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National Aerospace Laboratory NLR

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Summary

SPINEware is presented as a practical and complete approach to metacomputing. It provides the middleware and tools that enable the dissimilar resources from an enterprise's computer network to be integrated into a metacomputer, which provides the end users with the look-and-feel of a single computer, and which may be operated through a user-oriented graphical user interface. Details resulting from remotely accessing the resources available from the network are hidden from the user. The metacomputer may be used as a general computing system, but may also be tailored for specific application areas and groups of users.

1 Background

Enterprises constantly invest in their computing infrastructure in order to lower the cost of product engineering. On the one hand, they increase the available computational power by adding more powerful, faster, and advanced hardware. On the other hand, the engineers are burdened with operation of the individual resources from the network, and are usually confronted with networking issues, such as file transfer among computers, remote login and execution, and software and hardware heterogeneity. Also, they constantly need to familiarize with the changing computing infrastructure. The engineer usually must adapt to the computing infrastructure - rather than vice versa - which may easily divert the attention from the actual problems to be solved. As a result, a growing percentage of an enterprise's potential computer power remains unused.

Metacomputing is generally considered to be the solution to facilitate the use of a computer network. The key idea is to provide the user with the potentials of the network (e.g., computing power, storage facilities, and tools), in the form of a single, virtual computer, a so-called "metacomputer". Details concerning the networking aspects involved are hidden from the user. Most developments thus far, however, have resulted in partial solutions for metacomputing. Partial metacomputing solutions, such as network file systems (e.g., NFS and DFS), systems for network job scheduling (NQS, LSF, CODINE), and tools for remote execution, are generally available and valuable, but still leave technical details to the end user. SPINEware aims at providing a complete solution for metacomputing by glueing together partial solutions into one, coherent solution. It supports the construction of metacomputers that can easily be customized for specific application areas and groups of users.

2 SPINEware approach

SPINEware is a system that supports the development and operational use of general as well as application-specific working environments on top of computer networks. Such working environment provides its end user with access to, and efficient use of the resources - computing and storage, as well as information in the forms of tools, software, data, and on-line documentation - available from the network, as if the resources are available from one single computer. The user interacts with a working environment via an easy-to-use graphical desk-top system based on windows and icons.

SPINEware was initially motivated by the development of ISNaS in the late 1980s and the early 1990s [8]: the realization of a working environment for numerical flow simulation (CFD) in a computer network - such as NLR's network, comprising a supercomputer, mainframes, compute servers, and more than a thousand workstations, PCs, and terminals [4] - that is easy to use for the CFD engineer. SPINEware is targeted towards a generic solution for the development of application-oriented working environments, which are easy to operate by users who are neither computer scientists nor computer experts, span local and area networks while hiding all networking details, are easy to tailor for specific application areas and user groups, are portable, open, and extendible, support cooperative and multi-disciplinary work, and provide a firm basis for conservation and even accumulation of an enterprise's engineering information. SPINEware supports the development as well as the operational use of working environments.

Support for the development of working environments comprises tools for creating an initial working environment, and for modifying, that is, tailoring and extending, working environments. The initial working environment contains a minimum set of file-manipulation tools (e.g., a text-file editor) and on-line documentation organized into a virtual tree of directories. This working environment may be further developed into an application and/or user specific working environment, by modifying and extending the directory tree through integration of tools, data, documentation, and information (e.g., part of an interconnected computer's file system) available from the network. For example, SPINEware allows native tools - operating-system specific, commercial, as well as home-brew programs - to be integrated without the need to adapt the tools proper. A graphical editor is available for construction of tool wrappers without having to write, e.g., shell scripts. Tool wrappers serve to hide all specific details concerning the activation of native tools, and enables the user to activate tools in a uniform and intuitive way. The freedom and ease of linking and creating arbitrary files and directories (and trees) into working environments, and the ability to arrange for access permissions to these, allow work spaces to be set up for individual

users as well as teams.

Support for the use of working environments consists of a “user shell”, facilities for information management, and middleware for managing the resources from the network. The user shell provides a graphical desk-top system which enables the user to browse directories, manipulate files, and start tools in a uniform way, through point-and-click and drag-and-drop operations on icons in windows (cf. Windows systems for PC).

A tool - possibly running on different computers, and involving file transfer - can simply be activated by clicking, or dropping input files on, the tool’s icon. Additional parameters can be specified by entering values in a form popped up upon tool activation. Help information about specific tools or files can be obtained by dropping the corresponding icons on a help button. The desk top also offers capabilities for data-flow and work-flow driven computing: tools and so-called data containers (placeholders for data files) may be organized into a graph. SPINEware supports the construction of such graphs, and controls the execution of tools in the graphs. It provides the basic building blocks for definition of work flows.

SPINEware supports information management by providing facilities for managing storage of, access to, and modifications of data, documents, software, and related information, and for the exchange of information among users. These facilities include tools for controlling versions of software products, for organizing and manipulating data files, and for definition and usage of electronic forms.

The middleware serves to “glue” the desk top and information management facilities, and the computing and information resources available from the network, together into one coherent system that may be considered as the operating system of the metacomputer. The major task of the middleware, similar to that of an operating system on a single computer, is to manage the available resources in order to accomplish the single-computer model, and to exploit the potentials of the underlying computer network.

3 Conclusions

SPINEware has been used at NLR since 1993 for the development of several working environments, such as for numerical flow simulation [5, 6], software engineering, and control engineering [2]. SPINEware has been selected as most promising facility for the realization of intra-enterprise as well as inter-enterprise working environments, in several projects:

- NICE [3], a national project sponsored by the Dutch HPCN Foundation, of which the main purpose is to enhance the development and use of flow simulation techniques through HPCN;
- FASTFLO [1]: a BRITE-EURAM project also aiming at development and application of flow simulation;
- MDO [7], a BRITE-EURAM project, managed by British Aerospace, aimed at Multi-disciplinary Design, analysis, and Optimisation of aerospace vehicles.

In each of the projects, SPINEware has been considered a practical and “holistic” solution for metacomputing. Practical in the sense that SPINEware is available, and has proven to be successful for the realization of metacomputing in engineering environments. For example, unexperienced engineers were able to utilize working environments within short time. Holistic in the sense that it provides a framework for a complete - not just a partial - solution for metacomputing. The framework allows easy incorporation and integration of partial solutions for metacomputing.

Since 1996, the development of SPINEware has continued jointly by NLR and NEC. By the end of 1997, SPINEware version 2.0 is available for most of today’s UNIX variants found in enterprises: HP-UX, SunOS, and IRIX. Although SPINEware version 2.0 is targeted for UNIX (TCP/IP-based) networks, it is possible to operate the desk top of working environments from PCs that have NFS and X software installed. NEC has announced SPINEware as NEC product in January 1998, and will market SPINEware early 1998.

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