Geophysical Research Abstracts
Vol. 15, EGU2013-11206, 2013
EGU General Assembly 2013

Management of natural crises with choreography and orchestration of federated warning-systems

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The project Collaborative, Complex and Critical Decision-Support in Evolving Crises (TRIDEC), co-funded by the European Commission in its Seventh Framework Programme focuses on real-time intelligent information management in earth management. The addressed challenges include the design and implementation of a robust and scalable service infrastructure supporting the integration of existing resources, components and systems. Key challenge for TRIDEC is establishing a network of independent systems, cooperatively interacting as a collective in a system-of-systems (SoS). For this purpose TRIDEC adopts enhancements of service-oriented architecture (SOA) principles in terms of an event-driven architecture (EDA) design (SOA 2.0). In this way TRIDEC establishes large-scale concurrent and intelligent information management of a manifold of crisis types by focusing on the integration of autonomous, task-oriented and geographically distributed systems.

To this end TRIDEC adapts both ways SOA 2.0 offers: orchestration and choreography. In orchestration, a central knowledge-based processing framework takes control over the involved services and coordinates their execution. Choreography on the other hand avoids central coordination. Rather, each system involved in the SoS follows a global scenario without a single point of control but specifically defined (enacted, agreed upon) trigger conditions. More than orchestration choreography allows collaborative business processes of various heterogeneous sub-systems (e.g. cooperative decision making) by concurrent Complex Event Processing (CEP) and asynchronous communication. These types of interaction adapt the concept of decoupled relationships between information producers (e.g. sensors and sensor systems) and information consumers (e.g. warning systems and warning dissemination systems). Asynchronous communication is useful if a participant wants to trigger specific actions by delegating the responsibility (separation of concerns) for the action to a dedicated participant. Implementing CEP, none of the participants has to know anything about the others. Information is filtered from a stream of manifold events (triggers) assigned to certain and well-defined topics.

Both, orchestration and choreography are based on the specification of conversations, which comprise the information model, the roles and responsibilities of all participants, services and business processes, and interaction scenarios. By the maintenance of conversations in commonly available and semantically enabled registries it is possible to establish a federation of systems that is able to provide dynamic, yet coherent behaviour. TRIDEC establishes a reliable and adaptive SoS (concurrent processing of events and activities) which exposes emergent behaviour (e.g. intelligent and adaptive monitoring strategies, cooperative decision making or dynamic system configuration) even in case of partly system failures. In a process of self-organising (task balancing and dynamic delegation of responsibilities) as SoS is able to secure the reliability and responsiveness for real-time, long running & durable monitoring activities. Concepts like Design by Contract (DbC), service level agreements (SLA), redundancy- and failover-strategies as well as a comprehensive knowledge-based description of all facets of all potential interactions ensure the interoperability, robustness and expected behaviour of the TRIDEC SoS even if it is composed of managerial independent sub-systems. Beyond these features, the adaptability of a SoS offers scalability and virtualization regarding both, systems and domains. Composability and re-use of functionality can be achieved easily even across domain-boundaries.