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Machine Monitoring Solution

Technical and commercial overview

The solution automatically collects machine states through an OPC server and turns them into structured records of running time and downtime. Technical data is supplemented with operational reasons and comments so that production and management teams can understand both what is happening on the shop floor and why time is being lost.

Centralized collection, machine-level monitoring and consolidated analysis provide a common basis for tracking capacity utilization, prioritizing interventions and evaluating improvement measures. The solution covers the entire workflow, from reading signals to reports and automatic notifications.

Production visibility

Production managers monitor the current state of equipment and changes in its utilization. Downtime is classified into explicit categories, while analysis by machine, machine group and period highlights where nonproductive time is concentrated.

Information to support decisions

- Identifying frequent stoppages and causes with a significant impact on available time.
- Separating running time from scheduled downtime, delays and repairs.
- Linking automatic signals to explanations entered by operators.
- Flagging downtime thresholds being exceeded and distributing reports periodically.

Scope of use

The solution is intended for organizations operating machines whose states are accessible through an OPC server and that need consistent records of machine operation. Grouping allows production cells, shop floor areas or equipment categories to be analyzed according to the operational structure.

1 Monitoring model

The solution is based on a clear distinction between the signal read from the machine, the operational cause and the category used in analysis. This structure retains the technical information and allows it to be interpreted in a common language for production, maintenance and management.

Element	Role in the solution
Raw state RS	The state read from the OPC server for the monitored machine.
Reason REAS	The explanation associated with the state. It can be assigned by default or entered by the operator.
Final state FS	The category assigned to the event for monitoring and reporting.

Time classification

Category	Examples of interpretation
Running	Machine in an operating cycle.
Scheduled downtime	Scheduled maintenance, cleaning, operator breaks or periods not scheduled for production.
Delay	Waiting for material, parts or personnel; tool preparation or replacement.
Repair	Mechanical, electrical, hydraulic, software or cooling system problems.
Out-of-cycle time	Manual loading and unloading, part setup, quality checks or programming.
Not reading	An interval for which no monitoring data is available.

Each raw state is assigned a default reason, and each reason corresponds to a final state. Master data and colors can be managed so that the same classification is used in interfaces and reports.

Interpretation rules

For states that require explanations, exceeding a duration threshold triggers a request for a reason. The microstop consolidation rule classifies the intervals between two in-cycle events as running time when the combined duration of the intermediate states is less than three minutes.

Events retain the machine identifier, recording timestamp to millisecond precision, raw state, reason, final state and duration in seconds. Comments provide additional context when requested.

2 Architecture and data flow

The architecture separates signal acquisition from the operator interface and historical analysis. State readings run centrally on the server, independently of the availability of the workstation at the machine.

Component	Main responsibility
OPC Reader Process ORP	Reads machine states, records changes and monitors alert conditions.
OPCAdmin	Manages machines, rules and calendars; controls reading processes and displays errors.
OPCClient	Provides processing functions and machine-level interaction, including entry of reasons and comments.
OPCMonitor	Displays operational charts showing utilization and causes of downtime.
OPCAnalyser	Supports event analysis, review of reasons and report generation.
Automation	Runs reports periodically, distributes results by email and sends notifications.

From signals to history

The ORP process reads states through OPC, with separate execution for each machine. Changes are recorded in a database local to the collection process. Completed events are then processed and transferred to the main database, where they form the history used for analysis.

Local persistence decouples acquisition from write speed and temporary unavailability of the main database. Recent data is also retained in a local buffer covering the last 48 hours, used to populate charts and reduce requests to the central database.

Controlling collection and interruptions

The control mechanism prevents multiple reading processes from starting simultaneously for the same machine. Stopping readings is indicated by the Not reading state. On restart, cases where the previous process was forcibly terminated are also handled so that missing data is visible in the history.

An interruption in collection makes it impossible to reconstruct the actual machine state during the interval without data. These intervals are identified separately, while scheduled downtime periods are interpreted according to the calendar.

3 Administration and operation

Configuring the machine fleet

OPCAdmin supports adding, modifying and removing machines, with definitions for the code, name, OPC tag and mappings between raw states and default reasons. Reasons, final states and display colors are managed in the same area.

Machines are organized into groups for analysis and reporting. A machine can belong to one or more groups, allowing different views of the same equipment fleet.

Calendars and shifts

Each machine has a weekly calendar with periods and shifts in which planned states are defined. If a period without readings overlaps scheduled downtime, the calendar state takes precedence when interpreting that period. This rule retains the production schedule context in reports.

Operational control

The administrator can start or stop readings for one machine or all machines and check process status. Errors are recorded and available for diagnostics at both main process and machine level.

Operator-entered reasons and comments

The operator sees the current machine state and responds to requests for explanations in an event list. Default reasons reduce repetitive intervention, while explicit requests apply to states and durations that require clarification.

For states configured to request comments, exceeding the general threshold of N seconds allows an explanation to be entered while the event is in progress. When the state ends, an explanation is mandatory. Mandatory comment configuration is also associated with a request for a reason.

Example of use

A machine leaves its cycle and remains in that state beyond the defined threshold. The operator indicates that it is waiting for material and enters the required explanation. The event is assigned to the appropriate category, and its duration appears in both the machine history and group totals. The production manager can then identify whether the problem recurs and how much time it consumes.

4 Monitoring and notifications

The monitoring interface displays the current state and charts that link changes in utilization to the reasons for downtime. Information is available at machine level to track activity during the shift and quickly identify deviations.

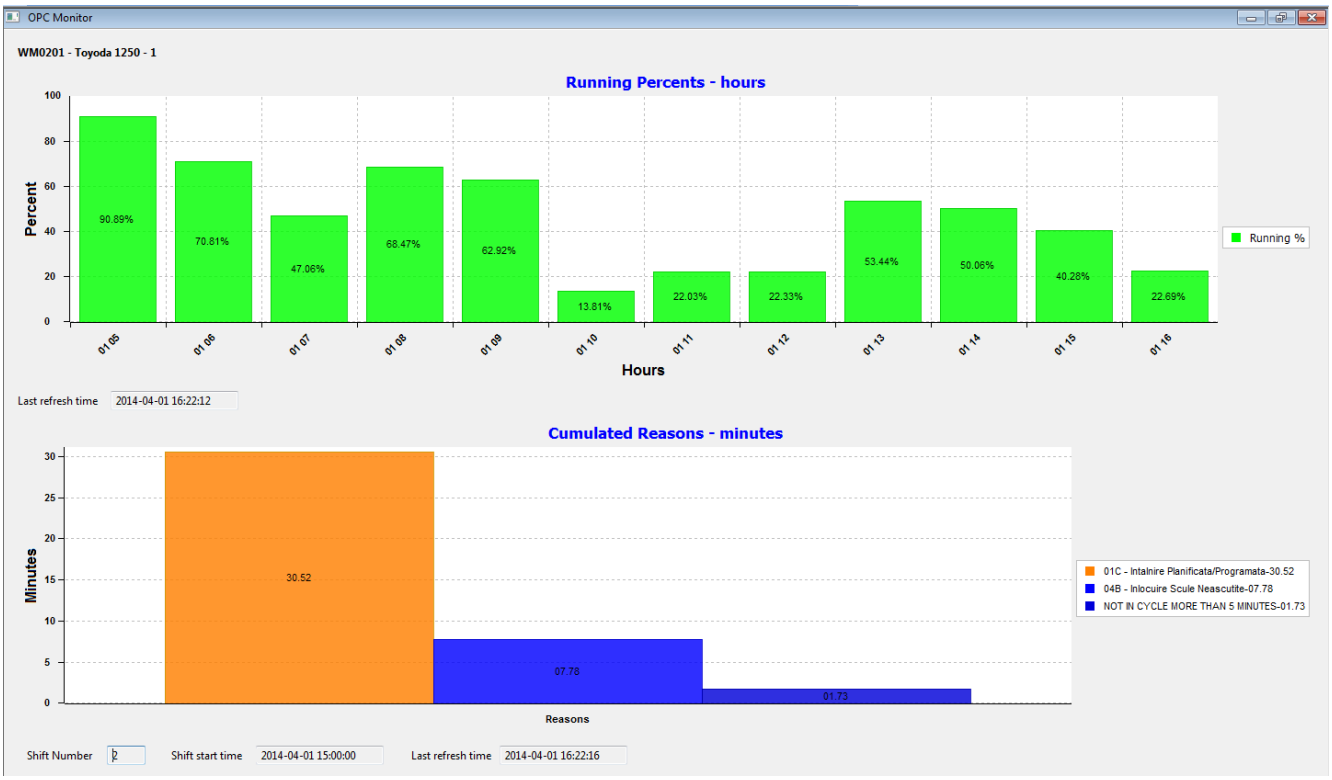


Figure 1 Example of hourly utilization monitoring and cumulative durations by reason

Reading the charts

The hourly utilization chart highlights variations in running time, while the cumulative reasons chart shows the causes that consumed time during the shift. Viewing them together allows periods of low utilization to be investigated using the recorded data.

Alerts when thresholds are exceeded

The solution tracks how long a machine remains in a configured state. For example, if out-of-cycle time exceeds N minutes, an email notification is triggered to the address defined for the OPC entity concerned. The threshold is configurable, and monitoring is performed by the collection process.

Messages are sent by a process separate from readings. The solution also generates derived events based on defined conditions, such as a state duration being exceeded, to turn deviations into explicitly tracked operational information.

The values in the screenshots are display examples illustrating how data is presented.

5 Reporting and analysis

OPCAnalyser allows users to select the period and machines to analyze, review reasons and view history. State and totals reports are available for one machine, all machines or a selected group.

Time distribution by machine and category

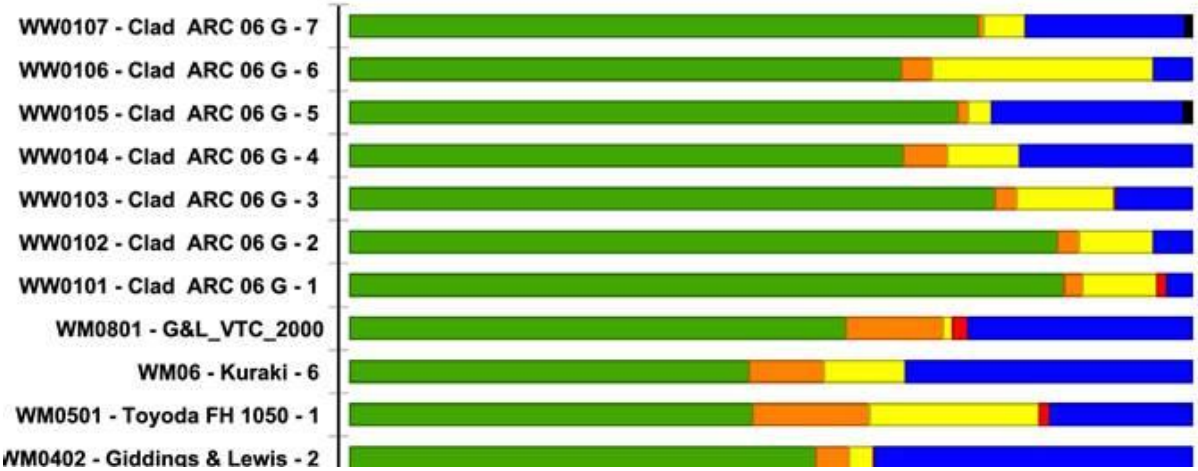


Figure 2 Example comparison of state distributions across multiple machines

The comparative view highlights differences between machines. Machines with a high proportion of delays, repairs or out-of-cycle time can be selected for detailed cause analysis.

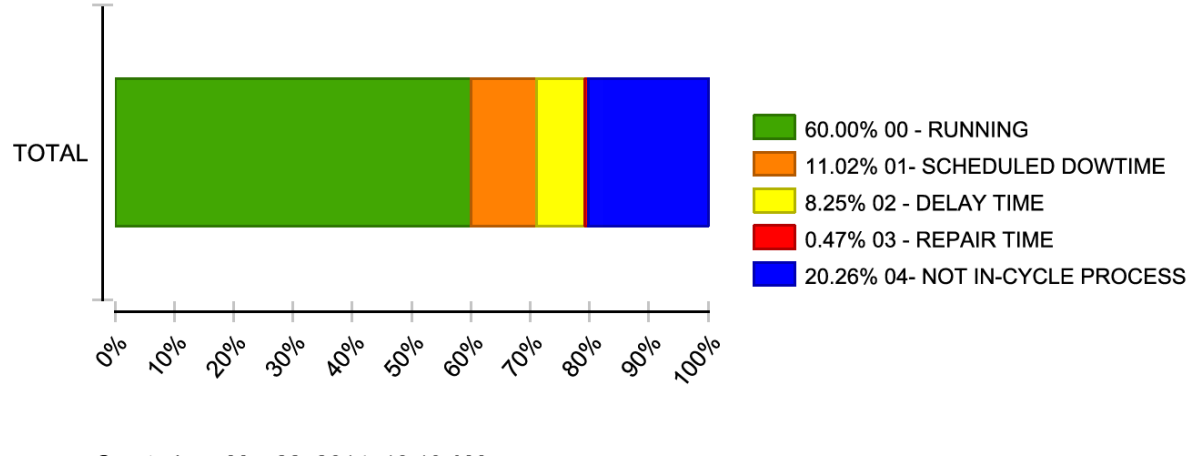


Figure 3 Example of aggregated time distribution by state category

The totals report details the number of occurrences, cumulative duration, share within the state category and share of total time. These indicators allow both event frequency and its impact on the analyzed interval to be assessed.

6 Automated analysis and use of data

History and investigation

The event log allows the sequence of states to be tracked and records containing comments to be filtered. Operators' explanations can be analyzed together with event duration and classification to clarify significant stoppages and recurring situations.

Aggregated data is also available for analysis in Excel, identifying the machine, reason, state, duration and number of occurrences. Subsequent analyses can use the same categories as operational reports.

Tracking utilization over the last 12 hours

The 12-hour utilization report shows hourly running trends and uses color highlighting for quick interpretation of results. Automatic execution is configured at intervals of N minutes for a predefined list of OPC entities so that information is updated periodically for the production team.

Periodic distribution of information

Reports are generated on a schedule and emailed to the configured address or distribution list. Managers therefore receive the same view of the analyzed period without manually rerunning each report.

Interpreting the indicators

Utilization expresses the proportion of running time within the report's reference interval. Durations, frequencies and shares by reason show where time is spent and support comparisons between periods or machine groups. Interpretation of the results takes calendars, classification rules and intervals without readings into account.

Technical foundation and operating requirements

The solution uses enterprise Java components, Windows client interfaces, interprocess messaging, local storage and a central SQL Server database. Connection requires an OPC server and tags exposing the relevant machine states, as well as connectivity to the collection and storage components.

Deployment includes signal identification, master data definition, threshold and calendar configuration, validation of event classification and user training. The quality of the analyses depends on the available signals and consistent entry of reasons and comments.

Benefit to the organization

The solution provides shared, verifiable records of machine utilization. Teams can prioritize interventions based on time lost, track the effects of measures implemented and support decisions on organizing activities and using production capacity.