Industry Customer Intelligence Solutions
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Asset Analytics for Rotational Equipment in Mining Solution Guide

IBM

Product Information

This document applies to Version 1.0 and may also apply to subsequent releases.

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Contents

Introduction

The IBM Asset Analytics for Rotational Equipment in Mining solution delivers proactive service related to the operations side of a mining process line. It provides predictive analytics on the performance of critical equipment.

Audience

This guide is intended for administrators and users of the Asset Analytics for Rotational Equipment in Mining solution. It provides information on installation, configuration, and use of the solution.

Finding information

To find product documentation on the web, including all translated documentation, access IBM® Knowledge Center (http://www.ibm.com/support/knowledgecenter).

Accessibility features

Accessibility features help users who have a physical disability, such as restricted mobility or limited vision, to use information technology products. Some of the components included in the Asset Analytics for Rotational Equipment in Mining have accessibility features. For more information, see Appendix A, "Accessibility features," on page 39.

Asset Analytics for Rotational Equipment in Mining HTML documentation has accessibility features. PDF documents are supplemental and, as such, include no added accessibility features.

Forward-looking statements

This documentation describes the current functionality of the product. References to items that are not currently available may be included. No implication of any future availability should be inferred. Any such references are not a commitment, promise, or legal obligation to deliver any material, code, or functionality. The development, release, and timing of features or functionality remain at the sole discretion of IBM.

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Chapter 1. Overview

IBM Asset Analytics for Rotational Equipment in Mining is a prepackaged solution that works with IBM Predictive Maintenance and Quality.

Important: Before you install the solution, IBM Predictive Maintenance and Quality 2.5.1 must be installed on your system.

The IBM Asset Analytics for Rotational Equipment in Mining solution is designed to help industries that need to build and test predictive analytics for slurry pumps.

In the mining industry, one of the most frequently used piece of rotational equipment is the slurry pump. Slurry pumps handle a broad range of slurry transport applications and are used to pump thick and abrasive materials, including chemical and solid materials, by using increased pressure.

A slurry pump is usually a centrifugal, lobe, peristaltic, or submersible pump. It is usually manufactured from thick and durable iron, which allows it to effectively handle harsh liquids, including chemicals, without damaging or wearing down the pump components.

The IBM Asset Analytics for Rotational Equipment in Mining solution is used to provide Time to Failure information as well as the Health Status and Health Score of slurry pumps. It provides a mining enterprise with the following benefits:

- Improved maintenance strategy
- Reduced machine downtime
- Increased efficiency and productivity

What need does the solution address?

Currently, functioning slurry pumps are halted monthly for preventive maintenance. In the case of a failed pump, reactive maintenance is performed, which can last between 12 and 24 hours, which affects production. It requires corrective action, which results in downtime for connected equipment, the loss of days of productive time, lost revenue, and expensive repairs. By performing predictive analysis on historical data of the slurry pump, IBM Asset Analytics for Rotational Equipment in Mining provides insight into when equipment is likely to fail. Acting on this insight can result in lower operations costs and a reduction in downtime and lost productivity.

What does the solution provide?

The Asset Analytics for Rotational Equipment in Mining solution predicts the Time-To-Failure (TTF) of a slurry pump through analysis of time series data. It uses historical maintenance data (preventive and corrective maintenance events) and operational data (current of pump, speed and density of the fluid) obtained from slurry pumps to develop an analytical model which predicts the Time-To-Failure and generates an operational Health Score for each pump. The solution includes a dashboard for the visualization of key historical pump telemetry information, health scores, maintenance events, and the most current prediction from the model along with essential pump metadata.

How is the solution used by an organization?

The solution can be used by maintenance or plant engineers who are in charge of scheduling maintenance or are responsible for the uninterrupted working of slurry pumps in an industrial environment. The dashboard provided by the solution provides both a high-level overview of the health of pumps being monitored as well as pump-specific diagnostic information for evaluation of each pump. The diagnostics and prognostics provided by this solution can be used to:

- Identify pumps in a critical state
- Indicate health of slurry pump via Health Score and Health Status
- Predict the Time To Failure of the slurry pumps
- Visualize historical events and sensor trends of each pump
- Prescribe recommended actions for each pump

Chapter 2. Installation and configuration

The Asset Analytics for Rotational Equipment in Mining solution is for use with IBM Predictive Maintenance and Quality.

Planning the installation and configuration of the solution

Prepare a deployment plan to specify which part of the solution is to be deployed and on which computer node.

Note: Ensure that the system ports that will be used by this solution are not used by any other application.

Prerequisites

Before you install the Asset Analytics for Rotational Equipment in Mining solution, there are prerequisites that must be met.

The following conditions must be met before the solution can be installed:

- IBM Predictive Maintenance and Quality 2.5.1 is installed and configured.
- You have a Linux system that you can install to. The application installer works only on Linux.
- You understand your existing environment so that you can determine where you want the various components of the application to reside.
- You have administration rights and the ability to copy files between computers.

Downloading the solution

You must download the Asset Analytics for Rotational Equipment in Mining solution from IBM Passport Advantage.

Before you begin

You must have a Passport Advantage account and be entitled to the package.

About this task

Passport Advantage contains package repositories. Instead of downloading the package from Passport Advantage and creating a repository locally, you access the repository on Passport Advantage.

Procedure

1. Set the Passport Advantage preference to connect to Passport Advantage.
2. Download the tar.gz file.
3. Move the tar file to the Linux node from which you want to run the installation.
4. Uncompress the tar file.

Contents of the download package

The Asset Analytics for Rotational Equipment in Mining solution package, which you download from Passport Advantage, contains several parts.

The following parts are included in the package:

- Analytics node artifacts: The IBM SPSS content is provided in a .pes file that you import into the IBM SPSS Collaboration and Deployment Services Content Repository. It consists of a training model and job, and a scoring model. Apart from that, there will be a CSV file for mapping recommendations.
- Data node artifacts: SQL files for creating the production data table in the IBMPMQ database and for importing data for those tables.
- Business Intelligence (BI) node artifacts: IBM COGNOS BI dashboards, images that are used in the dashboards, and the Framework Manager model.
- ESB node artifacts: IBM Integration Bus solution bar files for custom flows to onboard data and trigger the analytics training and scoring jobs. Also included are WebSphere MQ scripts, properties, and XML files that are required by the custom flows and for IBM Predictive Maintenance and Quality core components.

Modifying the sudoers file for the user who runs the installation

To run the Asset Analytics for Rotational Equipment in Mining installation, you must be either **root** user or have **sudo** permission on each node computer, and you must disable `requiretty` during the installation.

To install with **sudo** user permissions, you must also add the user to the `sudoers` file.

Procedure

1. Log in as **root** user.
2. Enter the following command to open the `sudoers` file for editing:
   `visudo -f /etc/sudoers`
3. Locate the following line:
   `Defaults requiretty`
4. Press the I key to insert text.
5. Type a number sign (#) in front of `Defaults requiretty` to comment out the line. For example, the line will appears as `#Defaults requiretty`
6. If you run the installer as a user with **sudo** user permissions, go to the end of the file, and add the following line for your user:
   username `ALL=(ALL) NOPASSWD: ALL`
7. Press the Esc key, and enter `:wq` to save and close the file.
8. Repeat these steps on each computer on which you install a Asset Analytics for Rotational Equipment in Mining node.

Computer firewall settings required for the installation

The solution installer requires bidirectional communication with each node when you install a server component or server artifact component, and your firewall can interfere with this communication.

To ensure bidirectional communication, you must configure your firewall settings for the installation. Alternatively, you can temporarily disable your firewall during the installation.

A script is provided to open all necessary ports on the installation node. You can either use the `firewall.sh` script, open the ports manually, or disable the firewall settings.

In addition to opening ports on the installation node computer, you must open some ports on each computer to which content from the solution will be copied.

Configuring your firewall settings on the installation node computer by using the Firewall script

You can run the firewall.sh script to open the ports on the installation node.

About this task

The firewall.sh script opens the following ports on the solution installer node:
- 8080 incoming
- 443 incoming
- 9683 incoming
- 22 outgoing

Procedure

1. As the root user or as a user with sudo permissions, log on to the computer that contains the solution installer node.
2. Back up your existing firewall settings by typing the following command: `/etc/init.d/iptables save`.
3. Run the firewall.sh script.

Manually configuring firewall settings on the installation node

If you prefer not to disable your firewall settings or use the firewall.sh script, you can manually configure your firewall settings on the installation node.

Procedure

1. As the root user or as a user with sudo permissions, log on to the computer that contains the solution installer node .
2. Back up your existing firewall settings by typing the following command: . `/etc/init.d/iptables save`
3. On the computer that contains the solution installer node, add rules for the ports that are required by the installer by typing the following commands:

```
iptables -I INPUT -p tcp --dport 8080 -j ACCEPT
iptables -I OUTPUT -p tcp --sport 8080 -m state --state
RELATED,ESTABLISHED -j ACCEPT

iptables -I INPUT -p tcp --dport 443 -j ACCEPT
iptables -I OUTPUT -p tcp --sport 443 -m state --state
RELATED,ESTABLISHED -j ACCEPT

iptables -I INPUT -p tcp --dport 9683 -j ACCEPT
iptables -I OUTPUT -p tcp --sport 9683 -m state --state
RELATED,ESTABLISHED -j ACCEPT

iptables -I OUTPUT -p tcp --dport 22 -j ACCEPT
iptables -I INPUT -p tcp --sport 22 -m state --state
RELATED,ESTABLISHED -j ACCEPT
```

Configuring firewall settings on other computers that will contain content from the solution

On all node computers to which content from the solution will be copied, the ports 443, 9683, and 8080 must be opened for the installation process.

Procedure

1. On each of the computers to which content for the solution will be copied, add rules for the ports that are required by the installer by typing the following commands:

   ```
   iptables -I OUTPUT -p tcp --dport 443 -j ACCEPT
   iptables -I INPUT -p tcp --sport 443 -m state --state RELATED,ESTABLISHED -j ACCEPT

   iptables -I OUTPUT -p tcp --dport 9683 -j ACCEPT
   iptables -I INPUT -p tcp --sport 9683 -m state --state RELATED,ESTABLISHED -j ACCEPT

   iptables -I OUTPUT -p tcp --dport 8080 -j ACCEPT
   iptables -I INPUT -p tcp --sport 8080 -m state --state RELATED,ESTABLISHED -j ACCEPT
   ```

2. Type the following command to save your firewall settings:

   ```
    /etc/init.d/iptables save
   ```

3. Type the following command to restart your firewall:

   ```
   /etc/init.d/iptables restart
   ```

4. Verify that your changes are applied by using the following command:

   ```
   iptables -L
   ```

   The added port appears in the list.

5. Repeat these steps on each computer on which you will install an IBM Asset Analytics for Rotational Equipment in Mining node.

Disabling firewall settings during installation (optional)

If you choose to temporarily disable your computer's firewall during the installation of the IBM Asset Analytics for Rotational Equipment in Mining solution, ensure that you enable the firewall on each node after the installation is complete.

About this task

Important: If you disable your computer's firewall during the installation, you must still ensure that the required ports are opened on each node computer when you restart your firewall.

Procedure

1. Log on to the computer as the root user or as a user with sudo permissions.
2. Type the following command:

   ```
   /etc/init.d/iptables stop
   ```

   ```
   /etc/init.d/iptables save
   ```

3. Repeat these steps on each computer on which you install a node and on the server from which you are running the installation.

What to do next

After the installation is complete, on each node, type /etc/init.d/iptables start to restart your firewall.

Deploying the installation files on the nodes

You use the Solution Installer to deploy the installation files to the appropriate nodes.

Before you begin

Ensure that you know the following information for each of the nodes in your solution:
- Host name or IP address
- Password of the **root** user ID or a user ID and password that has **sudo** permissions

About this task

In this task, you create an installation configuration of your solution by dragging nodes onto a canvas, adding components to the nodes, and defining properties for the components.

Procedure

1. Log on to the computer where you downloaded the solution package.
2. Decompress the solution package.
3. Go to the solution installer directory. For example:

   ```
   cd RotEquipMining_AssetAnalytics/SolutionInstaller/
   ```
4. Enter the following command:

   ```
   ./firewall.sh
   ```

   The ports that are used to transfer files to the nodes are opened on the server.
5. Enter the following command:

   ```
   ./setup.sh username first name last name email
   ```

   The web server is started and the URL for the Solution Installer is displayed in the command line.
6. Start the Solution Installer by pasting the URL into a web browser.
7. Read the license agreement and click **Accept**.
8. Click **New Configuration** and then click **OK**.
9. Define the Business Intelligence node:
   a. Under **Mandatory Content List**, drag a **Node** onto the canvas.
   b. Under **Property Editor**, enter values for the Business Intelligence node.
   c. Drag **Cognos BI Content** onto the node. Do not change the values under **Property Editor**.
   d. Drag **Cognos BI Report Images** onto **Cognos BI Content**. Do not change the values under **Property Editor**.
   e. Define the **DBNode** and drag **Database Content** onto **DBNode**. Do not change the values under **Property Editor**.
10. Define the IBM Integration Bus node:
    a. Under **Mandatory Content List**, drag a **Node** onto the canvas.
    b. Under **Property Editor**, enter values for the IBM Integration Bus node.
    c. Drag **IBM Integration Bus Content** onto the node. Do not change the values under **Property Editor**.

Creating new directories on the Integration Bus node

Content must be loaded to the IBM Integration Bus server from specific directories. You must create the directories before the content can be loaded.

Procedure

1. Log in to the Integration Bus node computer as the **mqm** user.

   Important: The user must be the **mqm** user or a member of the **mqm** group. If you copy the files as another user, they might not be processed by the Integration Bus node components.

2. Go to the /var/PMQ/MQSIFileInput directory.
3. Verify that the following directories are present:
   - eventdatain—The input folder for the maintenance & operational data.
   - masterdatain—The input folder for master data.
   - integrationin—The input folder for the scoring output.
   - properties—The configuration folder for the orchestration batch and properties folder.

Deploying and Configuring the DB Node artifact

The IBMPMQ_additional.sql file, is located on the DB node at the following locations /opt/IBM/IS_RotEquipMining_AssetAnalytics_1.0/). This DDL must be executed by the **db2inst1** user against the IBMPMQ database on the DB node.

Moving properties, orchestration, and solution definition files

You must move the properties, orchestration, and solution definition files to the appropriate directories on your Integration Bus node computer.

Procedure

1. Log in to the Integration Bus node computer as the **mqm** user.

   Important: The user must be the **mqm** user or a member of the **mqm** group. If you copy the files as another user, they might not be processed by the Integration Bus node components.

2. Copy the PMQ_solution_definition.xml file from the /opt/IBM/IS_RotEquipMining_AssetAnalytics_1.0/Scripts directory to the /var/mqsi/shared-classes directory.
3. Copy the PMQ_orchestration_definition_batch.xml file from the Scripts directory to the /var/PMQ/MQSIFileInput/properties directory on the Integration Bus node computer.
4. Copy the PMQ_orchestration_definition_REM_input.xml and PMQ_orchestration_definition_REM_output.xml file from the Scripts directory(/opt/IBM/IS_ RotEquipMining_AssetAnalytics_1.0/Scripts) to the /var/mqsi/shared-classes/orchestrations directory on IIB Node.
5. Copy the REM_Scoring_Status.txt file from the Scripts directory (/opt/IBM/IS_ RotEquipMining_AssetAnalytics_1.0/Scripts) to the /var/PMQ/MQSIFileInput/integrationin/ directory on the IIB Node.
6. Copy the scoring_data.txt file from the Scripts directory(/opt/IBM/IS_ RotEquipMining_AssetAnalytics_1.0/Scripts) to the /var/PMQ/MQSIFileInput/integrationin directory on IIB Node.

7. Copy the `scoring_duration.properties` file from the Scripts directory(`/opt/IBM/IS_ RotEquipMining_AssetAnalytics_1.0/Scripts`) to the `/var/PMQ/MQSIFileInput/properties` directory on IIB Node.

8. Copy the `IBMPMQ_Queues.mqsc` file from the Scripts directory(`/opt/IBM/IS_ RotEquipMining_AssetAnalytics_1.0/Scripts`) to the `/var/PMQ/MQSIFileInput/ properties` directory on IIB Node.

Configuring the orchestration files

You must update the orchestration files to include the server name and port number for your IBM SPSS® Collaboration and Deployment Services server that is running on your IBM Predictive Maintenance and Quality Analytics node.

Procedure

1. On the Integration Bus node computer, go to the `/var/PMQ/MQSIFileInput/ properties`, and open the `PMQ_orchestration_definition_batch.xml` file in a text editor.

2. In the `<SPTrainingModel>` identifier section, do the following steps:

   a. In the `<webservice>` section, change the `<url>` value to the server name and port number for your IBM SPSS Collaboration and Deployment Services server.

3. In the `<SPScoringModel>` identifier section, do the following steps:

   a. In the `<webservice>` section, change the `<url>` value to the server name and port number for your IBM SPSS Collaboration and Deployment Services server.

4. Save and close the file.

5. On the Integration Bus node, go to the `/var/PMQ/MQSIFileInput/properties`, and open the `scoring_duration.properties` file in a text editor. Set the number of hours after which scoring will be triggered. By default it has been configured to be triggered once in a day (24).

Creating queues

Procedure

1. Copy the `IBMPMQ_Queues.mqsc` file from the Scripts directory to `/var/PMQ/MQSIFileInput/properties` and Navigate to the `IBMPMQ_Queues.mqsc` location.

2. Type `runmqsc pmqmanager`, and press **Enter**.

3. Copy and paste the content of `IBMPMQ_Queues.mqsc`

Deploying BAR files

Bar files must be deployed to the broker **pmqbroker** with the execution group **pmqgroup1**.

Procedure

1. Log on to the Integration Bus node computer as the **mqm** user.

2. Navigate to the `/opt/IBM/IS_ManEquipAuto_AssetAnalytics_1.0/BAR/` directory.

3. Enter the following command for REMIntegration.bar:

   `mqsideploy pmqbroker —e pmqgroup1 —a REMIntegration.bar`

Source code files

The `REMIntegration_PI.zip` file provides the source code for the ESB flow and code. IBM Predictive Maintenance and Quality currently keeps these on an ESB node in the `/var/PMQ/MQSIFileInput/PMQSource` directory. The files can be placed in a subdirectory.

Note: All of the activities on the ESB node must be done using the **mqm** id. You must restart the **pmqbroker** service after you complete the activities.

Deploying the IBM Cognos content

For IBM Cognos Business Intelligence, you must catalog the database, create a data source connection, and then deploy the content files for the IBM Asset Analytics for Rotational Equipment in Mining solution.

Cataloging the IBMPMQ database

You must create a database connection to the **IBMPMQ** database in IBM Cognos Business Intelligence. Before you can create the connection, you must catalog the database in the IBM DB2 client.

Procedure

1. Log on to the Business Intelligence node computer, and change to the db2inst1 user.

   For example, in a terminal window, type su db2inst1.
2. Enter the following command to catalog the database server:

   db2 "catalog tcpip node OP(*<Nodename>*) remote *DB2_server_name* server *DB2_port_number*"

   Note: The **Nodename** cannot be more than 8 characters.
3. Enter the following command to catalog the **IBMPMQ** database:

   db2 "catalog database IBMPMQ as IBMPMQ at node OP(*<Nodename>*)"
4. Enter the following command to ensure that the database was cataloged correctly:

   db2 list database directory

   IBMPMQ should appear in the list.

Creating a data source connection to the IBMPMQ database

You create a data source connection using IBM Cognos Administration.

Procedure

1. Open a web browser.
2. Go to the IBM Cognos® BI portal URL.

   For example, go to `http://binodename/ibmcognos/`.
3. On the **Welcome** page, click **Administer IBM Cognos Content**.
4. Click the **Configuration** tab, and click **Data Source Connections**.
5. Click the **New Data Source** icon [icon].
6. In the **Name** box, type IBMPMQ, and then click **Next**.
7. In the connection page, select **IBM DB2**, ensure that **Configure JDBC connection** is selected, and click **Next**.

8. In the **DB2 database name** field, type IBMPMQ.
9. Leave **DB2 connect string** blank.
10. Under **Signons**, select both **Password** and **Create a signon that the Everyone group can use**, and then type the user ID and password for the DB2® instance owner user that you used to create the database, and click **Next**.

    For example, enter db2inst1 and the appropriate password.

    Tip: To test whether the parameters are correct, click **Test the connection**. After you test the connection, click **OK** to return to the connection page.
11. In the **Server name** box, enter the name or IP address of your IBM DB2 server computer.
12. In the **Port number** box, enter the DB2 port number. The default is 50000.
13. In **Database name**, type IBMPMQ.

    Tip: To test whether the parameters are correct, click **Test the connection**. After you test the connection, click **OK** to return to the connection page.
14. Click **Finish**.

Moving the IBM Cognos content

As a **root** or **sudo** user, you must copy the IBM Cognos content for the IBM Asset Analytics for Rotational Equipment in Mining application to the appropriate locations in your IBM Cognos installation to be able to deploy the content.

Procedure

1. Copy the IBM Cognos content from the computer where you deployed the Asset Analytics for Rotational Equipment in Mining Business Intelligence content to the *<BI_Install_location>*\deployment folder on the Business Intelligence node computer.

   The Asset Analytics for Rotational Equipment in Mining IBM Cognos content file is named REM_BIContent.zip.
2. Copy the IBM Cognos report image file to the *<BI_Install_location>*\webcontent\Images directory on the Business Intelligence node computer and decompress it.

   You must create the Images directory if it does not already exist.

   The report images file is named REM_Images.zip.
3. Copy the IBM Cognos map specification file (Rave Chart dumps-REM_Rave.zip) to any Business Intelligence Install location. Unzip it, and REM_AssetAnalytics_MainPagePumpVector_Rave.zip and REM_AssetAnalytics_LandingPage_Rave.zip are shown.
4. Copy the IBM Cognos Framework Manager model file to the Business Intelligence node install location.
5. If you want to edit the Framework Manager models, you must catalog the Asset Analytics for Asset Analytics for Rotational Equipment in Mining database on the computer where Framework Manager is installed.

Deploying the IBM Cognos reports

You must deploy the Asset Analytics for Rotational Equipment in Mining reports by using IBM Cognos Administration.

Procedure

1. Open a web browser.

2. Go to the IBM Cognos BI portal URL (`http://<ibmcognos_node_IP>/ibmcognos/`).

3. On the **Welcome** page, click **Administer IBM Cognos Content**.

4. On the **Configuration** tab, click **Content Administration**.

5. On the toolbar, click the **New Import** button.

6. In the **Deployment Archive** pane, select the deployment archive, and click **Next**.

   The deployment archive is named `REM_BIContent.zip`.

7. In the **Specify a name and description** pane, accept the default or enter a new name, and click **Next**.

8. In the **Select the public folders and directory content** pane, select all of the packages in the table, leave the **Options** as default, and click **Next**.

   Note: Ensure that the **Disable after import** option is cleared.

9. In the **Specify the general options** pane, accept the defaults, and click **Next**.

10. On the **Review the summary** page, click **Next**.

11. On the **Select an action** page, select **Save and run once**, and click **Finish**.

12. On the **Run with options** page, accept the defaults, and click **Run**, and then click **OK**.

13. Select **View the details of this import after closing this dialog** and click **OK**.

    Note: RAVE content is also imported as part of the `MEA_BIContent` import.

Importing the Rave specification to IBM Cognos BI

The Asset Analytics for Rotational Equipment in Mining application includes a Rave specification for the Executive Dashboard. You must import the Rave specification into IBM Cognos Business Intelligence.

Procedure

1. Open a web browser.

2. Go to the IBM Cognos BI portal URL.

3. On the **Welcome** page, click **Administer IBM Cognos Content**.

4. On the **Library** tab, click **Import Visualization**.

5. Browse to and select both `REM_AssetAnalytics_MainPagePumpVector_Rave.zip` and `REM_AssetAnalytics_LandingPage_Rave.zip` files.

6. Follow the steps in the wizard to import the file.

Opening the Framework Manager model

You can view the Asset Analytics for Rotational Equipment in Mining dashboard model in IBM Cognos Framework Manager. The Framework Manager project file (.cpf) for the Capacity Management Analytics model is included in the `REM_FM_Model.zip` file.

Procedure

1. Start IBM Cognos Framework Manager.

2. From the **Welcome** page, click **Open a project**.

3. Navigate to the folder where you decompressed the `REM_FM_Model.zip` file, and select the `IBMPMQ_Model.cpf` file.

4. Click **Open**.

5. If you must republish the packages, you must update the **Tenant_Id** in the **Tenant_lookup** parameter in the model.
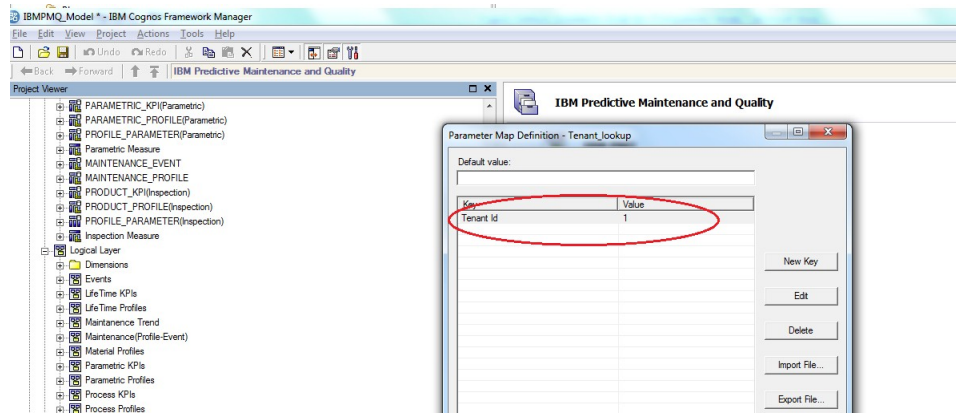
You can find the **Tenant_Id** in the **IBMPMQ** database by using the following database query:

```
Select Tenant_Id from pmqsch.tenant where Tenant_cd='PMQ'
```

6. After you have made changes to the model, you can republish the package.

   a. In the **Project Viewer** pane, expand **Packages**.

   b. Right-click the package, and click **Publish Package**.

   After publishing, the package should be available in **Public Folders** > **REM_AssetAnalytics** in the IBM Cognos Business Intelligence portal.

Deployment and Configuration of the SPSS Analytics Node

To prepare SPSS Collaboration and Deployment Services, you must set up links between the data in the database and the data used in the enterprise and in the application.

Before you begin

Ensure that following things are in place before importing content:

- IBM SPSS Collaboration and Deployment Services Deployment Manager is installed on any client (windows) computer.

- Copy the IS_REM_CDS.pes file from the location where you deployed the solution on the Analytics node computer to the computer where IBM SPSS Collaboration and Deployment Services Deployment Manager is installed. The default installation directory for this file is /opt/IBM/xxxx/Analytics/. (Where xxxx is the installation directory provided at the time of installation)

   `<BuildExtractedPath>/RotEquipMining_AssetAnalytics/SolutionInstaller/ NodeRoot/Downloads/IS_RotEquipMining_AssetAnalytics_1.0/Analytics`

- You know the admin credentials for the Predictive Analytics node, IBM DB2, and IBM SPSS Collaboration and Deployment Services.

- An ODBC Connection for the PMQ database is created in the name of IBMPMQ in the Analytics node. If not then complete the following steps:

1. Right-click **Data Sources**, and click **New** > **Data Source Definition**.

2. In the **Name** box, enter IBMPMQ.

3. In the **Type** box, select **ODBC Data Source**.

4. Click **Next**.

5. In the **DSN** box, enter IBMPMQ.

6. Click **Finish**.

Note: An ODBC Connection for the PMQ database is created in the name of IBMPMQ in the Analytics node. This step is done by the content installer of PMQ. If there are issues related to ODBC connectivity, see the information on IBM SPSS Modeler - ODBC Configuration Best Practices and Troubleshooting in the IBM DeveloperWorks article: http://www.ibm.com/developerworks/library/ba-pp-spss-page660/

Procedure

1. Start Deployment Manager.
2. Click **File** > **New** > **Content Server Connection**.
3. In the Connection Name field, enter a name that identifies the Predictive Analytics node.
4. In the Server URL field, enter `http://<analytics_node_IP>:<9080>/` and click **Finish**.
5. Right-click **Content Repository**, and click **Import**.
6. Browse to and select the `IS_REM_CDS.pes` file.
7. Click **Open**.
8. Accept the default options in the Import window, and click **OK**. The `IS_mining_REM` folder, two jobs in the `Jobs` folder, and two streams in the `Modeler Streams` folder are created.
   - Update the credential information for the Admin, db user (db2inst1), and root users so that the job and streams run successfully.
   - In the Content Explorer tab, under Resource Definitions, open the Credentials folder.
   - Update the Admin user with the credentials for the SPSS Collaboration and Deployment Services user that has access to the content repository and runs the job.
   - Update the db user (db2inst1) with the credentials for the user that has access to the IBM DB2 database.
   - Update the root user with the credentials for the user that has access to the Modeler Server.
9. Open the job in the `Jobs` folder and ensure that the user credentials match the credentials of the IBM DB2 instance on the **ODBC** tab.
10. Copy the `rem_recommendations.csv` file from the `/opt/IBM/xxxx/Analytics/` directory. (Where xxxx is the installation folder provided at the time of installation) to the `/usr/IBM/SPSS/ModelerServer/17.0/tmp/` folder on the analytics node.
11. There are two jobs that need to be executed. The Training Job creates the predictive models to be used by the Scoring Job. Therefore, the training job must be executed first.

Setting up the analytic content in IBM SPSS Collaboration and Deployment Services

You must add user credential definitions in IBM SPSS Collaboration and Deployment Services Deployment Manager for the IBM Asset Analytics for Rotational Equipment in Mining solution.

Procedure

1. On your Microsoft Windows computer, start IBM SPSS Collaboration and Deployment Services Deployment Manager. For example, click **Start** > **Deployment Manager**.
2. In Deployment Manager, click **Content Explorer**.
3. Expand **Resource Definitions** > **Credentials**.
4. Right-click **Credentials**, and click **New** > **Credentials Definition**.
   a. In the **Name** box, enter IBMPMQ, and click **Next**.
   b. In the **User ID** box, enter the database user name. For example, enter db2inst1
   c. In the **Password** box, enter the password for the database user.
   d. Leave **Security Provider** blank.
   e. Click **Finish**.
5. Right-click **Data sources**, and click **New** > **Data Source Definition**.
   a. In the **Name** box, enter IBMPMQ.
   b. In the **Type** box, select **ODBC Data Source**.
   c. Click **Next**.
   d. In the **DSN** box, enter IBMPMQ.
   e. Click **Finish**.

Onboard pump data

Custom flows are provided with the Asset Analytics for Rotational Equipment in Mining solution. You use the custom flows to onboard pump data and to trigger training and scoring models.

Master data and metadata must be loaded into the IBM Predictive Maintenance and Quality database, and you must also load the event data, before you can run the analytic training or the scoring models.

Master data and metadata for the solution

You must provide the master data and metadata for the Asset Analytics for Rotational Equipment in Mining solution. You must prepare the CSV files before you can load them into the environment.

The master data and metadata must be provided in the following CSV files:
- language_upsert.csv
- tenant_upsert.csv
- event_code_upsert.csv
- event_type_upsert.csv
- location_upsert.csv
- group_dim_upsert.csv
- measurement_type_upsert.csv
- production_batch_upsert.csv
- material_upsert.csv
- source_system_upsert.csv
- value_type_upsert.csv
- resource_type_upsert.csv

- product_upsert.csv
- process_upsert.csv
- material_type_upsert.csv
- resource_upsert.csv
- profile_calculation_upsert.csv
- profile_variable_upsert.csv

The following examples show the contents that each of the CSV files that you prepare must contain.

The files group_dim_upsert.csv, location_upsert.csv, and resource_upsert.csv should be based on the pump details, including its hierarchical relationship to other entities, such as wells and platforms, and organization relationships and suited to your environment.

```
language_upsert.csv - Notepad
File  Edit  Format  View  Help
language_cd,language_name,isdefault
EN,ENGLISH,1
FR,French,0
JA,Japanese,0
PT,Portugese,0
SC,Simplified Chinese,0
TC,Traditional Chinese,0
```

```
tenant_upsert.csv - Notepad
File  Edit  Format  View  Help
tenant_cd,tenant_name,isdefault
PMQ,PMQ,1
```

event_code_upsert.csv - Notepad

File Edit Format View Help

```
event_code_set,event_code_set_name,event_code,language_cd,tenant_cd
-NA-,Non applicable,-NA-,EN,PMQ
```

event_type_upsert.csv - Notepad

File Edit Format View Help

```
event_type_cd,event_type_name,Language,Tenant_CD
-NA-,Non applicable,EN,PMQ
SP_MAINTENANCE,Maintenance,EN,PMQ
SP_MEASUREMENT,Measurement,EN,PMQ
SP_RECOMMENDATION,Recommendation,EN,PMQ
```

location_upsert.csv - Notepad

File Edit Format View Help

```
location_cd,location_name,region_cd,region_name,country_cd,country_name,state_prov
-NA-,Not Applicable,,,,,,,,,,,EN,PMQ,1
Marandoo Mine,Marandoo Mine,Pilbara,Pilbara,Australia,Australia,Para,Para,Para,,,E
```

material_type_upsert.csv - Notepad

File Edit Format View Help

```
material_type_cd,material_type_name,language_cd,tenant_cd
-NA-,Not Applicable,EN,PMQ
```

measurement_type_upsert.csv - Notepad

File Edit Format View Help

```
measurement_type_cd,measurement_type_name,unit_of_measure,carry_forward_indicator
CURRENT,Plant Concentrate Pump Warman Current,amps,0,,0,EN,PMQ
SPEED,Plant Concentrate pump WARMAN RM Speed,rpm,0,,0,EN,PMQ
DENSITY,Concentrate Plant Distributor SP Density,,0,,0,EN,PMQ
MP,Preventive maintenance,,0,,0,EN,PMQ
MC,Corrective maintenance,,0,,0,EN,PMQ
TIME_TO_FAIL,Time to failure,hours,0,,0,EN,PMQ
HEALTH_SCORE,Health Score,,0,,0,EN,PMQ
HEALTH_STATUS,Health Status,,0,,0,EN,PMQ
RECOMMENDED_ACTION,Recomended Actions,,0,,0,EN,PMQ
```

process_upsert.csv - Notepad

File Edit Format View Help

```
process_cd,process_name,parent_process_cd,language_cd,tenant_cd
-NA-,Not Applicable,,EN,PMQ
```

product_upsert.csv - Notepad

File Edit Format View Help

```
product_cd,product_name,product_type_cd,product_type_name,parent_product_cd,paren
-NA-,Not Applicable,-NA-,Not Applicable,,,EN,PMQ,1
```

profile_calculation_upsert.csv - Notepad

File Edit Format View Help

```
profile_calculation_name,tenant_id
Interval Calculation,PMQ
Measurement of Type,PMQ
Event of Type Count,PMQ
Measurement of Type Count,PMQ
Measurement Text Contains Count,PMQ
Measurement in Range Count,PMQ
Last Date of Event Type,PMQ
Last Date of Measurement Type,PMQ
Last Date of Measurement in Range,PMQ
Measurement Above Limit,PMQ
Measurement Below Limit,PMQ
Life Span Analysis,PMQ
Life Span Analysis Failure,PMQ
Delta Calculation,PMQ
ASSIGN,PMQ
MathOneInput,PMQ
MathTwoInput,PMQ
MeanCalculation,PMQ
IfElseCalculation,PMQ
DateCalculation,PMQ
DateMathCalculation,PMQ
AVERAGE,PMQ
ComparisonCalculation,PMQ
SubstationOverloadAnalysis,PMQ
Measurement Text Does Not Contains Count,PMQ
SubstationCoolingStageAnalysis,PMQ
```

resource_type_upsert.csv - Notepad

File Edit Format View Help

```
resource_type_cd,resource_type_name,Language,Tenant_CD
ASSET,ASSET,EN,PMQ
AGENT,AGENT,EN,PMQ
```

source_system_upsert.csv - Notepad

File Edit Format View Help

```
source_system_cd,source_system_name,language_cd,tenant_cd,IS_ACTIVE
-NA-,Not Applicable,EN,PMQ,1
SENSOR,SENSOR,EN,PMQ,1
MD,Maintenance Data,EN,PMQ,1
PREDMAIT,PREDMAIT,EN,PMQ,1
```

value_type_upsert.csv - Notepad

File Edit Format View Help

```
value_type_cd,value_type_name,Language,Tenant_CD
PLAN,Planned Value,EN,PMQ
ACTUAL,Actual Measurement,EN,PMQ
FORECAST,Forecast Value,EN,PMQ
PREPROCESSED,Preprocessed Value,EN,PMQ
```

```
group_type_cd,group_type_name,group_member_cd,group_member_name,language_cd,tenant_cd
-NA-,Not Applicable,-NA-,Not Applicable,EN,PMQ
Mine,Mine,CE,Conceicao,EN,PMQ
Block,Block,Plant Concentration,Plant Concentration,EN,PMQ
Block,Block,Crushing,Crushing,EN,PMQ
Block,Block,Dams,Dams,EN,PMQ
Block,Block,-NA-,Not Applicable,EN,PMQ
Circuit,Circuit,Filtering,Filtering,EN,PMQ
Circuit,Circuit,Power Itabirite,Power Itabirite,EN,PMQ
Circuit,Circuit,Conventional Flotation,Conventional Flotation,EN,PMQ
Circuit,Circuit,Magnetic Concentration,Magnetic Concentration,EN,PMQ
Circuit,Circuit,Power Hematite,Power Hematite,EN,PMQ
Circuit,Circuit,Flotation Columns,Flotation Columns,EN,PMQ
Circuit,Circuit,Rebritagem Pellets,Rebritagem Pellets,EN,PMQ
Circuit,Circuit,Stacking,Stacking,EN,PMQ
Circuit,Circuit,Densification Residue,Densification Residue,EN,PMQ
Circuit,Circuit,Reject,Reject,EN,PMQ
Circuit,Circuit,Quaternary,Quaternary,EN,PMQ
Circuit,Circuit,Gold Concentration,Gold Concentration,EN,PMQ
Circuit,Circuit,Suction Dredge,Suction Dredge,EN,PMQ
Circuit,Circuit,-NA-,Not Applicable,EN,PMQ
Family,Family,Pumps,Pumps,EN,PMQ
Family,Family,Pump House,Pump House,EN,PMQ
Family,Family,Feeders,Feeders,EN,PMQ
Family,Family,Compressors,Compressors,EN,PMQ
Family,Family,Tabs,Tabs,EN,PMQ
Family,Family,Floatation Cells,Floatation Cells,EN,PMQ
Family,Family,Carriers,Carriers,EN,PMQ
Family,Family,Reclaimers,Reclaimers,EN,PMQ
Family,Family,Silos,Silos,EN,PMQ
Family,Family,Systems,Systems,EN,PMQ
Family,Family,Screens,Screens,EN,PMQ
Family,Family,Agitators,Agitators,EN,PMQ
Family,Family,Classifiers,Classifiers,EN,PMQ
Family,Family,Mixer,Mixer,EN,PMQ
Family,Family,Thickeners,Thickeners,EN,PMQ
Family,Family,Extractors Scrap,Extractors Scrap,EN,PMQ
Family,Family,Analyzers,Analyzers,EN,PMQ
Family,Family,Programmable Controllers,Programmable Controllers,EN,PMQ
Family,Family,Conditioners,Conditioners,EN,PMQ
Family,Family,Cone,Cone,EN,PMQ
Family,Family,Crushers,Crushers,EN,PMQ
Family,Family,Electrical Substations,Electrical Substations,EN,PMQ
Family,Family,Valves,Valves,EN,PMQ
Family,Family,Pipes,Pipes,EN,PMQ
Family,Family,Distribution Board,Distribution Board,EN,PMQ
Family,Family,Column Floatation,Column Floatation,EN,PMQ
Family,Family,Transformers,Transformers,EN,PMQ
Family,Family,Reservoirs,Reservoirs,EN,PMQ
Family,Family,Tanks,Tanks,EN,PMQ
Family,Family,-NA-,Not Applicable,EN,PMQ
Class,Class,Filter Plan,Filter Plan,EN,PMQ
Class,Class,Belt Feeders,Belt Feeders,EN,PMQ
Class,Class,Slurry Pump,Slurry Pump,EN,PMQ
Class,Class,Starch Pump,Starch Pump,EN,PMQ
```
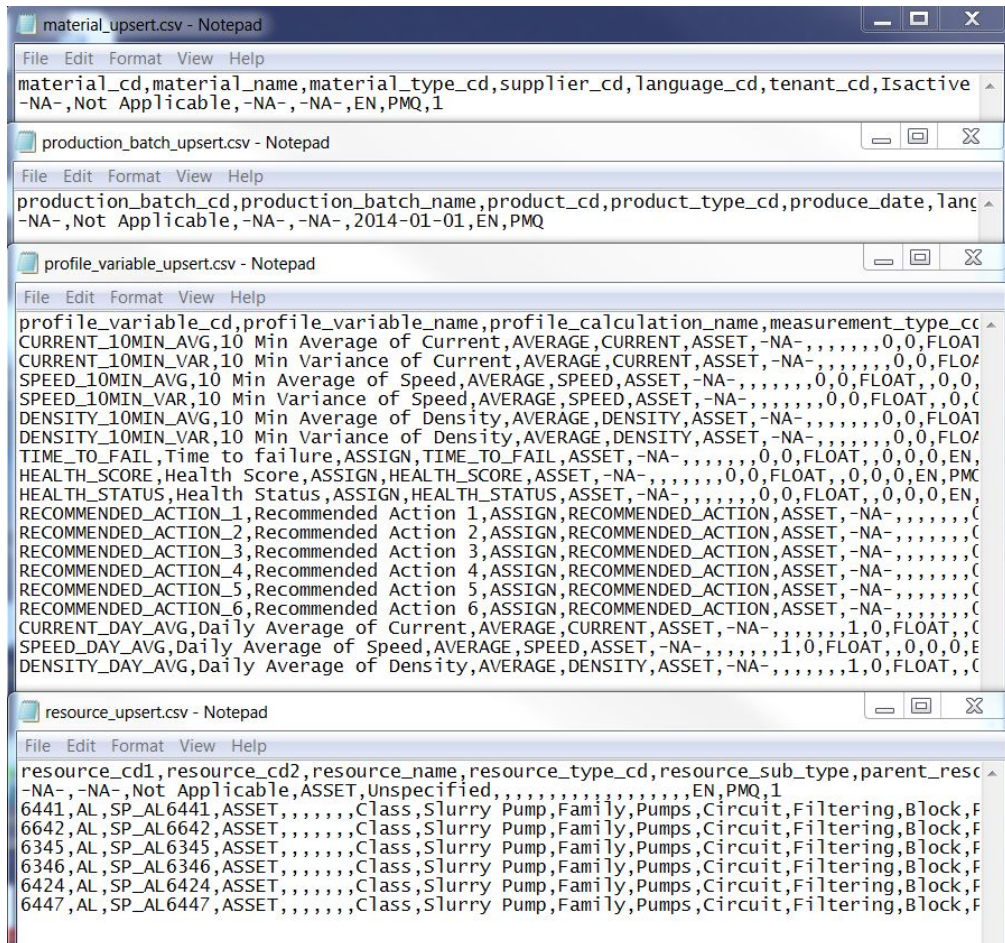
The Asset Analytics for Rotational Equipment in Mining solution provides for defining multilevel resource hierarchies that are augmented by group dimensions. A number of associations and relationships between resources and attributes can be defined. Any number of pumps can be defined, and associations can be defined to group them by any dimension; for example, OEM or Vendor can be defined as a dimension and associated with a pump.

The examples contain a base level of data that can be used for a fictional resource that is named SP_AL6441 of type SLURRY PUMP and is a child of ASSET. Irrespective of the resource hierarchy and group dimension associations that are defined, all Slurry Pumps in this example content are associated with the resource type SLURRY PUMP.

Loading the master data and metadata

You must load the master data and metadata for the Asset Analytics for Rotational Equipment in Mining solution in a specific order.

Procedure

1. Log in to the Integration Bus node computer as the `mqm` user.
2. Copy the files to the `/var/PMQ/MQSIFileInput/masterdatain` directory in the order that is shown in the following table:

Order	File name
1	language_upsert.csv

Order	File name
2	tenant_upsert.csv
3	event_code_upsert.csv
4	event_type_upsert.csv
5	group_dim_upsert.csv This file should be based on the pump details, including its hierarchical relationship to other entities, such as wells and platforms, and organization relationships.
6	location_upsert.csv This file should be based on the location of the pumps.
7	material_type_upsert.csv
8	measurement_type_upsert.csv
9	process_upsert.csv
10	product_upsert.csv
11	resource_type_upsert.csv
12	source_system_upsert.csv
13	profile_calculation_upsert.csv
14	value_type_upsert.csv
15	material_upsert.csv
16	production_batch_upsert.csv
17	resource_upsert.csv This file should be based on any other attribute that can be associated with a pump and defined as a group dimension. For example, Vendor or OEM can be defined as a dimension and associated with a pump.
18	profile_variable_upsert.csv

Important: The files must be copied one at a time.

For more information about master and metadata for IBM Predictive Maintenance and Quality, see the following topics in IBM Knowledge Center under Predictive Maintenance and Quality 2.5.1 :

- Master data process
- File format and location
- The flat file API

Event data

Event data must also be loaded for the Asset Analytics for Rotational Equipment in Mining solution.

Event data includes information such as maintenance data, and operational data.

The following are examples of the contents that each of the CSV files that you must prepare must contain. The CSV files that you use should reflect your environment.

The example custom flows expect event and other supporting operational data in the formats shown in the image.

Onboarding event data

You must load the event data for the Asset Analytics for Rotational Equipment in Mining solution.

Procedure

1. Log in to the Integration Bus node computer as the `mqm` user.
2. Copy the event data files that you created to the directory: `/var/PMQ/MQSIFileInput/eventdatain`.

Verifying your installation

You can verify your installation by accessing the Asset Analytics for Rotational Equipment in Mining dashboards in IBM Cognos Business Intelligence.

Procedure

1. Open a web browser.
2. Go to the IBM Cognos BI portal URL. For example, go to `http://bi_node_name/ibmcognos/`
3. Click **IBM Cognos Content**.
4. In the **REM_AssetAnalytics** folder, click **REM_AssetAnalytics_MaintenanceDashboard**.

   The welcome page should appear.

Chapter 3. Data model and data flows

This section describes the data model and data flows that are used for the Asset Analytics for Rotational Equipment in Mining solution.

Data mapping

The Asset Analytics for Rotational Equipment in Mining solution, uses tables from the PMQ data store.

Tables used in the Solution

Table 1. Tables used in the Solution

Table Name	Comments
CALENDAR	Auto populated during content installation.
EVENT_TIME	Auto populated during content installation.
TENANT	PMQ as the default tenant will be populated in this table.
LANGUAGE	English (EN) will be populated as the default language in this table.
MASTER_LOCATION	Location information is stored for the Slurry Pumps.
MASTER_SOURCE_SYSTEM	This table will be populated with the following values: • SENSOR – To be used for sensor data. • MD – To be used for maintenance data. • PREDMAIT – To be used for model output.
MASTER_MEASUREMENT_TYPE	The table will be populated with the following values: • CURRENT – For capturing the value of the current supplied to a pump. • SPEED – For capturing the speed of fluid passing through a pump. • DENSITY – For capturing the density of fluid passing through a pump. • MP – For capturing 'Preventive Maintenance' performed on the pump. • MC – For capturing 'Corrective Maintenance' performed on the pump. • TIME_TO_FAIL – For capturing SPSS model output. • HEALTH_SCORE – For capturing SPSS model output. • HEALTH_STATUS – For capturing SPSS model output. • RECOMMENDED_ACTION – For capturing recommended actions. Currently six variables are created to capture six actions.

Table 1. Tables used in the Solution (continued)

Table Name	Comments
MASTER_EVENT_TYPE	The table will be populated with the following values: • SP_MEASUREMENT– Will trigger orchestration for capturing values from sensors such as current, speed, and density. • SP_MAINTENANCE – Will trigger orchestration for capturing values of maintenance performed on the pump. • SP_RECOMMENDATION – Will trigger orchestration for capturing SPSS model output.
MASTER_VALUE_TYPE	The table will be populated with ACTUAL, FORECAST & PREPROCESSED values.
MASTER_PROFILE_CALCULATION	The table will be populated with ASSIGN & AVERAGE operations.
MASTER_PROFILE_VARIABLE	The table will be populated for capturing SPSS model output. The following variables will be created: • TIME_TO_FAIL • HEALTH_SCORE • HEALTH_STATUS • RECOMMENDED_ACTION_1 • RECOMMENDED_ACTION_2 • RECOMMENDED_ACTION_3 • RECOMMENDED_ACTION_4 • RECOMMENDED_ACTION_5 • RECOMMENDED_ACTION_6 The table will also be populated with the following variables for capturing daily average of predictors, that is, Current, Speed , and Density in the RESOURCE_KPI table: • CURRENT_DAY_AVG • SPEED_DAY_AVG • DENSITY_DAY_AVG
MASTER_GROUP_DIM	The following fields available from customer data will be captured as Group Dimension for example resource classification: • Group Type 1 – Class • Group Type 2 – Family • Group Type 3 – Circuit • Group Type 4 – Block • Group Type 5 – Mine
MASTER_RESOURCE_TYPE	The table will be populated with ASSET and AGENT values.
MASTER_RESOURCE	• Equipment ID from customer data will be segregated and mapped to columns RESOURCE_CD1 and RESOURCE_CD2. • name_equipment from customer data will be mapped to RESOURCE_NAME.

Table 1. Tables used in the Solution (continued)

Table Name	Comments
KEY_LOOKUP	The table will be auto populated by PMQ during insertion of master data.
EVENT & EVENT_OBSERVATION	Both operational and maintenance data will be populated in these tables. Operational data mapping will be as follows: • EVENT_START_TIME – Timestamp in format yyyy-MM-dd HH:mm:ss • EVENT_END_TIME – null • OBSERVATION_TIMESTAMP – same as EVENT_START_TIME • OBSERVATION_TEXT – null • MEASUREMENT – actual sensor reading Maintenance data mapping will be as follows: • EVENT_START_TIME – Start timestamp in format yyyy-MM-dd HH:mm:ss • EVENT_END_TIME – End timestamp in format yyyy-MM-dd HH:mm:ss • OBSERVATION_TIMESTAMP - same as EVENT_START_TIME • OBSERVATION_TEXT – Textual value • MEASUREMENT – null
RESOURCE_KPI	The table will be populated with daily averages for Current, Speed, and Density. Foundation will do the calculations as and when values for Current, Speed or Density are reported and will keep this table updated with their respective latest daily average.
EVENT_PROFILE	The table will store the output values from the SPSS model for all the profile variables as defined in the MASTER_PROFILE_VARIABLE table.
RESOURCE_PROFILE	The table will be populated with the latest recommended action as received from the analytical model. Recommended action values will be stored against the following profile variables for each resource. • RECOMMENDED_ACTION_1 • RECOMMENDED_ACTION_2 • RECOMMENDED_ACTION_3 • RECOMMENDED_ACTION_4 • RECOMMENDED_ACTION_5 • RECOMMENDED_ACTION_6

Data input flow

Default IIB flows as provided by the Predictive Maintenance and Quality 2.5.1 solution will be used for boarding the data in the PMQ data store. The orchestration file `PMQ_orchestration_definition_REM_input.xml` placed under `/var/mqsi/shared-classes/orchestrations` on the IIB node orchestrates the maintenance and operational (events) data loading in the **EVENT & EVENT_OBSERVATION** table.

The maintenance and operational (events) data CSV file (in PMQ specific format) will be placed in the `/var/PMQ/MQSIFileInput/masterdatain` and `/var/PMQ/MQSIFileInput/eventdatain` directories of the IIB node respectively. The IIB flow will pick up the file for processing and insert the data into the **EVENT & EVENT_OBSERVATION** table.

The flow will also calculate and insert the daily average of operations (event) data in the **RESOURCE_KPI** table. The new shared calculation group **RESOURCE_KPI_AVERAGE** has been defined in the `PMQ_solution_definition.xml` file, which will compute the average as and when values for current, speed, or density are reported. These average values will only be used to display time series charts in the solution.

The following event type codes are defined by the solution for data processing:
- **SP_MAINTENANCE** – Used to define maintenance data
- **SP_MEASUREMENT** – Used to define the event data

Data output flow

Output from the analytical model is also stored in the PMQ data store through IIB flows. The orchestration file `PMQ_orchestration_definition_REM_output.xml` is placed under `/var/mqsi/shared-classes/orchestrations` on the IIB node to orchestrate the flow of output data to be loaded in the **EVENT_PROFILE** table.

The SPSS analytical model will output the following observation values:
- **TIME_TO_FAIL** – The time left before the next pump failure (in hours) under the condition that no maintenance is carried out during that time.
- **HEALTH_SCORE** – An index (in percentage) that represents the overall condition of the pump. A higher number indicates a better health condition.
- **HEALTH_STATUS** - A categorical indicator of pump health has three values 0, 1, 2 indicating a normal, warning and critical health status of the pump respectively.
- **RECOMMENDED_ACTION_1** to **RECOMMENDED_ACTION_6** – Recommended action based upon the health status of the equipment.

The analytical model will put the scoring data in CSV format in the `/var/PMQ/MQSIFileInput/integrationin` directory of the IIB node. The IIB flow will pick up the file for processing and insert the data into the **EVENT_PROFILE** table.

The Event type code of the **SP_RECOMMENDATION** table is defined by the solution for the processing of model output data.

Training model triggering flow

The flow is responsible for generating the analytical model for prediction by consuming maintenance and event data. The SPSS Training Model will be triggered by the default **PMQBatchIntegration** flow in IIB on a periodic basis.

The configuration to run the model is configurable in the `PMQ_orchestration_definition_batch.xml` file under **SPTrainingModel** orchestration through the elements **scheduled_time** and **duration_in_days**. These values are defaulted as shown in the following image. This orchestration also contains the WebService url and jobLocationURI to invoke the SPSS training model.

```
<!-- Orchestration for Slurry Pump(SP) Training Model -->
<orchestration>
    <Identifier>SPTraining</Identifier>
    <scheduler>
        <scheduled_time>00:00:01</scheduled_time>
        <queue_name>PMQ.SPTIMER.IN</queue_name>
        <duration_in_days>90</duration_in_days>
    </scheduler>
    <!-- Webservice configuration for SP SPSS Training Model -->
    <webservice>
        <url>http://10.148.124.229:9080/process/services/ProcessManagement</url>
        <jobLocationURI>spsscr:///?id=124f2cfc3caee94400000151007d4f108098</jobLocationURI>
        <notificationEnabled>true</notificationEnabled>
    </webservice>
</orchestration>
```

For immediate triggering, change scheduled_time to a near future value, and then restart the broker. After training is complete, you can again change to the expected training (generally off peak hours) time and restart the broker.

As a part of the invocation of the training model, a new queue has also been defined and is configured in the base PMQ MQ Queue definition file. The `IBMPMQ_Queue.mqsc` file is located in the `/var/PMQ/MQSIFileInput/properties` directory.

Scoring model triggering flow

The scoring model is responsible for generating the Health Score for the set of pumps based upon the maintenance and event data associated with those pumps.

The content of the orchestration file is as follows:

```
<!-- Orchestration for Slurry Pump(SP) Scoring Model -->
<orchestration>
    <Identifier>SPScoring</Identifier>
    <!-- Webservice configuration for SP SPSS Scoring Model -->
    <webservice>
        <url>http://10.148.124.229:9080/process/services/ProcessManagement</url>
        <jobLocationURI>spsscr:///?id=124f2cfca9abd2c70000015105a77cb190c1</jobLocationURI>
        <parameters>
            <parameter>
                <name>endTime</name>
                <value>endTime</value>
                <type>dynamic</type>
            </parameter>
        </parameters>
        <notificationEnabled>true</notificationEnabled>
    </webservice>
</orchestration>
```

Note: The <hostname> is <port> here.

The triggering of the Scoring Model happens via the IIB flow **REMIntegration** based on the **endTime** (passed as a parameter to model) which determines the last 60 minutes of operational data that needs to be considered when calculating predictions for the available pumps.

Flow for scoring on historical data
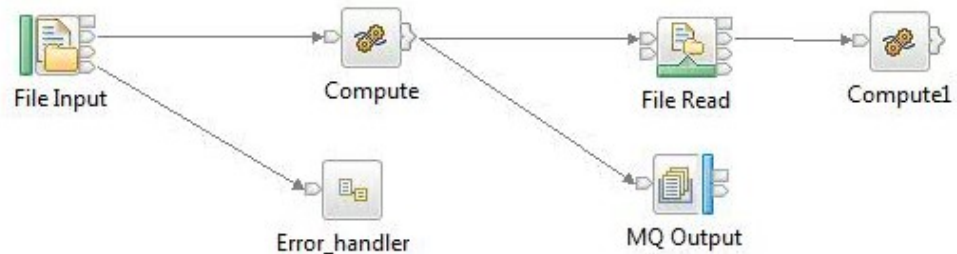
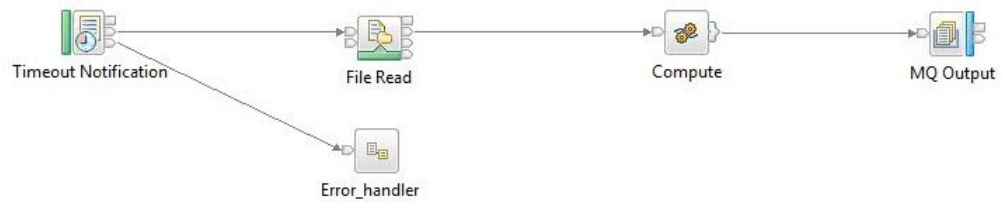This flow helps in triggering the scoring on historical data. Do the following to trigger the flow.

- Update the scoring_duration.txt file with the **scoring_duration** (duration in hours after which scoring should happen) and place it in the /var/PMQ/MQSIFileInput/properties/ directory.
- The scoring_data.txt file is populated with the **endTime** (time at which scoring should get triggered) and **frequency** (number of times scoring should happen after each duration) and placed in the /var/PMQ/MQSIFileInput/integrationin/ directory.
- The IIB flow will automatically get triggered when the scoring_data.txt file is placed in the /var/PMQ/MQSIFileInput/integrationin/ directory.
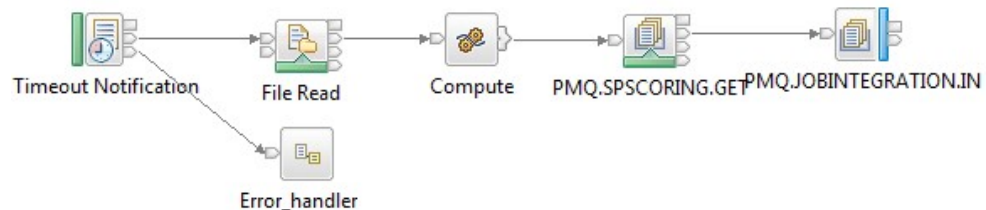
This flow also checks for the REM_Scoring_Status.txt (present under /var/PMQ/MQSIFileInput/integrationin/ directory) file, which contains the status of the scoring job as COMPLETE or RUNNING as updated by the SPSS scoring model. At initial setup value in this file will be IDLE.

The IIB flow constantly (after every three seconds) polls for the REM_Scoring_Status.txt file to determine when the next scoring job should be picked up for processing. Once the SPSS Model completes the job, the file is updated with the status as COMPLETE, and then the next message to be triggered is moved from the intermediate queue (PMQ.SPSCORING.GET) to the job execution queue (PMQ.JOBINTEGRATION.IN). This message will be processed by the default PMQ batch processing with the configurations as stated in the PMQ_orchestration_definition_batch.xml file.

Flow for scoring on real time data

This flow will trigger the scoring job for the current time and subsequently after the duration mentioned in the scoring_duration.txt file. The **endTime** will be passed as the current timestamp. To trigger the flow, complete the following steps:

- Update the scoring_duration.txt file with the scoring_duration (duration in hours after which scoring should happen) and place it in the /var/PMQ/MQSIFileInput/properties/ directory.
- Manually enable the **REMRealTimeSCoringIntegration** flow via the IIB console (*http://<hostname>:4414/*), and navigate to **PMQBROKER** > **Server** > **GROUP(pmqbroker)** > **Applications** > **REMIntegration** > **Resources** > **<flow name>** > **Start**

Chapter 4. Overview of the analytics model

The Asset Analytics for Rotational Equipment in Mining solution uses two SPSS Modeler based streams: the training model and the scoring model.

The following raw data is consumed by the models:

Operational Data
- Pump Name
- Observation Timestamp
- Measurement Values for Current
- Measurement Values for Flow Speed
- Measurement Values for Density

Maintenance Data
- Pump Name
- Downtime Start Timestamp
- Downtime Stop Timestamp
- Type – Preventive / Corrective Maintenance

Training model

The training model makes use of all available historical Maintenance and Operational data for slurry pumps to train an analytical model which can be used for scoring the Time-To-Failure.

System Behavior
- IIB will invoke the training model.
- This training model is intended to be refreshed (approximately) once every three months. The invocation frequency can be configured, for more details refer to the section on triggering flows.
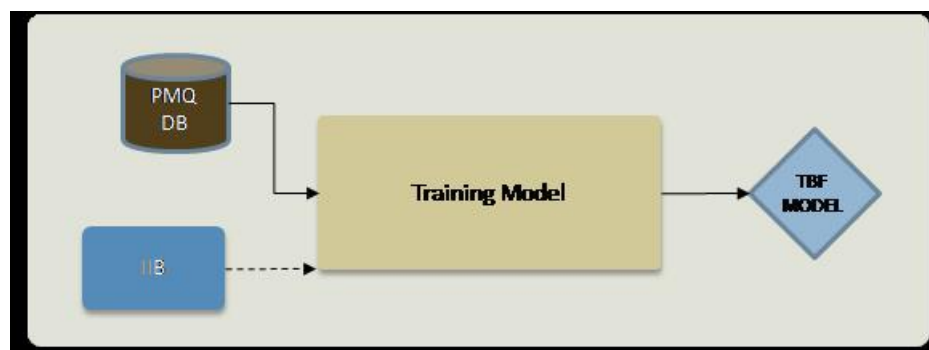
Model Behavior
- The model reads in historical Operations and Maintenance data for all pumps and sensors from the PMQ DB.

- The model output (`anModel.gm`) is a binary file which contains information that SPSS Modeler can consume to score pumps. It will be stored at `/usr/IBM/SPSS/ModelerServer/17.0/tmp/` folder.

Scoring model

The scoring model works on the latest data available for each slurry pump and produces a Time to Next Failure prediction, a connected Health Score and Health Status for each slurry pump. It also generates a set of 6 recommendations for each pump.

Expected System Behavior

- IIB will invoke the SPSS stream and pass a parameter T, which represents the time at which the scoring model is instructed to evaluate the condition of pumps (Format- yyyy-mm-dd hh:mm:ss). For example, if the scoring model is required to evaluate the condition of the pumps as of 4:30 p.m. on the 25th of December 2015, T will be 2015-12-25 16:30:00.
- IIB will read the CSV file that is output by the model and persist the output values in the PMQ database.
- The specific invocation frequency for this model is typically assumed to be once a day. But it may depend on the system configuration and number of pumps to be scored.
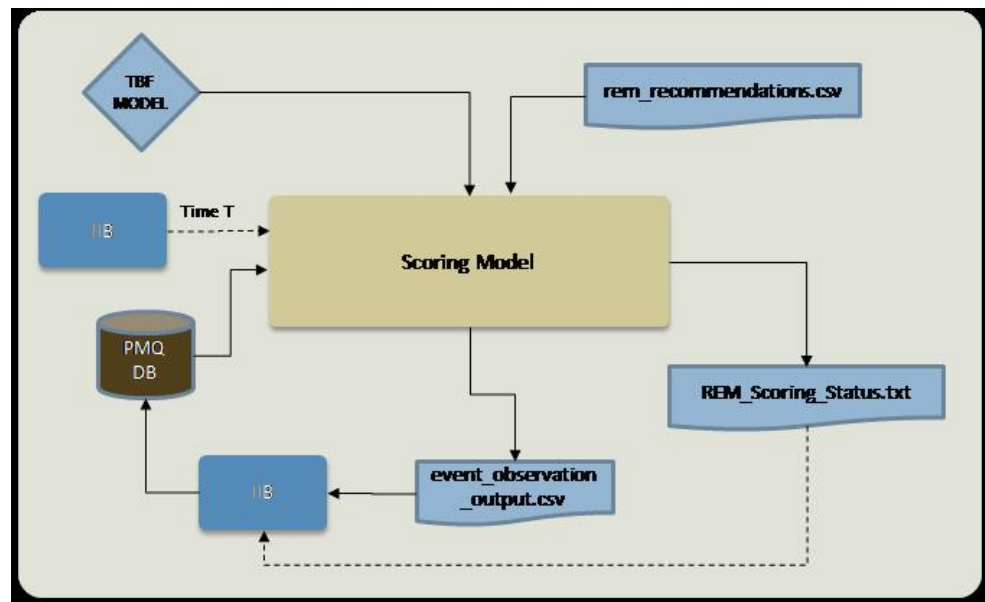
Model Behavior

- The model reads in historical Maintenance and Operations data from T-60 minutes until T, for all pumps and sensors.
- The scoring model first tries to read the output of the training file from `/usr/IBM/SPSS/ModelerServer/17.0/tmp/anModel.gm` (default configured path) and connect it within the stream. If this is successful, then it proceeds to write `REM_Scoring_Status.txt` with the text RUNNING. The text file will be written to `/root/integrationin/` for interpretation by IIB.
- The scoring model predicts the Time Before Failure (TBF) for each pump and also calculates a Health Score (percentage) for each pump. It also outputs a

heuristics based metric that is calculated based on two configurable thresholds (**warningThreshold** and **criticalThreshold**) set in the scoring stream. The following rules are used:

Table 2. Health Status Rules

Condition	Health Status
TBF ≥ warningThreshold	NORMAL
criticalThreshold ≤ TBF < warningThreshold	WARNING
TBF < criticalThreshold	CRITICAL

- Up to six recommendations defined in the rem_recommendations.csv file (at path /user/IBM/SPSS/ModelerServer/17.0/tmp/) are mapped to each pump based on the calculated Health Status.
- The scoring model output will consist of slurry pumps and their respective predicted Time to Next Failure, Health Score, Health Status and Recommendations (1-6) output as a CSV (event_observation_output) file which will be written to the /root/integrationin/ folder. At this point, the REM_Scoring_Status.txt file will also be written with the text COMPLETED.

Chapter 5. Using Asset Analytics for Rotational Equipment in Mining

The IBM Asset Analytics for Rotational Equipment in Mining solution provides insights into the functioning of slurry pumps in the mining industry. Dashboards provide maintenance operators with visualizations that indicate the status of each pump and provide predictions about when a pump will fail.

The solutions provides the following reports:

- Landing page, which provides a visual representation of the pumps and an indication of the health of each pump.
- Maintenance Dashboard, which provides information about a selected pump, including the maintenance history, current health, and recommended actions.
- Equipment Specification, which provides specification details for the selected pump.

An example of using the solution

When you open the Asset Analytics for Rotational Equipment in Mining solution, the Landing page provides a graphical view that indicates the status of each pump in your organization.

About this task

This task describes how a maintenance operator using the solution would identify a potentially faulty pump for further investigation. The screen shots shown are for example purposes and will vary depending on your particular implementation.
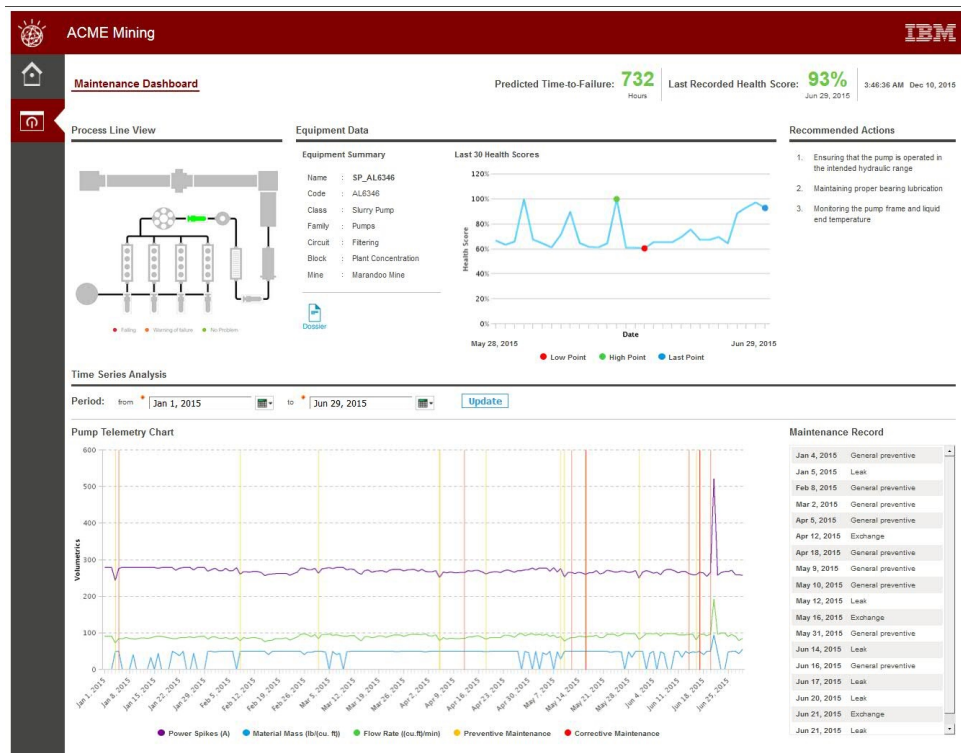
Procedure

1. Log on to the solution to scan for issues that need attention.

   The **Landing** page shows the status of each machine and the overall system health.
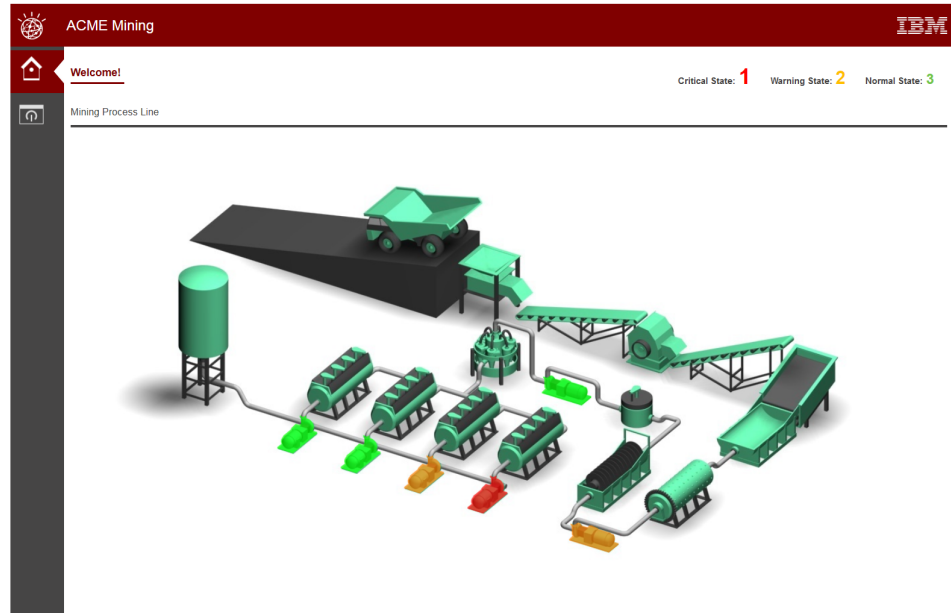
2. Click a pump to display the **Maintenance Dashboard** page for that pump.

The **Maintenance Dashboard** provides the following details about the pump:

- **Predicted Time-to-Failure**, which indicates the predicted time in hours until the failure.
- **Last Recorded Health Score**, which indicates the health of the pump.
- **Process Line View**, which provides a visual representation of the status of the pump.

- **Equipment Data**, which shows details for the pump and the last 30 health scores.
- **Recommended Actions**, which provides recommendations based on the pump's current health.
- **Time Series Analysis**, which includes the pump telemetry chart and maintenance record. You can set the period to filter the information shown on this report.

3. Click the **Dossier** icon to display the **Equipment Specification** page, which provides details for the pump.
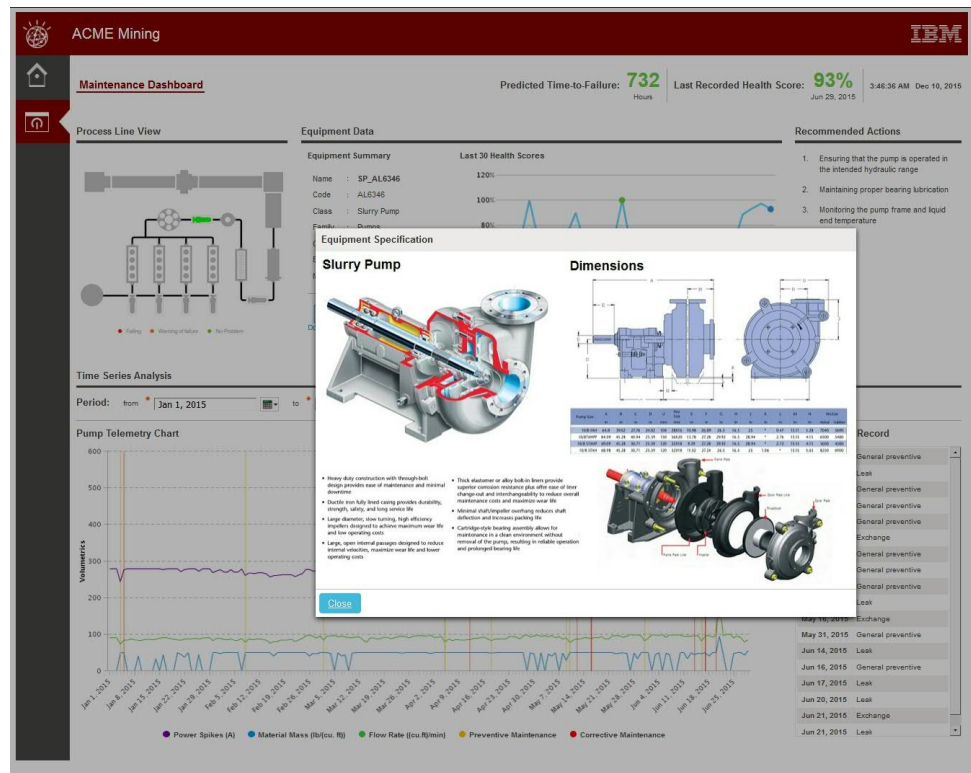
Appendix A. Accessibility features

Accessibility features help users who have a physical disability, such as restricted mobility or limited vision, to use information technology products.

For information about the commitment that IBM has to accessibility, see the IBM Accessibility Center (www.ibm.com/able).

IBM Cognos HTML documentation has accessibility features. PDF documents are supplemental and, as such, include no added accessibility features.

Report output

In IBM Cognos Administration, you can enable system-wide settings to create accessible report output. For more information, see the *IBM Cognos Business Intelligence Administration and Security Guide*. In IBM Cognos Report Studio, you can enable settings to create accessible output for individual reports. For more information, see the *IBM Cognos Report Studio User Guide*. You can access the previously mentioned documents at IBM Knowledge Center (http://www.ibm.com/support/knowledgecenter).

Appendix B. Troubleshooting

This section contains troubleshooting information for the Asset Analytics for Rotational Equipment in Mining installation.

Troubleshooting resources

Troubleshooting resources are sources of information that can help you resolve a problem that you are having with an IBM product.

Support Portal

The IBM Support Portal is a unified, centralized view of all technical support tools and information for all IBM systems, software, and services.

The IBM Support Portal lets you access all the IBM support resources from one place. You can tailor the pages to focus on the information and resources that you need for problem prevention and faster problem resolution. Familiarize yourself with the IBM Support Portal by viewing the demo videos (https://www.ibm.com/blogs/SPNA/entry/the_ibm_support_portal_videos).

Find the content that you need by selecting your products from the IBM Support Portal (http://www.ibm.com/support/entry/portal).

Before contacting IBM Support, you will need to collect diagnostic data (system information, symptoms, log files, traces, and so on) that is required to resolve a problem. Gathering this information will help to familiarize you with the troubleshooting process and save you time.

Service request

Service requests are also known as Problem Management Reports (PMRs). Several methods exist to submit diagnostic information to IBM Software Technical Support.

To open a PMR or to exchange information with technical support, view the IBM Software Support Exchanging information with Technical Support page (http://www.ibm.com/software/support/exchangeinfo.html).

Fix Central

Fix Central provides fixes and updates for your system's software, hardware, and operating system.

Use the pull-down menu to navigate to your product fixes on Fix Central (http://www.ibm.com/systems/support/fixes/en/fixcentral/help/getstarted.html). You may also want to view Fix Central help.

IBM developerWorks

IBM developerWorks® provides verified technical information in specific technology environments.

As a troubleshooting resource, developerWorks provides easy access to the most popular practices, in addition to videos and other information: developerWorks (http://www.ibm.com/developerworks).

IBM Redbooks

IBM Redbooks® are developed and published by the IBM International Technical Support Organization, the ITSO.

IBM Redbooks (http://www.redbooks.ibm.com) provide in-depth guidance about such topics as installation and configuration and solution implementation.

Software support and RSS feeds

IBM Software Support RSS feeds are a quick, easy, and lightweight format for monitoring new content added to websites.

After you download an RSS reader or browser plug-in, you can subscribe to IBM product feeds at IBM Software Support RSS feeds (https://www.ibm.com/software/support/rss).

Log files

Log files can help you troubleshoot problems by recording the activities that take place when you work with a product.

Error messages

The first indication of a problem is often an error message. Error messages contain information that can be helpful in determining the cause of a problem.

Troubleshooting a problem

Troubleshooting is a systematic approach to solving a problem. The goal of troubleshooting is to determine why something does not work as expected and how to resolve the problem.

Review the following table to help you or customer support resolve a problem.

Table 3. Troubleshooting actions and descriptions

Actions	Description
A product fix might be available to resolve your problem.	Apply all known fix packs, or service levels, or program temporary fixes (PTF).
Look up error messages by selecting the product from the IBM Support Portal, and then typing the error message code into the **Search support** box (http://www.ibm.com/support/entry/portal/).	Error messages give important information to help you identify the component that is causing the problem.
Reproduce the problem to ensure that it is not just a simple error.	If samples are available with the product, you might try to reproduce the problem by using the sample data.

Table 3. Troubleshooting actions and descriptions (continued)

Actions	Description
Ensure that the installation successfully finished.	The installation location must contain the appropriate file structure and the file permissions. For example, if the product requires write access to log files, ensure that the directory has the correct permission.
Review all relevant documentation, including release notes, technotes, and proven practices documentation.	Search the IBM Knowledge Center to determine whether your problem is known, has a workaround, or if it is already resolved and documented.
Review recent changes in your computing environment.	Sometimes installing new software might cause compatibility issues.

If the items in the table did not guide you to a resolution, you might need to collect diagnostic data. This data is necessary for an IBM technical-support representative to effectively troubleshoot and assist you in resolving the problem. You can also collect diagnostic data and analyze it yourself.

Troubleshooting known issues

There are solutions for known errors that you may encounter in IBM Asset Analytics for Rotational Equipment in Mining.

Table 4. Solutions to errors or problems in the executive dashboards in IBM Asset Analytics for Rotational Equipment in Mining.

| Error or problem	Action

Model or package does not exist.
 	
This error occurs with this message:
 	
`The model or package`
 	
`/content/folder[@name='REM_AssetAnalytics']`
 	
`/package[@name='IBMPMQ']/model[@name='2015-06-`
 	
`16T05:18:25.171Z'] does not exist or you are not`
 	
`allowed to use it because of security settings.`
	Ensure IBMPMQ Mode is published on the Cognos server in **Public Folders > REM_AssetAnalytics**.

Dashboards display "No Data Available" even if there is data available in the IBMPMQ database.	Ensure the Tenant ID is updated in the IBMPMQ model parameter, and the package is published.

Troubleshooting SPSS

If your SPSS job fails, there are some troubleshooting steps you can follow to resolve the issue. Troubleshooting the execution of SPSS jobs requires IBM SPSS Collaboration and Deployment Services Deployment Manager 7.0 to be installed on the workstation from which the server connection is to be established.

Procedure

1. Start IBM SPSS Collaboration and Deployment Services Deployment Manager 7.0.

2. Go to **File > New > Content Server Connection**.
3. Enter the **Connection name** and **Server URL** in the **Connection Information** dialog box, where *<server_ip_address>* is the IP address of the SPSS server node and *<port>* is the port number configured for the server connection.
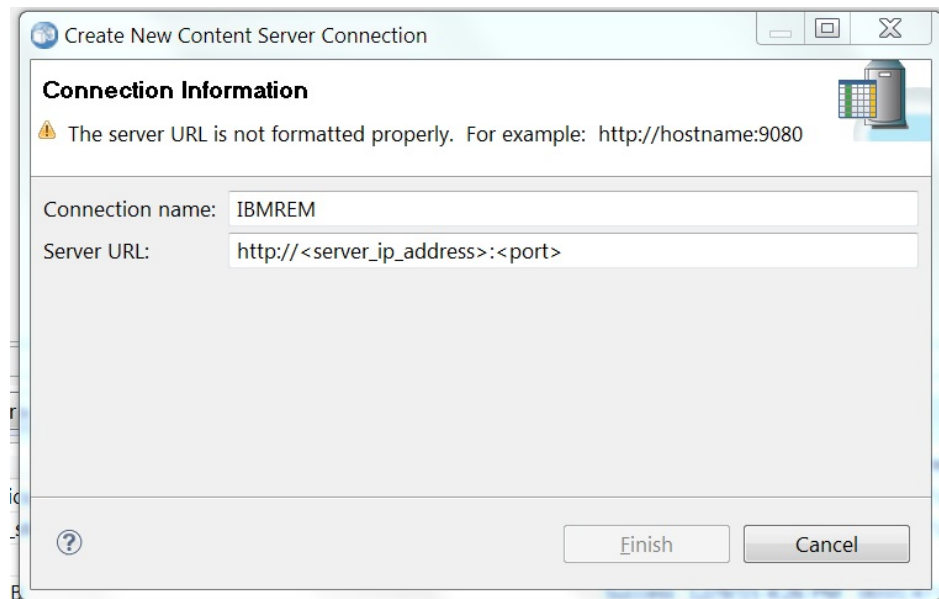
4. Expand the new **Content Server Connection** and provide the authentication details for the server.
5. Expand the IS_REM_AssetAnalytics folder in the Content Repository for the two job files: REM_TRAINING_JOB, for model training, and REM_SCORING_JOB, for model scoring.
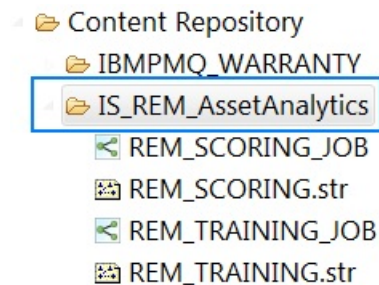
6. Right-click the job that you are troubleshooting and click **Show Job History**.
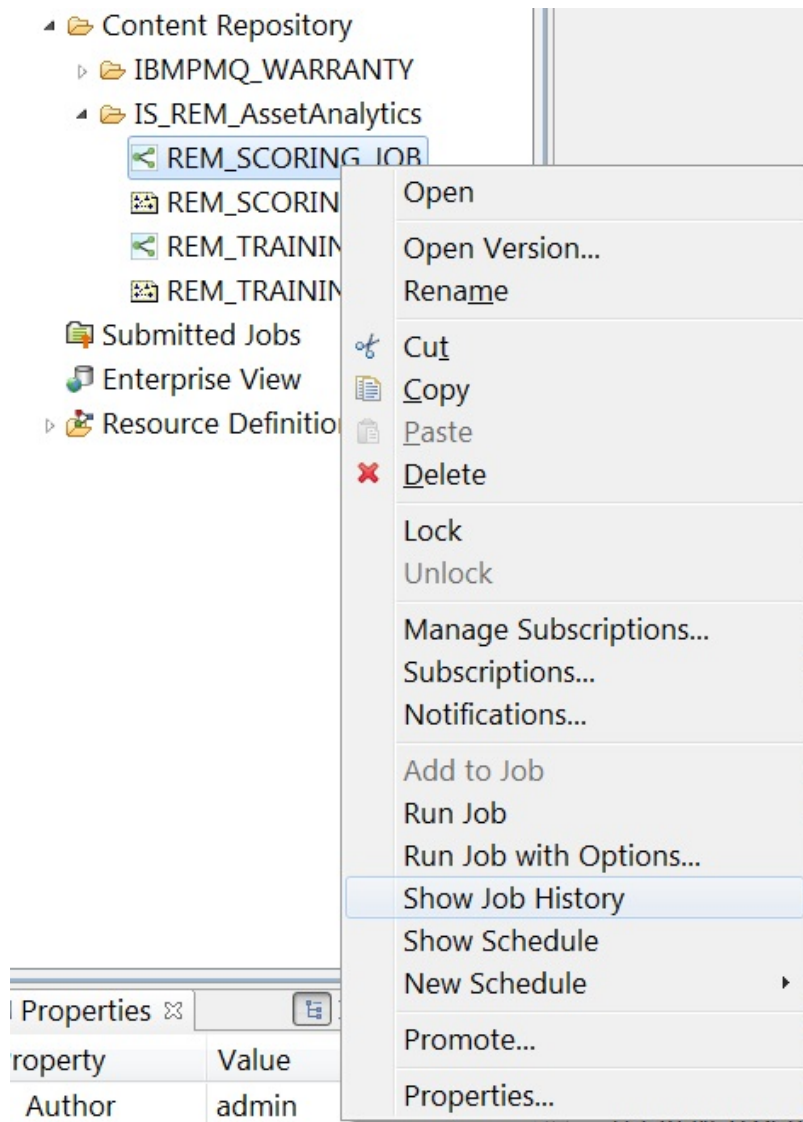
7. Two logs will be visible for each job. The first log shows information related to the job itself, such as the parameters used for running the job. The second log shows information related to the stream contained within the job.

8. To find the source of the failure, scroll to the error information provided near the end of the log file. Use this for problem rectification and further debugging.

Troubleshooting IIB

There are solutions for known errors that you may encounter while loading data. Errors will be logged in the folder /var/PMQ/MQSIFileInput/error.

Table 5. Solutions to errors or problems while loading data.

Error or problem	Action
Resource doesn't exist or location is not specified for the resource, please check serial number in the file name/master_resource table	Ensure that the SerialNo in the master_resource table and data file name are the same.
Invalid measurement value in the input file	Ensure that the values provided for design data are all numbers.
Please check the input file name, file name should have a prefix of <SerialNo>_	Ensure that the names of the data files are prefixed with <SerialNo_>.

After the solution installer is run, Chef processes are still running after the cleanup.sh script is executed

After the cleanup.sh script is run on the solution installer node, all chef processes should be terminated. However, in some cases chef processes are still running.

If you try to run the solution installer setup.sh file again, you might receive a message that required ports are in use, or creation of the chef user might fail.

The solution to this issue is to reboot the installation node after you run the "cleanup.sh" script.

Note: This information applies only to the solution installer node and not the client/target nodes.

Attention: The solution installer runs on Google Chrome 44 or later, or Mozilla Firefox 38 or later, web browsers. Internet Explorer is not supported.

Appendix C. Solution extensions

This appendix provides information on extensions to the Asset Analytics for Rotational Equipment in Mining solution.

Addition of new equipment

You can add and configure new slurry pumps to the IBM Asset Analytics for Rotational Equipment in Mining solution for predicting time-to-failure and health score for that pump.

Provide the master details, such as pump codes, pump name, location, and other organizational hierarchical information about a selected slurry pump in the resource_upsert.csv file as per the PMQ format.

Provide the other details about location and organizational hierarchy information in the location_upsert.csv and group_dim_upsert.csv file respectively as per the PMQ format. For more information on the process and sequence of loading master data into PMQ data store, please refer to PMQ Solution guide at:

http://www-01.ibm.com/support/knowledgecenter/SSTNNL_2.5.1/ com.ibm.swg.ba.cognos.pmq_solution_guide.2.5.1.doc/ c_conf_md_pmq.html?lang=en

Provide the historical operational data, such as current drawn by pump, speed of the slurry flow, and density of the slurry, as well as maintenance data such as corrective and preventive maintenance performed historically on the pump in the event_observation.csv file as per PMQ format. This data will be used for analytical model training.

For better predictions, provide the operational data for a minimum of three months including all the different possible working conditions of the pump. For more information on the process of loading operational (event) data into the PMQ data store, please refer to PMQ Solution guide at:

http://www-01.ibm.com/support/knowledgecenter/SSTNNL_2.5.1/ com.ibm.swg.ba.cognos.pmq_solution_guide.2.5.1.doc/ c_conf_measure_pmq.html?lang=en

For information about this pump to be available on the Cognos dashboard, complete the following steps: o Customers can add any other equipment than slurry pump for analysis may use out-of-box available analytical models of PMQ or may need to build a custom model based on available data and analysis required for that equipment. Please refer to PMQ Solution guide or connect to PMQ support team for more help.

- Reconfigure the landing page to add this pump to the Process Line Rave visualization
- Reconfigure the Process Line View Rave visualization in the main dashboard
- Add the pump specific dossier image in the <COGNOS_INSTALL>/ webcontent/Images/REMImages. The format is Slurry_Dossier_<PUMP_CODE>.jpg

You can add equipment other than slurry pumps for analysis by using available analytical models of IBM Predictive Maintenance and Quality, or you might need to build a custom model based on available data and analysis required for that equipment. Please refer to the Predictive Maintenance and Quality documentation or contact the Predictive Maintenance and Quality support team for more help.

Customize report or create new reports

Customers can customize reports or create new reports for a configured slurry pump by using IBM Cognos Report Studio.

Verify whether the Business Intelligence layer supports the required Framework Manager model necessary for the report that is being developed. If it does not, you must make changes to the provided model by using IBM Cognos Framework Manager.

Some examples of time series analysis reports:
- Time taken for preventive maintenance for n years
- Time taken for corrective maintenance for n years
- Total downtime per pump last year
- Time series analysis of health status
- Time series analysis of health score
- And so on

Customers can extend the solution by creating new reports using any other reporting technology available, by retrieving information residing in the PMQ data model. For more information, see the Master Data topic for IBM Predictive Maintenance and Quality on IBM Knowledge Center. http://www-01.ibm.com/ support/knowledgecenter/SSTNNL_2.5.1/ com.ibm.swg.ba.cognos.pmq_solution_guide.2.5.1.doc/ c_conf_md_pmq.html?lang=en

Customize predictive models

You can develop your own predictive models using any other modeling tools and input data.

The current solution's predictive model uses historical operational data, such as current drawn by the pump, speed of the slurry flow, and density of the slurry, as well as maintenance data such as corrective and preventive maintenance performed historically on the slurry pump for predictions. The predictability of the model can be enhanced further by identifying new parametric data. If such new parametric data is available, then complete the following steps:
- Load the meta-data related to this parametric data. For more information about loading master data into IBM Predictive Maintenance and Quality, refer to the Predictive Maintenance and Quality Solution guide at: http://www-01.ibm.com/ support/knowledgecenter/SSTNNL_2.5.1/ com.ibm.swg.ba.cognos.pmq_solution_guide.2.5.1.doc/ c_conf_md_pmq.html?lang=en
- Load actual parametric data. For more information about loading event data into Predictive Maintenance and Quality, refer to the Predictive Maintenance and Quality Solution guide at: http://www-01.ibm.com/support/knowledgecenter/ SSTNNL_2.5.1/com.ibm.swg.ba.cognos.pmq_solution_guide.2.5.1.doc/ c_conf_measure_pmq.html?lang=en

- Use IBM SPSS Modeler to retrieve the model from IBM SPSS Collaboration and Deployment Services' deployment manager. Open and modify the training and scoring streams of this solution as necessary.
- Again use IBM SPSS Collaboration & Deployment Services to redeploy the updated stream into the environment. Save the respective jobs.

Note: It is best to verify and test any change in the model or orchestration flows thoroughly in a staging environment before moving it to a production environment.

Integration with asset management and manufacturing execution systems

Customers can extend the solution to integrate with Asset management solutions

Integrating the solution with other asset management systems can be done by using the connectivity and data transformation capabilities of IBM Integration Bus (IIB). This involves creation of new message flows in IIB. The solution includes a prebuilt adapter for integration with the IBM Maximo asset management system. For more details, refer to the Predictive Maintenance and Quality documentation on IBM Knowledge Center.

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