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CYber-Infrastructure for CiviL protection Operative ProcedureS

System Requirements Document
(Deliverable D11)

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EXECUTIVE SUMMARY

The purpose of this deliverable aims at giving the specific Civil Protection requirements for Grid Technology adoption. This report represents an input for Work Package 4 and defines precisely Civil Protection community requirements for Grid technology adoption.

This report provides the functional and non-functional requirements of a Grid-based infrastructure for enabling Civil Protection applications.

The three previous deliverables, especially the use-cases approach (D09), drive the study of this last one. Finally, the Civil Protection requirements (D11) will lead the study of the research strategies for the design and the enhancement of the Grid technologies capabilities.

The document is structure as follows:

The first part (section 2) describes the Scope of the Document: the role of the document in the context of the project. In particular this section presents main objective of this deliverable.

The next part (section 3) describes the new designing of the French flash floods warning system with future potential improvements that Grid technology could bring. Based on these enhancements, the functional and non-functional requirements are detailed.

The next part (section 4) gives the Winter Fires Use-Case functional and non-functional requirements

The last part (section 5) summarize the whole of requirements given by each partners concerned by Civil Protection issues.

SCOPE OF THE DOCUMENT

The main objective of Work Package 4 is to define the Civil Protection requirements for Grid Platforms (PO_4). This study is a starting point for researches on grid infrastructure addressed for future projects.

To provide this main objective, the study is based on two main axes:

- The use-cases study for French and Italian partners allows defining precisely requirements to use their existing applications on a grid platform. This study also allows enhancing crisis management organisation, forecasting and warning systems to follow up and manage with the best accuracy respectively the threatening event and corresponding CP responses.
- The “Existing Analysis Document” form (Figure 1~~Figure 1~~), presented in the previous deliverable, in which the third part permitted to collect and inventory general requirements of main operational actors of Civil Protection services.

The use-cases document (D09) described the existing state of two warning and forecasting systems for Winter Fires in Italy and Flash Floods in France. This technical descriptive approach provided a whole of important functionalities necessary to an efficient functioning in a crisis management situation. This deliverable aims to precise them in a data-processing point of view, to take into account known advantages of Grid technology, and to design a new potential functioning.

3) CP users requirements

One of objectives of Cyclops project is to identify actual needs to enhance crisis management organisation and forecasting and warning systems to follow up and manage with the best accuracy as possible respectively the threatening event and corresponding CP responses. As described in the previous part, grid technology seems to have some technological solutions in this sense. However, it could be interesting to specify, with CP users, existing and known requirements to improve their system effectiveness. These requirements could be very basic and not directly linked to grid technology advantages.

One important point is the main purpose of Cyclops project which aims at adapting and improving grid technology infrastructure to reach specific requirements of CP systems and not the opposite.

We can quote few general requirements to help you in your investigation:

Requirements	Description
Real-time or near-real-time	
Computational power	
Data sharing facilities	
Interoperability	
Fault tolerance	
Security	
Others	

Figure 1 : "Existing Anlysis Document" form

1. FLASH FLOODS USE-CASE ANALYSIS

The “Use-Cases Document” (D09) describes the existing infrastructure of the floods warning service of Gard region (SPCGD) in its administrative and operational context. Technical specifications have been detailed thanks to an UML analysis, by a global use-cases diagram and four activities diagrams. The following study relies on this previous analysis, and the general knowledge on Grid technology capabilities. Based on these analyses, EMA has designed a future potential system allowing improving the monitoring and eventually forecasting of flash floods on the competence territory of SPCGD. This prototype is presented in following (Figure 2~~Figure 2~~), it will permit to precisely inventory functional and nun-functional requirements to perform it and to develop future study on required enhancements of the existing Grid technology functionalities (WP4).

1.1 Towards an efficient spatial decision support system

1.1.1. Overview – UML use-case diagram

The main objective of the SPCGD enhancement is the transition to a human-oriented decision system to service-oriented decision system. As seen in the deliverable D9, existing tools and applications support forecaster decisions by mainly providing rainfall and discharge raw data. So, knowledge and experience on the competence territory allows the SPCGD forecasters to broadcast to Civil Protection services available information on present and future threatening events.

By Grid technology adoption, important technological modifications could be added to reach the defined objectives of SPC. In particular, SPCGD service has to forecast flash floods and not only monitors the hydrologic activity. However, one of the main difficulties, to elaborate an accurate report on floods occurring, concerns the lack of computational power. This new power could permit to take into account more ecological parameters as input parameters and moreover use different models in a real-time or near-real-time context.

Another important enhancement concerns the interoperability situation which could improve the sharing of operational and ecological data and the common decision making among concerned actors of the crisis management.

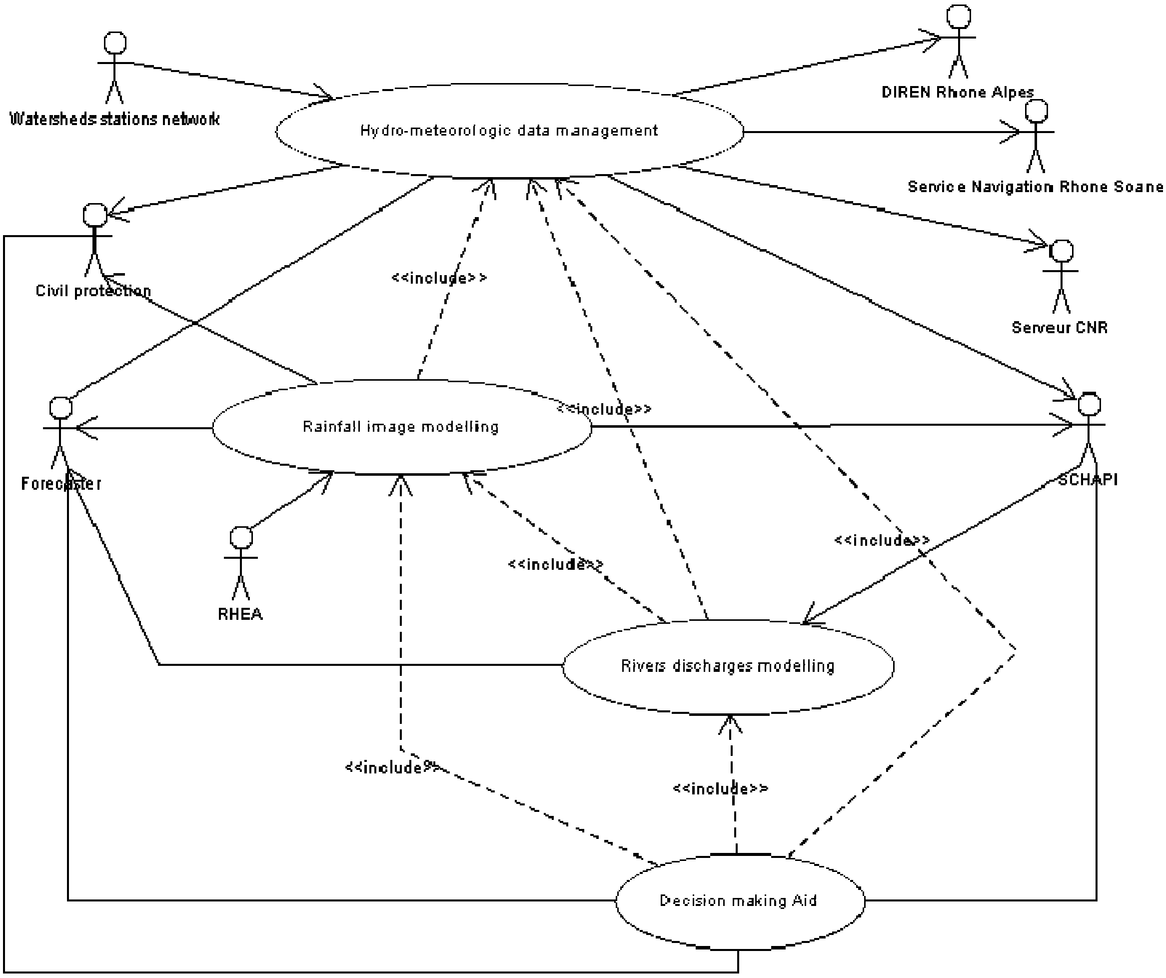

Figure 2 : The new SPCGD use-case diagram

In comparison with use-case diagram of deliverable 09, new associations and a new important activity “Decision Making Aid” have been added. Indeed, two associations with SCHAPI have been added. Presented in the administrative context of flash floods management of the deliverable 09, the SCHAPI is in charge of a floods warning services (SPC) support mission. For this reason, it exerts a mission of animation, assistance, advisor and training for the services and establishments intervening in the field of the flood forecast and, more generally, hydrology. Also, it seemed important to integrate this service in the data, information and services exchanges during a flash flood event.

The envisaged modifications are:

- The first association between "Rainfall Image Modelling" activity and SCHAPI means that SCHAPI will be able to access to calibrated radar image, action locally performed by SPCGD, to evaluate potential rainfall on the concerned zone. In this manner, SCHAPI will easily support and advice SPCGD in its decision making role.

- The second one between the "Rivers discharges modelling" activity and SCHAPI means that SCHAPI, thanks to its central role in the hydrologic issues, could provide a set of models to complete these ones already used by SPCGD.

- The new activity "Decision Making Aid" activity concerns the integration of the whole of raw and modelized data on unique web portal. By this webmapping approach, each concerned actors could more easily share its own data and consult external data. This new activity generates new associations towards:
    - SPCGD forecasters as originally
    - Civil Protection services, as the operational departmental service (CODIS) and the prefecture decision-making unit (SIDPC)
    - SCHAPI, in the same philosophy, of previous new association

1.1.2. Functioning enhancements – Activities diagrams

On the four activities detailed in the previous part (Figure 2~~Figure 2~~), two of theses ones could be improve by Grid technology adoption.

1.1.2.1. "Rivers discharges modelling" activity

Presently, the use of only one hydrologic model in an operational context, as shown in the deliverable 09, doesn't permit a reliable forecasting in a flood major event (Gard 2002, Gard 2005). Except a real need of computational power, the simultaneous use of different models could be an interesting issue.

Also, the collaboration between SPCGD and EMA, in the framework of Cyclops project, permitted to design a new infrastructure to potentially improve the modelling of flash floods in a real-time context. As seen in the previous part, SHAPI organism, in collaboration with Meteo-France, can provide a set of hydrologic models to assist SPC in their mission. A new interest is coming in the access and the use of these hydrologic models in a forecasting context. Also, it could be interesting to have a simultaneous using and confrontation of different hydrologic models in a real-time context to help forecasters in their hydrologic expertise development for public and, above all, Civil Protection actors.

For example, several models are presently used in different SPC in France:

- ALHTAÏR
- Neural network
- TopModel
- MARINE[1]
- SOPHIE[2]

The main objective is to implement a modelling platform accessible via a portal by all SPC. This platform could provide different models usable by SPC to perform an efficient forecast by confrontation of models results.

From a technical point of view, the functioning could be:

1. Secured connection to the platform
2. Inputting of competence territory characteristics

[1] Modélisation de l'Anticipation du Ruissellement et des Inondations pour des Evénements Extrêmes

[2] Système Ouvert de Prévisions Hydrologiques Informatisées avec Expertise

3. Models pre-calibration auto-choice
4. Rivers hydrographs modelling

From this point, forecasters could be able to provide an efficient confrontation of modelling results and *in situ* rivers discharges.

The following figure (Figure 3~~Figure 3~~) summarizes the previous explanation.

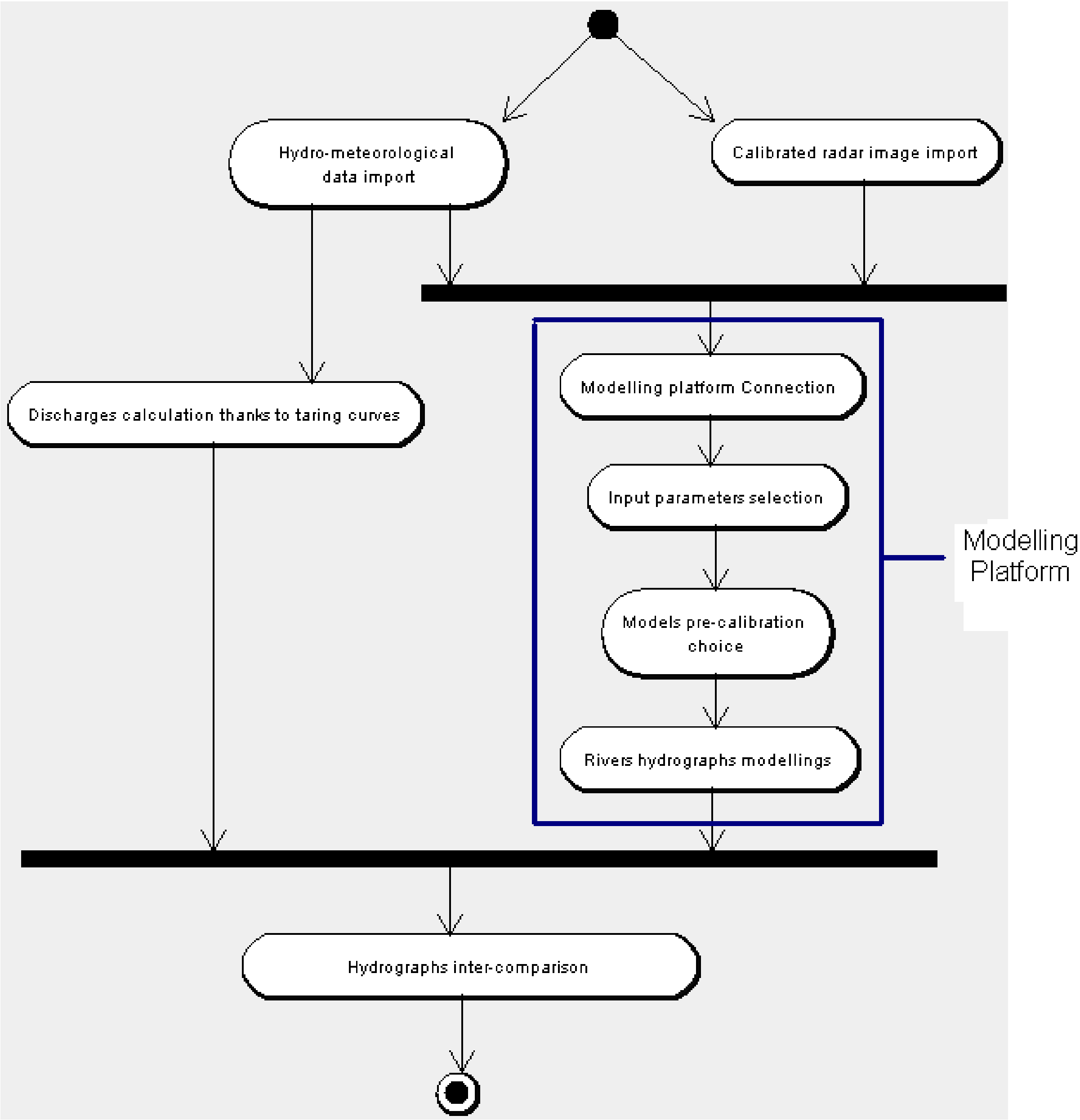

Figure 3 : "Rivers discharges modelling" activity

1.1.2.2. "Decision Making Aid" activity

Some meetings with SPCGD forecasters permitted to specify real requirements to improve the crisis management from the forecasting point of view. Presently, the data-processing infrastructure doesn't permit to have an integrated view of the whole of data and information provided by flood crisis management actors. Thematic results (rainfall data, hydrologic data…) are performed by different tools set up on different computers. Also, the direct confrontation of these results on one GIS interface is presently difficult, and is became a real need (Figure 4~~Figure 4~~). By extension, the designing of this new tool could be shared with all the flood crisis management actors in an objective of a real interoperability where each actor could share its own data and information.

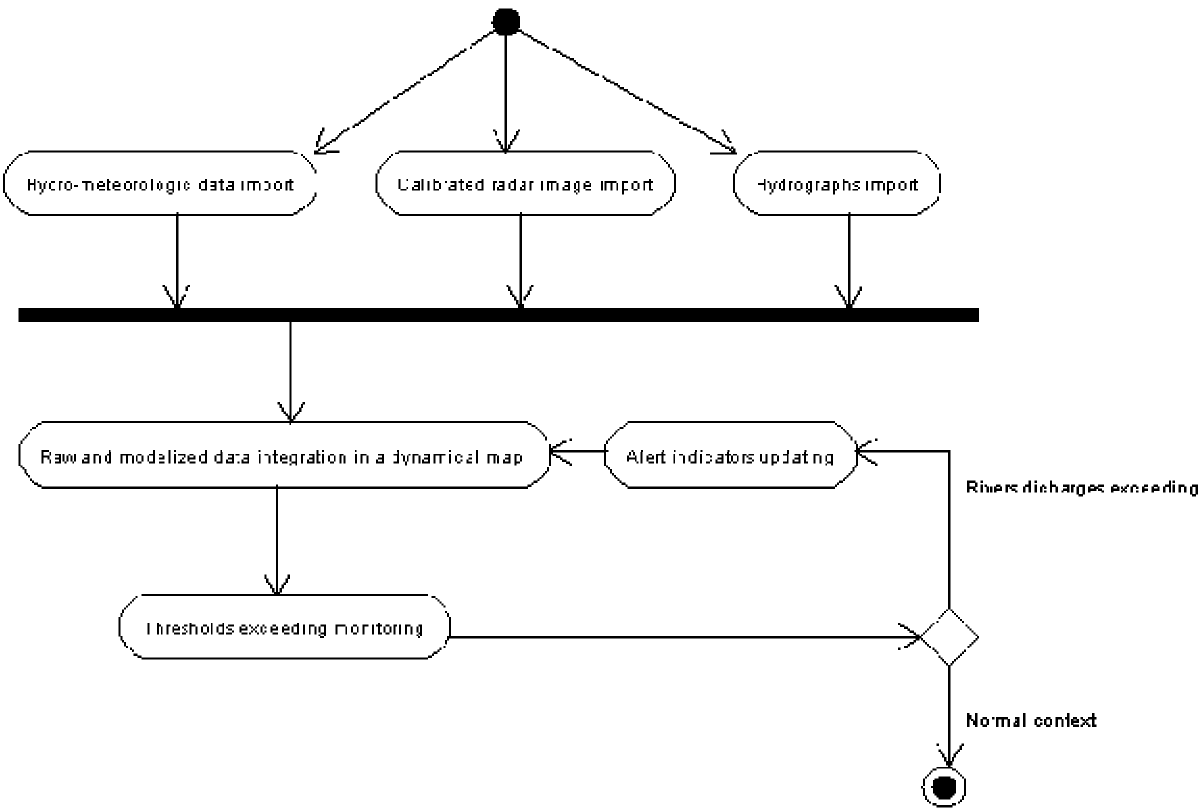

Figure 4 : "Decision Making Aid" activity

The previous figure (Figure 4Figure 4) is adapted to the SPCGD issues, as specified in the previous paragraph; some other input data could be added, especially all operational data coming from Civil Protection actors.

The implementation of this portal will be developed thanks to a WebMapping approach, in using Open Geospatial Consortium Web Services (OWS):

- Web Coverage Service (WCS) to manage raw and calibrated radar image
- Web Feature Service (WFS) to produce a integrated map
- Sensor Web Enablement (SWE), especially the Observation & Measurements (O&M) component to get raw data coming from raingauge and hydrologic stations

To complete this real-time observation portal, some simple queries will be added to support forecasters' decisions, with an automatic control discharges exceeding and automatic alerts.

One main challenge of this future spatial decision support system is to manage large datasets in a real-time context to efficiently support decision-makers in crisis management. To perform this objective application must have these following specifications:

- Updated data every 5 minutes from more a hundred measurement stations
- Multiple remote data management
- Geoprocessing functionalities on large raster data
- High time of response

1.2 Flash floods use-case requirements

According the D09 analysis completed by the previous expected enhancements presentation, a whole of requirements can be presented. To complete the technical analysis, some meetings with SPCGD experts have permitted to define other requirements. To a better understanding, and according to Annex I document advices, these requirements are classified in two fields, functional and non-functional requirements.

1.2.1. *Functional requirements*

Id	Name	Description
F1	Geospatial information access	The spatial decision support system needs to access geospatial data such as raw and calibrated radar image and raw hydro-meteorologic data
F2	Geospatial information publishing	The spatial decision support system needs to broadcast Civil Protection operational data, rivers discharges information and all input data
F3	Web coverage service functionalities	Civil Protection actors need to subset and to resample geospatial data for the analyses of thematic data and information
F4	Authentification and Authorization	The system requires a important secure access where only authorized users can access to the application and the portal
F5	Files replica	Raw and modelized data have to be stored and replicated in case of connection and/or data exchanges disruptions or failures
F6	Higher resolution processing	Forecast results and crisis management operations could be improved by higher resolution images (input and output)

1.2.2. Non-functional requirements

Id	Name	Description
NF1	Computational Power	To perform reliable modelling operations with several models, the modelling platform needs a important computational power
NF2	Time of response	The modelling platform must process data in a short time (5 min) to support SPCGD forecasters
NF3	Geospatial information standard interfaces	The adoption of standard interfaces is required both for access and publishing
NF4	Bandwidth	The modelling platform and the spatial decision support system need to access big amount of classical and geospatial data and information with a high frequency
NF5	Quality of Service negotiation	The system must make possible to define a resource prioritization and reservation in pre-alert phase (Start of vigilance phase)

NF6	Interoperability	Several actors have to communicate and to exchange a whole of critical data and information
NF7	Storage	The 5 minutes raw and calibrated radar images have a size of 1Go (545 km^2). The watershed has a surface of 2380 km^2.

2. FOREST FIRE RISK USE-CASE ANALYSIS

Based on the business process and technical description of the Forest Fire Risk use-case, several system requirements can be defined. These requirements describe the functionalities and performances that a system must provide to fully support a forest fire risk application. In particular the following requirements are based on the existing characteristics and desired improvements of the RISICO application. They are divided in functional and non-functional (performances) requirements.

2.1 Functional Requirements

Id	Name	Description
F1	Geospatial information access	The application needs to access geospatial information data such as Local Area Model output and Earth Observation data
F2	Geospatial information publishing	The application needs to publish its output that is geospatial information.
F3	Data Policy Support	The application needs to access distributed information which could have a well-defined data policy (e.g. requirements for access).
F4	Authentication and Authorization	The application must be accessed (for running and configuration) only by authorized users (humans and systems).
F5	Quality of Service negotiation	The system must make possible to define the required QoS, e.g. privileging time of response instead of accuracy;

2.2 Non-functional Requirements

Id	Name	Description
NF1	Geospatial information standard interfaces	Since there is not a predefined set. The adoption of standard interfaces (e.g. OGC) is required both for access and publishing.
NF2	Geospatial information standard data format	The system accepts and returns data in standard formats.
NF3	Bandwidth	The application needs to access geospatial information possibly characterized by big data amount (the real amount depends on the available data types).
NF4	Time of Response	The application must process data in a short time (approx 20 minutes or less) to support decision makers.
NF5	Resolution scalability	The application must be able to increase resolution without strongly affecting Time of Response.
NF6	Storage	The application needs about 20 Mb for a normal run for 2 Italian regions with a 5 Km grid. For a 100 m grid resolution 50 Gb are required;

The presented requirements of Winter Fires and Flash Floods use-cases are almost similar and mainly concern the implementation of efficient and powerful geospatial functionalities and also the need of high performance system permitting short time of response, distributed storage capabilities and an interoperability approach. An only difference concerns the quality of service negotiation. Indeed, Italian case stresses this study on privileging time of response instead of accurate results, while French case system needs both of them. The flash flood monitoring presently has some difficulty to efficiently manage and monitor the flash flood event principally because of an accurate results lack.

3. SYNTHESIS OF CIVIL PROTECTION REQUIREMENTS

According to the use-cases study and the form results, it is possible to summarize the Civil Protection requirements for the Grid technology adoption. The presented requirements mainly concern the enhancement of national warning and forecasting systems. However, it seems interesting to complete these requirements by the operational point of view. Indeed, even if forecasting and emergency management are very close in Italy, for French, Greek and Portuguese cases the important structural separation between these two phases required a more detailed analysis.

3.1 Functional requirements

3.1.1. Geospatial data support

The present trend of Civil Protection agencies is the using of geospatial data to the crisis management operations. As seen in the previous deliverables, all the concerned Civil Protection use more and more spatial data to specify natural event occurring such as RISICO system in Italy and AHLTAÏR in France, but also to monitor emergency operations such as SIZIF system in France. The next objective certainly concerns the global integration of the whole of data and thematic information provided by involved actors, towards an interoperable structure.

During the last years, in the geospatial research field, many efforts have been piloted towards interoperability capabilities. The Open Geospatial Consortium (OGC) is the best example, is “leading the development of standards for geospatial and location based services”. Presently, in Civil Protection services, even GIS systems are already implemented to visualize a natural event or an emergency situation, this approach is not yet totally developed. The implementation of Open Geospatial Consortium Web Services (OWS) is became an important challenge for Grid technology research. One of the two technical strategies, Grid-enabling OWS or Gridifying OWS (WP4 activity report), could permit to access and to publish large datasets with high performances working as required by use-cases users. To complete this requirement, each actor has to adapt data and information provided by other actors, as thematic information. Thus, it seems necessary to develop some basic OWS functionalities as subsetting and re-sampling on higher resolution product, implying an important computational power and storage capabilities.

Moreover, the need of data sharing among all involved actors of the crisis management justifies this implementation. It could be the most appropriate strategy. The use of data format and services standards with well-defined data policy and metadata information will assure efficient information sharing in a real-time context.

3.1.2. Security challenge

Another important requirements thematic concerns the security issues very close to the defence systems standards. Indeed, it represents an unconditional need to adopt new technology in Civil Protection infrastructure. Two different security topics have to take in account:

- The data and information security requiring an authentification and authorization support to safely exchange and access thematic and strategic data.
- In crisis management situation technical failures (e.g. power cut) can occur important risk for emergency phase and natural event monitoring. Thus, a files replica system among all Civil Protection actors appears as an important requirement for fault tolerance management.

3.2 Non-functional requirements

3.2.1. The hardware requirements

3.2.1.1. Computational power

Warning and forecasting systems use a large amount of data as input parameters to modelize natural event behavior. The experience of forecasting organisms (SPCGD for flash floods monitoring) has permitted to specify a real need of computational power to monitor and also forecast the natural event occurring. Lessons learnt of some major events (Gard 2002 and 2005) reveal a lack of computational power to monitor the event in a real-time context. The objective of new status of French floods warning services (SPC), to really forecast flash floods in real-time, can objectively be reached with an important increase of computational resources. The presented modeling platform can effectively improve the forecasting operation. However, the use of multi-models platform to get more accurate event behavior implies a distributed system capable of running several models in parallel and producing a large amount of results.

3.2.1.2. Storage capabilities

Generally, Geospatial data and results geoprocessing operations require an important storage capacity. For example, International Charter "Space and Major Disasters" which aims at providing a unified system of space data acquisition and delivery to those affected by natural or man-made disasters through authorized users is based on remote sensing data, known for their important size. Thus, Grid technology and its storage capacities could represent a real enhancement to manage Charter objectives. Moreover, one of technical requirement concerns the increasing of images resolution to have a more accurate assessment of natural event occurring. This requirement absolutely implies a storage capacity increasing. Thus, this capability is essential for a real-time management, but also to keep raw and modelized data in objective of models calibration and improving models efficiency in the post-crisis phase. Finally, for the lessons learnt automation, it seems interesting to easily and directly access operational and thematic information for all involved actors.

3.2.1.3. High connection and bandwidth

Crisis management situation is characterized by many exchanges among all involved actors. Present studies on Civil Protection functioning enhancements concern in particular the standardization and optimization of these exchanges such interoperability capability. The need of exchanges increasing requires an efficient connection infrastructure with a larger bandwidth permitting simultaneous information exchanges.

3.2.1.4. Time of response

One of the most important Civil Protection issues is the crisis management in near-real-time or real-time. The Use-Case (D09) study showed that these kinds of events (forest fires and flash flood) have a rapid kinetic and sudden occurring. Thus, applications and services which will port on Grid platform should run and deliver accurate results in few minutes (less than a half a hour) to support decision makers.

3.2.1.5. Quality of service

To conclude this hardware requirements study, each previous requirement could be effective in case of real resources reservation. For example, European Grid infrastructure (EGEE) provides resources for many organizations all around the Europe at the same time. Thus, it seems very important for Civil Protection agencies to have some special rights for resources getting in sudden occurring. The future system must make possible to define a resource prioritization and reservation in pre-alert phase. Without this capability, previous hardware requirements can’t be getting.

CONCLUSION

This “System Requirements Document” deliverable represents the ultimate stage of the Work Package 3 “Civil Protection systems analysis” and permits to launch the next Work Package 4 “Research and Innovation strategies definition”. These developments allow to study and understand the Civil Protection agencies functioning. “Business Process Analysis Document” (D06) and “Existing Analysis Document” (D08) revealed organizational complexity of Civil Protection agencies and their relative low level of equipment in term of data-processing.

In following, deliverable 08 specified that existing infrastructure doesn’t presently permit a rapid and global gridification of these existing systems, given their heterogeneous functioning and their subcontracting for applications development. The choice to study potential gridification possibilities by Use-Cases way allowed understanding that the grid-enabled Civil Protection services is only possible by a progressive strategy, in focusing on more suitable existing systems. The main advantage of use-cases focusing is that described services are already involved in national research strategies. In starting by a Grid-enabled warning and forecasting services, the Civil Protection agencies could take advantage of Grid technology capabilities without totally redesign their infrastructures.

Finally, one of the main challenges of next studies of Cyclops project concerns the Grid adoption strategy. As specified in part **Errore. L'origine riferimento non è stata trovata.**~~3.2.1.5~~, one of the main requirement concern important resources access in sudden time. The question of resources using requires an in-depth study to direct the future Cyclops project strategies. Indeed, the present European grid infrastructure represented by EGEE project provides resources and services for a hundred multi-thematic organizations. Resources consuming is often high. Thus, should Civil Protection agencies join the existing European Grid platform EGEE or design by Cyclops project way an independent European Civil Protection Grid platform?