WHITEPAPER

Automotive CAE Integration

Annex: Simulation Data Management

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Addendum to "Automotive CAE Integration: Requirements and Evaluation of Interfaces" published in 2009 by the working group "CAD / CAE Integration" at the steering committee 6 of the German automotive industry.

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Summary

The original paper “Requirements and Evaluation of Interfaces” focused on the simulation process itself, providing a definition of process modules, interfaces between those modules, and an evaluation of how currently used data formats support these interfaces, see [1].

The definition of the process modules, which is one of the key results of that paper, focused on the simulation process at the authoring tool layer, i.e. the pre-processing, solving, and post-processing activities. Modules on the so-called “xDM” layer, addressing Product Data Management (PDM), Team Data Management (TDM), Simulation Data Management (SDM) and Test Data Management (TestDM), have only been outlined to create a comprehensive picture.

The results of this activity have been handed over to the “Collaborative CAD/CAE Integration (C³I)” project group, which is a joint effort of the ProSTEP iViP Association and the German Automotive Industry Association (Verband der Deutschen Automobilindustrie, VDA). The module definition will become an integral part of the next release of the SimPDM (Integration of Simulation and Computation in a PDM Environment) Recommendation and thus an official industry standard. This new release is anticipated for 2011; see http://www.prostep.org/en/project-groups/c3i-collaborative-cadcae-integration.html for details.

As the next step, this paper now focuses on the aspects of Simulation Data Management. A definition of modules will be given, comparable to that of the CAE process modules, for the major functional areas of interest in this context. A grouping of the SDM modules is derived from the major tasks an SDM tool has to support, that administration, data management, and workflow management / process control. Each module will be defined by its function, input, and output.

At the end of this paper, a short conclusion and outlook is given.

Contents

1 Introduction

The general task of data management can be derived from the requirement to provide the right data in the right format at the right time. In the design domain, Product Data Management (PDM) and Team Data Management (TDM) for CAD data are well-established concepts. The same can be assumed for the data belonging to physical tests.

The role of Simulation Data Management (SDM) within the xDM tool layer, however, is not yet clearly defined. On the one hand, it is related to the role simulation and computation assume in the product development process. As CAE is applied not only to verification, but also to dimensioning and determination of design constraints, SDM becomes a data source for other domains in addition to managing the gathered information; including geometry, materials, connectivity, and so on. Hence a SDM system not only has to cope with the different types of data, but also with significantly different structures (functional vs. manufacturing-oriented) and has to provide mappings between those. It becomes an information hub ensuring that simulation results can be linked to the product data they were generated from, or to data from physical tests for comparison. The main task of an SDM system can therefore be described as the gathering and management of data usage relations.

On the other hand, SDM application scenarios typically cover more than just data management. There are administrative aspects including the provision of access for external subcontractors, who are often involved in all CAE steps including pre-processing, solving and post-processing – sometimes using their own tools (with settings provided by the OEM), and sometimes the systems provided by the OEM. The third main aspect of SDM is that of workflow management and process control. SDM systems often provide interfaces to CAE authoring tools, solvers, and especially HPC- and grid integration features, hence providing a comprehensive environment for the simulation engineer where he can manage his input data, start simulation runs, and process the results.

To achieve this high level of integration, it is mandatory that the SDM system is highly integrated into the surrounding system and IT landscape. Consequently, several of the functions defined in the modules cannot be fulfilled by the SDM system alone, but are often taken over by other components already established in the company's IT infrastructure, with SDM being linked to it either directly via an interface or API, or indirectly through a third-party integration software.

In current discussions with both end-users and software vendors these various aspects, though agreed on a high level, are often described with different terms, concepts in mind and scopes. This paper therefore aims to provide a standardized definition of the SDM modules, which is complementary to the CAE process modules defined in the original Whitepaper, "Requirements and Evaluation of Interfaces" [1], and intended to be the unambiguous foundation for further discussions.

2 The "Big Picture"

To provide a foundation for the communication on the comprehensive subject of CAD / CAE integration and SDM, a "birds eye view" on the field of investigation has been developed. The resulting high-level map is called the "Big Picture", and was introduced in the Whitepaper [1]. It is repeated here to give a full context.

The "Big Picture" distinguishes between data management systems (at the xDM tool layer) and data manipulating systems (at the authoring tool layer). Each layer covers the different areas under investigation: design (CAD, PDM/TDM), simulation (CAE, SDM) and physical test (CAT, TestDM).

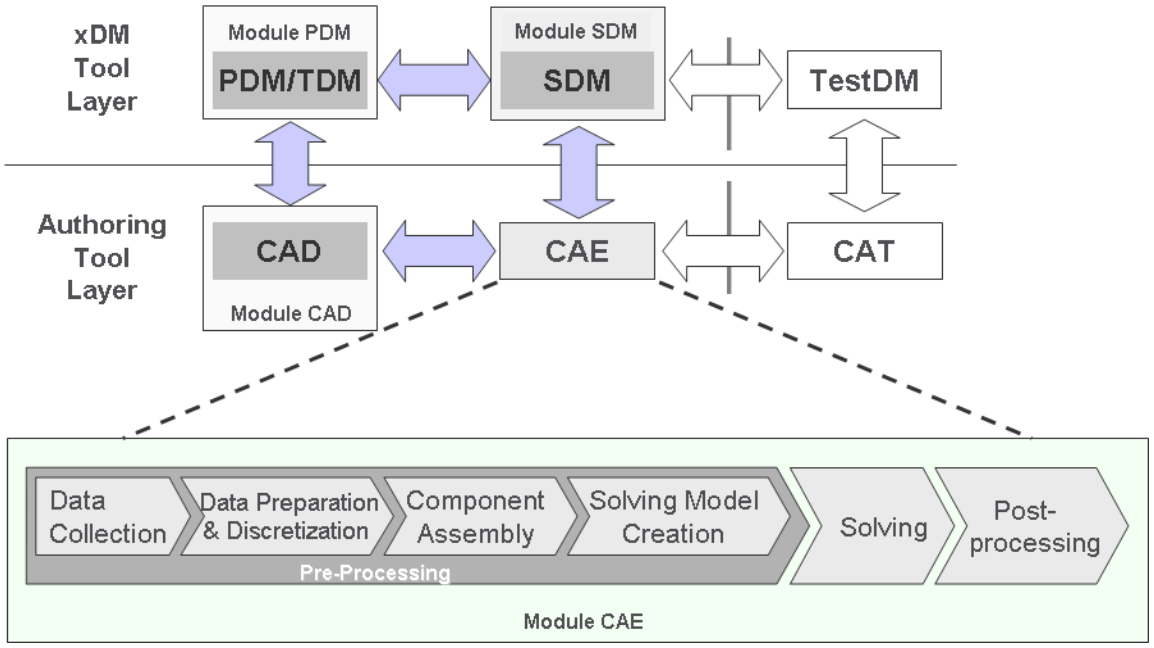

Figure 1: The "Big Picture"

Within the “Big Picture”, the original whitepaper provided a further detailing of the CAE module into sub-modules, focusing on the pre-processing steps.

This annex supplements this with a detailed view of the SDM module, which is subdivided into three layers containing a number of sub-modules each. Figure 2 provides the “Big Picture” for SDM:

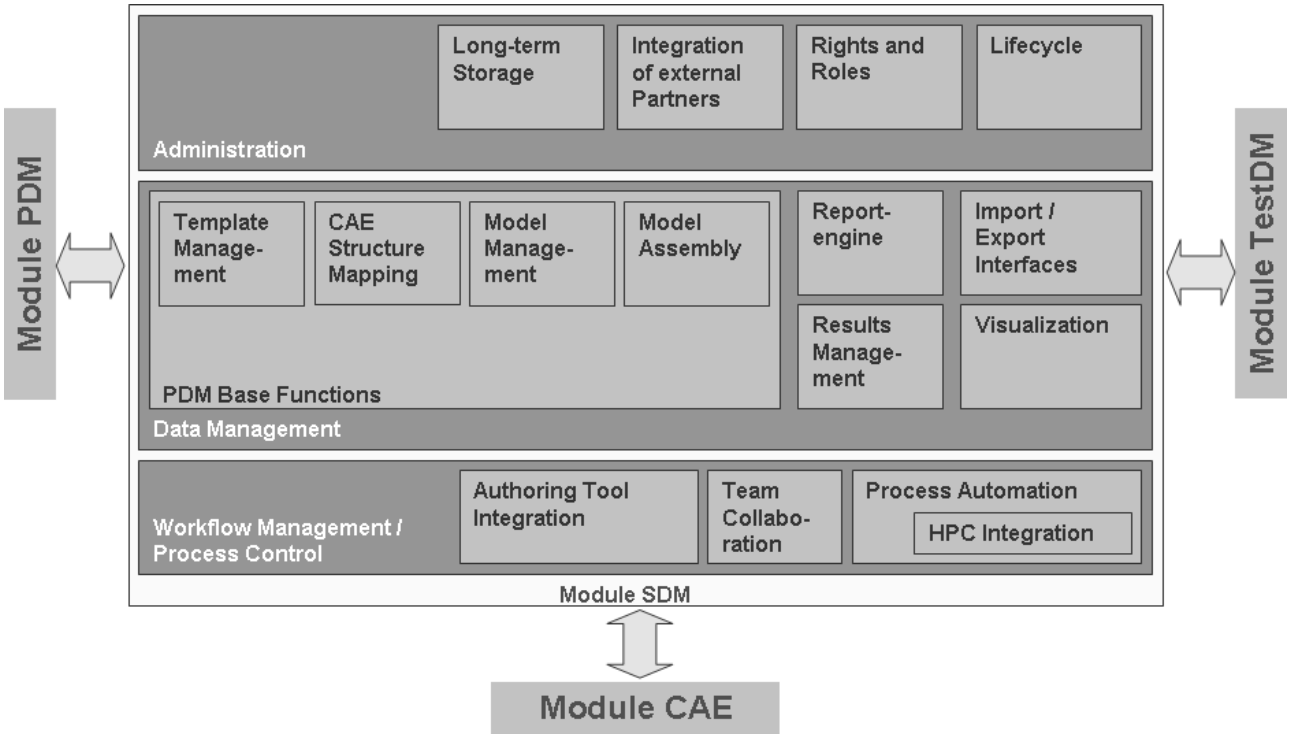

Figure 2: The "Big Picture" for SDM

3 Definition of SDM Modules

The starting point was the definition of functional modules given in the Whitepaper. Building on that, the main activities carried out in the context of SDM have been discussed with the participating companies, and a common understanding of these was achieved. The postulated coincidence of an activity and a functional module implies the existence of a defined set of information that can be transferred between modules. The data types which are being used in the description of the modules are identical with those defined in the Whitepaper (see [1], Annex B).

During the discussion it was found that the wide field of SDM can be subdivided into three main areas:

- Administration
- Data Management
- Workflow Management and Process Control

Administration relates to the CAE-specific aspects of task which are themselves of a more general nature, such as access to the long-term storage of simulation data and results, the integration of external partners into the CAE process, the definition of the effective rights and roles, and the management of simulation data lifecycles. Data Management covers the various information handled in the context of simulation and computation, provides the mechanisms to gain structured access to this data, and relates it to other data inside and outside of the CAE domain. Workflow Management and Process Control is the third area, providing the capability to run and evaluate simulations to the engineer.

Figure 2 above gives an overview over the layers and modules that have been defined and will be described in detail in the sections below. To give a starting point for the definitions, the original definition of the SDM Module given in the Whitepaper [1] is repeated here.

3.1 Original definition of the SDM Module

Function

SDM tools – in the sense of ready-to-use commercial-of-the-shelf products with necessary customization – are rather new. Their utilization in the development process currently often still is “under evaluation”. This is caused by a more or less obvious change of paradigms in the delineation and cooperation of design on one side, and layout / verification on the other. This process is characterized by a shift of tasks from physical to virtual prototyping, which in turn created the need for structured simulation data management.

This need is also based on a number of other requirements emerging from the currently changing process and tool landscape. With the increasing availability of simulation capabilities, the amount of projects and data created therein are rapidly growing, making effective search and find routines necessary, e.g. easily to come up with comparison data. Automated processes and cooperation with partners outside the simulation department also create demand for a structured SDM to guarantee access to the required data.

Consequently, the position of SDM within the xDM tool layer is not fixed yet, and may in future cover aspects of PDM as well as of TDM, possibly depending on the respective development process phase.

Where already implemented, SDM often takes on the role of a TDM for the CAE department underneath a “master” PDM system, or is even realized within the PDM system, and combines the two basic functionalities data management and workflow master (application process control).

The data management aspect covers typical functionalities, such as

- creation and maintenance of a product structure (here in the simulation context from a CAE point of view)
- management of product data in the (simulation) context
    - input data from other system domains (CAD, testing,…), as well as intermediate, interpreted, and end results from simulations and computation processes
    - as copy or master record, or as a reference or link
    - comprehensible and retraceable
- Organization, storage, retrieval of and access to simulation data and their describing (meta) data
- versioning of CAE information (creation of a CAE-specific development history)

The application process control serves two main purposes:

- to create, execute and document simulation processes in a retraceable way (CAE workflow management), e.g. to automate the process from solving to report creation, and
- to include simulation activities into the product development process (process control and integration).

These two basic functionalities are technically not required to be implemented in the same tool. For this reason the combination of data management and application control into one module is seen as critical with regard to the tasks at hand and the problem of vendor focus (software suites). Future activities need to check whether the two functionalities should be separated into two modules, which would put the resulting interface between data management (“hard drive”) and application control (“batch file”) in focus.

Out of Scope

The SDM module does not cover

- long-term archiving of simulation data (e.g. due to legal requirements)
- the manipulation of simulation data contents (user data) – these are usually not accessible for the SDM system
    - exception: extraction of meta data to create or check in a container for user data (e.g. a file)

3.2 SDM Modules in the Administration Layer

The modules in the Administration Layer are enablers for the actual SDM functionalities described in the Data Management and Workflow Management / Process Control layers.

3.2.1 Long-term Storage

CAE data – i.e. the input decks for a simulation and the computed raw results – are stored for varying periods of time. Usually, they are being moved from the original hard drive to dedicated storage spaces (e.g. magnetic tape) after a certain time interval, where they are kept for another pre-defined period of time, which usually depends on the maturity or release level of the data or can be set manually by the user. The SDM provides an interface to the storage locations which may or may not tell the user the physical location of the data; usually all data are accessed in the same way, but the access times differ. This interface, which is highly dependent on the existing IT infrastructure, may also define deletion rules, where in many cases only the actual data on the storage device is deleted, while the data base entry is being kept, though with void references.

Long-term storage in this context only relates to an interface being capable to retrace simulations at a later point in time. Long-term archiving, as may be legally required for product liability, is at the moment out of scope of SDM. It is likely to be handled by a general document management system in scope of the company's archiving strategy.

Function

- Provision of an interface to store documents in an external archive
- Provision of an interface to search and retrieve documents from an external archive
- Definition of deletion rules and exceptions from these for specific data sets

Out of Scope

- Data storage (this will be handled by an external archiving tool. SDM only provides the interface.)

Input and Output

Contents

- Status and archive information

Data types

- Meta Data
- Structure Information
- all Input and Output data of the CAE modules as not further interpretable documents or data packages

3.2.2 Integration of external Partners

In many cases, significant work packages of the simulation process are being contributed by external partners (subcontractors). This usually applies to pre-processing, and sometimes includes solving and post-processing as well. To enable the external partners so that they have access to the necessary input data, and to feed back their input decks or simulation results afterwards, the SDM system needs to provide the necessary lightweight interfaces (e.g. Web Client), protocols and client side tools.

The functions provided by this module are highly dependent on, and in some cases (e.g. data exchange tool) even provided by, the existing internal IT infrastructure. An SDM system with the capability to integrate external partners also needs to be adaptable to the effective security guidelines, e.g. internet access may not be limited to pre-set ports.

Function

- SDM access for external partners (e.g. Web Client)
- Data transfer
- Ability to remotely control simulation runs (see 3.4.3 Process Automation)
- Interface to an external data exchange tool

Out of Scope

- Management of data exchange jobs (see 3.3.8 Import / Export Interfaces)
- Management of rights and roles for external partners (see 3.2.3 Rights and Roles)

Input and Output

Contents

- Supplier data
- Control information for data transfer and simulation tools

Data types

- Meta data

3.2.3 Rights and Roles

Management of rights and roles is a basic administrative capability that has to be handled by every SDM system, so that e.g. a project leader can grant the appropriate access rights to members of the project team or external partners (subcontractors). Depending on the general company philosophy, the simulation world may have its own rights and roles, requiring an additional login when working with these systems, or re-use cross-domain rights and roles defined in an overall user management system.

Access rights may be defined based on vehicle project, (vehicle-independent) modules, CAE discipline, or groups (e.g. external suppliers for protection of fair competition), and can be granted in a cascading way (project leader – project staff – external partners).

Function

- Creation of user groups
- Management of access right for functions and data objects through dedicated attributes and life cycle status
- Assignment of rights to roles
- Assignment of rights to users and user groups

Out of Scope

- Project management (see 3.3.4 Model Management)
- User management (general service, such as LDAP)
- Management of external resources, e.g. supplier data (see 3.2.2 Integration of external Partners)
- Management of passwords, keys, certificates and identities (general service, such as LDAP)

Input and Output

Contents

- Role templates
- Access right regulations
- provided access right information (ACL – Access Control Lists)

Data types

- Meta Data

3.2.4 Lifecycle Management

Lifecycle Management in the scope of SDM covers the usual tasks of lifecycle management, with adaptations for CAE-specific needs where necessary. The main task is the definition of status networks – i.e. which stages a CAE data object can have, and the rules which apply for changing the life cycle stages (e.g. a CAE data object, once 'approved', may not go back into 'draft' status).

The defined status also identify whether a CAE data object is locked (i.e. checked out, e.g. sent to external partner for rework) nor not (i.e. not in work at the moment, or extracted for information only).

Function

- Management of status information
- Definition of status networks

Out of Scope

- Assignment of the defined status to data objects (see 3.3.2, 3.3.3, 3.3.4 and 3.3.7)

Input and Output

Contents

- Status information

Data types

- Meta data

3.3 SDM Modules in the Data Management Layer

The modules in the Data Management Layer provide the functionalities which are necessary to manage simulation and computation data in an organized and efficient way. This includes data management base functions as known from PDM systems, but also CAE specific tasks such as the management of results, reports, and the provision of visualization of both CAE data (e.g. meshes) and results.

3.3.1 PDM Base Functions

'PDM Base Functions' is not an SDM sub-module by itself (see Figure 2). This section combines all the functions and data contents which are common to its sub-modules (3.3.2 to 3.3.5), except when stated otherwise.

Function

- Base-lining: Description of a complete model by aggregating one defined stage of each model element (snapshot)
- Configuration: combinations of (meaningful) variants of a model
- Filtering: selection of model elements of interest (search for a complete model)
- Classification: Highlighting and grouping of model elements
- Check in / Check out: transfer of data control
- Searching: selection of model elements through pre-defined criteria (sharp, fuzzy, restriction, etc.)

Input and Output

Contents

- versioned structure information (PDM data)
- versioned model definition (meshes, simulation load cases, etc.)

Data types

- Meta data
- Master data
- Structure information
- all Input and Output data of the CAE modules as not further interpretable documents or data packages

3.3.2 Template Management

The template management SDM sub-module relates to all activities handling templates or pre-defined (sub-)models for CAE models, i.e. data which is typically being re-used in a number of simulation runs. These include dummies, barriers, unit loads for calibration purposes, templates for model creation and so on.

This sub-module does not cover report templates; these are handled separately.

Template Management extends the PDM Base Functions (see 3.3.1)

Function

- Management of templates for CAE model creation
- Management of component libraries
- Predefined simulation (sub-)models (dummies, barriers etc.)
- Load cases and boundary conditions (e.g. unit loads)
- Templates for solver control, model creation (pre-processor parameters, etc.)
- Organization, storage, retrieval of and access to templates

Out of Scope

- Management of report templates (see 3.3.6 Report Engine)

3.3.3 CAE Structure Mapping

Structure mapping describes the task of creating references between the product structure with referenced CAD information as it is created by the design domain, and the (special purpose task-oriented) model structure that is required for simulation and computation. The goal is to be able to retrace the input data for a simulation after it has been computed to correctly assign reports, or – vice versa – to be able to gather all reports for a certain subset of design data.

CAE Structure Mapping extends the PDM Base Functions (see 3.3.1)

Function

- Association of CAE structure with PDM structure, including referenced CAD information
- Association of structure and CAE information
- Versioning of CAE structure information (CAE development history)
- Identification of changes in the PDM structure

- Identification of changes in the CAD representation
- Filtering of configured PDM structures to create a “100%” CAE structure

Out of Scope

- Versioning of CAE model information (see 3.3.4 Model Management)
- Visualization of structures and associated CAD data (see 3.3.9 Visualization)

Input and Output

In addition to the Input and Output stated in 3.3.1:

Contents

- versioned CAD representation

Data types

- CAD data as not further interpretable documents or data packages

3.3.4 Model Management

Model Management relates to the handling of all kinds of CAE models and components, e.g. FEM or CFD meshes, MBS entities, the management of CAE projects relating to a simulation order etc. Model Management handles this data individually.

Model Management extends the PDM Base Functions (see 3.3.1)

Function

- Creation and Management of CAE projects
- Management of simulation order and test intention
- Handling of control information for solvers, pre- and post-processor parameters etc. according to simulation order and test intention
- Organization, storage, retrieval and access to structure information and meta data
- Versioning of CAE model information (CAE development history)

Out of Scope

- Long-term storage of simulation data (see 3.2.1 Long-term Storage)
- Manipulation of simulation data contents (user data – see CAE modules defined in [1])
- Exception: extraction of meta data for creation of data records and check in / check out
- Versioning of structure information (see 3.3.3 CAE Structure Mapping)
- Versioning of results (see 3.3.7 Results Management)
- Combination and decomposition of the managed data (see 3.3.5 Model Assembly)

3.3.5 Model Assembly

The Model Assembly sub-module provides the functionalities to (re-)combine the various CAE data clusters into simulation models as needed. This relates to the CAE sub-modules “Component Assembly” and “Solving Model Creation” on the authoring tool layer (see Figure 1). In some companies, this is handled by a separate, self-developed tool which makes use of the SDM import and export interfaces (see 3.3.8)

Model Assembly extends the PDM Base Functions (see 3.3.1)

Function

- Combination and decomposition of sub-models, templates, load cases, boundary conditions, settings etc.

Out of Scope

- Superposition of results of any kind (see CAE modules defined in [1])
- Management of the handled data (see respective Data Management sub-modules)

3.3.6 Report Engine

The SDM Report Engine comprises all functionalities concerning the creation and management of simulation reports based on simulation results (see 3.3.7 Results Management). This includes the management of report templates, the creation and management of various types of reports, and the automated creation of intermediary results (graphs, diagrams,…) for use in reports.

Function

- Creation and management of report templates
- Creation and management of secondary representations (graphs, diagrams, …) of results
- Creation of reports
- Extraction of results data for evaluation (Storyboard – possibly a separate component)
- Creation of variant reports
- Creation of comparison reports
- Organization, storage and retrieval of reports

Out of scope

- Management of post processor settings (see 3.3.4 Model Management)
- Creation of interpreted end results (see CAE modules defined in [1])
- Long-term storage of reports (see 3.2.1 Long-term Storage)
- Visualization of results data and secondary representations (see 3.3.9 Visualization)

Input

Contents

- Report data
- Report templates
- Simulation results

Data types

- Meta Data
- Structure Information
- CAE Results
- Template

Output

Contents

- versioned reports
- Report data

Data types

- Meta data
- Diagram
- Media
- Document

3.3.7 Results Management

Results management provides the functionality to organize, store and access all types of direct (raw) and indirect (interpreted) results as provided by either solver, post-processing or report engine (see 3.3.6 Report Engine), in relation to the CAE models and structures they are based upon.

Function

- Organization, storage, retrieval and access to simulation results and meta data
- Versioning of Results (CAE development history)
- Management of current intermediate simulation results
- Management of simulation end results
- Management of interpreted end results

Out of Scope

- Archiving of simulation data (see 3.2.1 Long-term Storage)
- Manipulation of simulation data contents (user data - see CAE modules defined in [1])
- Versioning of CAE Models, Reports, or Structure Information (see respective sub-modules)
- Visualization of results data and secondary representations (see 3.3.9 Visualization)

Input and Output

Contents

- versioned results data

Data types

- Meta data
- Master data
- Structure information
- all Input and Output data of the CAE modules as not further interpretable documents or data packages

3.3.8 Import / Export Interfaces

An SDM system needs to support a number of import and export interfaces to get or to provide access to the data it is designated for. This includes interfaces integrated into the SDM system itself, which, for instance, establish the connection to other data management systems like the PDM in the design domain, or the TestDM in the physical tests domain.

The SDM system also needs to control import and export interfaces to push and pull data in and out of the tools it controls e.g. for report creation, authoring tool integration or process automation.

The SDM interface typically doesn't handle the imported and exported data itself. This is done by the respective SDM sub-modules. It only controls which information is moved, and from where to where – both internally (moving data between tools or storage locations) or externally (moving data to and from external partners).

Function

- Creation, management and organization of data sources and sinks
- Management of exchange volumes
- Creation, management and organization of export and import filters
- Provision of an API and/or (web) services for access to the SDM data

Out of Scope

- Management of data access status (see 3.2.4 Lifecycle)

Input

Contents

- Data source and target information
- Identification for data set to be imported/exported
- Filter information

Data types

- Meta data
- Connection data

Output

Contents

- versioned export and import protocols
- Filter results

Data types

- Meta data
- Master data

3.3.9 Visualization

As the SDM system becomes the central data hub for the simulation domain with the task to organize and manage the related data, it also needs to provide visualization capabilities to enable the users to view, evaluate and navigate the information he is interested in. Hence the visualization capabilities are used by a number of other modules.

While structures and data correlations are usually visualized by the SDM system itself, CAD and CAE data may also be displayed using plug-ins.

Function

- Visualization of structures and correlations between data
- Visualization of CAD and CAE model data
- Display of single and combined results graphics and diagrams
- Update (manually or automatically) corresponding with progress of work

Out of Scope

- Process visualization (see 3.4.3 Process Automation)
- Documentation (see 3.3.6 Report Engine)

Input

Contents

- Visualization data

Data types

- Meta data
- Master data
- Diagrams
- Media
- CAE models

Output

None

3.4 Modules on the Workflow Management / Process Control Layer

The modules in the Workflow Management and Process Control layer provide the necessary functionalities to control simulation processes with the data managed in the SDM system. There are two major types of integration activities on this layer: One relates to all the process steps that are carried out by one simulation engineer, moving data between tools and launching the corresponding applications, the second relates to data and responsibility being handed over from one engineer or engineering team to another.

3.4.1 Authoring Tool Integration

Tools in the authoring tool layer (see Figure 1) can be integrated with the SDM system in two very different ways. Either the SDM provides an interactive interface to control the behavior of the tool, e.g. to start certain actions, or the authoring tools themselves offer access to the SDM system as a plug-in or extension, so that data managed by the SDM can be accessed directly from within the authoring tool.

Function

- Access to data managed by the SDM system from within an authoring tool (as extension or plug-in)
- Interactive interface to manually control actions in the authoring tools from the SDM system
- Interface to manipulate certain key attributes (e.g. thickness) in the user data from the SDM system (the change is carried out either by the SDM system e.g. for XML-based data, or by means of the integrated authoring tool)

Out of Scope

- Creation, management and organization of data sources and sinks (see 3.3.8 Import / Export Interfaces)
- Creation, management and organization of export and import filters (see 3.3.8 Import / Export Interfaces)

- Process automation (see 3.4.3)
- Manipulation of general simulation data contents (user data - see CAE modules defined in [1], with the exception mentioned above)

Input and Output

Contents

- Data references (id & location)
- Instructions

Data types

- Meta data
- Master data
- Structure information
- all Input and Output data of the CAE modules as not further interpretable documents or data packages

3.4.2 Team Collaboration

The Team Collaboration functionalities of an SDM system enable the user to define comprehensive processes which may be handled by different users within one team or in different teams. Templates for those processes can be defined, along with states when the work will be handed over. This includes the capability to track the work progress.

Function

- Definition, execution and logging of processes in a traceable manner
- Management (create, change, search, approve) of process templates
- Visualization of process flows

Out of Scope

- HPC integration and job control (see 3.4.4 HPC Integration)

Input and Output

Contents

- Versioned workflow protocols
- Workflow descriptions (including process templates)
- Process flow protocols

Data types

- Meta data
- Process definitions
- Process flows

3.4.3 Process Automation

Process automation relates to the capability to automatically carry out a series of instructions controlled by the SDM system (“batch mode”). The instructions may be directed to different tools and may include data transfer or conversion between those tools.

Function

- Definition, execution and tracking of instruction sequences
- Management of instruction sequence templates

Out of Scope

- Definition, execution and logging of processes in a traceable manner (see 3.4.2 Team Collaboration)
- HPC Integration (see 3.4.4 HPC Integration)
- Interactive access to CAE tools (see 3.4.1 Authoring Tool Integration)

Input and Output

Contents

- Data references (id & location)
- Instructions

Data types

- Meta data
- Structure information
- all Input and Output data of the CAE modules as not further interpretable documents or data packages

3.4.4 HPC Integration

The HPC (High Performance Computing) integration is a special case of the process automation for the solving step, which is usually executed on dedicated servers or clusters. The HPC integration module therefore extends the process automation module and provides the interfaces to the corresponding scheduling and load balancing tools.

Function

- Scheduling of simulation runs
- Job status monitoring

Out of Scope

- Solving (see CAE modules defined in [1])
- Interpretation and Management of Results (see 3.3.7 Results Management and CAE modules defined in [1])

Input and Output

Contents

- Data references (id & location)
- Instructions

Data types

- Meta data
- Structure information
- all Input and Output data of the CAE modules as not further interpretable documents or data packages

4 Conclusion and Outlook

This paper aims to provide a consistent nomenclature for use by the participating automotive OEMs in future technical and requirements specifications. The major achievement of this document is the agreement on general set of functions in the context of Simulation Data Management which are deemed necessary or useful by all companies.

The aim of this document is not to provide a comprehensive and detailed specification of the functional modules in an SDM system. As mentioned at several locations above, many of these modules and the respective provided functions are dependent on the existing IT landscape and the level of integration of the SDM system into it.

Additionally, a number of SDM systems in use by the participating companies were looked at and compared to the modules defined above. Some differences have been noted not only in which modules are covered, but also to what extent the modules in scope are supported. The general expectation of the OEMs is that a comprehensive SDM system needs to support all of the modules defined in this paper, with the exception of Team Collaboration (see 3.4.2), which is currently not in scope for most companies.

It was generally perceived that the SDM landscape – from the data perspective as well as from the process perspective – is still in constant motion, and much will happen in the future, providing great potentials. The expectations accordingly are that IT systems in this area have to be sufficiently flexible and adaptable to react to new and extended requirements. This also includes the provision and extension of interfaces to other data management system such as PDM or the electrics/electronics domain.

This paper is considered the groundwork for SDM system selection and further development by the participating automotive OEMs.

Annex A: References

[1] Bauer, S., Boy, J., Fröhlich, A., Grau, M., Gruber, K., Krempels, U., Merkt, T., v. Merten, K., Schlüter, W., Sebrantke, S.: “Automotive CAE Integration – Requirements and Evaluation of Interfaces”, Whitepaper, 2009