

Detailed Specification of a Rea
Time Production to Maintenance
Management Integration (RPMI)
Software

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I. Introduction

This document provides the specification of a Real Time Production to Maintenance Integration Software (RPMI) product. The product should be available off the shelf and should need very little, if not, no customization. The product should be simple to deploy and should be easy to use by a non technical user.

RPMI should provide bi-directional connectivity between the plant and the enterprise in the domain area of maintenance. The product should connect to existing applications (at the end user site) that are in use in the plant and the enterprise areas. This should be achieved as part of a configuration exercise without the need for any intrusion into the source codes or databases of the existing plant control systems and/or EAM/CMMS systems.

In the plant to enterprise direction, RPMI should achieve real-time integration between production and maintenance applications by: (a) monitoring events and conditions that are generated in the plant control systems software (such as PLC, SCADA, Historian or MES systems); and (b) in response to such events and conditions, driving real time actions in the Enterprise Asset Management systems (specifically, SAP® PM, Maximo®). Furthermore, some events and conditions generated in the plant control systems should be abstracted into meta-data in RPMI before they are used for driving actions in the EAM/CMMS systems. Such abstraction should be achieved by structured or independent aggregation of data over time inside the RPMI application.

In the enterprise to plant direction, RPMI should be able to provide the plant user the following pieces of information from the EAM/CMMS system in real time : (a) up to date status on transactional data of any equipment; and (b) ready reference (upon query) of all master data of any equipment. In addition, RPMI should be able to automatically detect changes in the status of transactional data (such as work order status, priority, etc.) and drive actions in the plant control systems (such as, raise alarms or notify appropriate personnel, etc.)

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The above mentioned general requirements are specified in detail in the following sections. The document is organized as follows: Section 2 describes the business uses that RPMI needs to satisfy. Section 3 describes in detail the product features that are needed in RPMI in order to meet the business requirements outlines in section 2.

2. Business Uses of RPMI

RPMI should allow for the following business uses.

2.1. Real Time Monitoring for Preventive Maintenance

RPMI should be able to significantly improve the agility of the Preventive Maintenance (PM) functionality of the EAM/CMMS system by monitoring the usage of equipment in real time production and generating real time PM actions in the EAM/CMMS system. Furthermore, the software must be capable of scaling up its functionality in order to optimize (and thereby reduce the cost of) the Preventive Maintenance function across the enterprise as a whole by driving work orders in the EAM/CMMS system for multiple pieces of equipment based on logistics, similar usage, alignment with some other planned downtime, etc. .

The various individual business use cases that are required to be satisfied by RPMI under the category of “Real Time Monitoring for Preventive Maintenance” are itemized below.

- Scheduled Meter reading updates (Meter Maintenance) of run hours, production cycles, etc., to EAM/CMMS;
- Real time aggregation of usage (run hours, production cycles) and sending notification to EAM/CMMS;
- Real time aggregation of usage (run hours, production cycles) in the RPMI and PM work order generation in EAM/CMMS;
- Cascaded Preventive Maintenance, that is, defining an escalated set of PMs for an equipment after every stipulated duration and attaching a different job plan for each PM in the EAM/CMMS system, and driving these PMs from the RPMI by means of real time monitoring of duration;
- PM optimized across similar equipment/ similar usage/ same manufacturer, etc.
- Opportunistic PM to minimize planned shutdowns via alignment with other plant events such as product change, tool change, etc.;
- Real time write back to SCADA/PA system (reset actions, on/off actions) upon work order closure (preventive, predictive or corrective) in EAM or any other change in EAM/CMMS;

- Real time tracking of delays in maintenance (Preventive, Predictive or corrective) execution and notification if abnormal;
- Real time tracking of usage of tools across several assets (example - use of a die across several presses) and generation of PM ;
- Real time tracking of usage of tools or equipment against planned maintenance - generation of scheduled CSV reports;
- Real time tracking of usage of spare parts inventory after every planned maintenance and notification;
- Ordering PM in EAM/CMMS system if predictive maintenance condition occurs close to a scheduled/planned PM;
- Real time tracking of the unplanned downtimes/costs between a series of successive PM cycles and notification if it is abnormal;
- Cascaded, Advanced notification (to authorized personnel) of approaching planned shutdown of equipment as usage levels near the PM threshold; and
- Real Time tracking of the Total Cost of Downtime and notification if TCD crosses a threshold.

2.2. Real Time Predictive Maintenance

Predictive Maintenance should be driven by RPMI in a EAM/CMMS system with an objective of eliminating unplanned downtimes. RPMI should allow for the configuration and generation of tactical and strategic proactive actions in the EAM/CMMS system in order to prevent such downtimes.

- Unplanned downtime avoidance type 1 - real time monitoring of one or more variables (temperature, pressure, vibration, etc.) and triggering predictive maintenance work order upon such variables crossing thresholds;
- Unplanned downtime avoidance type 2- real time monitoring of events - triggering work order if occurrences of events (waste, downtime, faults, environmental, etc.) are crossing acceptable thresholds;
- Unplanned downtime avoidance type 3- real time monitoring of a combination of events and variables and triggering work order upon simultaneous occurrence of a combination of events and variables;

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- Unplanned downtime avoidance type 4 - real time monitoring of a combination of events, variables and "floating" time intervals and triggering predictive work orders;
- Unplanned downtime avoidance type 5 - real time refinement of work order parameters based on escalated conditions;
- Unplanned downtime avoidance type 6 - real time monitoring for occurrence of mismatched input and output process conditions to trigger predictive work order;
- Unplanned downtime avoidance type 7 - real time monitoring of the first and second order trends (rates of change) of variables, events, process conditions with respect to typical, average rates of change expected to trigger predictive work order;
- Unplanned downtime avoidance type 8 - real time monitoring of the boundary conditions for usage, such as, undesired usage of equipment, undesirable environmental conditions and sending notifications ahead of PM if such usage is significantly higher and can cause damage;
- Unplanned downtime avoidance type 9 - real time monitoring of the weakest link of an equipment based on the failure history, MTBF, etc., (in EAM) for the equipment;
- Unplanned downtime avoidance type 10 -real time monitoring of non equipment related downtime, such as, cumulative duration between unplanned or unscheduled start and stops of equipment operation and sending notification should the cumulative value cross an acceptable threshold;
- Real time tracking of improvement in MTBF (change in MTBF recorded in EAM) of equipment and notification of such improvement either time or event based;
- Real time tracking of improvement in availability (change in availability) of equipment and notification of such improvement (change) either time or event based.

2.3. Automatic Generation of Corrective/Emergency Maintenance

RPMI should be able to coordinate between the plant and the enterprise asset management systems in real time in the case of the following business uses:

- Automatic, real time generation of a corrective maintenance work order in the EAM/CMMS system, upon failure of an equipment;
- Automatic, real time generation of a corrective maintenance work order upon repeated failures within a given duration; and
- Real time tracking of downtimes due to failures as a percentage of total downtime, total uptime, total production time, etc.

2.4. Single Window View Scenarios

RPMI should provide a web access (web portal) to view the following pieces of information in real time:

- View all EAM/CMMS information (PMs, work orders, job plans, failure histories, MTBF, spare parts, etc.) from Proficy portal using plant model; and
- View user defined aggregations that are made inside RPMI (number of faults/equipment, rate of change of a variable, trends, cumulative downtime durations of an equipment, etc.

3. Product Feature Specification

This section elaborates the features that are required in the product in order to satisfy the business uses mentioned in the previous section. RPMI should comprise the following modules: (a) Administrator; (b) Business (c) Control Panel and (d) Web Reporting. The requirements of each of these modules are outlined in individual sections below.

3.1. Administrator

The Administrator module should allow configuration required for connectivity between (a) RPMI server and the plant control systems, and (b) the RPMI server and the Enterprise Asset Management System. This module should be accessible only by designated users from administrators group consisting of IT/Plant Administrators. This module should allow administrators to:

- a. Define connection points called Plant Channel to interface a plant MES application or plant control systems software using the published standards of such software.
- b. Define connection points called Enterprise Channel interface with EAM/CMMS like Maximo or SAP PM. Similar to the standard method of interfacing with plant system, the product should interface with EAM/CMMS through the standard published interfaces provided by EAM. In the case of Maximo, the interface should be through Maximo SDK or Maximo or Maximo MIF (Maximo Integration Framework), for SAP it should be through SAP PI (Process Integration).
- c. Test the connectivity to the respective plant and enterprise servers.
- d. Define categories to group items based on 'frequency of change' at the plant. This grouping shall also be based on how immediately a value of an item needs to be processed in the rule engine.
- e. Download plant hierarchy as available in the plant system based on settings in plant channel.

- f. Download reference codes (Work order statuses, Work order priorities, Work order types, measurement points) and location-equipment hierarchy related to enterprise system.
- g. Filter downloads from EAM/CMMS such as, records matching specific site/plant and records after a given date.
- h. Map plant model of the assets to the enterprise model of the assets/equipment so as to achieve the necessary correspondence during the plant to enterprise and the enterprise to plant transactions. This should be achieved by dragging and dropping a plant asset to the corresponding enterprise equipment in a graphical user interface.
- i. Import bulk mappings between plant assets to enterprise equipment using a CSV file.
- j. Define processes to configure the product to
 - a. Send email notifications.
 - b. Send msmq notifications.
 - c. Create work orders of types Corrective, Emergency, Predictive and Preventive.
 - d. Update work orders.
 - e. Update meters or measurement points.
 - f. Update Values for Plant Items.
 - g. Update variables within the product.
- k. Define HTTP interfaces as processes against enterprise channel to post and receive XML messages using HTTP.
- l. Define new user profiles to access RPMI modules.

3.2. Business

This module should allow users (maintenance domain user) to create contextual information from raw plant data through aggregation. This module should also allow users to build rules with conditions based on raw data/meta-data abstracted using aggregation and accumulation. The rules on successful trigger of the condition should enable actions to be taken in EAM/CMMS or in the plant applications/control systems.

- a. Define Business Contexts (BC) – Should group data according to the needs of a real time asset management function. Primarily, the grouping should be based on how a business user would like to categorize entities as belonging to a certain class that would need a similar treatment from a maintenance perspective. These groups should be available by unique Business Contexts to be available for users in other functions of Business.
- b. Enterprise events based on Work orders or notification status updates should also be available as separate Business Contexts for users to define conditions as part of Rules against maintenance events.
- c. Discrete Aggregation Counters (DAC) should be one of the core mechanisms to achieve data abstraction from raw data of plant. The abstraction should be achieved by aggregation of data in one or more ways like accumulation, counting number of instances of an event occurred and defining trend of process variables based on rate of change, average rate of change, delta, maximum and minimum. The DAC aggregation mechanism should be determined by four triggers identified as Start, Aggregation, Reset and Termination properties.

All the four properties Start, Aggregation, Reset and Termination should be based on Time or Event triggers. Time based triggers should provide users to select specific date time, specific day of the week or a frequency. Event based triggers should be based on Start, Reset, Termination of other DAC, successful rule evaluation and also when an update is received for a plant item, BC.

DAC should start aggregation only after the Start trigger is met and should aggregate whenever the trigger for Aggregation is getting met. The aggregation should stop when Termination trigger is met and whenever the reset trigger is met, the value of the DAC should be reset to the value defined as Reset Value.

DAC should also be capable of counting time elapsed between a Start and Reset/Termination triggers.

- d.** Process Aggregation Counters (PAC) should provide structured, hierarchical aggregation of data and provide real time information on the dynamic inter-dependencies between different data items in real time.

PAC should allow users to define expressions based on the items within the PAC so that when a hierarchical aggregation is happening, the expression values shall also be evaluated.

PAC should allow users to configure XML reports based on the items part of the PAC and the reports should be configured to be sent to a queue based on a scheduler.

- e.** All DAC and PAC values must be available for building rule conditions to the user as part of rule builder user interface.
- f.** Constants – users should be able to define constants to store most frequently used threshold limits. These constants shall then be available as part of rule builder interface to create rules meant for monitoring process variables crossing particular threshold.
- g.** Actions – all processes that are defined in Administrators should be available as separate actions that can be attached to rules. Multiple actions shall be created by users, with each action denoting a particular behavior of the process.

- h.** Rules – Rules should have two parts, defining a condition part and an action part. As part of condition, users should be able to frame conditions based on Plant Hierarchy, BC, DAC, PAC and Constants. The condition building should provide arithmetic, relational and logical operations. As part of actions, user should be able to add multiple actions. The product should evaluate for the condition being met whenever an updated value is received for each of the variables/items used in the conditions. Whenever the condition is met, the actions attached to the particular rule must be taken by the product.
- i.** Users should be able to export configuration of BC, DAC, PAC and Rules as individual CSV files. Similarly, the users

3.3. Control Panel

The product should run seamlessly 24X7 and hence should have options as part of Control Panel to monitor the activities of the product. The Control Panel should also provide audit log details and options to backup and restore the database used by the product.

3.4. Web Reporting

This module should allow users to view Enterprise and Plant equipment (physical) models in a hierarchical structure, search and display data that is needed in a web environment and also export the data to Excel as needed. The unified view provided by the viewer should include-

- a.** Displaying information regarding equipment-location from EAM/CMMS into a plant application portal.
- b.** Ability to download latest equipment-location information from EAM/CMMS into a web portal by means of a user query.
- c.** Displaying information regarding work orders from EAM/CMMS into the web portal and also an ability to query the EAM/CMMS from the Portal for the current status.

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- d.** Capability to get information regarding failure histories and MTBF of equipment from EAM/CMMS into a plant application portal.
- e.** Download latest failure histories and Mean Time between Failures information from EAM/CMMS.
- f.** Displaying latest values of BC, DAC and PAC.
- g.** Ability to show/hide columns which are not required by the user as of his/her report view.
- h.** The viewer upon each selection of the asset in the plant hierarchy; the reporting data should be filtered specific to the enterprise equipment.

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