

# Enabling inter-enterprise collaboration in open distributed systems

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**Abstract.** One of the most important infrastructure services of tomorrow's enterprise computing platforms are the services needed for interoperability analysis and management of typing disciplines. In my research I will study the characteristics of business collaboration networks which use business services and their compositions to reach its business goal. This research will begin with an analysis resulting in thorough understanding of the nature of interoperability conflicts inherent in business networks. From these results a typing discipline for business services and networks based on a formal theoretical framework shall be formulated. Resulting type system is applied in practise as type repository functionality for web-Pilarcos platform.

Globalisation of markets, considerably stimulated by the development of ICT technology, introduces new kinds of demands for enterprises willing to stay competitive. Viability of an enterprise is not determined by its core resources or competencies but also by its ability to engage business with various partners, possibly in quite different business domains. An increasing amount enterprises' income is made inside collaboration networks and as a part of inter-enterprise value and supply chains.

Competition has shifted from rivalry between distinct enterprises to competition between business networks. Business network is a collaboration between enterprises with a certain business goal. In free markets business network which provides more valuable services or reaches its goals with lower costs will outlast those with lesser value or higher costs. To maintain its competence, a business network must be allowed subtle changes or evolution to reflect changing business needs and environments. Evolution of business network might be as simple as changing previous partner to a more suitable one or even changing business goals during a collaboration.

Flexible and dynamic collaborations shall be established even for short-term usage. This should be possible without considerable development or maintenance costs. Tomorrow's enterprise information systems and especially the supporting infrastructure must provide means for establishment and management of collaboration networks in an environment with autonomic and heterogeneous agents.

Enterprises must have a possibility to maintain and adapt their own services as needed. An enterprise wants to exploit technological developments and refined business processes to retain its competitive edge. To support this autonomy we cannot presuppose that distinct services will be implemented using same technological platform or that they would always behave the same. Business services offered by enterprises have independent development cycles and lifetimes. Enterprises are also autonomic administration domains with their internal policies. In this kind of operational environment static verification of interoperability is insufficient.

Collaboration model we have taken in web-Pilarcos project is quite similar to those in virtual organisation and workflow systems, such as WISE or Cross-Flow [1, 4]: contracts stating the responsibilities and behavioural properties of participants are used as the basis for business network operation. We follow an unified model where each participant in a collaboration may be using different execution platforms and technologies as long as they comply to the restrictions and behavioural patterns of the collaboration contract.

Business network descriptions are used to define the characteristics of an inter-enterprise community, such as topology of the community, processes used between participants and community specific functional and non-functional constraints and properties. Business processes are not used for execution of enterprise services as in traditional workflow systems, but as behavioural descriptions needed for static verification of service interoperability and dynamic monitoring of conformance between the behavioural contract and actual service behaviours.

Interoperability of business services is an issue that must be supported during design, implementation and operation of business collaboration networks and business services. Static verification of interoperability should be enforced by the mechanisms and disciplines used to develop, publish and manage business services and networks. When a new service is published to a public service trading system its behavioural properties and especially its conformance to the claimed service type must be verified. Type repositories are used to enforce these verification obligations and correct use of typing disciplines. During publication of new business collaboration models behavioural properties and logical integrity of these descriptions must be verified.

Process algebras, especially different forms of typed  $\pi$ -calculus [6, 5] can be used as theoretical framework for development of business service typing discipline and interoperability verification framework. To achieve a typing system where a service type can be used in different business networks, interface descriptions should be equipped with process descriptions that define bilateral behavioural patterns. One of the most greatest challenges will be the development of a typing discipline which provides “sufficiently complete” proof of service interoperability, yet supporting independent service and business network evolution.

Composition of service types into roles, the functional units of business service networks, must be supported by the type system in a such way that verification of composite behaviour remains a relatively light procedure. A type effect

system mechanism similar to correspondence assertions introduced in [2] could be used to separate the aspects of communication and coordination in business services and their compositions. Another interesting possibility could be use of some other logic, e.g. tile logic [3], to express and separate coordination and communication needs of service compositions.

Static verification done during development and publication phase of business services is not sufficient in our context with autonomic administration domains. For example internal policies not visible outside an enterprise may evolve during operation of a community, causing changes to functional or non-functional properties of its services. For this reason runtime monitoring and verification must be executed during operation of business networks.

My research will concentrate on research of interoperability support and management in collaboration communities involving autonomic business services. First task of my research will be a categorisation on the nature of interoperability conflicts: what are their causes and how could they be prevented or observed before they happen. Results of this analysis will be used in formulation of a typing discipline that shall be used for description of business services and networks.

Typing discipline must allow evolution and reuse of business services in a flexible manner. For this purpose I think it is necessary to separate aspects of communication and coordination such that these both aspects can be analysed separately and their properties and structures changed as independently as possible. Communication and coordination should be treated as orthogonal properties, as much as possible, the first one described in the interfaces of business services and the second one described mainly in business networks as “glue” composing distinct service types into business roles.

The theoretical framework must however support propagation of behavioural effects from the coordination dimension to the communication dimension and vice versa such that correct operation of role compositions can be verified. Theories and mechanisms of typed  $\pi$ -calculus and e.g. type and effect systems and model checking shall be studied for this purpose. Session types [5] are now used for the description of bilateral service protocols, but its applicability as part of service typing discipline is yet to be researched. The theoretical framework and the resulting typing discipline shall be tested in practise during my research: a type repository functionality is used as part of web-Pilarcos platform to ensure service interoperability.

## References

1. G. Alonso, U. Fiedler, C. Hagen, A. Lazcano, H. Schuldt, and N. Weiler. Wise: Business to business e-commerce. In *Proceedings of the Ninth International Workshop on Research Issues on Data Engineering: Information Technology for Virtual Enterprises*, page 132. IEEE Computer Society, 1999.
2. E. Bonelli, A. Compagnoni, and E. Gunter. Correspondence assertions for process synchronization in concurrent communications. In *FOCLASA 2003, the Foundations of Coordination Languages and Software Architectures*, volume 97 of *Electronic Notes in Theoretical Computer Science*, pages 175–195. Elsevier, July 2004.

3. R. Bruni and U. Montanari. Dynamic connectors for concurrency. *Theor. Comput. Sci.*, 281(1-2):131–176, 2002.
4. Y. Hoffner, H. Ludwig, P. Grefen, and K. Aberer. Crossflow: integrating workflow management and electronic commerce. *SIGecom Exch.*, 2(1):1–10, 2001.
5. K. Honda, V. T. Vasconcelos, and M. Kubo. Language primitives and type discipline for structured communication-based programming. In *Proceedings of the 7th European Symposium on Programming*, pages 122–138. Springer-Verlag, 1998.
6. N. Kobayashi. *Formal Methods at the Crossroads: From Panacea to Foundational Support*, volume 2757 of *Lecture Notes in Computer Science*, chapter Type Systems for Concurrent Programs. Springer-Verlag, 2003.