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A method for the production of simulation models with application to web interaction paradigms

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Abstract

Modern internet and web applications rely on interactions among remote host computers connected by heterogeneous networks (different LANs, gateways, WANs, MANs, etc.). Simulation modelling such networks is of great importance to the web application designer to predict, at design time, performance metrics such as the end-to-end delay between hosts, which is dramatically increased by the various mechanisms necessary to deal with heterogeneity (protocol conversion, packet fragmentation and re-assembly, flow control, etc.).

On the other hand, producing a simulation model of web interactions is a non-trivial task because of the great importance of the software aspects. It is thus necessary to provide general model production guidelines which can be then tailored and applied to specific simulation languages or packages.

This paper gives such general production guidelines with an example application to the production of simulation models for web interaction paradigms of client–server and mobile agent types. An example use of the models is also introduced to predict the most convenient paradigm and the best choice of the host capacities for each given network configuration.

Keywords: Simulation model production; Web applications; Interaction paradigms; Client–server; Mobile agents; Object-oriented simulation

1. Introduction

The performance of internet and web applications is a function of three factors:

(f_0) the performance of the interacting hosts;
(f_1) the performance of the heterogeneous network (LANs, gateways, WANs, MANs, etc.) that connects the interacting hosts;

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(f_2) the interaction paradigms used to carry on the host interaction. Example paradigms are the Client–Server (CS) paradigm, the Mobile Agent (MA) paradigm, the Code On Demand (COD) paradigm, the Remote Evaluation (REV) paradigm, etc.

Factor f_1 is largely responsible of the end-to-end delay between hosts, because of the various mechanisms necessary to deal with heterogeneity (protocol conversion, packet fragmentation and re-assembly, flow control, etc.).

Factor f_2 also affects performance to a great extent since, depending on the interaction paradigms, the application load is differently distributed on the network, or on one or the other interacting host.

According to [4], interaction paradigms can be characterized by:

(i) the location of the software components before and after the execution of a given service;
(ii) the computation of components responsible for the execution of code;
(iii) the location where the computation of service takes place.

This is better illustrated in Figs. 1 and 2 that consider a scenario in which a computational component A, located at host HA, needs the result of a service, and there exists another host HB that can be involved in the execution of the service.

Fig. 1 illustrates the CS paradigm, according to which the computational component B offering the service is located at host HB. The resources and know-how needed for service accomplishment are hosted by HB as well. The client component A, located at HA, requests the execution of the service by component B. This component performs the service by using the know-how and the resources also located at HB.

Fig. 2 instead shows the MA paradigm, according to which the know-how is owned by A which is hosted by HA, but the necessary resources are located at HB. To perform the service component A migrates to HB carrying the necessary know-how. Once it has moved to HB, A accomplishes the service using the resources available in HB.

Similar descriptions can be given for remaining paradigms, COD and REV, for which the reader is referred to [4].

In order to analyze the performance of web applications based on CS and MA interaction paradigms it is necessary to introduce a performance simulation model to study the effects of factors f_1 and f_2 in a combined form and to understand, for each given paradigm, the criticality of factor f_0, or of the capacities of the hosts.

The model evaluation yields numerical predictions of the time a given application takes to be run by the two hosts.

The guided production of performance models has recently received great attention in the academic and industrial fields as a way to simplify the work of system developers [2,3,7]. A similar consideration should be devoted to the production of simulation models, as also stated in [8,9,11,15].

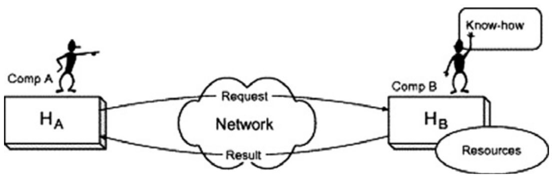

Fig. 1. CS paradigm.

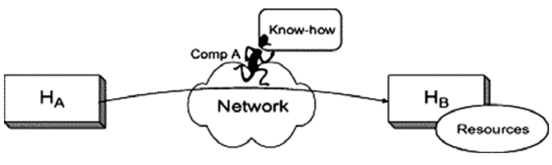

Fig. 2. MA paradigm.