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| **Project:** | PPGPL**\_**DT-IAPM |
| **Project Number:** | **PJ-109491-01-SW\_PPGPL\_DT-IAPM** |
| **Release Title:** | 20240829\_PPGPL\_V1\_Release\_Golive |
| **Date:** | 29.08.2024 |
| **System Version:** | PPGPL\_V1 plant, Point Lisas, Port of Spain (T&T) Region only  The scope of delivery is for Golive for Digital Twin for 3 Assets Gas Turbine, Pump for LF Tags, Cooling Tower Fan for LF Tags |
| **Electronic HW version:** | NA |
| **Software Version:** | V1 Release for 3 Assets |
| **Mechanical Design Version:** | NA |
| **Security Class:** | Confidential |

# Scope:

**DT Concept Evaluation and Test**

Phoenix Park Gas Processors Limited (PPGPL) is engaged in natural gas processing and the aggregation, fractionation, and marketing of natural gas liquids (NGLs), operating as an NGL hub.

PPGPL aspires to drive predictive maintenance for critical assets deployed in their Plant located in ( Port of Spain, Trinidad & Tobago ). The Digital Twin – IAPM (Integrated Asset Performance Management) solution is intended to bring long term value to PPGPL by increasing asset performance availability through timely alerts.

For the purposes of this SOW2, PPGPL and Bosch have determined three critical assets listed below to be in scope of the digital twin solution. These will further realize enhanced efficiency and reduce the unexpected downtime through digital intervention by deploying MVPs of “Digital Twin for Three (3) classes of Plant Assets.”

1. Pump

2. Cooling tower fan (Heat transfer fan) and

3. Gas turbine

The SOW2 covers the customization and deployment of MVPs of “Digital Twin for Three (3) classes of Plant Assets” jointly identified by PPGPL and Bosch. These MVPs are intended to show reduction of unexpected downtime for such assets through digital intervention by deploying asset performance management software and further enhance efficiency of these assets.

# Features Implemented:

* MVP for 3 Assets – Pump, Cooling tower fan and Gas turbine.
* **Fault Detection Model**

**Gas Turbine (GT451-A)**

1. Deployed Unsupervised Anomaly detection Model for Gas Turbine Power Turbine Thrust Bearing, Gas Producer Thrust Bearing
2. Deployed Unsupervised Anomaly detection Model for Gas Turbine Air Inlet Journal Bearing 1, Power Turbine Journal Bearing 4, Power Turbine Journal Bearing 5
3. Devised Operational Insights for GT451A based on available sensor tag parameters.

**Pump (P6301-A)**

* + Deployed models for Eccentricity, Broken Rotor bar and bearing based on Synthetic data (Models will be retrained once actual sensorization is available) **Will not be included in Golive as HF sensors are not available.**
  + Used Simulation Data for developing and deploying Cavitation Model **Will not be included in Golive** **as HF sensors are not available.**
  + Deployed Acceleration and Velocity Severity Algorithm for Vibration Signal. **Will not be included in Golive as HF sensors are not available.**
  + Devised algorithm for computing Operational Insights in Pump based on available sensor tag parameters. **Will not be included in Golive as HF sensors are not available.**

**Cooling Fan (AC-4402-A3)**

* + Deployed models for Eccentricity, Broken Rotor bar and bearing based on Synthetic data (Models will be retrained once actual sensorization is available) **Will not be included in Golive as HF sensors are not available**
  + Deployed Acceleration and Velocity Severity Algorithm for Vibration Signal

**Will not be included in Golive as HF sensors are not available**

* + Devised algorithm for computing Operational Insights in Cooling Fan based on available sensor tag parameters. **Will not be included in Golive as HF sensors are not available.**

**Dashboard**

* + Devised Template for Alerts and notification.
  + Devised algorithm for computing C-Suite page insights.
  + Devised Symptom, Mitigation, Consequence for each Asset fault prediction event and operational insight.
* **UI Implementations**
  + Data Protection Notice Page added, PPGPL to confirm Final DPN.
  + Sensor data page added dropdown for sub-part for all assets.
  + Modifications for FFT plots for sensor data page.( Not applicable as it is HF )
  + Added feature to show Historic Sensor Data showing all sensors associated with a sub-part and sensor channel.
  + Insight Engine – Display Engineering and Operational Insights.
  + Engineering Insights - historic data displayed when an anomaly is detected.
  + Implemented Asset Event History page to show day-wise events for the events that occurred in a year.
  + Common Causes of Failure - Shows the highest occurring faults as percentages for a given month.
  + C-Suite added KPIs in collaboration with PPGPL to show trends in the KPI along with user Manual and Logic for C suite.
* **API & Database Implementations**
  + Customized and configured the ingestion mechanisms for the low frequency and the high frequency pipelines will be taken once vibration sensors are deployed and will be taken as change request separately with PPGPL, as per the existing architecture of the PPGPL.
  + API are upgraded to include the sub-parts for the assets.
  + Customized the logic for FFT plots for the live data pages.(Not applicable as it is HF )
  + Developed the API to route to the historic data when anomaly is detected.
  + Customized the APIs for the insight engine page as per the requirements gathered.
  + Developed and customized the API for the Asset Event History page.
  + Customized the C-Suite APIs after alignment with PPGPL.
  + Developed new collections and database functions.
  + Developed and customized the Common Causes of Failure Page.
* **Data Acquisition and Cloud Implementation**
  + Data has been taken from PPAPPS105 SQL Server using a linked server To PHD shadow using Linked Service connection created in Azure Data Factory

via Pipelines to be ingested into Azure Data Explorer.

* + Azure Architecture 1.2 has been designed and deployed.
  + Azure Data Factory, Function App, Azure Data Explorer, Cosmos DB , Event Hub with service endpoint and private endpoint integrated with Managed identity has been deployed.
  + New Services Azure Static App for PPGPL dashboard and Web App for hosting the backend APIs has been deployed.
  + Cloud Cost optimization has been performed.
  + For fault notification Azure Logic App has been deployed and connected using Microsoft O365 Connector.
  + Data has been taken from PPAPPS105 SQL Server using a linked server To PHD shadow using Linked Service connection created in Azure Data Factory
* **Bosch Quality Process:**
  + Security Engineering Process has been completed including Security testing, Penetration testing & Vulnerability Scan. All the vulnerabilities reported during periodic scans (Fortnightly) on S-BOM are closed/addressed and report are shared to PPGPL.
  + Note:-The models are implemented on the assets based on synthetic data and will be retrained once the high frequency sensors are mounted on the pump and cooling tower fan. **(Not a Part of Golive)** and will be taken as change request in future if needed for PPGPL.

# Features with dependencies.

* Not applicable

# Release Package list (files in the packages):

**Release version name: Final Release for Go Live**

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| File Name/Label | Version Number of the file (as applicable) | Description of Deliverables |
| ppgpldevdtacreastus2 – analysis-api | V2.0 | Docker Image for the Analysis API running in the webapp. |
| ppgpldevmlopsacreastus2 – azureml/azureml\_5bcf894cef1e4e20a32196f98f35a143 | V2.0 | Docker image for ML Algorithms |
| ppgpl-dev-dt-dashboard-eastus2 |  | Static Web app service hosting the front-end application |
| ppgpldevshadxeastus2 |  | Azure based ADX service hosting the data received from the sensors. |
| ppgpl-dev-dt-appweb-eastus |  | Azure Web-App service hosting the analysis-api. |
| ppgpl-dev-dt-ml-inference-func-eastus2 | V2.0 | Function app running in the azure that is hosting multiple functions for calling both the Low Frequency and High Frequency Models |
| ppgpl-dev-dt-mlw-eastus2 |  | Azure Ml Studio for hosting the Low frequency and high frequency ML Models |
| [ppgpldevdthflf](https://portal.azure.com/#@ppgpl1.onmicrosoft.com/resource/subscriptions/b296ea85-a713-4f87-84ca-7c90b73c0bc4/resourceGroups/ppgpl-dev-rg-digitaltwin-eastus2/providers/Microsoft.Storage/storageAccounts/ppgpldevdthflf) |  | Storage Account for HF .CSV files for triggering the event grid |
| [ppgpldevdthflf-abd626dc-5540-4592-886f-eb9381fddd55](https://portal.azure.com/#@ppgpl1.onmicrosoft.com/resource/subscriptions/b296ea85-a713-4f87-84ca-7c90b73c0bc4/resourceGroups/ppgpl-dev-rg-digitaltwin-eastus2/providers/Microsoft.EventGrid/systemTopics/ppgpldevdthflf-abd626dc-5540-4592-886f-eb9381fddd55) |  | System topic for HF Data files |
| ppgpl-dev-dt-notfication-eastus2 |  | Logic App for Sending Notification of Faults |
| ppgpl-dev-dt-cms-eastus2 | 3.6 (Mongo API ) | Mongo Db for Hosting metadata |
| ppgpl-dev-shared-datafactory-eastus2 | Shared Resource By all tracks | Data Ingestion pipeline for low frequency data |

# Validations and Certifications

* Code reliability test
* Pen testing is completed.
* Vulnerability scan is completed, and all vulnerabilities are closed. (Reports shared to PPGPL on 27th Aug-2024)

# OSS Scan (Open-Source Scan) Reports and Approval from OSS Officer:

Delta OSS Scan is also completed, and report along with the Attribution documents for both the OSS and Delta OSS scan is attached.

# Third party S/W licensing:

No Third-Party SW is being used for this project.

# Status on information security and data protection:

- Penetration testing is completed with updated Network architecture

- DSO assessment is done w.r.t data protection (Personal data) for T&T specific

regulations and checked with External counsel and DPN are shared to PPGPL for final

checks and approval, once approved by PPGPL it will be implemented in Login.

Page. (Currently the Base version is uploaded in the DT Dashboard)

- All the bugs and vulnerabilities reported have been fixed/mitigated. The validated security

posture has been migrated to Prod subscription based on PPGPL request with NIL

security open issues, however, operations security after the release of the product is in

scope of PPGPL

# Known issues, concerns, and workarounds:

**Workaround:** Synthetic Data is used as referred in SOW2 due to non-availability of the HF-sensors on cooling tower fan of Pump and Motor and the same shall be updated in the ML Models once the data from vibration and current sensors are hitting the cloud through the installed sensors at PPGPL. **( This will not be part of Go Live since the HF sensors are not installed on the asserts )**

# Recommendations

* **Recommendation:** The current training of the AI Models is based on synthetic data and once the actual data from High Frequency sensors are ingested in the AI models the model will be retrained & insights can be used by PPGPL team for Pump and Cooling Tower Fan **(This will not be Part of Go Live , will be taken based on sensor availability with Change Request in future if needed by PPGPL )**

# Change Requests (if applicable)

CR#2 for Golive for 3 Assets for SOW2

# Mode of Release (with the location of the deliverables)

[**https://dt-dashboard.ppgpl.co.tt**](https://dt-dashboard.ppgpl.co.tt)

# Compatibility matrix

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| --- | --- | --- | --- |
| Platform / System Version | HW version | SW version | Web version |
| Not applicable | Not applicable | V1 Release | V1 Release |
|  |  |  |  |

# Future Releases

Not applicable

**Additional Information**

User Manual Documentation with is shared to PPGPL team with updates in documentation.