Enabling Framework for Service-Oriented Collaborative Networks
M. Sargolzaei
8.1 Summary

In today’s economy, collaboration and co-development among organizations has evolved from the traditional format of static supply chains to the dynamic formation of federated organization networks. Networking among business partners has proven to yield lower costs, higher quality, larger service/product portfolio, faster delivery, and more agility. However, the pace by which these trend changes need to occur has raised the demand on ICT-enhanced support for inter-organization collaboration, establishing the area of collaborative networks (CNs). We particularly address in our research two forms of CNs, namely the VO (Virtual Organization) and the VBE (VO Breeding Environment).

To enrich collaboration among potentially distributed partners, a challenging area for CN research is focused on new approaches to specification, sharing and integration of organizations business processes. Aiming to address this challenge, in our research the promising paradigm of Service Oriented Architecture (SOA) is investigated and applied as the base for enhancement of organizations collaboration. However, we argue that the current implementations of the SOA approach do not sufficiently support CN requirements and do not deliver the expected advantages for organizations sharing and integrating their business services. We therefore introduce a new reference framework - the service orientated collaborative networks (SOCN), as a customization of the traditional architecture and generic model of SOA, in order to efficiently support service oriented CNs.

An implementation architecture is also elaborated that addresses our identified requirements for the reference framework, and captures the needed elements and features for establishing the SOCN. Significant sub-components of the reference framework and their inter-relationships are introduced, as an extended SOA model. The architecture seeks to introduce common service semantics and a novel service behavior model, which can be used unambiguously across and between different implementation options. In this PhD work however, we have developed a
proof of concept (POC) for our approach, which employs particular architectures, standards, and technologies. The implementation details that realize our SOCN architecture are provided. The developed service-oriented architecture is conceptually composed of three main software modules: Specification Module, Discovery Module, and Composition Module, as briefly described below.

- **SOCN Specification Module** deals with the specification of software services that are offered by different members/stakeholders in the role of service providers within a VO. Such shared services in the VO are published in a service registry or directory, complying to some agreements, such as the SLA and OLA defined at the VBE level. In this module, we present an extension and improvement to the current web service description approaches and standards, in order to support more efficient service discovery and composition in VOs. First, we depict a data model namely C3Q (addressing the Capability, Costs, Conspicuiity, and Quality criteria of services) to represent the various information needed for the description of services. C3Q is considered as the services competency model within the VOs. Then, we introduce a light extension of WSDL that we call XWSDL, to specify web services according to the C3Q model. XWSDL provides a comprehensive description of capabilities of web services and particularly highlights the important role of service behavior in the realization of the semi-automated service oriented computing. We have also developed a user-friendly GUI, assisting service designers to correctly describe and visualize the behavioral specification of their services.

- **SOCN Discovery Module** of the framework provides mechanisms for efficient and accurate discovery and selection of the best-fit service among the existing shared services in the VO. Successful automated application of search-result services of this module requires the description provided through the Specification Module. We have presented a tool for similarity-based discovery of web services that is able to rank service descriptions in our registry, in accordance with a similarity score matching each registry entry with the description of a service desired by a user. The tool is based on implementing approximate operational-similarity evaluation with constraints, which allows to quantitatively estimate the differences between two behaviors. Defining this problem as an SCSP (Soft Constraint Satisfaction Problem) makes it parametric with respect to the chosen similarity metric (i.e. a semiring), and allows using efficient AI techniques for solving it.

- **SOCN Composition Module** of the abstract framework involves the functions introduced to support service composition. Efficient service composition to create new value-added services in the VO requires not only considering the rich meta-data captured in the service specification module,
but also the modeling of the intended coordination among the component services that form a composite service. While orchestration and choreography are two alternative approaches to handle such coordination concerns of the composition, we advocate orchestration for the VO service composition using the coordination language Reo. We have further developed a tool that automatically translates the orchestrators (i.e. the Reo connectors) into Java code, and creates a proxy for each involved component service. This proxy component is in charge of managing the communication between the technology behind the web service and the Reo environment.