

Chapter 19

Load Balancing Algorithms in Distributed Service Architectures for Medical Applications

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ABSTRACT

This paper investigates the performance of two proposed load balancing algorithms for Object-Oriented Distributed Service Architectures (DSA) that are open and flexible, enabling rapid and easy development of new applications on various kinds of software and hardware platforms, catering for telecommunications and distributed medical applications. The proposed algorithms, namely, Node Status Algorithm and Random Sender Initiated Algorithm, have been developed as solutions to the performance problems faced by the DSA. The performance of the proposed algorithms have been tested and compared with baseline load balancing algorithms, namely the Random Algorithm and Shortest Queue Algorithm. Simulation results show that both the proposed algorithms perform better than the baseline algorithms, especially in heavily loaded conditions. This paper discusses the mechanisms of the algorithms and reports on the investigations that have been carried out in comparing the load balancing algorithms implemented on a DSA-based network, which is useful for the distributed computing requirements of the medical field.

1. INTRODUCTION

The rapid growth in hospital information systems (HIS), paperless hospitals, telemedicine, digital diagnostic imaging and medical image processing has increased the dependence of the medical field on information technology and advanced

telecommunications network services. This is especially true when medical records, specialists and imaging equipment are located at different parts of the medical institution, or may even be in various locations on different continents. Furthermore, medical image processing, digital image manipulations and semi-automated diagnosis all

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require heavy processing power, which benefit from treatment in a distributed fashion across a number of processors or computers in a network. Load balancing is an important factor in making efficient use of the available technology. As many new the software applications are developed using object-oriented platforms, this paper proposes load balancing algorithms that concentrate on an object-oriented framework.

The current telecommunications market is moving towards a new era, i.e. de-regulation, which encourages the participation of a large number of telecommunications services and network providers. This creates a need for more flexible telecommunications architectures (of which the telecommunications networks are based on). Flexibility means that in most cases, more network intelligence is required for providing new services. Distributed Object Computing (DOC) is one such way to make a system more flexible. The distribution enables the computational tasks or loads to be shared among several processors in the network, while the object-orientated paradigm enables flexibility for the creation, maintenance and support of services.

Some examples of DOC architectures include CORBA (Common Object Request Broker Architecture) (Object Management Group, 2000), TINA (Telecommunication Information Networking Architecture) (Inoue, Lapierre, & Mossotto, 1999), IN (Intelligent Network) (Object Management Group, 1997) and OSA (Open Service Access) (Moiso & Sommantico, 2001). CORBA is a standard defined by the OMG (Object Management Group) and is able to support execution of object-oriented programs across multiple nodes or processors. It consists of a middleware layer known as Object Request Broker (ORB), which functions as the communications channel between objects, and provides the functionality of location transparency. Therefore, CORBA offers great flexibility for the creation of telecommunication services.

TINA (Inoue et al., 1999) is a software architecture supporting rapid service deployment and provision in a multi-vendor, multi-stakeholder environment. The key concepts used by this architecture are the object-oriented paradigm, transparent component distribution, the session concept and reference points. Combining information technology and the telecommunications environments, TINA promises a flexible architecture in meeting the requirements for telecommunications services creation (Lehmann, Cadorin, & Wurgler, 1998). The IN is capable of providing value added services in the Public Service Telephone Network (PSTN) such as credit card calling, freephone and televoting. Much investigation has been carried out to integrate CORBA into the current IN system (Widell & Parsons, 2000) such that scalability, reliability, and flexibility of the existing IN system may be improved. OSA, a new open service architecture for the 3G network, developed by the Third Generation Partnership Project (3GPP), has applications that can be extended to all types of communications networks such as PSTN, GSM and the Internet. OSA is based on object-oriented programming and consists of three parts—applications, the framework and the service capability servers.

Of paramount importance for the above-mentioned systems to be viable is their ability to fulfill the performance and QoS (Quality of Service) requirements. It is essential to formulate how these two factors can be met by the systems. The distributed nature of the systems and the complexity of the services running on them have caused the performance investigation to be difficult. However, the need to study the performance aspect is essential as the real-time traffic characteristics are important for the systems to compete in the telecommunications market. Unfortunately, although there has been a significant increase in such work in recent years, the systems performance analysis is still an open problem.

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