SEVENTH FRAMEWORK PROGRAMME (FP7)
SPECIFIC PROGRAMME 'COOPERATION' - ICT
THEME: INTELLIGENT INFORMATION MANAGEMENT (ICT-2009.4.3)
GRANT AGREEMENT NO: 258723

COLLABORATIVE, COMPLEX AND CRITICAL DECISION-SUPPORT IN EVOLVING CRISES

PROJECT SUMMARY

OBJECTIVES

TRIDEC is developing new approaches and technologies for intelligent information management in collaborative, complex and critical decision processes in earth management. The key objective in TRIDEC is the design and implementation of a collaboration infrastructure of interoperable services through which intelligent management of dynamically increasing volumes and dimensionality of information and data is efficiently supported thus enabling multiple decision makers to respond quickly via a collaborative decision-support environment.

TRIDEC will establish rapid, on-demand interoperability of inherited legacy applications and tools provided by the project consortium partners. Collaborative computing is used to establish the decision-support enterprise system of services which can deliver timely critically information to decision makers during environmental crises such as tsunamis or during the drilling process of an exploration well. Environmental crisis and subsurface utilisation are only two examples of the applicability of the proposed research, which integrates software services development and computational methods with collaborative technologies.

The main objectives of TRIDEC include:

- Construction of a robust, scalable service infrastructure supporting the integration and utilisation of existing resources including distributed sensor systems, monitoring facilities and geo-information repositories as well as simulation, processing and data fusion systems.

- Development of services for the flexible management and configuration of system resources especially sensor systems including the configuration of discrete sensor networks and tasking of sensors in order to realise intelligent observation and monitoring strategies.
- Design and implementation of a knowledge-base for intelligent information management providing essential context information for the aggregation, storage and retrieval of large volumes of information, e.g. about system components, prognostic models, rules, data and information models, ontologies, as well as past crisis events and simulated data for system tests.
- Construction of tools for the design and execution of complex information logistic processes and workflows steering ingest and fusion of data as well as rules for the selection of context information delivered by the TRIDEC knowledge-base.
- Design and implementation of an adaptable framework for collaboration and decision-support environments supporting complex business processes including both the intelligent management of crisis situations and the systematic testing of system features and training of decision makers.
- Development of two application prototypes for the validation of the TRIDEC system in the environmental crisis management and the Industrial Subsurface Development.

DEVELOPMENT CYCLES

In order to achieve the objectives and because of the complexity of the system, three life-cycles and system prototypes will be developed and evaluated against the requirement of the targeted user group. The specification of the overall system architecture plays an important role for the design and development of both TRIDEC core components and the application pilots. Especially the system-of-systems nature of TRIDEC has to be taken into account. The spiral approach for requirement analysis, design and development activities includes test phases with increasing quality levels so that the results of the project are validated against the requirements of the respective user domains:

- In the 1st phase (up to M12), a light-weight system will be implemented. The system consists of the core common components defined in WP3.3 that are integrated with a simple Decision Support Service (DSS), knowledge-base and basic user information access. This prototype will focus on supporting an event bus and a simple version of the service bus, and a resource, component and service repository.

- In the 2nd phase (up to M24), the existing light-weight system will be extended to also integrate a full enterprise service bus and security services in order to allow operators of the data acquisition sites to help protect the confidentiality and integrity of their data. This task will also integrate extended knowledge-base and DSS sub-systems. Prescribed workflows for more extensive thematic services will be supported. Any design changes necessitated by the performance, resilience and scalability modelling will be included.

- In the 3rd phase, this system will be further extended. A fully functional multi-bus supporting multimedia streaming as well as advanced DSS and knowledge-base sub-systems will be integrated. Full thematic pilot applications will be implemented. In order to respond to evolving conditions the system supports the dynamic composition of individual workflows that can be orchestrated and controlled at runtime.

TRIDEC focuses on two application fields namely environmental crisis (Tsunami use case) and subsurface development (Drilling Operations use case). Both environments have a very high social and economic relevance and represent only two examples of the broad applicability of the innovative TRIDEC concept.

TRIDEC System Architecture

The further development of the TRIDEC system was executed in three interdepending activity fields, the TRIDEC system architecture, the core software components as well as the demonstration and validation activities.

Scenarios, stories and use cases resulting from the requirements analysis of TRIDEC Y1 in conjunction with the Y2 demonstrators, helped to update specific user and systems requirements. The requirements provided important input for the system's architectural design and the development of the core components but also for the application pilot.

Guided by the feedback of the 2nd TRIDEC Review and the recommendations of the domain experts of the Scientific and Technical Advisory Board the core middleware components, including the middleware, the knowledge-base and the decision support components were integrated to complement the Y3 heavy-weight system. A key element for the System-of-Systems (SoS) implementation was the development of a federated message-oriented middleware (MOM), based on Apache QPID, including extensions for resilience and scalability to ensure guaranteed message delivery, broker replication and broker load balancing. Scalability and resilience support was enhanced with an improved MOM resilience model. Based on the achievements in Y2, the work progressed to integrate the knowledge-based components under the TRIDEC SoS as sub-systems, and the development of fusion and modelling services for both TRIDEC application scenarios.

Full thematic pilot applications were assembled from the evolved TRIDEC framework and software components. The TRIDEC system no allows the dynamic composition of individual workflows that can be orchestrated and controlled at runtime. The structure of the TRIDEC architecture follows the ISO and IEEE standard ISO/IEC42010/IEEE1471 on the description of system architectures.

Development Core Components

The challenge for Y3 was the integration of the core components, including the middleware, the knowledge-base and the decision support components into the heavy-weight demonstrator and to demonstrate their system requirements behaviour as part of the application-driven use-cases. A key element for the SoS implementation was the development of a federated message-oriented middleware (MOM), based on Apache QPID,

including extensions for resilience and scalability to ensure guaranteed message delivery, broker replication and broker load balancing. Scalability and resilience support was enhanced with an improved MOM resilience model. Based on the achievements in Y2, the work progressed to integrate the knowledge-base components of WP4 under the TRIDEC SoS as sub-systems and the development of fusion and modelling services for both TRIDEC application scenarios.

In the Natural Crises Management (NCM) scenario, the testing and tuning of TEDA (Tsunami Early Detection Algorithm) on the sea-level signals from tide gauges was carried out. The effects of meteorological conditions on Tsunami propagation and impact were assessed. Work continued on multilingual Twitter analysis with different classifiers. The work carried out in WP5 focused on harmonizing and adapting the Decision Support Services (DSS) and the Decision Support Ontology (DSO) with other TRIDEC components for integration into the System-of-Systems architecture. Specifically, a bundle comprising the main WP5 components was released for use by the other development packages. The bundle includes a number of interfaces for the Workflow and Rule Engine and for the Semantic Registry. For reference and test purposes, work on building-up and hosting a Decision Support and Workflow Management Infrastructure continued e.g., for Natural Crisis Management, the geo-references visualisation of Tweets and its integration into the CCUI via WMS/WFS.

In the Industrial Subsurface Development (ISD) scenario, work continued regarding the 'ream & wash' prediction algorithm, pump-startup evolution prediction, and critical operational state classification. The registration of SensorML-based 'sensor descriptions' in the Semantic registry via REST as well as remote access to the SR vie SPARQL was implemented. Outcome of the above work was the integration of WP5 components into the middle-weight demonstrators

DEMONSTRATION AND VALIDATION

The 3rd project phase started with the validation of results of the 2nd phase of the TRIDEC development process. This included middleware and knowledge-base, workflow management and decision support components as well as the application prototypes. The demonstrations were part of the 2nd Project Review Meeting in October 2012 that took place at the premises of the European Commission in Luxembourg. The mid-weight Y2 NCM system was also demonstrated to decision makers and operators during several training workshops at the premises of KOERI in Turkey and IPMA in Portugal.

An evaluation of an extended version of the mid-weight Y2 NCM occurred during the context of the international NEAMWave12 exercise. On November 27–28, 2012, KOERI and IPMA joined other countries in the North-eastern Atlantic, the Mediterranean and Connected Seas (NEAM) region as participants in an international tsunami response exercise. The NEAMWave12 simulated widespread Tsunami Watch situations throughout the NEAM region. It is the first international exercise as such, in this region, where a tsunami warning chain of the NEAM Tsunami Warning System (NEAMTWS) has been tested to a full scale with different systems. One of the systems is the TRIDEC NCM system and has been validated in this exercise by KOERI and IPMA against official international NEAMTWS requirements as well as individual national requirements. KOERI, representing the Tsunami

National Contact (TNC) and Tsunami Warning Focal Point (TWFP) for Turkey, is thus one of the key partners in TRIDEC. KOERI is responsible for the operation of a National Tsunami Warning Centre (NTWC) for Turkey and establishes for the Eastern Mediterranean, Aegean, Marmara and Black Seas so called Candidate Tsunami Watch Provider (CTWP) responsibilities, which correspond in other regions to Regional Tsunami Warning Centre (RTWC) or Regional Tsunami Service Provider (RTSP) responsibilities, as for the Indian Ocean Tsunami Warning System (IOTWS). Another key partner is IPMA, representing the TNC and TWFP for Portugal, establishing NTWC operations for Portugal, and establishing CTWP responsibilities for the North-eastern Atlantic region. Based on their profound experience both, KOERI and IPMA, are contributing valuable requirements to the overall TRIDEC system and are responsible for the definition and development of feasible tsunami-related scenarios in the context of activities in the Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North-eastern Atlantic, the Mediterranean and connected seas (ICG/NEAMTWS) of the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization (UNESCO-IOC). However, within the context of the TRIDEC project, KOERI's and IPMA's most important input focuses on testing and evaluating the TRIDEC system according to specified evaluation and validation criteria in order to meet ICG/NEAMTWS requirements.

The testing focus for the ISD scenario test bed was on evaluating the individual components in regards to primary reliability, scalability, performance and efficiency and correctness e.g. calculation errors, data-type violations as well as the performance of the whole test bed. The main goal was to provide relevant information about potential upcoming critical situations and how these situations can be avoided fro the drilling crew on a rig or the monitoring crew in the date centre. Therefore, the drilling alarm system (test-bed) has to provide the necessary information. Therefore, the current framework was further elaborated and components improved. Currently, the test-bed uses data from historic and computed tsunami events to demonstrate the TRIDEC Drilling Support system by using the improved Data Stream Player. As the demonstrator framework for the rig is available, algorithms can now be continuously improved, new ones developed and consequently tested within an integrated test-bed. The results of the algorithms are visualised in the application for the driller. This application as improved by considering the performance requirements (e.g., update rate of the rime serous diagrams, number of used points) of the 'drilling' application domain. The integration of components progresses iteratively and a test in Ketzin allowed to validate the software under real world conditions.

TRIDEC is funded under the 7th Framework Programme by the European Commission. The project started in September 2010 and, after a duration of 38 months, it ended in October 2016. For further information please refer to the TRIDEC Portal (www.tridec-online.eu) of contact the Project Coordinator Prof. Joachim Wächter (wae@gfz-potsdam.de).