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	Name / Function	Company / Organisation	Date
Managed by :	Tony Rye	BAE	22/12/08
Checked by:	Alan Cullen / SP3 leader	BAE	22/12/08
Approved by:	John Milsom	BAE	22/12/08
Released by:	Martine Couturier / project coordinator	EADS DS	23/12/08

Project Coordinator

Company name	EADS DS
Name of representative	Martine COUTURIER
Address	1 Bd Jean Moulin, Elancourt, France
Phone number	+33 (0)1 61 38 52 52
E-mail	martine.couturier@eads.com
Project WEB site	http://www.oasis-fp6.org/

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1 INTRODUCTION

The objective of Oasis is to define and develop an Information Technology framework based on an open and flexible architecture and using standards, existing or proposed by Oasis, which will be the basis of a European Disaster and Emergency Management system.

Oasis is intended to facilitate the cooperation between the information systems used by civil protection organisations, in a local, regional, national or international environment. This Disaster and Emergency Management system aims to support the response operations in the case of large scale as well as local emergencies.

Oasis provides within this framework an initial set of applications which cover the main needs that are identified by the end-users.

Clear situation awareness is a key factor for the effectiveness of disaster and emergency operations. It is based on the compilation of information collected from the different teams of responders. The building of such a picture relies on exchanging information.

1.1 Organisation of this document

This document provides an overview of the lessons learnt during the Oasis project in the area of the Command, Control, Communication and Information (C3I) applications which include situation awareness, resource management and planning tools. Section 2 provides a summary of the key achievements in this area of the project, together with a list of the key components and their status.

Section 3 summarises the key findings concerning the configuration and role of the modules which arose during the first set of Oasis trials (known as POS1) in September 2006 and in the sequence of trials (known as POS2) which took place from April to June 2008.

Section 4 reviews the lessons learnt within the C3I subsystems as deployed during the POS2 trials which were individually called the Shropshire, Czech and Romania trials[1]. These lessons are primarily issues concerning the C3I design concepts, module integration and user functionality, rather than being specific to the individual C3I applications.

Finally conclusions are drawn in section 5.

1.2 Terminology

This document refers to the TSO (Tactical Situation Object) which is a flexible XML-based representation of an incident that forms the core of the Oasis interoperability framework. The coded information in a TSO describes an incident, assigned resources and their missions. The TSO is the subject of a forthcoming CEN agreement. Refer to [2] for further information on the TSO.

This document also refers to TSO channels. These are an Oasis service that mediates TSO transmission between components generating situation data (TSO generators) and components consuming situation data (TSO consumers). For example a Resource Manager could share resource availability information with other components such as user displays via the TSO channel mechanism. This facilitates interoperability.

[1] The fourth POS2 trial, known as the Filton trial, examined the use of helmet mounted displays and voice links in a hostile environment for a fire-fighter at the incident. The C3I components discussed in this report were not deployed, and therefore the trial is not part of this assessment.

TSO may be grouped into channels according to criteria such as the incident and/or the applications expected to generate/consume the TSOs. Use of this flexible mechanism is a choice for system architects.

TSO generators can open/describe/close TSO channels and feed TSO data into the channels. TSO consumers can:

- Query the available TSO channels and then choose which is the most suitable TSO channel to be used.
- Retrieve the description of a situation defined by the TSOs fed into a channel.
- Subscribe to notifications each time the situation represented by a TSO channel is modified.
- Playback the situation as defined by the TSOs previously fed into a TSO channel.

1.3 References

[1] "Evaluation Report – POS2", D-TA2_17, OASIS_TA26_RPT_254_CRU.
[2] http://www.tacticalsituationobject.org/

2 SUMMARY OF C3I ACHIEVEMENTS

The objective of the C3I activities within Oasis was to provide a set of flexible tools to support the series of planned trials. Each of the trials deployed a different set of tools within differing operational and communications environments. This shows that the tools can be configured to operate in a range of configurations to meet the needs of particular deployments, e.g. in terms of the legacy systems and the user requirements. The C3I components developed are listed in the table below.

Tool	Description and Achievements
Resource Manager (RM)	Provides user tools for assigning resources to tasks and monitoring their utilisation and deployment using a TSO based interface that promotes integration with other systems. The trials provided a demonstration of the tool.
TSO Editor	A generic tool to display the contents of a TSO and allow a user to enter data into the system by generating and/or modifying an existing TSO. Its simple web based interface minimises client side installation requirements and the trials showed that the TSO Editor helps to promote information sharing across the user community. The TSO editor is available as an open source application (http://tsoeditor.sourceforge.net)
Situation Awareness & Common Operating Picture (COP)	The COP manages all the information provided by each user organisation and distributes the information to other Oasis applications and users. The COP fuses the information provided by different sources. The incident association concept (see section 4.2) was demonstrated to be important for multi-organisation incident management.
Planning and Tasking (P&T)	Supports the creation and management of an action plan for the deployed resources. The P&T is closely linked to the RM. The trials illustrated the role the P&T module can play in large scale events.
Crisis Management Console (CMC)	A universal application launcher which allows a user to launch Oasis applications from a single interface. This module replaced the earlier Situation Summary HMI and Activity Monitoring modules. The trials provided a proof of concept of this tool.
Alert Bar	The Alert Bar is designed to support the generation and notification of event summaries and changes in key parameters such as flood water heights. The trials provided a proof of concept of this tool.

3 INSTALLATION AND CONFIGURATION ISSUES

Experience gained during the POS1 trial revealed a number of issues concerning the installation and configuration of applications that were reported in the first version of this document. Many improvements were implemented for the POS2 trials and new capability was developed. This section presents the key findings on the installation and configuration of the C3I applications. Readers requiring more information on the POS2 trials are referred to [1].

3.1 TSO Editor

At POS1 it was noted that:

- This component was appreciated by the integrators for the fact that it needs no installation on the client side, i.e. only an internet browser is required. The TSO Editor is a client-server application. The client only requires connectivity to the TSO Editor server and to the Internet (to a public mapping service).
- An additional simplified mode of the user interface is required. Examples of functionality include pre-filled elements in the TSO and simplification of frequent actions such as the import of TSOs and their injection into the Oasis system.
- The capability to create an agency-specific TSO Editor is required. For example, for the police, the event type, the mission types and the resource types available should only include police elements.
- The TSO Editor should provide an application programming interface (API) for TSO-format specific features, such as the ability to retrieve a description of a given TSO code, or help find the code for a specific “description”, etc.

The POS2 version of the TSO Editor addressed many of these issues in an updated and expanded version of the tool.

The TSO Editor server was provided as a preconfigured virtual machine with the server running on Xubuntu operational system. Integration of the server into the Oasis trial architecture caused no major problems. The need for a clean PostgreSQL database installation was the only issue.

3.2 Common Operating Picture

At POS1 it was noted that:

- In its role as the core situation database, advanced features such as data fusion are required in the COP.
- The methods for injecting data into the COP are varied (from TSO, TSO channels, legacy systems). Additional applications which make use of these interfaces are to be developed.
- Special care should be taken with the “affiliated” components (e.g. Situation Summary HMI) to ensure that common conventions on the semantics of the data are adopted.

Conventions which define the semantics of the TSO were defined to reduce ambiguities in the data. This clarified the use of the TSO which is a schema that is capable of doing many things, and of doing some things in several different ways. This approach facilitated integration with legacy systems.

The COP module was expanded to support the management of associated incident metadata (see section 4.2 for further details). The distribution and management of this metadata was

successful but there is scope to develop a unified method for managing all the data in an Oasis multi-node architecture.

In addition the COP was supplemented with scripts to reset the database to facilitate running several scenarios in rapid succession during the trials.

3.3 Crisis Management Module

The Crisis Management Console, a new POS2 development, was created to provide a unified user interface and evaluated during POS2 trials. The CMC is an easy client side application with no special configuration needs.

3.4 Alert Bar

The Alert Bar, a new POS2 development, is a simple client-server application with no special configuration needs. However it depends on a special feature of the Oasis Application middleware called the HMI framework, which must be properly configured in order to run Alert Bar. This feature enables data and functionality sharing between running applications.

3.5 Planning and Tasking

The Planning and Tasking application is a client side application with straightforward installation, achieved by unpacking from archive into the installation directory; no configuration is needed.

4 SITUATION ASSESSMENT

This section covers experiences in deploying and using the C3I applications during the Oasis trials. These findings often relate to general C3I issues rather than to specific Oasis applications and are therefore not grouped by specific application.

A development in the Oasis C3I applications has been the introduction of the concept of related events. Three relationships have been identified:

- Merger: Duplicate events expected to contain the same information.
- Association: Events arising in different organisation that refer to the same incident. These events will have similar information but there may be differences resulting from the differences in the processes and capabilities of the organisations.
- Hierarchy: A major event composed of a number of related sub-events, e.g. a flood composed of many smaller floods.

The management of related events has added complexity to the management of information and has an impact on how information is stored and presented to a user.

4.1 Managing Shared Information

Information fusion: When two events that relate to the same incident are close, but not both at exactly the same geographical location, then a decision must be made as to the position of the fused event. This is an example of a general fusion problem, but is more obvious with positions than other event parameters. The fused position could be an average position, it could be multiple positions (e.g. the original locations of both events), or it could be the most accurate position (i.e. taken from a view of the source's accuracy, its credibility, or simply the fact that it is the most recent). Whichever approach is taken the user needs to be able to easily understand the data provided.

Experience during the trials suggests that the precise fusion of location information is not critical to the users, for the trial incidents. Indeed, it was observed that precise location information was not always entered into the systems. However the aggregation of incident information from all sources is important and made a valuable contribution to situation awareness.

General information model problems: Each agency has their own terminology, which is different from other agencies – for example many different codes are used for road accidents. The TSO provides a good mechanism for mapping all data into a common format for use within the Oasis system. There is however, some information loss with legacy systems since not all the detailed information used within an agency can be represented in the TSO; but neither is all the detailed information required by other agencies, nor indeed are legacy systems in other agencies capable of representing all the detail.

The trials illustrated the importance of incident history to users. While the TSO is designed to provide a snapshot of the current situation and a series of TSOs contain an incident history, the extraction and presentation of incident history is challenging and an area for improvement. This is particularly true for associated incidents.

Fusion of free text logs: Operational users place heavy reliance on simple text messages. Indeed it is very difficult to encode all operational information into a set of codes. While the encoded information is imperative for providing a means to control visualisation and decision

making applications, the free text data is also important. Furthermore the user requires access to the message history for his incident and associated incidents. The extension of the maximum length of text strings in the TSO will provide an improved capability.

The management of an incident requires the exchange of information on situation status (supported by the TSO) and other messages such as commands and requests (not supported by the TSO). The relationship between TSOs and other messages needs clarification. If TSOs are distributed in parallel to other messages, then there is scope to link the two sets of information.

The trials highlighted the constraints imposed by existing systems. While the TSO is capable of encoding many concepts, if existing systems provide information that is only partly encoded and contains critical pieces of information in free text, then not all of the TSO capabilities are being used. In addition users like text and it is widely used to describe an incident, user actions and to issue commands. The use of free text needs to be balanced against the clear advantages of the language independent coding provided by the TSO.

4.2 Incident Association

Incident association is an association between incident records when the same incident is handled by multiple organisations. The Oasis team acknowledge the support of Shropshire Fire and Rescue Service in developing this concept.

Associated event tree: It is possible to keep a history of associated events. Previous versions of the event tree are deprecated when changes are made, or when new events are added or removed. Implementing this functionality caused significant increases in complexity, both in the algorithms and in the display systems.

The merits of incident association were demonstrated during the trials. The ability to aggregate information from several control rooms using independent incident management systems was especially appreciated by the silver/gold users.

Generalisation of composite events: When designing the incident association capabilities, it was agreed that more general composite events were required, to support the merging of events and hierarchical event relationships, both within agency and between agencies. A new module, the Event Manager, has been added to manage the creation and closure of events and the relationships (if any) between events. Although both the COP and the Event Manager designs included functionality to allow for all event relationships, the implementation of these was not fully considered due to the extra complexity and constraints on resources. In particular, it currently is not possible to mix different relationship types, for example associating two events that are in an event hierarchy.

The trials provided feedback on the Oasis design and supported the hypothesis that while major incidents may require sophisticated mechanisms for managing different views of the incident, a system with limited functionality is appropriate and sufficient for many incidents.

Composite event metadata: Metadata is required to represent information describing an associated incident, which is outside the scope of the TSO. There are number of mechanisms by which this can be exchanged and stored:

- Through the Oasis notification mechanism. The main advantages of such a mechanism are that any module can subscribe to receiving a change in metadata, and that no knowledge of other modules is required. This was the approach adopted.

- Within the TSO data model itself. Although this would be the easiest technical way of transporting the metadata associated with the event, it was deemed that the TSO should not contain "control" information that is not a description of the event itself and may vary with operational processes.
- Within the TSO Channel. It is possible to extend the channel capability to hold the metadata, at the expense of increased complexity for all applications.
- A unique metadata channel. It is possible to create a new channel, not unlike the TSO Channel, to contain the metadata. This would be a good principle, as metadata can be written/read independently by modules in an asynchronous and persistent way.

User procedures: The facilities for creating automatic and manual associations which could be confirmed or denied by users were shown to be a minimum set. Enhancements to some of the tools were identified. Indeed it is clear that control room operators are primarily concerned with incident management and adding complex tools for incident association has drawbacks. A number of issues were identified:

- Level of user interaction – agency vs user. For example, does a user confirm an association as an individual or for their agency as a whole? It may be that incident association is best supported by a user tasked with liaison with other agencies.
- The use of a "third party" as a virtual user of an associated event that a user is not involved in, but potentially has an interest in should be considered.
- The ability to do manual associations needs to be enhanced to allow a user to join an existing association he is not currently party to.
- The ability to amend or propose fusion values (e.g. number of casualties) was discussed but never implemented. This would allow the user to have more control over the association process but obviously increases the workload of that user, and increases complexity of the fusion process.

4.3 Visualisation of the Oasis Common Picture

Map visualisation: Part of the information fusion problem is how a system should display associated events. The fusion of multiple locations can be converted to a map display problem by simply keeping all locations of the base events. Then it is a matter of how best to display this, for example with a spider effect connecting multiple events, or by icons or colours. A further problem, exaggerated when multiple agencies' information is held within one map, is how to create a clutter free map. The ability to show multiple incidents which are particularly close to one another is difficult, especially when the user zooms out to larger scales. A possibility discussed within the project is to make use of zoom levels and aggregate icons into a super-event icon.

A clear message from the trials was the need to provide a clean and concise visualisation of the Oasis information. This means that the information held by Oasis must be filtered to provide only the essential items for each user.

There is also a user preference for fused information to be displayed using existing display applications. This requires legacy applications to be updated to provide facilities to display Oasis information rather than adding a dedicated Oasis monitor for each operator.

The Czech trial was targeted at the strategic level of crisis management where there were different requirements for visualising information. The Czech users were quite happy with the way in which information was visualised. However users observed that the user interface of many applications looks rather outdated, and they would prefer a closer integration of the user interfaces.

Integration of the incident association user interface with the map display: A specific user interface was required to control incident association. The trial solution integrated a map display with the incident association mechanism, so that a user could select multiple event icons on a map and manually associate events. This was demonstrated to be an appropriate approach.

Alerting the user to information updates: When a picture of an emergency situation is displayed and something changes, as a result of actions in another agency, the user needs to be notified of the change so that action can be taken if necessary. This is difficult because not all changes are significant (e.g. movement of resources), but some are critical (e.g. resource arriving on scene, new text message, new incident, change in casualty estimates, etc). The trials provided feedback in this area, using the Alert Bar for major emergencies and change notifications integrated into geographical information displays for minor emergencies. When many systems generate information at frequent intervals (every 10 seconds in one trial), it is difficult for a user to monitor all activities. A capability to ensure that only relevant information is distributed to each user becomes critical. However the filter must be tailored to meet the needs of both the supplier (data privacy issues) and the recipients (importance and urgency of the information).

4.4 Resource Manager

The first version of the Resource Manager was developed for the POS1 trial and was based on a complete data model of resource derived from the military domain. The objective was to create a generic component compatible with civil and military requirements. The interface between this Resource Manager component and other components in the Oasis system also used the complete model. That solution was not convenient for the purpose of Oasis as the integration was complex and much of the military information in the model was inappropriate in the civil domain.

Following the POS1 trial another component using a simpler service interface was developed. It was based on concepts that are better suited to a civil disaster management system. It was interfaced with both the Planning & Tasking component and the GeoSpatial Manager (GSM) user interface to which it gives information about the resource availability. More specifically, the GSM is informed by the TSO channel mechanism about the allocation/deallocation of resources and the allocated resources are displayed on a geographical data (map or image).

The Resource Manager was used extensively in the Romanian trial. The feedback from the users was that it gave a quick view of the resource status and was easy to use.

The user interface gave two views: allocated/non allocated resources per organisation and allocated resources per event. It has been tested with a limited amount of resources and it is recommended that the Resource Manager is tested with a greater number of resources to check scalability aspects. Moreover when a vehicle is allocated to an event, it should be possible to link it to the personnel. This functionality has not been developed in Oasis as this functionality is closely linked to legacy systems and a set of COTS components that are usually called CAD or Computer Added Dispatch.

4.5 Planning & Tasking

In the Czech trial the Planning and Tasking (P&T) module was used for the creation of action plans based on general crisis plans imported from the national Czech Crisis Management Information System (CCMIS).

The P&T loads and stores files using its native XML format. This facilitated the creation of input transformation from CCMIS native XML format into P&T native XML format. However for use in the Oasis environment a direct import/export from/to TSO format would be of great benefit.

During the Czech Trial users requested controls that allowed them to easily move tasks up and down the task list in the Gantt chart. The manipulation of tasks in the Gantt chart was a bit tricky.

The integration between P&T and Resource Manager (RM) has been designed in a way that does not allow complete management of resources in the P&T. In particular, resources can be allocated to tasks in the P&T, but they can be created and deleted only via the RM. Also, additional resources can be defined first in the RM and then they are made visible to the P&T. Users reported that these operations should be possible also through the P&T.

4.6 TSO Editor

In the Czech trial the TSO Editor was used as the primary application for sharing of the common operational picture across all deployed trial workplaces. Some problems in handling large TSO files were observed. It was discovered that TSO Editor is not able to handle TSO files which contains thousands of geographical (GEO) elements. This may happen if for example the geographical extent of the described event (e.g. flood) is composed from many small extents. Therefore in the Czech trial the event extent used had to be simplified before loading into the TSO Editor.

Visualization of the content of large TSO files in TSO Editor user interface was another problem. By default a list of all event GEO elements is provided in the UI. This means the user must search the UI for other information which is included in the source TSO.

Some problems with redrawing the event layer while panning the map at a small scale were observed.

4.7 Crisis Manager's Console (CMC)

In the Czech trial the CMC was used as a unified end user application launcher and workplace manager. It enabled the user to launch various Oasis end user applications from one place and manage their windows via customizable user profiles.

The Information Chain (IC) functionality of the CMC depends on a special feature of the Oasis Application middleware called the HMI framework. This feature enables data and functionality sharing between running applications. However, although the CMC provides a complete implementation of this feature, there were no applications available which implemented both this feature and the IC, which is an essential assumption for running the IC. Therefore IC functionality (using its CMC front-end) could not be used in the trials.

The functionality of user profiles requires implementation of CMC interface by every user application launched from CMC. Unfortunately in the Czech trial only two applications had been interfaced, the Alert Bar and a Flood Contouring application (a modified version of an application provided by the EGERIS project).

4.8 Alert Bar

In the Czech trial the Alert Bar was used as tool for alerting the user to important events coming from the scene and reported to the Oasis system. Unfortunately there were no available Oasis applications emitting alerts which could be displayed in the Alert Bar. Therefore alert simulation applications were developed and used.

The users appreciated the potential of the Alert Bar to provide information summaries and alerts to key parameters for an incident. The Czech trial provided users with a set of hard-coded alerts, which proved the value of the Alert Bar concept. However they requested additional features to allow customisation of the information shown; users were not able to select or add Alert Bar parameters using the trial system..

5 CONCLUSION

This document has presented a summary of C3I experience gained from a series of Oasis trials. Overall the experience has been favourable; most users were keen to see the Oasis tools in operational use.

The POS2 trials provided an opportunity to demonstrate that the POS1 lessons had been learnt through the increased maturity of the applications and the development of new applications to meet requirements identified during the first trial. The POS2 trials also evaluated new concepts such as the management of incident relationships and the associated component developments, including user alerting schemes.

All of the trials were considered successful by both the user and engineering teams, and demonstrated the value and increasing maturity of the Oasis interoperability framework. The C3I application concepts were found to be of value to the user community. Considerable progress has been made but there remains scope for further improvements, especially in the following areas:

- Improved filtering so that the user has easiest access to the most relevant information. This should be supplemented by flexible alerting so that the user's attention is drawn to the most critical changes in information.
- Improved integration of tools so that the user is presented with seamless functionality rather than stove-piped applications. Such an integration must be sensitive to the processes of each user organisation.
- Broader support of the event merger, association and hierarchy capabilities.

The TSO has been demonstrated to be a success for describing incidents and for interfacing between tools and with legacy systems. Having been tested in a number of trials the TSO is approaching readiness for initial deployment. However there are some areas for research that are closely aligned with the C3I areas for further development above: transmission channels (i.e. information filtering and security) and the relationship between the TSO, text logs and messages.