PROGRESS REPORT

CONTRACT N° : IST-2000-29266

PROJECT N° : 29266

ACRONYM : VIRTUALFIRES

TITLE : Virtual Real Time Fire Emergency Simulator

PROJECT CO-ORDINATOR :
Institute for Structural Analysis/ SiTu-Research
Lessingstrasse 25/II
A-8010 Graz Austria

PARTNERS :
Christian Doppler Laboratory for Applied Computational Thermofluiddynamics (CD), Austria
Fraunhofer Gesellschaft zur Förderung der Angewandten Forschung e.V. (FIGD); Germany
Kungl Tekniska Högskolan (KTH), Sweden
Lyon Turin Ferroviaire (LTF), France
Ministere de l´Equipement, du Logement et des Transports (METL), France
Stadt Dortmund, StA 37 Feuerwehr (FDDO), Germany
European Virtual Engineering, S.A. (EUVE), Spain

REPORTING PERIOD : FROM 2003-05-01 TO 2003-10-31

PROJECT START DATE : 2001-11-01   DURATION : 30 Months

Date of issue of this report : 2003-12-22

Project funded by the European Community under the 'Competitive and Sustainable Growth' Programme (1998-2002)

1 Table of contents

2 Executive publishable summary

A Virtual Reality Real Time Fire Emergency Simulator (VIRTUALFIRES) will be developed using techniques of virtual reality. In the simulator, the observer will be able to visualise the fire and smoke development and the transport of heat and toxic combustion products inside a tunnel and walk or run through the virtual structure in the same way as through a real tunnel. The simulator will use and access a database, which contains the results of three-dimensional transient combustion (Computational Fluid Dynamics - CFD) simulations for particular tunnel geometries with associated safety installations, particular fire hazard scenarios, etc.

It is planned to develop the system as a fixed installation in a CAVE virtual environment and as a portable installation using a PC and a head-mounted display (HMD). Two systems are planned: one where the CFD simulation is pre-calculated, stored into a data base and then displayed another where it is carried out in parallel to the visualisation. In the first system the user will be able to move through the data but will not be able to change the characteristics of the simulation, for example the ventilation characteristics. In the second system the user may change the properties of the simulation while the data are displayed.

The VIRTUALFIRES system will be a unique system that can be used for assessing the fire safety of tunnels and aircraft, for training of rescue personnel and for planning rescue scenarios and will be able to replace or supplement real fire tests. The end users of this system will be rescue organisations such as the fire brigade and police, tunnel operators and government organisations concerned about tunnel safety. The system can be used for making an objective assessment of the fire safety of existing European tunnels. It can also be used for training drivers on how to behave in the case of a fire emergency in a tunnel.

3 Objectives and strategic aspects

We propose to apply the method of virtual reality to develop a simulator for assessing the fire safety of tunnels and for training rescue personnel. In a virtual computer-simulation-based environment all data about the structure, the safety equipment, ventilation, the fire and smoke development and vehicles/passengers exist in computer memory only. These data are displayed in such a way that the user has the possibility to study all the hazardous effects of a real fire emergency. The project therefore aims to contribute to efforts by the Community to increase the fire safety of European tunnels. It also aims to extend the range of application of virtual reality techniques.

The objective is to develop and implement a Virtual Reality Real Time Fire Emergency Simulator (VIRTUALFIRES). In the simulator, the observer will be able to visualise the fire and smoke development and the transport of heat and toxic combustion products inside a tunnel and walk or run through the virtual structure in the same way as through a real tunnel.

By the end of this project a prototype of the VIRTUALFIRES simulator will have been developed which can be used by government authorities, tunnel operators and rescue personal. Currently the only method available to assess the fire safety of tunnels is to perform real fire tests. The advantages of virtual reality based simulations are that they offer virtually unlimited scope, are economical (the only expense being the computer time) and are environmentally friendly because no toxic waste is produced. As a result of the project’s activity, through the availability of VIRTUALFIRES, the fire safety of tunnels will be increased because all European tunnels can be tested for fire safety and virtual fire tests can be made obligatory for new tunnels.

The work plan is to develop computer software, which together with specialised hardware can be used to display in a virtual reality environment the geometry of a tunnel with all its structural elements and safety installations together with the results of computer simulations of fires. The simulator will use and access a database, which contains the results of three-dimensional transient combustion (Computational Fluid Dynamics - CFD) simulations for particular geometries, hazard scenarios, etc. It is planned to develop the system as a fixed installation in a CAVE virtual environment and as a portable installation using a PC and a head-mounted display (HMD) although emphasis will be placed on the development of the CAVE installation.

The applications on which we will concentrate the development include:

Training of rescue personnel. Currently this can be only done with real fire test, which are expensive and produce toxic material.

Objective assessment of the fire safety of tunnels. This is currently either done using a list of rather arbitrary rules or by performing real fire/smoke tests (i.e. Mont Blanc Tunnel).

The simulator can also be used for:

Training of drivers. Using the simulator truck and other drivers can be trained on how to behave in a case of a fire accident.

Intervention management. The tunnel operators will be able to train the intervention procedures in order to mitigate the effects of a fire emergency.

4 Scientific and technical performance

4.1 Objective summary

4.1.1 Work package 2

The objective is to continuously update the system specifications in response to decisions of the consortium.

4.1.2 Workpackage 3

For the remaining time of the project the objective is to optimise the data management especially in the face of the real time simulation and to add minor extensions. Finally, the documentation for this part of the VIRTUALFIRES Simulator will be written.

4.1.3 Workpackage 4

The objective is to implement the VIRTUALFIRES functionality specified in WP2 in the VR environment. The aim is that the same software will run both in the CAVE environment and in a Head Mounted Display (HMD) system with some modifications. The HMD-version of VIRTUALFIRES is designed to run on a well-equipped graphics workstation or PC. To display CFD data requires many optimisations because of the size of the data and is also demanding from a user interface perspective. The coupling of real-time generation of CFD-data to the VR-environment is highly innovative and raises many unsolved problems.

4.1.4 Workpackage 5

The objective is to develop advanced, efficient and user-friendly simulation tools for the computer aided analysis of tunnel fire hazards and embedding them into the VR environments (CAVE and HMD) of the other partners. Two approaches have been followed during the past period concerning the development of these tools. The first one was the a-priori generation of CFD data for various anticipated tunnel fire hazards (MontBlanc and Gleinalm tunnel) using the commercial CFD package FLUENT™, whose underlying numerical algorithms are based on implicit time integration schemes and body fitted computational meshes. The results of these computations have been stored in the central VIRTUALFIRES database and can now be accessed by the different VR systems for the visualisation of flame front and smoke movement.

Whilst the above approach represents a standard way to display data in a VR environment, the second solution strategy pursued is much more challenging and definitely contained some technical risk. Here it was envisaged to run the CFD simulations in real time embedded in the VR systems. The numerical methodology is based on the Lattice-Boltzmann method and utilizes explicit time integration schemes. Initial tests, which have been already performed, proved the feasibility of the proposed solution strategy. However, it is obvious that this approach requires significant computing resources and it will not be feasible to compute in a concurrent fashion the fire hazard taking place in the entire tunnel geometry. It is therefore planned to solve the full three dimensional conservation equations only in regions of interest (an extended area around the user). The remote areas of the tunnel will be treated using one dimensional transport equations for the hydrodynamic quantities. The boundary conditions at the interface between the 1D/3D areas are adopted continuously.

4.2 *Technical progress*

4.2.1 Workpackage 3

The three main parts of the software development in Workpackage 3 are the DataManager, the DataManagerController (DMC) as a Covise Module and the CFDController. The basic functionality was presented at the review-meeting in June 2003 as first prototype. This prototype was basically used to test the communication between the modules shown in fig.1.

The work in period 4 was mainly focused on the extension of the functionality of the Virtualfires Simulator.

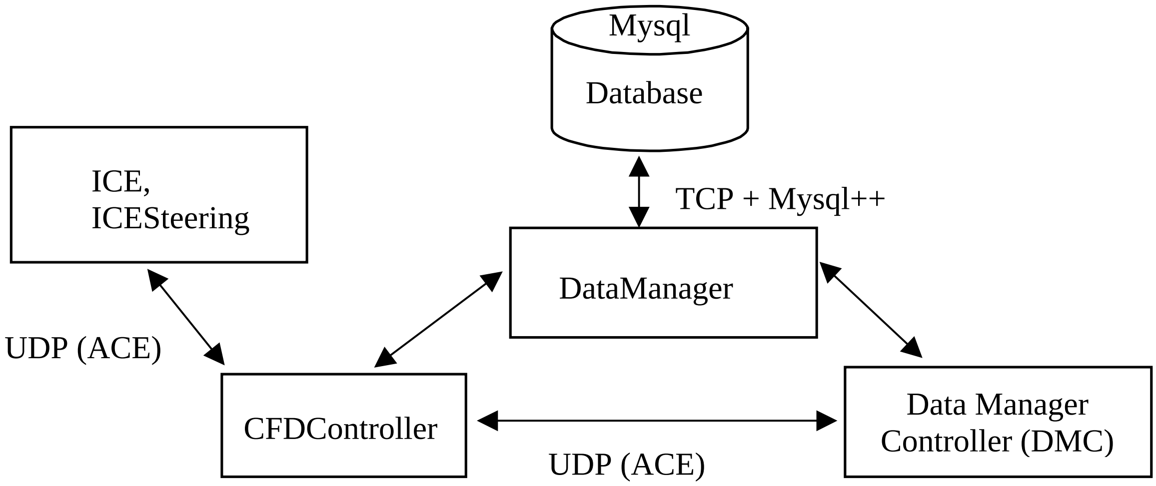


Figure 1 Modules of Workpackage 3

4.2.1.1 DataManager

The DataManager provides an abstraction layer for the persistence management and decouples the handling of the data as required by the logic of the simulator completely from the SQL-server used for storage. It exposes an object oriented API to either the DMC or the CFDController.

The DataManager is built atop of the MySQL++ C++ library [3], which itself is based on the native C-API of the MySQL server.

While the DataManager provided the basic functionality for storing and retrieving offline calculated CFD data, it was extended during this period to fully support the handling of changing missions and the requirements of the reworked and extended protocol between DMC and UIC.

4.2.1.2 DMC

The Covise Module DMC provides the information stored in the database for all components within the Covise VR Environment. Therefore the DMC talks to the User Interface Controller (UIC) and the Covise Module ReadCGNS. The data exchange between DMC and UIC is defined by the UIC-DMC communication protocol. The data for the UIC is transferred as a string using the feedback option within Covise. The CFD data is stored locally on hard disk and the path is sent to the ReadCGNS module. The ReadCGNS module prepares the CFD data and forwards them to the visualisation plugin developed by FIGD.

The communication between DMC and UIC is asynchronous, therefore message numbers are used to establish the relationship between requests by the UIC and the response from the DMC.

The requests are parsed by the DMC using the BOOST library version 1.30.2 [1]. Depending on the request a message is sent to the CFDController or the DataManager is asked for the required information. Messages to the CFDController are sent via TCP using ACE (ADAPTIVE Communication Environment) [2].

4.2.1.3 CFDController

The CFDController is a daemon, who listens for connections from the DMC and ICE (see [2]). The second prototype of the CFDController is able to handle one connection to a DMC and several connections to ICE, so it is possible to start more than one CFD calculation simultaneously. The CFDController receives a message, when a new result file is available. This file is uploaded to the database via the DataManager and the DMC is informed that a new result file is available.

The CFDController can handle following use cases:

- Start Computation: CFDController has to provide the CFD simulation input data and starts ICE in a new process. ICE connects to the CFDController and informs the CFDController, when new results are available.

- Stop Computation: CFDController can stop a running computation. Therefore he has to send a message to ICE and the ICE process terminates by itself, so the process does not have to be killed by the CFDController.

- Computation finished: ICE notifies the CFDController when the CFD simulation has reached the end of the mission and terminates.

The information for a CFD simulation is stored in missions. These contain among other things the necessary input data using XML objects. Before a CFD simulation starts the CFDController collects all data from the DataManager parses the XML descriptions and stores the necessary data as input files for the CFD simulation. The data cannot be changed during a running simulation. When the user changes a mission, the simulation has to be stopped and restarted again.

4.2.2 Workpackage 4

In work package four, work has proceeded on the following system subcomponents: the graphical user interface, the user interface controller, the geometry handler, the visualisation system and the communication protocols connecting all these.

4.2.2.1 Graphical user interface

The graphical user interface is the component with which the user interacts. It can be displayed on a PDA, for use in CAVE environments, or on the computer desktop, for HMD or 2D presentation.

The GUI is a standalone application. It has been implemented in Java for maximum portability and ease of user interface development.

The functionality that has been implemented in the current period lets the user:

- Select an existing mission definition in the database.

- Visualise a computation that has been stored in the database.

- Adjust the speed of visualisation of that computation, forwards and backwards.
- Restart the computation of a given mission.
- Start a new computation for a given mission.
- Stop an ongoing computation.

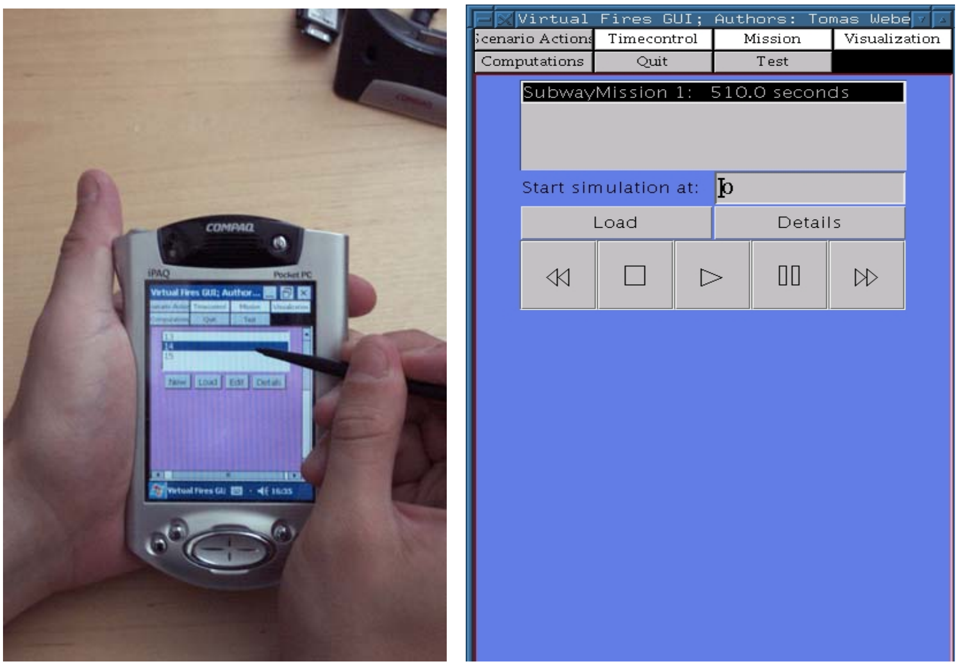


Figure 2 The GUI as presented on a PDA and a desktop, respectively.

The current implementation of the user interface is based on the AWT toolkit, but we have now successfully extended the Java virtual machine on the Compaq iPaq PDA that will be used in the CAVE environment with the more advanced Swing toolkit. In all likelihood we will re-implement parts of the user interface in order to use the improved functionality of Swing.

The functions of the user interface have been reworked over the period in order to be more intuitive. The definition and editing of missions has been redesigned, as has the way the selection of visualisation methods is done.

We still have not been able to get information on how to handle communication between the PDA and the tracking equipment in the CAVE, but should hopefully get hold of this soon.

4.2.2.2 User interface controller

The user interface controller coordinates the activities of most subcomponents. Actions are initiated by the user through the GUI and marshalled by the UIC to the correct recipients. The UIC, being a central component, also stores information on the currently available visualisation data as well as the current state of objects present in the tunnel currently being visualised. In the interest of extensibility, information on simulation objects (flammable material, fire-fighting equipment, etc) is stored and transmitted as XML.

The UIC has been implemented in C++ as a COVER plugin and uses the built-in COVISE communication mechanisms to communicate with the DMC, the visualiser and the geometry handler and UDP sockets to communicate with the GUI.

During the period the UIC has been extended to handle corresponding extensions and changes in the connected component.

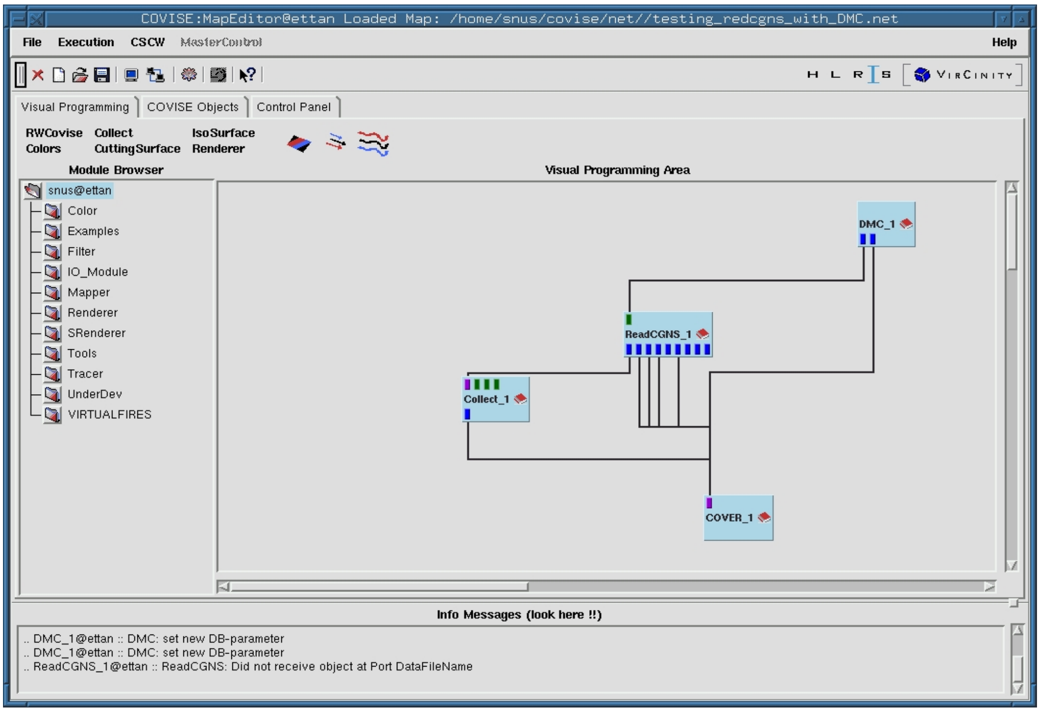


Figure 3 The current COVISE network for the visualisation.

However, the UIC still has problems parsing the XML objects mentioned above due to incomplete parsing functions in the Spirit parser library (part of the Boost C++ library functions repository). A fix has been promised shortly.

4.2.2.3 Geometry handler

A further COVER plugin with the working name “Thingy” has been implemented to enable us to display geometry of objects in the virtual environment.

It uses the OpenGL Performer functionality passed on by COVER in order to read model files and add them to the scene graph displayed in COVER. Currently the models can only be moved through internal messages, but the next step is to let the user interactively move objects in the environment, in order to e g define boundaries for visualisation functions, select fire-fighting equipment to turn on or off, etc.

4.2.2.4 *Visualization of CFD data*

Kernel

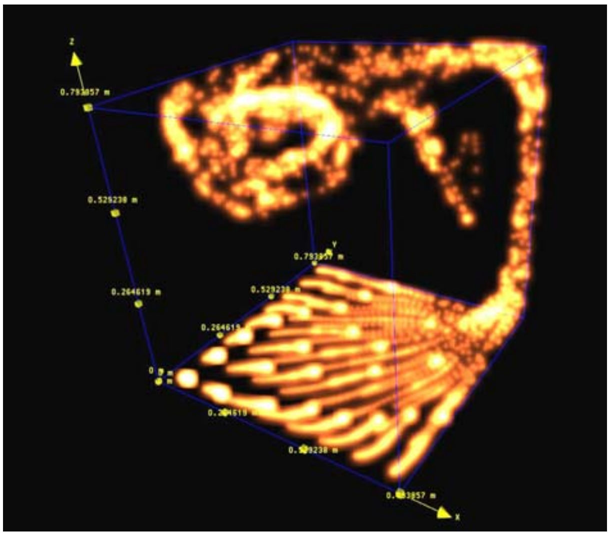


Figure 4 Particle Rendering of a velocity field.

As presented in the previous progress reports, FIGD designed and implemented a parallel processing kernel, for the generation, management and visualization of CFD-simulation data. Together with some visualization methods already integrated in the system, the kernel and the data management have been reworked into a COVER-Plugin for the COVISE environment. In order to facilitate a message controlled communication with the other parts of the VIRTUALFIRES System a parser has been added to the kernel. A protocol has been developed together with KTH to define the communication interface.

Particle Rendering

Besides porting the system into a COVER-Plugin. FIGD worked on two visualization modules. Particle Rendering is added as new visualization method for vector field data. The particles can be rendered as streamlets or geometry primitives as well as textured billboards.

Volume Rendering – Realistic Display of Smoke and Fire

As presented in the last progress report, FIGD developed and implemented a 3D texture and shader based volume rendering algorithm which is based on slab by slab rendering. By using an appropriate colour mapping, fire and smoke can be rendered with a granularity based on the simulation data. Now a refinement of this method uses a random distortion field (“noise”) to add details into the scenery with a higher resolution level. The distortion model formerly used on a 2D image has been successfully applied to a three dimensional visualization. Even if the distortions are random features they can be controlled with the amplitude of the distortion to avoid misinterpretations. The appearance and the dynamic of these low-scale features provide a more realistic impression of both the fire and the smoke.

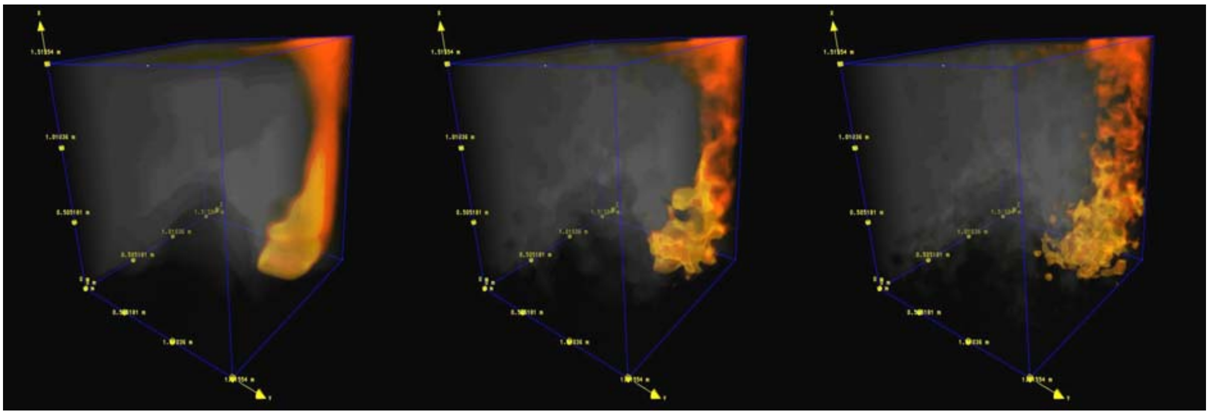


Figure 5 Volume Rendering of a temperature distribution field.(left: original volume rendering, middle: light distortion with medium frequency noise, right: medium distortion with high frequency noise)

Limitations of the COVISE and CAVE Environment

The computations done for the visualization of smoke and fire are done on a per pixel basis (rather than per vertex), which means a tremendous computational effort which cannot be expected to be done in reasonable time without dedicated hardware (i.e. graphics boards following the DirectX9 Standard), which have been available since late 2002. In the context of the VIRTUALFIRES System both COVER/COVISE and the CAVE pose a limitation to hardware shader based rendering, which is currently available only on PC (Linux or Windows) based environments. Unfortunately the CAVE hardware at KTH, consisting of a Silicon Graphics Onyx2, has not been replaced yet. From COVISE no substitution has been provided so far for the Performer Scenegraph used by COVER, which is not able to use 3D-Textures. The complete shader capabilities will be available when the hard- and software of the CAVE environment are updated.

Further there is a problem with running the system in the CAVE environment as several subcomponents use library functions that are based on mutually incompatible versions of the C++ standard and cannot easily be combined using the C++ compilers available under Irix. Work is underway to come up with a work-around. (Under Linux all software is compiled with the Gnu g++ compiler.)

Refining the visualization methods

The OpenGL shaders provided for Unix-based Systems, however, could be used to refine the visualization methods available for the CAVE (to a limited extent). FIGD is currently working on the possibility to provide a temperature field as additional data for all visualizations (even vector field visualizations). The temperature data will be mapped to a colour scheme which resembles fire.

4.2.2.5 Communication protocols

The communication between the UIC and all connected components is based on a human-readable ASCII protocol. The communication overhead as compared to a binary protocol is trivial, but speeds up debugging, which is more important at this point. Later on a binary protocol may be defined, if it is felt to be necessary.

The protocols have been iteratively improved as necessary functionality has become more clear in the course of testing. They are now well-defined and stable.

4.2.2.6 Integration HMD, Tracker and Spacemouse

In this period the integration of the tracker and Spacemouse is finished. SiTu provided Vircinity the code for reading the data from the tracker that is integrated in the HMD and the Spacemouse. This code was used to implement a TrackerServer and a SpacemouseServer, who sends the data to the Covise VR Environment.

All display methods used with Covise have fixed projection screens, so the VR Environment was not able to handle the tracker data correct. Vircinity did some additional implementation to support moving projection screens and provided us a new version of their system.

4.2.2.7 Integration for SGI-CAVE

As Vircinity builds Covise on IRIX by using the MipsPro CC compiler all software modules had to be adapted for this compiler because the linker on IRIX was not able to successfully link objectfiles generated by gcc 3.3.1 against libraries of the MipsPro compiler.

At the current stage of the development not all modules could successfully be adapted to the MipsPro compiler.

4.2.2.8 Migration from SuSE 8.1 to 8.2

As Vircinity provided the latest version of Covise only for SuSE 8.2 and gcc 3.3.1 all software modules and their required base libraries had to be migrated.

While the DMC and the CFDController could be shifted smoothly to gcc 3.3.1, the DataManager and especially the MySQL++ library required a greater effort, because of the lack of a part of the standard library.

4.2.3 Workpackage 5

4.2.3.1 Parallelisation

Most time of the 4th reporting period was spent on the parallelisation of the CFD solver using a message passing approach. The resulting parallel code was verified to be coincident with the serial version. The verification is depicted below for a simple diffusion problem. The results of the serial and the parallel simulation agree up to machine accuracy.

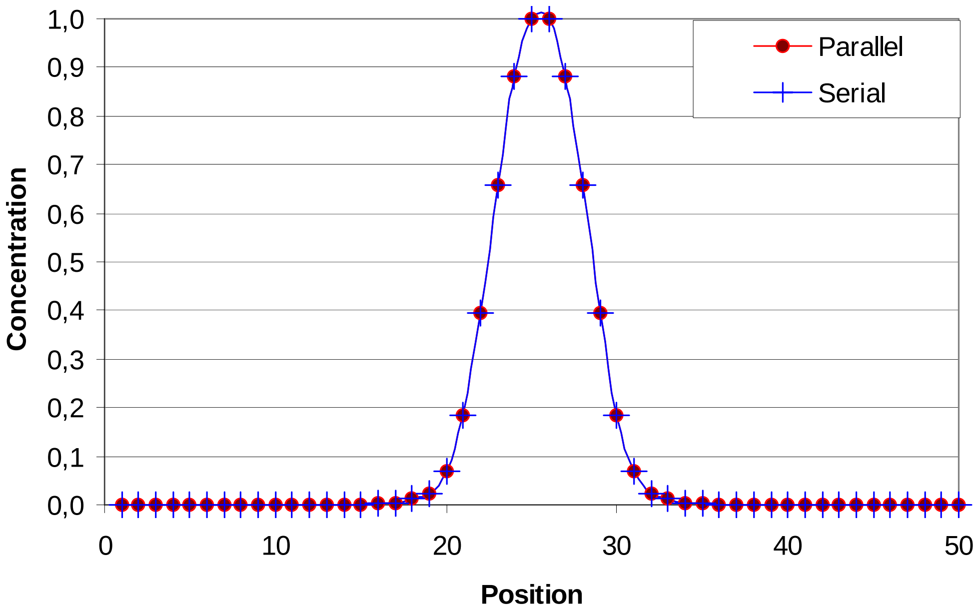


Figure 6. Diffusion problem – Comparison between serial and parallel results

The parallel performance was measured on two different computational environments:

- DEC Alpha ES 40 equipped with 4 833 MHz processors interconnected by a cross bar switch
- A Linux based cluster containing 4 2.4 GHz and 2 2.8 GHz Intel processors connected by GigaBit Ethernet
- Additionally to the Linux cluster 3 workstations each equipped with 2 2.8 GHz Xeon processors connected by 100 MBit Ethernet were involved

Three different configurations were selected for the performance tests:

- Test case A consists of 60.000 computational cells and is the most representative for the current use of ICE within the Virtual Fires project
- Test case B consists of 250.000 cells
- Test case C is the biggest one and contains 2.000.000 cells

Fig. 7 shows the parallel speed up for the DEC Alpha ES 40. Remarkable is the super linear speed up for test case A. This is probably due to strong caching effects.

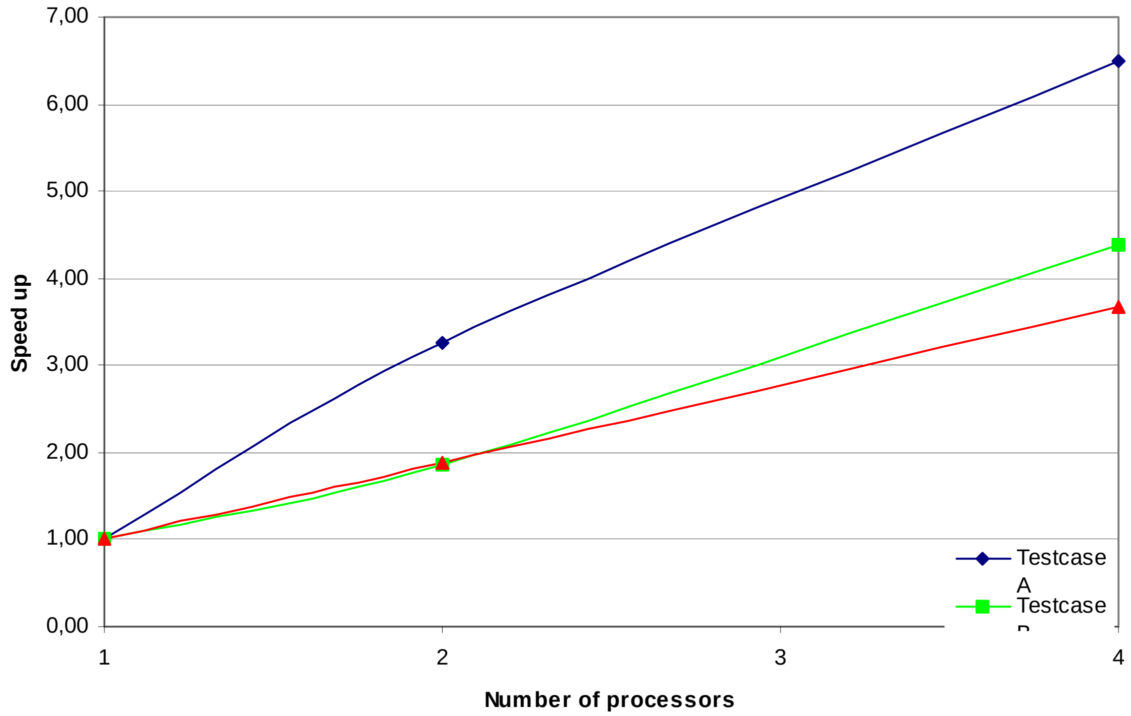


Figure 7. Performance on the DEC Alpha ES 40

Fig. 8 depicts the speed up obtained on the Linux cluster (1 to 6 processors) and the additional workstations (involved in the calculations on 8 to 12 processors). Although the connection between the workstations is relatively slow (100 MBit Ethernet) the speed up is remarkable. For small problems (Test case A & B) the performance breaks down if more than 8 processors are involved due to the relative increase of communication compared to calculation.

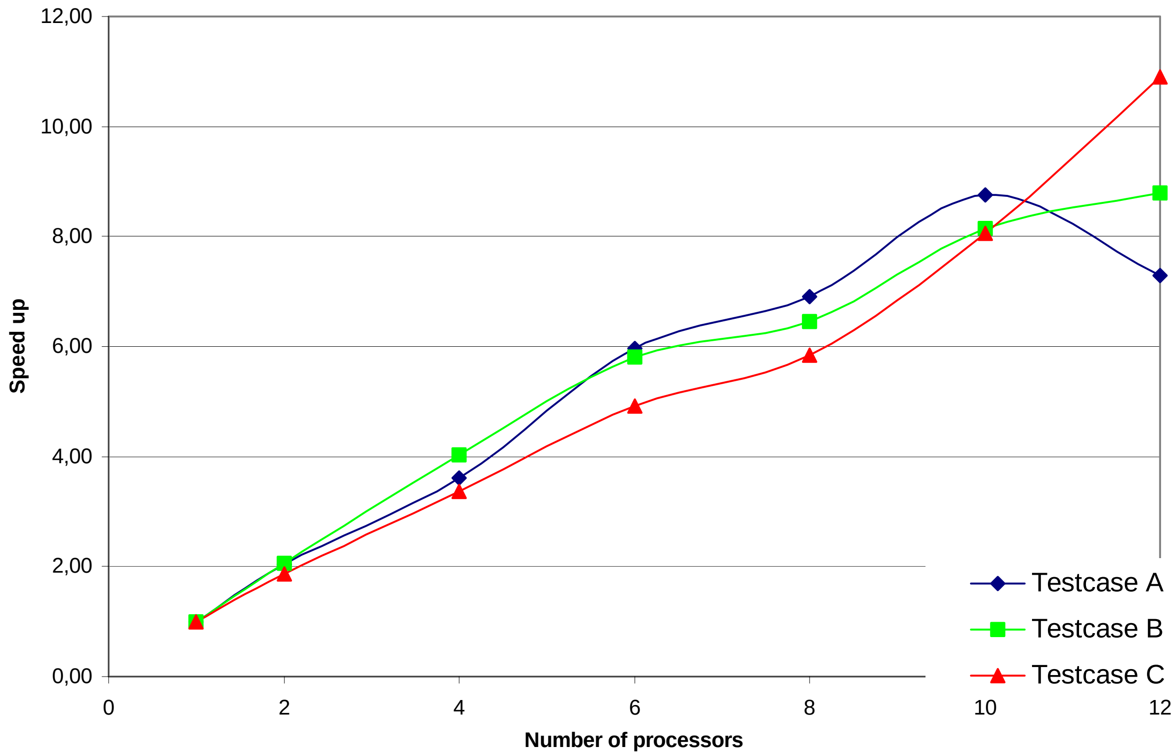


Figure 8. Performance on the Linux cluster

Nevertheless, comparing the costs for setting up a Linux based cluster to the acquisition of a dedicated parallel computer the performance is excellent. The authors found this result of big importance as a cluster solution may be an easy realisable alternative for the end users.

Looking on the single processor performance the DEC Alpha system using a 3 year old technology is beaten by far by the 2.8 GHz Intel processors as can be seen from fig. 9.

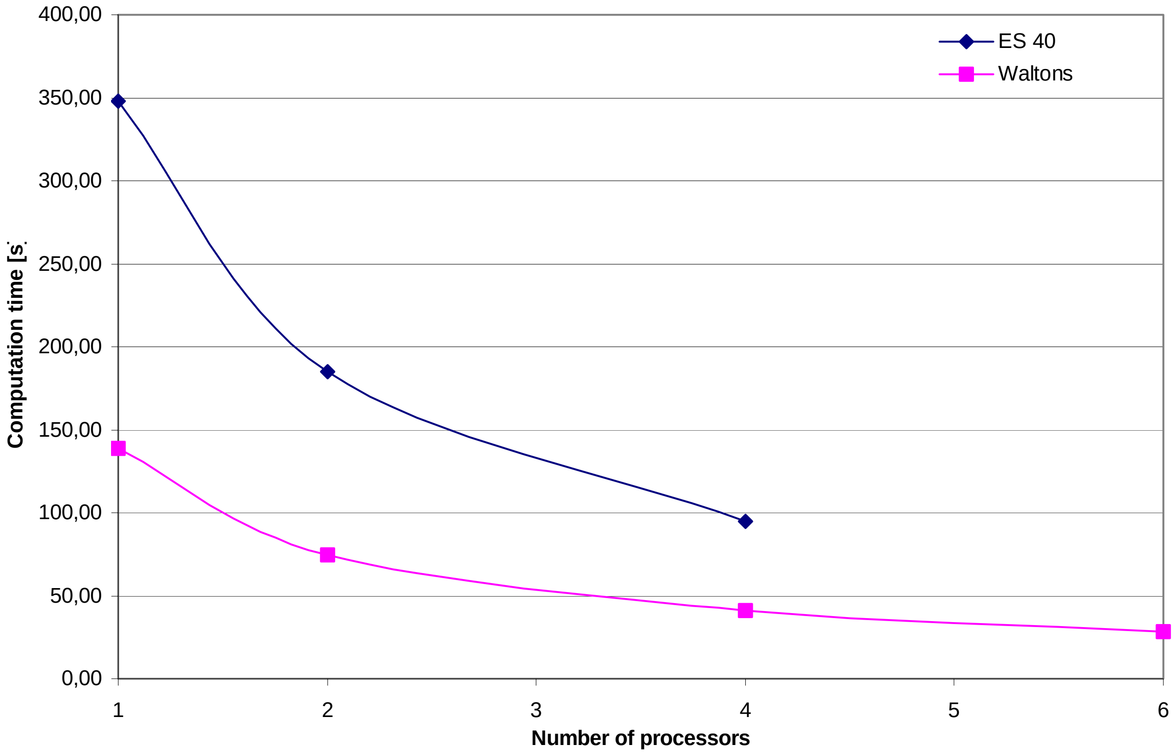


Figure 9. Test case C – Comparison DEC Alpha / Linux cluster

4.2.3.2 Coupling of 3D/2D models to 1D model

The data structure of the ICE code has been modified in order to allow expansion/reduction of the 3D grid when/where necessary. The 3D grid is expanded if the variation of the concentration of species at its boundaries exceeds some critical value defined by the user. The first tests of the coupled model with adaptive grid has been performed and the resulting graphs are shown in fig. 7 for a 2D grid and fig. 8 for a 3D grid. Here, this model has been compared to the 3D model. As one can see, the first results seem promising. Further, the 1D equation has been modified by including a friction term, which consists of steady and unsteady components. The role of this term is to improve agreement in the wave speed and the velocity losses between the two models.

Fig. 10 shows a coupled model, which consists of the 1D model (solid green line) at the ends and the 2D model (red stars) in the middle, is compared to the 2D model (dotted blue line). A source of species is put into the tunnel and the input velocity is defined on it's left side. The concentration of species is shown after 100 (no grid expansion), 200 (one grid expansion) and 300 timesteps (two grid expansions). Notice that the averaged cross section values are used in the 2D model.

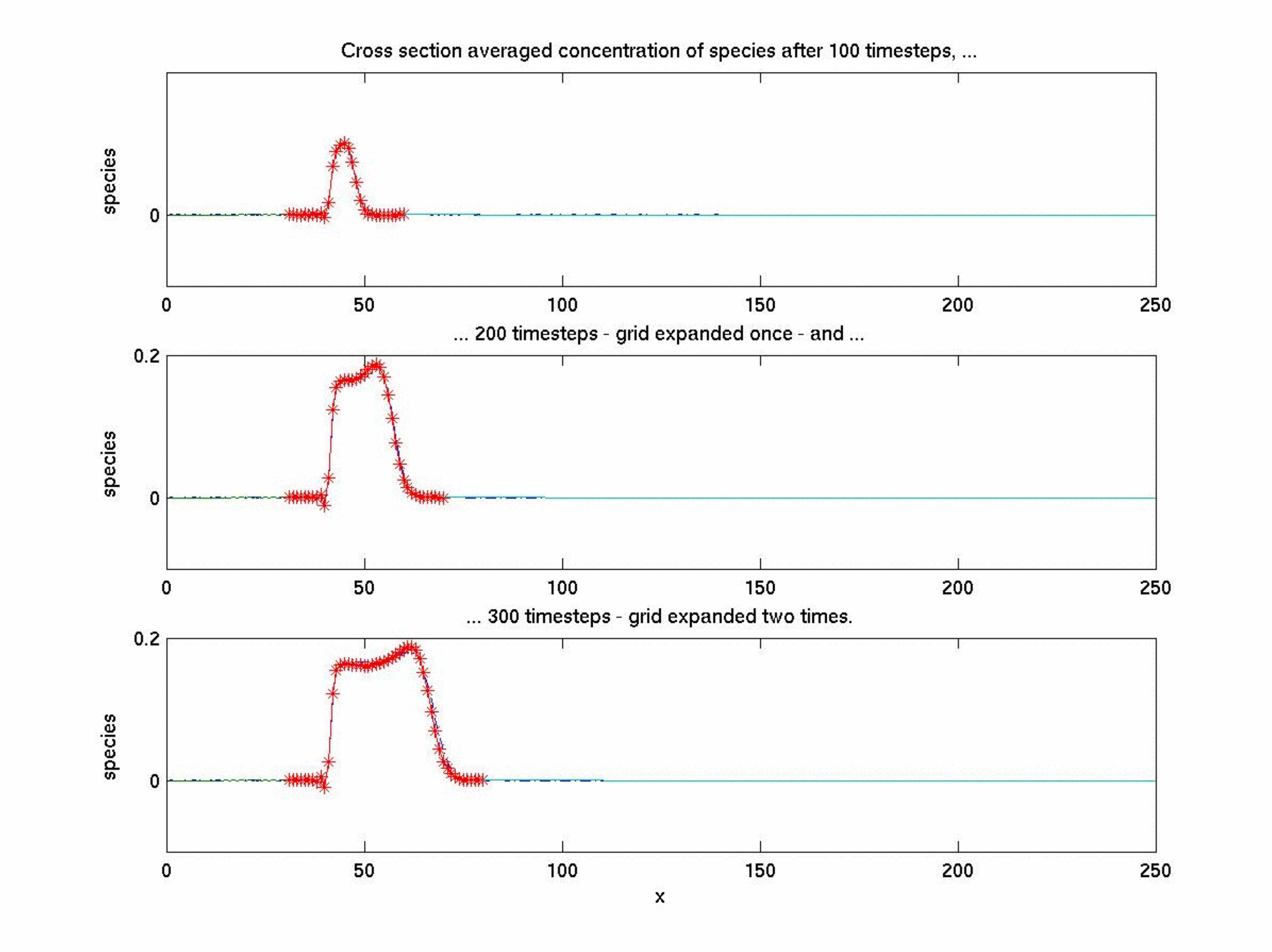


Figure 10. Coupled model – 1D/2D/1D

Fig. 11 shows the coupled model, which consists of the 1D model (green solid line) at the ends and the 3D model (green stars) in the middle, is compared to the 3D model (blue dotted line). A source of species is put into the tunnel and the input velocity is defined on it's left side. The concentration of species is shown after 100 (no grid expansion), and 250 timesteps (one grid expansion). Notice that the averaged cross section values are used in the 3D model.

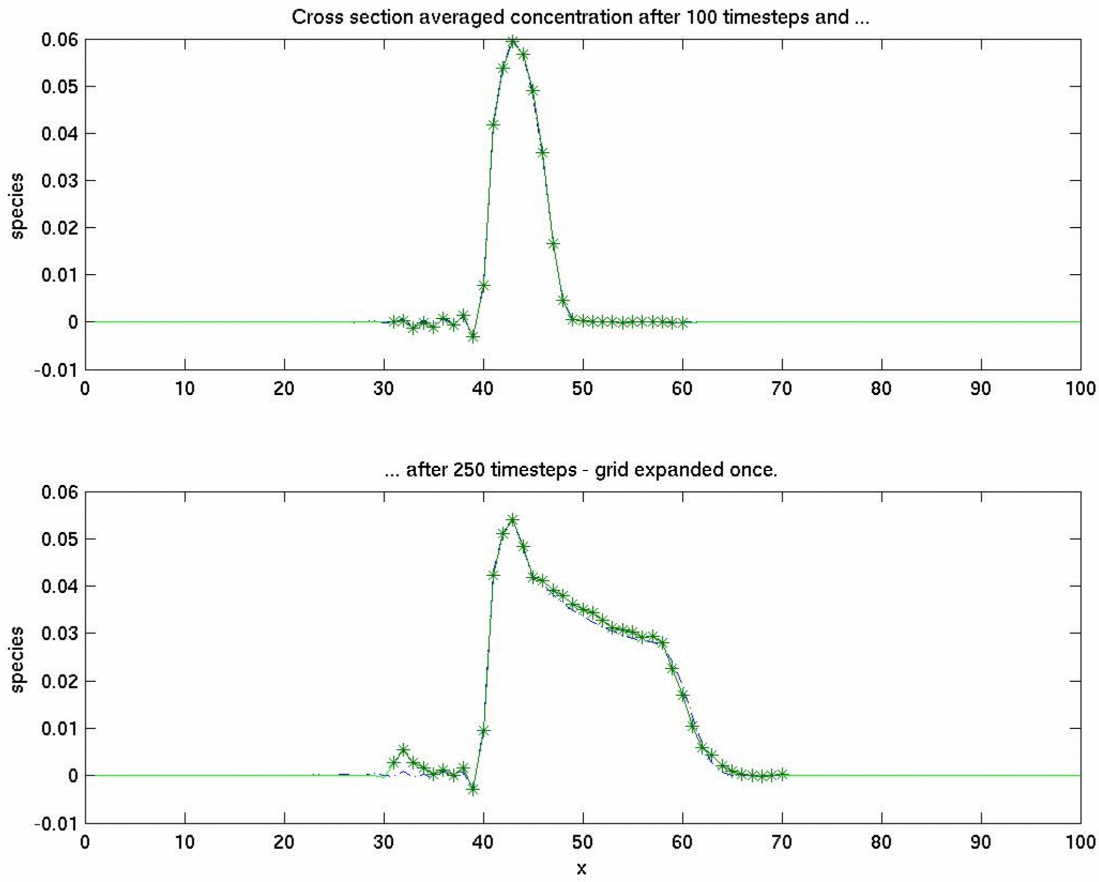


Figure 11. Coupled model – 1D/3D/1D

4.2.3.3 Development of ICE

The usual software maintenance work has been done. The structure of the input files was adapted according to the requirements of the data manager.

Some smaller modifications and extensions of the turbulence model were done. The implementation of the Van Driest damping function at solid boundaries was completed.

It is now possible to specify several potential fire regions, which are activated if some criteria are fulfilled, e.g. the temperature within the fire region exceeds a certain critical value (which is based on user input).

For demonstration purposes the evolution of smoke and temperature resulting from a train fire in a part of the subway station provided by the Fire Department Dortmund was simulated. Fig. 12 a – 12 d show the 400 [K] temperature isosurface (red) and three different isosurfaces of smoke concentration (grey).

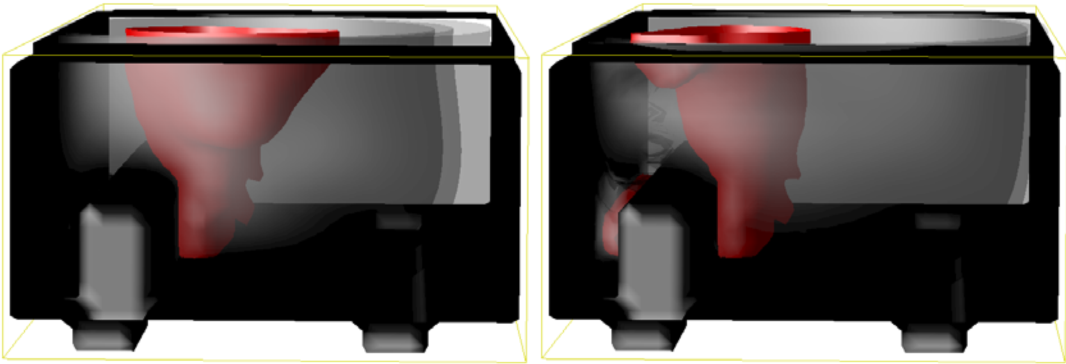


Figure 12a & 12b. Left: Time t = 1000; Right: Time t = 3000

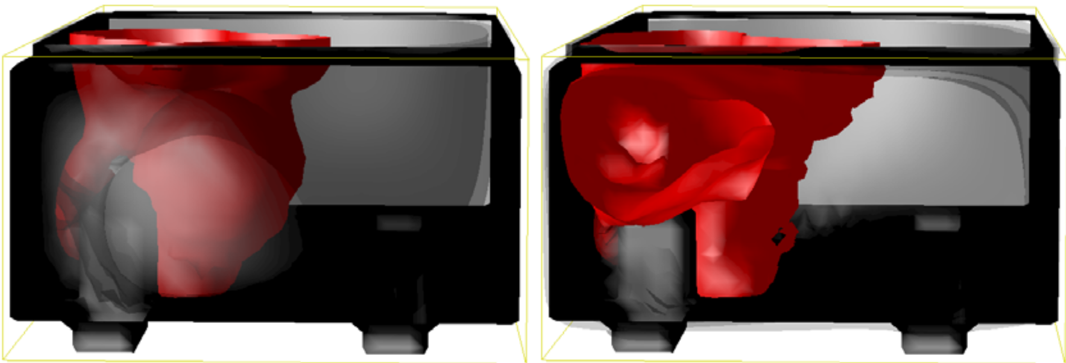


Figure 12c & 12d. Left: Time t = 5000; Right: Time t = 8000

It can be clearly seen how the fire spreads if the a priori defined potential fire regions are activate if the critical temperature is exceeded.

4.3 Comparison planned activities and actual work

4.3.1 Reports

Two deliverables were produced, which are listed in Table 2. In general all the planned activities were carried out successfully. The completion of some reports was delayed for a short time because information was not available in time.

Delive rable	Title	Planned Closing date	Achieved closing date	Reason for delay
D3.5	Beta version of data management for second prototype	2003-06-30	2003-09-30	DataManager is continuously updated
D5.3	Parallelisation efficiency report	2003-10-31	2003-11-17	Waiting on availability of Linux cluster

Table 2: Planned activities and actual work done

4.4 State of the art review

There are many tools on the market for displaying CFD datasets. However, at present they are not able to perform simultaneously the CFD simulation and the display of data in real time. The main advance of VIRTUALFIRES over existing methods is the complete interaction of the user with the simulation and real time display of data in a realistic way. For that reason a development of massive parallel visualization methods was initiated. These methods, which utilize partly sophisticated hardware capabilities of new graphic cards available on the market, are integrated in a state of the art visualization system (parallel visualization kernel / Covise).

4.5 Planned activities for the next period

4.5.1 Workpackage 3

4.5.1.1 DataManager

As during the testing and evaluation period some minor functional issues are expected to emerge only bug fixing is likely to happen. However, for the management and configuration of the simulator an administrative tool, that doesn't require the interaction in the VR environment, is planned to be implemented.

4.5.1.2 DMC

Some minor extensions will be performed.

4.5.1.3 CFDController

The are some extensions necessary to implement the concurrent version of the VFS simulator.

4.5.2 Workpackage 4

The immediate future will comprise:

- Development of testing protocols in cooperation with EUVE.
- Further improvement of the GUI based in user evaluation.
- Better support for working with missions in the GUI.
- Development of end-user-oriented documentation.
- Extension of the functionality of the geometry handler.

4.5.2.1 Integration for SGI-CAVE

Further investigation in resolving the issues caused by the MipsPro compiler on IRIX.

4.5.3 Workpackage 5

4.5.3.1 ICE

Within the next working period the release of version 2.0 of the simulation software is scheduled for month 26.

As it will be the final period all components regarding steering and communication with the VR environment have to be integrated.

The 1D/3D coupling will be integrated within the parallel software. In order to obtain a more robust model, the following work will be done:

- The grid reduction will be implemented. So far only the grid expansion is possible.

- The 1D equation will be modified by including body force terms.

- Updating of the values at the inner interfaces between the models will be improved by using velocity profiles.

- Extensive testing will be performed, especially with the long tunnels.

Continuous improvement of the simulation software will accompany the validation process done by the end user.

If the I/O bottleneck between the VR system and the simulation software can be removed real time simulations on the Linux cluster "Lucidor" at PDC/KTH will presumably possible.

4.5.3.2 ICE Steering

For the concurrent version of the VFS simulator it is necessary to change the input data during a running CFD simulation. A new method will be implemented to exchange the information between the CFDController and ICE.

5 List of deliverables (Month 19 – 24)

No.	**Deliverable (D) or** **Milestone (M) name**	**WP no.**	**Lead Participant**	**Estimated person-months**	**Del. type***	**Delivery (proj. month)**	**Delivered (proj. month)**
D3.5	Beta version of data management for second prototype	3	SITU	5	Prototype	20	23
D5.3	Parallelisation efficiency report	5	CD	1,5	Report	24	25

6 Exploitation and dissemination of results

6.1 Exploitation

Using the e-tip software supplied on CORDIS a draft Technological Implementation plan was prepared and submitted.

6.2 Dissemination

At the combined TCC/PCC meeting in Dortmund members of the consortium had the opportunity to see a real fire exercise of the Dortmund fire brigade in a disused part of the Dortmund underground. The exercise attracted publicity with TV and press were present. The coordinator of VIRTUALFIRES attended a press conference, where he presented the aims of the project. Some articles appeared in the local press and a short excerpt from the interview appeared on TV.

The coordinator has prepared a paper on the project for a conference in South Africa in July 2004. An exhibition space has been requested to present a VIRTUALFIRES prototype at the 1. International Symposium on Safe and Reliable Tunnels organised by the FIT (Fire in Tunnels) network. This conference is to be held in Prague on February 4-6, 2004.

A presentation entitled "Implementing a CFD steering system for immersive environments" was presented by Kai-Mikael Jää-Aro, KTH at the 3rd CAVE Programming Workshop in Helsinki, Finland 27–29. August 2003The paper discussed the experiences gained from developing the user interface for the VIRTUALFIRES simulator and the implications they had for the design of future visualization tools and graphical programming languages.

7 Management and coordination aspects

The main coordination effort was concerned with the preparation for the review meeting on November 24. The following meetings were organised:

1. Ordinary TCC/PCC Meeting, Dortmund, May 13, 2003
   Main topics:
   - Liaison with Dr. Wirse, Managing Director of Vircinity, company that has developed and markets COVISE. Vircinity is interested in the distribution of VIRTUALFIRES and will be added to the exploitation partners in e-tip
   - Preparation for extraordinary review meeting on June 5, 2003

2. Extraordinary TCC/PCC meeting, Darmstadt, August 7, 2003.
   Main topics:
   - To discuss and resolve concerns about CFD capabilities.
   - To prepare a roadmap and timeline for the November review meeting

At that meeting the following was decided by the consortium:

1. The Consortium decided unanimously to drop the automatic generation of the CFD-domain from the scene geometry for the review in November.
2. On the remaining three issues – fire doesn't spread, fire can't be extinguished, fire doesn't stop by itself – the Consortium decided unanimously to use energy release curves for the simulation of the November review meeting which will not resolve the above issues. For the smoke density the CFD-program will deliver a value between 0 and 1 which than can be used for visualisation by FIGD.
3. Data management: scene modification was cancelled. Adaptation for mission handling, head-tracker-integration and the administration tool for the database server will be done according to the timeline.
4. For the steering of ICE, SiTu and CD will extend the current available interaction mechanism and develop the automatic generation of the CAS-files from the mission description.
6. Visualisation methods (FIGD): the integration of missing visualisation methods will be finished by September 15, 2003.

The following timeline was proposed in the lead up to the review meeting:

Timeline for Reviewmeeting @ Stockholm Nov.

V 0.3

Timeline: Jul 01 | Jul 15 | Aug 01 | Aug 15 | Sep 01 | Sep 15 | Okt 01 | Okt 15 | Nov 01 | Nov 15

Tasks	Partners	Date	Activity
T1:	**SiTu**, Vircinity	Okt 01	HMD Tracker support
T2:	**CD**, SiTu, FIGD	Jul 15	Data verification
T3:	**CD**	Aug 15	Computational Domain for FDDo Testcase
		Aug 01	Selection of mission parameters
T4:	**CETU**,LTF,FDDo,EUVE	Aug 01	Definition of remaining testcases
		Sep 01	Preparation of computational domain of remaining Testcases
T5:	**CD**	scratched	Implementation of simulation extensions for correct fire behaviour
T6:	**CD**	scratched	Generation of CFD-domain from scene geometry
T7:	**SiTu**, CD	Okt 01	ICE Steering extensions for mission data and concurrent changes
T8:	**CD**, FIGD	Aug 01	Definition of calculated parameters for visualisation
T9:	**KTH**, SiTu	Jul 15	Definition of GUI-Extensions and Protokol UIC-DMC
		Sep 15	Implementation of Extensions
		scratched	Testing and further extensions of GUI (Infodisplay inside VR)
T10:	**FIGD**	Okt 01	Implementation of missing viz methods
		Sep 01	Adaptions for CAVE environment
T11:	**KTH**, FIGD	Aug 15	Definition of extentions of UIC-VIZ Protokol
		Sep 01	Implementation of extensions
T12:	**SiTu**	Okt 01	Extension/modification of DM and implementation of Admin Gui-Tool
T13:	**SiTu**	Okt 01	Generation of viz models for testcases

Remark: **Bold** printed partners are responsible for the successful execution of this task.

Milestones

Aug 15	Testcase FDDo available
Sep 01	remaining Testcases available
Sep 15	GUI supporting interaction with CFD finished
Sep 15	GUI with mission editing available
Okt 01	autom. mission generation and interaction with CFD working
Okt 01	Admin GUI for DB-Server available
Okt 15	Prototype for Review available
Okt 15	CAVE version of prototype for Review available

Due to various problems encountered in the implementation of the VR system an intensive meeting activity of the developer team took place. The following 4 meetings were organised in the lead up to the review:

From	To	Location	Participants
2003-10-23	2003-10-24	Stockholm	SiTu, KTH, CD
2003-10-25	2003-11-01	Graz	SiTu, KTH
2003-10-31		Graz	SiTu, FDDO, KTH, FIGD
2003-11-17	2003-11-22	Stockholm	SiTu, KTH

8 Glossary

SiTu Institute for structural analysis, Graz University of Technology, Austria

CD Christian-Doppler-Laboratory for Applied Computational Thermofluiddynamics, Austria

FIGD Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung, Germany

KTH Kungl. Tekniska Högskolan, Sweden

LTF Lyon-Turin Ferroviaire, France

METL Ministere del’Equipment des Transport et du Logement, Centre d’Etudes de Tunnel, France

FDDO Stadt Dortmund, Feuerwehr (fire brigade), Germany

EUVE European virtual engineering, Spain

9 Annexes

9.1 Deliverable and major milestone list

No.	Deliverable (D) or Milestone (M) name	WP no.	Lead Participant	Estimated person-months	Del. type*	Security**	Delivery (proj. month)
D2.1	Report on available developer tools	2	FIGD	1,5	Report	Int.	2
D2.2	Selection of developer tools	2	FIGD	1,4	Spec.	Int.	2,5
D2.3	Report on available system capabilities (hardware)	2	FIGD	1,8	Report	Int.	2
D2.4	Specification of planed system capabilities (software)	2	FIGD	7,5	Spec.	Int.	2,5
D2.4a	Update System Specification	2	FIGD		Spec.	Int.	
D2.5	Report on existing VR-systems, Adaptability to VIRTUALFIRES	2	FIGD	1,1	Report	Int.	3,5
D2.6	Specification of selected VR System & required extensions	2	FIGD	2,2	Spec.	Int.	4
D1	Project presentation	1	SITU		Publicity	Ext.	3
D2	Dissemination and use plan	7	METL		Report	IST	6
Total		**WP2**		**15,5**			
D3.1	Report on geometrical data base	3	SITU	3	Report	Rest.	5
D3.2	Report on CFD data base	3	SITU	2,5	Report	Rest.	5
M1	CFD computation of fire reference simulations completed	1-5	CD		Demonstration	IST	6
D3.3	Report on compression/ optimisation	3	SITU	3,5	Report	Rest.	6
M5.1	Release of VIRTUALFIRES a-priori results database	5	CD		Dem.	IST	11
D3.4	Beta version of data management for first prototype	3	SITU	6	Prototype	Rest.	15
D3.5	Beta version of data management for second prototype	3	SITU	5	Prototype	Rest.	20
M3.1	Beta testing of software completed successfully	3	SITU		Demonstration	Rest.	16
D3.6	Release version of data management	3	SITU	4	Serial	Rest.	26
Total		**WP3**		**24**			
D4.1	Specification on methods of displaying CFD data	4	KTH	4	Report	Rest.	12
D4.2	Specification of user interface in VR-environment	4	KTH	4	Report	Rest.	12
D4.3	Report on hardware HMD specification	4	KTH	2	Report	Rest.	13
D4.4	Integration of HMD system completed	4	KTH	6	Prototype	Rest.	16
M5.2	Software release V1.0	5	CD		Dem.	IST	17
D4.5	VR implementation with limited functionality and speed	4	KTH	13	Prototype	Int.	18

No.	Deliverable (D) or Milestone (M) name	WP no.	Lead Participant	Estimated person-months	Del. type*	Security**	Delivery (proj. month)
D4.6	VR implementation with full functionality optimised for speed	4	KTH	8	Prototype	Int	25
D4.7	VR integration with real-time CFD data generation	4	KTH	8	Prototype	Int	25
D4.8	VIRTUALFIRES users manual	4	KTH	4	Report	Int.	26
Total		**WP4**		**49**			
D5.1	CFD database containing results of 6 computational studies	5	CD	30	Database	Int.	11
D5.2	Report: Interactive Field Simulation Techniques; Solver and Data Flow Parallelization	5	CD	37	Report	Int.	11
D5.3	Parallelisation efficiency report	5	CD	1,5	Report	Int.	24
D5.4	Software User Guide V1.0	5	CD	5,5	User guide	Int.	14
M5.3	Software release V2.0	5	CD		Demonstration	IST	26
D5.5	Software User Guide V2.0	5	CD	5,5	User guide	Int.	26
Total		**WP5**		**79,5**			
D6.1	Report on CAVE/ HMD installation	6	EUVE	12	Report	Int.	26
M4.1	Beta testing of software completing successfully	4	KTH		Demonstration	Rest.	27
M6.1	Requirements accomplishment	6	EUVE		Demonstration	IST	27
D6.2	VIRTUALFIRES results report	6	EUVE	6,5	Report	Int.	28
Total		**WP6**		**18,5**			
D7.1	Definition of cases	7	METL	2	Report	Int.	8
D7.2	Journal articles	7	METL	2	Report	Ext.	28
D7.3	Conference papers and exhibition at conferences	7	METL	2	Report	Ext.	28
D7.4	Webpage	7	METL	3	Website	Ext.	6
Total		**WP7**		**9**			

* *A short, self-evident description e.g. report, demonstration, conference, specification.*

** *Int.* *Internal circulation within project (and Commission Project Officer if requested)*

Rest. *Restricted circulation list (specify in footnote) and Commission PO only*

IST *Circulation within IST Programme participants*

FP5 *Circulation within Framework Programme participants*

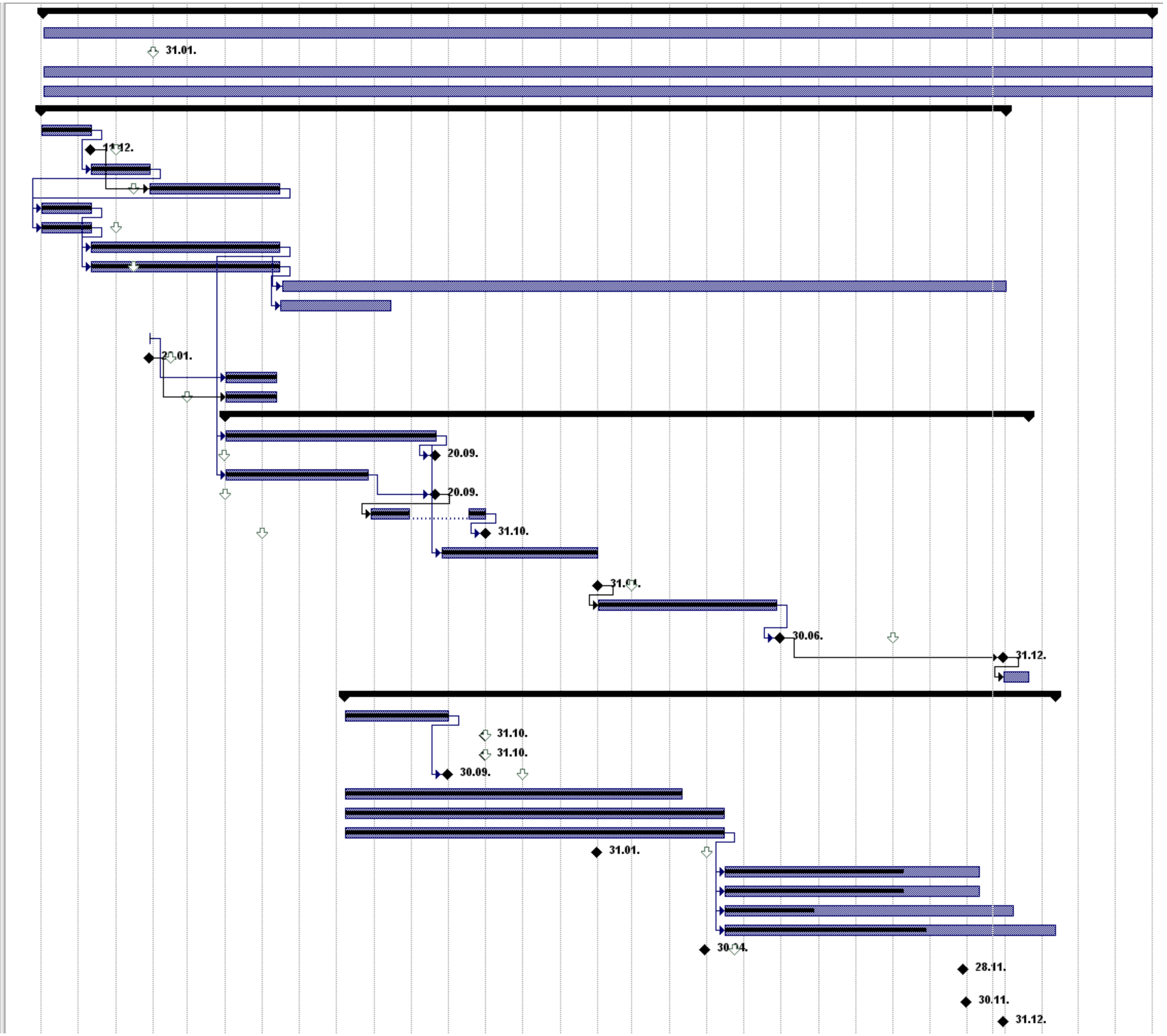
Table 1 Man power use plan

Task/Subtask (N°/title)	Partner (Name/ abbrev.)	- - - Man-Month - - - Planned efforts - at start of period (MM) Year 1	Year 2	Year 3	Total	Actual effort (MM) Year 1	Year 2	Forecast effort (MM) Year 3	Total	Deviation (MM) Totals	- - - Technical Progress % - - - Planned (%) Year 1+2	Assessed* (%) Year 1+2	Deviation (%) Year (now)	Comments on major deviations and/or modifications of planned efforts.
		a	b	c	d	a1	b1	c1	d1	d1-d				
1. Management	SiTu	9	7	4	**20**	9,28	7,54	3,18	**20**	***0***	80%	84%	*4%*	
	CD	0		1	**1**			1	**1**	***0***	0%	0%	*0%*	
	FIGD	0,34	0,33	0,33	**1**	0,34	0,33	0,33	**1**	***0***	67%	67%	*0%*	
	KTH	0,4	0,4	0,2	**1**	0,44	0,31	0,2	**0,95**	***-0,05***	80%	79%	*-1%*	
	ALPE/LTF	0,4	0,4	0,2	**1**	0,37	0,37	0,2	**0,94**	***-0,06***	80%	79%	*-1%*	
	METL	0,5	0,3	0,2	**1**	0,53	0,35	0,2	**1,08**	***0,08***	80%	81%	*1%*	
	FDDo	0,1	0,2	0,2	**0,5**	0,28	0,2	0,15	**0,63**	***0,13***	60%	76%	*16%*	
	EUVE	0,4	0,4	0,2	**1**	0,4	0,4	0,2	**1**	***0***	80%	80%	*0%*	
	Total	**11,14**	**9,03**	**6,33**	**26,5**	**11,64**	**9,5**	**5,46**	**26,6**	***0,1***	76%	79%	*3%*	
2. System Specification	SiTu	3	0	0	**3**	5,08	0		**5,08**	***2,08***	100%	100%	*0%*	
	CD	1,5			**1,5**	1,5			**1,5**	***0***	100%	100%	*0%*	
	FIGD	3			**3**	6			**6**	***3***	100%	100%	*0%*	
	KTH	2,5			**2,5**	2,36			**2,36**	***-0,14***	100%	100%	*0%*	
	ALPE/LTF	1,5			**1,5**	0,17			**0,17**	***-1,33***	100%	100%	*0%*	
	METL	1			**1**	0,48	0,02		**0,5**	***-0,5***	100%	100%	*0%*	
	FDDo	3,5			**3,5**	2,93	0,4		**3,33**	***-0,17***	100%	100%	*0%*	
	EUVE	1,5	0	0	**1,5**	0,75			**0,75**	***-0,75***	100%	100%	*0%*	
	Total	**17,5**	**0**	**0**	**17,5**	**19,27**	**0,42**	**0**	**19,69**	***2,19***	100%	100%	*0%*	
3. Data Processing	SiTu	11	5		**16**	9,79	10,89	3	**23,68**	***7,68***	100%	87%	*-13%*	
	CD	1,5			**1,5**	1,5			**1,5**	***0***	100%	100%	*0%*	
	FIGD		1,5		**1,5**		1,5		**1,5**	***0***	100%	100%	*0%*	
	KTH	0,3	1	0,2	**1,5**	0,08	0	0	**0,08**	***-1,42***	87%	100%	*13%*	
	ALPE/LTF	0,2	0,8	0,5	**1,5**	0,17	0,06	0,5	**0,73**	***-0,77***	67%	32%	*-35%*	
	METL	0,25	0,25		**0,5**	0,25	0,24		**0,49**	***-0,01***	100%	100%	*0%*	
	FDDo	0,5	4		**4,5**	0,13	4	0,5	**4,63**	***0,13***	100%	89%	*-11%*	
	EUVE	0,8	0,2	0	**1**	0,8	0,2		**1**	***0***	100%	100%		
	Total	**14,55**	**12,75**	**0,7**	**28**	**12,72**	**16,89**	**4**	**33,61**	***5,61***	98%	88%	*-9%*	
4. VR Implementation	SiTu	1	15	4	**20**	1,04	11,89	4,78	**17,71**	***-2,29***	80%	73%	*-7%*	
	CD	1	1		**2**	1	1		**2**	***0***	100%	100%	*0%*	
	FIGD	3	7,5	1	**11,5**	5	6	0,5	**11,5**	***0***	91%	96%	*4%*	
	KTH	4	5	2,5	**11,5**	4,89	12,39	7	**24,28**	***12,78***	78%	71%	*-7%*	
	ALPE/LTF		0,8	0,7	**1,5**	0	0	0,7	**0,7**	***-0,8***	53%	0%	*-53%*	
	METL	0	0,8	0,2	**1**		0,02	0,2	**0,22**	***-0,78***	80%	9%	*-71%*	
	FDDo	1	2		**3**	0	4		**4**	***1***	100%	100%	*0%*	
	EUVE	0,5	1,3	0,2	**2**	0,5	1,3	0,2	**2**	***0***	90%	90%	*0%*	
	Total	**10,5**	**33,4**	**8,6**	**52,5**	**12,43**	**36,6**	**13,38**	**62,41**	***9,91***	84%	79%	*-5%*	
5. CFD Data Generation	SiTu	0	10	2	**12**	0	1,36	2,94	**4,3**	***-7,7***	83%	32%	*-52%*	
	CD	12,5	18	18	**48,5**	15,5	15	18	**48,5**	***0***	63%	63%	*0%*	
	FIGD				**0**				**0**	***0***	0%	0%	*0%*	
	KTH	3	7	4	**14**	0,86	9,29	4	**14,15**	***0,15***	71%	72%	*0%*	
	ALPE/LTF	0,2	0,4	0,4	**1**	0,11	0	0,4	**0,51**	***-0,49***	60%	22%	*-38%*	
	METL	0,2	0,8	0,5	**1,5**	0,11	0,35	0,5	**0,96**	***-0,54***	67%	48%	*-19%*	
	FDDo		0,5	0,5	**1**		0	0,5	**0,5**	***-0,5***	50%	0%	*-50%*	
	EUVE	0	1,5	0,5	**2**	0	1,5	0,5	**2**	***0***	75%	75%	*0%*	
	Total	**15,9**	**38,2**	**25,9**	**80**	**16,58**	**27,5**	**26,84**	**70,92**	***-9,08***	68%	62%	*-5%*	
6. Evaluation/Validation	SiTu			3	**3**			3	**3**	***0***	0%	0%	*0%*	
	CD			2	**2**			2	**2**	***0***	0%	0%	*0%*	
	FIGD			1,5	**1,5**		0,25	1,25	**1,5**	***0***	0%	17%	*17%*	
	KTH			1,5	**1,5**			1	**1**	***-0,5***	0%	0%	*0%*	
	ALPE/LTF			2	**2**			2	**2**	***0***	0%	0%	*0%*	
	METL			1,5	**1,5**		0,06	1,5	**1,56**	***0,06***	0%	4%	*4%*	
	FDDo		0	3,5	**3,5**		0,25	3,2	**3,45**	***-0,05***	0%	7%	*7%*	
	EUVE	0	0	5	**5**	0	0,75	5	**5,75**	***0,75***	0%	13%	*13%*	
	Total	**0**	**0**	**20**	**20**	**0**	**1,31**	**18,95**	**20,26**	***0,26***	0%	6%	*6%*	
7. Dissemination	SiTu	0,5			**0,5**	0,71	0		**0,71**	***0,21***	100%	100%	*0%*	
	CD			0,5	**0,5**			0,5	**0,5**	***0***	0%	0%	*0%*	
	FIGD			0,5	**0,5**	0,11		0,39	**0,5**	***0***	0%	22%	*22%*	
	KTH	0,1	0,1	0,3	**0,5**	0,15	0,4	0,3	**0,85**	***0,35***	40%	65%	*-2%*	
	ALPE/LTF	0,2	0,4	0,4	**1**	0,17	0,17	0,4	**0,74**	***-0,26***	60%	46%	*3%*	
	METL	1,5	0,9	0,6	**3**	1,37	0,81	0,6	**2,78**	***-0,22***	80%	78%	*-2%*	
	FDDo		1	1	**2**	0,05	0,5	1,2	**1,75**	***-0,25***	50%	31%	*-19%*	
	EUVE	0,7	0,9	0,4	**2**	0,2	0,9	0,9	**2**	***0***	80%	55%	*-25%*	
	Total	**3**	**3,3**	**3,7**	**10**	**2,76**	**2,78**	**4,29**	**9,83**	***-0,17***	63%	56%	*-7%*	
TOTALS	SiTu	24,5	37	13	**74,5**	25,9	31,68	16,9	**74,48**	***-0,02***	83%	77%	*-5%*	
	CD	16,5	19	21,5	**57**	19,5	16	21,5	**57**	***0***	62%	62%	*0%*	
	FIGD	6,34	9,33	3,33	**19**	11,45	8,08	2,47	**22**	***3***	82%	89%	*6%*	
	KTH	10,3	13,5	8,7	**32,5**	8,78	22,39	12,5	**43,67**	***11,17***	73%	71%	*-2%*	
	ALPE/LTF	2,5	2,8	4,2	**9,5**	0,99	0,6	4,2	**5,79**	***-3,71***	56%	27%	*-28%*	
	METL	3,45	3,05	3	**9,5**	2,74	1,85	3	**7,59**	***-1,91***	68%	60%	*-8%*	
	FDDo	5,1	7,7	5,2	**18**	3,39	9,35	5,55	**18,29**	***0,29***	71%	70%	*-1%*	
	EUVE	3,9	4,3	6,3	**14,5**	2,65	5,05	6,8	**14,5**	***0***	57%	53%	*-3%*	
	TOTAL	**72,59**	**96,68**	**65,23**	**234,5**	**75,4**	**95**	**72,92**	**243,32**	***8,82***	72%	70%	*-2%*	

**) Please note that the actual technical progress percentage and the updated remaining efforts must reflect the physically assessed status of the work.*

Table 2: Project plan

Task
WP1: Management
WP 1.1: Coordination of activities
D 1: Project presentation
WP 1.2: Steering committee meetings
WP 1.1: Web page maintenance
WP2: System Specification/Development Tools
WP 2.1: Report on available developer tools
D 2.1: Report on available developer tools
WP 2.2: Selection of developer tools
D 2.2: Report of selected developer tools
WP 2.3: Report on available system capabilties
D 2.3: Report on available system capabilities (Hardware)
WP 2.4: Specification of planned system capabilities
D 2.4: Report of planned system capabilities (Software)
WP 2.4a Update specification
D 2.4a: Report of planned system capabilities (D 2.4 update according reviewer comments)
WP 2.5: Report of existing VR systems
D 2.5: Report of existing VR systems
WP 2.6: Specification of selected VR system
D 2.6: Report of selected VR system and required extensions
WP3: Data processing / compression
WP 3.1: Specification of geometrical data base
D 3.1: Specification of geometrical database
WP 3.2: Specification of CFD data base
D 3.2: Specification of CFD database
WP 3.3: Data compression/optimisation techniques
D 3.3: Report on available compression/optimisation techniques
WP 3.4: Implementation of datamanagement for first prototype of VFS
D 3.4: Beta version of datamanagement for first prototype
WP 3.5: Implementation of datamanagement for second prototype of VFS
D 3.5: Beta version of datamanagement for second prototype
D 3.6: Release of datamanagement
WP 3.6: Documentation
WP4: VR Implementation
WP 4.1: Selection and integration of hardware for HMD system
D 4.1: Specification of methods of displaying CFD data
D 4.2: Specification of user interface in the VR-environment
D 4.3: Specification of hardware requirements for HMD system
WP 4.2: Implementation display of geometric data
WP 4.3: Implementation display of CFD data
WP 4.4: Implementation of user interactions
D 4.4: Integration of HMD system completed
WP 4.5: Optimisation of CAVE version
WP 4.6: Integration of real-time CFD data generation
WP 4.7: Documentation
WP 4.8: Testing of system with real data
D 4.5: VR implementation with limited funktionality and speed
D 4.6: VR implementation with full functionality. Optimised for full speed
D 4.7: VR integration with real-time CFD data generation
D 4.8: VR system user manual



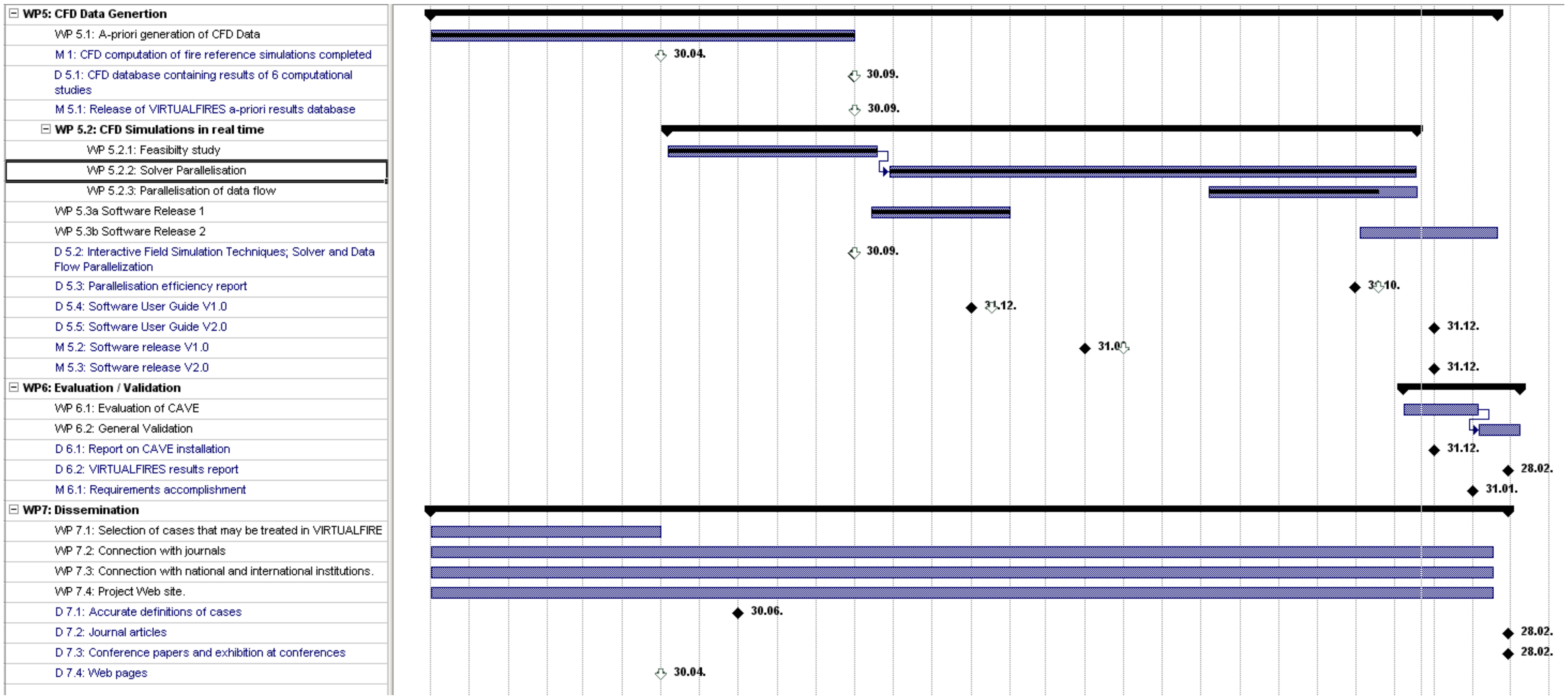

WP5: CFD Data Genertion
WP 5.1: A-priori generation of CFD Data
M 1: CFD computation of fire reference simulations completed
30.04.
D 5.1: CFD database containing results of 6 computational studies
30.09.
M 5.1: Release of VIRTUALFIRES a-priori results database
30.09.
WP 5.2: CFD Simulations in real time
WP 5.2.1: Feasibilty study
WP 5.2.2: Solver Parallelisation
WP 5.2.3: Parallelisation of data flow
WP 5.3a Software Release 1
WP 5.3b Software Release 2
D 5.2: Interactive Field Simulation Techniques; Solver and Data Flow Parallelization
30.09.
D 5.3: Parallelisation efficiency report
D 5.4: Software User Guide V1.0
D 5.5: Software User Guide V2.0
31.12.
M 5.2: Software release V1.0
M 5.3: Software release V2.0
31.12.
WP6: Evaluation / Validation
WP 6.1: Evaluation of CAVE
WP 6.2: General Validation
D 6.1: Report on CAVE installation
31.12.
D 6.2: VIRTUALFIRES results report
28.02.
M 6.1: Requirements accomplishment
31.01.
WP7: Dissemination
WP 7.1: Selection of cases that may be treated in VIRTUALFIRE
WP 7.2: Connection with journals
WP 7.3: Connection with national and international institutions.
WP 7.4: Project Web site.
D 7.1: Accurate definitions of cases
30.06.
D 7.2: Journal articles
28.02.
D 7.3: Conference papers and exhibition at conferences
28.02.
D 7.4: Web pages
30.04.

Table 3: Budget plan

PARTNER	Cost Category	BUDGET (EUR)	ACTUAL COSTS (EUR)					Total Pct. Spent (%)				Remaining Budget (EUR)	*Comments on major deviations from budget.*
			Year 1	M13-18	M19-24	Year 4	Total	Year 1	M13-18	M19-24	Year 4		
		e	a1	b1	c1	d1	e1	a1/e	a1+b1/e	a1+b1+c1/e	a1+b1+ c1+d1/e	e-e1	
Partner 1 SiTu	Labour	332443	111267,67	70884,37	67249,89		249401,93	33%	55%	75%		83041,07	
	Overheads	83658	26843,82	16134,61	16468,5		59446,93	32%	51%	71%		24211,07	
	Labour+Overheads	416101	138111,49	87018,98	83718,39		308848,86	33%	54%	74%		107252,14	
	Travel	25000	13122,11	7044,13	12130,03		32296,27	52%	81%	129%		-7296,27	redistribution of budget
	Durable Eqmt.	57501	4470,86	2903,57	2947,59		10322,02	8%	13%	18%		47178,98	redistribution of budget
	Consumables	3340	5358,49	-158,99	14,98		5214,48	160%	156%	156%		-1874,48	redistribution of budget
	External Assistance	4766	200,00				200,00	4%	4%	4%		4566,00	
	Other												
	..												
	Total	506708	161262,95	96807,69	98810,99		356881,63	32%	51%	70%		149826,37	
Partner 2 CD	Labour	206126	91339,17	24900,66	60360,66		176600,49	44%	56%	86%		29525,51	
	Overheads	56109	24757,95	8736,81	17632		51126,76	44%	60%	91%		4982,24	
	Labour+Overheads	262235	116097,12	33637,47	77992,66		227727,25	44%	57%	87%		34507,75	
	Travel	10000	8989,07	2888,52	6521,33		18398,92	90%	119%	184%		-8398,92	
	Durable Eqmt.	50421	19641,24	15894,85	21278,01		56814,10	39%	70%	113%		-6393,10	
	Consumables	14000	3820,28				3820,28	27%	27%	27%		10179,72	
	External Assistance												
	Other												
	..												
	Total	336656	148547,71	52420,84	105792		306760,55	44%	60%	91%		29895,45	
Partner 3 FIGD	Labour	160334	95612,62	14179,95	2307,4		112099,97	60%	68%	70%		48234,03	
	Overheads	153976	112689,89	64420,74	3661,81		180772,44	73%	115%	117%		-26796,44	
	Labour+Overheads	314310	208302,51	78600,69	5969,21		292872,41	66%	91%	93%		21437,59	
	Travel	15000	5218,39	3084,29	434,66		8737,34	35%	55%	58%		6262,66	
	Durable Eqmt.												
	Consumables	5000	1600,00	450,18			2050,18	32%	41%	41%		2949,82	
	External Assistance												
	Other												
	...												
	Total	334310	215120,90	82135,16	6403,87		303659,93	64%	89%	91%		30650,07	
Partner 4 KTH	Labour	163065	32983,86	28056,18	51415		112455,04	20%	37%	69%		50609,96	
	Overheads	44240	8450,37	6276,66	12609		27336,03	19%	33%	62%		16903,97	
	Labour+Overheads	207305	41434,23	34332,84	64024		139791,07	20%	37%	67%		67513,93	
	Travel	24138	6308,64	3327,09	9853		19488,73	26%	40%	81%		4649,27	
	Durable Eqmt.	5000										5000,00	
	Consumables	4000	1636,17				1636,17	41%	41%	41%		2363,83	
	External Assistance												
	Other												
	Computing	25000	1321,09		1775		3096,09	5%	5%	12%		21903,91	
	Total	265443	50700,13	37659,93	75652		164012,06	19%	33%	62%		101430,94	
Partner 5 ALPE/LTF	Labour	48713	5313,00	1214,40	1062,6		7590,00	11%	13%	16%		41123,00	
	Overheads	9742	1062,60	242,88	212,52		1518,00	11%	13%	16%		8224,00	
	Labour+Overheads	58455	6375,60	1457,28	1275,12		9108,00	11%	13%	16%		49347,00	
	Travel	15000	1565,92	1928,65	1961		5455,57	10%	23%	36%		9544,43	
	Durable Eqmt.												
	Consumables												
	External Assistance												
	Other												
	..												
	Total	73455	7941,52	3385,93	3236,12		14563,57	11%	15%	20%		58891,43	
Partner 6 METL	Labour	48713	14041,40	4605,80	5464,8		24112,00	29%	38%	49%		24601,00	
	Overheads	9742	2808,28	912,20	1092,96		4813,44	29%	38%	49%		4928,56	
	Labour+Overheads	58455	16849,68	5518,00	6557,76		28925,44	29%	38%	49%		29529,56	
	Travel	15000	2761,20	1656,00	1052		5469,20	18%	29%	36%		9530,80	
	Durable Eqmt.												
	Consumables												
	External Assistance												
	Other												
	..												
	Total	73455	19610,88	7174,00	7609,76		34394,64	27%	36%	47%		39060,36	

Partner 7 FDDo	Labour	45021	13347,90	1501,20	8927,9		23777,00	30%	33%	53%		21244,00	
	Overheads	12004	2669,58	593,04	1785,58		5048,20	22%	27%	42%		6955,80	
	Labour+Overheads	57025	16017,48	2094,24	10713,48		28825,20	28%	32%	51%		28199,80	
	Travel		4185,76	1464,00	230		5879,76					-5879,76	
	Durable Eqmt.												
	Consumables												
	External Assistance	52500	15000,00		25000		40000,00	29%	29%	76%		12500,00	
	Other												
	Computing	15000										15000,00	
	Total	124525	35203,24	3558,24	35943,48		74704,96	28%	31%	60%		49820,04	
Partner 8 EUVE	Labour	54648	11187,36	8774,40	13819,68		33781,44	20%	37%	62%		20866,56	
	Overheads		8949,89	7019,52	11055,74		27025,15					-27025,15	
	Labour+Overheads	54648	20137,25	15793,92	24875,42		60806,59	37%	66%	111%		-6158,59	
	Travel	15000	4827,88	2749,06	3992,62		11569,56	32%	51%	77%		3430,44	
	Durable Eqmt.												
	Consumables	2000										2000,00	
	External Assistance												
	Other		1600,00				1600,00					-1600,00	
	..												
	Total	71648	26565,13	18542,98	28868,04		73976,15	37%	63%	103%		-2328,15	
TOTAL	Labour	1059063	375092,98	154116,96	210607,93		739817,87	35%	50%	70%		319245,13	
	Overheads	369471	188232,38	104336,46	64518,11		357086,95	51%	79%	97%		12384,06	
	Labour+Overheads	1428534	563325,36	258453,42	275126,04		1096904,82	39%	58%	77%		331629,18	
	Travel	119138	46978,97	24141,74	36174,64		107295,35	39%	60%	90%		11842,65	
	Durable Eqmt.	112922	24112,10	18798,42	24225,6		67136,12	21%	38%	59%		45785,88	
	Consumables	28340	12414,94	291,19	14,98		12721,11	44%	45%	45%		15618,89	
	External Assistance	57266	15200,00		25000		40200,00	27%	27%	70%		17066,00	
	Other		1600,00				1600,00					-1600,00	
	Computing	40000	1321,09				1321,09	3%	3%	3%		38678,91	
	Total	1786200	664952,46	301684,77	360541,26		1327178,49	37%	54%	74%		459021,51	

Literature/Links

[1] www.boost.org

[2] http://www.cs.wustl.edu/~schmidt/ACE.html, ACE Adaptive Communication Environment, Inventor Douglas C. Schmidt