PARASUITE Technology

White Paper

PARASUITE 1.0

A framework for analyzing the behavior of industrial products and production plants

White Paper

Version 1.0

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1 Background

Many producers of industrial goods and users of industrial plants will try and reduce their operating costs by the use of smart sensors. This includes - but is not limited to - the producers of locomotives, trucks, high speed milling machines, ships etc.

Technically that means that the industrial goods and plants will be equipped with smart sensors at the most informative locations and continuously monitored. In case deterioration or unexpected failures are detected, it is possible to intervene immediately. That will lead to better industrial products with higher availability and less operating costs. For the producers of sensor equipped products this will in the long term result into higher market shares.

In order to exploit these opportunities, the producers and operators will have to store general product and real-time data in one backend system and run a variety of analyses. These analyses will support different processes belonging to different phases of the product lifecycle. Prominent examples are the identification of design errors, breakdown forecast, residual lifetime analysis or optimal decommissioning of products. Each of these objectives needs different data and different methods of decision support. However, the evaluation of the sensor data is the most important step for optimizing the processes and increasing profitability. These methods might sometimes be quite simple; in other cases they might be highly complex and need advanced statistical algorithms. It is often the case that a better algorithm leads to substantial benefits without increasing the cost side.

2 Functionality

PARASUITE is a software framework which offers a set of functions which are important for a variety of engineers, maintenance personnel and technicians.

2.1 Basic Framework PARASUITE 1.0

PARASUITE 1.0 is the basic framework in which all relevant product data are stored and administered. It consists of

- a database which is developed to store large amounts of various product related data incl. regularly generated sensor data;
- generic import and export components for connecting to the surrounding IT systems;
- a flexible reporting builder which allows the design of regularly needed standard reports;
- automatically invoked (e.g., nightly) computations, in order to update the reports;
- automatic alarm functionality when thresholds are exceeded;
- the disconnection of the database server in order to work offline with a subset of the data.

This framework forms the backbone of the PARASUITE decision support solution. Even without sophisticated mathematical prediction and data mining analyses, it simplifies the work of the engineers. They can look at the field data, relate them with failures and investigate the product in many ways.

In this framework it is possible to embed further application specific analysis functions. The common process to implement this consists of the following steps:

1. Definition of the analytical problem;
2. Identification and export of a meaningful data subset;
3. Identification and test of the best algorithms;
4. Embedding of the final algorithm into the PARASUITE framework,
5. Usage of new functionality as needed, e.g. by automatically running it in the night, displaying results in certain reports or setting alarm thresholds.

In the next section a set of possible sophisticated functions is presented for which custom-tailored solutions have been developed previously.

2.2 Possible extensions by integrating application specific analyses

On top of the basic framework PARASUITE 1.0 customers can run their application specific product analyses. The subsequent list reflects the range of functions for which PARASUITE has been used.

For the design engineer in the Beginning of Life phase (BoL):

- By applying methods of data mining and pattern search based on field-, diagnosis- and environmental data PARASUITE provides information on reliability indices, like failure rates or MTBF and information on root causes of failures and faults of the considered systems. The possible causes are ranked with respect to their likelihood.
- PARASUITE estimates the design efficiency of single product components, i.e. it identifies the set of products equipped with this component and measures the efficiency of this subset of products compared to design target values.

For the technicians in the repair stations during the Middle of Life phase (MoL):

- By using predictive-maintenance algorithms PARASUITE evaluates the current state of deterioration or upcoming breakdowns. It furthermore proposes appropriate measures, e.g. inspection intervals or actions like “no intervention”, “modification of the product” or “replacement of components”. This technology optimizes the maintenance for a single product by taking into account its availability and costs.
- PARASUITE supports the technicians by allowing them to describe the given problem and all related information according his observation/inspection and by then associating this problem description with a historical “CASE” and its solution.

For strategic operational planning tasks in the company office the forecasted state of all the components in all products can be used for a variety of different optimizations. Among them are the following:

- PARASUITE can be used to optimize the maintenance of a family of products, taking into account the availability of all products, availability of necessary services like repair facilities, and maintenance costs for the entire family of products.
- PARASUITE can be applied to prepare a list of required spare parts for a period based on the respective predictive maintenance results.
- PARASUITE can prepare a list of all products that need maintenance. The list will display them ordered by town. As a consequence the maintenance crew can minimize traveling costs.

For the recycling specialists in the End of Life phase (EoL):

- When the product is arriving at its final destiny, e.g. a repair station, PARASUITE helps the service personal to judge if individual components of the product should be dismantled, or should be left on the product to await shredding. In order to support this task the product series number is entered as input and this automatically produces the bill of materials (BOM) for the specified product; subsequently the remove decision is made based upon this BOM and a set of key criteria like legislation, quality, cost or second hand market.

3 Core Technology

PARASUITE 1.0 is designed as a very flexible 3-tier architecture. Figure 1 illustrates the architecture with its components and the data sources.

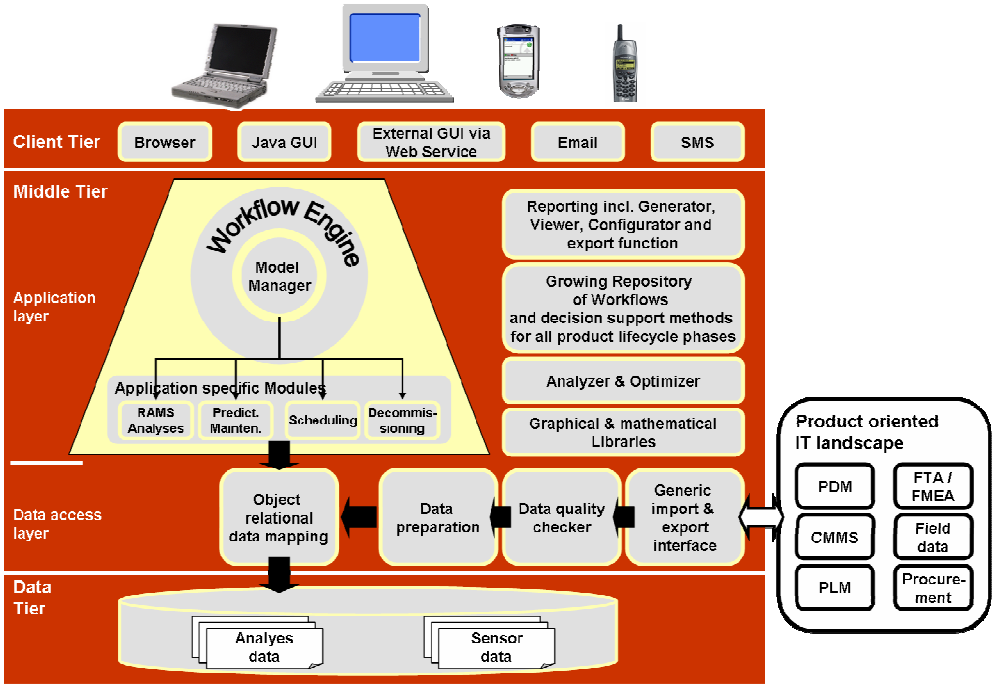


Figure 1: Architecture overview of PARASUITE 1.0

At the lowest level of the architecture, the Data Tier in combination with the data access layer comprises of all external operational data sources feeding the PARASUITE data store with relevant data. PARASUITE itself consists of different components for data integration, data management, data analytics, and user and control interfaces.

PARASUITE computes the data which can be used for decision support by the engineers. These computations use the imported data coming from the external sources. BoL-specific data sources include PDM or SCM databases, which are largely static. MoL- and EoL-specific data is captured in a real-time manner from products using the attached sensors or from PDM and field databases.

Inside the application layer a set of different decision support algorithms is implemented, one for each functional application. A workflow engine controls the responses to user requests. According to the user request the engine chooses the appropriate decision support algorithm out of a set of algorithms and starts it in order to compute the needed result.

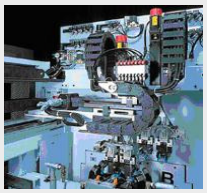
This "library" of algorithms is organized in such a way, that new functions be added and new reports can be designed and stored. In cases where different applications operate on the same data model, all existing algorithms of the library can easily be modified to run for all applications. Only the parameter settings should be modified in a way that the algorithm shows an optimal performance.

At the very top of the architecture is the Client Tier. This is the interface to the end user. Due to the separation of the GUI from the middleware it is possible to have different customer dependent GUI solutions without changing the application logic.

4 Benefits

The application of sensor technology in connection with a strong data analysis framework can raise the profitability enormously. This is because the real-time data analysis mainly leads to an increase of efficiency, i.e. achieving the same performance by consuming fewer resources. Well-known examples from different branches proved that increasing the efficiency by 10% can easily lead to a profit gain of 50%.

PARASUITE is designed to exploit exactly this potential e.g. by optimizing maintenance activities or decommissioning. However, in contrast to previous approaches PARASUITE has further advantages: Its architecture allows to incrementally extend the number of analyses. Based on a database in which a variety of product related data are stored, a library of product analyses is operating. This approach supports the common development process in large companies. It is often needed to start with a first specific analytical question over the data and then to continuously formulate new questions whose answers might lead to further efficiency gains. PARASUITE 1.0 allows to incrementally include new functionalities without changing the underlying system.



Producers of a variety of complex machines can equip their products with sensors and determine the current degree of deterioration. In case it exceeds certain thresholds, the decision methods compute the best alternative, i.e. no activity, adjustment of different parameters or replacement of components. The decision is met depending on the economical consequences of each choice. Machines offering this technology have a higher availability and will thus increase its market share.

The main advantages of this approach are as follows:

- PARASUITE supports the decision quality in different lifecycle phases of the product by transfering knowledge between the phases. MoL information can be used to improve the design and decommissioning. BoL information can optimize the decision process in the MoL phase. In future, this across-the-phases analysis will be essential for exploiting further efficiencies.
- The extension of PARASUITE by a new functionality has to cover only the costs of the new analysis. The database, import and export components, libraries, and large parts of the GUI can be reused. Contrary to most former approaches PARASUITE does not force the clients to build a new complete system for each analysis.
- If a company has different products it can use PARASUITE for the analysis of each one. If all data are kept in one database, analyses over all products are possible, e.g. if a client wants to analyze the quality of components used in more than one product.
- If a company has different products it can reuse the analyses developed for one product for the others.
- Finally, the reuse of the PARASUITE framework leads to substantially less system failures. The confidence into the results and the system availability are therefore much higher.

Truck produces can optimize their efficiency by different analysis steps: On the one hand, they apply predictive maintenance technologies in order to anticipate future maintenance activities and reschedule the maintenance process. On the other hand, they can exploit the exact knowledge over the actual state of the components for reusing the best components in the decommissioning process. It is easy to estimate that these efficiency gains will cause substantial additional profit over the entire fleet of trucks.

5 Standard Reporting with PARASUITE 1.0

The ability of a company to deliver business-critical reports to customers, partners, suppliers and employees is a vital component of being competitive. The integration of a powerful reporting tool augments PARASUITE to meet these requirements.

PARASUITE offers a large set of functions for slicing and dicing data, ranking, sorting, forecasting and nesting information to get a better sense of causes, effects and trends. With PARASUITE end users can create a rich variety of reports. This includes:

- listing reports that include sorting, grouping and totals;
- summary reports, such as top N reports;
- charts including pie, line, bar, and gauge charts and
- master-detail reports.

The PARASUITE reporting tools make it possible for non-programmers to build and deploy complex reports with minimal effort. The integrated reporting solution has two main components: a report designer plug-in for PARASUITE GUI and a runtime engine embedded into PARASUITE middleware. The report designer plug-in is used to create, explore or modify reports. The resulting report is an XML report file which is automatically deployed to the PARASUITE middleware using the runtime engine.

The final report can be parameterized and viewed from within the PARASUITE GUI or a web browser. Figure 2 shows the reporting perspective of PARASUITE GUI.

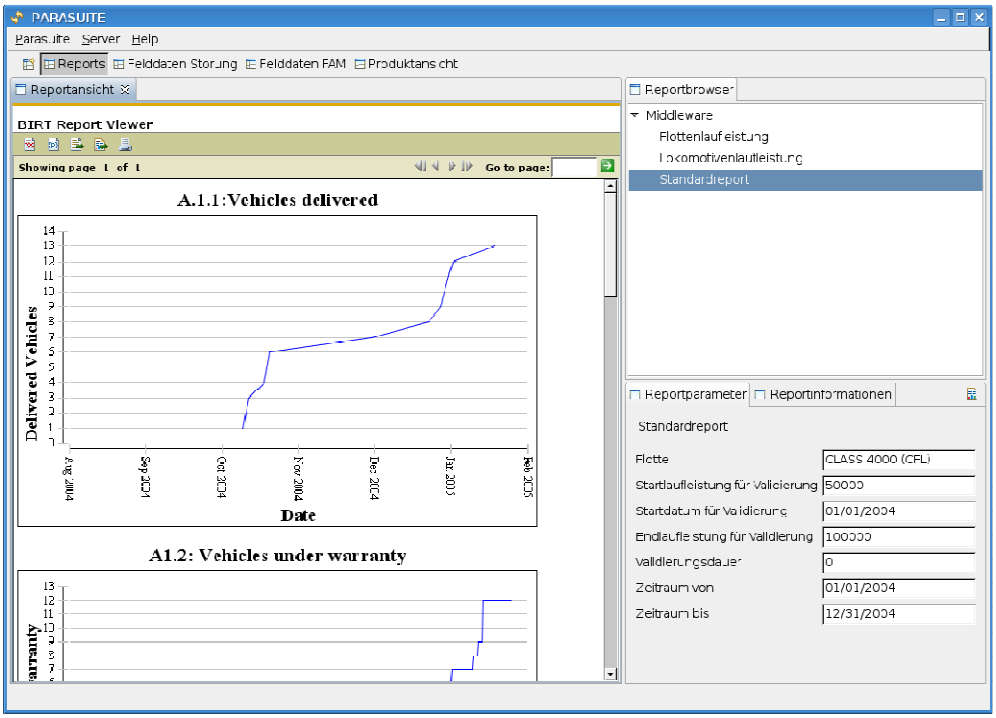


Figure 2: PARASUITE GUI reporting perspective

6 Programming environment

The PARASUITE framework development is carried out with Java-based technologies. The development environment consists of the following components:

- Sun Java 2 Platform Standard Edition 5.0 Development Kit (JDK 5.0)
- JBoss IDE 2.0.0 Beta 2 (This version consists of JBossIDE 2.0.0.Beta2, Eclipse 3.2.1 and Webtools 1.5.1)
- Target platform for GUI development: Eclipse Platform Runtime Binary 3.3

The PARASUITE middleware runs on top of a MySQL 5.0 database inside a JBoss Application Server 4.2. Due to this configuration it is possible to install PARASUITE in a Linux or Windows environment.

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