Scaling Challenges For A Large-scale Drilling Asset Health Digital Twin Solution With Generative AI Model

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Objectives/Scope: This work highlights the challenges and solutions in scaling a drilling asset health digital twin solution with Generative AI (GenAI) model to over 100 rigs in under two years while processing 2-billion real-time data points and 60-Million database queries per day. The authors explore the solutions implemented to overcome challenges including distributed data collection, data processing, database reliability, and GenAI model integration.

Methods, Procedures, Process: The energy industry is actively adopting AI, yet many solutions fail to proceed beyond the pilot stage. This work describes the process of scaling a drilling asset digital twin solution across 100 rigs in under two years. Scaling challenges include: 1) collecting and cleaning multi-source, asynchronous data from disparate data sources across rig sites, cloud-based services, and third-party providers; 2) supporting demanding data processing requirements at a commercial scale; 3) Solving database scaling problems; 4) supporting GenAI Asset Life Model integration; 5) Rapidly iterating with end users and domain experts to drive successful adoption.

Results, Observations, Conclusions: The project's business case relied on rapidly scaling the solution to prevent or mitigate an array of failure events which drive down asset reliability and increase total cost of ownership. Upon reaching 30 rigs, data processing stability issues arose which halted expansion. A novel architecture using distributed data processing plus database containers introduced a stable, clean data-layer which enabled scaling from 30 to over 100 rigs.

End-user adoption was prioritized in the project scope as an enabling force to reach the entirety of the rig fleet. Low-code data workflows enabled rapid, iterative development; rapid development cycles provided faster resolution to end-user and domain expert feedback. This feedback varied from pain-points, use cases, and feature enhancements; quick implementation of solutions resulted in enhanced user experience and improved user engagement. Furthermore, legacy workflows were not rewritten but complemented with the new tool. Existing workflows relied on paper ledgers, where the more onerous data entry in a digital workflow reduced the overall effort for the task through automation.

The creation of GenAI asset and component life models introduced normalized health predictions across variable operating parameters and regions. These models not only improved rig maintenance decisions but proved critical in assessing vendor performance and subsequent supply chain efficiencies.

Novel/Additive Information: This paper examines unanticipated challenges in the scaled deployment of a high-performance digital twin solution with advanced Generative AI model. While many focus on the building of models, the infrastructure behind the model proved critical to process and wrangle 2-billion data points per day in real-time. Furthermore, the prioritization of rapid integration of end-user feedback drove engagement with remote teams to drive successful adoption.