

CITRINE - COMMON INTELLIGENCE AND TRACEABILITY FOR RESCUE AND IDENTIFICATION OPERATIONS

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Keywords

EU policies, humanitarian operations, coordination, integration, decision making

Abstract

Nowadays, humanitarian action is impaired by delay, due to poor situation assessment, and by organization problems, due to lack of coordination between all involved agencies.

CITRINE is a PASR Project co-founded by European Commission that aims at developing an integrated set of shared information management tools and models to facilitate the efficient integration of diverse emergency and management services for humanitarian operations and rescue tasks, in support of the external policies of the EU, with an emphasis on security aspects and attention to organizational structures, inter-organizational co-ordination and communication, distributed architectures and human factors.

CITRINE will support the crisis management process in mitigation, damage assessment and preliminary recovery phase, focusing on humanitarian activities provided by NGOs and Health Services.

The objectives of CITRINE are:

1. Development of a scalable, modular information system for situation assessment that will:
 - a) Collect, analyze, store and display data for early warning,
 - b) Provide a coherent picture of the current situation along with prediction to assist through a DSS the decision makers in situation understanding.
2. Reporting on specific points of coordinating operational emergency team to an incident.

CITRINE is the only project of PASR focused on NGO operations and aiming to pave the way towards a pan-European humanitarian IT System.

CITRINE has developed a generic system that can be implemented in all the entities and level of the humanitarian chain. This system is composed of IT host structure, applications and communications, and builds up a library of modules. The effectiveness of CITRINE has been demonstrated during the trials (library of modules and ITC structure) for both coordination and tactical phases.

Introduction

Nowadays, humanitarian action is impaired by **delay** due to **poor situation assessment** and by organization problems due to **lack of coordination** between all involved agencies (NGO, Health Services, Civil Protection, Local Authorities, etc.). Recent natural events like earthquakes in Turkey (August and November 1999), Tsunami in Indonesia (December 2004)

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and Katrina hurricane in New-Orleans (August 2005) emphasized such problems resulting in a large number of casualties and weeks of total disorganization for protecting endangered populations.

When assessing the situation each agency addresses partially the situation with regards to its domain of expertise. No overall situation assessment is performed, which often results in misinterpretation and inadequate engagement and action.

CITRINE is a PASR Project co-founded by European Commission that aims at developing an integrated set of shared information management tools and models to facilitate the efficient integration of diverse emergency and management services for humanitarian operations and rescue tasks. CITRINE has been developed through the active interaction of the following partners: SESM (IT), ELSAG (IT), THALES Security Systems (FR), THALES Research and Technology (FR), EADS Defence and Security Systems (FR), SKYSOFT (PT), UNIVERSIDAD POLITECNICA DE VALENCIA (ES), AMI (PT) and ITTI (PL).

CITRINE integrates state of the art building blocks into a consistent system to develop a first version of a coordination centre, while focusing on the humanitarian mission domain. The system has been demonstrated in the trials.

First, for that purpose, data, models and consequences corresponding to the crisis itself are needed. How many casualties are created, of what severities and with what geographic distribution? How many hospitals are damaged and to what degree, how many bridges and roads? Second, the assets and operational procedures of, and relationships between, the emergency response organizations must be known.

Without the first there is no crisis state to be understood, and without the second there is no awareness possible of what the responders need to understand, no knowledge of what constitutes situation awareness for those users. For that purpose, a wrong crisis Situation Assessment (SA) is a contributing factor to many accidents and incidents.[1]

Regarding decision making mechanisms, research shows that almost 80% of the time currently spent in the decision cycle is in the information-gathering and collaboration phases, leaving little time for the actual decision and almost no time for action.

CITRINE Decision Support System (DSS) reduces the first two phases, leaving the human with enough time to do humanitarian collaborative operations.

CITRINE allows exploring how co-ordination could be achieved among NGOs mandated by the European Union to intervene on the field of a large disaster and humanitarian organizations. The way to improve the overall efficiency relies on technical means but also on standardization, common procedures or policies to be implemented at European level.

Thesis

Information is fundamental to successful cooperation in crisis management operations. Communications interoperability and shared situational awareness are widely recognised as vital to effective emergency response. The proper management of information and the resulting analysis of crisis situations are crucial for informed decision-making and the effective use of resources. A coherent and co-ordinated reaction can only be based on accurate information that must be produced and transmitted with speed and precision.

Nowadays, the only available framework born with the aim of coordinating interventions in the event of major emergencies, which may require urgent response actions at European and International level, is the Community Mechanism for Civil Protection. It acts as a focal point for the exchange of requests and offers of assistance and through the Common Emergency Communication and Information System (CECIS), it manages emergencies all over the world as well as inside the EU. CECIS is a tool that allows current information on the situation to be shared as well as identifying what is needed. Its main task is to host a database on potentially

available assets for assistance, to handle requests for assistance on the basis of these data, to exchange information and to document all action and message traffic.[2]

This European Civil Protection mechanism supports the National Authorities in preparing the intervention, rather than supporting day-by-day operations, and it is accessible only by Civil Protection. CITRINE aims at overcoming these limitations, as well as enhancing the number of available functionalities.

The potential benefits of wider cooperation have historically been mitigated by the unavailability of robust communications or transportation systems to support them. Increasingly, however, this barrier is being eliminated. Rapid dissemination and exploitation of usable information can be of great benefit in the first few hours after crisis strikes. Accurate wide-area damage, casualty and resource assessments can be used to direct responders effectively, guide evacuation efforts and position assets. A key enabling technology for effective information exploitation is Information Fusion.

Mastering information has a lot of meanings, sometimes contradictory:

- Navigating within the information flow subject to the COS (Cognitive Overflow Syndrome) whilst looking for the “good” information,
- Filtering the necessary and sufficient set of data related to the information we want, in order to understand the situations awareness,
- Correlating different information coming from various sources and sensors for standardize their pertinence,
- Merging and fusing the data before analysis and Synthesizing afterwards,
- Measuring the impacts and the invariants of the interpretation processes, in order to avoid the complete restart of an analysis process while changing the hypotheses and the data etc

The field of information fusion is an **interdisciplinary** research area embracing mathematical theories (decision theories, game theory, automata, categories, standard and non standards logics), data mining, knowledge Rendering, language technologies, ontologies, image and video processing (wavelet transforms, etc.), uncertainty management and perception based on human factors issues. CITRINE federates these skills in order to develop the unified Situation Assessment frame.

CITRINE innovates and brings a breakthrough to DSS. CITRINE objectives are to define a unified approach to cognitive information fusion and then to validate it through the design of an innovative information frame enhanced by understanding capabilities through the definition of models for situation perception and comprehension in order to acquire the deep understanding of the situation. This frame provides means for a situation awareness picture featuring decision-aid mechanisms. For that purpose, CITRINE:

- Captures several types of knowledge: declarative knowledge (what to do), procedural knowledge (how to do it) and operational knowledge (when to do it);
- Overcomes human limitations (cognitive overload, etc.).

Moreover this sequential way (which is currently in use in most of the practical situations, due to a lack of **interoperability** among the different tools in use) in addition to its low performance rate and computing time, generates errors and misinterpretations. These approaches based on the latent concepts of rapidity and of simultaneity must be definitely applied, when dealing with multi sources and multi-type information, which will be the future of information Decision and Management systems and which is a key characteristic factor of “Crisis Management” both in anticipative or current management modes.

The ultimate objective of CITRINE is the development of a scalable decision support system based on advanced models and technology for supporting two major issues: the coordination and the logistic of humanitarian and rescue teams and the evacuation of the injured people.

Interoperable framework

CITRINE provides a new systemic approach in crisis monitoring by adapting or developing innovative concepts and techniques from other fields through the facilities provided by an interoperable framework.

Technological software components whatever their abilities to process data to reach meaningful results always require from users manual operations (data export and import) to take advantage of them all. Automatic interfaces can speed up processes but can't provide users with possibilities such as navigating through the data, or automatic alerts.

CITRINE implements a new conceptual approach that integrates state-of-the-art software components to achieve the best performing solution possible through an interoperable and scalable architecture. In this area innovation lays also in a new architectural concept, enabling software component to interact together through a generic framework that has interfaces with various legacy systems.

To achieve these results, maximum benefit is taken from the combination of isolated technologies through a robust framework that provides interoperability capabilities and services able to automatically process data in such ways it is of greatest help to organizations working in the area of humanitarian collaborative operations.

Early warning and crisis monitoring

To assist this crisis monitoring process, constructive communication can be used to address misconceptions and misunderstandings over situation change, risks and uncertainties. Indeed, steps should be taken to ensure that the importance of uncertainty to the end decision is effectively communicated in any step of the crisis. This should include providing:

- an appreciation of the overall degree of uncertainty and variability and the confidence that can be placed in the analysis and its findings;
- an understanding of the key sources of variability and uncertainty and their impacts on the analysis;
- an understanding of the critical assumptions and their importance to the analysis and findings; this should include details of any such assumptions which relate to the subjective judgements of the analysts performing the analysis;
- an understanding of the (un)important assumptions and why they are (un)important;
- and an understanding of the extent to which plausible alternative assumptions could affect any decision.

Decision support

Dynamic decision making is often complicated by the complexity of the information involved. Much of this complexity arises from context-sensitive variations, multiple levels of details, uncertainty and the dynamic nature of the underlying phenomena. These problems are particularly complicated with regard to both the different types of information and the complexity of events. Therefore, to make decisions in high density and/or ambiguous situations such as crisis situations, a DSS needs to be able to represent and manage such a myriad of information.

Cognitive Decision Support Systems, as successors of DSS, traditionally follow the decision logic line of thinking, and include algorithmic tools found in DSS to improve the choice activity of decision makers. This includes optimization methods, mathematical programming, multi criteria models etc. The actual weakness of DSS is that they are "structure related", that is, they normally assume that the decision problem can be formulated mathematically and do not stress information processing and display. By contrast to DSS, Expert System (ES) or knowledge-based systems, as successors of the "General Problem Solver" follow more the process paradigm of cognitive decision theory; they do not necessarily assume that the

decision problems can be formulated as mathematical models; they substitute human expertise for missing efficient algorithms and they are not structure- but context related, with much smaller domains of application than DSS. Some consider ES as part of DSS, others see DSS and ES as basically different systems and others combine the two approaches into “cognitive decision support system”.

Emergency and Crisis situations are examples of dynamic decision making where a cognitive decision support is necessary. Equipped with such support system, users will:

- better select appropriate strategies and tactics;
- better determine a course of actions;
- predict possible reactions and consequences;
- optimize the allocation of limited resources;
- provide explanation of decisions made;
- reduce uncertainty and speed up reasoning processes.

CITRINE demonstrates various decision support techniques that can be of high value for the early warnings systems in stressed situations. These techniques do not aim to replace the system operators, but greatly facilitate their tasks by presenting a set of various actions to undertake and explaining the advantages/disadvantages of each option. The “intelligent” modules implemented in the system are easily configurable to be adapted to the organizational rules, preferences or working habits of each user. The definition of the HMI (in a broad sense) has been therefore performed in full interaction with an NGO.[3]

Implementation

The next-generation of DSS for crisis management must address two fundamental issues central to the work of CITRINE – cognitive overflow and the integration of structured and unstructured insight.

The analysis components directly addresses cognitive overflow through systematic screening and interpretation of information to identify relevant evidence for analyst consideration. It is essential that mark-up schemas in structured data are maintained and available for analysis in combination with information extracted from unstructured data.

Seven modules, one hardware and six software compose CITRINE system:

- PSS (Patrol Support System)
- AGATE (Advanced Geographic Alert Tool for Emergency)
- GEOXCIA (GEOgraphic eXpedite Crisis Information Assessment)
- EMERALD (Electronic Management of Elements Representation And Location Database)
- OPAL (Operative Procedures Advanced Lab and Messaging Tool)
- AMETRINE (Assistant Management Enhanced Tool for Refugees and Internally displaced pEople camps)
- SAPPHIRE (Strategic Action Plan Preparation for improving Humanitarian Rescue Efficiency)

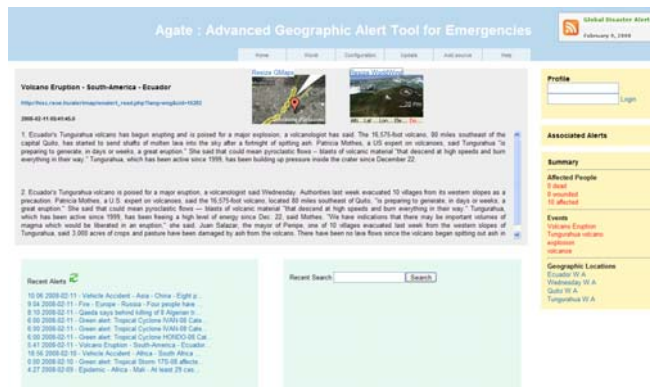
Here below a synthetic description of them.

Figure 1: Example of PSS interface



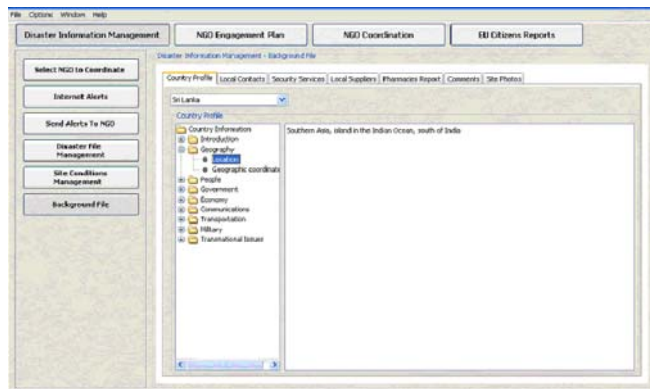
PSS is a palm-held device mounted in a shock-resistant, water-proof, protective shell, which acquires pictures (even in night vision), audio, text notes and fingerprints; it associates GPS references to acquired data and downloads information on a central database for further elaborations. PSS allows people on field to capture relevant information useful to support rescue operations and coordination.

Figure 2: Example of AGATE interface



AGATE is a module for data acquisition and information fusion. It monitors news from the Internet and processes it using semantic analysis techniques. AGATE automatically extracts key features of relevant news: disaster, geographic location, number of affected people.

Figure 3: Example of GEOXCIA interface



GEOXCIA is a network-centric distributed system for overall situation awareness and common picture. GEOXCIA provides up-to-date reports on the disaster situation and background.

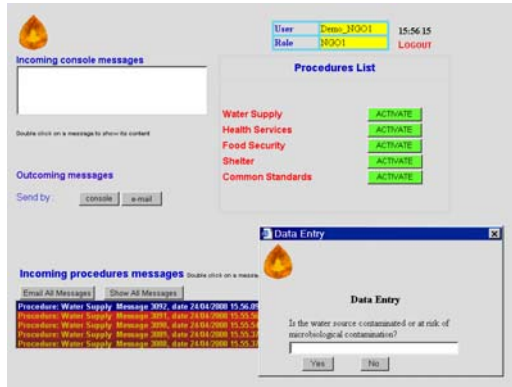
Figure 4: Example of EMERALD interface



EMERALD is an object representation display for situation awareness, supporting situation assessment. EMERALD is also the database of the overall CITRINE application for all the information to be stored with many interfaces and data synchronization. This database is specially designed for emergency relief management systems based on international standards for such

a situation system, which guarantees interoperability with other agencies systems (police, sanitarian, etc.). EMERALD uses the schematic map with the most important information about roads and communications.

Figure 5: Example of OPAL interface



OPAL supports activity coordination, allows the correct information flow, suggests the operators what to do, monitors the evolution of the events and reports the decisions and actions taken. OPAL collects at coordination level information and alerts coming from other modules, dispatches useful information to all actors involved in the humanitarian crisis management in each operational phase, provides procedural guidelines to on-field operators, produces operational reports.

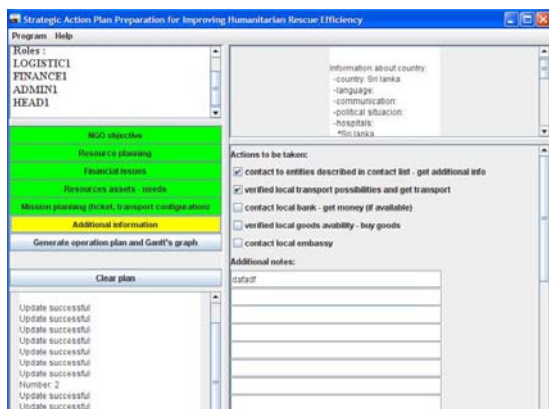
Figure 6: Example of AMETRINE interface



AMETRINE is a disaster camp management support tool. As inputs, it uses disaster planned resources and camp residents database. AMETRINE performs, at tactical level: resources and needs assessment, needs forecast, resources allocation, alarms

triggering. AMETRINE uses algorithm for extrapolation and statistical modelling, constraints programming and genetic algorithms.

Figure 7: Example of SAPPHERE interface



SAPPHERE's objective is to help NGOs to prepare the operational plan for the humanitarian operation and coordinate it with the plans of other NGOs. SAPPHERE provides resource plan and operational plan (including Gantt graph).[4]

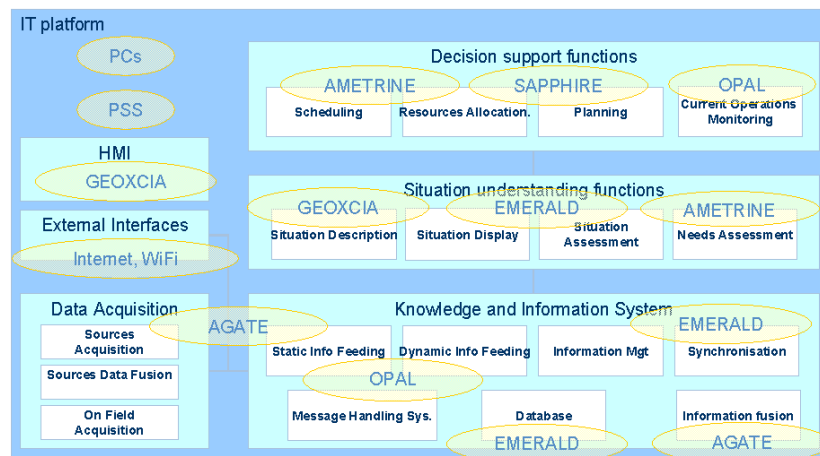
CITRINE provides four main functionalities:

- Data Acquisition
- Knowledge and information repository

- Situation understanding
- Decision support

The following picture shows how software modules provide these functionalities.

Figure 8: Functional representation of CITRINE integrated modules



Application

In order to demonstrate CITRINE effectiveness in managing humanitarian crisis, a demonstration has been organised in Lisbon in May 2008.

One of the partners, AMI, is a NGO and its role in CITRINE project was user requirements definition and demo validation. AMI tested, as an end user, the final release of the system during the demonstration, analysing also usability and portability functions, in order to validate the overall solution. The test session covered a complete crisis process, from detection of humanitarian disaster to on field tasks.

CITRINE system is a software solution not having specific constraints on hardware, it is able to work on standard PCs. Moreover, the architecture of CITRINE allows to fully work offline and synchronise when a connection is present. CITRINE system is by essence modular. Each module has a specific role and the modules shares a common database for the system.

Findings

The flow of operation shown during the demonstration has been divided in nine functions. All functions and results obtained from demonstration were validated from AMI.

1. *Day to day monitoring of real events*

CITRINE system scans approximately 10 simulated sources (generating dispatches), giving information on 3 distinct kinds of disasters. An alert triggering concerning the Tsunami disaster in Sri Lanka is shown.

AMI comment: CITRINE would allow getting about a disaster scenario. Although information about a disaster are available through the media or in the Internet, CITRINE gives access to organized, useful and up-dated information which will help NGOs in the decision process.

2. *ALERT in EU Agency centre for coordinating humanitarian operations*

CITRINE broadcasts alarm to all users. CITRINE provides informal exchange of messages between EU Agency and NGOs headquarter to coordinate.

AMI comment: It is extremely important that the humanitarian aid provided by European NGOs becomes more coordinated and consequently more effective. Considering this, the fact that CITRINE allows NGOs to have a direct contact with EU Agency, from the moment the disaster occurs to all the aid process, is certainly an added value. CITRINE is crucial to strengthen the sequence of events that occurs in disasters.

3. Disaster: impact evaluation, info gathering, file creation. NGOs decision to go

A disaster file is automatically pre-fed by CITRINE and completed with information provided by the EU Coordinator. CITRINE shows a MAP with situation of disaster. NGOs consult the early status of the disaster file created, then the related background information.

AMI comment: the disaster file should be available in a very short period of time, due to the fact that NGOs will take the decision to go to the field in the first 24 hours after the disaster and will send the exploratory mission to the field in the first 48 to 72 hours. This helps the NGO to arrange things in a much more reliable and efficient manner. Having a map of disaster area indicating which kind of aid is already being provided (health, nutrition, water sanitation) and which geographical areas are already covered, will help NGOs to choose in which area the intervention will be more useful.

4. Mission planning, Planning Coordination

NGOs perform their mission planning. CITRINE compares the expression of needs in the disaster file with the cumulated expression of the goods made available by the NGOs responses. Messages exchanges go back and forth between NGO and EU Agency to coordinate through CITRINE. NGOs update their planning after discussion and finally EU Coordinator communicates his validation of plans of intervention.

AMI comment: CITRINE allows defining all the humanitarian goods to be provided (either to be achieved in Europe or in the disaster area) according to the real needs in the field. Having an overall picture of the several humanitarian interventions in the disaster area, the EU coordinator can provide NGOs important information to the definition of their intervention. CITRINE helps communication and coordination between NGO's and the EU Coordinator.

5. Deployment: exploratory team, area survey, NGOs Sites selection, full deployment

EU Delegate takes control over the disaster file, and updates it in CITRINE with all available information from the field. All localised objects are putted on a geographical map. EU Delegate on field puts information that were not yet localised. NGO Exploratory Teams performs a site survey in the area of the disaster. CITRINE helps them in localising and taking pictures of important things. Information can be updated directly on the map and be viewable by all NGOs.

AMI comment: CITRINE helps in terms of preparation and continuation whilst on the field. CITRINE helps to visualize the real scenario on the field. Through its PSS module, CITRINE helps in identifying missing or deceased persons on the field. This is vital in a catastrophic situation.

6. Daily activities

CITRINE allows the easy production of day to day reports from NGO Team to NGO HQ and EU Delegates. EU Delegate on field checks on CITRINE Map the situation regarding NGOs.

AMI comment: CITRINE provides detailed information from the team in the field to the headquarters and helps localising what has been done and what still needs to be taken care of.

7. CAMP management - Resources and needs assessment

CITRINE displays for each camp: resources and needs assessments (set-up, medical, water and food) and resources and needs forecasts. CITRINE also proposes a new allocation of resources as needed.

AMI comment: NGOs need CITRINE to optimize their resources in the refugee camp and to assure that any essential humanitarian good will not be missing. It helps in the preparation of sending new materials, medical aid, equipment etc.

8. Additional threatening event over the disaster

NGO Team is driving across the area of disaster and discovers something unexpected. CITRINE helps to dispatch this information.

AMI comment: When already settled in the field, NGOs are a very important local source of information, because they can detect danger situations, goods shortages or any other kind of

needs and they can alert other actors for that. CITRINE is very important at this level because it allows NGOs to communicate with other NGOs or any other actors in the field.

9. *Sphere handbook support procedures*

CITRINE helps in following best practices through a checklist.

AMI comment: CITRINE aims at making the procedure consultation quicker and more effective.[5]

Discussion

CITRINE allows getting about a disaster scenario, giving access to organized, useful and updated information that will help NGOs in the decision process of intervention. It is extremely important that the humanitarian aid provided by European NGOs becomes more coordinated and consequently more effective. Under this perspective CITRINE allows NGOs to have a direct contact with EU Agency for coordinating humanitarian operations, from the moment the disaster occurs to all the aid process.

CITRINE allows defining all the humanitarian goods to be provided according to the real needs in the field. It helps in terms of preparation and continuation whilst on the field and in localising and identifying missing or deceased persons found.

CITRINE supports the exchange of information between NGOs headquarters and their teams on the field, reporting what has been done and what still needs to be taken care of.

What is more effective, CITRINE helps in optimizing resources and tasks in a refugee camp and to assure that any essential humanitarian good will not be missing.

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