



## REACTOR - a Concept for establishing a System-of-Systems

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REACTOR is a working title for activities implementing reliable, emergent, adaptive, and concurrent collaboration on the basis of transactional object repositories. It aims at establishing federations of autonomous yet interoperable systems (Systems-of-Systems), which are able to expose emergent behaviour. Following the principles of event-driven service-oriented architectures (SOA 2.0), REACTOR enables adaptive re-organisation by dynamic delegation of responsibilities and novel yet coherent monitoring strategies by combining information from different domains. Thus it allows collaborative decision-processes across system, discipline, and administrative boundaries.

Interoperability is based on two approaches that implement interconnection and communication between existing heterogeneous infrastructures and information systems: Coordinated (orchestration-based) communication and publish/subscribe (choreography-based) communication. Choreography-based communication ensures the autonomy of the participating systems to the highest possible degree but requires the implementation of adapters, which provide functional access to information (publishing/consuming events) via a Message Oriented Middleware (MOM). Any interconnection of the systems (composition of service and message cascades) is established on the basis of global conversations that are enacted by choreographies specifying the expected behaviour of the participating systems with respect to agreed Service Level Agreements (SLA) required by e.g. national authorities. The specification of conversations, maintained in commonly available repositories also enables the utilisation of systems for purposes (evolving) other than initially intended. Orchestration-based communication additionally requires a central component that controls the information transfer via service requests or event processing and also takes responsibility of managing business processes.

Commonly available transactional object repositories are well suited to establish brokers, which mediate metadata and semantic information about the resources of all involved systems. This concept has been developed within the project Collaborative, Complex, and Critical Decision-Support in Evolving Crises (TRIDEC) on the basis of semantic registries describing all facets of events and services utilisable for crisis management systems. The implementation utilises an operative infrastructure including an Enterprise Service Bus (ESB), adapters to proprietary sensor systems, a workflow engine, and a broker-based MOM. It also applies current technologies like actor-based frameworks for highly concurrent, distributed, and fault tolerant event-driven applications. Therefore REACTOR implementations are well suited to be hosted in a cloud that provides Infrastructure as a Service (IaaS). To provide low entry barriers for legacy and future systems, REACTOR adapts the principles of Design by Contract (DbC) as well as standardised and common information models like the Sensor Web Enablement (SWE) or the JavaScript Object Notation for geographic features (GeoJSON).

REACTOR has been applied exemplarily within two different scenarios, Natural Crisis Management and Industrial Subsurface Development.