

# RigSync: A Digital Twin Platform for Onshore Rig Move Planning, Monitoring, and Delay Analysis

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### BACKGROUND / OBJECTIVE

Rig move operations involve relocating drilling rigs using over 100 heavy loads. Currently, the process relies on static spreadsheets, manual coordination, and radio communication.

This leads to:

- High Non-Productive Time (NPT)
- Inefficient scheduling
- Significant financial losses

**Objective:**  
Develop RigSync, a digital twin platform to optimize planning, monitor real-time execution and reduce delays and costs.

### PROBLEM STATEMENT

Traditional rig move operations are:

- Manual and error-prone
- Lacking real-time visibility
- Unable to adapt to delays dynamically

Resulting in:

- Poor coordination of trucks & cranes
- Increased flat time
- Inefficient decision-making

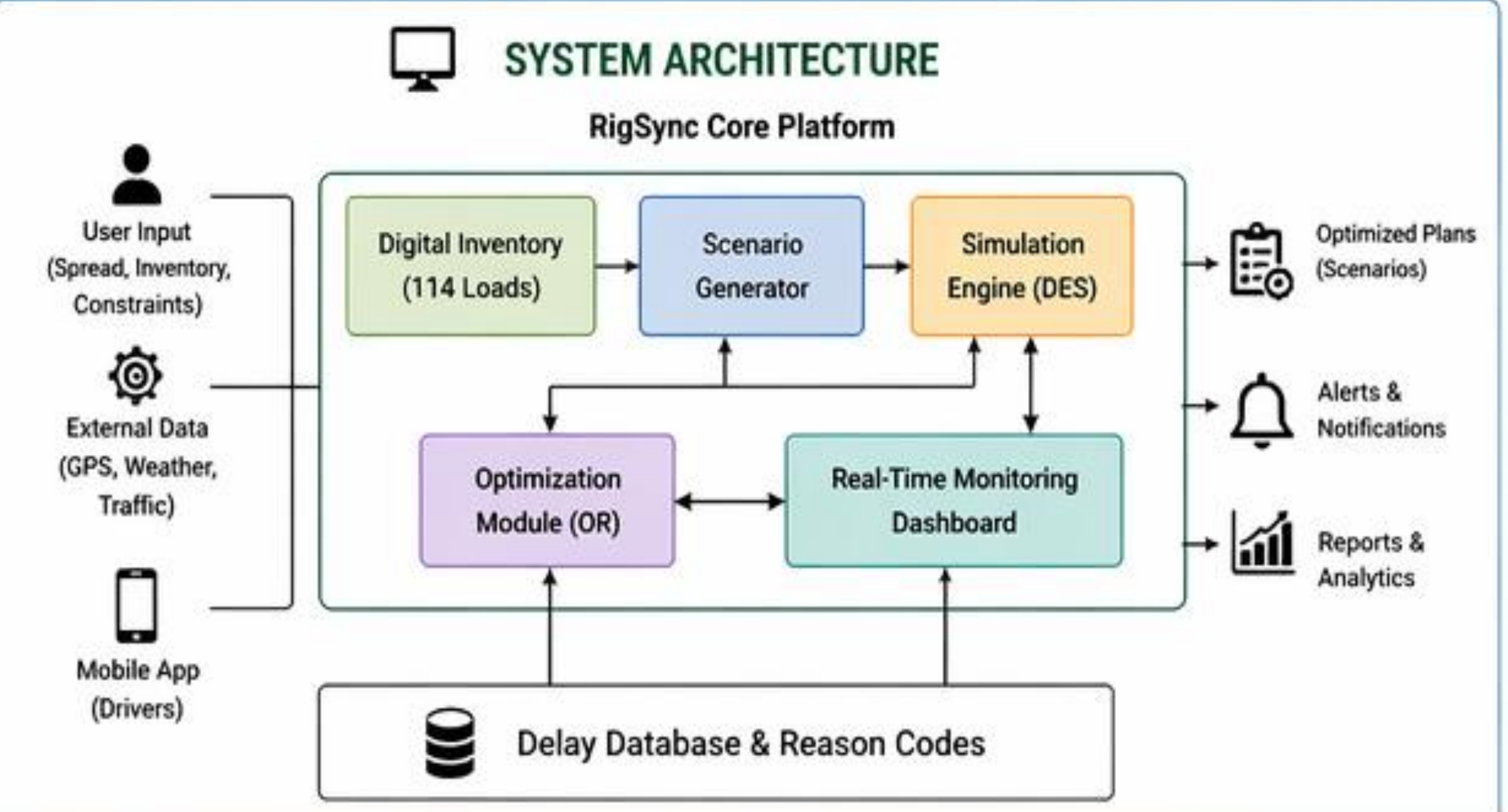


### SOLUTION OVERVIEW (RigSync)

RigSync integrates:

- Discrete Event Simulation (DES) → Scenario generation
- Critical Path Method (CPM) → 100% dependency accuracy
- Real-time Tracking (GPS) → Execution monitoring
- Optimization (OR Models) → Cost & time reduction
- Delay Analysis & Reason Codes → Continuous improvement

**Key Feature:** Real-time Plan vs Actual comparison + delay alerts



### CONSTRAINTS

- Multi-scenario planning capability
- Multi-device accessibility (web + mobile)
- Critical lifts must be scheduled during daylight
- Store delay data for post-move analysis and future planning
- Task dependency enforcement (CPM logic)

Example: Start time of task (t) ≥ Finish time of predecessor task (p)

A → B → C

### SPECIFICATIONS

- The simulation must correctly sequence 100% of rig-down dependencies (e.g., Mud Pumps cannot move before lines are disconnected).
- The system shall update plan-versus-actual comparison results within 10 minutes of receiving an execution event.
- The system shall support at least 2 languages.
- The system shall correctly identify 100% of critical-path activities for each scenario.
- The OR optimization module shall reduce the total rig move expenditure by 5% compared to traditional manual scheduling.
- 100% of rig components must be assigned to their corresponding truck type.

### INTEGRATED SPECIFICATIONS

- Update the Estimated Time of Completion (ETC) within 3 minutes after a delay event.
- Support creation and comparison of at least 3 feasible rig move scenarios per planning session.
- Generate and export a report of Real-Time Rig State and Delay Variance every 12 hours.
- Assign a reason code to all delays exceeding 20 minutes before the move can be marked as "Complete" in the system.

### MULTI-DISCIPLINARY CONTRIBUTIONS

PETE Petroleum Engineering	ISE Industrial & Systems Engineering	ICS Computer Science
<ul style="list-style-type: none"> <li>Rig breakdown into 114 transport loads</li> <li>Sequencing &amp; dependency logic</li> <li>Critical lift safety analysis</li> <li>Process knowledge &amp; field expertise</li> </ul>	<ul style="list-style-type: none"> <li>RCPS scheduling model</li> <li>Optimization (cost, time, utilization of resources)</li> <li>Constraints management</li> <li>(Max 30 workers, Max 3 concurrent tasks)</li> <li>Queueing theory for truck &amp; crane allocation</li> </ul>	<ul style="list-style-type: none"> <li>System architecture &amp; software development</li> <li>Backend, database &amp; API</li> <li>Real-time GPS tracking &amp; data integration</li> <li>Web dashboards &amp; mobile application</li> <li>Delay detection &amp; alerts</li> </ul>

Seamless integration of PETE, ISE, and ICS to deliver a complete digital twin solution for rig move operations.

### PROTOTYPE DESIGN

### VALIDATION & TESTING

Functional Testing	Performance Testing	Scenario Testing
<ul style="list-style-type: none"> <li>API endpoints tested and verified</li> <li>Scenario generation validated</li> <li>Dependency logic verified</li> </ul>	<ul style="list-style-type: none"> <li>ETC updated within 2-3 minutes</li> <li>Real-time updates &lt; 2 sec latency</li> <li>System uptime &gt; 99%</li> </ul>	<ul style="list-style-type: none"> <li>Fastest Plan</li> <li>Cheapest Plan</li> <li>Best Resource Utilization Plan</li> </ul>

All validated successfully

### RESULTS

Performance Improvements	System Capabilities
<ul style="list-style-type: none"> <li>Cost reduction compared to traditional planning</li> <li>Up to 14% Improvement in total schedule (flat time)</li> <li>100% Accurate critical path identification</li> </ul>	<ul style="list-style-type: none"> <li>Real-time monitoring of all loads and crews</li> <li>Automatic delay detection &amp; alerts</li> <li>Standardized reason codes for delays</li> <li>Multi-scenario comparison for better decisions</li> <li>Reports generated every 12-hour shift</li> </ul>

### CONCLUSION

RigSync successfully demonstrates that rig move operations can be digitized, optimized, and monitored in real time.

- Improves planning accuracy
- Reduces delays and costs
- Enhances resource utilization
- Supports data-driven decisions

RigSync provides a scalable, low-cost digital solution that can significantly reduce NPT and improve operational efficiency in the oil & gas industry.

### FUTURE WORK

- Integrate real field data instead of synthetic data
- Enhance GPS & IoT integration for better accuracy
- Improve UI/UX for non-technical users
- Deploy in real rig move operations & collect field feedback
- Add predictive analytics using historical delay data