AIAA
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Recommended Practice

The CFD General Notation System – Standard Interface Data Structures

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Maintained by
The CGNS Steering Sub-committee of the AIAA CFD Committee on Standards

Abstract

The CFD General Notation System (CGNS) is a standard for recording and recovering computer data associated with the numerical solution of the equations of fluid dynamics. The intent is to facilitate the exchange of CFD data between sites, between applications codes, and across computing platforms, and to stabilize the archiving of CFD data.

The CGNS system consists of a collection of conventions, and software implementing those conventions, for the storage and retrieval of CFD data. It consists of two parts: (1) a standard format for recording the data, and (2) software that reads, writes, and modifies data in that format. The format is a conceptual entity established by the documentation; the software is a physical product supplied to enable developers to access and produce data recorded in that format.

The standard format, or paper convention, part of CGNS consists of two fundamental pieces. The first, known as the Standard Interface Data Structures, is described in this Recommended Practice. It defines the intellectual content of the information to be stored. The second, known as the File Mapping, defines the exact location in a CGNS file where the data is to be stored.

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Foreword

This document contains the Standard Interface Data Structures (SIDS) definitions for the CFD General Notation System (CGNS) project. This project was originally a NASA-funded contract under the AST program, but control has now been completely transferred to a public forum known as the CGNS Steering Committee, a sub-committee of the AIAA CFD Committee on Standards.

The purpose of this document is to scope the information that should be communicated between various CFD application codes; the target is 3–D multizone, compressible Navier-Stokes analysis. Attention in this document is not focused on I/O routines or formats, but on the precise description of data that should be present in the I/O of a CFD code or in a CFD database.

This document therefore contains a precise definition of information pertinent to a CGNS database. Specifically, the following information is addressed:

- grid coordinates and elements
- flow solution data, including nondimensional parameters
- multizone interface connectivity, including abutting and overset
- boundary conditions
- flow equation descriptions
- time-dependent flow
- reference states
- dimensional units and nondimensionalization information associated with data
- convergence history
- association to geometry definition
- topologically based hierarchical structures

This information is encoded into C-like data structures.

This revision "A" of AIAA R-101 replaces in whole AIAA R-101-2002. Changes made to the document since the last release are outlined in Section 1. At the time of approval, the members of the CGNS Steering Committee were:

Chris Rumsey, Chairman	NASA Langley
Steve Allmaras	Boeing Commercial
Juan Alonso	Stanford University
Bob Bush	Pratt & Whitney
Thierry Chevalier	AM-Airbus
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Kurt Weber	Rolls Royce / Allison
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Nick Wyman	Pointwise, Inc.

The above consensus body approved this document in December 2005.

The AIAA Standards Executive Council (Mr. Amr ElSawy, Chairman) accepted the document for publication in December 2005.

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1 Introduction

CGNS (CFD General Notation System) is a collection of conventions, along with software implementing those conventions, for the storage and retrieval of CFD (computational fluid dynamics) data. The CGNS system is designed to facilitate the exchange of data between sites and applications, as well as to help stabilize the archiving of fluid dynamic data. In today's environment, it is important in many technical arenas to maintain detailed records of scientific computations. CGNS was designed to help promote a long-lasting and extensible standard for this purpose. Many companies and institutions choose to adopt the CGNS standard in order to increase productivity by (1) reducing the time required to translate between data created and used by different applications, and (2) increasing the quality, longevity, and re-usability of archived data.

The CGNS standard is a conceptual entity established by the documentation. The CGNS software is a physical product supplied to enable writing and reading data according to this standard. All CGNS software is completely free and open to anyone. By using the supplied software, it is relatively easy for users to adhere to most of the standard described in detail in this document.

The CGNS project originated during 1994 through a series of meetings that addressed improved transfer of NASA technology to industry. A principal impediment in this process was the disparity in I/O formats employed by various flow codes, grid generators, and other utilities, and CGNS was conceived as a means to promote "plug-and-play" CFD. Agreement was reached to develop CGNS at Boeing, under NASA Contract NAS1-20267, with active participation by a team of CFD researchers from NASA's Langley, Lewis (now Glenn), and Ames Research Centers, McDonnell Douglas Corporation (now part of Boeing), and Boeing Commercial Airplane Group. This team, which was joined by ICEM CFD Engineering Corporation of Berkeley, California in 1997, undertook the core of the development. However, in the spirit of creating a completely open and broadly accepted standard, all interested parties were encouraged to participate; the US Air Force and Arnold Engineering Development Center were notably present. From the beginning, the purpose was to develop a system that could be distributed freely, including all documentation, software and source code. This goal has now been fully realized; further, control of CGNS has been completely transferred to a public forum known as the CGNS Steering Committee.

The principal target is the data normally associated with compressible viscous flow (i.e., the Navier-Stokes equations), but the standard is also applicable to subclasses such as Euler and potential flows. The initial release addressed multi-zone grids, flow fields, boundary conditions, and zone-to-zone connection information, as well as a number of auxiliary items, such as non-dimensionalization, reference states, and equation set specifications. Extensions incorporated since then include unstructured meshes, connections to geometry definition, time-dependent flow, and support for multiple species and chemistry.

It is worth noting that extensibility is a fundamental design characteristic of the system, which in principal could be used for other disciplines of computational field physics, such as acoustics or electromagnetics, given the willingness of the cognizant scientific community to define the conventions.

The standard format, or paper convention, part of CGNS consists of two fundamental pieces. The first, known as the Standard Interface Data Structures (SIDS), describes in detail the intellectual content of the information to be stored. It defines, for example, the precise meaning of a "boundary