A Software FrameWork for HPEC System Development

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Abstract

Improved interface standards, lower costs and increased network performance are driving an increase in the use of high performance embedded computing systems (HPECs) in distributed applications. Web technology is well suited for access to remote systems since users can access application interfaces with a browser. Middleware technologies provide standards that promote reusablity and scalability. An appropriate software architecture is required to exploit currently available technologies. The image exploitation (ImEx) FrameWork is being used to integrate embedded remote sensor processing into a distributed application for command and control.

Introduction

A software FrameWork for high performance embedded computing is under development at the Air Force Research Laboratory (AFRL) Rome Research Site. The project is part of the Common High Performance Computing Software Support Initiative (CHSSI) of the High Performance Computing Modernization Program (HPCMP) [1]. The FrameWork incorporates middleware standards and Web technologies to integrate high performance computing systems into networked applications. The FrameWork defines standards for interface development and for communication that are independent of specific software packages. The application interface defined by the FrameWork specifies a standard for parameter inputs. The FrameWork backend interface specifies how parameters are passed to each application that is incorporated into the FrameWork.

Backend Systems

Backend system "services" implement interfaces to FrameWork "middleware" Services include codes on high-performance computers (HPCs) and systems for cataloging and retrieval. HPC codes request input parameters through a middleware interface that can be accessed by a frontend Web browser interface. A Server object which implements the HPC interface interacts with the user until, at the appropriate time, an HPC program is executed. FrameWork backend interfaces are currently being developed for access to the Broadsword [2] interface and the Joint Battlespace Infosphere (JBI) [3]. The FrameWork allows application developers to connect to multiple backend interfaces to implement distributed applications involving multiple HPECs.

Web Interface

A Web interface provides access from any system with a Web browser. There are two approaches to building Web interfaces. The ImEx FrameWork uses the Common Gateway Interface (CGI) approach. It requires that a Web server be installed along with the

FrameWork client software, to allow interaction with users through Web browsers. The ImEx FrameWork client is executed by the Web server. Java [4] interfaces can be downloaded by client systems through the Web but the system must be configured with the Java Runtime Environment (JRE) since Java applets run on the client system. The FrameWork client displays forms to request user parameter input for selected services. Input parameters are sent to the service implementations with execution requests. Each interactive request submitted by a user through a Web browser to the FrameWork client interface is handled as a separate execution request, requiring a complete set of parameters. CGI programming techniques must be used to maintain the state of the execution between requests in the connectionless Web environment.

Middleware Issues

The FrameWork is an object-oriented system. The ImEx FrameWork client is implemented as a Corba [5] object in C++. Client object functionality could be implemented in any language that implements a standard Corba middleware interface. FrameWork servers are currently implemented in either Java or C++. Using Corba allows systems to be quickly and easily integrated into the FrameWork. Communication and data formatting are handled automatically if the Corba interface is implemented by new servers added to the system.

In the ImEx FrameWork, new services that become available are registered with the Common Object Services (COS) naming service [5]. The services may then be selected from a menu by a user, through the FrameWork client interface. New services may be added to replace an existing service, for example when an HPC is taken down for maintenance. Each step in processing is handled as a standalone request. An advantage to this approach is that requests may be routed to a backup server in case of a failure. This approach may also facilitate load-balancing schemes. The ImEx FrameWork is implemented using the OmniORB [6] for the FrameWork client and C++ servers and the JacORB [7] for java servers.

HPC Codes

HPC codes themselves can benefit from middleware. The Message Passing Interface (MPI) [8] provides architecture independence for HPCs by implementing basic primitives for parallel processing, like send and receive, in the MPI runtime environment. The MPI middleware provides a standard interface to communication and remote process invocation. The FrameWork is also developing additional capabilities for HPC-based support functions, like data management support for cluster computers. In addition to HPC parallel high performance codes, system and data management functions can be supported through a FrameWork client interface.

Using the FrameWork to Process Remote Sensor Inputs

The ImEx FrameWork, using an embedded 128 processor Sky [9] parallel computer for image enhancement is under development at the AFRL. The Sky processes raw sensor images as they are collected or when they are selected for processing through the FrameWork. The images are then processed for atmospheric correction or sent directly to other HPCs where images can be processed for other purposes, like target detection. Codes to

process the corrected images are currently running on the Hades Linux cluster at AFRL and on the Huinalu Linux cluster at the Maui High Performance Computing Center [10].Image metadata or resulting reports can be cataloged into Broadsword or JBI for appropriate dissemination. Additional codes are being implemented at the Army Research Laboratory [11], the Naval Research Laboratory [12], the Space and Naval Warfare Systems Center [13] under the CHSSI program.

Conclusion

The ImEx FrameWork implements a convenient interface to high performance embedded computer systems. New services can be added to the system without reconfiguring the FrameWork client. Reliability and scalability are addressed through transparent connections, backup servers and redundant processing resources. The Web-based interface and Corba middleware can accommodate parallel processing architectures involving multiple HPCs. The ImEx FrameWork demonstrates the flexibility and extensibility of the architecture to exploit changing HPC resources.

References

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