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TRIC³DEC

Collaborative, Complex and Critical

Decision Support in Evolving Crises

Co-funded by the European Commission under FP7 (Seventh Framework Programme)

ICT-2009.4.3 Intelligent Information Management

Project Reference: 258723

Challenge Earth Management

From Knowledge...

Never before in the human history mankind has been able to watch and monitor continents moving and the large potential fields like the magnetic field or the gravity field changing at various different scales and intervals as in our days. The enormous movements of matter and energy in the deep interior of the Earth cannot be touched directly but observed by indirect ways of sounding. Classical methods are brought in for this purpose by geology, geophysics, and geodesy. The advent of the digital revolution, however, has influenced these scientific disciplines in a dramatic way, bringing them to an evolution at a speed hitherto unknown. More than enlightenment, the introduction of digital information and communication technologies has led to an explosion of knowledge concerning materials, processes, and history.

How do continents move? What are the driving forces behind the existence of mountain ranges? Why do oceans and ridges open and close? What is a safe place for settlement, and what not? Where to find metals under ground, or water in the desert? How to make critical raw materials, i.e., rare metals, available to the markets that are driven by technology innovation cycles? Many of the crucial questions seem to be closer to a solution than ever before. This vast basket of abilities, hence, is necessary as human societies are facing the enormous challenges of continuing huge population growth and the effects of global warming.

Questions of dramatic size and importance remain, others are newly generated by the way. Indeed, we started bridging the huge gap between autonomy of natural processes and the human habitat, or anthroposphere. System architecture, intelligent data management and responsible data handling are key factors on our way to cope with Earth's intrinsic signs of steady evolution and the constantly ongoing global change. Humans have excelled in ignoring, misunderstanding and over-exploiting the planet. It is an expression of wisdom when we keep on going into a different direction and strive for the next steps in order to secure lives and health of men, and to take responsibility for our unique telluric habitat.

Towards Management....

Because we can't change the geology, natural scientists and engineers have focused on new ways to use our knowledge on Earth's generation and the 4.6 billion years of development history. Based on the new evidence and the enormous range of monitoring and observation tools, it is timely to embark on a new geoscientific approach towards Earth management. Certainly, the large amounts of incoming data are required to have the shape and properties suiting to our needs. They call for standards, protocols and up to date user profiles. Geographical Information Systems make available the data for models and scenarios which constitute the basement of societal measures, e.g. warnings to be issued at the time of imminent geological hazard. Moreover, it is more and more critical to become aware of crises, both Earth intrinsic and Earth technology generated, at the earliest possible stage, and to have the solutions by the hand.

Preface

Science and engineering communities in Europe and the rest of the world now live in an information age with increasing volumes of information from monitoring and observation systems via affordable means of communication. This information is accessible to much larger communities of multi-disciplinary users than ever before. Furthermore, the volume of generated data is growing continuously. In the natural science and engineering disciplines alone, field survey data has increased from gigabytes into terabytes during the last decade and will likely exceed tens (or hundreds) of petabytes in the next decade. Such large volumes of data have to be stored, intelligently retrieved, analysed and efficiently distributed to groups of collaborating users.

The magnitude of the challenge taken on in TRIDEC becomes obvious when one looks at the expected development in computer sciences:

While computing power doubles every 18 months (according to Moore's Law), meaning that it grows by a factor of 100 in ten years, the input/output bandwidth in systems increases by only 10% each year, or a factor of 3 in ten years, with data volumes doubling every year, or by a factor of 1000 in ten years. Consequently, as the growth in data volume accelerates, it becomes very challenging to manage such data and intelligently retrieve important information in time for decision-making. This challenge can never be greater than in those crises, noted in the earlier paragraph.

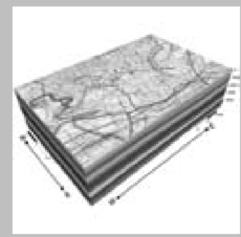
In particular, the challenge is to design appropriate software architecture, that is able to handle and make use of the extraordinary volumes of data we are confronted with. The potential fields of application are innumerable.

In this project, we focus on two use cases:

1) Tsunami Events: Large numbers of technical experts and emergency decision-makers from intergovernmental agencies are involved in monitoring of real time occurrence of Tsunami. This work is based on information provided from sensors networks, video feeds and other media reports. The objective is to minimize the likely impact of the tsunami on coastal regions and to take timely measures for saving lives and ensure the evacuation of vulnerable communities to safer zones inland.

2) Drilling Operations: Large numbers of engineers, financial analysts and decision-makers from energy companies work collaboratively in planning- and forecasting of drilling systems operations. These tasks are based on real-time monitoring via sensor networks, assessing the integrity and performance of the drilling operations. The main benefit consists in avoiding of critical situations and accidents and thus minimising operational delays and financial losses.

Environmental crisis and subsurface utilisation are only two examples of the applicability of the TRIDEC concept which integrates software services development, computational methods with collaborative technologies. This brochure gives an outlook on the approaches to manage and make use of excessively large data amounts in TRIDEC.



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Intelligent Solutions for Earth Management

One of the most important strategies in 21st Century Earth Management related science and engineering disciplines concerns the integration and implementation of intelligent solutions for sensing the Earth environment, numerically simulating the natural and anthropogenic processes involved and the automated service delivery of extracted knowledge for decision-support. In situ, airborne and space-borne Earth observations which are performed by multiple research and industrial organizations around the world are now generating a large volume of data and information about Earth processes and ecosystems. Nevertheless, such generated data and information cannot be efficiently managed using traditional methods of data storage and access by a large community of multi-disciplinary and collaborative decision makers, particularly those specializing in Critical Earth Management. There is, therefore, an urgent need for the deployment of generic knowledge base and decision-support services put in context of event driven service architecture and make them available on demand to large subscribing communities of users according to their professional requirements for conducting crises as they evolve in time and the action they may take to mitigate upon foreseeable impacts which may occur during crises. The TRIDEC project will deploy Knowledge Base services specializing in reusable and structured data fusion, mining and meta-information enrichment services for decision-support. These services scalability and robustness will be tested on two major pilot studies concerning natural and industrial crises management. Specifically, these respectively include the management of Tsunami events on coastal cities; and Industrial system malfunctions during exploratory oil and gas drilling operations. The TRIDEC intelligent information management based technology will also explore further applications in context of „Living Labs for Earth Management“. These will be provided with the Knowledge Base services, as the TRIDEC generic enablers, for achieving participative „Earth Management“ in the future.

1 The TRIDEC Project

TRIDEC

Collaborative, Complex and Critical

Decision Support in Evolving Crises

TRIDEC Facts

FP7 ICT Call 5:
Intelligent Information Management

Acronym:
TRIDEC

Reference:
258723

Start Date:
01.09.2010

End Date:
31.08.2013

Duration:
36 months

Contract Type:
Collaborative project - IP

Costs:
8.9 million €

Funding:
6.79 million €

Coordinator:
GFZ German Research Centre for Geosciences

TRIDEC is an Integrated Project – partly funded by the European Commission under the Seventh Framework Programme. It focuses on new approaches and technologies for intelligent geo-information management in complex and critical decision-making processes in earth sciences.

Decision-making processes usually depend on the collaboration of many different services and institutions. The key objective in TRIDEC is to design and implement a collaboration infrastructure of interoperable services through which intelligent management of information and data, dynamically increasing both in terms of size and dimensionality, is efficiently supported. This will enable multiple decision-makers to respond efficiently using a collaborative decision-support environment.

TRIDEC will establish rapid and on-demand interoperability of inherited legacy applications and tools owned by the project consortium partners. By using collaborative computing techniques TRIDEC makes the components work together to establish a decision-support enterprise system of services which can critically deliver timely information to decision-makers. Those are concerned with natural or industrial crises such as those encountered during tsunami events or operational processes during exploratory drilling respectively.

The main objectives of the TRIDEC project include:

- Construction of a robust, scalable service infrastructure supporting the integration and utilisation of existing resources. These include distributed sensor systems, monitoring facilities and geo-information repositories as well as simulation, processing and data fusion services.
- Design and implementation of a knowledge-base for intelligent information management providing essential context information for fusion, and mining of large volumes of information, e.g. about system components, prognostic models, rules, data and information models, ontologies, past crisis events and simulated data for system tests.
- Construction of tools for the design and execution of context-aware intelligent information processing and orchestration, steering the ingest, fusion and mining of data under the guidance of the latest task, uncertainty and belief contexts available.
- Development of application demonstrators for the validation of the TRIDEC system: Firstly for simulated tsunami events (environmental crisis management) and secondly for the monitoring and management of drilling processes at an exploration well (Industrial Subsurface Exploration).

The TRIDEC architecture focuses on the design, and specification of the scalable, robust and resilient TRIDEC collaboration platform, the core infrastructure for the TRIDEC system, using hybrid design principles based on Service Oriented Architecture (SOA), Event-Driven Architecture (EDA).

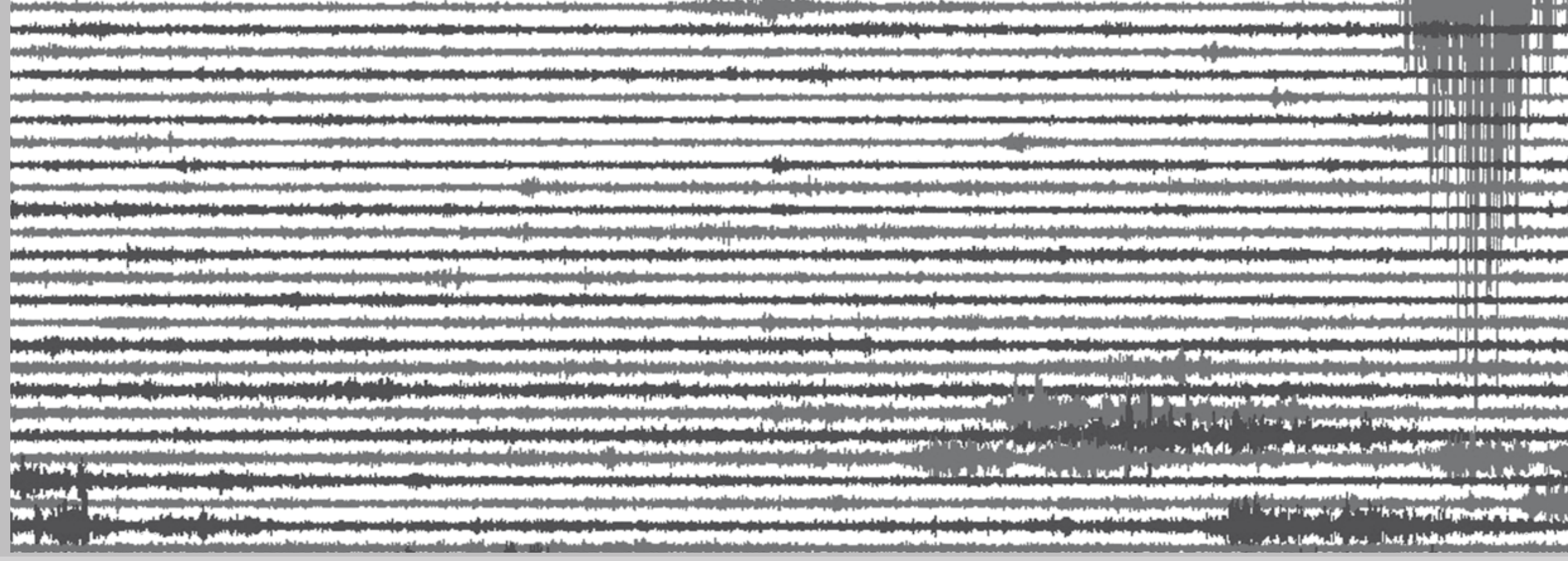
Loosely coupled service components, such as atomic and compound data processing services sensor-based or data feeds; and data storage resources coupled to a network infrastructure will provide the basic components of the TRIDEC information logistic system.

The major architectural design of the TRIDEC system of services comprises the following:

- Interfaces with the thematic and domain specific services for the two use cases
- Interfaces with the Knowledge-base Services
- Interfaces with large data servers

2 Data to Knowledge

How TRIDEC supports decisions



Current early warning systems like the German Indonesian Tsunami Early Warning System (GITEWS) already make extensive use of standardisation and functional integration. Based on the results of successful EU FP6 projects DEWS, SANY, TRANSFER, NERIES and other international ventures like GITEWS, the TRIDEC crisis management prototype assimilates state-of-the-art mechanisms which are derived from the principles of international standards and service oriented architectures:

- Encapsulation of proprietary resources
- Loose coupling of components
- Location transparency of services
- Separation of concerns

Following these principles, it becomes possible to realise robust systems which allow interoperability between arbitrary types of systems, including legacy systems, the seamless integration of various heterogeneous information resources and components, and the efficient access to generic services based on international standards.

In addition to the integration of existing and new resources, innovative methods, processes and workflows might be developed and adapted to the decision-support system.

As far as the integration of new resources is concerned, large progress will be achieved by decoupling their utilisation from the implementation phase.

One of the primary objectives of TRIDEC is to provide a set of or generic, components, processes, and workflows which are exchangeable and applicable to many collaborative information management system. The application of knowledge to and semantically qualifying processes and information according to their specific and respective domain contexts in TRIDEC will lead to significant progress for the establishment of autonomous, adaptive, and agile systems of systems.

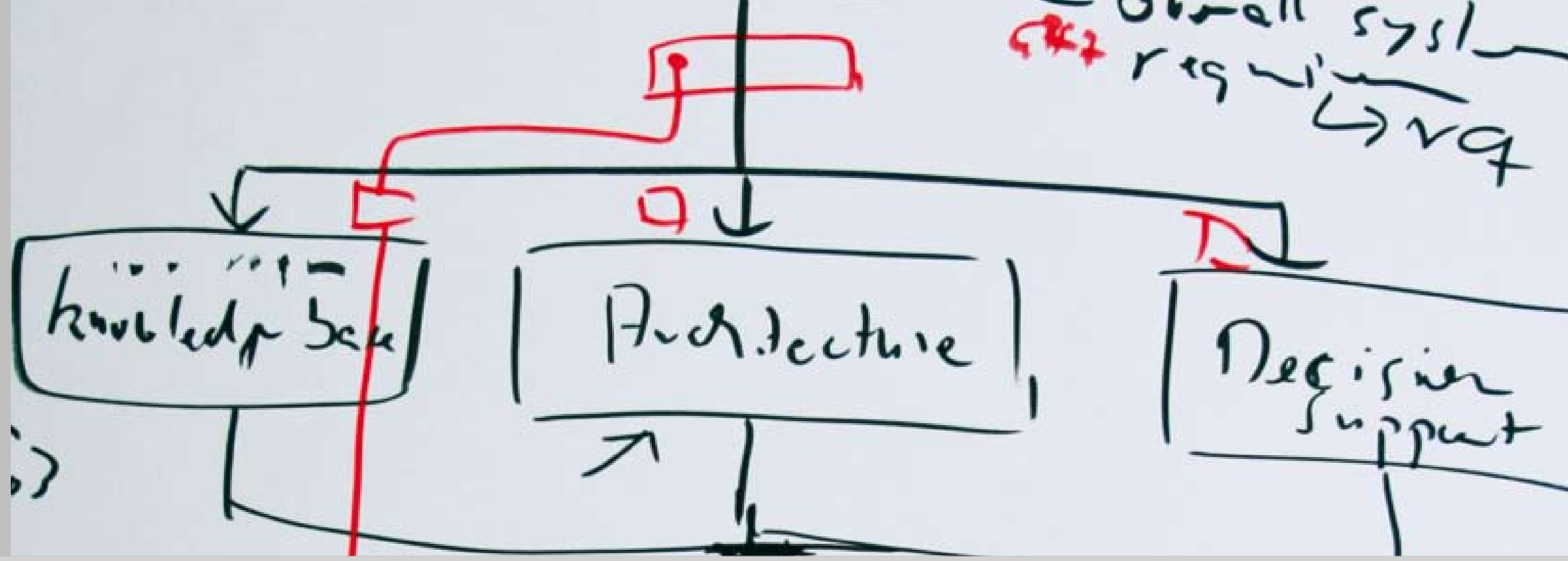
It is of paramount importance to critically deliver the relevant information to the right people at the right time in natural and industrial crisis management.

Due to the large volume and heterogeneity of data and information to be processed critically for decision-support, it is necessary to put in place collaborative and interoperable system environments. Furthermore, a system of systems can sustain the federation of concerns high flexibility for the delivery of critical information for decision-support in crises management.

One of the most promising approaches in the delivery of large data and information is to dynamically subscribe to real-time observation data, reference data, simulation results, field information, and feedback of human target groups from different sources with standardised access. The TRIDEC system of services will maintain itsoperations even with reduced or varying quantity, quality and reliability of information from multiple heterogeneous sources. TRIDEC will provide decision-support through mechanisms for orchestrating basic services into human-understandable and semantically rich simulations and decision-support services. Other high-level services will be provided by the Knowledge-Base, e.g. for metadata enrichment of real-time information feeds or context-aware intelligent information filtering prior to data fusion. Service orchestration will be based on semantically enhanced descriptions of the capabilities of the basic services. The scenario-specific workflows will generate tasks which make use of these high-level services for answering requests posted by – even inexperienced – end-users.

3

System Architecture - *Enabling Intelligent Information Management*



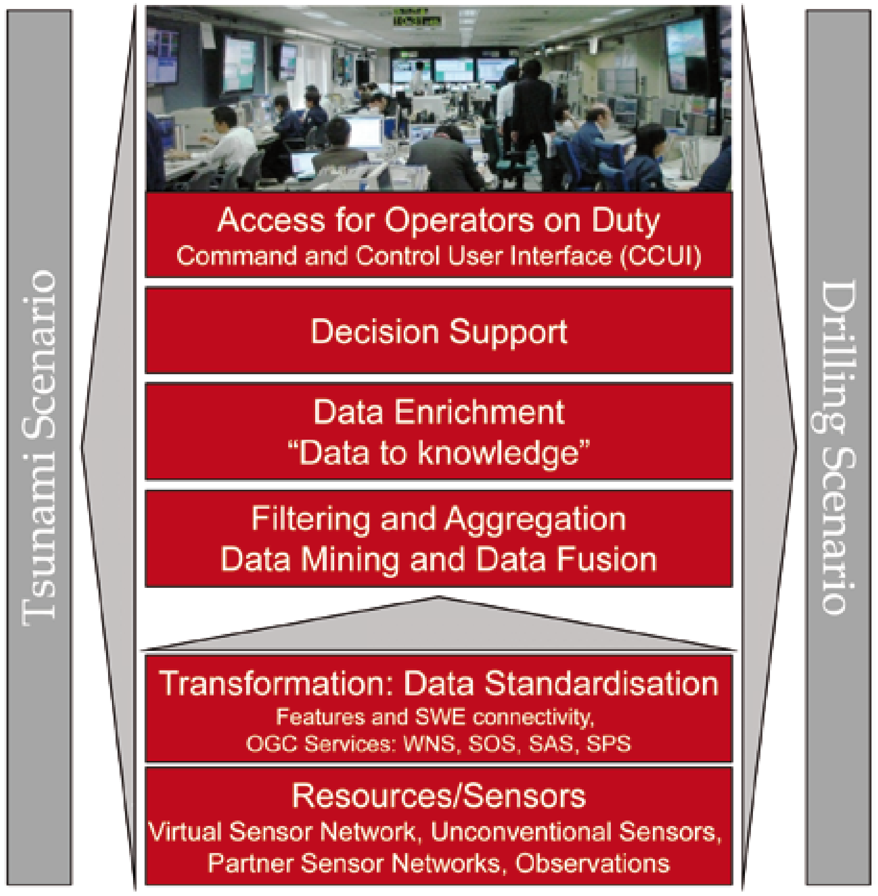
Information management during environment crises concerns managing local interaction among people and between people and information systems within the vicinity of environment crises. It concerns managing remote interaction with emergency management personnel and information services. Local interaction concerns the acquisition of data from various sensors that monitor part of the physical environment, e.g., a region prone to a specific natural event such as a Tsunami or an industrial site such as an oil rig where a manmade environment crisis could occur. Intelligent Information management processes in general involve intelligent information resource management, including acquisition and pre-filtering, intelligent information exchange, processing, storage and interactive presentation for human use.

Multimedia information exchange and heterogeneous information flows: Collections of environment sensors produce time-sensitive streams of alphanumeric data. In addition, local people may create and distribute multimedia images, text messages and videos, intermittently and asynchronously. Information processing and decision processes that are operational during environment monitoring may generate pre-planned or dynamically planned synchronised information workflows. Information at different levels of precision and richness may be used by a variety of stakeholders ranging from: citizens and untrained personnel that require clear, simpler, understandable information to inform and guide their activities; to environment scientists and data processors that require accurate numerical data to help them better understand what is happening; to decision makers that require data summaries, rich multimedia data and redundant data flows to help them confirm data decisions and to orchestrate informed data flows.

Volatile, intermittent and very variable bandwidth data flows: of the order of hundred if not thousands of environment sensors may routinely make measurements within a region, from once per ten seconds to a hundred times per second depending on the signal frequency and the rate of change of signal of interest. Hence, data rates and data volumes of the order of 100 MB/s equivalent to several tetrabytes (1000s of gigabytes) per day of data are generated and need to be processed. Human generated multimedia data and environment information services generate additional data. During crises, some sensors tend to be configured to make measurements more frequently because the environment is in a high state of flux; the rate of human multimedia communication also increases substantially. This high rate of information flow is coupled by both sustained and intermittent disruption to communication caused by physical destruction of network components, disruptions in the supporting network infrastructure and network congestion.

Current practice to support communication during environment crises tends to be designed to support relatively low rates of sensor data flow and to support single media communication and homogeneous synchronous information flows based upon service-oriented system models that do not tend to perform well with high data volumes. In addition, many systems have no specific strategies to deal with volatile communication links.

The system architecture proposed by TRIDEC is designed to handle the core challenges. Firstly, TRIDEC will make use of a communication infrastructure to separate out and more optimally manage event-based, e.g., sensor, data, synchronised service interaction. Different types of interaction can be separated into optimised communication channels but multiple interactions can also use a common bus if needed. Secondly, TRIDEC will explicitly build and test performance models of different designs to model what–if and worse-case scenarios, e.g., escalating system loads, data floods and resource failures. Thirdly, TRIDEC will specifically design and incorporate best-practice resilience design, through extending its wealth of existing expertise in designing resilient communication infrastructures and combining this with the results of its substantial performance monitoring and evaluation models and expertise.



Overview over the modular TRIDEC core structure being applicable to both the Tsunami and Drilling Scenarios.

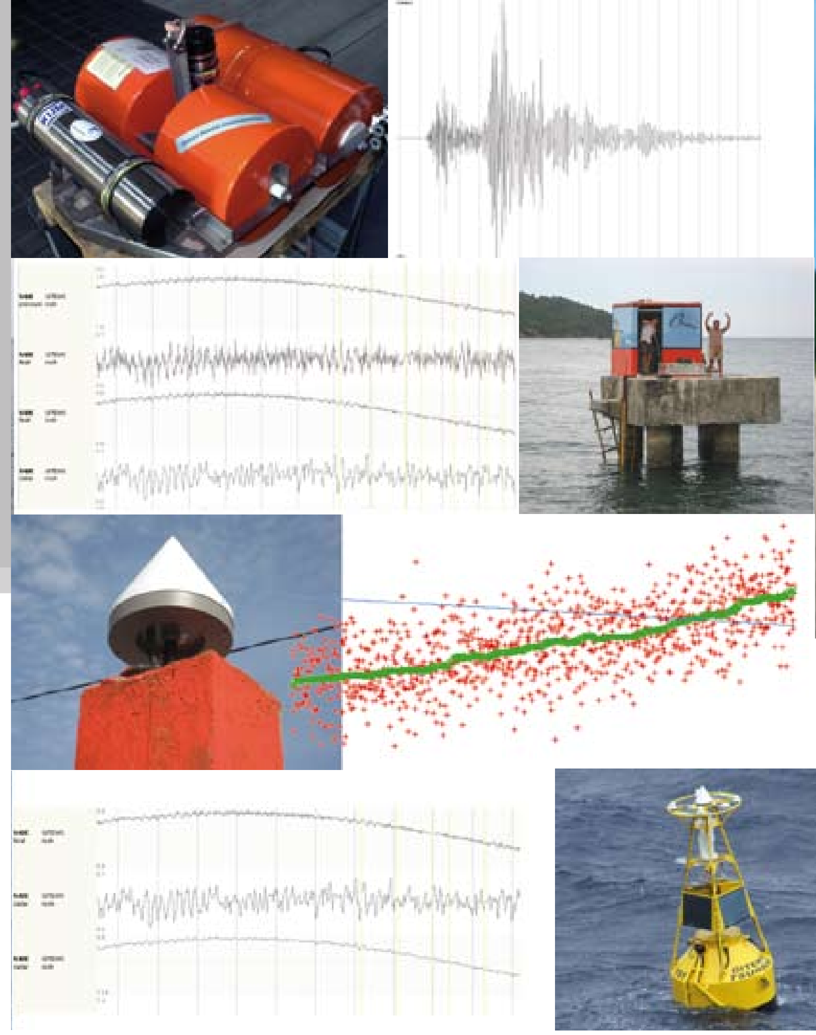
4 Use Case: Natural Crisis Management for Tsunami

The TRIDEC concept will be applied and tested in two application domains. The first one deals with a crisis related to natural causes. In particular the occurrence of a tsunami in the Mediterranean and eastern Atlantic region. The reason for choosing this test case is manifold and can be summarised as follows. The tsunami which occurred on December 26th 2004 in the Indian Ocean clearly demonstrated that tsunamis can be destructive over spatial scales ranging from local (i.e. close to the source) to wide areas, as they can travel across ocean basins and produce destruction even very far from the source. Although several countries around the world started to develop national tsunami warning systems (TWSs) and despite the improvements made by already existing TWSs, very recent events in the world (September 29th 2009, Samoa islands; February 27th 2010, Chile; October 25th 2010, Mentawai islands, Indonesia) demonstrated that the challenge of reducing drastically the time needed to detect a tsunami and to send proper alerts to all the countries and/or the communities that are close to the tsunami sources still lacks a proper and effective answer. Furthermore, the choice of the Mediterranean Sea and of the eastern Atlantic ocean is suggested by the fact that 1) these areas represent the basins with the largest number of historical documented tsunami occurrences after the Pacific Ocean, 2) millions of people live in coastal areas exposed to the threat of tsunamis, 3) potential tsunami sources, especially in the Mediterranean, are not limited to tectonic sources but include also landslides and volcanic eruptions, 4) tsunami sources are placed close to the coasts, making the TRIDEC challenge even more demanding.

Hence a TWS based on appropriate monitoring and sensor systems, on suitable information and communication technologies including data mining and fusion, on a reliable Decision Support Service and on a verified alert dissemination chain can win the challenge of having the TWS reacting in a time span appropriate for the affected area, e.g. confined within minutes for communities close to the source. The TRIDEC Natural Crisis Management case for tsunami will pursue this target by moving from a number of earthquake- and landslide-generated tsunami scenarios to the integration of the available real-time sensor networks and data, from the definition of the roles of national TWSs and local Civil Protection Agencies to the identification of the End users and stakeholders and of their requirements.

Beyond the needs for national TWS an effective cooperation across national as well as system boundaries is crucial in any tsunami crisis management. Therefore TRIDEC addresses collaborative information management and decision-support processes in hypothetical natural crisis situations caused by a tsunami in the Mediterranean and eastern Atlantic region. Beyond early warning limited to local areas and conditions the demonstrators aim at establishing a collaboration infrastructure covering an area which is not only characterised by its size but also by its heterogeneity concerning impact of crises, management equipment, available communication infrastructures, or the availability of human resources involved in decision taking.

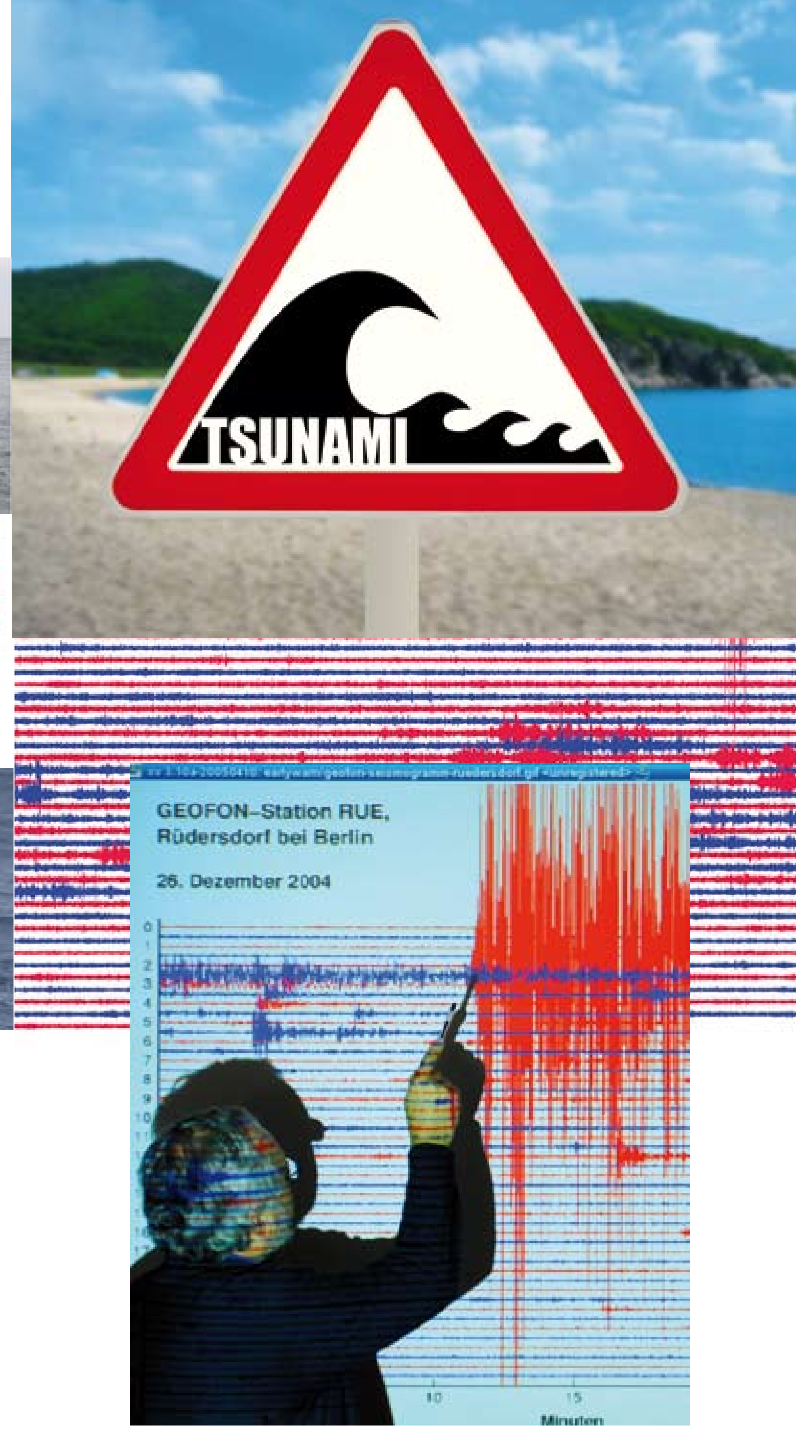
In the framework of the natural crisis test case, the term data represent two major groups of information. The first group is connected to real-time and dynamically collected sensor measurements. The main data sources will consist of seismic data coming from already established national or transnational seismic networks, GPS data, deep ocean observations and tide gauge recordings. Already established sensor networks will be used in TRIDEC, but the Consortium envisages the possibility of deploying new sensor installations as well as of using non-conventional sensors, such as Internet-related information (social networks, RSS feeds and similar), accelerometers of permanently deployed hard drives and human “sensors” with mobile devices. The second group includes reference data (bathymetry, topography, coastal



infrastructures, land use), catalogues (earthquakes, tsunamis, historical instrumental records), and databases with simulations forecasting possible propagations for a variety of tsunami sources and estimating the impact of possible affected areas..

Managing the huge amount of data and the resulting information flow which accumulates in crises situations is one of the most challenging tasks in modern information management. In case of emergency situations information has to be exchanged with national and regional crisis management systems. These mechanisms safeguard that no evolving crisis is overlooked. Vice versa, local systems might deliver observations and measurements for regional systems thus providing additional input for the successful handling of the crisis situation. It is of vital importance to show that system boundaries of both a physical and a logical nature do not necessarily have to be clearly delimited. Especially in case of one system’s breakdown another system should be able to take over its range functions in parts or completely.

Each studied scenario will represent a test bed for the TRIDEC TWS demonstrators in terms of capacity of tsunami event detection, of warning centre communication on a local and wide area scale and early damage estimation in case a tsunami is confirmed by sensors and will strike a given coastline. The quality



of the TWS does not only rely on the ability to detect the event and communicate the relevant information to the identified warning centres, but it also largely depends on fulfilling requirements defined by the end users and their expectations.

Furthermore TWSs have a long lifespan and evolve over time. New sensor-systems and types will be developed and deployed, sensors will be replaced or redeployed and the functionality of software will be improved. TRIDEC also provides management functionality which is beyond simple administration a matter of adjusting and calibrating models, or configuring sensor parameters. Moreover TRIDEC secures the reliability and responsiveness of the system by applying permanent quality control to sensor systems, reference data and analysis methods.

5 Use Case: Industrial Subsurface Exploitation

TRIDEC should help to improve the safety of drilling operations and prevent e.g. oil spills using software that is able to detect critical events. In the past several accidents showed that safety in drilling is still an issue. Sometimes such catastrophic events happen too fast. A human cannot cope with it in time. The drilling crew needs help to ensure safe operations in the oil & gas and geothermal industry.

Drilling a well is always accompanied by technical, economic and safety constraints. In the technical area safety plays a major role to prevent crew, equipment and environment from injury, damage and pollution. Equipment and instrumentation are inspected, tested and refurbished at regular intervals determined by a combination of risk assessment, local practice and legal requirements. Such a procedure helps to avoid accidents and uncertainty in risk assessment. However, the behaviour of the well formation may cause crucial situations at the rig caused by critical events such as kick, fluid loss or stuck pipe during the drilling process.

Fact is that drilling projects require a lot of capital. Thereby, drilling is the largest single expense within an exploration and reservoir development program. Consequently, there is an on-going demand to improve safety, avoid oil spills and decrease drilling costs. New intelligent information tools are necessary to help planners and drilling crews to overcome the huge technical challenges in this area. The Industrial Subsurface Development (Drilling) scenario is utilizing planning as well as historic data to build an alarming system which integrates real-time decision-support in drilling operations.

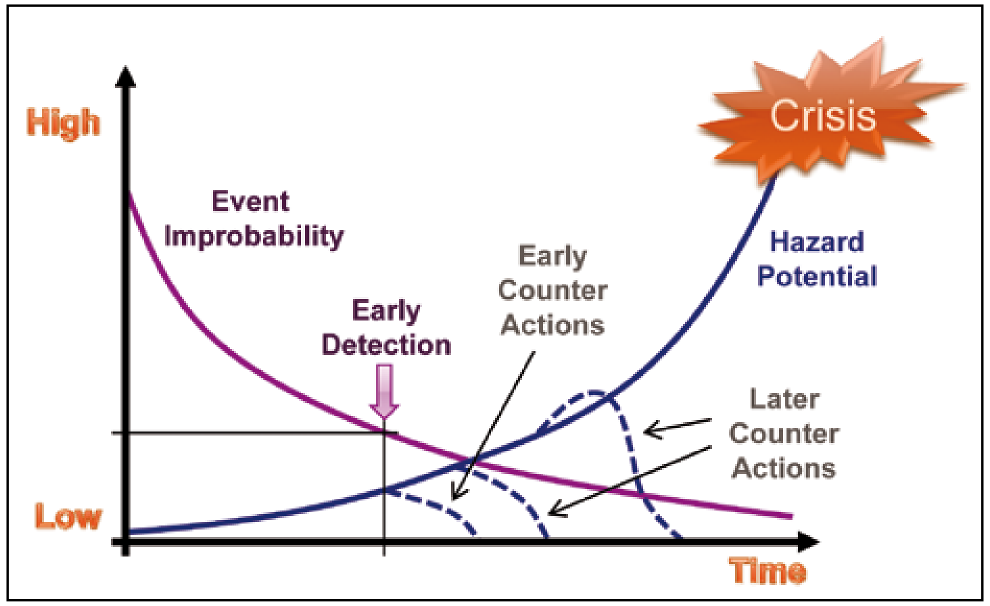
The main goals of the drilling operation alarm system are to provide the drilling crew on the rig or the monitoring crew in the data centre with the necessary information to guarantee safety and cost reduction.

- Safety can be increased by informing the crew of potential upcoming critical situations and by providing information of how this situation can be avoided. This can be done with a graphical user interface which is showing, for example, a kick alarm and providing context sensitive counter measures and emergency instructions.

- The decision-support system is responsible for detecting upcoming critical situations as well as tracking the current operation. It is very important to continuously adapt the „upcoming critical event classification“ on site by a local adaptation to the specific situation, which will be reached by on-line learning methods that we are planning to use.

- To reduce cost it is important to track the operations on the rig floor, to inform the crew when deviating from the planned operation duration (target) and to identify and reduce non-productive time.

Deepwater Horizon oil spill
The oil slick as seen from space by NASA's Terra satellite on May 24, 2010. © NASA



Recognition of critical events and associated counteractions

For operational drilling management, the real-time sensor data streams, textual reports from the drilling crew and the available planning data is used as input for the local decision-support system on a rig. In addition, the data is also streamed into a data centre and analysed there too. Later, this archived sensor data may also be used for training decision-support systems.

From the system's point of view, it is essential that the alarm system allows evolutionary changes. The alarm system has to be adaptive as new plans of drilling sites are added, drilling rigs are moved to different locations, rigs are added, or the sensor setup is changed. A service-oriented approach - as it is planned with TRIDEC - fits very well with these use cases. The drilling monitoring alarm system includes components such as sensor systems, repositories, simulation- and data mining tools e.g. incremental on-line learning, clustering algorithms or dynamic data mining techniques for the support of agile monitoring processes.

6 Training, Education, Data and Data Policies

Training, Learning, Knowledge Base

TRIDEC produces architectures and software for data and information management in complex crisis situations. The main goal of the concerted venture is the development of an innovative software architecture, embracing a service platform as well as the next generation of work environments supporting human experts to manage and mitigate emergency situations which have their causes in the Earth system, in particular in the geosphere.

The intelligent information management requires context enhanced data. For this purpose, special software tools are being developed in TRIDEC, which enable the users to optimise operation and deployment of system resources based on a knowledge base. New functions to support both – complex workflows and decision processes – can be dynamically adapted by orchestration.

For the implementation, TRIDEC introduces a very wide range of activities suited for active and passive users. In addition, large groups of system developers and software engineers will be in need to make themselves familiar with the system in order to customise the product either for their national and political or structural and cultural – including language – conditions in the tsunami use case, or the company and project specific conditions in the case of drilling. As a consequence, TRIDEC software is not self-explanatory and needs thorough introduction.

In order to cope with the education and training demands in the scope of the project, a well balanced scheme of measures is prepared. For both application domains educational and training materials are produced and made available through the TRIDEC web portal. Training courses will be held in the Potsdam GeoLab in order to train the personnel involved in the demonstration activities. These courses are supported by means of e-learning and blended learning. They will be available even after the lifetime of the project and their contents is introduced into the actual curricula of the involved academic institutions and instructors.

Data Policies

The creation of crisis management systems requires access to large amounts and a high variety of data and information. An important task coming with TRIDEC is the definition of the principles and an implementation scheme for the acquisition, handling and exchange of data.

The policy has to become part of a set of more overarching data and information policies that aim to strengthen the ability of the Mediterranean states in Europe and Africa to establish effective early warning infrastructures for tsunami and drilling hazards. As a side effect, scientific and research communities as well as interested companies may find an entry to the field of intelligent information management.

Geological processes and geological hazard do not stop at political borderlines. Principal goals of the TRIDEC Data Policies concerning early warning include the free and unconstrained access to data, in particular trans-national sensor data sharing. Another important issue is the fitness for purpose – including the type, standard and quality of data and information, including, e.g., timeliness. Conventions will also include the agreed and valid delivery mechanisms between the partner countries.

Outlook

The pending and future requests of our society for the use of the geosphere are enormous and they will exceed the former demands in many respects. The general goals are to save human lives and property, to enable environmental sound and steady development, and to foster prosperity as well as sustainable growth. The TRIDEC project delivers a new paradigm by means of its concept of intelligent data management combining geosciences and ICT. A substantial innovation is introduced with resource efficiency and safety as most thriving factors on the economic side.

When seen from the geosphere viewpoint, there are numerous fields where the joint forces of intelligent information and Earth management will prove their usefulness. Societies try to become free of impact from natural hazards like earthquakes, volcanos, tsunami or landslides. A big step in this direction will be made by a new generation of sophisticated early warning and hazard assessment systems. Security of sites of construction or other human use with respect to sinkholes, subterranean and/or gravitational movements, subrosion or ground failure, from natural causes or from former human activities like mining or historical settlements etc. will be improved a great deal through the introduction of intelligent data management into geoscientific research expertise.

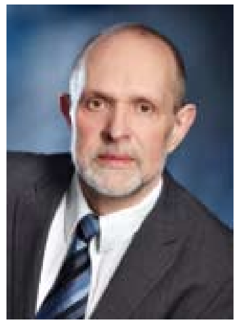
An important part of the demand concerning the various mineral resources – from sand to strategic metals – is step by step settled by means of recycling. But their exploration and controlled exploitation, carried out and supported by geoscience and backed up by intelligent information management will still have to contribute the major part. The same mechanism applies for water, in particular the strongly increasing freshwater demand and the concern about wastewater.

The geological sphere is used as a long term storage facility for unwanted gaseous materials in numerous locations. Combustion-produced CO_2, fluids and solid wastes, sometimes toxic or even radioactive, are deposited. It is a realistic option to define safety standards for the selection of suitable sites and to take over control over the necessary drilling and tunneling operations for reconnaissance, exploration and commissioning. Steady and reliable monitoring and analysis become possible by way of custom designed sensor architecture and data management which make available effective decision support.

Contintal lithosphere is our home but our dependency on the oceans and the cryosphere – arctic or continental permafrost is pressing. Soil cover may be around one meter in thickness and atmosphere roughly 20 kilometers. But: to the central core of the Earth the distance measures nearly 6.400 kilometers! No drill bit will ever be able to make its way to this depth, so we need to employ methods of global geophysics and geodesy in order to find out about the Earth's interior and its ongoing movements and changes – masses, viscosities, pressures, velocities, energy and matter, from step to step, from sand to ferro-nickel. However, it is mainly drilling which guarantees us direct access to the deeper underground. Drilling operations security improvement and, at the same time, the drastic reduction of cost will be important drivers of the economy and the better availability of renewable energy resources, e.g., geothermal energy.

Last but not least, it is of utmost importance to serve the scientific communities in order to enhance the possibilities of carrying out basic and fundamental research in order to enable the scientists to gain profit from the TRIDEC experience and methods, and to further develop the system, as well as its components and the overall TRIDEC philosophy.

TRIDEC Workpackages & Leader



WP1
Management

Prof Joachim Wächter

GFZ

WP2
End-User Requirements and Scenario definition

Prof Stefano Tinti

University of Bologna

WP3
Architecture and Core Components

Dr Stefan Poslad

Queen Mary University

WP4
Knowledge Base

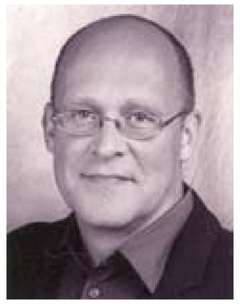
Dr Zoheir Sabeur, MInstP, CEng, CPhys

IT-Innovation

WP5
Service Orchestration and Decision Support Workflows

Fernando Chaves-Salamanca

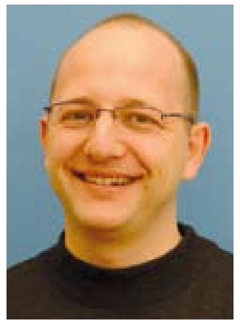
Fraunhofer-IOSB



WP6
Natural Crisis Management

Rainer Häner

GFZ



WP7
Industrial Subsurface Developement (Drilling)

Herwig Zeiner

JOANNEUM

WP8
Project Communication - Dissemination - Exploitation

Andreas N. Küppers

GFZ

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