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Abstract:	This document provides information on the technical standards adopted in IDIRA. Several meetings and evaluation events have been held during the project, whose results have been used to identify and collect a list of gaps and areas of potential improvements, to be used for providing recommendations in the standardisation and harmonisation fields. These recommendations are listed in the present document, too. While the project was running, WP7 partners have participated to different meetings and activities focused on standardisation topics: these activities are reported in a dedicated section of the deliverable. Collected list of recommendations will be considered by project's partners for further discussions during future events and activities focused on standardisation and harmonisation: some of these events, already planned, are reported in the same section of the deliverable. The adopted approach to interoperability, strongly focused on the use of standards for information exchange, led to the definition of an interoperability model which was at the basis of the IDIRA MICS architecture design. Step-by-step guidelines for the adaption of existing systems following these model, allowing them to interoperate through the IDIRA MICS or, in general, between each other, are provided in the last section of the deliverable.
Keywords:	interoperability, standards, standardisation, harmonisation, guidelines, recommendations, gaps

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Part II: Executive Summary

Use of standards for interoperability

IDIRA approach for achieving syntactical and semantic interoperability is based on the use of open and, whenever possible, standard data formats and communication technologies for data integration and information exchange. The data model of IDIRA has been designed by taking into account this approach: information coming from external data sources within standard XML data structures for example, are easily integrated and stored in the in the IDIRA database for further processing.

By taking into account the different types of information and communication scenarios relevant during disaster management, we can distinguish between:

- Information areas where suitable actual or de-facto standards have been adopted for information exchange
- Information areas where non-standard solutions have been adopted, simply because standardised ways of sharing certain types of information are not available yet

Information exchange in IDIRA is mainly based on the following technological solutions:

- Communication technologies
    - SOAP Web Services for synchronous communication between software components, both internal and with external systems
    - REST web services, based on oData, for internal communication
    - Publish-Subscribe mechanisms for internal, asynchronous communication between software components
    - ATOM and RSS feeds for communication with external systems
    - OGC WMS/WFS standards for integration of geographic layers and retrieval of geospatial data from multiple sources on the Internet
    - OGC SOS standard for the integration of sensors measurements
- Data formats
    - EDXL family of standards for the integration of alerts, incidents, tasks and resources related information
    - OGC SensorML and O&M for what concerns integration of sensor data, observations and measurements from sensors
    - PFIF for the synchronisation on information on missing persons between IDIRA Missing Person Tracing components, and external Missing Person Tracing systems
    - Shapefiles and OSM XML formats for storing physical features such as roads or buildings in a geospatial vector data format
    - OGC SLD to provide styling or visualisation of the map data

Gaps and recommendations for harmonisation and standardisation

Through the adoption, testing, and the evaluation of the developed IDIRA tools during disparate events with both internal and external end users, such as EUAB meetings, small scale trainings and large scale exercises, gaps for an efficient use of the above mentioned, standard or non-standard data formats in realistic disaster management scenarios have been identified, and recommendations for improvements or for the realisation of new standards, have been derived. These recommendations can be summarized as follows:

- There is room/need for small improvements in the specifications and the use of EDXL family of standards, and specifically
    - multilingual support could be added in EDXL-RM and EDXL-SitRep which currently do not support it
    - multilingual support in EDXL-CAP, already present, could be improved by avoiding repetition of unchanged fields in the corresponding info blocks
- It would be also recommended to improve some other aspects related to the use of the EDXL-CAP, such as
    - definition of guidelines and/or best practises (or a complete new EDXL-CAP profile) for the harmonisation of the way different alerting sources can describe the same event (e.g. earthquake) using EDX-CAP parameters
    - in order to support multi-hierarchical structures, together with the use of parameters, it would be beneficial to foresee the possibility to add XML extensions to the EDXL-CAP specifications
- It is also recommended to extend the PFIF specifications with further fields, which have been identified as needed in realistic situations, as discussed in Section 3 and in the Appendix (Table 6)
- For what concerns specific simulation tools whose results were integrated in the COP, it is recommended to
    - improve the information available for spatial data representation and description in OSM
    - build new standards for the representation, as well as the exchange of information on population data and hazard data with external Evacuation simulation tools
- In the sensors field, it is recommended to build a new, standard language and runtime environment to define, deploy and manage the lifecycle of sensor data fusion applications
- It has been identified the need to build a new standard for annotating the invocation of the DSS services, so that the adoption of this standard provides the means for the invocation of DSS services and their responses. Under this perspective, every system that wants to use functionalities provided by a DSS could then be aligned with the terminology defined in the this standard
- In the taxonomy domain, it is recommended to build, starting from the TSO taxonomy adopted in IDIRA, a generic taxonomy that should be extensible and adaptable with the needed information to represent resources, disasters and incidents within a given disaster, or mission. It is also recommended that taxonomy subsets be prepared for specific types of disasters, e.g. providing templates targeting the needs of a specific disaster type. The taxonomy should also include the possibility to combine different resources in order to create and handle the concept of “bundle resources” used in some disaster management contexts

- It is also recommended the realisation of uniform, understandable and meaningful icon sets that would help making situation maps more useful for international and cross-agency interoperability. Beyond the symbol pictures, standardised properties of the icons should be also used (like e.g. different shapes for representing different items, and colors coding for representing different status of items, etc.)

Partners' participation to events and activities in the standardisation domain

Part of partners' effort in Task 7.3, was dedicated, and will be dedicated in the near future, to the participation to meetings, workshops and activities dealing with the standardisation domain and standardisation issues in general. These activities are listed below:

- Participation of the IDIRA partner IES to the EU Emergency Services workshop organised by EENA in April 2013
- Participation of the IDIRA partner IES to the regular CAP implementation workshop in Geneve, in September 2013
- Participation of the IDIRA partner CNVVF to the regular CAP implementation workshop in Negombo (Sri Lanka), in June 2014
- Participation of the IDIRA partner IES to the ETSI SatEC Working Group (STF472) meeting on the use of Satellite Systems in Emergency scenarios, in January 2015
- Contributions of the IDIRA partner CNVVF to the works of the Technical Committee on Mass Evacuation and Sheltering (NFPA 1616), with the First Draft Meeting held in Denver, U.S.A. on March 2015
- Planned participation of the IDIRA partner FRQ to the the workshop on Geospatial ICT Support for Crisis Management and Response at ISCRAM 2015 (May 2015)
- Planned participation of IDIRA partners IES and CNVVF to the regular CAP implementation workshop in Rome, in September 2015, that will be hosted by CNVVF

Application guidelines for the adoption of technical solutions for interoperability

Existing systems (e.g. C&C, Missing Person Tracing systems) or equipment (sensors) needs to be adapted for opening to the possibility to share data, using the approach for interoperability (standards and open technical solutions) proposed in IDIRA. These adaptations imply some steps which can be easily generalised, and adopted for building MICS-compliant ICT systems, that is:

- systems able to send-receive information to-from the MICS, as well as to integrate their results for visualisation through specific MICS components (e.g. as geographical layers of the COP)
- systems able to send-receive information to-from other interoperable systems. This could be the case of the synchronisation between 2 different PFIF repositories, or the information exchange between 2 different C&C systems which share data directly with each other without using the IDIRA MICS

The most important adaptations needed for enabling interoperability of existing systems, can be summarised as follows:

1. Mapping and conversion of information produced by existing systems, with the XML data structures needed for the type of information to share (e.g. EDXL messages, PFIF records, SensorML / O&M messages)

2. Publishing generated geo-referenced information, such as simulation results, to WMS/WFS servers in order to be consumed as WMS/WFS layers

3. Implementation of the needed software adapters for parsing and/or handling the needed data structures and information types

4. Implementation of software interfaces / API for inbound and outbound data transmission between systems, such as:
    - SOAP Web Services / REST based interfaces
    - ATOM / RSS Feeds interfaces
    - SWE SOS Web Services interfaces specific for sensor data sharing
    - OGC WMS / WFS interfaces for geographic / geo-referenced data sharing, including simulation results

Although the application of the above mentioned adaptations to an existing system could be not negligible, they can be realised with restrained effort thanks to the fact that they are based on open and well documented technologies. The final benefits, of having a system open for information exchange with other systems during emergency situations, have been clearly recognized by the end users during the different demonstration events (EUAB, small scale trainings and large scale exercises) held within the project timeframe. According to the experience of project's partners IES and CNVVF, the same benefits, in terms of efficiency in cooperation between emergency agencies and, as a consequence, in terms of response time, have been also demonstrated in the actual use of interoperable systems, following similar approaches proposed by IDIRA, in real life situations.

Part III: Main Section

1 INTRODUCTION

1.1 Scope of D7.3

Deliverable D7.3 reports and analyses, from the technical standpoint, the solutions adopted in IDIRA for data handling and information exchange.

Recommendations on standardisation and harmonisation needs, and gaps in standard ICT solutions for the emergency management domain, are provided starting from the analysis of the above mentioned solutions, and from the experience acquired during small scale trainings and large scale exercises with the end users, carried out for the evaluation of the MICS platform.

Special emphasis is given to the description of standard communication technologies, and standard data formats used with the aim to achieve seamless interoperability between different information systems, integrated to realise the MICS interoperable platform. Keeping standardisation and standards as the main concepts addressed within the document, D7.3 should help the reader understanding how the adoption of standards can help for realising interoperability at syntactical and semantic level.

All project partners' activities, which are linked to standards or standardization aspects – such as meetings, workshops and conferences – are also reported. The main outcomes, and in any case the level of relevance of such activities for the project, are highlighted.

The last section of the document, specifically targeted to end users interested in interoperability of ICT solutions for the emergency management domain, provides hints and guidelines for the interoperable integration of existing ICT systems with the MICS, therefore for the realisation of MICS-compliant ICT systems.

1.2 Work Methodology

The results presented in deliverable D7.3 are mainly built upon the work of the project's partner in previous work packages.

The technical work carried out in WP2 first, for the high level design of the IDIRA Architecture presented in deliverable D2.2, and then in WP3 and WP4 for the detailed specification of the different software components, led to the identification of suitable, and standard software technologies for the communication between IDIRA services, and for the integration of external systems. These are the software technologies presented in the following of the document.

Moreover, the design of the data model described in detail in deliverable D3.2 was inspired, and built upon the need to support specific standard data formats for interoperable information exchange: these standard data formats, which in most of the cases are XML structures, are reported in the following of the document, too.

The integration and demonstration events occurred during the project (EUAB meetings, small scale trainings and large scale exercises), aimed at the evaluation of the MICS platform, thanks to the collected feedback, made it possible to identify possible areas of improvements and gaps related to the use of the MICS technologies. The identified areas of improvements are used as staring point to provide recommendations for further enhancements related to the standardisation and harmonisation domain.

Part of the effort of partners involved in task 7.3, was devoted to the concrete participation in activities covering the standardization areas, whose main outcomes are reported in the following of the document.

The technical concepts, and the experience acquired by the technical partners with the concrete integration of manifold existing systems, data sources and data consumers in the MICS "ecosystem", are used for providing, at the end of the document, guidelines for the interoperable communication and integration of different disaster management systems.

1.3 Common Abbreviations

A global list of abbreviations used in IDIRA is maintained in a shared table. The list below is an extract, containing the abbreviations relevant for this document

Abbreviation	Meaning
API	Application Programming Interface
C&C	Command and Control
CAP	Common Alerting Protocol
COP	Common Operational Picture
DSS	Decision Support System
EDXL	Emergency Data Exchange Language
EDXL-CAP	Emergency Data Exchange Language – Common Alerting Protocol
EDXL-DE	Emergency Data Exchange Language – Distribution Element
EDXL-RM	Emergency Data Exchange Language – Resource Messaging
EDXL-SitRep	Emergency Data Exchange Language – Situation Report
ICT	Information and Communication Technology
IETF	Internet Engineering Task Force
EUAB	End Users Advisory Board
GDACS	Global Disaster Alert and Coordination System
GIS	Geographical Information System
GML	Geography Markup Language
GUI	Graphical User Interface
JSON	JavaScript Object Notation
MICS	Mobile Integrated Command and Control System
MPT	Missing Person Tracing
OASIS	Organisation for the Advancement of Structured Information Standards (related to EDXL)
OASIS	Open Advanced System for dISaster and emergency management (EU Project, related to the TSO)
OGC	Open Geospatial Consortium
OGC O&M	Open Geospatial Consortium Observations & Measurements
OGC SensorML	Open Geospatial Consortium Sensor Model Language
OGC SLD	Open Geospatial Consortium Styled Layer Descriptor
OGC SOS	Open Geospatial Consortium Sensor Observation Service
OSM	Open Street Map
PFIF	People Finder Interchange Format
REST	Representational State Transfer (web API design model)
RFC	Request For Comment
RSS Feed	Rich Site Summary (standard web formats to publish frequently updated information)
SFE	Sensor Fusion Engine
SLD	Styled Layer Descriptor
SOA	Service Oriented Architecture
SOAP	Simple Object Access Protocol
TSO	Tactical Situation Object

UI	User Interface
URI	Uniform Resource Identifier
WFS	Web Feature Service
WMS	Web Mapping Service
WMTS	Web Map Tile Service
XML	Extensible Markup Language

Table 1: Common abbreviations

2 IDIRA APPROACH TO STANDARDS FOR INTEROPERABILITY

2.1 Overview

Being interoperability the most important focus of the project, the IDIRA system architecture has been built on very specific design and development principles, aimed at making it possible the communication with existing, external legacy systems, as well as the integration of the different IDIRA tools and heterogeneous types of data coming from disparate sources.

Such design and development principles can be summarised in the choice of architectural patterns for ensuring loose-coupling of components, in a clear distinction between internal services and services used to enable the communication with external systems, and in the adoption of a modular implementation approach, which allows different functionalities to be plugged / unplugged as needed.

Besides the choice of the above mentioned principles, the key enabler for the IDIRA interoperable architecture was, with no doubts, the choice to find and use the most suitable standards to consume or provide specific types of information.

For addressing the syntactical interoperability aspects indeed, two main elements have been considered:

- The data model design in IDIRA was carried out taking into account specific actual or de-facto standard data formats to be used for representing each different type of information: in practical terms, this means that the different data structures used internally, are mapped as much as possible with the corresponding data formats, to be used for handling information that are exchanged or integrated from external systems. Hence, information on incidents, resources and tasks, as well as information on sensors, or results from external simulation systems, can be easily integrated and then processed within IDIRA
- The software interfaces and protocols for the communication with external systems, have always considered the use of open and not-proprietary, and standard whenever possible, communication interfaces

The use of standards for achieving interoperability at semantic level has been also considered: although not the specific focus of the project, a possible approach has been implemented which takes into account, as part of the IDIRA data model, the use of a common taxonomy, i.e. a shared dictionary of terms and definitions for emergency related information.

The final solutions adopted in IDIRA for implementing the above mentioned principles, will be presented in the following sub-sections by tackling the aspects listed below:

- Actual or de-facto standards used in IDIRA, together with their scope and the reasons at the basis of their choice
- Specific cases where the use of standards was not possible, and the reasons for this (e.g. missing standards for a given domain / information type)

2.2 Technical solutions adopted for syntactical and semantic interoperability

Besides actual standards, so called de-facto standards have been considered for the technical development. In the following of the document, the former definition refers to standards defined and published by accredited standardisation organisations, or by technical working groups and consortia which are focused on providing suitable technical specifications for data formats and communication technologies: this is the case, for example of OASIS [1]. The latter definition refers, on the other hand, to worldwide recognized, and widely adopted technologies or data formats that are not or not yet standardised, and for which concrete and already standardised alternatives are not available.

In the following tables, the technical solutions adopted in IDIRA for data handling and information exchange are presented, by highlighting when they refer to actual or de-facto standards: each of them concerns a different thematic area for information exchange and representation.

When no specific actual or de-facto standards have been used for given information areas or services, existing gaps will be highlighted, and suggestions for the creation of completely new standards will be provided later in the document.

2.2.1 Overview and classification of adopted data formats

Table 2 below presents data formats and taxonomies adopted for different information representation and processing.

Data format	Issuing organization / consortium (where applicable)	Classification	Thematic area / use in IDIRA
EDXL-CAP / CAP	OASIS	Standard	• Inbound data flow: information on incidents provided by external legacy systems (e.g. C&C) to IDIRA • Inbound data flow: information on events provided by external alerting sources to IDIRA • Outbound data flow: information on incidents provided by IDIRA for external legacy systems (e.g. C&C) and other consumers
EDXL-DE	OASIS	Standard	Inbound data flow: envelope for information on incidents, resources, and situation reports provided by external legacy systems (e.g. C&C) to IDIRA
EDXL-RM	OASIS	Standard	• Inbound data flow: information on resources provided by external legacy systems (e.g. C&C) to IDIRA • Outbound data flow: information on resources provided by IDIRA for external legacy systems (e.g. C&C) and

			other consumers
EDXL-SitRep	OASIS	Work in progress for becoming a standard	• Inbound data flow: information on observations and situation reporting provided by external legacy systems (e.g. C&C) to IDIRA • Internal data flow: processing of Observations created with either the COP Web Client or the Mobile Native Client
OGC O&M	OGC	Standard	Defines XML schemas for sensors observations, and for features involved in sampling when making observations. It is an essential dependency for the OGC Sensor Observation Service (SOS) Interface Standard. • Inbound / internal data flow: information exchange between sensor data sources and Sensor Inbound Service. • Outbound data flow: information exchange between Sensor Outbound Service and external systems.
OGC SensorML	OGC	Standard	Provides models and XML encodings for describing any process related to sensors and sensor systems. It is an essential dependency for the OGC Sensor Observation Service (SOS) Interface Standard. • Inbound / internal data flow: information exchange between sensor data sources and Sensor Inbound Service. • Outbound data flow: information exchange between Sensor Outbound Service and external systems.
OGC SLD	OGC	Standard	Allows the specification of styling rules which governs the portrayal of the WMS maps on the web browser
OSM XML	Open community	Not standardized	Stores spatial data as data primitives (nodes, ways and relations)
PFIF	Technical Specification released under	De-facto standard	Management of data about people who are missing or displaced in the aftermath of natural or human-made disasters

	the GNU Free Documentation License 1.2		
Shapefiles	ESRI	De-facto standard	Store non topographical geometry and attribute information for the spatial features in a data set
TSO	Oasis EU project / CEN workshop	Technical agreement / de-facto standard (for the taxonomy part)	• Inbound/Internal data flow: extension of incoming EDXL messages with common TSO codes for events (EDXL-CAP) and resources (EDXL-RM) • Representation of information for incidents, resources and tasks (missions) handling with the Common Operational Picture (CO)

Table 2: Data formats used in IDIRA

2.2.2 Description and scope of adopted data formats

2.2.2.1 Data formats for Inbound-Outbound data exchange on Incidents, Resources and Tasks

At the best of project's partners knowledge, the most relevant and widely used standard formats for representing, processing and sharing critical emergency information like incidents' details, resources and tasks are those belonging to the EDXL (Emergency Data Exchange Language) family of standards [2]. EDXL contains a wide range of XML-based emergency data exchange standards, to enable sharing of information about life-saving resources between different emergency and alerting systems:

- EDXL-DE (Distribution Element) [3] is an advanced standard that provides flexible message-distribution and addressing mechanisms for data sharing
- EDXL-CAP (Common Alerting Protocol) [4] provides an open message format for all types of alerts
- EDXL-RM (Resource Messaging) [5] is used to coordinate requests for emergency equipment, supplies and people, as well as for sharing any other type of resources-related information like deployment status, and so on
- EDXL-SitRep (Situation Reporting) [6] is a format for sharing general information (normally situation reports) across disparate systems of any public or private organisation about any situation

EDXL-CAP / CAP

Although originally intended for alerts and warnings distribution, EDXL-CAP messages are also suitable for the communication between different emergency services cooperating in a specific critical situation, therefore for carrying and sharing information on specific incidents. It supports the possibility to provide updates of previous messages, as well as the possibility to link different messages as belonging to the same incident: this latter feature is useful when different emergency organisations are cooperating in emergency activities related to the same incident.

For the above reasons, the use of the EDXL-CAP standard in IDIRA was mainly conceived for the following 2 purposes:

a) as the data format used to receive and process alerts concerning a specific emergency situation from disparate alerting sources, especially during the immediate aftermath of a disaster

b) as the data format to receive (Inbound) or public (Outbound), incident related information from-to legacy systems, therefore enabling data sharing in scenarios where IDIRA actually acts as an information hub, between existing external systems

Available EDXL-CAP message fields, allow to determine whether a given message is the original one of a specific thread, the update of a previously posted message, or just another alert belonging to the same thread but, for example, posted by a different organisation handling the same emergency situation. Other relevant fields allow to identify the sender of a message (the alerting source, or a specific emergency service), as well as the intended recipients: this information is used by some of the processing components of IDIRA, to address the messages to the specific organisation/s, using dedicated outbound communication channels. Each message can be marked as public or private, allowing the same originator of the message to decide whether the message should be only handled within IDIRA or, anyway, shared with organisation working on a specific disaster using IDIRA, or if it can be made publicly available, in both cases using IDIRA outbound communication interfaces.

Besides providing a set of well-defined mandatory and optional XML fields, including the ones for specifying the urgency, certainty and severity of the event, or the event type and related sub-types (e.g. Fire and Forest Fire), EDXL-CAP provides a high level of extensibility by using “parameter” fields, where any type of additional custom information needed can be inserted (e.g. the magnitude of an earthquake).

Additionally, within the “Resource” block it is possible to encode photos or other media, and any other kind of additional resource or file: these can be embedded in the message Base64 encoded, or can be just referenced using the URI of the external resource available. The possibility to provide geocoding information inside EDXL-CAP messages, allows the alert or incident to be visualised on the COP map as a geographic layer.

EDXL-DE

EDXL-DE works like an envelope, giving the possibility to carry other (not only XML) documents as payloads. The actual message payload is included in the “contentObject” XML block, a container element for messages like EDXL-CAP, EDXL-RM, EDXL-SitRep, and any other XML or not XML information. It is also possible to include photos, videos and other documents, Base64 encoded.

Thanks to these characteristics, and to the fact that it also provides XML blocks suitable for messages distribution and addressing purposes, the use of EDXL-DE in IDIRA was designed to be mainly targeted at carrying and distributing other EDXL messages. The “targetArea” allows to distribute and target a message to recipients (e.g. emergency organisations) working / having responsibilities in a specific geospatial or political area. On the other hand, the use of the “explicitAddress” field makes it possible to state explicitly the intended recipients of a specific message. Other relevant fields are the “keyword” and the “recipientRole” ones, allowing the distribution of messages based on the provided list of keywords or on the role of the recipients.

EDXL-RM

EDXL-RM is a highly suitable specification for messages carrying information on any type of resource, both material and human and, to a certain extent, also some information about the tasks that human resources are dealing with, or that have been assigned to them. All this information can be encoded using disparate types of XML fields, covering in total sixteen different message models, each of them suitable for a different purpose, for example:

- to request needed resources, or to post resources offers
- to request resources information, and provide answers
- to request information, and provide information about resources deployment status (e.g. whether resources are available, on travel, on duty and so on)

In IDIRA, mainly the resources deployment status message model was used, in order for external legacy systems (e.g. C&C) to send and / or receive information about the type, the status and the location of the resources employed for a given disaster. Position of resources, and position updates, can be visualised on the COP map as a geographic layer.

EDXL-SitRep

EDXL-SitRep provides a standard XML format for exchanging information gathered from a variety of sources that provides a basis for incident management decision making, cooperation and coordination about the current situation, incident or event over its life-cycle. EDXL-SitRep purpose is to provide situation reports for guiding emergency organisation during all disaster management phases - preparation, response, management and recovery - through seamless information-sharing. In the same way as EDXL-RM provides different message structures according to the specific type of communication (requests, offers, deployment status updates, etc.), EDXL-SitRep provides message models for different use cases (e.g. for reporting field observations, for situation information, or for resources information). In IDIRA however, the only message models that was extensively used is the “FieldObservation” ones, mainly for carrying Observations collected from the fields and inserted by the fields commanders via the IDIRA Mobile Client, or Observations directly inserted by the tactical commanders from the COP Web Client. The use of EDXL-SitRep to summarize information about the total resources employed using the “ResponseResourcesTotals” message models was also adopted in a few demonstration scenarios. Finally, the use of the “SituationInformation” message model for providing an overview of the incident status and related activities has been taken into account and, although this needs to be further investigated, it seems a suitable, standardised way for providing generic and updated Situation Reports.

2.2.2.2 Missing Person Tracing component

PFIF

The People Finder Interchange Format [25] is an XML based format. Information to identify a person are stored in a “record”. To each record arbitrary “notes” could be added that contain comments, status and location updated for this person. PFIF describes also the exchanged of records and nodes between different repositories. This is done by just copying records to the other repository. Identification is done using unique identifiers for the records and nodes, and a link to the owning/source repository.

In IDIRA the PFIF format is used in three different usage scenarios: the MPT Web APP uses it as internal data model and for synchronisation with other repositories that support PFIF; the MPT Mobile APP uses it to send information collected from the field, to the repository; the data collected with the “Xenios” tool, are exported in PFIF format so that a PFIF repository can import them.

2.2.2.3 Common data dictionary for IDIRA internal taxonomy

Tactical Situation Object (TSO)

In a cooperative environment, where different actors need to work on the same set of data, to share information they produce, as well as updates on each other activities, the problem of the different ways the relevant emergency related information is encoded arise. Each emergency service has its own set of event types and codes, its own way to encode resources names and types, or to indicate tasks.

The solution adopted by IDIRA was to rely on a common taxonomy, i.e. a common dictionary of codes. The dictionary of codes developed within the framework of the OASIS EU project (not to be confused with the OASIS standardisation organisation), later released as a CEN WorkShop agreement and called TSO (Tactical Situation Object) [7, 8] was adopted.

Basic incident types, resources and missions (tasks) types are directly translated in IDIRA according to the TSO dictionary of codes representation, and are part of the IDIRA master data for a given disaster type. Further, all information that can be potentially shared with IDIRA - e.g. incident types coming from existing C&C systems within EDXL-CAP messages, or resources types sent using EDXL-RM, and missions types – need to be translated in the corresponding TSO codes. For this to be possible, external emergency services need to provide the mapping between local and TSO codes, then 2 different scenarios are possible:

- External systems are able to provide to IDIRA messages containing already information encoded using the TSO data dictionary, together with their original code, or
- Local organisation codes are translated into the corresponding TSO ones, once the EDXL message is received by IDIRA, using a dedicated software service called TSO Translation Service (described in deliverable D4.1)

The TSO Translation Service is a Web Service ad-hoc developed for this purpose. It normally extends the received EDXL messages including the TSO codes when needed. It was also used to perform a reverse translation from the TSO codes value to the local organisation codes value, allowing an organisation B to make sense of information (events, resources, tasks codes) sent by an organisation A.

2.2.2.4 Integration of the Evacuation simulation component and results

OGC Styled Layer Descriptor (SLD)

The Styled Layer Descriptor (SLD [17]) allows the specification of styling rules to allow user-defined styling and colouring of geographic features. The WMS/WFS services (described in the following of the document) support basic styling options for the map image. However, WMS/WFS allow the specification of the name of a style file to be associated with a map request and thus style the map as needed. There are two ways to style a map/data set. The simplest method would be to colour all features of the map in the same colour. This type of styling does not require the knowledge of the attributes or type of feature of the underlying data. However, the evacuation simulation component required a more complicated method to style features of the data depending on the value of the attributes of a feature. For example, when rendering population density contours a grid cell with less than 0.1 people per square meters can be assigned a dark blue colour; a grid cell with more than 0.1 people per square meters and less than 0.4 people per square meters can be assigned a lighter blue/green colour and so on until a population density of between 3.8 people per square meters and 4.0 people per square meters that is assigned the colour red. Thus producing a heat map based on the density of people. Using OGC SLD it is possible to assign a style according to the feature attribute values of a WMS layer to produce this heat map which could then be overlayed on a basemap.

ESRI Shapefiles

Shapefiles [15] are used to store non-topographical geometry and attribute information of geographic data. The geometry of features is stored as a shape (point, polygon or line) described by a set of vector co-ordinates. One or more attributes can be associated with each shape record. The evacuation simulation tool used in IDIRA and described within WP5 deliverables, EXODUS, produces snapshots of the population density contours at pre-defined time steps during a simulation. These snapshots are stored as shapefiles in the evacuation simulation server. The shapefiles store the population density contours as 6m X 6m cells using the polygon shape type. Values for the attributes such as population density and level of service (LOS) are assigned to each cell or shape. The shapefiles can be uploaded and published to GeoServer [18], the GIS server used in IDIRA for handling WMS and WFS layers. The GeoServer stores the shapefiles and serves them out as WMS layers to the requesting web browsers. The attribute values of the shapes in the shapefile are used by SLD to style the WMS layer and produce heat maps showing the density of people or the level of service over the evacuation region.

OSM XML

OpenStreetMap (OSM]) provides a free editable map of the world storing the geospatial elements of the map in a crowd sourced geo-database. It also allows users to download the map of the world or parts of it in the *OSM XML* format [19] which describes the real world elements such as roads, buildings, etc, using the core *OSM* elements – *nodes*, *ways* and *relations*. A *node* represents a precise point on the earth's surface defined by a pair of co-ordinates (its latitude and longitude). A *way* is an ordered list containing anywhere between 2 and 2,000 nodes. Relations specify the relationship between two or more *nodes*, *ways* or other *relations*. For example a building will be represented by a *way* which is a list of *nodes* representing the corners of the building and *relations* may describe how two or more buildings are related to each other (e.g. adjacent buildings, one building is contained within another, etc). The OSM XML data is utilised by the evacuation simulation tool, EXODUS, to model a computer based virtual representation of space which can be used to simulate pedestrian evacuation within this space. Open source tools such as JOSM [20] are available that allow the OSM data to be modified. This is normally necessary given the crowd sourced nature of OSM data and its purpose resulting in many cases that some data may be missing or wrongly represented (for example connectivity between roads and open spaces). JOSM allows the easy addition and modification of spatial data and attributes.

2.2.2.5 Sensor Data Integration subsystem

OGC SensorML

SensorML [23] provides a common framework for any process, but is particularly well-suited for the description of sensor and systems and the processes surrounding sensor observations. Within SensorML, sensor and transducer components (detectors, transmitters, actuators, and filters) are all modelled as physical processes that can be connected and participate equally within a process network or system. Processes are entities that take one or more inputs and through the application of well-defined methods and configurable parameters, produce one or more outputs. SensorML also supports a framework within which the geometric, dynamic, and observational characteristics of sensors and sensor systems can be defined. Also, it is a dependency for the OGC Sensor Observation Service (SOS) Interface Standard.

In IDIRA, SensorML provides the models and encodings for describing the metadata of different types of the integrated sensors, including fixed and mobile sensors. Being a dependency of Sensor Observation Service is used by the Sensor Inbound and Outbound Service of IDIRA enabling the interoperable sensor-related information exchange between external entities and IDIRA.

OGC O&M

The OGC Observations and Measurements (O&M) [24] defines a conceptual schema for observations, and for features involved in sampling when making observations. These provide models for the exchange of information describing observation acts and their results. Observations commonly involve sampling of an ultimate feature-of-interest. O&M defines a common set of sampling feature types classified primarily by topological dimension, as well as samples for ex-situ observations. The schema includes relationships between sampling features (sub-sampling, derived samples). O&M is a dependency for the OGC Sensor Observation Service (SOS) Interface Standard.

In IDIRA, O&M provides the models and encodings for describing the sensor observations. Being it a dependency of Sensor Observation Service, is used by the Sensor Inbound and Outbound Service of IDIRA enabling the interoperable sensor-related information exchange between external entities and IDIRA.

2.2.3 Overview and classification of adopted communication technologies

Table 3 below presents communication technologies for the different information exchange needs.

Communication technology	Issuing organization / consortium (where applicable)	Classification	Thematic area / use in IDIRA
ATOM Web Feeds	IETF	Standard (ATOMPub / ATOM Syndication RFCs)	• Inbound data flow: information retrieval from external legacy systems (e.g. C&C) and external alerting sources (e.g. alerting authorities) to IDIRA • Outbound data flow: private / public information published by IDIRA for external data consumers
oData	OASIS (Microsoft)	Standard	RESTful data access protocol • Read access to the central data store, used by COP plug-ins
OGC SOS	OGC	Standard	• Inbound / internal data flow: information exchange between sensor data sources and Sensor Inbound Service. • Outbound data flow: information exchange between Sensor Outbound

			Service and external systems.
OGC WFS	OGC	Standard	Retrieve and update geospatial data encoded in GML
OGC WMS	OGC	Standard	Overlay map images on a basemap
RSS Web Feeds	-	De-facto standard	Inbound data flow: information retrieval from external alerting sources to IDIRA
SOAP Web Services	W3C	Standard	• Inbound data flow: information sending from external legacy systems (e.g. C&C) and other information sources (e.g. alerting authorities) to IDIRA • Internal data flow: information exchange between IDIRA services in the Inbound information flow

Table 3: Communication technologies used in IDIRA

2.2.4 Description and scope of adopted communication technologies

2.2.4.1 <u>Communication technologies for Inbound-Outbound IDIRA services, for data exchange on Incidents, Resources and Tasks</u>

<u>ATOM Web Feeds</u>

ATOM Web feeds are based on two different specifications, the ATOM Syndication Format [10] and the AtomPub Protocol [11]. The former one defines the structure of a typical ATOM feed document (XML structure), while the latter one provides the protocol specifications for publishing entries within ATOM feeds. Both have been released as IETF RFC.

In IDIRA, ATOM Web Feeds interfaces are used by the Inbound EDXL Feed Service to get EDXL-CAP messages published by external alerting sources or other legacy systems. The Inbound EDXL Feed Service implements the client side interfaces for requesting and getting ATOM feeds updates once they are available, by polling the sources.

The Outbound EDXL Service implemented for IDIRA to publish EDXL messages for external consumers, also publish them as public or private ATOM Web feeds, using the AtomPub protocol interface.

<u>RSS Web Feeds</u>

Some alerting sources, such as GDACS [12], provides alerting information via RSS feeds [13]. In IDIRA, RSS feeds interfaces are used to get information in Inbound, exactly in the same way as ATOM feeds interfaces are used. The Inbound EDXL Feed Service implements the client side interfaces to request and get RSS feeds updates once they are available, using a polling approach.

<u>SOAP Web Services</u>

SOAP Web Service [9] is the most widely adopted standard for communication between different services and systems in a SOA (Service Oriented Architecture) environment. Being the SOAP specifications agnostic, they allows interoperability between client and server side software systems, which can communicate each other provided they implement the SOAP Web Services protocol, no matter what is the programming language used for implementing them.

In IDIRA, the Inbound EDXL Web Service that exposes methods for receiving EDXL messages from external emergency information providers or alerting sources, is implemented as a SOAP Web Service. In a similar way, SOAP Web Services are used for the synchronous communication between the Inbound EDXL Web Service and other internal IDIRA services involved in the inbound communication flow, such as the TSO Translation Service and the Storage Service.

2.2.4.2 Integration of the Evacuation simulation component and results

OGC Web Map Service (WMS)

A Web Map Service (WMS [14]) is the most widely used standard to produce maps of spatially referenced data (in the form of images) dynamically from geographical data such as shapefiles [15]. Geographic data formats such as shapefiles contain raw geographic data which are converted into geo-referenced images using the WMS standard. Geo-referenced images can then be displayed graphically on a map. The OGC WMS format is used, in IDIRA, to serve spatial data containing population density contours as heat maps (hotter colours, e.g. red, representing high density and colder colours, e.g. blue, representing low density) and critical density regions (areas of congestion that affect free movement of people). This data is served as web images over the Internet using HTTP to the platforms used in IDIRA, i.e. the Evacuation Simulation Expert GUI and the COP.

OGC Web Feature Service (WFS)

The Web Feature Service [WFS] [16] is a standard used for creating, modifying and exchanging vector geographic data over the Internet. Thus the WFS format, in addition to providing the map images similar to WMS over the Internet also allows the query of geographical features. The WFS protocol is used to display information pop-ups listing the attributes of the clicked features on the Evacuation Simulation Expert GUI. For example the user can click on a feature in the critical density layer (thematic map showing areas of congestion) and view information such as the duration of the critical density experienced by the people in that region, the start/end time of the critical density, etc. Similarly, on the COP GUI the attribute data of the features displayed on the COP are shown in the overlay panel.

2.2.4.3 Sensor Data Integration subsystem

OGC SWE

The Sensor Web Enablement (SWE) [21] family of standards defined by the Open Geospatial Consortium (OGC) provides a set of standards and protocols that allow the integration of sensor data into spatial data infrastructures. Three different standards are used in IDIRA: Sensor Observation Service (SOS) is a Web service specification for requesting, filtering, and retrieving observations and provides the interface between data processing applications and the sensor data providers. SensorML provides a way to describe sensor processes using an XML model. Finally, the Sensor Observation & Measurement standard is used to send actual sensor measurements to the system.

OGC Sensor Observation Service (SOS)

The Sensor Observation Service (SOS) [22] provides a standard interface for managing and retrieving metadata and observations from heterogeneous sensor systems. Used in conjunction with other OGC specifications the SOS provides a broad range of interoperable capability for discovering, binding to and interrogating individual sensors, sensor platforms, or networked constellations of sensors in real-time, archived or simulated environments. The SOS operations can be distinguished into four profiles: core, enhanced, transactional and entire. The SOS is part of the OGC Sensor Web Enablement (SWE) framework of standards.

In IDIRA, the core and transactional profile are mainly used. The Sensor Inbound Service is based on a reference implementation of the Sensor Observation Service (SOS) Interface Standard allowing the interoperable integration of sensor data sources to IDIRA. Specifically, the operations "RegisterSensor" and "InsertObservation" are supported. If a sensor data source needs to send sensor observations to IDIRA, firstly it must register itself to the SOS infrastructure. This is done via a "RegisterSensor" message/operation, featuring the Sensor description in SensorML. Upon successful registration, the "InsertObservation" operation can be used for the insertion of observations related to this specific sensor / sensor system. In IDIRA, the integrated sensor data sources can be divided into two separate categories: a) IDIRA sensor data sources (e.g., Davis Weather Station Wireless Vantage Pro2, Sensordrones) and b) external data providers (e.g., Wedaal, Wunderground).

The Sensor Outbound Service is also based on a reference implementation of the SOS Interface Standard allowing external systems / applications to access the integrated sensor data. Using the "GetCapabilities" operation, an external entity can subsequently request available sensor sources and observations using temporal, spatial and other types of filtering capabilities.

2.2.5 Comparison with existing alternatives

2.2.5.1 Standard data formats for information exchange on incidents, resources and tasks

There are not so many, neither actual nor de-facto standards dealing with emergency information exchange issues. According to the consortium research and knowledge in this domain, one available alternative would be the use of the TSO message structure [7]. Beside the provision of the dictionary of codes, used to develop the common IDIRA taxonomy indeed, TSO also includes the technical specification of an XML message format for emergency information exchange, the main difference with the EDXL family of standards being that, using TSO, all information exchange is realized using a single message structure. Specifically, the TSO message structure provides the possibility to include in a single message:

- The description on a specific event / incident
- Information on the defined missions
- Available and employed resources

In IDIRA, the selection of the EDXL family of standards over the TSO message structure, was motivated by the following reasons:

- Less complexity and more modularity, as it is easier and more manageable to work with dedicated message structures for different information types
- The EDXL-CAP, which is the natural, widely recognized and only available choice for what concerns the interaction with alerting sources, can be efficiently used also for information exchange on incidents with external C&C systems, allowing the use of a single standard for 2 different usage scenarios

- The EDXL-SitRep, and specifically the FieldObservation report type, has been selected as the most suitable way for modelling observations sent from the field. Other available report types allows to create situation awareness reports in a comprehensive way
- Different use cases can be potentially covered by the EDXL-RM structure as well, thanks to the significant number of message types provided (for e.g. requesting, providing resources, and reporting on resources status)

2.2.5.2 Taxonomy dictionaries

Even in the field of taxonomies (emergency data dictionaries), there are not many alternatives to the TSO dictionary of codes, at the best of the consortium knowledge. Another known dictionary is the one represented by the Specific Area Message Encoding (SAME) [30], which provides a protocol used to encode alert messages for the Emergency Alert System (EAS) and NOAAs Weather Radio (NWR) in the U.S., and the Weatheradio Canada in Canada.

SAME defines a list of event codes used by the above-mentioned systems. Due to its focus on the encoding of events for warnings and alerts only, the limits of SAME with respect to the TSO data dictionary are, quite clearly:

- Limited number of event codes
- Missing possibility of providing a common taxonomy for the encoding of other information relevant in emergency management, such as resources categories and missions types

2.2.5.3 Communication technologies for Inbound / Outbound and communication between internal services

A valid alternative to SOAP Web Services are the RESTful Web Services, an approach which leverages the CRUD (Create, Read, Update, Delete) HTTP paradigm, for implementing the communication between a client and the Web Service. This approach is based on the concept of resources – each HTTP request for posting or getting information is always made on a specific resource. Due to these characteristic however, a REST approach is most suitable when API to work on specific resources (access and filter, update or delete them) needs to be implemented. For the specific IDIRA needs, i.e. to provide a mechanism for synchronous exchange of XML messages between components, the use of the SOAP standard has been considered the most appropriate one.

For what concerns outbound communication, basically there are two different methods to realise a communication between a client and a server: push and pull technology. Other technologies can be derived from them. Getting information from external information providers, when such information is provided as ATOM or RSS Web Feeds, is normally realised using a polling approach (pull technology). Using polling for communication over the Internet, the initial request for data originates from the client and is responded by the server. If a client wants to get information nearly in real-time, it needs to poll the server quite frequently to get information. This can make the pull approach inefficient, as permanent requests for new information would generate a huge amount of data.

An alternative to the polling approach is the pushing approach. In this case, the transaction (to get new information) is initiated by the server. The client subscribes to various information channels provided by a server. If new information is available, the server pushes the information to the client, which gets information immediately, without useless data traffic.

Some of the most known and widely used approaches implementing pushing mechanism are:

- The use of a Message Bus, such as the one based on Apache ActiveMQ [44] product, used to implement a publish-subscribe communication pattern, used in IDIRA for the internal, asynchronous communication between some components
- The PubSubHubbub [45] is an open, push inspired, protocol for distributed publish-subscribe communication on the Internet, realized by Google

The main purpose of the above approaches is to provide real-time notifications of changes, which improves upon the typical situation where a client periodically polls the feed server at some arbitrary interval.

Currently, most of the emergency information and alerts providers, make the information available as simple ATOM / RSS feeds, meaning that they cannot be retrieved using approaches different from the polling one, as e.g. push based notifications they are not implemented on the service provider side. One advantage of polling is, indeed, in its simplicity, as there are no actions on the server side. Moreover, more sophisticated methods exist that could be used in conjunction with the basic polling approach that, while requiring some more information to be exchanged between the client and server in order to avoid resending of not needed information, can result in a more efficient communication.

For what concerns the Outbound EDXL communication part, again push and / or publish and subscribe methodologies could have been used in IDIRA, but the choice of publishing information using ATOM feeds was related to the fact that information provided as ATOM feeds can be, with respect to other approaches, more easily consumed on the client side, by using a normal Web Browser, custom or already existing and freely available feed readers.

2.2.5.4 Data formats and technologies for the integration of simulation components and results

OGC WMS

A WMS request could consist of varying geographic bounds, varying scale, varying coordinate reference systems, etc. The WMS standard is the most flexible standard providing clients the exact image matching their specific request. While, WMS supports a basic styling of the map, the addition of SLD allows a rich set of styling information to be associated with the images while displayed on the client's browser. The ability of the WMS to incorporate SLD makes it an ideal choice as it allows to style thematic maps based on data associated by the features of the map. However, all this flexibility comes at a price: each client request will produce a new image; the server image processing must scale with the number of requesting clients; and there are limits to how many images may be cached on the server and client. The WMTS (Web Map Tiled Service) [26] standard is faster than WMS as all the tiles are pre-rendered for various bounding box and scales. Images returned by WMTS may be returned not confirming to the exact request but based on the availability of the pre-rendered tiles. For example, if a client makes a WMTS request with certain bounding box values and if a pre-rendered tile matching exactly that bounding box is not available then the closest matching tile to the request will be served out. Any text in these tiles will thus be stretched or compressed which can result in poor visualisation experience. Though WMTS can be faster than WMS, the latter was chosen due to its flexibility and ability to provide dynamic map layers with customised styles.

OGC WFS

WMS is mainly used to render and serve map images over the Internet. WMS can also be used for simple get feature information requests. A map feature is an object having associated properties such as a name, a type and a value. WFS on the other hand provides direct access to the feature's data allowing the reading, writing and updating of the features. WFS allows to create a new feature, delete/modify an existing feature and query features based on spatial and non-spatial constraints. However, adequate steps need to be taken while using WFS as clients will have direct access to the data on the server.

OGC SLD

While SLD is the OGC standard to specify styles for WMS layers, an alternative is to use the GeoServer CSS module. GeoServer CSS is customized for use in GeoServer and provides access to spatial utilities such as powerful filter expressions that are useful not only for choosing the features to render but also for transforming geometries and other attributes on-the-fly during the rendering process. It is much more compact than SLD allowing authors to see more of the style without scrolling and to make edits without worrying about details such as closing nested XML tags in the proper order. The cascading nature of CSS allows styles to specify common attributes in one place rather than repeating it for each feature. GeoServer CSS is much easier than SLD from a coder's perspective and will be very familiar to web designers as it follows the CSS syntax. For the IDIRA project, SLD was preferred over GeoServer CSS as the former is an OGC standard and the latter is used only within GeoServer. Also, the GeoServer CSS code is internally translated to SLD code by the GeoServer.

ESRI Shapefiles

An alternative to shapefiles was initially experimented using the GeoTIFF format. However, the raster based GeoTIFF format was not as efficiently served as WMS layers by the GeoServer. The GeoServer ran into memory issues while serving out data from the GeoTIFF data source. The main reason being the large size of the GeoTIFF files produced. While it is possible to compress the GeoTIFF files to optimise data storage and enhance rendering speed using GDAL tools [27] it was deemed more suitable to use the defacto ESRI shapefile format. The advantage of shapefiles over other formats is that they do not have the processing overhead of a topological data structure and hence allow faster generation of map images. They require less disk space than the other formats.

OSM XML

The main advantage of OSM XML data is that it is freely available and is in an easily understandable format for both humans and machines. It contains the spatial data in XML format containing the map data in a vector format. It contains the co-ordinates of the spatial elements along with attributes containing values to describe them, for example, whether the spatial element is a building or a road. This helps EXODUS to correctly represent an abstraction of the real world element such as a building or road within the simulation environment appropriately. OSM was chosen over other proprietary tools such as googlemaps as it is freely available. The XML structure of the OSM XML format makes it easier to generate the virtual environment compared to the raster based format available from other providers such as googlemaps. There are two main disadvantages of the crowd sourced OSM data - missing data and wrongly specified data. Missing data refers to objects (e.g. a building or a road) that exists in the real world but not modelled in OSM. However, there are many open source OSM editors such as POTLATCH and JOSM that provide a user friendly interface to add the missing data. The regions modelled for IDIRA have been in the range of 4-7 km^2 and adding the missing data via JOSM was not difficult. However, for larger areas such as modelling an entire town or city this may be a tedious task. However, the OSM data is getting richer and may well overtake some of the leading map providers such as googlemaps, Navteq [28] and Tele Atlas [29] in the near future. Wrongly specified data refers to data that has been wrongly specified by users who are not experts in mapping or other reasons such as lack of local knowledge. For example specifying the maximum speed of a road as 20mph when it is actually 30mph;

specifying a road as a one way road when it is actually a 2 way road. These kind of errors do not affect pedestrian evacuation modelling significantly. The kind of errors that would matter are outright errors such as specifying a road as a building. These errors were quite rare in the areas that were modelled for IDIRA.

2.2.5.5 Standards for Sensor Data Integration

No actual standards dealing with interoperable interfaces and metadata encodings, that enable real time integration of heterogeneous sensor data sources exist, that can be compared with OGC Sensor Web Enablement (SWE) family of standards.

2.2.5.6 Standard data formats for Missing Person Tracing

The most relevant and known alternatives to PFIF data model are EDXL-TEP [32] and EDXL-TEC [33]. Using these solutions, the process of tracing is split into two phases:

Phase I - Tracking of Emergency Patients (EDXL-TEP). This XML messaging standard is used to exchange of emergency patient and tracking information across the EMS emergency medical care continuum. TEP provides real-time information to responders, management and care facilities in the chain of emergency care and transport. Patient tracking information is exchanged from patient encounter (possibly re-using dispatch information) through admission or release. TEP also supports hospital evacuations and day-to-day patients transfer.

Phase II - Tracking of Emergency Clients (EDXL-TEC). This XML standard expands Phase I scope to support clients across the general population for more effective evacuation and services management. It provides real-time information to responders, decision-makers, and facilities in the chain of care and transport. The primary objectives include the following:

- Non-medical evacuee movement & tracking (also self-evacuees and shelter-in-place)
- Regulation
- “Richer” data sources
    - Person finding
    - Family notification & re-unification
    - Sharing of “self-registration” data

Both standards are under development. This was the main reason that led to the adoption of PFIF in IDIRA. Also, the above-mentioned working standards aim at providing much more functionalities than just tracing missing persons. They can be used for the whole emergency lifecycle of a person.

2.2.6 Status of standardisation initiatives related to the solutions adopted in IDIRA

2.2.6.1 EDXL family of standards

EDXL-CAP used in IDIRA was, since the beginning, the most updated version of the standard available (version 1.2). Although the CAP community is quite active through discussions, as well as with the organisation of workshops where all main EDXL-CAP based solutions’ implementer presents and discuss their own “showcases”, there were not specific evolution of the standard specifications during the latest years. The same applies to the EDXL-RM standard specification, which is still in the consolidated version 1.0 adopted in IDIRA.

The EDXL-DE specification adopted in the project is version 1.0, which is still the official and consolidated version of the standard, although during the project time a new version 2.0 Committee Specification 01 (CS01) was approved and published, which is therefore in the process of being reviewed for becoming the new EDXL-DE OASIS standard. This new version of the EDXL-DE specification expands the possibilities already present in the previous version, namely:

- It allows to link (relate) the different types of messages, or content objects (e.g. any of the different EDXL message types) that are carried by the same EDXL-DE envelope
- It improves the already existing addressing and distribution mechanisms, which is based on the target location, keywords, recipients role or explicit addresses

In the same way as other EDXL standards proposals, the EDXL-SitRep specification is still under development to become an actual OASIS emergency standard. In IDIRA the first approved Committee Specification (CS01) of the version 1.0 provided by OASIS was used, although during the course of the project a new Committee Specification (CS02) was circulated which, however, seems not to be an approved CS yet.

2.2.6.2 Evolution of the TSO taxonomy

TSO (both the data structure for information exchange and the data dictionary), originally developed as a NATO (military) standard, was then adopted and adapted by the Open Advanced System for CrisIS Management (OASIS) project, a sixth framework programme (FP6) EU project. Then, it was also approved by the CEN as a Workshop Agreement (CWA): this is the latest version adopted within the IDIRA consortium, for what concerns the use of the dictionary of codes [8].

Recently, the original TSO specifications have been taken over by the ISO/TC (ISO Technical Committee) 223 [35], and specifically within the program dealing with Societal security, Emergency management, Guidance for monitoring of facilities with identified hazards. Starting from the results previously achieved, the ISO TC 223 is working on the realisation of a technical specification document (TR22351), covering both the description and use of a message structure for information exchange, and the description of the available dictionary of codes.

2.3 Use of common icons approach for improving semantic interoperability using IDIRA

Different groups of users are not only using different natural languages. They also use different terms, taxonomies and icons for items in the domain of disaster management, and so are doing the IT systems to be connected to the IDIRA information space.

The IDIRA internal representation of these data types is a taxonomy that follows the TSO standard and data dictionary (see 2.2.2.3), using the TSO codes and the English item names used in the TSO specification. The representation in the GUI and in the interface to the connected IT systems has to transform this to the taxonomy used by the user's organisation. In order to facilitate the interoperability and to avoid ambiguity and misunderstanding in the communication, IDIRA provides a bi-directional, taxonomy-based translation service between the TSO and the taxonomy specific for given user organizations (see 2.2.2.32.2.2.3).

The full-blown TSO data dictionary as described in [8] was considered too extended for being used as the common denominator for the users of IDIRA, considering that the taxonomy was not the specific focus of the project and that, other dedicated projects exist dealing with the taxonomy issues. Therefore, a sub-set of codes was defined within IDIRA, and all local codes / item names were mapped on this sub-set. The IDIRA TSO subset is not hard-coded but stored in a database table that can be administered in the Admin GUI and might be adapted to different scenarios (IDIRA templates).

In the same way, emergency organisations willing to interoperate with and through IDIRA, can provide a set of icons that represents the different items graphically. These icons are displayed accordingly, based on the logged in users of each organisation, which are looking on the map. So every user can get the graphical representation he is used to get from his organization. The TSO syntax is the syntax of a directory tree. In the same way, the organisations should provide the icons files in a zip folder that contains the complete tree of TSO sub-set codes adopted in IDIRA (e.g. <org>/EVENT/ETYPE/ENV/DIS/CBRN.gif) for each type of event or resource represented.

On every level, a DEFAULT.gif icon represents all TSO codes that are unknown in the taxonomy of the organization on this level; e.g. fire brigades may use different icons for specific fire fighting vehicles, but the Red Cross gets just one default icon for every kind of fire fighting vehicles.

There is a standard organization tree “IDIRA” that contains default icons on every level (following the suggestions of FP7 project INDIGO [31]). If a joining organization doesn’t provide their icons and taxonomies, the IDIRA default is rendered for the users belonging to this organization. Adding an icon set for an organization means to copy the IDIRA tree and amending the appropriate folders by the icons specific for the organization.

3 GAPS, AREAS OF IMPROVEMENTS AND RECOMMENDATIONS

In this Section we report about the most important gaps and areas of improvements in the standardisation and harmonisation domains, which have been identified for what concerns specific information exchange needs. The list that will be presented in the following has been realised thanks to the different events with the end users, namely EUAB meetings, small-scale trainings and large-scale exercises. Specifically, it is the result of the practical use and evaluation of the system components, through the oral or written feedback received by the end users.

The concepts reported, and the possible solutions identified, could be used to:

- Trigger discussions and provide suggestions for improvements to the related standardisation bodies (such as OASIS in the case of EDXL-CAP or other EDXL message types)
- Provide suggestions for the realisation of new standards in the future, once the suitable standardisation body where to submit the idea, will be identified

3.1 Overview and classification of main gaps and areas of improvements identified

We classify the identified gaps or areas of improvement using the following main categories:

- Missing fields of information in the available (standard or not) data formats
- Limits & inefficiencies
- Missing actual or de-facto standards
- Harmonisation needs

With "Missing fields of information" we refer to situations where a given available data structure does not provide all the fields of information that could be needed in a real emergency situation.

"Limits & inefficiencies" refers to situations where the use of certain capabilities was not found efficient, or put in evidence some drawbacks, while "Missing actual or de-facto standards" highlights specific information exchange scenarios, domains or integration needs, for which well defined, not proprietary data structures are not available yet.

Finally, with the term "Harmonisation needs" we refer to the cases when the use of specific approaches for information exchange could be made more efficient, by harmonising the way the information are organised and provided.

The following table presents an overview of each identified item, classified according to the above categories.

Thematic area	Classification	Description	Suggestion for improvement
EDXL-CAP alerts coming from different sources	Harmonisation needs	Different alerting sources may use available CAP fields in different ways, when publishing	Harmonise the way how alerts are produced for a given type of event (e.g. defining specific CAP

		information on the same type of event (e.g. earthquakes). Leading to the need to create, for each case, custom parsers for interpreting and using the provided information	profiles for each type of event), from the different alerting sources
Multilingual information exchange using EDXL-CAP messages	Limits & inefficiencies	Multi-lingual support is not efficient in terms of EDXL-CAP messages dimension	Possible changes in the XML structure, e.g. by repeating only the translated textual fields, not all <info> fields
Acknowledgement of EDXL-CAP messages	Missing fields of information	Unforeseen possibility to “enforce” the Acknowledgement of sent EDXL-CAP messages, avoiding to solicit them via the implementation of custom (e.g. parameter) fields	A field could be foreseen as part of the CAP specifications, to flag the message as one explicitly requesting an ACK, without the need to agree on custom profiles fields
Hierarchical structured data support using EDXL-CAP	Limits & inefficiencies	Highly hierarchical structured data are hardly supported by EDXL-CAP, as they require redundancy as well as more effort and customisation in the parsing of the information	Possibility to define and use standard XML extensions in EDXL-CAP messages
Missing Original ID and Source ID for EDXL-RM	Missing fields of information	Completeness of EDXL-RM	Original ID and Source for EDXL-RM would be good. When a system is synchronised with IDIRA, it needs to distinguish between resources from the system itself and other systems
Multilingual information exchange using EDXL-SitRep	Limits & inefficiencies	It is not possible to identify the language of different multilingual EDXL-SitRep messages, with the same content embedded into one EDXL-DE	Use similar concepts as implemented and suggested in EDXL-CAP
Spatial data specification for evacuation simulation tools	Missing fields of information	OSM data does not contain • Spatial connectivity data • Locations of	OSM data is XML based and can be extended to include the additional data

		entrance/exits to buildings • Elevation data	
Population data specification for evacuation simulation tools	Missing actual or de-facto standards	Presently there is no standard to provide population data to evacuation simulation tools	A suggestion on what population data is required and the format in which it can be specified for evacuation tools is described in the following
Hazard data specification for evacuation simulation tools	Missing actual or de-facto standards	Presently there is no standard to provide hazard data to evacuation simulation tools	A suggestion on what hazard data is required and the format in which it can be specified for evacuation tools is described in the following
Information exchange about missing persons	Missing fields of information	PFIF Standard does not contain • Phonetic information • Geo coordinates • Alerts • Temporary residence	Add additional fields to the standard as specified in the following
Taxonomy of resources and services	Missing fields of information	TSO data dictionary does not support the representation of "bundled" resources or services, like e.g. in the case of the IFRC relief items catalogue	Addition of other TSO categories for describing bundled resources, and/or more complex relationships further to the available hierarchical structure
Taxonomy in general	Missing fields of information	TSO offers sometimes limited, sometimes too detailed set of icons for representing the variopus items which need to be exchanged in disaster management. In a similar way, a common set of icons which is suitable for all needs of multinational, big disaster management has not been standardized yet.	For practical use, generic taxonomies should be extensible and adaptable, and taxonomy subsets could be prepared for specific types of disasters, in order to provide templates targeting on the needs of a specific disaster type. In a similar way, the development of uniform, understandable and meaningful icon sets would help making situation maps more useful for international and cross-

			agency interoperability. Beyond the symbol pictures, standardised properties of the icons could be also used (like e.g. different shapes for representing different items, and colors coding for representing different status of items, etc.)
Language for the definition of sensor data fusion applications	Missing actual or de-facto standards	Presently there is no standard language to define sensor data fusion applications. The existing languages are targeted to data fusion domain but they are not taking into account the specific characteristics of sensors data sources.	A suggestion of a standardised language and runtime environment to define, deploy and manage the lifecycle of sensor data fusion applications.
No standard way for annotating the invocation of DSS services	Missing actual or de-facto standards	Presently there is no standard way for annotating the invocation of DSS services, so that for example a given system like IDIRA could provide to other external systems the possibility to invoke and use the functionalities and/or results derived by the IDIRA DSS tool.	To build a new standard for annotating the invocation of the DSS services. IDIRA DSS could be seen as a black box that provides a number of functionalities to external systems. Such interaction could be realised through the adoption of a standard that provides the means for the invocation of DSS services and their responses. Hence, under this perspective, every system that wants to use functionalities provided by a DSS should be aligned with the terminology defined in the discussed standard.

Table 4: Identified gaps and areas of improvements in the adopted data structures and approaches

3.2 Description and final recommendations on improvements, harmonisation and standardisation needs

3.2.1 EDXL Family of standards

3.2.1.1 EDXL-CAP – Alerts from different sources

A specific EDXL-CAP profile has been designed and adopted in IDIRA, with a set of custom rules for EDXL-CAP messages exchange with external C&C systems: in this way, C&C systems of interoperating organisations can be easily integrated, just following specific rules and guidelines.

A similar approach was not currently used for EDXL-CAP messages coming from different alerting authorities. According to the IDIRA project's experience, such alerting authorities are providing, today, similar information in a very different way. Let's consider for example, Figure 1 in the following, showing excerpts of EDXL-CAP alerts sent by 2 different alerting authorities – USGS and QLARM (the monitoring and alerting system of the IDIRA partner WAPMERR) - both of them dealing with earthquake events. Although the same standard alerting format is used, similar information - all information related to a given earthquake - is carried in heterogeneous ways, using different custom EDXL-CAP <parameter> values, making it more difficult the correct interpretation, parsing and use of the same information on the receiving system.

Hence, to start a study for the definition of guidelines on how to profile information about the same type of disaster inside EDXL-CAP messages, would be recommended, to be followed by any kind of authority involved in emergency monitoring and alerting.

3.2.1.2 EDXL-CAP – Acknowledgements

While EDXL-CAP provides the possibility to build and send messages of type "ACK" to confirm the reception of a given message, it does not provide any built-in mechanism for enforcing the request of the ACK itself, meaning that the source and recipient/s should agree beforehand on the way to request an ACK. Further, it may happen that a source cannot control, without such agreement, the number of acknowledgement messages that could be received back. This latter situation (uncontrolled number of ACK messages generated) can happen for example when alerting messages are broadcasted to the public and received through customized devices. In such scenarios (alerting to the public) no specific profiles and rules are normally defined and, in case the receiving devices are programmed to always send back acknowledgements, they can easily flood the source, in some cases even overwhelming the network capacity.

The recommendation would be, in this case, to add a way (e.g. an EDXL-CAP field) to explicitly request the reception of the acknowledgement, only when needed by the source itself.

3.2.1.3 EDXL-CAP – Multilingual support

While the possibility to transfer information in different languages is a very useful characteristic provided by EDXL-CAP, the way it is currently supported seems not to be efficient. For each language a new <info> block is added, where some information (category, event, urgency, area, etc.) needs to be repeated even if it is the same in most of the cases.

It would be recommended to repeat only the fields carrying free text that can be translated (e.g. <headline>, <description>, <instruction>), translated in different languages, avoiding to repeat all other information which stays unchanged.

```xml
<parameter>
<valueName>EventTime</valueName>
<value>20150220T074621.200Z</value>
</parameter>
<parameter>
<valueName>EventIDKey</valueName>
<value>usc000trsv</value>
</parameter>
<parameter>
<valueName>Magnitude</valueName>
<value>4.7</value>
</parameter>
<parameter>
<valueName>Depth</valueName>
<value>10.0 km (6.2 miles)</value>
</parameter>
<parameter>
<valueName>HorizontalError</valueName>
<value>8.4 km</value>
</parameter>
<parameter>
<valueName>VerticalError</valueName>
 <value>0.0 km</value>
</parameter>
<parameter>
<valueName>NumPhases</valueName>
<value>54</value>
</parameter>
<parameter>
<valueName>MinDistance</valueName>
<value>707.9 km</value>
</parameter>
<parameter>
<valueName>RMSTimeError</valueName>
<value>1.07 seconds</value>
</parameter>
<parameter>
<valueName>AzimuthalGap</valueName>
<value>75 degrees</value>
</parameter>
```

```xml
<parameter>
<valueName>Epicenter</valueName>
<value>38.11,23.6</value>
</parameter>
<parameter>
<valueName>Depth</valueName>
<value>15</value>
</parameter>
<parameter>
<valueName>Magnitude - M</valueName>
<value>7</value>
</parameter>
<parameter>
<valueName>Max. Intensity</valueName>
<value>VIII</value>
</parameter>
<parameter>
<valueName>Population at Intensity VI</valueName>
<value>328917</value>
</parameter>
<parameter>
<valueName>Population at Intensity VII</valueName>
<value>2503895</value>
</parameter>
<parameter>
<valueName>Population at Intensity VIII</valueName>
<value>1088690</value>
</parameter>
<parameter>
<valueName>Population at Intensity IX+</valueName>
<value>0</value>
</parameter>
<parameter>
<valueName>Estimated Injured</valueName>
<value>3000 - 50000</value>
</parameter>
<parameter>
<valueName>Estimated Fatalities</valueName>
<value>500 - 3000</value>
</parameter>
```

Figure 1: Excerpts of EDXL-CAP alerts from USGS (left), and QLARM system (right), with parameters providing details of an earthquake

3.2.1.4 EDXL-CAP – Hierarchical structured data support

Extensions in the CAP standard are easily supported by the mean of <parameter> blocks: any additional information, not covered by the explicit fields foreseen by the specifications, can be supported just adding custom parameters (see e.g. Figure 1).

Let's consider the case when structured and hierarchical organised information needs to be carried within a message, particularly when a given hierarchical XML structure needs to be repeated many times for describing different items of the same type (just to make one example, many Earthquakes, and each of them characterized by similar parameters, but with different values). This could result in quite inefficient representation and handling of the same information.

For covering such situations more efficiently, the possibility to add XML extensions to the EDXL-CAP schema can be recommended.

3.2.1.5 EDXL-RM

A resource in EDXL-RM can have only one ID. In an "information hub" like IDIRA this would be the internal IDIRA ID. But when an external resource management system is synchronised with IDIRA, it needs to distinguish between resources from the system itself and other systems.

Two additional fields to the resource, "Original ID" (ID in the source system) and "Source ID" (ID of the source system), for EDXL-RM would be recommended.

3.2.1.6 Multilingual information exchange using EDXL-SitRep

IDIRA supports exchange of information acquired in the field with mobile devices, through the so called structured communication forms. This should allow field commanders to send situation reports in different languages. For example the Czech fire brigade commander operating in Germany enters the information in Czech, it will be translated to German and English for communication with other units. EDXL-SitRep does not offer the possibility to contain the same information in different languages. Consequently it should be adapted as already implemented in EDXL-CAP and suggested above.

As this multilingual information exchange is of importance for all EDXL standards, it would be more efficient to enhance EDXL-DE. EDXL-DE right now allows to transport the same EDXL payload in several languages, but it is not possible to identify the language of each EDXL payload. Consequently EDXL-DE should supports to transport several EDXL payloads where each payload is in a different language, and the language of each payload is specified in EDXL-DE. The contentObject of EDXL-DE should be expanded by a language attribute.

3.2.2 Missing Person Tracing and PFIF data structure

Recommendations on the extension of the PFIF data structure, for covering the gaps highlighted by the end users during several meetings, trainings and exercises, are reported in Table 6, in the Annex.

3.2.3 Evacuation Simulation integration

3.2.3.1 Spatial data specification

While the OSM XML data was utilised to generate a virtual representation of real environments in the evacuation simulation tool, some key data was found missing from a pedestrian evacuation perspective. The major omission is lack of connectivity information specifying how various spatial elements are connected with each other. For example, connectivity between buildings and roads are very important for modelling pedestrian movement which is missing in OSM. Though there exists a provision to specify the locations of entrances and exits to buildings in OSM these data are mostly missing. Lack of road and pavement widths force the assumption of this data. Lack of elevation data of geographic locations forced the assumption of uniform elevation of the regions modelled for IDIRA. There is a standard provision to specify the entrance/exits for buildings and elevation data in OSM. However, due to the wiki nature of OSM these data are not normally specified.

The extensible nature of XML on which OSM is based allows the missing data - connectivity of spatial elements, entrance/exits for buildings and elevation data to be specified.

3.2.3.2 Population data specification

Modelling the evacuation of a region requires knowledge of the population distribution and the characteristics of the population in that region. The former refers to the number of people in the affected area and how they are distributed in the area. These factors are not only area specific, they are also time/date dependent. Depending on whether it is a working day the number and distribution of the people in areas will differ. Similarly depending on whether it is office hours the number and distribution of the people in areas will differ. The characteristics of the people such as age, gender and any mobility impairments is also a very important factor determining the outcome of an evacuation. The walking speed of a person which is a very important factor to determine the overall evacuation time for the region is dependent, amongst others, on these three factors. For example, on average a younger male pedestrian would walk faster compared to an older male. Also, on average, males would walk faster compared to females of the same age. The mobility of the population is a very important factor as well. Whether people can walk unimpaired, slightly impaired with or without crutches or requiring wheel chair will have a significant outcome on the evacuation performance.

Evacuation simulation tools would benefit immensely from data of this nature provided by external sources since the population could be represented much more accurately. A GIS based web service to provide the population data in XML or JSON format would be very useful for the evacuation simulation component. The population data could then be analyzed and fed into the simulation tool, EXODUS, to provide more reliable evacuation time estimates taking into account the actual demographic data of the region being modelled. A recommendation of what population data is required (list of suggested fields for the specification of population data) is provided in detail in the Appendix (Table 5 of the Annex).

3.2.3.3 Hazard data specification

In IDIRA hazard data could be specified from four sources - via the Evacuation Simulation ExpertGUI, COP GUI, ChemSim and Forest Fire Simulator (FFS). The ExpertGUI and the COP GUI are used to specify hazards manually which could be examined as part of a what-if scenario investigation or applied as an observation on the field. ChemSim and FFS utilize simulation tools to determine areas affected by chemicals and fire respectively. In the IDIRA project the evacuation simulation tool treated all hazards in a similar manner i.e. by modelling the affected areas as loss of routes. The agents in the affected areas are assumed to be unable to move out of their cut off area and therefore unable to get to a safe location. Conversely, agents on their way to safety will have to circumvent a hazard area (i.e. they cannot cross it) in order to reach safety. This is a simple way of modelling hazards within evacuation simulation tools. A more advanced way of modelling hazards would be to obtain the level of severity of the hazard - low risk, moderate risk, high risk or catastrophic and introduce different rules based on this. For example, if a region is categorized as low risk then majority of the people start evacuating immediately; all people in a moderate risk area will start evacuating immediately; people in a high risk area will evacuate immediately but with reduced walking speed due to the hazards; and people in high risk area will be assumed to be trapped and unable to escape. The external sources should thus be able to classify the severity of the observed or simulated hazards to these categories.

In order to incorporate hazard data from external sources within the evacuation simulation component, the following hazard related data need to be included: source of the hazard (e.g. ChemSim, FFS, etc), coordinates of the affected region, duration of the simulation during which the hazard needs to be active, nature of hazard (e.g. flood, building collapse, fire, etc) and severity of hazard (low risk, moderate risk, high risk or catastrophic).

A GIS based web service to provide this data in XML or JSON format would be very useful for the evacuation simulation component. The hazard data provided in this standard format could then be analyzed and fed into the simulation tool.

3.2.4 Definition of sensor data fusion applications

In IDIRA, for the purpose of defining sensor fusion applications inside the Sensor Fusion Engine (SFE), an XML meta-language has been devised. This language is known as Application Description Language (ADL) and provides structures that allow defining:

1. The input data flows (i.e., the sensor data streams)
2. The set of data processing elements along with their configuration parameters (e.g., algorithms / operators to execute, algorithm parameters, etc.)
3. The connections between the defined processing elements (i.e., data-in to data-outs)
4. The format of the desired output, along with the transmission protocol/adapter which will be used for the dissemination of data produced.

Domain experts can use this language to create scripts, which can be subsequently injected into the SFE through an Expert User Interface developed for that purpose. During the field-trials and exercises of IDIRA sample applications were developed in order to assess the applicability of such an approach. In practice, the language proved quite generic and expressive to model complete sensor data fusion applications but some constructs are rather bound to the underlying target platform.

At the best of our knowledge, they already exist some standard languages for modeling data fusion processes but there is a gap in the existence of a standardised language targeted to the specific characteristics of sensor data sources. More specifically, the existing languages do not provide any means for the definition and execution of a coherent workflow from data processing elements to alerting mechanisms which is a highly desirable feature for disaster management situations.

3.2.5 Semantic interoperability beyond data formats and languages: understanding codes and icons

Syntactic interoperability means the capability to exchange data sets, using defined formats and protocols. It is a pre-condition for automated information exchange, but receiving data and storing them in the own repository doesn't guarantee that the information is understood.

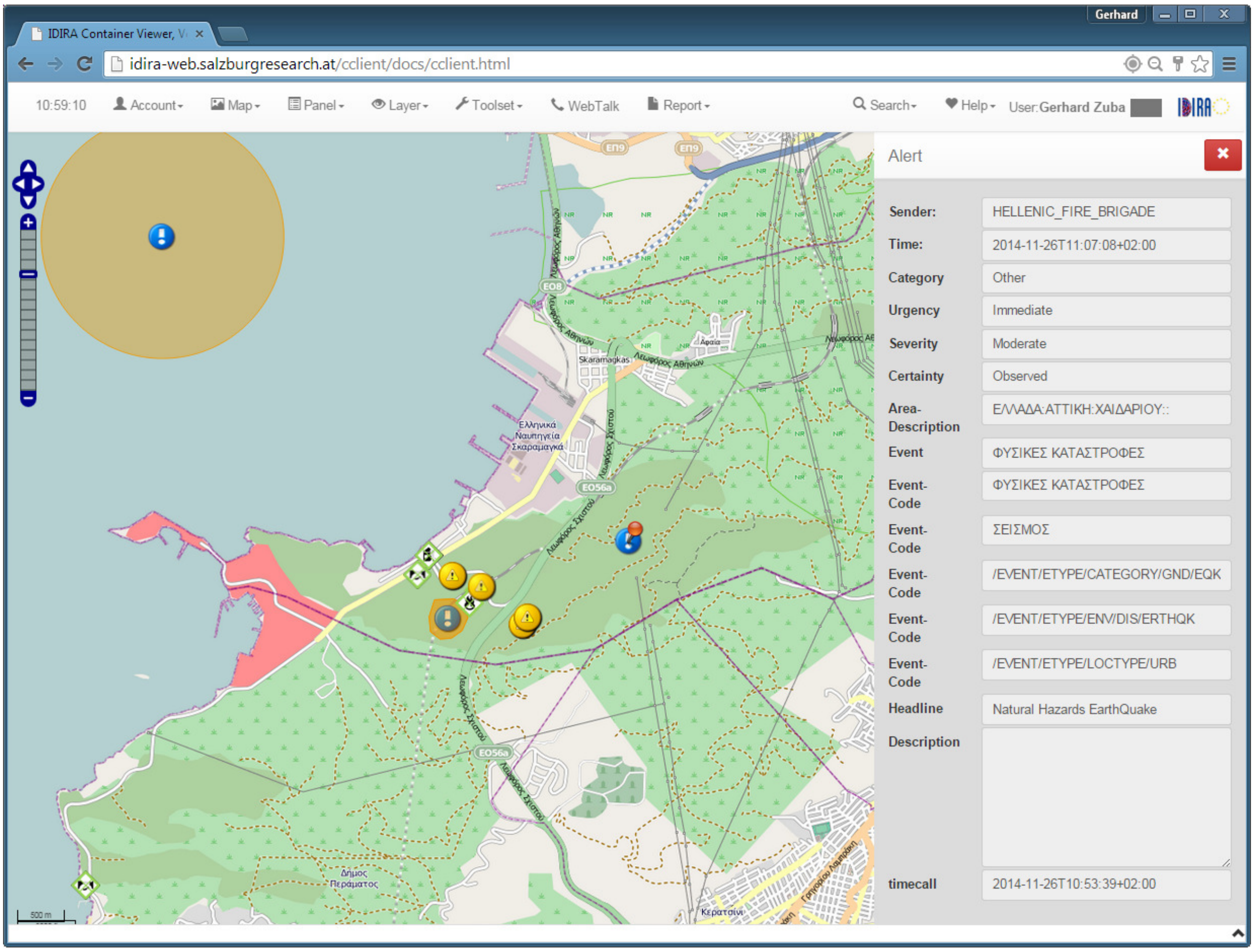

Figure 2: Who understands the CAP message from Hellenic Fire Brigade in COP?

3.2.5.1 TSO Taxonomy and recommendations for a generic taxonomy

While free text is “just” a matter of language translation or agreeing on a common language, encoded information has to be mapped on a common taxonomy or – even better – represented as ontology, in order to enable sense-making and automated information processing.

The TSO data dictionary [8] provides promising concepts; however it has considerable shortcomings and needs to be thoroughly revised in order to derive a compact and comprehensive taxonomy for disaster management on a tactical level.

The TSO (Tactical Situation Objects) is derived from the military domain and therefore covers many terms of combat together with other terms specific to crisis and disaster management. At the one hand, the TSO taxonomies given in [8] are much too detailed but nevertheless not complete in all areas. It is hardly possible and needless to manage several hundreds of table entries per type. On the other hand, the structures and hierarchy levels are not consistent and hard to interpret.

For tactical Crisis Management, a revised and restructured subset of the TSO data dictionary will be required. As an example to better explain these concepts, there are specific codes for various food rations (package of fixed portions; fresh food allotted for persons; tinned food), but there is no single encoding indicating a forest fire. It needs a combination of different taxonomy attributes – CATEGORY/FIRE + LOCTYPE/NAT/HFR (high forest) or even possible LOCTYPE/OTH/LFR (woodland) to describe a given forest fire.

Bundled resources and response unit capabilities, are important categories in the European crisis management mechanism that are also missing an unambiguous representation in the TSO data model.

We recommend the building of a generic interoperable taxonomy for tactical crisis management as a building block of a commonly used interoperable crisis management ICT infrastructure. The taxonomy should support hierarchy of terms, so that the level of details used can be varied. The following data elements need to be comprised:

- Disaster type (e.g. natural disaster – flood)
  categorizes the overall situation of the disaster that causes the deployment of international response.
- Incident type (e.g. pollution – chemical incident)
  categorizes events within a disaster that require response actions.
- Task (or Mission) category (e.g. rescue activity – USAR)
  categorizes response activities related to an incident, or responsibilities assigned for an area.
- Resource type (e.g. material – vehicle – fire truck - facility)
  categorizes material, infrastructure and human resources to be used for tasks.
- Quantity (e.g. number of casualties; transportation capacity)
  standardized way of quantifying incidents and resources.

Within the scope of IDIRA – tactical crisis management – taxonomies should be restricted on a manageable level of details and provide a consistent hierarchy of categories. The taxonomies used within the interoperable systems have to be unambiguously mapped on the standard taxonomy. If a specific term doesn't have an equivalent counterpart, at least a mapping to the correspondent generic term must be guaranteed.

Example: the TSO code /MAT/VEH/ROADVE/FRFGTN/HAZMAT identifies firefighting vehicles specifically equipped for managing hazardous materials. In a tactical taxonomy, this item may be sufficiently mapped to /MAT/VEH/ROADVE/FRFGTN – firefighting vehicle, while the details are reserved for the detailed description and used within the providing organization.

For practical use, generic taxonomies should be extensible and adaptable, and taxonomy subsets could be prepared for specific types of disasters, in order to provide templates targeting on the needs of a specific disaster type.

3.2.5.2 Icons

Icons (symbols on a map) are the graphical representation of taxonomy, showing different types of items by different symbols. In addition to the type they represent, basic symbol can be styled and amended with additional symbolic, color coded or even textual information in order to express attributes of the item. For human understanding icons are even more important of taxonomy – as expressed by some of the users during some of the training and exercises events organized, a picture is worth a thousand words.

Analogue to taxonomy building, the development of uniform, understandable and meaningful icon sets would help making situation maps more useful for international and cross-agency interoperability. Beyond the symbol pictures, standardised properties of the icons could be used in a way like this:

- shape (indicating the class of item, e.g. diamond for incidents, circle for alerts and observations, square for resources)
- border colour (indicating the status, e.g. green for available, red for occupied, yellow for in-transit)
- background colour (indicating situation e.g. red for danger, yellow for caution, green for OK)
- symbolic/numeric annotations (indicating the magnitude of an incident or the capacity of resources)

Unfortunately a commonly used set of symbols fitting for Crisis Management was not found. Some icon sets are used in a specific sector only (e.g. Tactical Symbols, powerful but not self-explaining), or don't cover fully the needs of Crisis Management (e.g. UN OCHA humanitarian signs, rather addressing humanitarian aid than crisis management [46]). A promising approach was made in the FP7 project INDIGO [31] with intuitive symbols and a systematic presentation scheme.

As it is unlikely to agree upon uniform icon sets in the whole Crisis Management community, a way of linking individual icon sets, provided by organizations, to the generic taxonomy and presenting every user the icons of his or her organization was implemented in IDIRA, as shown in Figure 3.

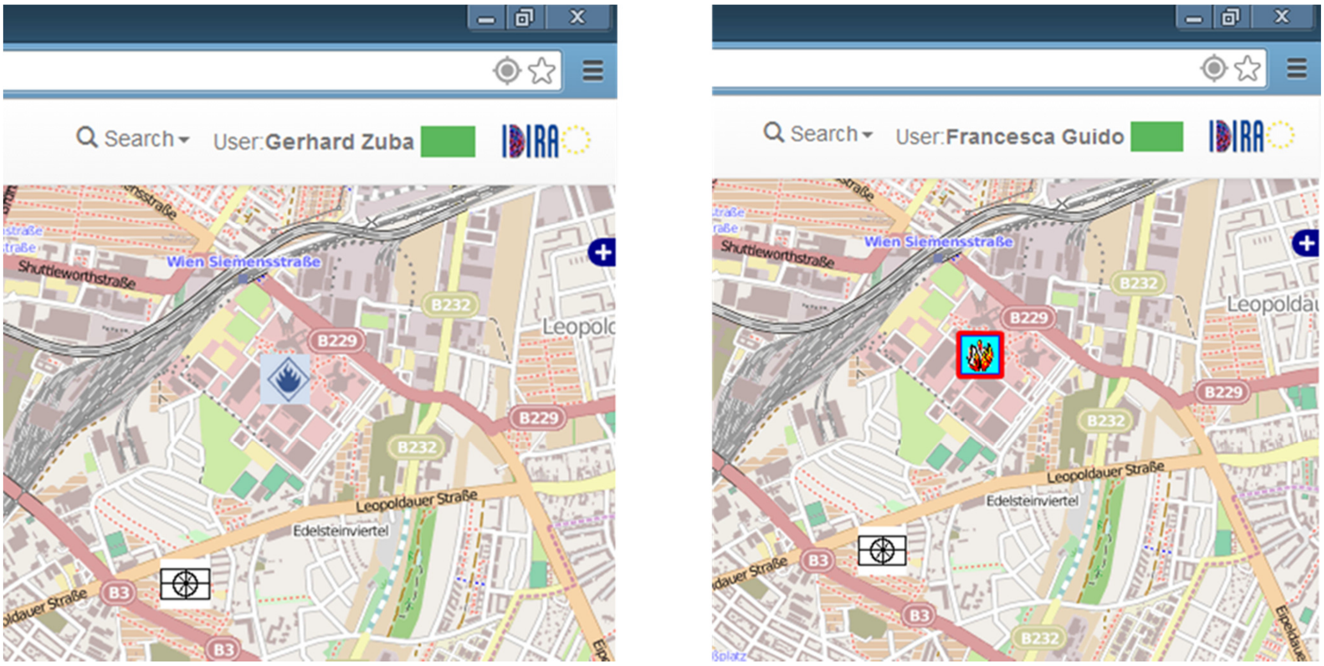

Figure 3: Different users getting different icons for the same item (incident urban fire)

3.2.6 Integration of Decision Support Systems

The DSS in IDIRA, aims to help the decision makers with ad-hoc planning and operational tasks during response to disasters. IDIRA DSS can be adopted in different phases of disaster management: (a) during the preparation phase before an incident happens and (b) in the disaster response phase. The DSS functionalities are provided on top of geographic information (e.g., maps, amenities such as roads, bridges, etc.). The spatial information is built and managed by adopting open interoperable geospatial standards, which are basically the same already described when writing about the integration of external simulation systems (see 2.2.2.4).

In the DSS provided in IDIRA specifically, the following technologies and frameworks are used:

- A PostgreSQL database to store the spatial information that needs to be displayed;
- The PostGIS spatial database extender for PostgreSQL allowing the storage and the management of spatial objects;
- The GeoServer adopted to handle the information retrieved by PostGIS tables and allow the COP GUI to get access in this information through the WMS and WFS formats. WMS allows the display of spatial objects as overlays on top of the base map and WFS allows the visualization of data associated with the spatial objects in the overlay panel.

In general, geographic information standards provide digital coding to locate and describe features on the Earth's surface. However, no technical high level interoperability for decision support tools exists. Decision support tools in the relevant literature are based on immature algorithms. Many extensions should be developed for deriving high quality algorithms for decision support in disaster management scenarios. Each effort relies on a dataset of resources that is used and updated by the provided services.

Moreover, users need information to answer a query or support a decision. Users have to locate relevant data, assemble data from several sources / servers, process the data and then visualize the results. As interoperability is one of the main goals of IDIRA, DSS tools should be easily discovered and clearly described.

DSS tools in IDIRA are implemented as web services and, thus, they can be easily accessible. The DSS tools can be accessible by any PC or tablet with a network connection to the IDIRA MICS (server infrastructure) by any end-user on-site. Hence, the provided services can be consumed by any organization.

Except from their functionalities as web services, the description of DSS tools should follow well known standards like the following which play key role in interoperability of web services in general:

1. **Web Services Inspection Language (WSIL)** [38]: WSIL is an XML-based open specification that defines a distributed service discovery method that supplies references to service descriptions at the service provider's point-of-offering, by specifying how to inspect a Web site for available Web services. A WSIL document defines the locations on a Web site where you can look for Web service descriptions.
2. **SOAP** [9]: an XML-based standard for messaging over HTTP and other Internet protocols (see also 2.2.4.1). It consists of three parts:
    - An envelope that defines a framework for describing what is in a message and how to process it.
    - A set of encoding rules for expressing instances of application-defined data types.
    - A convention for representing remote procedure calls and responses.
      SOAP enables the binding and usage of discovered Web services by defining a message path for routing messages.
3. **Web Services Interoperability** (WS-I)[39]: The WS-I Simple SOAP Binding Profile provide interoperability guidance for core Web Services specifications such as SOAP,

WSDL, and UDDI. The profile uses Web Services Description Language (WSDL) to enable the description of services as sets of endpoints operating on messages.

In addition to the standards reported above, the DSS system used in IDIRA could be enhanced with the use of the **Web Processing Service (WPS)** [40], a standard used for geospatial data analysis. Web Processing Services are easily accessible and flexible libraries of geo-processing algorithms in a web service environment (like a stand-alone GIS contains a library of geo-processing algorithms in a stand-alone environment). To function in a web service environment a WPS has to offer self-describing atomic geo-processing tasks, which can be accessed and used by humans and other web services. It provides services for geo-processing raster and vector spatial data. Standard defines data transfer protocol, format of the commands for process execution and data retrieving. WPS defines three main operations:

- GetCapabilities - for extracting web services metadata and list of the processes.
- DescribeProcess - returns a detailed description of the selected process, including information about the input and output parameters.
- Execute - starts the process and returns result.

Web Processing Service accepts these commands in XML format or as a URL-encoded request. The standard is very flexible, thanks to the following properties:

- Input and output data could be either references to the data, or be integrated into the body of the request or response.
- If the answer is simple, such as an image in the GIF format, the web service can return it directly, without wrapping in XML.

This will allow the automated integration of services according to their self-description.

More importantly, the consortium identifies the need of a new standard for annotating the invocation of the DSS services. For instance, the IDIRA DSS could be seen as a black box that provides a number of functionalities to external systems. Such interaction could be realised through the adoption of a standard that provides the means for the invocation of DSS services and their responses. Hence, under this perspective, every system that wants to use functionalities provided by a DSS should be aligned with the terminology defined in the discussed standard. The IDIRA consortium recommends future works to go in this direction. The interaction process between the DSS and external systems should be clearly defined, and specific terminology should be proposed according to the implemented components. The discussed terminology should be in the form of an hierarchy where generic as well as more specific concepts will be described.

The aim of the consortium partners is to initiate an interaction with widely known standardization institutes for conveying the experience and expertise of the IDIRA DSS.

4 PARTICIPATION TO STANDARDIZATION ACTIVITIES AND WORKSHOPS

This section reports on partners' participation to activities or events relevant for the standardisation and harmonisation domain.

4.1 ETSI SatEC Working Group (STF472) meeting on the use of Satellite Systems in Emergency scenarios

IES participated to the meeting #28 of the SatEC Working Group of ETSI. The meeting was hosted by Telecom Bretagne in Toulouse (France) on 13th and 14th January 2015. At the meeting, the activities of the Specialist Task Forces 472 (Reference scenarios for Emergency satellite-assisted Telecommunication Services - https://portal.etsi.org/stfs/stf_homepages/STF472/STF472.asp) and 473 (Alert Message Encapsulation - https://portal.etsi.org/stfs/stf_homepages/STF473/STF473.asp) were reported and the next steps discussed and agreed.

IDIRA was presented by Uberto Delprato (IES Solutions) and was considered relevant for STF472, and the scenarios implemented for the Large Scale Exercises were presented and discussed aiming at identifying the role that Satellite-assisted Telecommunication could have played in the events and how they could have worked in combination with the EDXL based tools implemented in IDIRA.

4.2 Meeting with other projects dealing with interoperability and taxonomy issues

IES participated to a meeting of the projects funded under the topic SEC-2012.5.1-1 (Analysis and identification of security systems and data set used by first responders and police authorities) of the last FP7 Security Call. The four project (EPISECC, SECINCORE, SECTOR and REDIRNET) are all researching on topics relevant for IDIRA. In particular, the coordinated efforts on the definition of a common taxonomy for data sharing between emergency services fits well with the features of the system developed in IDIRA. The meeting was hosted by CISCO in Paris (France) on 24th November 2014 and outlined the areas where the efforts of the four projects will be coordinated. The experience gained in IDIRA was shared and included as a reference for the "Task Forces" on Taxonomy and on Standardisation.

4.3 Participation to the EU Emergency Services Workshop 2013

On 17th -19th April 2013, EENA (European Emergency Number Association) organised their annual workshop in Riga (Latvia). IES participated to the conference, showing in a dedicated booth the progress achieved in the implementation of the EDXL-CAP inbound services for IDIRA. The conference had more than 350 participants and Uberto Delprato (IES Solutions) chaired the finals plenary session where requirements and expectations for the future 112 services were discussed.

4.4 CAP implementation workshop 2013

The regular"Common Alerting Protocol (CAP) Implementation Workshop" took place in Geneve (Switzerland) on 23rd and 24th April 2013. Hosted by the WMO (World Meteorological Organisation) the meeting gathered CAP experts and implementers from all over the world. Massimo Cristaldi (IES Solutions) participated to the workshop and presented the progresses achieved in Italy and in the IDIRA project for what concerns the implementation of interoperable CAP-based services.

4.5 CAP implementation workshop 2014

The Common Alerting Protocol (CAP) Implementation Workshop was held in Negombo, Sri Lanka, from 17 to 18 June 2014. The Workshop was co-sponsored by the International Telecommunication Union (ITU), OASIS (Organization for the Advancement of Structured Information Standards), and the World Meteorological Organization (WMO). The focus of PWS includes how official alerting authorities disseminate alerts and warnings to the public, to media, and to disaster management and civil protection authorities. The host of the Workshop was Learning Initiatives on Reforms for Network Economies Asia (LIRNEasia), based in Sri Lanka. The Workshop was part of the IOTX Convention hosted by LIRNEasia, where IOTX stands for the 10th anniversary of the tragic Indian Ocean Tsunami. Marcello Marzoli (CNVVF) participated to the workshop and presented the further progresses achieved in Italy and in the IDIRA project for what concerns the operational implementation of interoperable CAP-based services.

4.6 Technical Committee on Mass Evacuation and Sheltering (NFPA 1616) First Draft Meeting held in Denver, U.S.A. on March 3-5, 2015

CNVVF is contributing to the Technical Committee on Mass Evacuation and Sheltering to edit the first draft of the NFPA 1616 standard (http://www.nfpa.org/codes-and-standards/document-information-pages?mode=code&code=1616). The National Fire Protection Association (NFPA - http://www.nfpa.org/) is a United States association, which creates and maintains standards and codes to be adopted and used by local governments. Their scope covers model building codes, firemen equipment and firefighting, as well as hazardous material and rescue response. In particular, the NFPA 1616 standard want to establish a common set of criteria for Mass Evacuation, Sheltering and Re-entry.

It is worth to highlight that, even if NFPA standard codes are created and maintained in USA, they are adopted 'as is' and enforced by those Authorities which do not have the needed background and structure to create and maintain their own regulation, but even where strong Authorities are enforced, in most cases they accept NFPA as a reference, due to their high quality. As a result, as soon NFPA 1616 will be released, a great number of the Authorities (worldwide) which will have to plan for mass evacuation will take a look to this standard and as a matter of facts to the IDIRA outputs.

Here below are listed those public inputs proposed by CNVVF, basing on internal professional competences as well as taking advantage from knowledge and direct experience gained from the participation in IDIRA:

- Assessment tools to estimate egress time of mass evacuation: proposal of considering benchmark simulations which could be used to compare different procedures and protocols and rank evacuation performance (accepted for inclusion into an Annex D - Evacuation Requirements Analysis)
- Public warnings: adoption of the following common standards and guidelines: Common Alerting Protocol (CAP) and Public Warning Design Guidelines for Federation for Internet Alerts (FIA) Messaging (accepted for inclusion into an Annex K Emergency Communication: Public Alerts and Warnings).

- Seamless data exchange between shelters' Authorities Having Jurisdiction (AHJ) and other stakeholders: adoption of common standards possibly based on OASIS EDXL Hospital AVailability Exchange (HAVE) and implementation of related interoperability features (accepted for inclusion into an Annex N Evacuation, Sheltering and Re-entry Data Interoperability).
- Person Registering and Tracing Systems for Family reunification tools: adoption of common standards possibly based on OASIS EDXL Tracking of Emergency Clients (TEC) and implementation of related interoperability features (accepted for inclusion into an Annex N Evacuation, Sheltering and Re-entry Data Interoperability).

The Technical Committee on Mass Evacuation and Sheltering met into the First Draft Meeting (NFPA 1616) on 3-5 March 2015 in Denver. CNVVF participated to the meeting to present the IDIRA project and support the above-mentioned contributions. This activity will continue well after the IDIRA project conclusion, up to the release of the standard in 2017.

4.7 Planned participation CAP implementation workshop 2015

A Common Alerting Protocol (CAP) Jump-Start and a CAP Implementation Workshop will be held 22-24 September 2015, in Rome, Italy. These events will be hosted by the CNVVF Fire Corps Academy of Italy, Istituto Superiore Antincendi. Participants will hear presentations on new CAP implementations as well as updates on some of the many existing CAP implementations. CNVVF and the Italian Air Force National Meteorological Service will present as CAP has been introduced within operational procedures in Italy. The results achieved in IDIRA will be presented by Massimo Cristaldi (IES Solutions).

Among other topics of the 2015 CAP Implementation Workshop will be the proposed WMO Alert Hub. This free facility on the Internet will help disseminate copies of alerts as designated by official sources listed in the international Register of Alerting Authorities. The WMO Alert Hub will be designed to address crucial alerting requirements for high levels of responsiveness, availability, reliability, authenticity, and security. Yet, it will not compromise the authoritative voice for alerting because alerts facilitated by the WMO Alert Hub remain clearly a product of the alerting authority. A related topic of discussion will be how CAP can be applied to Earthquake Early Warning systems. In these systems, warnings triggered on detection of an earthquake are sent electronically to warn people before destructive ground motion arrives. In these and most other public warning systems, alerts should be sent over all media available. An emerging trend is for CAP alerts (e.g. tornado warning) to be presented by online media through the overlay of Internet advertising. This capability has been pioneered by the Federation for Internet Alerts (FIA) which will present its progress and plans to the Workshop. Participants in the CAP Workshop will hear presentations on new CAP implementations as well as updates on some of the many existing CAP implementations. Among the newest CAP implementation presentations could be Burundi, Brazil, the Philippines, and Rwanda. Also likely is an update from MeteoAlarm on public access to CAP in 35 languages from 34 European nations. Other presentations will focus on countries where CAP implementation is now underway.

For example, the India Meteorological Department is now engaged in CAP implementation. Initiatives have also started in other countries, including Jamaica and Sri Lanka. In Italy, CAP implementations are spreading from the Italian Ministry of Interior to the National Meteorological Service as well as Civil Protection Authorities.

4.8 Planned FRQ participation to the workshop on Geospatial ICT Support for Crisis Management and Response at ISCRAM 2015

FRQ prepared a contribution for the Workshop on Geospatial ICT Support for Crisis Management and Response. This workshop is organised by the ISCRAM conference and the Open Geospatial Consortium (OGC) and its Emergency and Disaster Management (EDM) domain working group. The workshop will take place at the ISCRAM 2015 in Norway on Sunday 23. May 2015. The contribution comprises a crisis-response scenario description, which illustrates an urgent and challenging need for geospatial ICT support exceeding current capabilities in terms of functionality and quality. The scenario is titled “Collaboration during a Flooding Event with Cascading Effects”. Author is Christian Flachberger, Frequentis AG. On 22.03.2015, we were informed by the workshop organizers that the contribution passed the review-process positively and was accepted.

5 APPLICATION GUIDELINES FOR INTEROPERABLE TECHNOLOGICAL SOLUTIONS AND ADOPTION OF STANDARDS

In this section we report on practical, application guidelines and technical steps needed for opening existing systems (e.g. C&C) or equipment (e.g. sensors) to the use of standards and approaches for interoperability proposed in IDIRA.

The said guidelines are aimed at making it possible the interoperable integration of external systems with the IDIRA MICS, as well as the seamless information exchange between any type of system or tool for emergency management. Starting from the specific examples of the connection between external existing systems and the MICS platform indeed, the described steps can be easily generalised, so that similar approaches, based on the implementation of standard communication technologies and the use of standard data formats, can be adopted for direct information exchange of systems which does not use the MICS as information hub. In practical terms, these guidelines can be adopted for:

- building systems able to send-receive information to-from other systems in an interoperable environment
- building systems able to send-receive information using the MICS as information hub, as well as to integrate their results to specific MICS components (e.g. as geographical layers of the COP)

5.1 Technical guidelines for interoperable integration of information on alerts, incidents, resources and tasks

5.1.1 Guidelines for the adoption of suitable/standard data structures and technologies

Adoption of standard data structures and technologies as proposed by the IDIRA/MICS interoperable architecture, entails the need of adapting existing systems. The needed steps can be summarized as follows:

1. Mapping of information produced by own systems, with the XML fields envisaged by the corresponding EDXL data structure (see Section 2.2.2.1), according to the type of information to share

2. Mapping of internal organisation taxonomy, to the common TSO taxonomy used within IDIRA

3. Implementation of the needed software adapters and interfaces

As far as the mapping of information with the XML fields of the adopted EDXL data structures is concerned, some practical use cases can be considered:

a. By using his own C&C system, an operator normally inserts information, which refers to the specific event/incident to be reported and/or managed: incident type, caller name, incident location, and special notes just to name a few. The set of information inserted, needs to be mapped to the corresponding EDXL-CAP fields, the data structure that will be used to share the same information with the MICS and / or other interoperable systems. A simple example of how this mapping would work, considering only a few subset of information needed to fill in some of the most relevant EDXL-CAP fields, is reported in Table 7 of the Appendix.

b. By using his own C&C system, the tactical commander inserts information, which refers to the available resources, resources being dispatched or already deployed, such as: resources status, resources location, resources type, and so on. This information set, needs to be mapped to the corresponding EDXL-RM fields, the data structure that will be used to share the same information with MICS and / or other interoperable systems.

c. An existing alerting system, collect information about an event already happened (earthquakes characteristics, earthquakes impact and losses estimation), or about some critical conditions which could potentially lead to a serious emergency situation or disaster, such as for example critical weather conditions, and so on. This information needs to be published in order to be consumed directly by disaster managers with their own systems, or through a disaster management systems such as the MICS: for this to be possible, there is the need to create an EDXL-CAP message out of this information, by mapping them to the most suitable EDXL-CAP fields. A simple example of how this mapping would work, considering only a few subset of information needed to fill in some of the most relevant EDXL-CAP fields (parameters), was already shown in Section 3.2.1.1, Figure 1.

d. EDXL-CAP messages describing a specific incident have to be consumed by an existing legacy system. Once it is received, the information inside needs to be interpreted in order to be handled / visualised from within the proprietary receiving system. This will require, on the destination system, the capability to parse and understand the received EDXL-CAP messages.

Similar considerations apply to the need of converting existing, own taxonomies to TSO codes, for a common understanding of the information being shared, according to the semantic interoperability concepts explained in Section 3.2.5. A typical use case refers to an incident or resource type, being shared with other stakeholders: the mapping between the local representation, adopted and understood only within the originating organisation, and the corresponding TSO codes, will be needed. Table 8 of the Appendix, reports how few of the event codes used by the CNVVF, the Italian National Fire Corps partner in IDIRA are mapped with TSO codes.

Of course, all the above-mentioned information will be subject to continuous updating in the legacy systems (e.g. the times at which a Fire truck leaves the Fire Station, the time when it arrives in place, etc.). Such updates generate a flow of information which will have to be thoroughly mapped into the XML structures, so as not to leave inconsistencies behind (e.g. a Fire truck which seemingly remain in place forever due to a missing follow-up).

Finally, there is the need to develop the needed software adapters, to implement the abovementioned mappings, together with the software interfaces for enabling the possibility to provide and consume information to-from the MICS or other interoperable systems. These concepts are detailed in following Section 5.1.2.

5.1.2 Software adapters and interfaces

Figure 4 provides a high level overview of the Inbound/Outbound EDXL-based interfaces between the IDIRA MICS and existing external systems, and of the needed adapters, standards and technologies involved, for enabling information sharing on alerts, incidents, resources and tasks.

According to what explained in the previous section, an EDXL Adapter conceptual component will be needed, in order to perform the mapping and conversion of the information generated from within the considered system, to EDXL standard messages. Optionally, a Taxonomy Adapter conceptual component can be implemented within the external system, in order to produce information which is already translated into the IDIRA (TSO) taxonomy or other common taxonomy agreed between systems.

The actual connection and information sharing between the existing, external system and the IDIRA MICS, will happen through the implementation, on the external system side (e.g. an existing C&C system), of further conceptual components, used to support one or more of the following communication scenarios:

- EDXL-CAP Feed producer, to publish EDXL-CAP messages as ATOM feeds, that will be consumed by the corresponding IDIRA Inbound EDXL Feed Service
- Inbound EDXL Client, to send EDXL messages through the SOAP Web Service interface provided by the Inbound EDXL Web Service of the IDIRA MICS
- EDXL-CAP Feed Consumer, to consume EDXL-CAP messages, generated from within IDIRA or from within other proprietary systems and published through IDIRA, via the ATOM Feed interface of the Outbound EDXL Feed Service

IDIRA Inbound and Outbound EDXL Services highlighted in Figure 4, currently run on the IDIRA MICS. Services descriptions, or WSDL, of the Inbound Web Service and the Taxonomy Translation services, are accessible for example at the following URLs:

- http://idira-ies.salzburgresearch.at:3030/Inbound_EDXL/services/Inbound_EDXL_WebService?wsdl
- http://idira-ies.salzburgresearch.at:3030/Inbound_EDXL/services/TranslationWSIDIRA?wsdl

Using the above WSDL, it is possible to build the related Inbound EDXL Client on the external system side, in order to be able to send EDXL messages to the IDIRA MICS

Feeds published by the Outbound EDXL Feed Service, indicating messages sent by a given source and addressed to IDIRA, are currently accessible from the MICS through password protected Web links like:

- https://idira-ies.salzburgresearch.at/QLARM/IDIRA

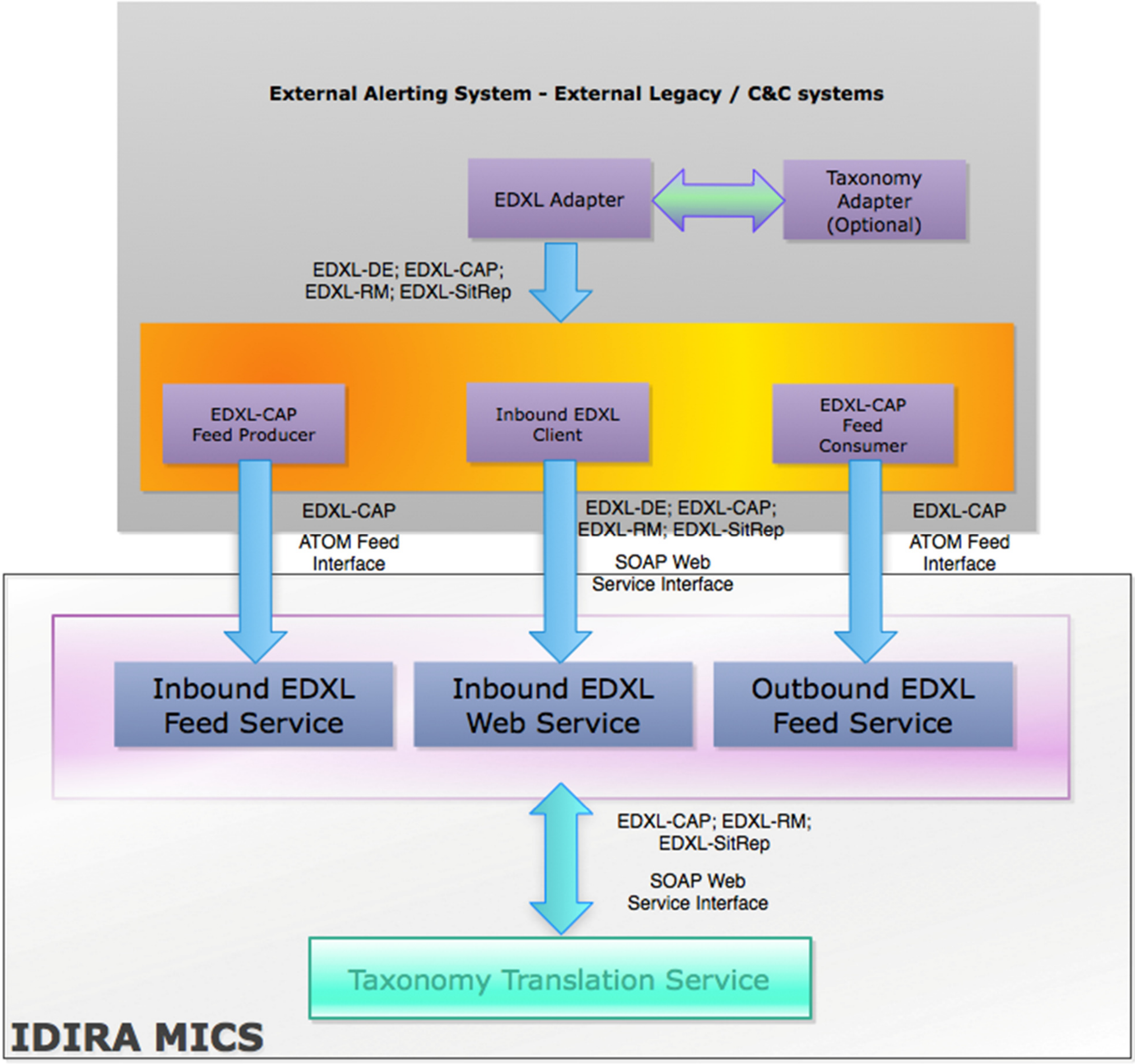

Figure 4: High level concepts for the interoperable communication of existing systems with the IDIRA MICS, for data sharing on alerts, incidents, resources and tasks

Worth to mention again, as the above concepts can be generalised so that basically any existing MICS-compliant system, can be enabled to the direct information exchange with other existing systems, provided they both implement MICS-compliant approaches, based on the use of open communication interfaces and standard data formats for information exchange.

5.1.3 Prerequisites, and lesson learned from the adoption of the described solutions

During the project, the guidelines provided in Sections 5.1.1 and 5.1.2 have been followed for the adaptation of existing systems owned by project's partners. The following showcases were implemented and adopted during the several testing and evaluation events (reviews, small scale training and large scale exercises), for what concerns incident related information exchange:

- the emergency management systems Jixel owned by IES, was adopted for Inbound/Outbound incidents information exchange using EDXL-CAP as data format, the EDXL-CAP Feed Consumer (Outbound) and the Inbound EDXL Client interfaces;
- the C&C system Engage owned by STWS, was adapted for Inbound/Outbound incidents information exchange as well, again using EDXL-CAP as data format. the EDXL-CAP Feed Consumer (Outbound) and the Inbound EDXL Client interfaces;
- the resources management system Mobikat, used by Fraunhofer, was adapted for Inbound/Outbound resources information exchange, using EDXL-RM as data format
- the earthquake alerting and losses estimation system owned by WAPMERR, called QLARM, was adapted and used for Inbound integration of earthquake related alerts

A certain effort is of course required for modifying existing systems in order to implement the needed adapters and software interfaces. According to the experience acquired in IDIRA however, this process can be concluded in limited time, provided there is complete access and freedom to modify the code and update the technologies used in running systems, as it was possible for the abovementioned showcases.

Project's partner CNVVF is currently using, for interoperability between both all Italian Fire Brigades Control Rooms in Italy and with external emergency agencies, a custom version of the emergency management system Jixel. This version of Jixel is integrated with the official C&C solution called SO115. In such specific, real cases, the process for changing the existing system and adopting interoperable solutions can be more time consuming. This is normal as such a process involves facing with issues like:

- The need to update obsolescent technologies in existing legacy systems
- The need of changing the way the technology itself is used for day-to-day operations
- The transition of a production system to an updated one without interrupting the provided service

The same solution for interoperability adopted in production by the CNVVF, was also used during the large scale exercises in Wels (Pandemic, Austria) and Athens (Fire/Earthquake, Greece). This experience was a proof of the efficient integration of external existing systems, from both the technical and the organisational (e.g. in terms of procedures) point of view.

Apart of the abovementioned lessons learnt, there are no special pre-requisites in order for such integration to be possible in case of a real disaster management situation. Provided existing systems have been already adapted according to the IDIRA MICS guidelines and approach, a limited configuration effort could be just needed to put them in the condition to send-receive information to-from IDIRA.

5.2 Technical guidelines for interoperable integration of existing sensors and sensing devices

Sources of sensor data can be integrated to the IDIRA MICS platform through the Sensor Data Integration subsystem. This subsystem consists of core back-end components plus a number of interfaces components that facilitate the communication of this core with external entities. A detailed description of the Sensor Data Integration component and the interoperable standards that have been adopted is provided in details in the IDIRA deliverable D3.4.

During the field-trials and large scale exercises of IDIRA and following the end users requirements and suggestions, a set of sensor data sources (e.g., Davis Weather Station, sensordrones) have been integrated to the IDIRA MICS platform, through the Sensor Inbound Service. This service provides a standardized interface (i.e., Sensor Observation Service described in 2.2.4.3) allowing the interoperable integration with any external sensor source. Specifically, if a sensor data source needs to send observations to the MICS, firstly it must register itself via a "RegisterSensor" message / operation of SOS standard, featuring the sensor description in SensorML (see Section 2.2.2.5). Upon successful registration, the "InsertObservation" operation can be used for the insertion of measurements related to this specific source. To ease the integration of new sensor sources, the sensor infrastructure of the MICS can be categorised on two main categories:

- simple sensors that measure a single phenomenon
- sensor systems that provide measurements for multiple phenomena

5.2.1 Guidelines for the adoption of suitable/standard data structures and technologies

Sensor data in IDIRA is integrated using the OGC SWE standards family (SOS and SensorML). This allows inbound and outbound services using this standard, and provides to external systems the possibility to send and receive sensor information through MICS sensor in- and outbound services.

The following options are possible:

- An external system is able to connect to a SWE service (see Section 2.2.4.3). In this case, the external system can directly send SensorML messages to the MICS Sensor Inbound Service. This is, for example, the case for IDIRA-controlled sensor sources, like mobile clients (that directly connect to the Sensor Inbound Service)
- An external system is not able to directly connect to a SWE service. This is mostly the case for third party services (like Wedaal, Wunderground and Pegel online). In this case, a connector/adapter is implemented in the MICS, converting the external (proprietary) sensor information to SensorML.

To send sensor data anyway, a sensor data source needs to register itself via a "RegisterSensor" message / operation of SOS standard, featuring the sensor description in SensorML. Upon successful registration, the "InsertObservation" operation can be used for the insertion of measurements related to this specific source.

SWE provides a taxonomy for many sensor types, following the URN (uniform resource name) specification. Where possible, those pre-defined URNs were used, for example:

- Atmospheric Pressure: "urn:ogc:def:phenomenon:OGC:1.0.30:pressure"
- Temperature: "urn:ogc:def:phenomenon:OGC:1.0.30:temperature"

If no URN is available, IDIRA defines a new URN in the IDIRA namespace, for example:

- Mobile Signal Strength: "urn:ogc:def:phenomenon:IDIRA:RSSI"

5.2.2 Software adapters and interfaces

The sensor subsystem provides three main interfaces:

- Sensor Inbound/Outbound Services for external systems as described above
- The sensor plugin for the COP user interface showing raw sensor data in the client
- The output of the Sensor Fusion Engine is currently available as EDXL-CAP messages, or directly as email for the field commander. This makes it possible for external systems to receive information about sensor data even if the system is not able to interpret SWE data, but just using EDXL-CAP format.

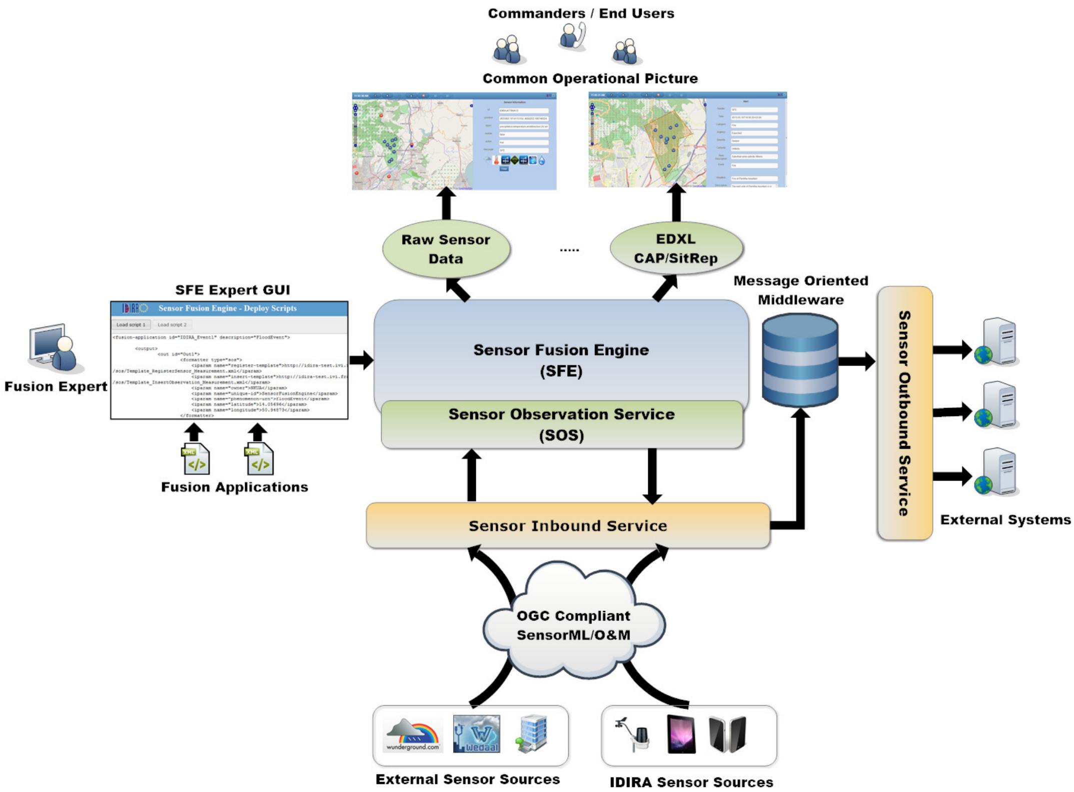

Figure 5: High level concepts for the interoperable integration of data from sensor sources to the IDIRA MICS

5.2.3 Prerequisites, and lesson learned from the adoption of the described solutions

In practice, there is a vast variety of sensor vendors and heterogeneity on the communication protocols between the sensor platforms and the data collection modules. It is not a common practice that a sensor data source complies with the SOS standard and so the necessary interfacing component has to be implemented for integration purposes. To ease this procedure a set of XML templates of core SOS operations have been developed and are presented in details in Annex II of deliverable D3.4.

5.3 Technical guidelines for interoperable integration of Missing Person Tracing tools

5.3.1 Guidelines for the adoption of suitable/standard data structures and technologies

In IDIRA all data about missing persons is communicated via the PFIF format, as described in Section 2.2.2.2. The PFIF standard also defines the procedure of synchronising different repository which was implemented by IDIRA.

Systems that want to be interoperable with the IDIRA MICS (MICS-compliant system), or wants to implement MICS-like approaches for interoperating with other Missing Person Tracing repositories, just need to export their data as PFIF XML files. If they also support import of PFIF XML files a two-side synchronisation can be done.

So the main effort to make a Missing Person Tracing system MICS-compliant, is to map information produced by this system to data fields of the PFIF standard.

No special taxonomies where introduces or used in the Missing Person Tracing components, so there is no need for any taxonomy translations.

5.3.2 Software adapters and interfaces

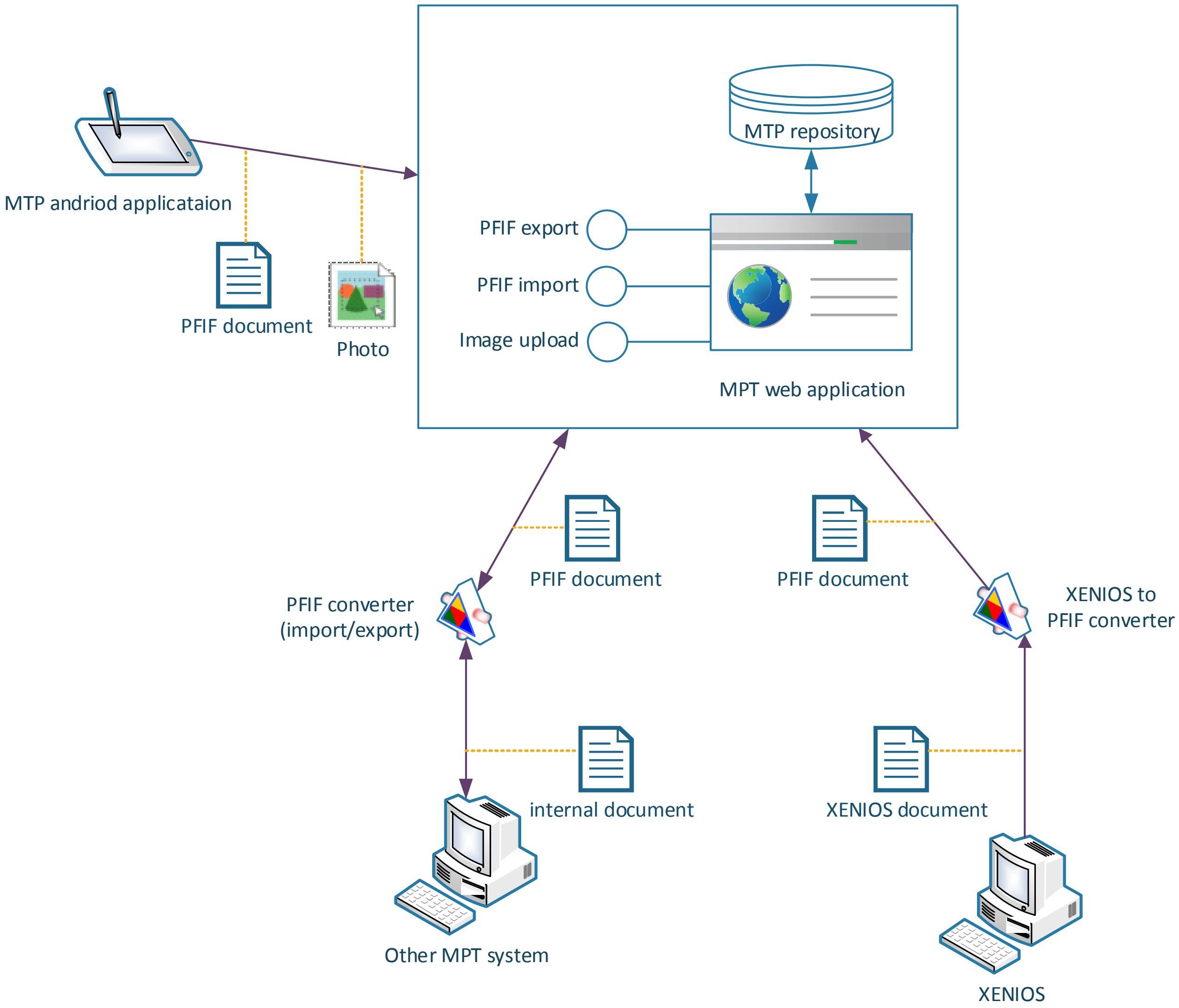

Figure 6: Overview of MPT interfaces and communication

The MICS MPT Web Application provides three interfaces for other systems

- PFIF import: import external data into the repository
- PFIF export: export the internal data, so other systems could import the MICS MPT data.
- Image upload: Upload images referred in the PFIF document.

The IDIRA MPT android application is used to collect information about missing persons in the field. The collected data is stored in an MPT document and uploaded to the server (photos may also be uploaded).

For the legacy system XENIOS used by the IDIRA partner DRK-SN, a PFIF converter was written that converts the XENIOS data into the PFIF format. This could be uploaded to the MPT repository.

In the same way the data of other MPT systems could be converted into the PFIF format and a synchronisation with the MICS MPT system would be possible.

5.3.3 Prerequisites, and lesson learned from the adoption of the described solutions

To make a system compliant to the PFIF standard one of the following must be possible

- Direct access to the source code of the system
    - In this case a full compliance may be possible by changing the system if the internal data model is flexible enough to map the PFIF field to it.
- Some kind of import and export of the internal data of the system
    - In this case, a full compliance may impossible because of missing functionalities of data fields of the export

In XENIOS PFIF converter is based on a XENIOS backup file. XENIOS has a quite large data model, so a considerable effort was needed to define the data field mapping to PFIF. Because of the complexity of the XENIOS backup file and missing functionalities of it, only an export to PFIF data format was possible, not the import. This demonstrate that, sometimes, the amount of time needed to adapt one existing system to standard technologies for information exchange in a cooperative environment, is not negligible. It is important however, to understand also that, once the work is done, the advantages, in terms of efficiency gain, of having a system able to interoperate with other systems, is worth the investment in money and human resources.

5.4 Technical guidelines for interoperable integration of geographic data

5.4.1 Guidelines for the adoption of suitable/standard data structures and technologies

The core of the COP is a graphical representation of the situation on a map. The map viewer comprises a selection of base maps (e.g. physical map, street map, aerial image) and a number of information layers, displaying defined geospatial information from various sources (external data sources and information generated by IDIRA functions). The base maps and the IDIRA layers have to be provided and configured as plug-ins (see Section 5.6) and corresponding information in the GeoServer.

GeoServer [18] – an open-source server written in Java – allows users to share, process and edit geospatial data. Designed for interoperability, it publishes data from any major spatial data source using open standards. Input data can be stored in the server (fixed layers) or dynamically accessed by web services (WMS, WFS) or from a geospatial database (PostGIS).

Raster data (e.g. aerial imagery) and some vector data that are available and useful during operation but that are not implemented as IDIRA layer can be dynamically integrate as new as ad-hoc layers.

Data sources and formats that can be supported as Ad-Hoc Layers are:

Shapefile
: popular geospatial vector format that is supported by almost all GIS system

GML – Geography Markup Language
: OGC standard to exchange vector data via XML files

WMS – Web Map Service
: OGC standard protocol for serving georeferenced map images over the Internet

WFS –Web Feature Service
OGC Interface Standard allowing requests for geographical features across the web

GeoTiff
a public domain metadata standard which allows geo-referencing information to be embedded within a TIFF file

KML – the Keyhole Markup Language
XML notation for expressing geographic annotation and visualization

5.4.2 Software adapters and interfaces

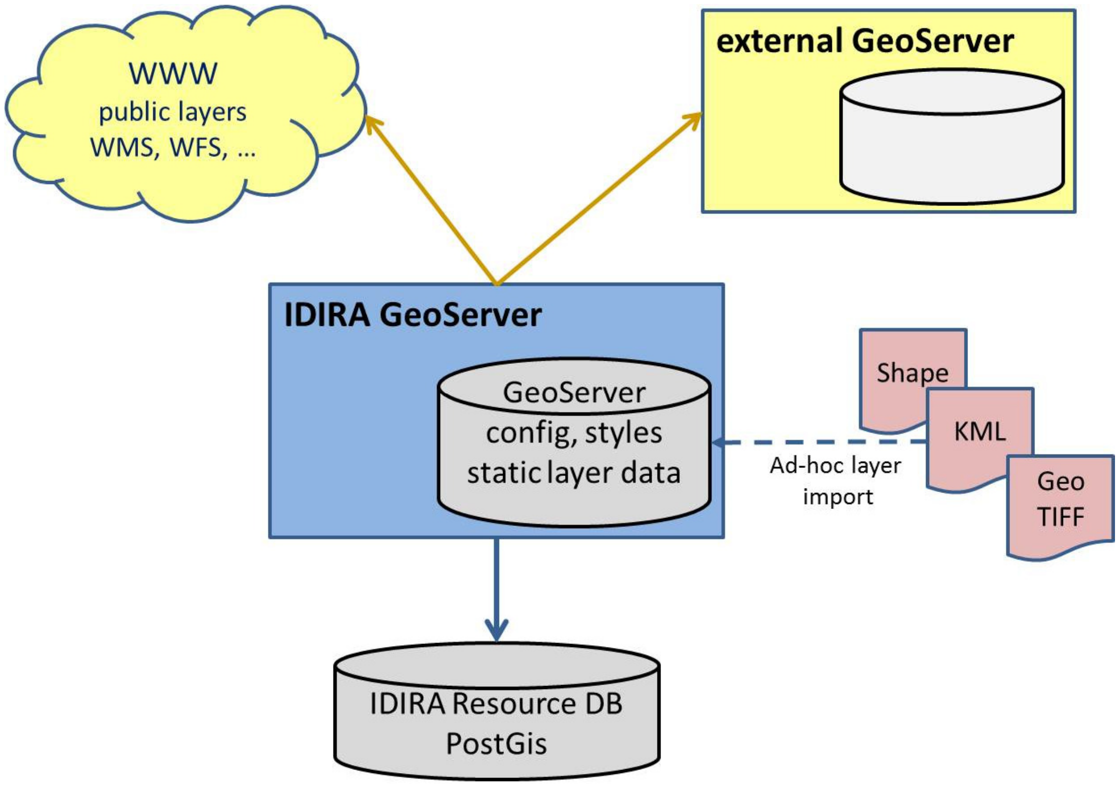

Figure 7: Concepts for the interoperable integration of geographic data

The IDRA admin GUI provides functions for the administration of ad-hoc Layers: creating a layer, defining styling, and de-activating. For ad-hoc layer creation, the user can select an existing Shapefile (zip library that contains the set of files building the shapefile), GeoTiff or KML file that is uploaded to the GeoServer, or he enters a valid URL of a WMS/WFS service. He can define simple styles (colours and line width of standard shapes) and assign them to imported layers, if he wants to overwrite standard styling.

The tool automatically configures a GeoServer layer following naming conventions. The same function can be triggered by a REST service call from another tool providing appropriate data.

A COP standard plug-in scans the GeoServer and makes all ad-hoc Layers available during COP start-up.

5.4.3 Prerequisites, and lesson learned from the adoption of the described solutions

The open GeoServer is a powerful tool for building GIS systems. It offers a wide variety of possible configurations, processes almost all common geospatial data formats and protocols, and can smoothly be integrated with the OpenLayers [42] JavaScript library for displaying map data in web browsers.

At the other hand, it requires well-trained and experienced administrators who are able to configure it in the right way and a reasoned programming of the interfaces. Unskilled use of GeoServer easily leads to performance bottlenecks and unexpected side-effects.

5.5 Technical guidelines for interoperable integration of external simulations and Decision Support algorithms results

5.5.1 Guidelines for the adoption of suitable/standard data structures and technologies

In general the usage of standardised communication and data representation protocols is needed. This includes

- SOAP of REST for remote method invocations
- WMS/WFS to transmit spatial data

5.5.2 Software adapters and interfaces

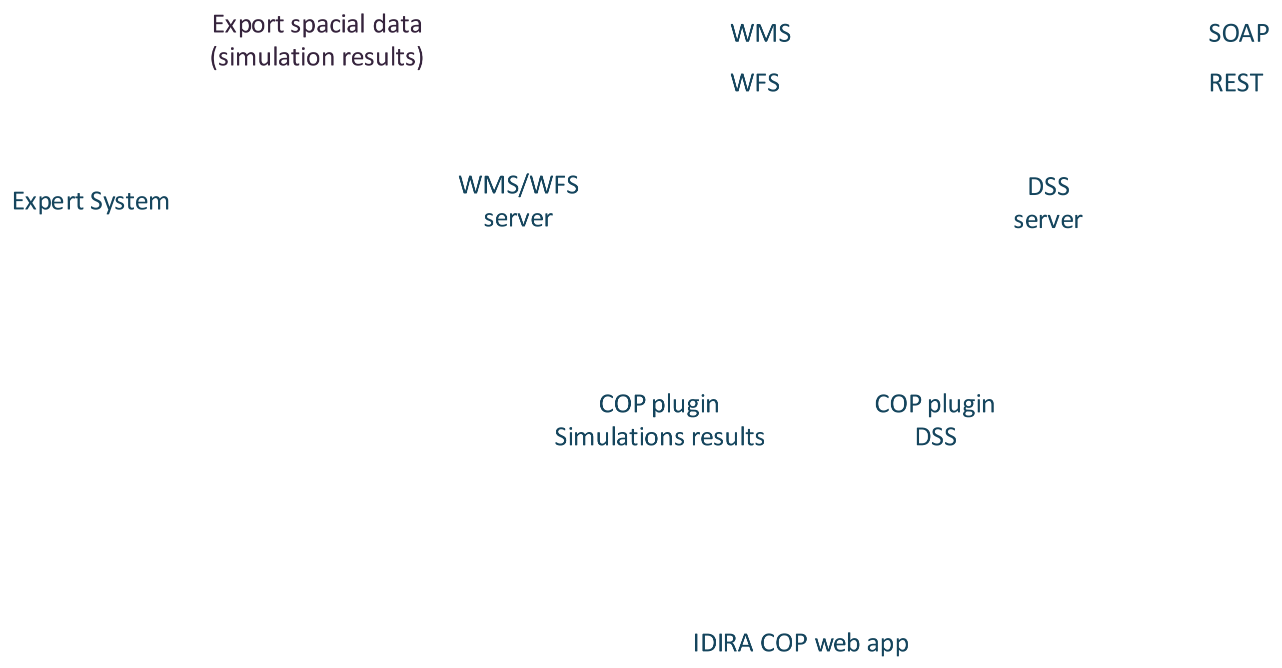

Figure 8: Overview of the DSS/Simulation interfaces and communication

All Decision Support algorithms are available as web service and so they could be integrated into any other system. As standards for communication the SOAP and REST protocols are used. In IDIRA the integration was done via special COP plugins that empower the uses of the COP web application to directly access this services. The COP plugins provide GUI to input the parameter, to send the request to the services, receive the results and to visualize the results (also on the map).

For the external simulations, first the external Expert GUI needed to be opened. The simulations are done. The Expert GUI user then decides which result should be exported to IDIRA. The export is done to a WMS/WFS server. In the COP special plugins add layer to the map that visualize the data from the WMS/WFS server.

5.5.3 Prerequisites, and lesson learned from the adoption of the described solutions

For the Decision Support algorithms the most important prerequisites are, that the provided functionalities are available via a Web Service. If this is achieved, only a limited effort is needed to implement a COP plug-in, for the integration of the DSS results into the COP, although there is no standardised way to share the results themselves, for what concerns the data format, as already explained in Section 3.

Similar concepts apply for the simulation systems. The most crucial step is the ability to upload spatial data to a WMS/WFS server. If this is achieved, only a limited effort is needed to implement a COP plug-in, for the integration of the DSS results into the COP.

5.6 Technical guidelines for the interoperable integration of geo-referenced data sources, connected systems, joint applications in the IDIRA COP

5.6.1 Practical guidelines for the adoption of the needed technologies

The COP consists of a base map and various layers of graphical information that can be switched on/off by the users, in order to provide a meaningful set of information at one glance. The layers may provide additional functions for retrieving detailed information or for creating and editing information in the respective layer.

In order to implement an open and interoperable concept for the integration of different sources of information (published geo-referenced data sources, connected systems, joint applications), every functionality or layer that shall be addressed in the **COP Web client** has to be provided by plug-ins as described below. This architecture implements the integration of loosely coupled components into the COP GUI and allows easily integrating information from various internal and external sources.

As a design principle, the base functionality is played in a core library, and every layer plugin is self-contained concerning data handling and GUI elements, and independent from other layers.

The COP GUI is implemented using the OpenLayers [42] framework and GeoServer [18]. Every Layer plug-in needs a corresponding layer configuration in the GeoServer. If plug-ins need data in the IDIRA backend, oData (Open Data Protocol) [36] is used to access the Central Data Store.

We figured out that the best performance was achieved using WMS for static layers and vector format WFS for dynamic layers that have to be updated frequently. For rendering the base map from a local copy of OpenStreetmap, Mapnik [43] server and seeding the current region (preparing all rendered tiles in the cash) provides satisfactory response time, or using an online map from the Web.

The **COP Tablet client** is a native Android App that provides all IDIRA functions necessary for operational users:

- Global map-based overview about the current situation (incidents, resources, tasks, observations and alerts)
- Creating and posting observations to IDIRA
- Requesting Resources
- Accepting tasks, and changing task status
- Allow those tasks even while offline (no communication to IDIRA servers)

Main functionality of the native client is offline mode. This means, the most important functions are available while offline. As a result, map based browsing of information, and even posting of new information is possible while no connection to the back-end is available.

To do this, the client periodically updates its local database with updated data from the server. The server logs any changes to the database in its "history_log" table. In the case a server connection is available this information is requested by the client periodically. If any changes are found, affected data is synchronized with the server.

The same is true for information gathered on the client (resource requests, observations). Those are stored on the device until a server connection is available, and then are sent to the IDIRA server.

The base map is always installed locally on the Tablet client.

5.6.2 Software adapters and interfaces

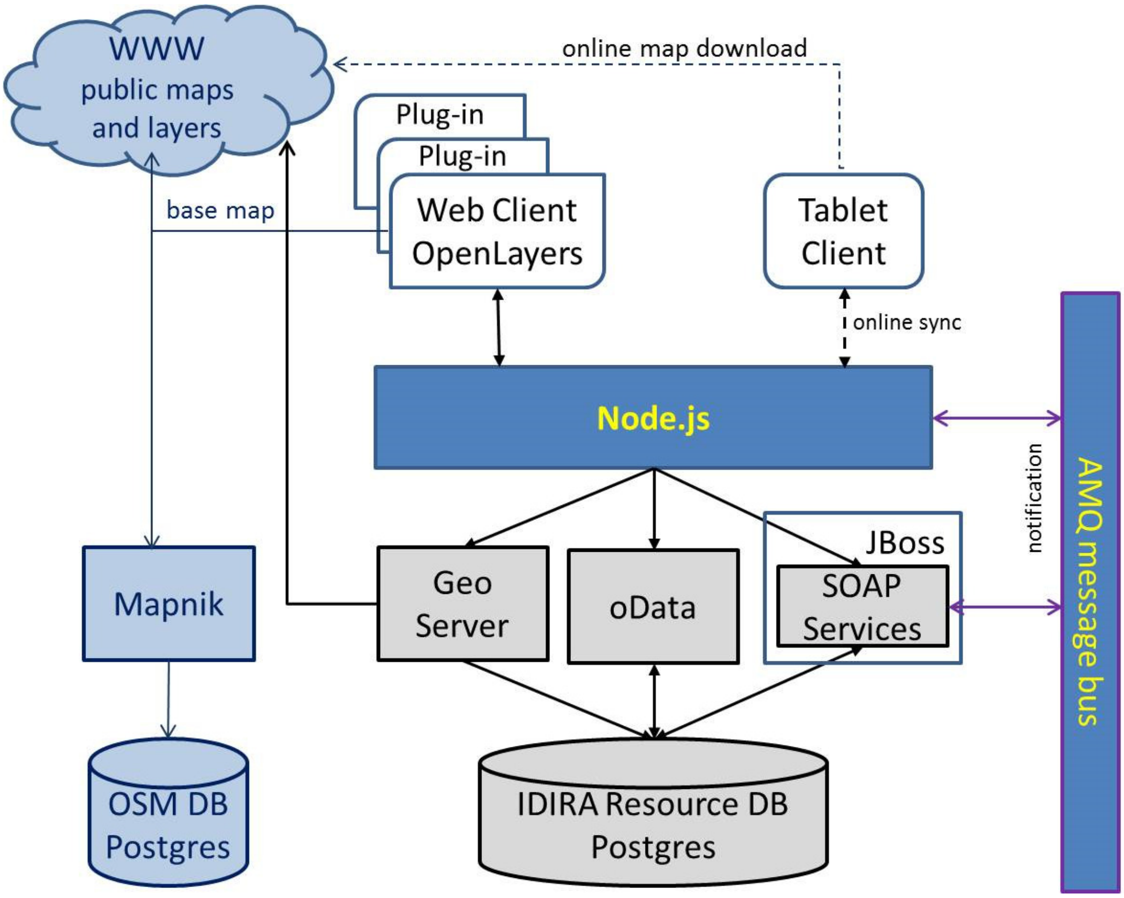

Figure 9: COP Layer Architecture

Dynamic loading of JavaScript files

IDIRA COP is realized in JavaScript and doesn't request any SW installation on the clients. To add plugins (JavaScript files) dynamically during startup, it is necessary to load these files in a main method in the core library. The loading will be done in the following procedure:

Loading of base JavaScript files and of COP specific JavaScript files

1. Loading JavaScript files for plugin's (if timeout during loading was reached, the status of the plugin will be set to deactivated)
2. The plugins are placed in a subdirectory structure, following naming conventions, that is used for retrieving the plug-ins during loading. Every plugin has to implement one function that returns a JSON object with meta-information needed for the plug-in management. That allows adding new plug-ins without any modification in the COP core components.

There are three types of plug-ins supported by the COP core:

Layer Plugin

The Layer Plugin is responsible for handling an Information Layer. For each plugin an entry in the Layer Selection menu will be added. The base functionality (enable / disable / wfs) is done by the general (core) implementation. Additional functionality is not foreseen within this plugin.

LayerSelection Menu will be created by grouping layer (done by tags). This makes the Layer selection dynamic. The LayerSelection offers two functionalities: Open complete Layer Group and/or select/deselect specific layers.

Layer Function Plugin

This plugin is the extension to the Layer Plugin. In this plugin it is possible to add additional own functionality. The functions content is placed in the overlayPanel on the right side (text fields, buttons, drop downs…).

Toolset Plugin

A Toolset is an additional entry in the “toolset Menu”. As Toolset an external Application is opened in a new Tab (Browser Window). A toolset is not adding any functionality to the COP (e.g. Early Situation Awareness).

Basemap handling

COP offers the possibility to switch between configured BaseMap layers. A BaseMap a layer that will not be displayed in the LayerSelection but as a selectable item in the BaseMap Layer Selection and that always builds the background of the operational picture.

6 SUMMARY AND OUTLOOK

Based on the IDIRA partners' experience, the use of standards and open technologies for information exchange has proven to be an effective approach for interoperability.

Particularly, the IDIRA MICS has been designed as an information hub, providing Inbound and Outbound interfaces, and the rules to share specific information types by using suitable, standard data formats, together with a Web-based and modular environment for the interoperable integration of external data and tools. Therefore realising an integrated set of tools and a common information space, to be used in cooperative, multinational disaster management scenarios.

There is, surely, potential for further improvements in the adoption of specific standards, as well as the possibility to propose new ones: project's partners intend to disseminate such findings, by bringing the IDIRA results, as far as standardisation and harmonisation topics are concerned, to the attention of existing standardisation bodies and communities.

Finally relevant showcases, concerning the connection and interoperable integration of existing systems and data with the IDIRA MICS have been realised during the project. This demonstrates how interoperability by adapting existing systems, following the model and guidelines proposed in IDIRA, can be realised in practice with a sustainable effort.

Part IV: ANNEX

Details of technical suggestions for improvements or for the realization of new standards

Suggested fields for a new, standard XML / JSON structure, for data population integration in the Evacuation Tool

ITEM	Description
ID	A Unique identifier for the dataset
Polygon	A list of coordinates describing a polygon as a WKT [34] MultiPolygon geometry. This represents the spatial region whose population data is specified in this dataset. The CRS of the coordinates has to be specified as well.
Source	Specify the source of the data such as an organization that collects and publishes population data. This will help users to check if the source is reliable or not.
Source date	Date of data collection. This will help users to check if the data is outdated.
Area	Area of the polygon in square meters
Time	Time and zone relevant to this dataset
Local Holiday	Specify whether the data was collected during a local holiday or not
Number of people	Specify the number of people in this region
Population density	Number of people divided by the area of the polygon
Males_17_29	This is a composite data type containing the following information: Number of males in the population aged between 17 and 29 years. Weight (Minimum, Maximum, Average) Height (Minimum, Maximum, Average) Mobility (normal, slightly impaired without crutches, slightly impaired with crutches or require wheelchair)
Males_30_50	This is a composite data type containing the following information: Number of males in the population aged between 30 and 50 years Weight (Minimum, Maximum, Average) Height (Minimum, Maximum, Average) Mobility (normal, slightly impaired without crutches, slightly impaired with crutches or require wheelchair)
Males_51_80	This is a composite data type containing the following information: Number of males in the population aged between 51 and 80 years Weight (Minimum, Maximum, Average) Height (Minimum, Maximum, Average) Mobility (normal, slightly impaired without crutches, slightly impaired with crutches or require wheelchair)
Females_17_29	This is a composite data type containing the following information: Number of females in the population aged between 17 and 29 years Weight (Minimum, Maximum, Average) Height (Minimum, Maximum, Average) Mobility (normal, slightly impaired without crutches, slightly impaired

	with crutches or require wheelchair)
Females_30_50	This is a composite data type containing the following information: Number of females in the population aged between 30 and 50 years Weight (Minimum, Maximum, Average) Height (Minimum, Maximum, Average) Mobility (normal, slightly impaired without crutches, slightly impaired with crutches or require wheelchair)
Females_51_80	This is a composite data type containing the following information: Number of females in the population aged between 51 and 80 years Weight (Minimum, Maximum, Average) Height (Minimum, Maximum, Average) Mobility (normal, slightly impaired without crutches, slightly impaired with crutches or require wheelchair)

Table 5: Suggested fields for population data specification

Suggested fields for the improvements of the PFIF data structure

ITEM	Description
Name spelled in the International Phonetic Alphabet [37]	In Europe we are confronted, not only with many languages, but also the use of a different alphabet (and the spelling when converted). A standard needs to be agreed upon, and the use of a phonetic search could be looked into
Physical characteristics	Information on physical characteristics, clothes last whereabouts should be included
Alerts	When the different notes are added to the case, it must be possible to add an alert (health, such as disease, mental disorder, or other kind of alert) that can be found quickly
Temporary residence	The possibility to add a temporary residence (i.e. Shelter A, Hospital B, etc.) should be added

Table 6: Suggested fields for the improvement of the PFIF data structure

Mapping of information generated from within existing systems, to standard data structures fields

Original information	Corresponding EDXL-CAP XML field
Date & time when the information is generated	alert.sent
Event type according to the internal taxonomy / description	alert.info.event
Textual description / instructions	alert.info.description alert.info.instruction
Caller details	alert.info.contact
Description of the event location	alert.info.area.areaDesc
Geographical coordinates of the event location	alert.info.area.circle alert.info.area.polygon

Table 7: Mapping of incident related information with EDXL-CAP fields

Local Taxonomy	Corresponding TSO code
Ascensore bloccato con persone (Lift blocked with people trapped)	ASR (Assistance or rescue for persons/animals)
Emergenza Protezione Civile (Crucial emergency situation involving Civil Protection)	PSW (Public Safety/Welfare)
Incendio a seguito rilascio gas (Fire due to gas leak)	EXP/GAS (Gas explosion with fire)
Acqua allagamenti (Water floods)	FLD (Flood)

Table 8: Local event codes from CNVVF to TSO taxonomy conversion

References

[1] OASIS (Organization for the Advancement of Structured Information Standards)
https://www.oasis-open.org/

[2] Emergency Data Exchange Language (EDXL)
https://www.oasis-open.org/committees/tc_home.php?wg_abbrev=emergency

[3] EDXL-DE
http://www.oasis-open.org/committees/download.php/17228/EDXL-DE_Spec_v1.0.pdf

[4] Common Alerting Protocol (CAP)
http://docs.oasis-open.org/emergency/cap/v1.2/CAP-v1.2.html

[5] EDXL-RM
http://docs.oasis-open.org/emergency/edxl-rm/v1.0/EDXL-RM-SPEC-V1.0.html

[6] EDXL-SitRep
http://docs.oasis-open.org/emergency/edxl-sitrep/v1.0/edxl-sitrep-v1.0.html

[7] TSO message structure
https://www.oasis-open.org/committees/download.php/42411/CWA_15931-1.pdf

[8] TSO data dictionary
https://www.oasis-open.org/committees/download.php/42411/CWA_15931-2.pdf

[9] SOAP Web Services W3C Recommendation
www.w3.org/TR/SOAP

[10] ATOM Syndication Format
http://tools.ietf.org/html/rfc4287

[11] AtomPub Protocol
http://tools.ietf.org/html/rfc5023

[12] GDACS Real Time Alerts
http://www.gdacs.org/xml/rss.xml

[13] RSS 2.0 specifications
http://cyber.law.harvard.edu/rss/rss.html

[14] OGC WMS
http://www.opengeospatial.org/standards/wms

[15] ESRI Shapefile
http://www.esri.com/library/whitepapers/pdfs/shapefile.pdf

[16] OGC WFS
http://www.opengeospatial.org/standards/wfs

[17] OGC SLD
http://www.opengeospatial.org/standards/sld

[18] GeoServer
http://geoserver.org/

[19] OSM XML
http://wiki.openstreetmap.org/wiki/OSM_XML

[20] JOSM
https://josm.openstreetmap.de/

[21] OGC Sensor Web Enablement (SWE) framework of standards.
http://www.opengeospatial.org/ogc/markets-technologies/swe

[22] OGC Sensor Observation Service (SOS)
http://www.opengeospatial.org/standards/sos

[23] OGC SensorML
http://www.opengeospatial.org/standards/sensorml

[24] OGC O&M
http://www.opengeospatial.org/standards/om

[25] PFIF
http://zesty.ca/pfif/1.4/

[26] WMTS
http://www.opengeospatial.org/standards/wmts

[27] Geospatial Data Abstraction Library
http://www.gdal.org/

[28] Navteq
https://www.here.com/navteq-redirect/?lang=en-US

[29] Tele Atlas
http://en.wikipedia.org/wiki/Tele_Atlas

[30] SAME Event codes
http://en.wikipedia.org/wiki/Specific_Area_Message_Encoding

[31] INDIGO, FP7 project
http://indigo.diginext.fr/EN/

[32] EDXL-TEP
https://www.oasis-open.org/committees/tc_home.php?wg_abbrev=emergency-tep

[33] EDXL-TEC
https://www.oasis-open.org/committees/tc_home.php?wg_abbrev=emergency-tec

[34] Well-Known Text Format
http://www.geoapi.org/3.0/javadoc/org/opengis/referencing/doc-files/WKT.html

[35] ISO TC/223
http://www.iso.org/iso/home/store/catalogue_tc/catalogue_tc_browse.htm?commid=295786&published=on&development=on

[36] OData; Open Data Protocol
http://www.odata.org
https://www.oasis-open.org/committees/tc_home.php?wg_abbrev=odata

[37] International Phonetic Alphabet
http://www.internationalphoneticassociation.org/

[38] Web Service Inspection Language
www.ibm.com/developerworks/webservices/library/ws-wsilspec.html

[39] Web Services Interoperability

http://www.ws-i.org

[40] Web Processing Service

http://www.opengeospatial.org/standards/wps

[41] NFPA 1616 standard

http://www.nfpa.org/codes-and-standards/document-information-pages?mode=code&code=1616

[42] OpenLayers
http://openlayers.org/

[43] Mapnik
http://mapnik.org/

[44] Apache ActiveMQ
http://activemq.apache.org/

[45] PubSubHubbub protocol by Google
https://code.google.com/p/pubsubhubbub/

[46] UN OCHA Hiumanitarian Symbols
http://www.unocha.org/top-stories/all-stories/ocha-launches-500-free-humanitarian-symbols

Standards Committees and standards used in IDIRA

IDIRA uses open standards that are issued by standard committees or published as public outcome of research projects. This annex shall provide an overview over the standards used in IDIRA, and the sources that provided the standards.

Issuer (Standards Committee)	Comments
Standard References	*The texts below are literally cited from the internet pages resp. documents*
Berkman Center for Internet & Society http://cyber.law.harvard.edu/	The Berkman Center's mission is to explore and understand cyberspace; to study its development, dynamics, norms, and standards; and to assess the need or lack thereof for laws and sanctions
RSS Really Simple Syndication /Rich Site Summary http://cyber.law.harvard.edu/rss/rss.html RSS 2.0 Specification, version 2.0.1, 2003-07-15	RSS uses a family of standard web feed formats to publish frequently updated information. RSS is a dialect of XML. All RSS files must conform to the XML 1.0 specification
CEN European Committee for Standardization http://www.cen.eu/	The European Committee for Standardization (CEN) was officially created as an international non-profit association based in Brussels on 30 October 1975. CEN is a major provider of European Standards and technical specifications.
Tactical Situation Object (TSO) CWA 15931-1, Workshop Agreement, Feb. 2009 Disaster and emergency management - Shared situation awareness - Part 1: Message structure https://www.oasis-open.org/committees/download.php/42411/CWA_15931-1.pdf CWA 15931-2, Workshop Agreement, Feb. 2009 Disaster and emergency management - Shared situation awareness - Part 2: Codes for the message structure https://www.oasis-open.org/committees/download.php/42412/CWA_15931-2.pdf	This CEN Workshop Agreement can in no way be held as being an official standard developed by CEN and its Members. This CEN Workshop Agreement is publicly available as a reference document from the CEN Members National Standard Bodies. The context of this CEN Workshop Agreement (CWA) is disaster and emergency management, and it aims to assist organizations involved by providing the list of codes for the message structure for the transfer of information between computers based systems in such a way that it can be reliably decoded. This is done by encoding the information in an XML Schema. The CWA-Part 2 provides a system of terms relating to disasters and emergencies and their encoding. Many of the XML fields are required to use a term from this companion CWA-Part 2, rather than free text, so that the information is well defined, and can be automatically translated into language appropriate to the user.

Issuer (Standards Committee)	Comments
Standard References	*The texts below are literally cited from the internet pages resp. documents*
IETF The Internet Engineering Task Force http://www.ietf.org/	The mission of the IETF is to make the Internet work better by producing high quality, relevant technical documents that influence the way people design, use, and manage the Internet.
ATOM feeds RFC 4287, Proposed Standard, 2005-12, Updated by RFC5988 Errata The Atom Syndication Format https://datatracker.ietf.org/doc/rfc4287/ RFC 5023, Proposed Standard, 2007-10 The Atom Publishing Protocol https://datatracker.ietf.org/doc/rfc5023/	The Atom Publishing Protocol (AtomPub) is an application-level protocol for publishing and editing Web resources. The protocol is based on HTTP transfer of Atom-formatted representations. The Atom format is documented in the Atom Syndication Format.
OASIS Organization for the Advancement of Structured Information Standards https://www.oasis-open.org/ Emergency Management Technical Committee Emergency Management Adoption TC OASIS Open Data Protocol (OData) TC	OASIS (Organization for the Advancement of Structured Information Standards) is a non-profit consortium that drives the development, convergence and adoption of open standards for the global information society. OASIS promotes industry consensus and produces worldwide standards for security, Cloud computing, SOA, Web services, the Smart Grid, electronic publishing, emergency management, and other areas. OASIS open standards offer the potential to lower cost, stimulate innovation, grow global markets, and protect the right of free choice of technology.
Common Alerting Protocol (CAP) https://www.oasis-open.org/standards#capv1.2 CAP-v1.2-os, Version 1.2, 2010-07-01 Common Alerting Protocol Version 1.2	The Common Alerting Protocol (CAP) is a simple but general format for exchanging all-hazard emergency alerts and public warnings over all kinds of networks. CAP allows a consistent warning message to be disseminated simultaneously over many different warning systems, thus increasing warning effectiveness while simplifying the warning task. CAP also facilitates the detection of emerging patterns in local warnings of various kinds, such as might indicate an undetected hazard or hostile act. And CAP provides a template for effective warning messages based on best practices identified in academic research and real-world experience.

Issuer (Standards Committee)	Comments
Standard References	*The texts below are literally cited from the internet pages resp. documents*
Emergency Data Exchange Language (EDXL) https://www.oasis-open.org/committees/tc_home.php?wg_abbrev=emergency	The Emergency Data Exchange Language (EDXL) is a broad initiative to create an integrated framework for a wide range of emergency data exchange standards to support operations, logistics, planning and finance: • EDXL Common Alerting Protocol (EDXL-CAP) • EDXL Distribution Element (EDXL-DE) • EDXL Hospital AVailability Exchange (EDXL-HAVE) • EDXL Resource Messaging (EDXL-RM) • EDXL Reference Information Model (EDXL-RIM) • EDXL Situation Reporting (EDXL-SitRep) • EDXL Tracking Emergency Patients (EDXL-TEP)
Distribution Element (EDXL DE) https://www.oasis-open.org/standards#edxlde-v1.0 EDXL-DE-v2.0, Version 2.0. 2013-06-04 Emergency Data Exchange Language (EDXL) Distribution Element	This Distribution Element specification describes a standard message distribution framework for data sharing among emergency information systems using the XML-based Emergency Data Exchange Language (EDXL). This format may be used over any data transmission system, including but not limited to the SOAP HTTP binding.
Resource Messaging (EDXL-RM) https://www.oasis-open.org/standards#edxlrm-v1.0 EDXL-RM-v1.0-OS-errata-os, 22 Dec. 2009 Emergency Data Exchange Language Resource Messaging (EDXL-RM) 1.0	The primary purpose of the EDXL-RM Specification is to provide a set of standard formats for XML emergency response messages. These Resource Messages are specifically designed as payloads of Emergency Data Exchange Language Distribution Element- (EDXL-DE)-routed messages. Together EDXL-DE and EDXL-RM are intended to expedite all activities associated with resources needed to respond and adapt to emergency incidents.
Situation Reporting (EDXL-SitRep) http://docs.oasis-open.org/emergency/edxl-sitrep/v1.0/cs01/edxl-sitrep-v1.0-cs01.zip edxl-sitrep-v1.0-wd19, Draft 02, 2012-08-07 Emergency Data Exchange Language Situation Reporting (EDXL-SitRep) Version 1.0	This XML-based EDXL Situation Reporting specification describes a set of standard reports and elements that can be used for data sharing among emergency information systems, and that provide incident information for situation awareness on which incident command can base decisions.

Issuer (Standards Committee)	Comments
Standard References	*The texts below are literally cited from the internet pages resp. documents*
Open Data Protocol (OData) MS-ODATA - v20131025, Version 3, 2013-10-25, (Copyright © 2013 Microsoft Corporation) OData V3 Protocol Specification http://www.odata.org/docs/ odata-v4.0, Working Draft 05, 2013-11-04 OData V4 Protocol Specification https://www.oasis-open.org/committees/tc_home.php?wg_abbrev=odata#technical	The Open Data Protocol (OData) enables the creation of REST-based data services, which allow resources, identified using Uniform Resource Locators (URLs) and defined in a data model, to be published and edited by Web clients using simple HTTP messages
OGC Open Geospatial Consortium http://www.opengeospatial.org/	The Open Geospatial Consortium (OGC) is an international industry consortium of companies, government agencies and universities participating in a consensus process to develop publicly available interface standards. OGC® Standards support interoperable solutions that "geo-enable" the Web, wireless and location-based services and mainstream IT. The standards empower technology developers to make complex spatial information and services accessible and useful with all kinds of applications
Sensor Model Language (SensorML) http://www.opengeospatial.org/standards/sensorml OGC® 07-000 Version: 1.0.0, 2007-07-17 OpenGIS® Sensor Model Language (SensorML) Implementation Specification OGC 07-122r2, Version: 1.0.1, 2007-10-25 OpenGIS® SensorML Encoding Standard, version 1.0 Schema - Corrigendum 1	The OpenGIS® Sensor Model Language Encoding Standard (SensorML) specifies models and XML encoding that provide a framework within which the geometric, dynamic, and observational characteristics of sensors and sensor systems can be defined. There are many different sensor types, from simple visual thermometers to complex electron microscopes and earth observing satellites. These can all be supported through the definition of atomic process models and process chains. Within SensorML, all processes and components are encoded as application schema of the Feature model in the Geographic Markup Language (GML) Version 3.1.1.

Issuer (Standards Committee)	Comments
Standard References	*The texts below are literally cited from the internet pages resp. documents*
Sensor Observation Service (SOS) http://www.opengeospatial.org/standards/sos OGC 06-009r6, Version: 1.0, 2007-10-26 Sensor Observation Service OGC 12-006, Version: 2.0, 2012-04-20 OGC® Sensor Observation Service Interface Standard	The SOS standard is applicable to use cases in which sensor data needs to be managed in an interoperable way. This standard defines a Web service interface which allows querying observations, sensor metadata, as well as representations of observed features. Further, this standard defines means to register new sensors and to remove existing ones. Also, it defines operations to insert new sensor observations. This standard defines this functionality in a binding independent way; two bindings are specified in this standard: a KVP binding and a SOAP binding
Web Feature Service (WFS) http://www.opengeospatial.org/standards/wfs OGC 09-025r1 and ISO/DIS 19142, Version: 2.0.0, 2010-11-02 OpenGIS Web Feature Service 2.0 Interface Standard	WFS offers direct fine-grained access to geographic information at the feature and feature property level. Web feature services allow clients to only retrieve or modify the data they are seeking, rather than retrieving a file that contains the data they are seeking and possibly much more. That data can then be used for a wide variety of purposes, including purposes other than their producers' intended ones. In the taxonomy of services defined in ISO 19119, the WFS is primarily a feature access service but also includes elements of a feature type service, a coordinate conversion/transformation service and geographic format conversion service.
Web Map Service (WMS) http://www.opengeospatial.org/standards/wms OGC® 06-042, Version 1.3.0, 2006-03-15 OpenGIS® Web Map Server Implementation Specification	The OpenGIS® Web Map Service Interface Standard (WMS) provides a simple HTTP interface for requesting geo-registered map images from one or more distributed geospatial databases. A WMS request defines the geographic layer(s) and area of interest to be processed. The response to the request is one or more geo-registered map images (returned as JPEG, PNG, etc) that can be displayed in a browser application. The interface also supports the ability to specify whether the returned images should be transparent so that layers from multiple servers can be combined or not