ERCIM "Alain Bensoussan" Fellowship Scientific Report

Fellow: Balakrishna PRABHU
Visited Location : CWI, Amsterdam
Duration of Visit: August 1st, 2006 to April 30th, 2007.

I - Scientific activity

(1 page at maximum)

Information Dissemination in Large-Scale Networks

Along with Dr. Sindo Nunez-Queija (CWI, Amsterdam), we investigated the performance of distributed information dissemination algorithms in large-scale networks. This work was in continuation of the research activity on P2P networks started during my ERCIM visit to VTT. In that activity, we developed a distributed algorithm to broadcast a file to a fixed population of nodes.

In the present research activity, we investigated the efficiency (i.e., the broadcast time) of a distributed algorithm and quantified its dependence on the level of node cooperation (i.e., nodes download but do not upload, also called free-riding).

In the litterature on multiple message broadcasting, it is known that the minimal broadcast time scales logarithmically with the size of the population. This minimal broadcast time is acheived in an ideal setting, i.e., when nodes participate actively in the file dissemination process. However, in the Internet this is not always the case, and nodes often leave as soon as they have download the file. Moreover, the distributed nature of file dissemination algorithms means that there is an inherent randomness in the dissemination process which also adds to the inefficiency. Thus, in order to compare the performance of distributed P2P algorithms with the optimal algorithms, it becomes important to study the effect of randomness and free-riding on the mean broadcast time in a distributed setting.

Our research activity focussed on investigating this relationship between randomness, node cooperation and the scaling law of the mean broadcast time. Specifically, we studied a P2P network in which nodes randomly contact other nodes in search of a given file. Once a node has successfully downloaded the file, it stays in the network for a random amount of time, and then leaves the network. During its stay in the network, a node uploads the file to other nodes requesting it. We showed that the relation between the contact rate and the node departure rate has a significant effect on the scaling law. If the departure rate is smaller than the contact rate then the mean broadcast time scales logarthmically with the number of nodes, otherwise a significantly worse linear scaling law is obtained. Intuitively, it means that if a node uploads once (on an average) before leaving

the network, the mean broadcast time is of the same order as the minmal broadcast time. Thus, node cooperation in P2P networks is essential for
acheiving performance gains attributed to it.

Load Balancing in Multi-Server Systems

Along with Urtzi Ayesta (LAAS-CNRS, Toulouse) and Eitan Altman (INRIA, Sophia-Antipolis), we began an investigation into optimal routing of tasks to a pool of servers. Web service providers, like Google, Amadeus, etc., employ a large number of servers to process requests originating from Internet-based clients. In such a multi-server system, it is important to assign the incoming requests to servers in such a way as not to excessively load any one server, i.e., the requests should be routed in a fair way. This problem of routing the requests in a multiple-server system is called load balancing.

We investigated the optimal routing policy so as to minimize the mean waiting time of requests in the system. We computed the optimal policy for two settings : (i) the centralized setting in which a central node receives the requests and routes this request to an appropriate server; and (ii) the decentralized non-cooperative setting in which each request decides for itself the server it joins.

II- Publication(s) during your fellowship

Please insert the title(s), author(s) and abstract(s) of the published paper(s). You may also mention the paper(s) which were prepared during your fellowship period and are under reviewing.

Title : Scaling laws for file dissemination in P2P networks with random contacts.

Authors : R. Nunez-Queija and B.J. Prabhu

Workshop : 16th IEEE International Workshop on Quality of Service (IWQoS 2008)

Abstract : In this paper we obtain the scaling law for broadcast time of a file in a P2P network with an initial population of N nodes. In the model we consider, at Poisson rate λ a node initiates a contact with another node chosen uniformly at random. This contact is said to be successful if the contacted node possess the file, in which case the initiator downloads the file and can later upload it to other nodes. In a network with altruistic nodes (i.e., nodes do not leave the network) we show that the broadcast time is $O(\log(N))$. In a network with free-riding nodes, our main result shows that $O(\log(N))$ broadcast time can be achieved if nodes remain connected to the network for the duration of at least one more contact after downloading the file, otherwise a significantly worse $O(N)$ time is required to broadcast the file.

III -Attended Seminars, Workshops, and Conferences

Please identify the name(s), date(s) and place(s) of the events in which you participated during your fellowship period.

Conference : IEEE INFOCOM,

Dates : May 8-10, 2007.

Place : Anchorage, Alaska, USA.

Title of the talk and of the paper : Discrete Power Control: Cooperative and Non-Cooperative Optimization.

Workshop : 2nd Benelux wokshop on «Performance analysis of communication systems »

Dates : Feb. 5-6, 2007.

Place : Antwerpen, Belgium.

Title of the talk: Flash crowd in a file sharing system based on random encounters