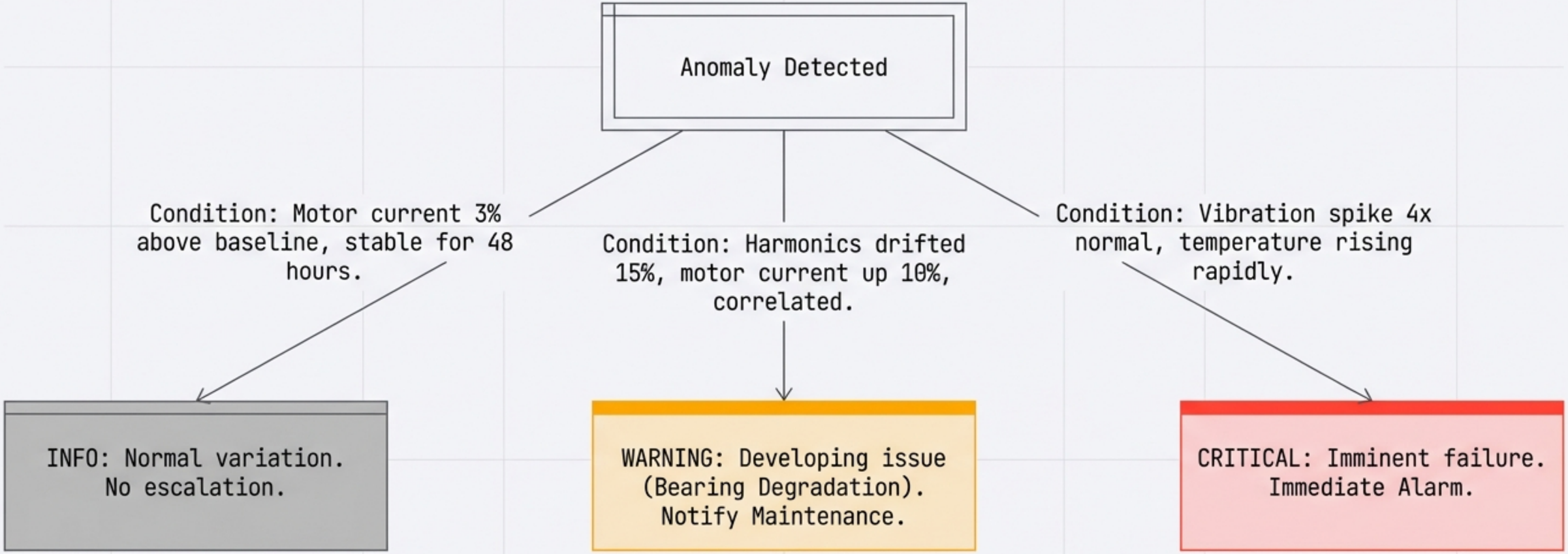
Logic Gates: The Classification Engine



Context (duration, rate of change, correlation) determines classification, not just raw value.

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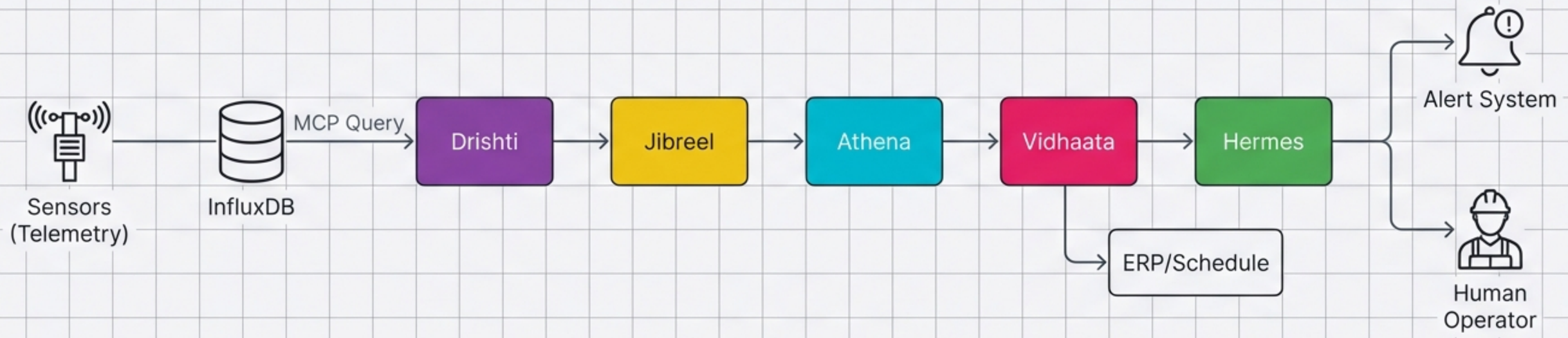
The Complete Circuit: System Architecture



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Human-in-the-Loop: The Safety Valve

AI Agents are ADVISORS, not autonomous controllers

Decider

Makes final decisions on maintenance scheduling and shuts down.

Approver

Validates diagnoses and signs off on work orders before execution

Teacher

Provides feedback on false positives to improve the model's accuracy.

Volume Control: The Swarm handles the 2,000 daily alarms so the human can focus on the 3 critical decisions.

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The Alternative Timeline: Saving Neel

Day 3
Drishti flags subtle harmonic drift.

Day 5
Jibreel classifies potential bearing issue.

Day 7
Athena confirms degradation (78% confidence).

Day 8
Vidhaata schedules maintenance for Day 14.

Day 9
Hermes notifies team & orders parts.

Day 14
Bearing replaced during planned maintenance.

Day 21
Neel operates a healthy machine. He goes home safe.

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The Mission Continues

Summary of Achievement

- Moved from raw Telemetry to Intelligent Agents.
- Built an architecture that learns, reasons, and protects.

Call to Action

Your next step: Take these concepts back to your institution. Build demos. Train students.

Create the next generation of engineers who design systems that protect workers like Neel.

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Appendix & Resources

Workshop Materials	MCP Documentation	ISA-95 Reference	FDP Next Steps
Slides, Source Code, and Dataset.	Model Context Protocol Standards.	Industrial Automation Architecture Guide.	Student Project Templates.

Ghost in the Machine: Session 2 Complete

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