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Information Technologies – Agents and Middleware
Work Package 9 - DISTAL Take-Up

Public Final Report of EUTIST-AMI Cluster Take-up Project

DISTAL Take-Up

Trials to promote take-up of the agent-based ASP software DISTAL
for software on demand

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LIST OF ISVS HAVING PROVIDED FREE TEST LICENSES FOR THE PROJECT

NO.	SOFTWARE	VENDOR	CONTACT
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{2}	ST-ORM	EASi Engineering GmbH Alzenau / Germany http://www.easi.de	Rainer Hoffmann Managing Director mailto:rainer.Hoffmann@easi.de
{3}	MSC.Nastran	MSC.Software Netherlands BVGouda / The Netherlands http://www.mscsoftware.com	Patrick de Visser Account Manager mailto:Patrick.deVisser@msc.software.com

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1.0 ABSTRACT

DISTAL (*'Distributed Software Access for Large - Scale Engineering Applications'*) is a set of software components that provide an end-to-end environment for business-to-business (B2B) electronic commerce for the execution of engineering simulation packages. DISTAL provides a secure infrastructure for a dynamic e-business marketplace, providing simulation on demand through on-line pay-per-use services.

2.0 SYNOPSIS

2.1 Overview of major achievements

The DISTAL project ('Distributed Software Access for Large - Scale Engineering Applications', Esprit 26386) has developed a set of software components based on intelligent agent technology that provide simulation on demand through secure on-line pay-per-use services. The DISTAL system covers the registration of the business partners, selection of appropriate resource providers, negotiation of the terms and conditions of the work, signature of contract, execution of the simulation, transfer of all input and result files, up to issuing the invoice.

The DISTAL results have been promising and have undergone a program of user functional testing within the DISTAL project itself. However, the DISTAL prototype was not ready for commercial exploitation. Therefore, the DISTAL Take-Up project has tested the DISTAL Application Service Providing (ASP) software in an industrial environment at the European Space Agency (ESA) in their European Space Research and Technology Centre (ESTEC). Concurrent to these tests DISTAL has been upgraded and customised by its developers at IT Innovation Centre. DISTAL ASP is now sufficiently mature to enable simulation on demand through secure on-line pay-per-use services

2.2 The benefits of using DISTAL in the engineering sector

DISTAL enables a user to solve problems that were previously not solvable with the existing user resources (because of their size or complexity) by providing software and hardware resources on demand. Typical applications have been identified in aerospace and automotive engineering which can take most benefit from using DISTAL ASP, e.g. for:

- stochastic analysis of mechanical systems which needs to run hundreds of discrete simulations in a short period of time
- large structural, thermal or fluid simulations
- automated design optimization
- Multi-Physics Simulation, for example fluid-structure-interaction (FSI), optionally coupled with electrical and / or thermal effects.

The main benefits that have been evaluated during the DISTAL Take-Up project are due to potential large savings in computation time which

- reduce the product design and development time and as such personnel effort & cost
- alternatively allow more simulations in a given design period which then leads to a better design
- can also reduce two- or three-yearly up-front investment for larger local hardware resources since they can be scaled to average resource loads
- last but not least can save cost of licenses for application software depending on the on-demand pay-per-use licensing policy of the Independent Software Vendors (ISVs).

It is clear that DISTAL ASP is not restricted to engineering applications. Similar large simulations are also required in the biological, chemical, medical, multi-media and many other research and industrial product development sectors.

In particular, the approach offers to Small and Medium-Sized Enterprises (SMEs) the possibility to tune their resources to their current needs whereas having nevertheless access to appropriate resources for covering peak loads and demanding cases.

In addition, it is expected that the approach will become widespread with the advent of GRID computing methods, and in this frame DISTAL is paving the way for usage of commercial applications on GRID.

2.3 Project partners and contacts

The DISTAL Take-Up industrial robustness tests have been performed by the European Space Agency (ESA) in the Thermal & Structures Division (TOS-MC) of the European Space Research and Technology Centre (ESTEC):
ESA / ESTEC
Michel Klein
Head of Thermal & Structures Division
Keplerlaan 1, Noordwijk ZH, 2201 AZ
http://www.estec.esa.nl

IT Innovation Centre Southampton / UK has developed the DISTAL technology and software and further customised and upgraded DISTAL concurrent to the tests of the DISTAL Take-Up project.

Atos Origin Engineering Services B.V., Leiden, The Netherlands, and Atos Origin GmbH, Stuttgart / Germany have provided DISTAL service and hardware resources for the trials, and have managed the technical coordination of the Activity.

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3.0 EXECUTIVE SUMMARY

3.1 Background

Product development cycles and costs, e.g. in aerospace and automotive industry, can be significantly reduced using engineering simulations instead of costly and time consuming experiments. To get accurate results from numerical simulation methods in engineering requires more and more sophisticated analysis of very large-scale and refined models of the real physical problems. For example, reliability of high-tech light weight structures can be investigated by stochastic methods which require execution of hundreds of variants of a single model within 'reasonable engineering time', i.e. within one or two weeks, a few days or even hours. Regular up-front investment to permanently provide in-house the required powerful hardware resources and multiple application software installations would be unacceptable high, even for big production companies or research and technology centres like ESA / ESTEC.

3.2 The problem to be solved

The main issues of on-demand distributed computing via the internet are

- the currently rather low band width which does not allow for effective transfer of large amounts of data. The transfer rate will be even more reduced if higher level data security (encryption / decryption) is required;
- the need for an automatic management of legal and contractual issues between all parties involved in an on-demand b2b e-commerce process, i.e. users, DISTAL service providers, hardware and application software resource providers;
- who will pay for the service in case of malfunction (networking failure, data transfer not being complete, job execution failed, job lost, results data not received, etc.);
- availability of on-demand pay-per-use licensing models which are acceptable for both, users and resource providers

3.3 The solution

DISTAL can currently certainly be used most successfully to enable distributed on-demand stochastic applications since the model data needs to be sent to each hardware resource (computer or node) only once, and then only a few input and results data has to be transferred for each model variant. For extensive usage, as for example when in stochastic linear structural simulations hundreds of model variants have to be run, the ASP capabilities need to be automated. Since currently stochastic applications are of high interest in aerospace and automotive product design the DISTAL ASP software has been upgraded and customised to meet design engineer requirements as far as possible.

For time domain and iterative engineering simulations of big models that need to transfer lots of data for each of hundreds of time steps the current DISTAL service via web may not provide the same benefit as for stochastics.. This type of application particularly requires job monitoring and control functionality, to continuously enable the user to check convergence criteria and to allow for cancellation of a job if convergence is not achieved. For this purpose the CONDOR software has been integrated in DISTAL.

To sort out contractual issues it is clear that a DISTAL service provider has in advance to establish an ASP framework consisting of a pool of registered trusted parties, the users, hardware and application software resource providers who all enter into a basic contract, duly signed on paper by all parties. DISTAL is flexible to allow to integrate individual payment models for the provision of hardware and software resources according to the requirements of the ASP providers.

All other details of each individual ASP service project are then negotiated automatically between the DISTAL client agent (User) and the DISTAL ASP service provider agent (Broker) who negotiates with the agents of their contracted resource providers until agreement is achieved between all parties.

3.4 Overview of major achievements

The DISTAL project (*'Distributed Software Access for Large - Scale Engineering Applications'*, Esprit 26386) has developed a set of software components based on intelligent agent technology that provide simulation on demand through secure on-line pay-per-use services. The DISTAL system covers the registration of the business partners, selection of appropriate resource providers, negotiation of the terms and conditions of the work, signature of contract, execution of the simulation, transfer of all input and result files, up to issuing the invoice.

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- reduce the product design and development time and as such personnel effort & cost
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In particular, the approach offers to Small and Medium-Sized Enterprises (SMEs) the possibility to tune their resources to their current needs whereas having nevertheless access to appropriate resources for covering peak loads and demanding cases.

4.0 FULL TECHNICAL TEXT

4.1 State of the Art

4.1.1 The need for Application Service Provision (ASP) in Automotive and Aerospace Design

In recent years the need to use on-demand access to High Performance Computing (HPC) and application software, which is known as 'Application Service Provision' (ASP) has in particular been observed in engineering design, as for example in the aerospace and automotive industries and their suppliers, most of them '**S**mall and **M**edium-Sized **E**nterprise**s**' (SMEs). One of the main reasons was and still is that engineering designs in these industries are expensive lightweight-structures and have at the same time to be as safe as possible. This however requires that any uncertainties, as for example they arise from the scatter of physical properties in e.g. fibre-reinforced or ceramic materials have to be taken into account in the design and production process.

Stochastic analysis is meanwhile the well established technique to take into account such uncertainties, however this method requires several hundreds of numerical simulations of the physical phenomena of the product. This means that the design engineers needed a tool to control the execution of so many simulations and the evaluation of the results data, and at the same time on-demand access to many more soft- and hardware resources than usually available on-site. Funded by the European Commission two Research and Technical Development (RTD) projects have been performed between 1995 and 1999 to provide the required tools as will be shortly reviewed in the next sections.

4.1.2 The PROMENVIR software for stochastic applications

ESPRIT 20189 PROMENVIR, the **PRO**babilistic **M**echanical Design **ENVIR**onment, a software tool for stochastic analysis, has been developed between 1995 and 1996 by *AtosOrigin, BLUE Engineering, CASA, CEIT, ItalDesign, PAC (now IT Innovation Centre), RUS* and *UPC* with the financial support of the European Commission, DGIII, Industry, within the 4th RTD Framework Programme. Further project information can be found at
IT Innovation [http://www.it-innovation.soton.ac.uk/research/grid/promenvir.shtml], or
Atos Origin Engineering Services, Leiden / NL [http://www.distal@62.58.73.21/promenvir/index.htm].

PROMENVIR is an advanced Meta Computing tool for performing stochastic analysis of generic physical systems. Stochastic analysis, whether applied to Structural Mechanics or Computational Fluid Mechanics, is a technique which enables one to take into account the scatter that is present in all the data managed by engineers and scientists.

One of the original, and most important, aims of the PROMENVIR project was to demonstrate the use of the PROMENVIR tool in a Meta-Computing environment, bringing together computing resources in a pan-European Wide Area Network (WAN) experiment, to solve a large stochastic problem of industrial significance.

The PROMENVIR consortium assisted PAC (*now IT Innovation Centre*) by making available 102 CPUs displayed geographically in Fig. 1. This Meta-Computer consisted of a variety of different SGI workstations and multi-processor machines, such as Power Challenge and Origin 2000. A major achievement of the WAN experiment was to enable stable connections between the APS and remote hosts through both the PAC firewall and other firewalls at various partner sites.

The test case used for the WAN experiment was a Multi-Body Simulation (MBS) of a satellite antenna unfolding, developed by CEIT and CASA. 1000 shots of the SIMAID solver were distributed by the APS across the Meta Computer, of which only 25 failed due to network problems (2.5%). The total simulation, which would have taken around 250 hours on a typical SGI workstation, took only 4 hours and 40 minutes.

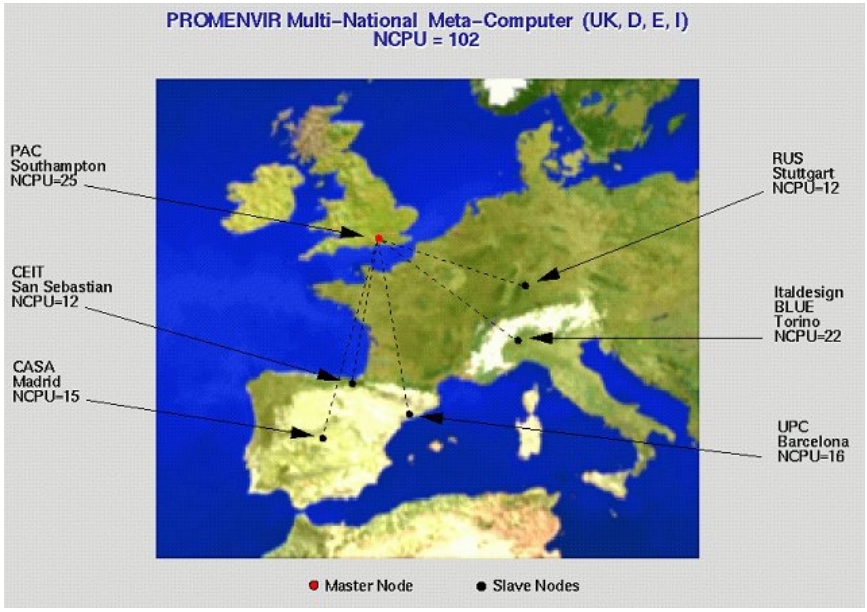

Fig. 1 PROMENVIR Meta-Computer

However, a lot of personnel effort that is not acceptable in daily engineering design had been required to build and run the meta-computer, since communication had to be done via e-mail and telephone. Therefore, by the end of PROMENVIR a decision was made to provide another proposal to the commission with the objective to develop an ASP tool to enable on-demand access to hard- and software resources via internet.

4.1.3 DISTAL – the ASP enabling on-demand access to soft-and hardware resources

DISTAL, the '**DIST**ributed Software **A**ccess for **L**arge-Scale Engineering Applications' has been developed between August 1998 and February 2001 with funding from the European Commission (Esprit Project 26386), together with six European partners under the leadership of IT Innovation Centre {http://www.it-innovation.soton.ac.uk/research/grid/distal.shtml}.

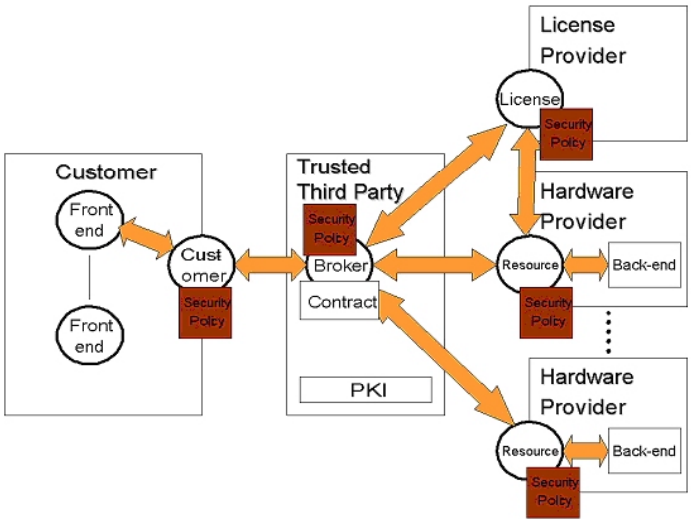

Fig. 2 DISTAL Architecture

DISTAL is an open Grid outsourcing system for large-scale meta-computing. The DISTAL

architecture is shown in Fig. 3. The DISTAL system enables loosely-coupled, geographically distributed, third-party computing systems and software to be utilised for simulation applications.

DISTAL makes the routine use of meta-applications financially viable by implementing a "software and hardware on-demand" business model, supported by an agent-based electronic marketplace. The implementation uses web, agent and security technologies to provide a robust and secure environment for trading these resources and executing industrially relevant applications.

At the end of the DISTAL project a Pilot Service had been offered by IT Innovation which should enable potential customers to test the ASP. However, it appeared that the targeted customers did not yet accept the new service. Either they did not trust in DISTAL ASP data security or they did not want to send out confidential model data to an external resource. The big companies preferred to occasionally perform stochastic analyses on their own resources via secure Local Area Network (LAN).

However, the results of DISTAL have been so promising that it has been decided that also Small and Medium-Sized Enterprises (SMEs) should be enabled to outsource large-scale applications or perform stochastic analyses using DISTAL ASP. Therefore it has been agreed during the final DISTAL review between the project officer, the reviewers and project partners to promote the transfer of DISTAL to the engineering market via a Take-Up Activity funded by the Information Society Technology (IST) programme of the EC.

4.1.4 DISTAL Take-Up - to promote use of DISTAL ASP in Engineering Design

DISTAL Take-Up was started on 01 January 2002 as one of 13 (meanwhile 17) activities of the IST-2000-28221 EUTIST-AMI cluster under the principal coordination of ENEA, in order to enable all participants in the cluster to mutually benefit from their experiences from using agent technologies, security tools and techniques to transfer data through firewalls.

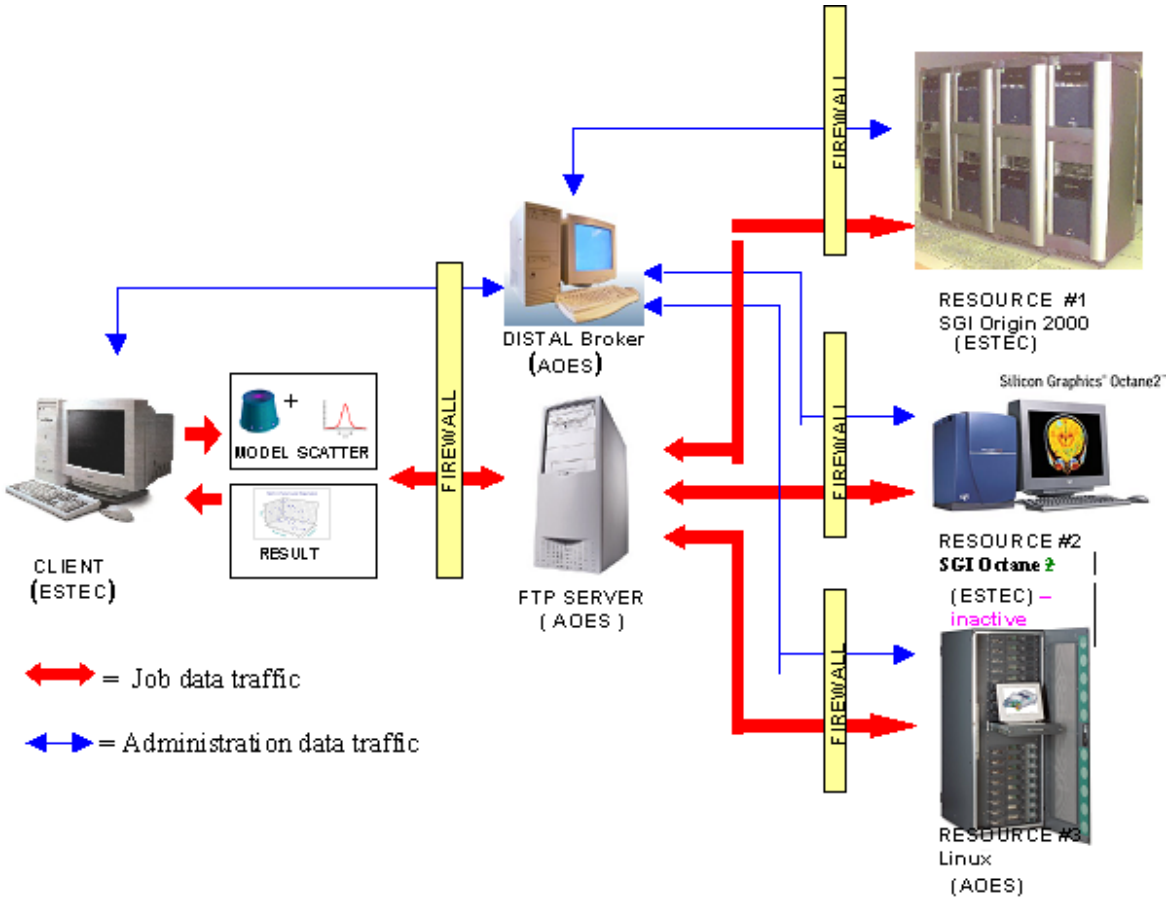

Fig. 3 Typical DISTAL ASP meta-computer for stochastic analysis

The DISTAL Take-UP consortium, IT Innovation as technology and software provider, AOES B.V. as application service provider and ESA / ESTEC in the role of the user, has used DISTAL ASP to outsource large-scale-simulations of ESTEC to AOES in order to check the performance (cost / effectiveness ratio) and robustness of the service. Concurrent to the tests the software has been continuously updated according to the needs reported be users and service providers.

The typical DISTAL ASP meta-computer for stochastic analysis is shown in Fig. 3. In this DISTAL ASP robustness test configuration AOES has taken the role of the service provider to enable the user, here represented by ESTEC, to use soft- and hardware resources at AOES, in addition to a local resource at ESTEC, to run stochastic applications.

The second mainly important industrial test case evaluated by the DISTAL Take-Up activity consortium was focused on using DISTAL ASP to outsource large-scale applications to external resource providers when ever local resources are not available.

4.2 Approach

The main DISTAL software components that have been involved in the DISTAL Take-Up robustness tests and customisation are:

- DISTAL agents
- Resource Management tools
- Security infrastructure.

The engineering application software used for the tests has been

- MSC.Nastran for large-scale structural applications and stochastics (*using free of charge test licenses provided by MSC.Software*)
- CFD-ACE for large-scale fluids and multi-physics simulations (*using free of charge test licenses provided by CFDRC Europe*)
- ST-ORM Stochastic Analysis tool (*using free of charge test licenses provided by EASi Engineering GmbH*)

4.2.1 Outsourcing of a large-scale engineering application on a remote resource

The diagram in Fig. 4 below shows the major components of DISTAL required for execution of an engineering application on a remote resource. Each component is classified according to which entity it is operated by: engineering user; broker; or resource provider. The diagram also shows two options for the software used at the resource provider. The first option is for DISTAL to execute the engineering application directly on a single server machine. The second option is for DISTAL to use a third-party resource management tool for the execution of engineering applications on one or more machines, for example a multiple processor server or a cluster of machines.

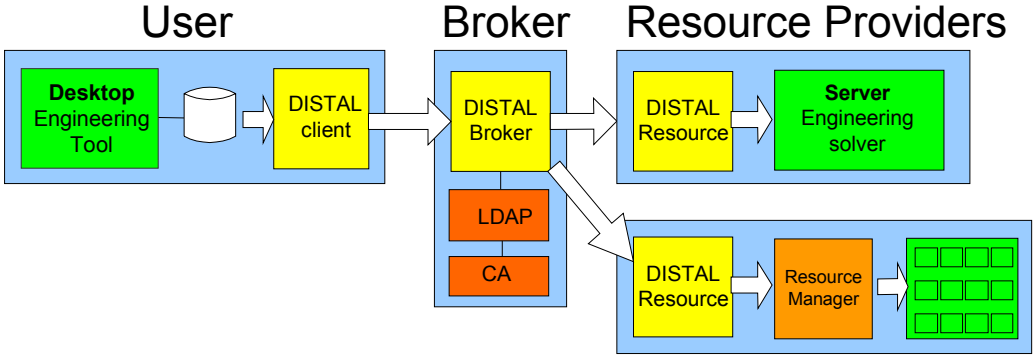

Fig. 4 DISTAL components used for a single execution of an application on a remote machine

4.2.2 Distribution of stochastic engineering application to remote resources

The diagram in Fig. 5 below shows the major components of DISTAL required for execution of an engineering application as part of a stochastic analysis on one or more remote resources. For stochastic analysis, ST-ORM software (in full or in part) is required at both the user and resource provider site. As with a single execution of a engineering application shown in Fig. 4 , for stochastic analysis two options are shown for the resource provider depending on whether a third-party resource manager is used. Note that the DISTAL client component is shown with an orange bar to signify that it appears as local resource manager as far as the user's ST-ORM installation is concerned. The DISTAL resource component is shown with a blue bar to signify that it can generate ST-ORM jobs for direct execution on a server or for submission to a resource manager.

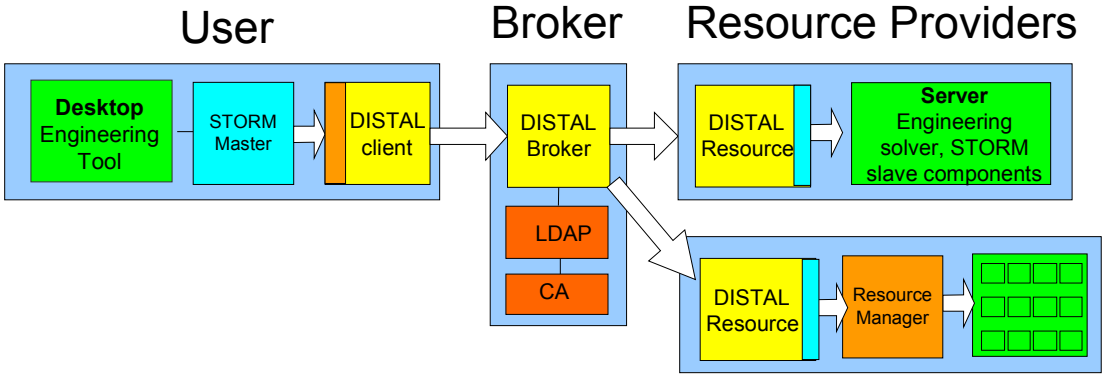

Fig. 5 DISTAL components used to execute a stochastic analysis on one or more remote machines.

The software components shown in Fig. 4 and Fig. 5 are:

Engineering applications (solvers) executed at the resource provider. For example, MSC.Nastran and CFD-ACE. Execution of the engineering applications is the main source of value to the user.

Public Key Infrastructure (PKI). DISTAL requires a PKI security infrastructure in order to operate. The PKI software can be installed and used independently of the DISTAL software, and indeed it may already exist within a broker organisation. Fig. 4 and Fig. 5 show two components of the PKI: a certificate authority (CA) and certificate directory (LDAP). Currently, the CA is Unicert from Baltimore and the LDAP is SecureWay from IBM.

DISTAL software agents. The users, resource providers and the broker all need the DISTAL software so that they can communicate according to structured business processes.

ST-ORM. ST-ORM is a meta-computing application from EASi Engineering that provides a software framework for execution of stochastic analyses. A complete installation of the software is needed at the user site, including a ST-ORM master, and enables stochastic analysis jobs to be sent to DISTAL (as well as execution on in-house resources). ST-ORM slave components are also required at the resource provider site in order to execute each shot of a stochastic analysis. These ST-ORM components greatly reduce the network traffic since the full data deck and results files do not need to be transferred for every shot. The exact location of the ST-ORM components at the resource provider is determined by local network topology.

4.2.3 DISTAL Take-Up Robustness Tests and Customisation to Engineering Requirements

The reason to ask ESTEC to participate in the project and do the trials is because at ESTEC a wide area of engineering applications is daily business. The requirements to ASP as specified by ESTEC are typical and generic for the aerospace and automotive engineering section.

Requirements and Expectations as regards DISTAL ASP to Engineering Design

TOS-MC, the Thermal and Structures division of ESA/ESTEC is responsible for the functional support to feasibility and definition studies of future spacecraft and approved projects in the preparation of specifications, analysis of industrial proposals, monitoring of procurement and

development contracts and evaluating design and test results. TOS-MC is the focal point within the agency for all Thermal, ECLS (Environmental Control and Life Support), and Structures aspects.

Main activities are in the development of Thermal, ECLS and Structural subsystems: design, analysis, manufacturing and testing:

- Structural Analysis Facility
  - numerical tools for conceptual design, analysis, verification, and test evaluation;
  - e.g. **MSC.Nastran**, SAMCEF / MECANO, BOSOR, RAYON, **ST-ORM**;
- Thermal Analysis Facility
  - numerical tools related to thermal configuration, design and verification;
  - e.g. ESARAD, ESATAN, FHTS, POLYTAN,THERMXL, ECOSIM, **CFD-ACE**;

Needs with regard to performance and computation cost

Engineering designers require that DISTAL ASP enables large-scale simulations

- faster, better and if possible also cheaper, but at constant quality at least
- with larger model sizes and / or more comprehensive models
- Sensitivity and robustness analyses to parameter variations
  - Stochastic approach, e.g. using ST-ORM
  - Meta-Applications, e.g. using the DISTAL meta-computer

It is also expected from the DISTAL service that all simulations - regular and peak computing requirements can be handled

- in the same elapsed time, and
- with minor increase of cost (hard- and software)

4.2.4 Evaluation and validation of DISTAL Take-Up on-demand application services

The robustness tests have investigated the three most important parameters to measure the benefit of using on-demand DISTAL ASP to outsource large-scale applications such as CFDRC and meta-applications such as stochastics analysis using DISTAL – ST-ORM – MSC.Nastran, i.e.

- the total computation time using the existing hardware configuration at ESTEC, that is the time used from the start until completion of the job;
- the (estimated) shared cost for using internal hardware resources and support;
- the shared cost for using internal application software licenses and resources.

The evaluations of the DISTAL tests have clearly shown that the dominant part of the cost for on-demand application services provided to engineering clients is currently coming from on-demand application software license prices that are surprisingly high, since nearly all the vendors of standard engineering software have not yet developed acceptable pay-per-use licensing models which is explained in more detail in section 4.4.

It is also clear that the costs for using external hardware resources are rather low, and as such they are not an issue since they are definitely only a minor part of the total on-demand service cost. For this reason it's also not an issue that shared cost of using local hardware at the user site could not exactly be quantified but only estimated by the DISTAL Take-Up users during the robustness tests.

The evaluations have clearly shown that the main benefits from using DISTAL on-demand services result from the substantial savings in elapsed computation time for both, out-sourcing of large-scale simulation projects and in particular when using the DISTAL application service for stochastic meta-applications. Even when both applications are not daily business and only needed from time to time, availability of on-demand services provide substantial benefits, not only to big companies and research institutions but also to SMEs. The details of this investigation and the evaluation of the results found are presented in the next section..

4.3 Results, Achievements and Benefits

4.3.1 Results

Extensive trials have been done by the users (clients) located at ESTEC (Noordwijk, NL) using on-demand application software and hardware resources which were located at AOES B.V. (Leiden) and ESTEC (Noordwijk).

DISTAL has been successfully tested and customised to enable on-demand application services for large-scale physical simulations in the engineering sector:

- Stochastic analysis using ST-ORM and MSC.Nastran
  - Up to 500 shots per job have been distributed to multiple external resource providers with no failure
  - DISTAL works perfectly through different firewall settings as at ESTEC and AOES.
- Large-scale Engineering Application :
  - MSC.Nastran with up to 25 MB input and 195 MB result data
  - CFD-ACE model which included user written routine

During tests DISTAL has shown promising possibilities to reduce computation time by distributing ST-ORM shots to multiple service providers and within one provider multiple shots can be executed using CONDOR job management and job monitoring.

Also the one-to-one outsourcing of large-scale engineering applications can help to reduce overall computation time which can be utilized to either save personnel effort / cost or to analyse more variants within a given period of time to get a better design of the product.

4.3.2 Design time, computation time and cost savings when utilizing DISTAL ASP

The following investigations and measurements of potential computation time and cost savings that have been reported during the project period by the users have to be only considered as a typical example. The results from such measurements mainly depend on the existing local resources and potential benefits from using DISTAL have to be evaluated individually by other users.

Computation time of stochastic analysis using current in-house hard- and software resources

Table 1 shows the estimated elapsed CPU time for stochastic analyses with each 100 shots if three MSC.Nastran jobs can be executed simultaneously on three separate processors of local resources.

Elapsed time using local resources	Stochastic job size		
	Small	Medium	Large
Pre-processing (local)	15 min	75 min	750 min
100 MSC.Nastran shots (remote)	3.000 min	15.000 min	150.000 min
Post-processing (local)	15 min	75 min	750 min
Total elapsed time in minutes	**3.030 min**	**15.150 min**	**151.500 min**
Elapsed time if max 3 shots run in parallel	»35 hrs	»175 hrs	»1750 hrs
Total working days	» 4 days	» 2 weeks	» 20 weeks

Table 1 Computation time of stochastic analysis using current in-house resources

The figures in the table are based on the average elapsed CPU time that a MSC.Nastran job needs on a single processor, i.e. a small job needs around 30 minutes, a medium-sized job needs around 2.5 hours, and a large job needs around 25 hrs.

Computation time of stochastic analysis using DISTAL ASP with twenty ST-ORM and MSC.Nastran licenses

The elapsed CPU time estimates when using DISTAL ASP and distributed resources are presented in Table 2 . They are based on the assumptions that

– at least 20 MSC.Nastran and 20 ST-ORM licenses from multiple service providers are available.

– the hardware performance of the available remote resources are at least the same as the SGI Origin 2000 on which the estimated run times of are based.

Again each 100 shots of a small, medium-sized and large-scale MSC.Nastran model are considered.

Elapsed time using DISTAL ASP	Stochastic job size		
	Small	Medium	Large
Pre-processing (local)	15 min	75 min	750 min
100 MSC.Nastran shots (remote)	150 min	750 min	7500 min
Post-processing (local)	15 min	75 min	750 min
Total elapsed time in minutes	180 min	900 min	9000 min
Total elapsed time in hours	3 hrs	15 hrs	150 hrs
Total working days	» 0.5 days	» 2 days	» 18 days

Table 2 Computation time of stochastic analysis using DISTAL ASP

Comparison of the total elapsed time figures in Table 1 and Table 2 shows that DISTAL ASP can in this case enable time reduction by the factors 35/3, 175/15 and 1750/150 which is approximately 11,6.

4.3.3 Outsourcing large-scale multi-physics applications

Outsourcing of large-scale engineering applications is a helpful measure when in-house resources are nearly exhausted. For example, at the time of investigating the elapsed time figures for this report the average load on hardware at ESTEC / TOS-MPA has been around 80%. Any time such peak loads are observed DISTAL ASP can provide substantial time savings by outsourcing large-scale engineering applications, such as for example multi-physics simulations which are daily business in aerospace and automotive engineering, e.g. using the CFD-ACE code from CFDRC.

CFDRC Application	Average job runtime increase rate during high work load periods		
Normal runtime	small job (one day)	medium sized job (2-7 days)	large job (8 and more days)
Work load 50%	1	1	1,2
Work load 70%	1	1,3	2
Work load 90%	1,5	3	6

Table 3 Average job runtime increase rate during peak load periods

Table 3 shows an estimated job runtime increase rate between 1,5 for a small and 6 for a large CFD-ACE job when the hardware resource is loaded by 90 percent. It is clear that such time savings also mean savings of personnel efforts and cost, which certainly can only be measured case by case, and which are considered to at least balance the extra cost for using the ASP.

4.3.4 Impact on the business of the users of DISTAL ASP for engineering applications

Design engineers may hesitate to use DISTAL ASP because they do not really trust in security and stability of data transfer via internet. Some users may also want as much job control as is usually

enabled on in-house resources, and last but not least it is clear that DISTAL ASP depends on many external resources (internet connection, service providers, broker) which can be a disadvantage as compared to use of local resources. However, the required level of security and user control can be individually negotiated and fixed according to individual needs in the DISTAL ASP service level agreements.

Business impact due to savings of cost for soft- and hardware resources

In engineering design, in-house hard- and software resources have to be upgraded every two to three years to enable handling of the largest possible amount of simulation workload and to manage any potential peak load periods. Significant cost savings can be achieved by

- reducing up-front investment for upgrading of local hardware resources
- using medium-sized hard- and software configurations to cover the small and medium-sized jobs
- using DISTAL to outsource stochastics and large-scale jobs during peaks

However, individual evaluation of total computation cost using DISTAL ASP will still need to be done case by case since DISTAL service cost mainly depends on the cost ISVs will charge for on-demand license provision.

Business impact due to savings of cost for development time and personnel resources

If a reduction of the computation time for both applications, stochastics and out-sourcing, as outlined in section 4.3.2 can be realised, then this will

- either significantly reduce personnel effort and cost,
- or allow more analyses within a given design period and budget,
- and, if so, in turn certainly provide a better product design and quality.

It is clear that most of these benefits can be taken from stochastic applications (provided that user-friendly on-demand licensing conditions are available) that need distribution of several hundred shots. However, during peak loads on in-house resources, also the outsourcing of large-scale applications via DISTAL ASP can provide all the benefits mentioned above.

Once again it has to be mentioned here that exact cost figures for DISTAL ASP mainly depend on the on-demand license fee for the application software and have as such to be individually agreed with the respective ISVs. Unfortunately, most of them are still in the process to develop and evaluate flexible on-demand licensing models.

4.3.5 Impact of DISTAL ASP on business of service provision to the engineering sector

As already mentioned, the impact of DISTAL ASP on the business of potential service provider depends mainly on the condition that they need to own the application software or just can control the licensing policy, that means charging as much as customers accept..

Modest impact of DISTAL ASP expected on engineering services business

In general the requirements and expectations of AOES on DISTAL as their future tool for Application Service Provision to their aerospace engineering customers have been met;

- The DISTAL approach has been accepted by the aerospace engineering users
- DISTAL ASP has passed all tests successfully and could now enable also small and medium-sized enterprises on-demand access to soft- and hardware resources
  - to perform stochastic meta-applications
  - or to outsource large-scale applications.

However, the original focus of AOES to enable stochastics via DISTAL ASP to their aerospace customers is no longer existent, mainly due to the current defensively high pay-per-use application software license prices of some ISVs and several other reasons summarized below:

– previous ASP services like EASi Engineering Stochastics Excellence Centre (SEC) did not survive since
  - new product data is usually confidential, in particular in aerospace and automotive design;
  - stochastic simulations have still not gone mainstream and most of them are not time critical,
  - which allows big companies to schedule stochastics when sufficient local resources are available, e.g. on weekends or during holidays
– customer-owned IT services offer lower charges than ASPs can afford

With regards to outsourcing large-scale engineering applications previous experiences shows that these services cannot bring the big business because

– they are only required from time to time, e.g. to manage peak loads
– customers expect to receive the full service, software and hardware at a price around 1€ per CPU hour
– the administration effort is rather high as compared to the potential income

The current chances of DISTAL ASP to the aerospace and engineering community are not good enough to justify the required investment for a big marketing campaign. Nevertheless it is expected that AOES after the end of the project will offer DISTAL ASP to outsource large-scale applications from potential customers from the aerospace sector. An extension of the service to the automotive sector will strictly depend on the licensing policy of ISVs.

Substantial impact of DISTAL ASP expected on business of ISVs

During a round table workshop (GRID issues) at the 4th EUTIST-AMI cluster review on 07 October at DFKI in Saarbruecken / Germany, QUANTECH (http://www.quantech.es/) the provider of the Stampack® Software for the simulation of sheet forming processes in the automobile, aeronautics / aerospace and metal packing industries has been identified as potential DISTAL ASP. The company offers distance computing and consultancy to their customers and will need to distribute customer application jobs to several servers as soon as their customer base will grow.

It is expected that other ISVs can be found who can benefit from offering DISTAL ASP to enable their customer base on-demand access to their own or their potential service partners resources.

IT Innovation has already also contacted EASi Engineering (http://www.easi.de/), the provider of ST-ORM and MSC.Software (http://www.mscsoftware.com/), the provider of MSC.Nastran, and offered them to take over parts of DISTAL software in order to build their own ASP software tools in order to benefit from additional on-demand services to their existing customer base.

Potential impact of DISTAL application services on business of users in other sectors

DISTAL has the potential to be applied wherever there is a requirement for large-scale computation that needs to be distributed across a set of independent, third party service providers in a managed and secure way which include for example

– Digital film restoration
– Digital film post-production
– Multimedia content-based analysis and indexing
– Medical Applications
– Combinatorial Chemistry

These potential application areas for DISTAL in other markets than aerospace and automotive engineering have been investigated in reference [01].

4.4 Dissemination

The main target audience

As the full name of the acronym DISTAL says, the software has been designed to provide *'Distributed Software Access for Large - Scale Engineering Applications.* Already during the development period of the DISTAL software dissemination activities have focused on the sectors aerospace and automotive. Both sectors have been mainly addressed during the project period, and also the first market approach after the end of the project is focused on them.

4.4.1 Presentation and demos for potential DISTAL ASP users

DISTAL ASP has been presented to the attendants of the 2nd ESA Space Systems Design, Verification & AIT (SSVAIT) Workshop, 15-16 April 2003 at ESA/ESTEC, Noordwijk / NL, most of them from the aerospace research and industry and as such potential users of DISTAL ASP. The mailing and e-mail address data of the participants and other clients from aerospace engineering with a potential interest to use DISTAL ASP services will be stored in a prospect customer data base in order to use this data for later mailing actions.

At the ASP-BP Conference Milan on 1st October 2003 DISTAL has been presented under the title 'DISTAL - The use of remote, brokered resources to solve very large engineering problems' by Michael Jones of IT Innovation Centre.

4.4.2 Presentation and demo for potential DISTAL ASP service providers

On 8 September 2003 the consortium has presented and demonstrated DISTAL ASP at AOES B.V. Leiden / NL to potential DISTAL ASPs. AOES has suggested two DISTAL commercialization models to be offered after the end of the project period over a two-year start-up period, i.e.

- AOES B.V., providing DISTAL services to the aerospace engineering sector
- EASi Engineering, providing DISTAL services to the automotive engineering sector
- Optional extension to other sectors if business successful in the above.

ISVs that have been invited to join a DISTAL marketing campaign

The following ISVs attending the meeting have been invited to participate in a two-year marketing campaign in order promote commercialisation of DISTAL ASP in the engineering design sector:

- CFDRC Europe GmbH, Stuttgart / Germany, as the vendor of
  - CFD-ACE for complex computational fluid dynamics and multi-physics simulations
- EASi-Engineering GmbH, as the vendor of ST-ORM for automatic processing of stochastic analyses with various application software, e.g.
  - ST-ORM – MSC.Nastran
  - ST-ORM – PAM-CRASH (provided by ESI Group
- MSC.Software Benelux, as the vendor of
  - MSC.Nastran and MSC.Marc, and
  - other physical simulation software

It has also been envisaged to provide on-demand access to other application software resources in cooperation with potential ISVs who are supporting a lot of customers in aerospace and automotive, as for example

- ALSTOM Technology Centre, Whetstone http://www.techcentreuk.power.alstom.com the developers and vendors of
  - ESATAN thermal analysis code, standard used in European aerospace industry
- ESI-GROUP in France, http://www.esi-group.com), the developers and vendors of
  - PAM-CRASH - predictive virtual crashworthiness simulations in the transportation industry

The proposed DISTAL ASP two-year start-up marketing campaign

It has been planned to promote transfer of DISTAL technology to the target market via a start-up e-commerce ASP service period for around two years to evaluate performance and acceptance by users. The proposed strategy is rather straightforward, i.e.

- Build Start-Up Consortium of broker and resource service providers
  - DISTAL software license providers
  - DISTAL service provider
  - Application software providers
  - HPC resource providers
- Agree on favourable license & service conditions for the envisaged trial service period
- Offer DISTAL ASP to registered user community
  - Users register and sign service agreements for a certain period of time
  - Users get on-demand access to catalogued services provided by the consortium
- Win big players first
  - Develop partnerships / strategic alliances with potential key accounts
  - Develop success stories
- Expand marketing activities to Small and Medium-Sized Enterprises (SMEs)
  - Demo and Workshop for SMEs
  - Organise user meetings

The planned DISTAL ASP e-commerce consortium in the aerospace sector

The registered user community should be built from key accounts to be addressed in aerospace research and industry and their suppliers

- EADS – AIRBUS and other aircraft companies
- ESA / ESTEC and other agencies
- Alcatel, Alenia, Astrium, EADS and other spacecraft companies
- and their suppliers

The current potential DISTAL Service Providers for start-up ASP to the aerospace sector are

- AOES B.V. as DISTAL service provider
- CFDRC Europe GmbH as provider of CFD code
- Other application software providers to be included according to customer needs

Other potential DISTAL markets and service providers will be identified during the e-commerce start-up period.

4.4.3 Feedback from the partners invited to join a DISTAL marketing consortium

By the end of the meeting on 8 September 2003 it became quite clear that application services are more and more accepted by the user community, but not so much by the ISVs since their business is focused on yearly software lease contracts and most of them are not prepared, or even not willing, to provide short term on-demand licenses and support at reasonable conditions.

Previous Experiences with commercial ASP at EASi Engineering

For around three years, EASI Engineering, the vendor of ST-ORM have offered to their customers in automotive engineering ASP for stochastics together with TeraPort, an HPC resource provider, however the service did not fly, among other for the reasons listed below:

- Stochastic simulations have still not gone mainstream which means they are in most cases not time critical. Therefore they are scheduled on free local hardware resources on weekends or holiday.

– New product data is usually confidential and it is hard to win customers trust to send sensitive product data via the internet.

– Inside IT departments there is a strong reluctance to outsource engineering applications to an external HPC provider.. No matter what quotes the service providers come up with, there is always some internal quote that is apparently lower.

– Software Vendors fear ASP as they loose control over their software. Therefore, they make it unattractive to ASP vendors. In terms of stochastics applications ASPs were able to negotiate very favourable pay-per-use conditions, but the software vendors never stood behind this business.

Reluctance of ISVs to provide favourable pay-per-use licenses for stochastics

Favourable pay per use license prices have been negotiated more or less without success, for example with MSC.Software in terms of DISTAL- ST-ORM-MSC.Nastran stochastic applications. Some of the reasons for the reluctance of ISVs to provide favourable pay-per-use licenses for meta-applications have been openly explained by MSC.Software as follows:

– Meta-applications need to use software licenses in different countries, however MSC-Software support is organized to provide services to individual countries, which means that several providers would contribute to one ST-ORM-MSC.Nastran application

– Currently the pay-per-use cost for running MSC.Nastran on 365 CPUs over 24 hours would be equivalent to a yearly license (around 32 K €). (This needs no comment.)

– Last but not least, MSC.Software are developing their own stochastics driver in the framework of their RobustDesign tool which shall be available in 2004.

Since most stochastic applications focus on structural design and MSC.Nastran is a standard in automotive and aerospace for this purpose, it becomes clear that MSC.Software have rather an interest to do this business themselves than to support ASPs.

Concluding remarks on the planned DISTAL marketing campaign in the engineering sector

The current chances of DISTAL ASP to the aerospace and engineering community are not good enough to justify the required investment for a big marketing campaign. It is expected that AOES after the end of the project will offer DISTAL ASP to potential customers from the aerospace sector. An extension of the service to the automotive sector will strictly depend on the licensing policy of ISVs providing the standard application software tools to the engineering sectors.

4.4.4 DISTAL Take-Up dissemination material

The consortium has produced the following DISTAL Take-Up dissemination material

Web and FTP sites

– internal to the activity members all documentation has been made available on the ftp site located on a server at AOES B.V. Leiden / NL

– IT Innovation have developed some short videos as a backup to the DISTAL demonstration at the final review.

– information on the three coherent projects focused on meta-computing, PROMENVIR, DISTAL and DISTAL Take-Up is available on the AOES hosted web pages at http://www.distal@62.58.73.21, e.g.
  - the current DISTAL Take-Up Flyer in Acrobat Reader format
  - the preliminary DISTAL Take-Up web success story in Acrobat Reader format
  - a new version of the flyer is in development

– further public reports and presentations will be made available shortly on the AOES hosted web pages at http://www.distal@62.58.73.21 which will include in Acrobat Reader format
  - the current DISTAL Take-Up Final Report

- the deliverable report DISTAL Take-Up D2.5 – Transfer of DISTAL to other markets, see reference [01]
- the Final DISTAL Take-Up web success story
- the PowerPoint presentation from the DISTAL demonstration for potential users at the 2nd ESA Space Systems Design, Verification & AIT (SSVAIT) Workshop, 15-16 April 2003 at ESA/ESTEC, Noordwijk / NL
- the PowerPoint presentation presented at the ASP-BP Conference Milan on 1st October 2003 under the title 'DISTAL - The use of remote, brokered resources to solve very large engineering problems'.

– material provided to the EUTIST-AMI cluster web site at http://www.eutist-ami.org
- preliminary DITAL Take-Up web success story in Acrobat Reader format
- final DITAL Take-Up web success story in Acrobat Reader format, to be delivered to ENEA together with this report
- a new DISTAL Take-Up Flyer in Acrobat Reader format, in the EUTIST-AMI flyer template design is in development and will be delivered shortly

Publications

In addition top the twenty internal project reports and the deliverables to the cluster coordinator a series of internal papers and technical notes on DISTAL upgrading and customisation has been published by IT Innovation concurrent to the three test phases. A few technical papers on the installation and testing of the software have been also issued for internal use at AOES and ESTEC.

Further information in addition to the public reports and PowerPoint presentations available on the web pages mentioned above is certainly available on request.

Mailing actions

It has been planned that by the end of the project period all prospect customers that have been identified during the project period shall be addressed by a mailing with an invitation to a marketing event to demonstrate DISTAL and explain the benefits of using DISTAL ASP for large-scale engineering applications and in particular stochastic analyses.

The data base that should be used for the first mailing action has been described in section 4.4.1. This mailing action has now been postponed until acceptable pay-per-use licensing models will be offered by the vendors of standard engineering application software for stochastic analyses which is a prerequisite for successful DISTAL ASP business.

4.5 Conclusions

The European Space Research and Technology Centre (ESTEC) located in Noordwijk in the Netherlands have extensively tested DISTAL. ESTEC used DISTAL to access remote resources over the Internet, which were hosted at Atos Origin Engineering Services (AOES B.V) located in Leiden, which is also in the Netherlands. In addition, ESTEC have tested DISTAL using a second resource within ESTEC in order to make combined use of internal and external resources.

DISTAL was successfully tested for:

- Stochastic analysis using the ST-ORM stochastics tool from EASi and the MSC.Nastran finite element solver. Up to 500 shots per analysis were distributed across the AOES and ESTEC resources. The DISTAL software managed the execution of this large-scale stochastic analysis with no failures.
- Large scale Engineering Applications using MSC.Nastran with up to 25 MB input and 195 MB results data and a computational fluid dynamics test using CFD-ACE from CFDRC which included a user written routine.

The conclusions of AOES and ESTEC were:

- DISTAL works perfectly through different firewall settings as they exist at ESTEC and AOES.
- During tests DISTAL has shown possibility to reduce computation time by distributing ST-ORM shots to multiple service providers
- DISTAL is suitable for outsourcing of large-scale engineering applications, e.g. fluid, structure or even complex multi-physics simulations.
- General applications can be integrated and executed using DISTAL, which means almost anything as long as it can be executed in “batch” mode.
- Full data security is guaranteed via encrypted data transfer over the internet
- The DISTAL client is easy to use thanks to its Graphical User Interface (GUI)
- The DISTAL resource can utilize third-party resource management software for job management and monitoring (Condor was used in the tests).

The benefits that the DISTAL users have evaluated during the tests were:

Significant cost savings in terms of hardware resources can be achieved by

- reducing up-front investment for upgrading of hardware resources every two to three years;
- using medium-sized hardware configurations to cover the small and medium-sized jobs
- using DISTAL to outsource stochastics and large-scale jobs during peaks.

However, individual evaluation of total computation cost using DISTAL ASP will still need to be done case by case since DISTAL service cost mainly depends on the cost ISVs will charge for pay-per-use licensing application software.

Even more important are the savings in computation time and personnel effort / cost that can be achieved using DISTAL ASP for both applications, out-sourcing large-scale simulations and in particular stochastic applications.

Substantial benefits can be achieved by utilising the reduced job run time

- either to perform more analyses within a given period of time and amount of budget,
- which at the end provides a better design and product quality and improves competitiveness;
- or use the personnel effort savings to start a new design cycle or other project work earlier than planned

Barriers that currently make DISTAL ASP to aerospace and automotive engineering difficult

However, whilst DISTAL provides proven technical solution, there are several factors that are currently hampering take-up in the aerospace and automotive engineering sector

- Current pay-per-use license prices of some Independent Software Vendors (ISVs) are defensively high;
- Previous ASP services like EASi Engineering Stochastics Excellence Centre (SEC) did not survive since:
  - new product data is usually confidential, in particular in aerospace and automotive design;
  - stochastic simulations have still not gone mainstream and most of them are not time critical,
  - which means big companies tend to schedule stochastics when sufficient local resources are available, e.g. on weekends or during holidays
  - Customer-owned IT services offer lower charges than ASPs can afford.

From a service provider perspective with regards to outsourcing large-scale engineering applications, previous experiences shows that these services cannot bring big business because:

- They are only required from time to time, e.g. to manage peak loads
- Customers expect to receive the full service, software and hardware at a price around 1€ Euro per CPU hour
- The administration effort is rather high as compared to the potential income

Current ISV licensing costs and models is the single most significant factor in preventing take-up of DISTAL (or similar approaches) in the aerospace and automotive sector today. In general, application services are becoming more accepted by the user community, but nowhere near as much by the Independent Software Vendors (ISVs). This is because ISV business is focused on yearly software lease contracts and most of them are not prepared, or even not willing, to provide short term on-demand licenses and support at reasonable conditions.

Other markets that can benefit from DISTAL ASP have been identified

However, the issues above are economic, social or political and are not problems with the DISTAL software itself, or the way that it operates. Therefore, DISTAL could be an ideal solution for other markets that have the same need for DISTAL-like solutions, but don't share the same barriers as the automotive and aerospace sector.

DISTAL has the potential to be applied wherever there is a requirement for large-scale computation that needs to be distributed across a set of independent, third party service providers in a managed and secure way which include for example

- Digital film restoration
- Digital film post-production
- Multimedia content-based analysis and indexing
- Medical Applications
- Combinatorial Chemistry

These potential application areas for DISTAL in other markets than aerospace and automotive engineering have been investigated in reference [01] which is also a public report of the DISTAL Take-Up project available on the AOES web site http://www.distal@62.58.73.21.

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The overall total allowable cost has been limited to around 687 k €,
the total EC contribution has been limited to 561 k €.

LIST OF REFERENCES

RefNo.	Document Title	Authors	Date of Issue
[01]	DISTAL Take-Up D2.5 – Transfer of DISTAL to other markets	Matthew Addis IT Innovation Centre	26 Sep 2003
[02]	Project IST 2000-28221 EUTIST-AMI Web Success Story WP9 DISTAL Take-Up	Matthew Addis IT Innovation Centre	13 Sep 2003
[03]			
[04]			
[05]			
[06]			

APPENDIX 1 DISTAL TAKE-UP T25 - DISTAL USE CASES

Technical Note DISTAL Take-Up T25 – DISTAL Use Cases

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ABSTRACT

Following the recommendations of the reviewers provided with the feedback at the end of the final DISTAL Take-Up review on 7 October 2003 at DFKI in Saarbruecken, IT Innovation have developed a document that describes the functionality of the DISTAL software.

The use cases describe what DISTAL does, but not how it does it. Details of the design and implementation of DISTAL can be found in D4.4 Software Developers Guide.

These use cases describe what the user does with the software (e.g. ‘start-up the software’ or ‘specify a job’). Some of the use cases describe actions of the software on external systems that don’t involve any user interaction (e.g. ‘transfer data’ or ‘execute application’).

The use cases do not cover requirements for further development of DISTAL. These requirements can be found in Deliverable D4.4 Software Developers Guide.

The document DISTAL TAKE-UP T25 - DISTAL USE CASES is not a public report but marked ‘Commercial in Confidence’. Therefore it is not appended hereto but has been delivered to the EC project officer, the EUTIST-AMI cluster coordinator, and the reviewers the as a separate document in Acrobat Reader format. It is certainly on request also available from IT Innovation Centre.