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Using web services for remote data access and distributed applications

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Abstract

This paper presents the use of web services for accessing data and building distributed applications. Currently, such an application is constructed for numerical calculations of dipole matrix elements between bound–bound, bound–free and free–free states belonging to complex atoms, used in the evaluation of effective oscillator strengths averaged over the continuum, position of high Rydberg states with large angular quantum number. A data access service exposes the atomic data from the database in a system independent and auto descriptive format offering methods for data filtering and sorting.
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Keywords: Web services; Remote data access; Databases

1. Introduction

Research on fusion requires effective collaboration between members who are not co-located in time and space. Remote computing environments are needed to share information between experts in institutions distributed throughout one or more countries.

The amount of available data is increasing continuously, requiring new techniques for compression, archiving and retrieval. Recently, hybrid data acquisition systems with MDSplus have been proposed [1] to acquire data and then archive it onto a hard disk. The Wendelstein7-X data acquisition system [2] includes three typical DAQ stations: the timing system, the monitoring subsystem, and the data archive. In order to solve the problem of simultaneously accessing data provided by different computer systems at the large helical device (LHD) at the National Institute for Fusion Science in Japan, the Kaiseki server [3] has been developed to allow the storage of this data in a unified format.

We present the possibility of using web services to implement a collaborative environment for remote participation in fusion research. Before choosing this approach, other alternatives were considered, like remote procedure call (RPC) and common object

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request broker architecture (CORBA). The main advantages of using the web service approach are the security features that can be implemented inside the service or in a service independent manner, using mechanisms provided by the web server, and the possibility of using standard hyper text transfer protocol (HTTP) proxies.

A web service has been developed that offers processing routines for standard spectroscopic data. The facing of the reactor wall and the divertor in magnetic fusion devices contain Be-like ions as impurities in the fusion plasmas. Electron impact data is therefore required to model the populating processes of the radiating levels used in the spectral analysis of the impurity distribution. In the present application, atomic data as bound energy levels, radiative transition probabilities and oscillator strengths, obtained from Cowan and R-matrix atomic structure codes, is used to calculate the Gaunt factor for the refinement of Zeff evaluation in the fusion plasmas.

Radial components of the hydrogenic and Coulomb Green's function in its Sturmian representation are integrated numerically based on other web services where mathematical calculations (binomial coefficients, hypergeometric functions, the Pochammer symbol) are performed. All these services are used by the 'top level' one, which outputs values of dipole matrix elements between hydrogenic and Sturmian radial components to output the effective oscillator strengths averaged over the continuum included in a Gaunt factor generator of special value for integrated and spectrally resolved bremsstrahlung and free–bound continua [4]. This gives a structured architecture for the web service (Fig. 1).

Web services can be created and used in any programming language, including Java, FORTRAN, C/C++ and PHP. Libraries are available that can simplify the programmer's work.

The present application uses NuSOAP, which is a framework for building and using web services, written in php. The reasons for choosing this framework over other ones, like the OASIS web services resource framework (WS-RF) and WSRF.NET, are the system independent implementation of NuSOAP and the easiness of creating and consuming services.

2. Remote data access

Data collections are usually organized by using different database management systems (DBMS), like

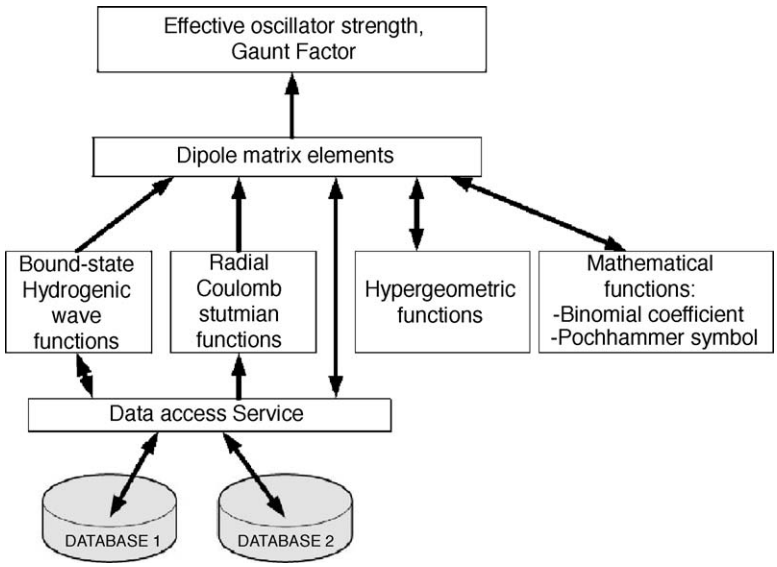

Fig. 1. Web services application architecture: atomic data, as output from different structure codes, is stored into DATABASE 1 and/or DATABASE 2 and accessed by higher-level services (hydrogenic, Sturmian radial wave functions, matrix elements, oscillator strength, Gaunt factor) through the data access service.

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