Transforming Static Facilities into Living Operational Platforms

A Case Study in Digital Twin Implementation for Hyperscale Data Centers

Roots BIM LLC

Hyperscale expansion outpaces traditional facility management

Managing cloud computing, AI processing, and high-density server deployments requires orchestrating thousands of interconnected, highly redundant physical assets.

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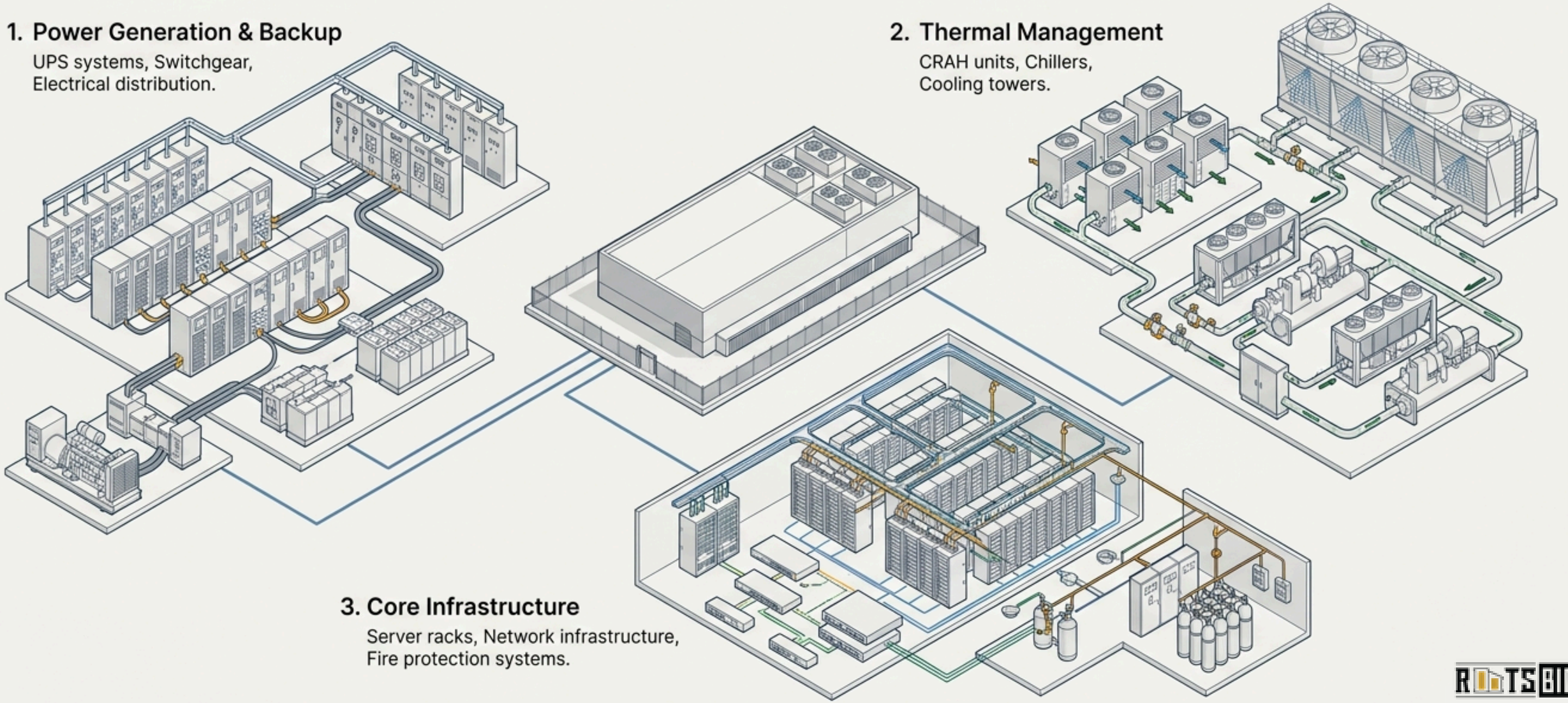
1. Power Generation & Backup

UPS systems, Switchgear,
Electrical distribution.

2. Thermal Management

CRAH units, Chillers,
Cooling towers.



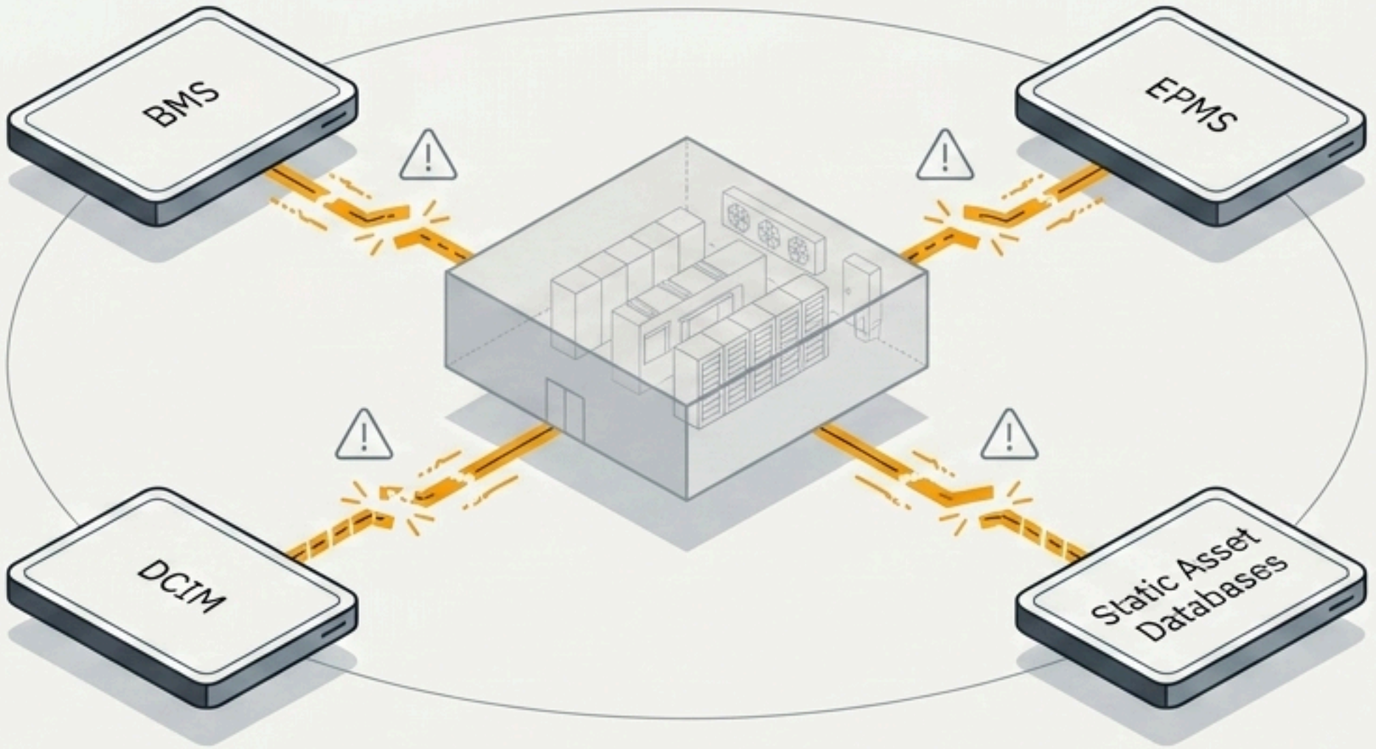
3. Core Infrastructure

Server racks, Network infrastructure,
Fire protection systems.

Fragmented data creates unacceptable operational latency

Facility engineers are forced to cross-reference multiple disconnected platforms, leading to reactive maintenance, extended troubleshooting, and blind spots in capacity planning.

The Anatomy of Fragmentation

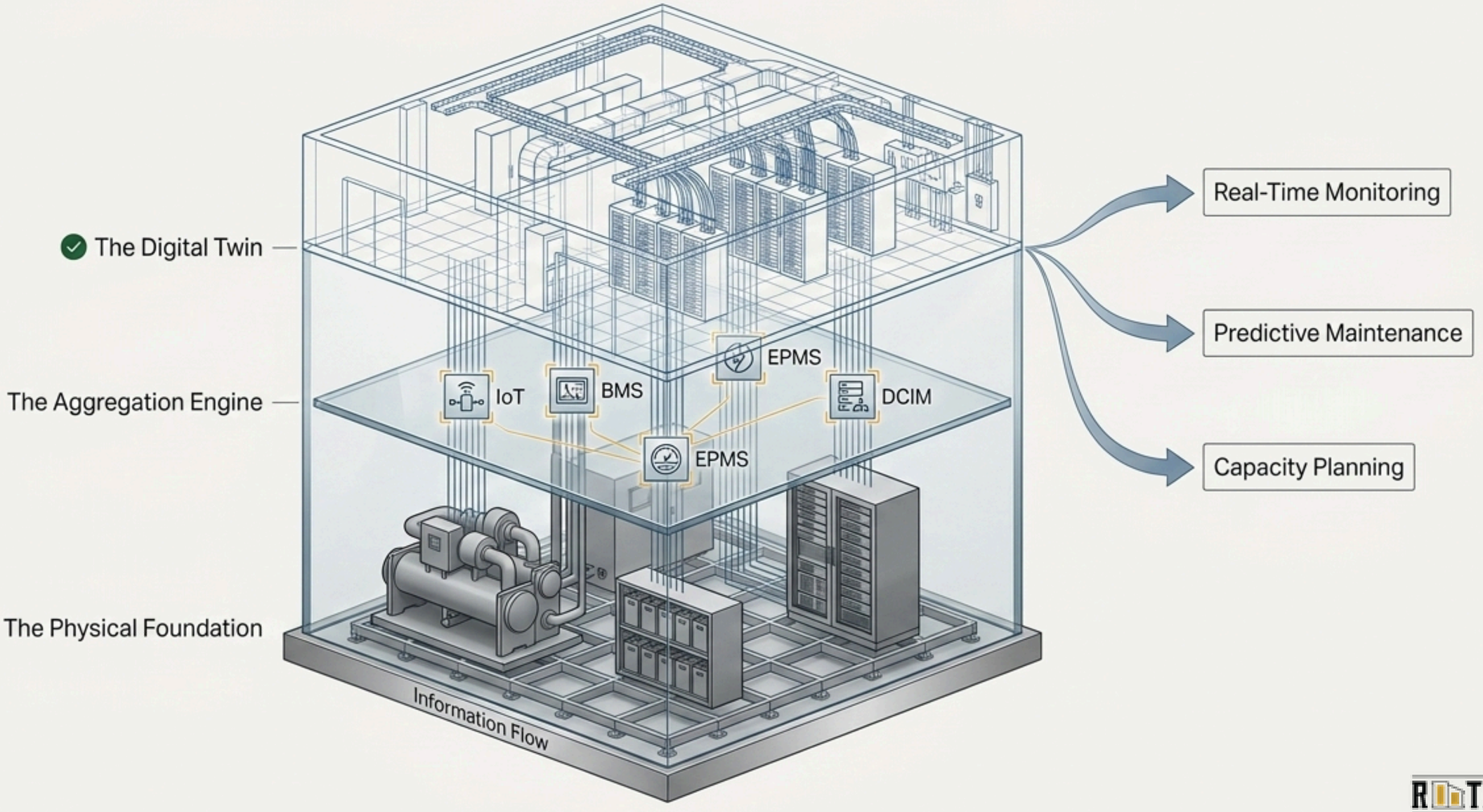


The Operational Paradigm Shift

	Legacy Facility Management	Digital Twin Intelligence ✓
Visibility	Siloed Dashboards & fragmented databases	Single, unified 3D spatial environment
Maintenance	Schedule-based, reactive service intervals	Condition-based, predictive ML anomaly detection
Capacity Planning	Spreadsheet estimates & static forecasting	Dynamic scenario simulation for power, space, and cooling
Asset Data	Static handover documents	Living Asset Information Model

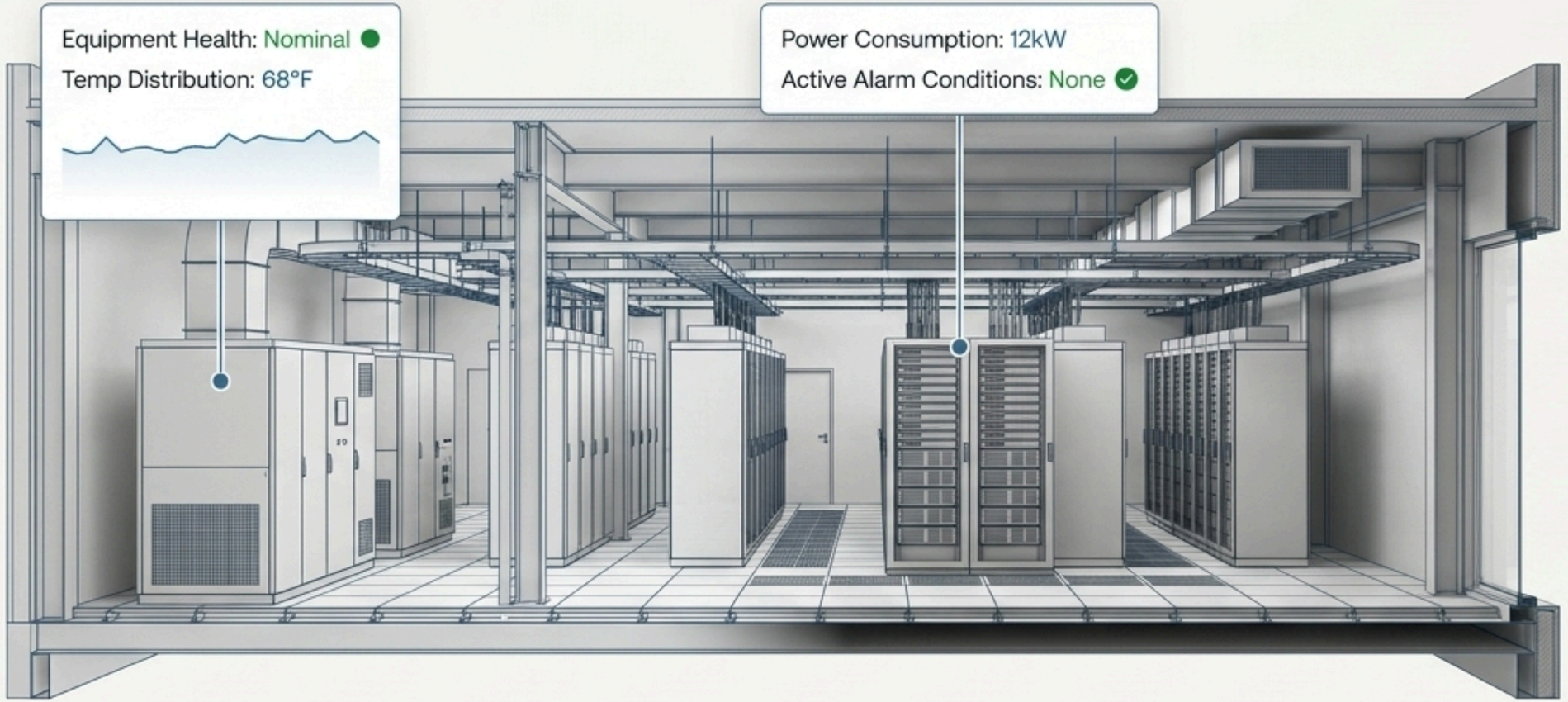
The Unified Digital Twin Ecosystem Architecture

Roots BIM integrates static geometry, live telemetry, and facility management platforms into a single, continuous operational environment.



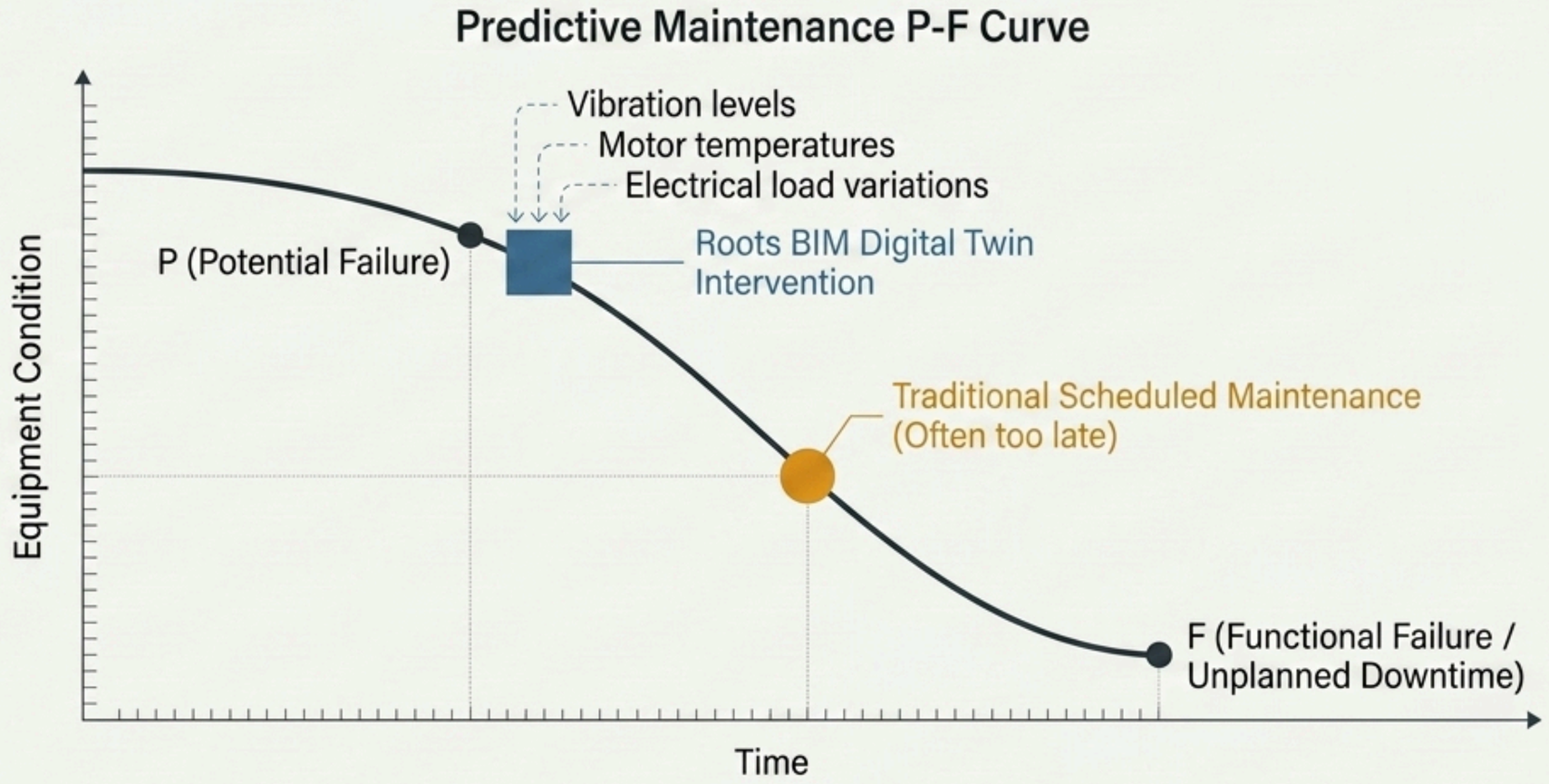
Pillar 1: Single-pane visibility across all critical operations

Facility engineers no longer review isolated dashboards. Every critical asset is monitored directly within a highly accurate, living 3D representation of the facility.



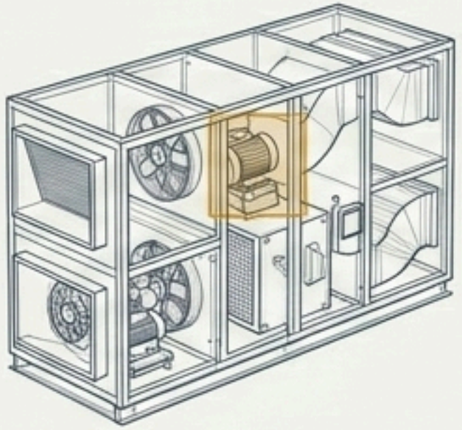
Pillar 2: Intervening before functional failure occurs

By continuously evaluating runtime analytics, sensor telemetry, and performance trends, machine learning detects degradation long before scheduled maintenance would catch it.



Translating telemetry into predictive action

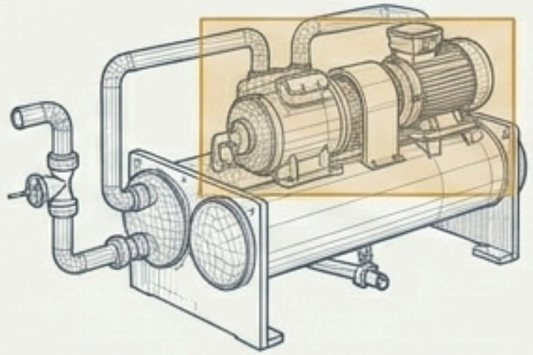
Proactive intervention replaces reactive firefighting, directly extending asset lifecycle performance and neutralizing the risk of cascading failures.



Anomaly Detection Grid

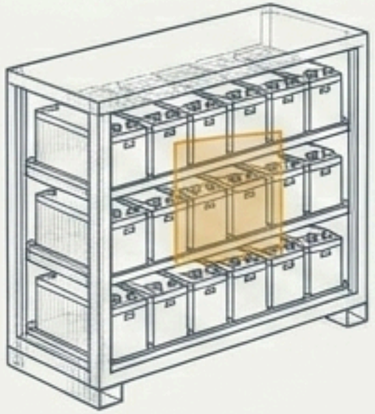
CRAH Units

Early detection of fan degradation based on runtime thresholds.



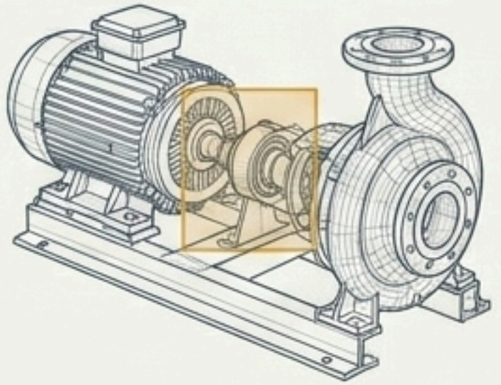
Chillers

Identification of efficiency reduction trends before cooling capacity drops.



UPS Systems

Detection of battery performance decline under electrical load variations.

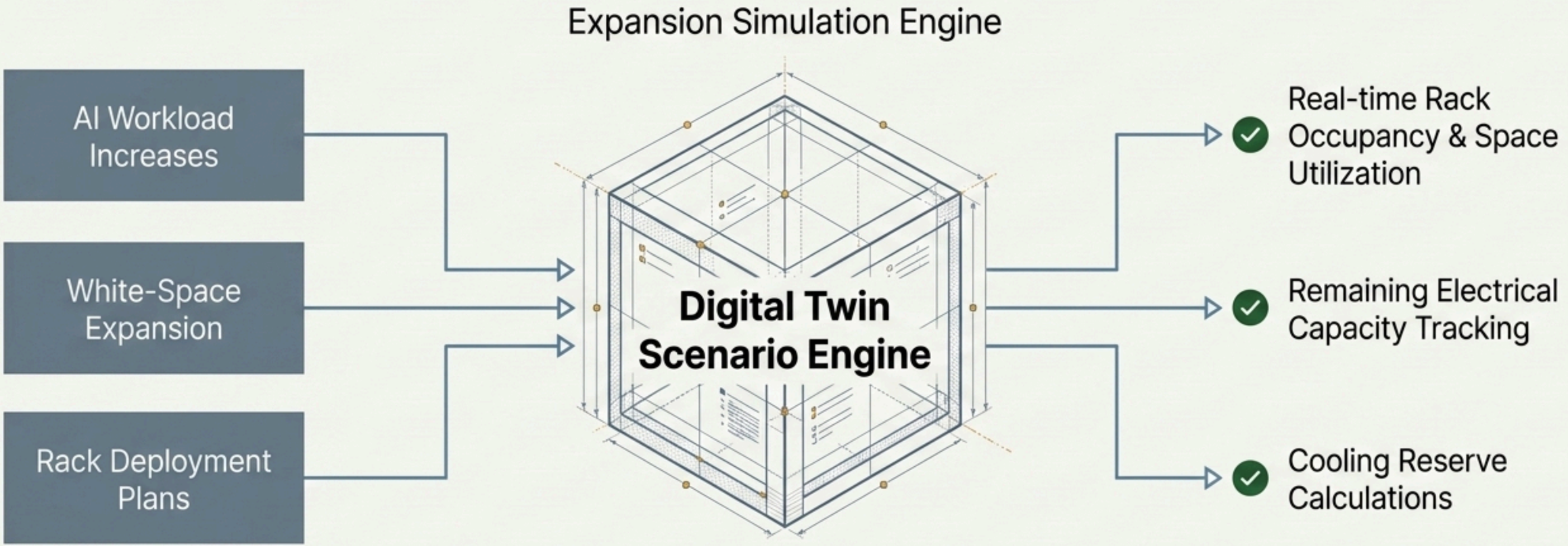


Pumps

Isolation of vibration abnormalities indicating imminent bearing wear.

Pillar 3: Simulating expansion without operational disruption

High-density computing demands precise foresight. The Digital Twin transforms capacity planning from a static spreadsheet exercise into a dynamic, data-driven engineering simulation.



Measurable operational resilience and risk reduction

Operational Visibility

- Single source of truth established
- Faster incident response
- Total system transparency

Maintenance Optimization

- Drastic reduction in reactive firefighting
- Earlier fault detection
- Improved baseline equipment reliability

Capacity Management

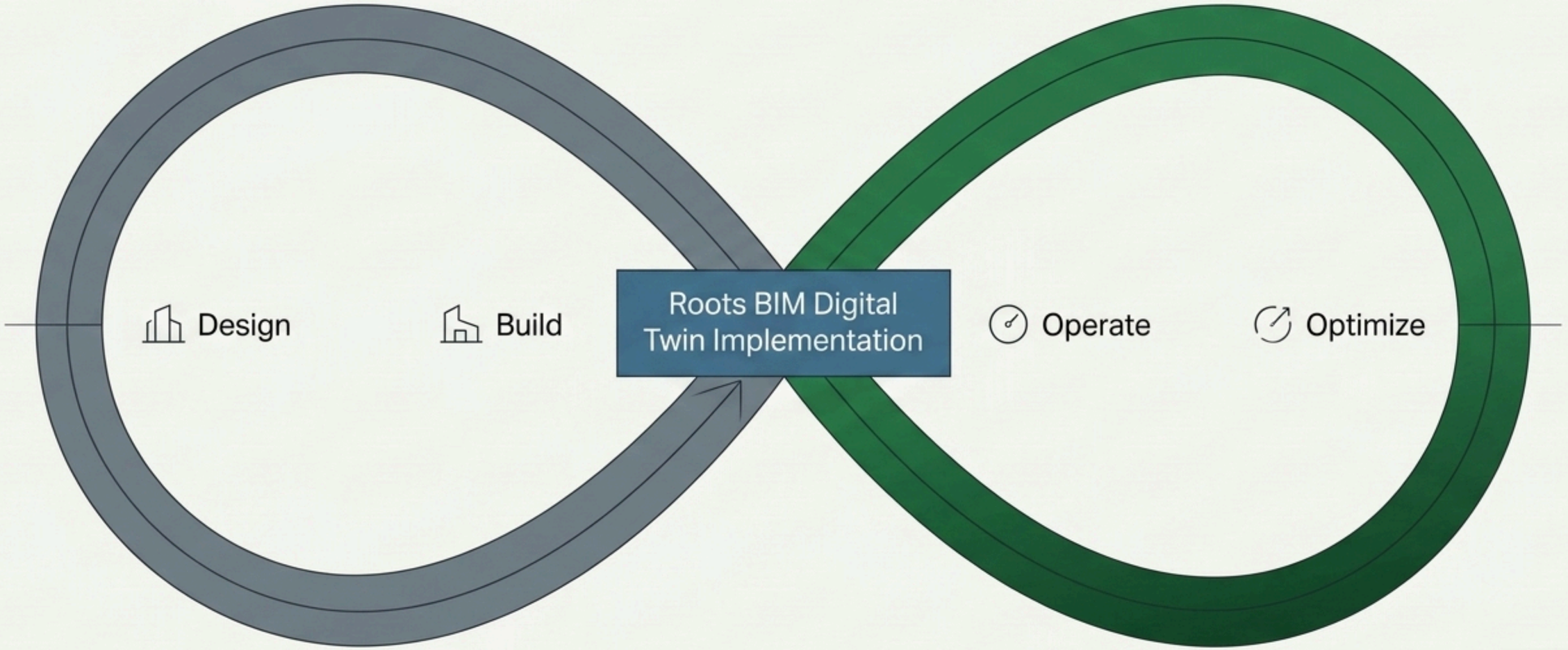
- Precise forecasting for high-density AI expansion
- Maximum utilization of existing power and cooling

Risk Reduction

- Enhanced facility-wide operational resilience
- Optimized asset lifecycle management
- Probability of unplanned outages minimized

BIM is the genesis of an operational intelligence platform

For modern data centers, BIM no longer ends at project handover. Intelligent data created during design and construction is inherently a strategic operational asset.



Engineering Intelligence Beyond Construction

Roots BIM empowers data center owners with actionable insights that guarantee performance, reliability, and efficiency throughout the entire asset lifecycle.

Technical Deliverables Checklist

- ✓ Federated BIM-based Digital Twin
- ✓ Asset Information Model (AIM)
- ✓ IoT & Sensor Integration Framework
- ✓ Real-Time Operational Dashboards
- ✓ Predictive Maintenance Analytics
- ✓ Capacity Planning Simulation Models
- ✓ Equipment Lifecycle Management Database
- ✓ Interactive 3D Facility Visualization

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