WP 3 Project Deliverable D3.2

Specification of CFD database

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Abstract	WP3 Task 2 is responsible for the specification of the CFD-Database. The results of this workpackage are summarised in this report and define how the CFD data. will be stored and transferred between CFD-calculation, Database and VR-System
Keywords	Specification, Database, CFD

Contents

1 Overview

The database management for the VFS will provide the services for the storage and retrieval of the required data for the simulation environment. This contains data for CFD-Calculation, all data for the simulation in the VR-System, data for the definition of missions etc. WP3 Task 2 is responsible for the specification of the Database regarding CFD-Calculation results. The results of this workpackage are summarised in this report and define, how the CFD data will be stored and transferred between CFD-solver, Database and VR-System. The delay of delivering this report accrues, because report D2.4 [VF1] has to be taken into account, which was closed on 19th of August 2002. The specification of the geometrical (D3.1) and the CFD database (D3.2) are the basis for the implementation of the database. Some additional specifications about management of simulations will be defined separately and summarised in report for D3.4.

2 Abbreviations

VFS ..... Virtual Fires Simulator

CFD ..... Computational Fluid Dynamics

DM ..... Data Management

BLOB ..... Binary Large Object

BC ..... Boundary Conditions

CGNS ..... CFD General Notation System [CGNS 1]

3 Requirements

3.1 Functional Requirements

The CFD-Database must contain all CFD-result data required to display a realistic fire simulation in the VR-System as defined in [VF1].

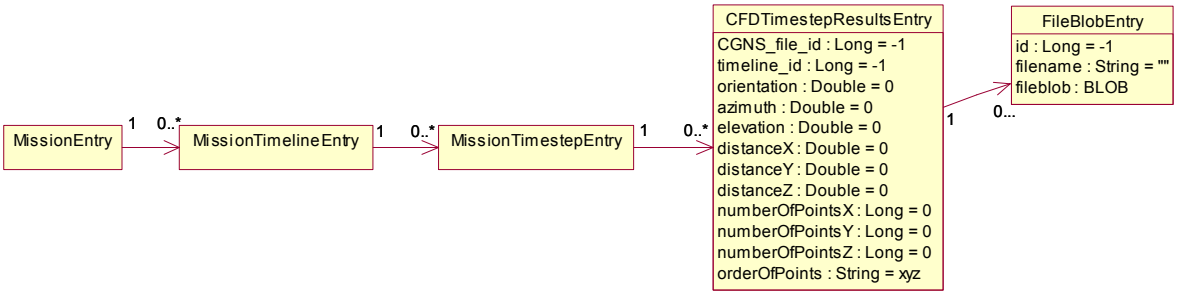
The CFD-data must be stored separately for each timestep.

The CFD-Database should contain information for restarting CFD-Calculation at a given timestep. This feature is necessary, when the calculation has to restart at a different location.

The CFD-Database should use a mechanism for reduction of CFD data.

4 Specification

4.1 Detailed logical model for CFD data



4.1.1 Description of CFDTimestepResults

Each MissionTimelineEntry has zero or more CFDTimestepResultEntrys. One CFDTimestepResultEntry contains all required values of CFD-Results (see chapter 4.2) to display the fire simulation in the VR-System for one timestep. Additionally each CFDTimestepResultEntry contains information about location and resolution of the grid described in chapter 4.3.3. These values are stored in the object FileBlobEntry (see chapter 4.3) and are organised separately described in [VF2].

4.2 Stored values of CFD results

The results of CFD-Data must contain following values for each grid point.

- Temperature
- Smoke density
- Air velocity
- Toxicity

These values are necessary to display realistic fire simulations.

Values that are necessary for restarting CFD-Calculation depend on the CFD-Solver used for the Simulation. This data will be stored as BLOBs and must be platform independent.

4.3 Data format for CFD results

CFD-Results for each timestep are stored in the CFD General Notation System (CGNS) Format as specified in [VF1]. A detailed description of this format can be found at [CGNS1].

4.3.1 Short description of CGNS

"It is an effort to standardize CFD input and output, including grid (both structured and unstructured), flow solution, connectivity, BCs, and auxiliary information. CGNS is also easily extensible, and allows for file-stamping and user-inserted commenting. It employs ADF (Advanced Data Format), a system which creates binary files that are portable across computer platforms. CGNS also includes a second layer of software known as the mid-level library, or API (Application Programming Interface), which eases the implementation of CGNS into existing CFD codes." [CGNS1]

4.3.2 Name identifiers inside the CGNS file

The CGNS format includes conventions for Data Name Identifiers [CGNS2]. For each of the required CFD-result values used by VFS following Data Name Identifiers are used:

Value	**Name Identifier**
Temperature	`Temperature`
Smoke density	`MassFractionProduct`
Air velocity	`VelocityX, VelocityY, VelocityZ`
Toxicity	`MassFractionSymbol`

4.3.3 Structure of the grid

The CFD-Solvers used by VFS produces results in structured or unstructured and regular or irregular grids. The VR-System requires the CFD-Data for a regular structured grid. Therefore it will be necessary to resample CFD-data. This converted data will be stored in CGNS files as a structured regular grid.

Instead of storing the coordinates of each point, the grid is defined using the following values:

- Reference Point
- Orientation, azimuth and elevation
- Distance between to points in x, y, z direction
- Number of points in x, y, z direction
- Order of the structure of the grid points (ie "xyz")

4.3.4 Input

The DM must be able to receive data defined within a structured regular (for CFD Solver ICE) or unstructured irregular grid (Fluent). Data defined in an unstructured and irregular grid must be resampled into a structured

regular grid within the DM. After resampling data compression methods can be used. The first prototype will show the location of bottlenecks and where compression techniques must be implemented.

4.3.5 Output

The VR-System requests a regular structured grid. The resolution of the required grid must be defined before the CFD-calculation starts, to avoid another resampling. The first prototype will show, if the CFD-data must be compressed for saving transfer time.

4.3.6 Transfer

All data will be transferred via CORBA Interface. CGNS-files will be transferred as BLOBs for each timestep separately.

4.4 Storage size

Based on the assumption that the CFD delivers at least 6 values for about 100000 voxels on a regular grid, a minimum datavolume of 4,6 MB (= 6 parameters * 8 bytes for floating-point representation * 100000 voxels) per timestep will be generated.

For a simulation period of about 30 min with a timestep of 5 seconds yields to 1,6 GB for the whole dataset. This scales linearly up with the number of parameters and voxels.

5 Final remarks

The definition of the interfaces between CDF-Calculation, DM and VR-System will be summarised in the report for D3.4.

These specifications will be adapted during the development of the VFS.

6 Literature/Links

[CGNS1] Userguide of CGNS CFD data standard (http://www.cgns.org/UsersGuide.html)

[CGNS2] http://www.grc.nasa.gov/WWW/cgns/sids/dataname.html part of Standard Interface Data Structures (http://www.grc.nasa.gov/WWW/cgns/sids/sids.pdf)

[VF1] Virtualfires Report for Delivery D2.4: Specification of planned system capabilities (software)

[VF2] Virtualfires Report for Delivery D3.1: Specification of geometrical database