# 38 Adaptive Resource Management Methods in Telecommunications

**Haitao Tang and Olli Simula**

## 38.1 Resource Management Problems in Telecommunications

Adaptive resource management of telecommunication networks has become more and more important with the advent of Intelligent Networks, ATM, mobile communication networks, etc. With the increase of processing capacity alone, it may still not be possible to cope with the requirements, e.g., the Quality-of-Service (QoS) requirements to network. Thus, adaptive resource management methods are appreciated. In addition to their help to meet the requirements, the adaptive resource management systems have demonstrated their ability to increase system utilization, i.e., the more efficient use of system resources.

To solve the resource management problems, it is quite helpful to model the telecommunication networks with the ideas of server, client, and agent. The server, related to data networks, is a host in the network if it offers one or more services to the network, subnetworks, or applications in the networks. Likewise the network is the server for the hosts in the networks to get the needed transmission services. Those who receive the service(s) are called clients. For further dimensioning, sometimes, some components in the networks are called agents if they act between the server(s) and the clients. The agents pre-process the requests from the clients and route certain requests to certain server(s) for the required services; in this sense, the agents take both server and client roles. Therefore, the relation between a server and other components in the network can be modeled as the client-server or the client-agent-server. The server consists of certain elements, where some of the elements can take the manager role while others are simply the managed elements.

The server is usually a resource-sharing system (e.g., time-sharing system, memory-sharing system, or bandwidth-sharing system) which is the case in data networks. The server provides one or more services to the clients.

## 38.2 Adaptive Approaches to Resource Utilization

Generally, for the resource assignment, we have to consider two issues: the traffic adaptation and the adaptive resource allocation. The traffic adaptation is the first step of resource assignment, which understands the resource requirements for the services. The adaptive resource allocation is the final step of the resource assignment, which conducts the resource allocation for the requirements according to the traffic adaptation and server capacity (the effective resource of the server). When a server serves several services or service classes, the resource allocation for different service is correlated with each other, which may add difficulty to the adaptive resource allocation.

Because of the various traffic and server features, the solutions (if found) can be

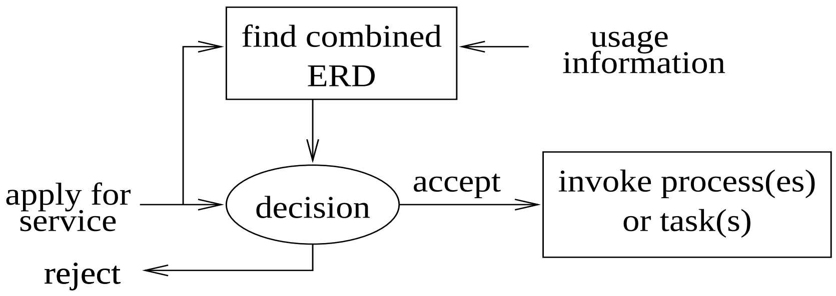


Figure 71: The principle of the admission control of an application for a service provided by the computer.

largely case-dependent or even heuristic. Thus, adaptive methods are used to solve the adaptation problems. They may help to decrease the case-dependency somehow, i.e., at least for the adaptive information processing part which is the heart of the resource assignment. Moreover, the adaptive methods may offer better solutions. There have been some studies which demonstrate the above advantages.
From 1995 to 1997, we proposed several methods for traffic adaptation, which were introduced in the 94-96 triennial report. They are not covered in this report. Since 1997, several other methods for traffic adaptation have been found. Furthermore, the corresponding resource allocation methods which include the resource reuse have been developed.
In the first approach, a mnemonic map (or age-boosting) is developed and used with the aging algorithm to adapt to the accessing environments of data pages and to increase the page access throughput of a database or other information systems. The scheme consists of the partially-weighted majority algorithm and the aging algorithm. These methods have been tested successfully by simulations. The results show: (a) the age-boosting scheme converges very fast; (b) the throughput improvement of the age-boosting scheme over the aging scheme is 8% - 45% and 22% on the average after the age-boosting scheme has converged. The integrated performance of the age-boosting scheme is much better than that of the aging scheme and is similar to that of the "fixed scheme".
The second approach is proposed for the systematic analyses of the effective capacities of a computer as a node in the network. The approach is developed through modeling a computer as a resources server, its components as resource objects, and its service tasks as resource-consuming processes with effective resource demands (ERDs). The service admission and the QoS management of the computer are then developed with the approach. A resource-consuming process on a resource object is the amount of resource units that the resource object should provide to the process in each time unit in order to achieve the given QoS requirement(s). The examples show that the approach is applicable. The principle of the service admission control is shown in Figure 71.
In the third approach, a combined flow control approach of IN is proposed as shown in Figure 72. A dynamic model is created to predict the SCP system state, where

two methods are also proposed to adapt to a functional relationship in the model. The service rate for the flow from SMS (the internal flow control) is then decided according to the predicted system state and the guaranteed system response delay which is calculated through the analytical relationship among the system state, the system response delay, and the confidence level. The combined flow control is thus constructed by the internal flow control and ACG, which provides the needed performance.

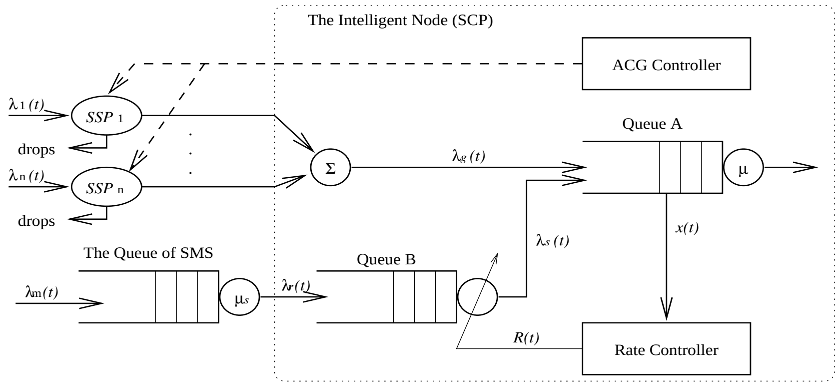


Figure 72: The queueing model for the major part of an Intelligent Network, where an SCP is connected with an SMS and $n$ SSPs; the model is oriented to investigate the combined flow control.

As the fourth publication, the doctoral thesis of Haitao Tang summarizes some essential issues of the adaptive resource management and introduces the adaptive resource management approaches proposed by focusing mainly on the adaptive resource management of Intelligent Networks and computer-based end systems.

# Publications


1. H. Tang, O. Simula, and K. Raatikainen, "Age-Boosting Page Replacement Scheme," International Conference on Telecommunications, Vol. 3, pp.1115-1120, 1997.

2. H. Tang and O. Simula, "The Effective Resource Demands of the Applications and Their Managements in a Computer," The Third Asia-Pacific Conference on Communications, Vol. 1, pp.267-271, 1997.

3. H. Tang and O. Simula, "Another Dimension of Flow Control for the Intelligent Node," International Conference on Telecommunications, Vol. 2, pp.425-429, 1998.

4. H. Tang, "Applying Adaptive Techniques and Operations Research Methods to the Resource Management in Telecommunications", ACTA POLYTECHNICA SCANDINAVICA, Ma 92, Espoo, 1998 (a publication of the doctoral thesis).