QoS-aware services delivery in SOA-based systems

Systems based on SOA (Service Oriented Architecture) paradigm offer services which are delivered as composition of basic components called atomic services [12-14]. The main feature of such an attempt is that the required complex services may be efficiently and flexibly composed of available atomic services providing certain, well defined, required and personalized functionality. Requested complex services are characterized by set of parameters specifying both functional and nonfunctional requirements; the former define exact data processing procedures, while the latter describe various aspects of required service quality. The set of parameters describing requested complex service form SLA (Service Level Agreement) [1,13-15].

Functionalities of the requested complex service are available as a sum of atomic services functionalities. In order to deliver complex service with requested functional and non-functional properties appropriate atomic services must be chosen in the process of complex service composition [10]. Required functionality, precisely defined in the SLA, determines a set of required atomic services as well as a plan according to which atomic services are performed in distributed environment. Non-functionality of the requested complex service, which is mainly related to QoS (Quality of Service), in most cases, i.e., in distributed environment, may be assured or obtained by proper resources (processing and communication) and tasks (atomic services) allocation [4,5,7,17].

Discussed complex services delivery approach is available only at the distributed environment; possible parallel execution of distinguishable atomic services requires allocation of proper amount of processing and communication resources in parallel manner. The distributed environment may be obtained both by allocation of separated or virtualized resources.

In order to obtain various required quality of service levels in distributed environment well-known QoS strategies, i.e., best-effort, integrated services and differentiated services concepts may be applied. Usefulness of the mentioned concepts strongly depends on formulation of the non-functional part of the entire SLA. Application of the best-effort concept, based on common resources sharing, leads to solution, where the same, high enough, average quality of service is delivered to all performed services. The next two previously mentioned concepts offer differentiated quality of service for requested services (also guarantees) and are mainly based on resources reservation for individual requests (integrated services concept) or for classes of requests (differentiated services concept) [4,16].

In general, the task of complex service composition consists of finding, for given ordered set of required functionalities (stated in the SLA), an order of atomic services execution such that non-functional requirements are met [2,3,11]. The task of complex service composition can be decomposed into three subtasks each of which provides an input for subsequent subtask:

1. Complex service structure composition – transformation of the SLA into set of required functionalities and the precedence relations between them. The result of this task is complex service structure represented as a directed graph (not necessarily connected) of required functionalities.

2. Complex service scenario composition – transformation of complex service structure graph into single and consistent graph of required functionalities with precisely defined order of execution of all atomic functionalities. Determination of the complex service scenario is composed of two stages. The gain of the first is to propose for given complex service structure graph a set of consistent graphs each representing certain order of execution of atomic functionalities. The aim of the second stage is to select the best (for assumed criteria) connected graph (scenario). Among others this task consists in making decision on whether to apply possible parallel execution to functionalities, which are not
bound by precedence relations from complex service structure. Since it is possible, that single functionality is delivered by more than one atomic service (different versions of atomic service), the scenario graph represents in fact a family of execution graphs where member graphs differ in atomic service versions applied to deliver required atomic functionality.

3. **Complex service execution plan composition** – choice of particular atomic services in complex service scenario graph such that non-functional requirements of complex service are met. This stage is composed of three substages. In the first one, nodes (functionalities) of optimal scenario graph are replaced by subsets of atomic services providing respective functionalities. In the second substage particular atomic services from atomic services subsets are chosen. In the last substage particular versions of chosen atomic services are picked.

The main advantage of SOA-based systems is that atomic services which deliver certain functionalities may be provided by different service providers, what allows users to chose required complex services from many, functionally and non-functionally equivalent, available alternatives. In order to facilitate such capabilities service providers have to describe delivered services semantically in a unified manner. In order to deliver to the user a complex service with requested functionality semantic matching of service request and available complex services has to be performed. This very important step of complex service composition is performed as a part of the first stage of complex service structure composition task which was described above [6-9].

Since service requests, besides required functionality, include required non-functional parameters, they must be taken into account during service composition procedure. These parameters however concern, in general, the quality of required service, which vary in time and depends mostly on current state of computer communication system used as a backbone for complex service delivery. The aim of this paper is to provide framework for QoS-aware complex service composition, which allows to make decisions based on the network state of the SOA-based system.

In order to deliver complex service with requested functionality and non-functional properties various optimization tasks need to be solved on consecutive stages of complex service composition task (i.e.: stages of complex service structure, scenario and execution plan composition).

The basic aim of the presentation is to present proposed models, procedures and approaches related to the abovementioned complex services structure, scenario and plan composition and realization in network environment purposes. The elaborated approach is illustrated by numerical examples as well as by possible applications.