# An e-Science Environment for Aerospace Applications on Teragrid

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***Abstract* - e-Science Aerospace Integrated Research System(e-AIRS) is one of e-Science projects in KOREA. This system has been developed for aerospace researchers to be offered total research environment which is integrated and collaborative environment to enable computational simulation and remote experiments via portal. This paper presents that the core part of this system is adapted to Teragrid at NCSA. By way of this goal components of e-AIRS system are updated and customized to Teragrd and is added existing grid portal technology. Also this system is interlocked with NCSA tools to use Teragrid resources. Through these efforts e-AIRS offers easy-to-use research environment to aerodynamic researchers on Teragrid.**

## I. INTRODUCTION

Today many countries have research activities related to e-Science as a next research infra-structure such as UK e-Science and Cyberinfrastructure in US [1] [2]. These projects aim for providing application scientists to easily access and use the research environment such as massive computational and storage resources, and collaborative environment.

In Korea, Korean Institute of Science & Technology Information (KISTI) has been initiating a project, funded by the Ministry of Science and Technology, called "Korea e-Science Project" since year 2005. Main goal of this project is to build a Korea e-Science infrastructure. To achieve this goal, we lunched 5 initiative projects – an equipment project, an aerospace project, a nano-technology project, a biology project and a meteorology project.

Among these projects, this paper will discuss an aerospace system called e-AIRS [3]. This system offers aerospace researchers to share massive computational resources, a visualization tool, a collaborative method and experimental equipment like a wind-tunnel through a web portal. So this provides them to remotely access aerospace vehicle design data, the results of CFD (Computational Fluid-Dynamics) model execution or wind-tunnel testing and collaborate with results. Hence this makes them to reduce theirs efforts and avoid overlapping investment to share data of other researchers. Also this offers one-stop service to them involved from the beginning of design of aerospace vehicle, computation to visualization by step-by-step through a user-friendly interface on a portal.

We already present e-AIRS system in other papers [4] [5]. Main issues of this paper are to present how e-AIRS system is successfully adapted to Teragrid based on international collaboration between KISTI and NCSA [6]. Initial e-AIRS system was not developed Tegragrid in mind. This led us to customize and update e-AIRS system to fit in Teragrid and to interlock with other grid and Teragrid tools.

This paper is organized as follow. Section 2 gives the background of e-AIRS project and the approach for e-AIRS to adapt for Teragrid. Section 3~6 give the overview of the design of this system and the description for components: e-AIRS middleware, job submission and job monitoring with Clumon and customized portlets [7]. Section 7 summaries what has been achieved so far in this project and outlines the future work.

## II. BACKGROUND

### *A. e-AIRS*

The e-AIRS, one of projects of the construction of national e-Science in Korea, aims at to establish the powerful and ease-use research environment to aerodynamic researchers. The focus of the project is collaboration of results between numerical wind- tunnel and a wind-tunnel experiment via a numerical wind-tunnel, remote wind tunnel experiment and visualization. Thus, as researchers actively study their research on one system, the goal of this is to provide aerodynamic researchers to the research environment customized to aerospace domain which is multi-disciplinary study made of Aerodynamics, Structure, Propulsion and Control. By way of this goal the e-AIRS system is made of 3 parts as in Fig. 1.

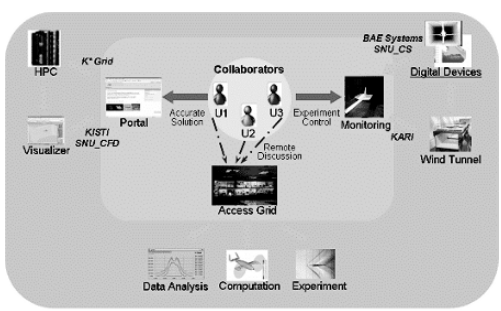


Fig. 1 System relation in e-AIRS



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The first part of this is numerical wind-tunnel service which consists of e-AIRSMesh, CFD solver service, data management service, e-AIRSView as a visualization tool. The e-AIRSMesh implemented by java applet as pre-processor is the mesh generator to generate geometries for aerospace vehicle as input data of CFD solver. CFD solver service is the portlet to select mesh data files and computation resources, submit a job to remote machines, transfer these data files for CFD simulation from the cluster to the storage and check process of calculation by graph. The e-AIRSView implemented by java applet as post-processor is the visualization tool to display the result of calculation as 3D image.

The second part is the remote wind tunnel service which remotely request wind tunnel experiment and receive the result of experiment through the portal. After the user requests wind-tunnel experiment on the portal, the operator who actually tests in wind-tunnel can check requested experiment on the portal. After the operator tests this and uploads result images to the portal, the user can view the result on this.

The third part is Access Grid which cooperates between researchers via video chat and sharing visualization.

This system is released for the first time in Jan 2006 and numerical wind-tunnel service and remote wind-tunnel service is serviced on web.

### *B. The Approach to the e-AIRS adapted to Teragrid*

The e-AIRS is the total solution as PSE (Problem Solving Environment) for numerical wind-tunnel. And it has also the remote wind tunnel service and the Access Grid to collaborate between researchers.

As Fig.2 shows, flow of wind tunnel simulation service can be distinguished into three major parts which is pre-process, calculation, post-process. Pre-process will produce mesh by using mesh generator (we called e-AIRSMesh). We also can accept pre-existing mesh data. As a input format we can use raw CAD data which is accepted as a regular mesh input and is made suitable format for e-AIRSMesh. After mesh data is produced by e-AIRSMesh, the simulation part will perform simulation of CFD. CFD simulation will be distributed in many computational resources to get a best performance. Post-process can make view of simulation result using e-AIRSView as a visualization tool in 3D format.

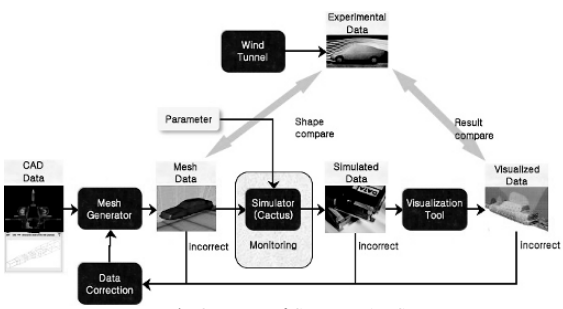


Fig. 2 Process of CFD on e-AIRS

However the e-AIRS System is alpha version, so some components are not perfect or tightly coupled to them or restricted by hardware resources. And the project, International collaboration between KISTI and NCSA, was given only about 8weeks. So we decided that only CFD solver service essential part of whole process is adapted to Teragrid. For this, we used and customized Grid Portlets on Gridsphere to use a grid credential management, a job submission and Clumon to monitor PBS job on Teragrid at NCSA [8]. And we used CFD solver made by Dr. Byoung-Do Kim who works at NCSA.

## III. THE IMPLEMENTATION OF THE E-AIRS ADAPTED TO TERAGRID

### *A. The Architectural change of the e-AIRS for Teragrid*

As Fig. 3 shows, the architecture of original e-AIRS system is changed to make suitable for Teragrid at NCSA. CFD solver service of e-AIRS System consists of e-AIRS middleware which has job submission, automatic result data file transfer, data management of jobs and files and portlets which are job submission UI, job monitoring, resource management, display of residual and time survey graph. This has only one grid credential to submit job because it manage and access all data by means of user management based on database and job runs only one cluster based on Globus without a job scheduler [9].

Howerver, Teragrid at NCSA has PBS as a scheduler on to job submission and Clumon as the job & resource monitoring tool related with this PBS. And Teragrid is based on the grid credential by each user.

So among these functions of CFD solver service, job submission parts of e-AIRS middleware and a portlet are removed. Also job monitoring and resource management portlets are removed. Instead of these we used and customized Grid Portlets to use grid credential for each user, submit job and manage resources and Clumon as a job monitoring tool because all job is submitted and managed by PBS on Teragrid at NCSA.

On the other hand, 3rd party transfer via GridFTP and remote file monitoring about several result files produced by CFD solver are added to automatic result data transfer. This is the overall system diagram of Ge-AIRS System adapted to Teragrid at NCSA.

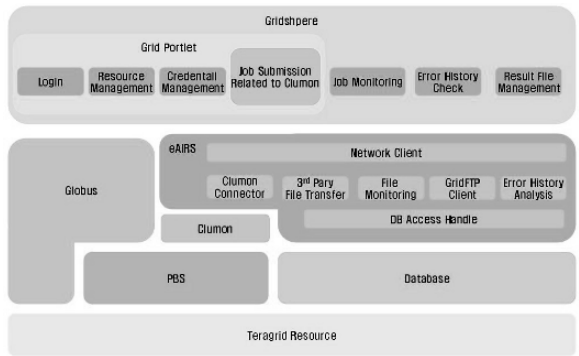


Fig. 3 System Architecture of e-AIRS adapted to Teragrid at NCSA

### *B. The relation of physical hardware resources*

The whole physical hardware resource is showed in Fig. 4.