Palantir

# Palantir Foundry for Energy

## Optimizing Operations with Vertex

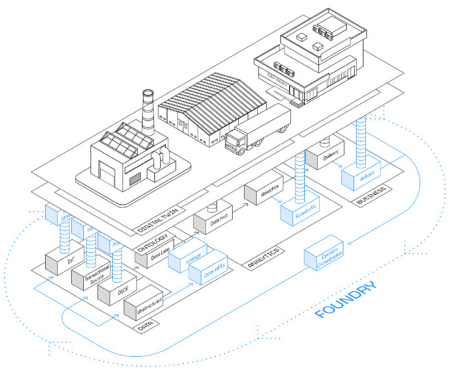
Palantir Technologies
→ palantir.com



Copyright © 2022 Palantir Technologies Inc. ("Palantir"). All right reserved. The information in this document is proprietary and confidential, and includes certain Palantir trade secrets. Unauthorized disclosure to any third party is strictly prohibited. The content provided herein is provided for informational purposes only and shall not create a warranty of any kind.

Palantir

# Palantir Foundry Energy – Optimizing Operations with Real-Time, Digital Twin Simulations




Building operator trust in new tooling is one of the most significant challenges of digitalization. While testing and experimentation is the required process of discovery to ensure the optimal operation of all our assets, rigorous safety and uptime requirements make iteration difficult. Digital twins help bridge this gap by providing a virtual sandbox that matches the physical reality—allowing for digital exploration of numerous possibilities to identify the correct scenario to replicate in the physical world.

These decisions all hinge on constructing a true twin—a perfect mirror—of any asset. Managing the real-time sensor streaming scale, simulation modeling complexity, asset visualization, and data analysis is a towering challenge for any organization. Palantir's Vertex digital twin product suite streamlines this process so that assets can be rapidly mirrored in digital environments and can be trusted to match the physical reality through time. The Vertex tooling ensures that operators can not only respond to immediate problems today, but they can focus on defining the desired operation and lifecycle of an asset into the future.

## Features

### 1 Live data integration

Vertex connects to your sensor streaming infrastructure to provide real-time insight into asset operation. This allows the digital twin to serve as a live mirror for the asset, and built-in analytical tooling allows for inline transformation and analysis of this timeseries data.

### 2 Simulation model mesh

Complex machinery routinely utilize distinct models for each phase of the operation. These models are normally run independently, but during physical operation, the outputs of one phase are the inputs of the other. Vertex's model mesh infrastructure manages this complexity by chaining individual models, allowing the model mesh to be run as a single model representing the totality of the asset while respecting the interdependencies between each stage.

Copyright © 2022 Palantir Technologies Inc. ("Palantir"). All right reserved. The information in this document is proprietary and confidential, and includes certain Palantir trade secrets. Unauthorized disclosure to any third party is strictly prohibited. The content provided herein is provided for informational purposes only and shall not create a warranty of any kind.

Palantir

## 3 Asset visualization

Vertex provides graph-based tools to understand relationships between asset components, and these can also be viewed as PFDs or P&IDs to match operator experience. The digital linkages within the digital twin allow for full traversal across a plant's diagrams, and live sensor and sim results provide full interactivity for operators to interrogate their assets.

## 4 Data analytics & modeling

Vertex natively integrates with the Foundry platform, allowing for all digital twin configurations and results to be analyzed and explored within low-code/no-code and developer environments. The open APIs with Foundry allow for further extension and interoperability with existing software investments, allowing Vertex to easily integrate into your target architecture.

## Solutions

Further information is available in the dedicated case studies for each solution.

### 01 Operations Monitoring →

Vertex digital twins are configured with leveled safety limits for sensor feeds to provide real-time, contextualized signal for changing conditions on the asset. The Foundry Taurus engine provides additional flexibility for operators to define complex, cascading scenarios for differing warnings and triggers using a no-code authoring environment. These are then continually monitored utilizing AI tooling and operator feedback to identify high-signal events and reduce the noise within the event stream. This feedback loop ensure the most critical events are always prioritized for operation decisioning and action.

### 02 Performance Simulation →

Vertex's simulation mesh allows for continuous evaluation of the expected behavior of the asset by flowing through real-time sensor and asset configuration data. These expected yields and performance characteristics provide operators a baseline for comparison. These results can then be easily interrogated with Foundry's built-in timeseries and data transformation tools to construct performance metrics, trend analyses, and yield assessments.

### 03 Digital Twin Health →

Real-time results from the Vertex simulation mesh are compared to actuals reported from the asset to identify deviations between the digital twin and reality. This streamlines digital twin setup by quickly identifying the points where the model needs to be tuned to better represent the physical asset and accelerates the construction of a true mirror. Once the digital twin is in operation, deviations between simulations and actuals provide additional signal on performance or reliability issues for equipment over time as drift occurs and provides a live view on the health of both the twin and the asset.

Copyright © 2022 Palantir Technologies Inc. ("Palantir"). All right reserved. The information in this document is proprietary and confidential, and includes certain Palantir trade secrets. Unauthorized disclosure to any third party is strictly prohibited. The content provided herein is provided for informational purposes only and shall not create a warranty of any kind.

04 Scenarios & Opportunities →

Identifying opportunities can be a long cycle effort between engineering, operations, and maintenance teams with wide confidence intervals on the expected value. Vertex allows teams to directly test configurations, visualize the impact on the current plant based on live sensor data, save these scenarios as discrete opportunities, and schedule work orders to deploy the change in the field. Past scenarios are routinely re-run as the operating environment changes between initial request and implementation time to ensure the expected value of the work order is still realized.

05 Yield Optimization →

Finding the optimal setpoint within current operating limits can be a tedious, trial-and-error effort. Vertex leverages its built-in AI techniques to evaluate thousands of possible configurations and surface the optimized setpoint based on the operator's goal (max boe, min gas, min carbon impact). This optimization can then be taken further by assessing the impact on topside, collection, and transportation infrastructure and associated models. This chained execution through the simulation mesh enables Vertex to identify global optima across the value chain.

## Getting Started

Vertex is a cloud-managed, modular product suite, simplifying the deployment and startup process. We provide the below connectors to bootstrap your digital twin, and our open APIs allow us to connect to more complex and customized systems. Don't have all the pieces yet? Let us know and we can share our expertise on constructing the most accurate digital twin to drive the largest operational impact—no matter where you are in the journey.

1 Timeseries data

- → OSISoft PI
- → SCADA/HMI
- → Cygnet

2 Simulation models

- → GAP
- → PROSPER
- → HYSYS

3 Asset configuration data

- → SAP
- → WellBook
- → PI AF



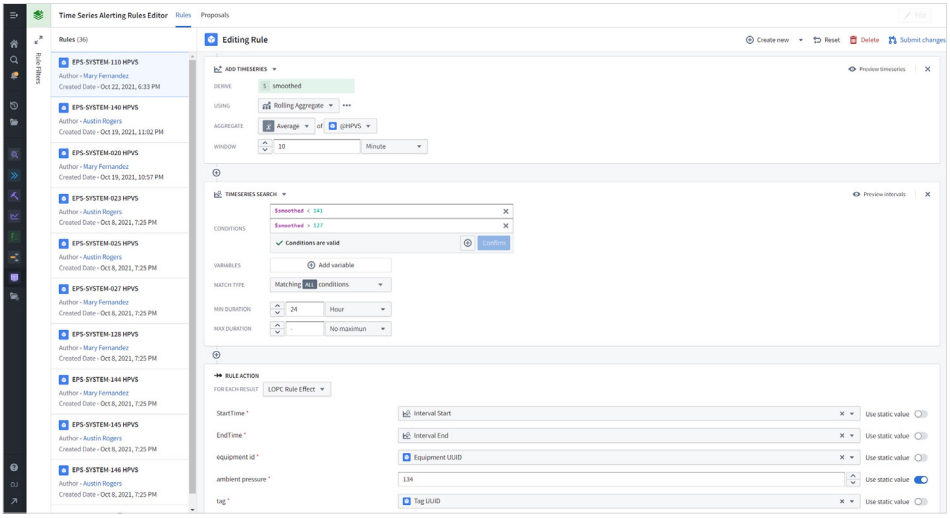
Copyright © 2022 Palantir Technologies Inc. ("Palantir"). All right reserved. The information in this document is proprietary and confidential, and includes certain Palantir trade secrets. Unauthorized disclosure to any third party is strictly prohibited. The content provided herein is provided for informational purposes only and shall not create a warranty of any kind.

Palantir

# Operations Monitoring – Separate the signal from the noise and action the most important issues

- → Where is the risk greatest on my asset? Where should I focus?
- → Do I trust my alerts? Are they actionable signals?
- → How do I contextualize this alert within the system it operates in?

Increased measurement and real-time sensor streaming can overload operators with a deluge of potential signal that currently is just noise. The barrage of alerts pull operators in numerous directions, and the stream of false positives can undermine operator trust. Vertex solves these failures by focusing operator attention on the most critical alerts, and it continuously learns from operator feedback to tune alerts and suppress false alerts. By integrating with the digital twin, every alert is contextualized within its equipment constellation to streamline root cause analysis.




## Features

### 1 No-code definitions

Users can define alerts on equipment from simple thresholds to complex decision trees without writing a single line of code

### 2 Alert scoring

Operator feedback allows alerts to be cataloged based on their accuracy, focusing operator attention where it's needed most

### 3 P&ID integration

Alerts are integrated directly into the digital twin view to allow related alerts for linked systems to be identified and collectively actioned

Copyright © 2022 Palantir Technologies Inc. ("Palantir"). All right reserved. The information in this document is proprietary and confidential, and includes certain Palantir trade secrets. Unauthorized disclosure to any third party is strictly prohibited. The content provided herein is provided for informational purposes only and shall not create a warranty of any kind.

## Case Study

| | | | |
|---|---|---|---|
| 01 | Define operating limits | → | A partner uses the Taurus engine (pictured above) to enable operators to unilaterally define alerts and thresholds without IT assistance. Alerts are shared across teams to allow cross-region pollination of operating behaviors and surface the best paradigms from across the business. |
| 02 | Contextualize alerts within the broader asset | → | Operators leverage the Vertex digital twin to track current sensor readings and associated alerts in-line. Alerts upstream and downstream of a particular event can quickly be identified, and operators bundle these into a single investigation for ease of analysis. |
| 03 | Provide feedback on the outcome and next steps | → | Operators save analysis results against the alerts and note the outcome. This is then indexed by Vertex, so that when the particular alert type triggers in the future, operators can quickly review how the event was handled in the past and carry forward any context from similar events. |
| 04 | Integrate operator feedback to improve future alerts | → | Vertex continually scores alert types based on operator action and surfaces low-signal alerts to engineering and operations teams for review. The teams collectively review past investigations to refine the alerting criteria. |



Copyright © 2022 Palantir Technologies Inc. ("Palantir"). All right reserved. The information in this document is proprietary and confidential, and includes certain Palantir trade secrets. Unauthorized disclosure to any third party is strictly prohibited. The content provided herein is provided for informational purposes only and shall not create a warranty of any kind.

Palantir

# Performance Simulation – Interrogate your digital twin to analyze current, and forecast future, performance

- → Are current measurements for my asset in-line with expectations?
- → What can I infer about performance of my unmetered equipment?
- → How can I expect my asset to perform in future periods if conditions remain the same?

Operators receive continuous data on what's happening on the asset, but it's equally important for operators to have a handle on what should be happening on the asset. Without it, operators are faced with an execution fog obscuring which way the asset is trending and how all the intermediate systems are functioning. Vertex cuts through this haze and provides operators clarity. Contextualize real-time asset performance against modeled expectations, understand operating points of intermediate systems, and forecast the future trends for your asset—all achievable with the Vertex suite.




## Features

### 1 Simulation model mesh

Vertex integrates your models with real-time sensor data to provide a live look into expected asset performance.

### 2 Timeseries analysis

Transform and combine timeseries data to model asset performance, even at unmetered points.

### 3 AI & modeling

Complex machine learning techniques to standardized regressions can be executed to forecast expected future performance.

Copyright © 2022 Palantir Technologies Inc. ("Palantir"). All right reserved. The information in this document is proprietary and confidential, and includes certain Palantir trade secrets. Unauthorized disclosure to any third party is strictly prohibited. The content provided herein is provided for informational purposes only and shall not create a warranty of any kind.

## Case Study

| | | | |
|---|---|---|---|
| 01 | Run simulations using live, timeseries sensor data | → | A partner used to rely on their subsurface modeling only for annual planning in Jan., and operators had limited visibility into expected behavior for the rest of the year. Vertex allowed for real-time monitoring of simulated yield, and operators could now contextualize performance against the expected plan. |
| 02 | Construct synthetic timeseries for unmonitored equipment | → | Operators took this one step further by conducting their own analyses on simulation results to generate inferred timeseries for unmetered equipment. This allowed operators to understand how these unmetered parts were behaving and how this fit into their reliability and maintenance plans. |
| 03 | Analyze system production and performance | → | Simulation results were also utilized to provide real-time analyses of expected vs. actual yields across the field and allowed operators to identify deferral events that were previously unreported. These production deltas could then be tracked through time to close the operating gap. |
| 04 | Forecast future performance | → | Operators then extended these analyses using modeling tools within the Vertex suite to build trend analyses for production yield in the current conditions. These were then also saved as synthetic timeseries to allow continuous comparison between the forecasted performance and actual results. |



Copyright © 2022 Palantir Technologies Inc. ("Palantir"). All right reserved. The information in this document is proprietary and confidential, and includes certain Palantir trade secrets. Unauthorized disclosure to any third party is strictly prohibited. The content provided herein is provided for informational purposes only and shall not create a warranty of any kind.

Palantir

# Digital Twin Health – Build trust in your digital twin to build trust in your operational decisions

- → Does my digital twin perfectly mirror my physical asset?
- → Is divergence between the two due to model error or asset issues?
- → Has the operating envelope for my equipment changed?

One of the most significant challenges digitalization efforts face is building operator trust in new tooling. After all, if a digital twin doesn't perfectly mirror the physical reality, it's just another pretty dashboard without functional use. Vertex tackles this issue head-on by providing operators a continuous line of sight into model health throughout the digital twin configuration process. Once operators are confident in simulation outputs, they diagnose divergence drivers on the asset and build confidence in the expected results of their actions.




## Features

### 1 Simulation APIs

Vertex ships with out-of-the-box connectors for the most popular simulation engines. If you have in-house solutions, our extensible APIs will integrate with these as well

### 2 Model health monitor

Vertex continually calculates the deviation between modeled and actual values, allowing teams to track the temporal health of their digital twin. The fidelity of this model can then provide context for the fidelity of operator decision-making.

Copyright © 2022 Palantir Technologies Inc. ("Palantir"). All right reserved. The information in this document is proprietary and confidential, and includes certain Palantir trade secrets. Unauthorized disclosure to any third party is strictly prohibited. The content provided herein is provided for informational purposes only and shall not create a warranty of any kind.

## Case Study

| | | | |
|---|---|---|---|
| 01 | Define operating limits | → | A partner selected a cross-functional team of engineers and operators to stand up the digital twin for their first asset. The group defined their models with GAP, PROSPER, and HYSYS and believed the network to be the best representation possible. After integrating it with Vertex and running the health module, discrepancies in actual results were identified and the team iterated on their digital twin setup. This effort improved model health and saw an organization-wide improvement in trust of their modeling and digital efforts. |
| 02 | Remedying issues in equipment operation | → | In the first divergence event, yield through a compressor station dropped relative to the simulated target. As model health metrics had been historically green for the trailing period, a work order was opened for the specific part with deviating measurements and the issue was identified. This automation accelerated the time to root cause and moved the focus to resolution. |
| 03 | Assessing model divergence | → | In a following event, pressure readings for a station saw a sudden swing in readings. The digital twin's integration with the SAP work order management system allowed operators to flag a recent bypass action that had been performed on the system. This change was integrated into the model to quickly bring model health back in sync, and operator trust in results endured. |



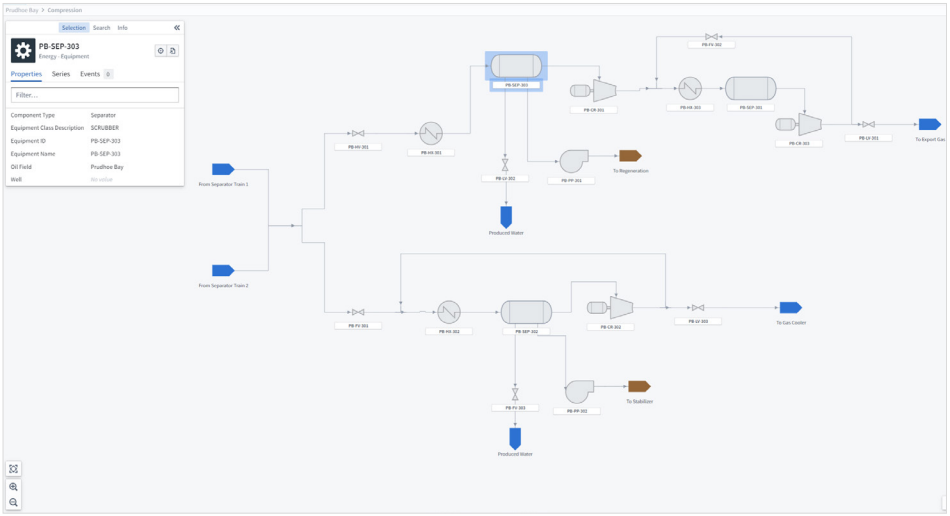
Copyright © 2022 Palantir Technologies Inc. ("Palantir"). All right reserved. The information in this document is proprietary and confidential, and includes certain Palantir trade secrets. Unauthorized disclosure to any third party is strictly prohibited. The content provided herein is provided for informational purposes only and shall not create a warranty of any kind.

Palantir

# Scenarios & Opportunities – Discover value by taking your digital twin where your asset has never gone before

- → How is performance impacted if I make this change on the asset?
- → How will the asset respond to such changes in environmental conditions?
- → Can I still expect the same yield from changes I planned in the past?

Discovering opportunities for improvement is an iterative process on any asset, but this can prove to be too risky on complex systems where uptime is of paramount importance. Vertex allows operators to digitally run various scenarios—consisting of changes to the asset or its surrounding environment—in order to surface valuable opportunities without risking the asset itself. Deploy changes with confidence and ensure every change has the desired impact, especially when planned years before installation.




## Features

### 1 Config Constructor

Operators may define scenarios of interest within the no-code/low-code authoring space.

### 2 Scenario Analysis

Scenarios are run through the simulation model mesh and results are collated for comparison.

### 3 Opportunity Monitor

Save certain scenarios as opportunities and tie them to associated work orders and maintenance events. Track these opportunities through time.

Copyright © 2022 Palantir Technologies Inc. ("Palantir"). All right reserved. The information in this document is proprietary and confidential, and includes certain Palantir trade secrets. Unauthorized disclosure to any third party is strictly prohibited. The content provided herein is provided for informational purposes only and shall not create a warranty of any kind.

## Case Study

| | | | |
|---|---|---|---|
| 01 | Defining scenarios of interest | → | Engineers at a partner worked with finance and operations teams to define a series of scenarios to transition the asset. A minor program defined setpoint changes within the current operating envelope, a major program defined pipe routing changes at an export bottleneck, and a special carbon program defined a proposal to cut scope 1 & 2 emissions. |
| 02 | Understanding the opportunity | → | Scenarios were run through the simulation model mesh within Vertex and results were collected for comparison. The major/minor program review surfaced that the larger change would have a great impact to production totals and was scheduled for the asset. The carbon program was reviewed with the finance team in preparation for changes to emissions targets. |
| 03 | Ensuring the desired result is achieved | → | Over the next year, several additional changes were required on the asset based on maintenance and environmental factors. The opportunity monitor within Vertex continued routine assessment of the previously scheduled major program, and it alerted engineers when the expected yield could no longer be achieved given the current asset configuration. This enabled engineers to proactively remove the work order from the schedule in favor of other opportunities with greater expected yield. |



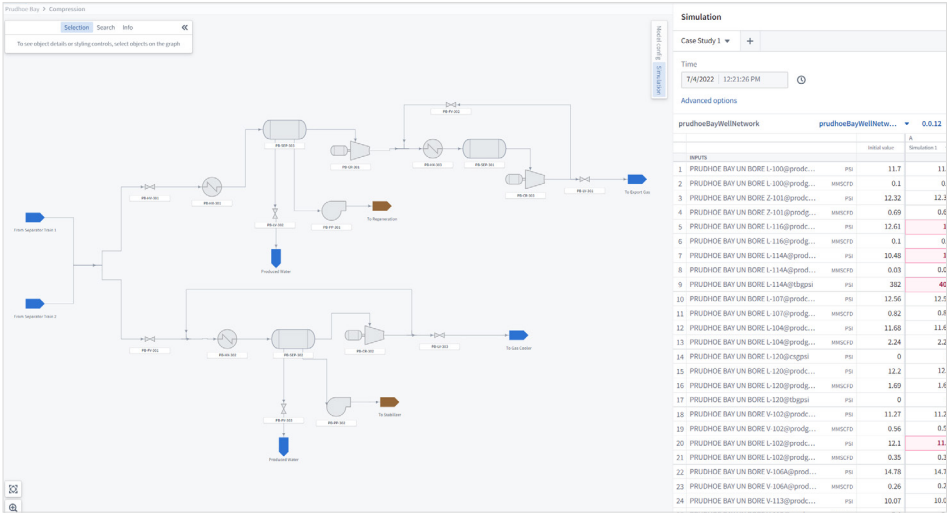
Copyright © 2022 Palantir Technologies Inc. ("Palantir"). All right reserved. The information in this document is proprietary and confidential, and includes certain Palantir trade secrets. Unauthorized disclosure to any third party is strictly prohibited. The content provided herein is provided for informational purposes only and shall not create a warranty of any kind.

Palantir

# Yield Optimization – Let your digital twin stay up all night to find the perfect asset configuration

- → How can I change the configuration of my asset to maximize yield in current conditions?
- → Where should I change the asset design to have the largest impact on overall performance?

Even with the most sophisticated simulation tools, operators face the challenge of identifying the right setpoint with their digital twins. With every marginal step forward through scenario modeling and discovery, the question remains whether there's still headroom for further improvement. Vertex takes the guesswork out of this process by deploying optimization routines to find the configuration that generates the greatest yield. In fact, Vertex can replan your asset as well, identifying if resizing equipment is a path to greater success.




## Features

### 1 Integrated optimization

Vertex executes optimized search functions through the model space.

### 2 Multi-target optimization

Balance yield across multiple outcomes (e.g. liquids, gas, carbon) to reach a true optima for multiple criteria.

### 3 Asset reconfiguration

Vertex allows optimization routines to run in hypothetical boundaries with a multitude of equipment sizes to allow operators to right-size their setup for maximum yield.

Copyright © 2022 Palantir Technologies Inc. ("Palantir"). All right reserved. The information in this document is proprietary and confidential, and includes certain Palantir trade secrets. Unauthorized disclosure to any third party is strictly prohibited. The content provided herein is provided for informational purposes only and shall not create a warranty of any kind.

## Case Study

| | | | |
|---|---|---|---|
| 01 | Defining target variables and operating limits | → | After configuring their digital twin, a partner dove into identifying optimization opportunities. Operators set high/low operating thresholds for equipment and associated sensors to bound the Vertex optimization routines. Operators may choose limits that extend beyond current limits, as this allows them to evaluate just how much juice can be squeezed by upsizing equipment and infrastructure. |
| 02 | Executing optimization routines | → | Vertex translated the set of conditions into numerous scenarios and parallelized simulation execution to accelerate the optimization process. Each iteration in the optimization routine was surfaced to operators to not only identify the optimized result, but also lay out the process the system used to identify the solution. This provided operators clarity on how Vertex achieves its optimal results and allowed operators to refine their own scenario modeling. |
| 03 | Identifying global optima through chained simulations | → | This partner leveraged Vertex's support of multiple modeling modalities to chain together multiple simulations across their topside and subsurface infrastructure. While operators historically ran these individually and there was little optimization at the interface, Vertex properly fed results from one model into the next to ensure that all knock-on effects are accounted for. This allowed Vertex to identify true global optima across the full system. |



Copyright © 2022 Palantir Technologies Inc. ("Palantir"). All right reserved. The information in this document is proprietary and confidential, and includes certain Palantir trade secrets. Unauthorized disclosure to any third party is strictly prohibited. The content provided herein is provided for informational purposes only and shall not create a warranty of any kind.