



Complex Event Processing

Alejandro Buchmann, TU Darmstadt,
Boris Koldehofe, Universität Stuttgart

Complex Event Processing (CEP) has evolved into the paradigm of choice for the development of monitoring and reactive applications. It also has a strong impact on future information systems and the way we subscribe to and consume information. Besides being a highly active research field, CEP already plays an important role in many application areas like logistics, energy management, finance, or manufacturing processes. Its importance for information systems is expected to grow further with the increasing number of decentralized information sources, such as blogs, and with the deployment of tagging and sensing technology as well as its integration in real-world objects.

CEP addresses two crucial prerequisites to build highly scalable and dynamic systems. First, it decouples providers and receivers of information. Neither the providers need knowledge about the set of relevant receivers, nor do receivers need to know the set of relevant data or event sources. Second, CEP-systems do not only mediate information in form of *events* between providers and consumers, but support the detection of relationships among events, for instance, temporal relations that can be specified by definition of correlation rules (often called *Event Patterns*). Through aggregation and composition new *complex events* can be generated and used subsequently to derive more abstract events. CEP provides a natural decoupling between basic events with a strong relationship to the semantics of the underlying technology (e.g. sensor readings) and complex events closer to the semantics of the application. Therefore, it enables information systems to perform independent reconfigurations at the technical and application level. Furthermore, the stepwise correlation of events can help to reduce the message load and thus contributes towards a highly scalable information system.

Business applications are increasingly interconnected and can impose a massive event load to be processed by current CEP systems. Moreover, the importance of sensing devices in applications is expected to grow. In the future, the Internet of Things may comprise billions of sensing devices. CEP will be a tool to derive understandable information on the basis of a large number of events. In this context it is important to support the distribution

of event correlation in the presence of highly dynamic systems and support mechanisms for self-organization. Guaranteeing non-functional properties, such as, reliability, availability, performance, and security pose major challenges on the technical infrastructure, while expressiveness of event languages, event derivation and usability are challenges to make CEP accessible to a broader user community.

This special issue intends to provide an insight on the applications and principles as well as the evolution of CEP. Moreover, we believe the selected articles from International and German researchers illustrate current trends and challenges in designing powerful, scalable as well as secure event processing systems.

The group of Sharma Chakravarthy has a long experience in the field of Complex Event Processing and has designed one of the early and very influential event correlation languages, called Snoop. The work by Chakravarthy et al. gives a historical view on the development as well as the roots of Complex Event Processing. Furthermore, the authors point out important applications and challenges that go hand-in-hand with the development of CEP Systems.

Distributed event-based systems are the key to increase the scalability of today's information systems. Jacobsen et al. present the PADRES system which addresses the design of adaptive event-based systems. In their approach they show how content-based publish/subscribe systems can be extended to account also for composition of complex events as well as enable uniform query mechanisms for events in the future and the past.

While in the past many efforts have focused on the design of efficient and expressive event-based systems, it is often hard to estimate the performance of event-based systems in combination with QoS requirements of applications. The work by Kounev and Sachs bridges this gap by reviewing and proposing performance models that fit Distributed Event-Based Systems particularly well.

Although the benefits of distributed event-based systems are often highlighted by researchers, so far most industrial solutions still rely on centralized event processing technology. Pletat et al. identify in their article one obstacle in deploying distributed event processing



in the context of business applications, namely the lack for supporting heterogeneity. In the context of business applications they emphasize the need to account for heterogeneous event correlation technology and introduce the DHEP framework which is developed in a cooperation by the IBM Deutschland Research & Development GmbH and the Universität Stuttgart.

Finally, when moving to distributed event processing systems, it is not only important to provide efficient routing and filtering of events between providers and consumers of information, but also to account for appropriate security mechanisms. Since the routing of events often relies on the content of messages it is a major challenge to provide good security and privacy mechanisms without actually exposing content and violating confidentiality and privacy of subscribers. Only few researchers currently address security in event-based systems. The work of Bacon et al. introduces an approach to account for secure event-based systems.

We hope that you enjoy this special issue on Complex Event Processing.

Prof. Dr. Alejandro Buchmann

Dr. Boris Koldehofe



Prof. Dr. Alejandro Buchmann graduated from Universidad Nacional Autónoma de México and received his M.S. and Ph.D. degrees from the University of Texas at Austin. He is Professor since 1991 in the Department of Computer Science of Technische Universität Darmstadt where he is responsible for the area of databases and distributed systems. He has held industrial positions with Química Hoechst de México, Computer Corporation of America, Cambridge, MA, and GTE Laboratories in Waltham, MA, and academic appointments at IIMAS-UNAM and TUD as well as multiple visiting positions. His current research interests are in the areas of distributed event based systems, P2P systems, wireless sensor networks, middleware and performance modeling and benchmarking.

Adresse: TU Darmstadt, Hochschulstraße 10, 64289 Darmstadt, Germany, Tel.: +49-615116-6230, Fax: +49-615116-6229,
E-Mail: buchmann@dvs.tu-darmstadt.de



Dr. Boris Koldehofe graduated at the Universität des Saarlandes, Germany, and obtained a Ph.D. at Chalmers University of Technology. Since 2006 he works as senior researcher and lecturer at the Institute of Parallel and Distributed Systems (IPVS), Universität Stuttgart. His current research is centered on distributed systems and computer communications. In particular, his research interest includes services and applications for the Next Generation Internet, Peer-to-Peer Systems, Distributed Event-Based System, and Global Sensor Networks.

Adresse: Institute of Parallel and Distributed Systems, Universitätsstr. 38, 70569 Stuttgart, Germany, Tel.: +49-711-7816357, Fax: +49-711-7816424,
E-Mail: boris.koldehofe@ipvs.uni-stuttgart.de