Generic Information Logistics for Early Warning Systems

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ABSTRACT

The delivery of user-tailored warning messages for heterogeneous user groups is a challenge rarely covered by hazard monitoring and early warning systems. While attention is mostly focused on sensor measurements and disaster prediction, warning message dissemination is often based on technical terminology and is not appropriate for the majority of interested user groups. This article describes the concepts of generic information logistics developed for the distant early warning system (DEWS). It is designed to not be limited to specific hazard types, languages or other deployment specifics. Instead, it enables the generation of user-tailored warning messages that account for specific needs and it provides several filter mechanisms to avoid unintended message flooding in emergency situations. Moreover, the importance of spatial references in messages is highlighted and accounted for in both automatic message processing and message reception by humans. Warning messages are based on the common alerting protocol (CAP) to allow interoperability with other early warning systems.

Keywords

Disaster management, early warning, information logistics, CAP, EDXL, tsunami.

INTRODUCTION

The basic functionality of early warning systems (EWS) consists of (1) detecting the event and (2) quickly warning the public (Setten, 2009). Whilst the first topic has been covered by several projects and productive EWS, the second is still often disregarded. The detection of hazards is based on the upstream information flow from physical processes to the desktop early warning application, where hazard specific data is displayed and aggregated with relevant information ("Upstream" in Figure 1) to generate the situational picture for operators. They are in charge of situation evaluation and decision making: "Decide & Act" in Figure 1.

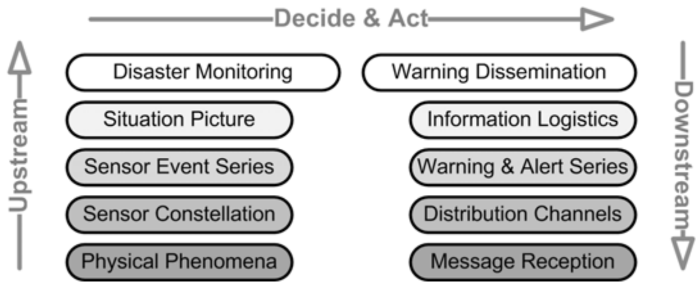

Figure 1. Upstream and downstream event and information flow in early warning systems

The downstream, including the generation of warning products with evacuation orders or the activation of disaster control procedures, are frequently beyond the scope of EWS and research projects. These procedures are carried out by local administration authorities in the military or civil protection infrastructure. The interface between both worlds often consists of human to human interactions, such as regular status reports or simple phone calls, in emergency situations. This modus operandi designates a person in charge who has to justify his

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actions and who is ultimately responsible for making critical decisions like evacuation orders. However, this modus operandi is not suited for all situations and hazards. The time critical nature of several types of man-made and natural hazards, such as tsunamis or nuclear meltdowns, is an elementary part of the disaster and its progression. Another dimension is the spatial expansion of the disaster; if the threat exceeds a certain threshold, it is no longer possible to adhere to the manual procedures described above. The overabundance of data, combined with a high degree of urgency, rules out the possibility of in-time early warning because human processes might not be fast enough to inform all affected subjects such as civilians, rescue services or military forces. Finally, information demand varies among different user groups. Thus, information logistics applications must generate individual messages to serve different needs (Jaksch et al., 2003). The challenge is to reach only the appropriate recipients as efficiently as possible (Working Group on Natural Disaster Information Systems, 2000). In the event of a disaster, the automatic processing of available data, forecasts and predications, in combination with message generation and dissemination, must be realised by information logistics that seamlessly glue together both the upstream data flow and the message dissemination parts of an early warning centre infrastructure.

The concepts presented in this paper incorporate the requirements and specifications of the UNESCO Intergovernmental Oceanic Commission (IOC) for the development of ocean-wide tsunami EWS as described in UNESCO (2008). Although the presented information logistics are not limited to tsunami hazards, only few official guidelines for early warning systems exist. Achieving compliance with IOC specifications was a main objective of the Distant Early Warning System (DEWS) project, which is described below and in which context this research took place.

RELATED WORK

The development of EWS for both man-made and natural hazards is the focus of various research projects covering a wide range of topics, including the following:

- Analysis of geophysical events and their effects
- Development of in-field sensor technologies and their applicability
- Simulation-based risk assessment for public infrastructure and industrial facilities
- Development and utilisation of international standards, such as the integration of heterogeneous sensor systems using OGC (Open Geospatial Consortium) Sensor Web Enablement (SWE) standards

While most attention has focused on sensor measurements and disaster prediction, the delivery of user tailored warning messages for heterogeneous user groups is a challenge rarely covered by hazard monitoring and EWS. Instead, warning messages are often based on administrative or technical terminology and are addressed to specialists, but are not intended to inform the general public. Over the past few years, several early warning projects have addressed this topic. This chapter depicts and outlines the most relevant projects and their activities in this field. Though the developed concepts possess similar strategies, to date, an overall generic concept for EWS is missing.

The Weather Information on Demand service (WIND) provides information about adverse weather conditions based on user needs with respect to content, location, time and quality (Jaksch et al., 2003). This project was a driving force in the development of information logistics applications in EWS, and several ideas have been incorporated and enhanced in this work. In CHORIST (Integrating Communications for enHanced envirOnmental RISk management and citizens safety), a research project of the 6th Framework Programme (FP) of the European Commission (EC), a warning subsystem was designed and developed to provide a template-based Message Creator & Dispatcher component that is connected to dissemination channel gateways (Setten, 2009). All warning products are manually qualified, selected and created by human operators, and are thus limited for urgent warnings dealing with high volumes of data. ERMA, the "Electronic Risk Management Architecture for Small- and Medium-sized communities", also a 6th FP project, outlines a citizen relationship management system to support communication with citizens (Berger et al., 2007). It is focused on local communities and provides a collaboration platform; but it is limited in addressing the requirements of large-scale EWS in tackling large spatial areas and multilingualism. In GITEWS (German Indonesian Tsunami Early Warning System), a Decision Support System (DSS) generates tsunami warning messages based on templates. Different message types and languages are supported, as well as the subsequent insertion of generated warning messages into Common Alerting Protocol (CAP) container files (Raape et al., 2009). The Istanbul earthquake rapid response and early warning system provides notifications for infrastructure facilities (e.g., metro, gas and electric power distribution network, industrial facilities). The earthquake early warning signals will be transmitted to the end users by employing communication companies as service providers (Erdik et al., 2009).

These notifications are suited for automated emergency shut-downs in the event of strong and non-ambiguously measurable earthquakes, and are thus less appropriate as a public early warning system that covers a wide range of user groups. The alpEWAS (Early Warning System for Alpine Slopes) project, dealing with landslide monitoring and early warning, offers basic email alarming and notification functions (Thuro et al., 2009). Technical messages that track sensor plug-in statuses are automatically sent to administrators, and notification of sensor data can be activated using thresholds for any of the handled datasets like deformation rate. Because no pre-processing or forecasting assesses the impact of these measurements, the message content is, according to the "data, information, knowledge, wisdom" (DKIW) hierarchy (Ackoff, 1989), on the data-level and is thus inappropriate for most target groups except scientists or early warning experts. Moreover, multiple web based information systems or EWS provide notifications on hazards like earthquakes, tsunamis, hurricanes or volcanic eruptions. However, they are all limited in one or more dimensions regarding spatial reference, message filtering, multilingualism, dissemination channels, preciseness or accuracy and are often focused on a certain target audience.

PRELIMINARY CONSIDERATIONS

Requirements of a generic information logistics

A generic reference architecture for EWS should have components designed to serve in new deployments and new sites without re-programming or compilation procedures. Instead, deployment-specific add-ons or plug-ins should be easily added based on the needs of a specific scenario. Consequently, not only must the upstream be unbound to specific hazard characteristics, but the downstream, including the warning message generation and its dissemination, must be realised independent of any hazard and infrastructure specific characteristics. Therefore, the information logistics must not be hazard-specific and must not be limited to a predefined set of message types. Hazard-specific message types, such as tsunami warnings, must instead be dynamically addable. The information logistics must also be independent from any specific dissemination channel. An early warning centre must support a wide range of dissemination channels, such as SMS, email and fax, but must also provide products for TV and radio stations. Moreover, warning products must contain an adequate common situational picture and, if required, clear and understandable instructions. User needs must be respected to ensure and enable proper message reception for all recipients. Further requirements include the following:

Message type filtering: Different user groups are interested in different message types. For example, rescue services are interested in alert status changes in order to begin preparations according to crises that might result from an on-going threat. In contrast, civilians must not be confused with low priority or highly detailed messages because they could reduce the importance of the received warning messages and because false alarms result in a general loss of public confidence in warning systems and lower risk awareness (Fernandez-Steeger et al., 2009).

Area of interest: Only message products that spatially reference the area of interest should be delivered to recipients. Spatial referencing has to distinguish between users in a static area of interest, such as rescue services responsible for a region that spans one or more political subdivisions and mobile users such as civilians who are interested in warning messages for the area they are currently staying in. This second category must be reachable by dissemination channels that themselves establish the spatial reference. For example, Cell Broadcasting is considered a viable alternative to SMS, as it uses a common broadcast channel to disseminate text messages to all subscribers at once within a defined geographical broadcast area (Mutafungwa, 2009).

Message vocabulary: The vocabulary of how information is phrased, which wording is applied and what degree of detail is used are of high importance in critical emergency situations. Of all the requirements that a public warning must fulfil, being understandable may be the most crucial for the warning's overall success (Botterell and Addams-Moring, 2007). Depending on the message receiver's role in a hazard, a certain message vocabulary is crucial to ensuring proper message reception. Civilians need unambiguous event descriptions together with clear instructions about what to do, such as "Seek high ground" in a tsunami hazard, whereas rescue services are interested in details of the on-going event, such as precise estimations about hazard time and severity parameters, e.g., the estimated wave height (EWH).

Multilingualism: In most countries of the world, different languages are spoken in parallel without having one language that is mastered by all inhabitants. The support of different languages and different character codes is of fundamental importance for the reasonable usage in a multilingual environment. Otherwise, the notification of and the reception by affected subjects cannot be guaranteed.

The Common Alerting Protocol (CAP)

The Common Alerting Protocol (CAP) standard (OASIS, 2005) is a XML data format for exchanging information and warnings in emergency situations. CAP has been developed due to the incompatibility of information exchange by different media such as broadcast radio, internet, cellular networks, etc. The standard bridges this communication gap and enables public warning information over a wide variety of data networks and systems. The standard was approved in 2004 by the Organization for the Advancement of Structured Information Standards (OASIS) and has been continuously enhanced since then. The International Telecommunications Unions (ITU) recognised CAP as an emerging global standard for alert and notification systems (ITU, 2007). CAP is widely used, in particular by American agencies such as the United States Department of Homeland Security and the National Weather Service but also by EWS such as GITEWS (Raape, 2009) and CHORIST (Setten, 2009).

A CAP message contains one or more information ("info") elements, each compiling all threat-specific attributes for a certain area. Information elements include basic metadata such as date, time or technical message type ("test", "warning", "clear"). Standardised criticality parameters for urgency, severity and certainty enable the classification of emergency situations with pre-defined parameter values. Hazard-specific attributes can be added as key-value pairs in parameter elements. This structured information, mainly used for automated message exchange and processing, is complemented with human readable information comprising headline, description and instruction. In message processing systems, these three elements are used to generate warning messages in plain text. Spatial references are defined in "area" child elements. Several referencing styles are possible and are discussed in the next section.

To obtain compatibility with other warning systems and with existing automatic message processing systems, the usage of international standards is of the highest priority. Comparable alternatives do not exist, and the suitability of CAP has been approved in several warning and notifications systems.

Spatial Reference in Early Warning Messages

The spatial reference of warning messages is of utmost importance for the message recipient. Hazard details such as severity or estimated onset are valueless if the spatial reference is either missing or cannot be interpreted correctly. Human recipients must be able to assess if they are endangered or not and to build a situational picture to define their individual course of action.

CAP offers three alternatives for spatial referencing, each with specific pros and cons. References can be established by either defining perimeters (centre and radius), defining arbitrary polygons (lists of vertices) or by addressing (political) areas/regions with standardised geocodes. Describing the affected area of a hazard with a single circle will reflect the reality only in rare cases and is only suited for hazards that have a well-defined centre and whose criticality declines with distance from the centre, e.g., earthquakes. The specification of a polygon of arbitrary complexity enables the precise definition of the affected area, such as the surface of an oil spill or the lava flow from an erupting volcano, but also areas threatened by a tsunami. However, human perception of this spatial reference is reduced with increasing complexity of the polygon. Humans are not normally aware of their current position in terms of coordinate values, and it is even less possible to identify the shape of the polygon and which parts of the real world are inside or outside. Thus, processing the polygons must be done with tools and geographic information systems (GIS) that display the polygons' shapes and positions in a human-readable manner. In contrast, addressing areas/regions with geocodes for territorial subdivisions, such as federal states and counties, provides a spatial reference that is directly usable for all message recipients. The mapping of spatial references to administrative units in EWS is examined in detail in Lendholt (2011). Hierarchical administrative territories are structured according to historic cultural and ethnic landscapes or logistics districts that are commonly known and widely used. Thus, civilians directly know if they are located in the affected area or not. Because structures and hierarchies of governmental agencies are often aligned with political subdivisions, this usage also fits with the business aspects of these services. Limitations based on the impreciseness of administrative units as affected areas can be softened with the combined usage of geocodes and precise polygons. Consequently, the parallel usage of geocodes (for human readable message parts) and precise polygon definitions (for automated processing) combines the benefits of both approaches. Moreover, this enables and supports the usage of broadcasting dissemination channels for which the vertices have to be converted into the Universal Geographical Area Definition (GAD) (3GPP, 2006). CAP does not request a specific geocode standard to be used; instead, areas are addressed by one or more key-value pairs in which the key defines the geocode standard and the value contains the geocode. Different geocodes based on different standards, such as ISO-3166, or secondary administrative level boundaries data sets (SALB) can be used alone or in combination with each other.

CONCEPTS OF THE GENERIC INFORMATION LOGISTICS

The field of information logistics aims at developing concepts, technologies and applications for need-oriented information supply. Information-on-demand services are a typical application area for information logistics, as they have to fulfil user needs with respect to content, location, time and quality (Jaksch et al., 2003). Because most EWS focus on the upstream part and neglect the downstream part, the realisation of information logistics should provide a flexible design and decoupled implementation, allowing easy adoption and integration.

Analysis of the requirements reveals that the central task of information logistics is the generation of user-tailored warning messages. In a typical hazard scenario, different phases are encompassed; initial physical events are followed by observations, forecasts and decision-making. These phases and the alarm level must be reflected by different message types. For example, during a tsunami threat following the initial earthquake, "Heads-Up" messages are disseminated, which inform about the possibility of a triggered tsunami. These are followed by "Tsunami Warning" messages based on observed wave propagation or "All Clear" messages if no tsunami is generated. Other hazards might require other message types. **Message Types** (Figure 2, left) are hazard-specific and are defined by the **Hazard Type** (Figure 2, middle). The name of Message Type itself is a statement such as "All Clear Message". The message content describes the situation with on-going and up-to-date information. It is a mixture of hazard type independent values such as onset time or affected area and hazard type specific attributes such as tsunami wave height or radioactive contamination value. The **Hazard Type** defines both the available **Message Types** and **Hazard Specific Message Attributes** (Figure 2, right), which are added as key value pairs into the CAP message.

Figure 2. The Hazard Type entity and its relations to Message Type and Message Attributes

The **Message Recipient** (Figure 3, middle) is the subject that receives the disseminated messages from the early warning system. These can be individuals (e.g., civilians or the governor of a province) or institutions such as rescue services or local warning authorities (e.g., watchtowers at the beach). This grouping is realised with **Message Recipient Categories** (Figure 3, top left), which handle group-wide settings such as filtering (see next paragraph). The Message Recipient defines the preferred **Language** in which he wants to receive the messages, the **Area of Interest** for which he wants to be informed and the **Dissemination Channels** he makes use of, as indicated below:

- **Language** (Figure 3, bottom right) preference is specified by ISO 639-1 codes, e.g., "en" for English or "si" for Sinhala (ISO, 2002). As aforementioned, the request for multilingualism is accompanied by the request for the support of different character sets. This is implemented by supporting Unicode Transformation Format (UTF).
- **Area of Interest** (Figure 3, top right) is defined by one or more geocodes that address administrative areas and matching affected areas identified in a threat.
- **Dissemination Channels** (Figure 3, bottom left and Figure 4, middle) are specified by Message Recipients, typically those channels that subjects want to be used to be informed and that are most efficient in an emergency situation. Civilians, for example, will be registered with SMS or email but not by their workplace FAX number.

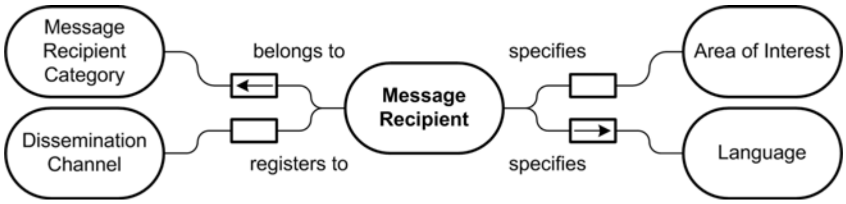

Figure 3. The Message Recipient entity and its relations

Message Recipients belong to a certain **Message Recipient Category** (Figure 3, top left and Figure 4, middle) such as rescue service or general public. To ensure that all message recipients belonging to the same group are informed under the same conditions, all message filters – except for the Area of Interest – are linked to the Message Recipient Category and not to the Message Recipient.

- One filter specifies the **Message Types** (Figure 4, top right) that are of interest for the category.

- Three filter matches on the three aforementioned **CAP Criticality** (Figure 4, bottom right) values (urgency, severity and certainty).Thresholds are defined for each Message Recipient Category and must be reached or exceeded to be passed.
- In addition to the contributing filter mechanisms, a Message Recipient Category specifies the **Vocabulary** (Figure 4, bottom left) requested for all of its messages. This allows for different levels of knowledge and terminology that account for different Message Recipients.

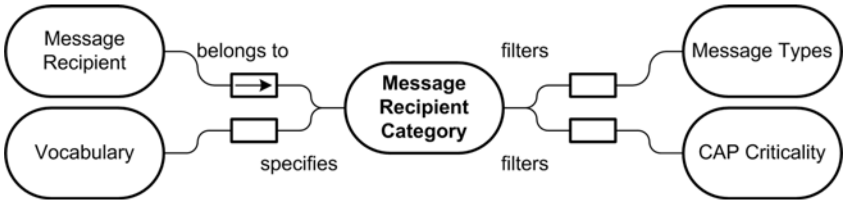

Figure 4. The Message Recipient Category entity and its relations to Filter Types

All filters (area of interest, message type, cap severity, cap certainty and cap urgency) defined by the Message Recipient and its related Message Recipient Category are applied one after another during the message generation process, and all have to be matched to trigger message dissemination. Message generation is only performed if all the filters match.

The CAP elements Title, Description and Instructions constitute the human readable part of the message. These elements are not generated manually or on-the-fly during message generation. Instead, predefined **Message Templates** are used. A template is addressed and selected by message type, vocabulary, language and dissemination channels (see formula 1).

f(Message Type, Vocabulary, Language, Dissemination Channel) → Message Template (1)

The translation into different languages could alternatively be realised with an on-the-fly translation service. Although such translation services are the subject of research projects, the reliability and accuracy for EWS is not sufficient. The CHORIST project investigated automatic template translation, though the results thus far are not convincing (Setten, 2009). The fourth key (Dissemination Channel) has been added to incorporate dissemination channel specific limitations such as character encoding (e.g., insufficient UTF support for the fax or SMS receiver) or text length limitations (e.g., SMS with 160 characters).

To enrich message templates with details of the on-going hazard, placeholders are used that enable on-the-fly replacement during message generation:

- Criticality placeholders: severity, certainty and urgency. These are based on the corresponding CAP elements and use the same predefined values. Their situation specific values are based on the characteristics of the on-going event.
- Spatial reference: corresponds with geocodes as used in the area elements of the CAP message.
- Time: corresponds with the onset parameter defined in the CAP message.
- Hazard-specific placeholders: these are based on the hazard-specific message attributes that are also included as key value pairs in the CAP additional parameters section.

All generated messages are converted into channel specific encodings and protocols before being disseminated to the message recipients. Based on user preferences and the dissemination channel capabilities, either the human readable parts or the whole CAP is communicated. This feature is of interest for recipients using automated (CAP-) processing systems. Channel characteristics such as the character limitation in SMS may overrule this preference.

Figure 5 summarises the overall information logistics concept.

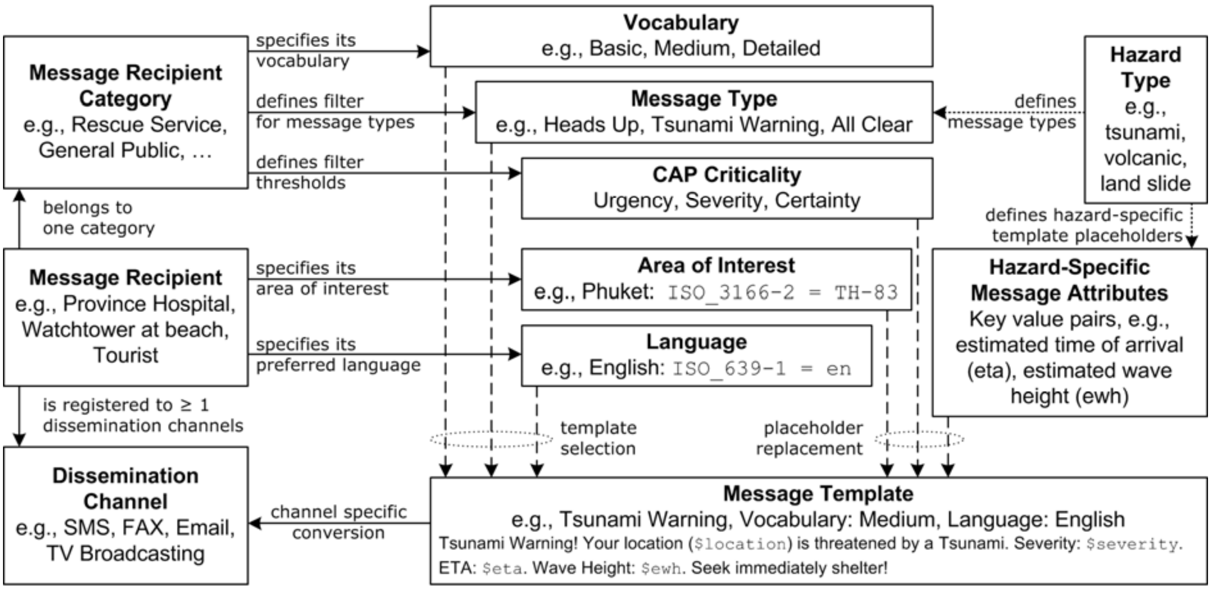

Figure 5. Overall Information Logistic Concept for early warning systems

REALISATION AND IMPLEMENTATION

The Distant Early Warning System (DEWS, http://www.dews-online.org/) project was funded in the 6th FP of the EC. A well-balanced consortium of public and private organisations from several EU member states, as well as partners from around the Indian Ocean, have worked closely in order to design and implement an open, standard based EWS realising both reliable hazard detection and effective warning dissemination (Wächter et al., 2009). Within the project, a reference architecture for EWS has been developed; its hazard-independent and generic information logistics are presented here.

The simplified architectural blueprint (Figure 6) provides an overview of DEWS following the principles of SOA (Service Oriented Architecture). Sensor platform, map services and simulation systems – together compiling the upstream information flow – are connected to the Command and Control User Interface (CCUI) using standardised OGC services. The downstream, including the message dissemination from CCUI via the Information Logistics Component (ILC) and Information Dissemination Component (IDC) to the message recipients, has been realised with web service technology using SOAP (Simple Object Access Protocol).

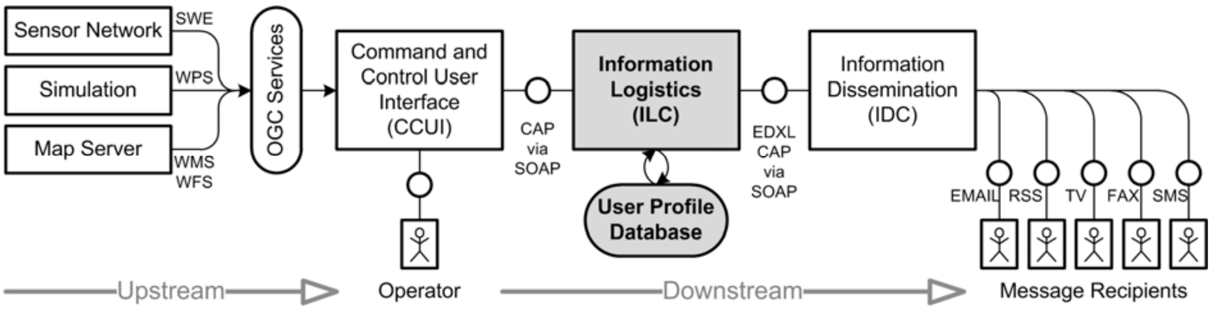

Figure 6. Information Logistics Component (ILC) in the DEWS reference architecture

The message generation process is divided into three phases and components:

1. The CCUI releases an initial threat-specific CAP warning message. For each affected area, one CAP information element is generated that contains all area specific attributes, such as the estimated time of arrival (ETA) and EWH. These CAP messages are independent from specific user settings and do not provide the headline, description and instruction elements.
2. The ILC generates one customised CAP message for each user and the respective dissemination channel as described in Figure 7:
    a. All affected message consumers are identified according to their areas of interest.

b. For each user and for each of its effective areas, all filters are applied.

c. Templates for all relevant dissemination channels are generated, respecting the message consumer's preferred language and vocabulary defined by the category he belongs to. Placeholders are replaced with area specific values.

d. Generated CAP messages are embedded into an EDXL-DE (Emergency Data Exchange Language Distribution Element) envelope (OASIS, 2006) equipped with addressing data.

3. The IDC converts the EDXL-DE/CAP messages into channel-specific formats and finally disseminates them to the message recipients.

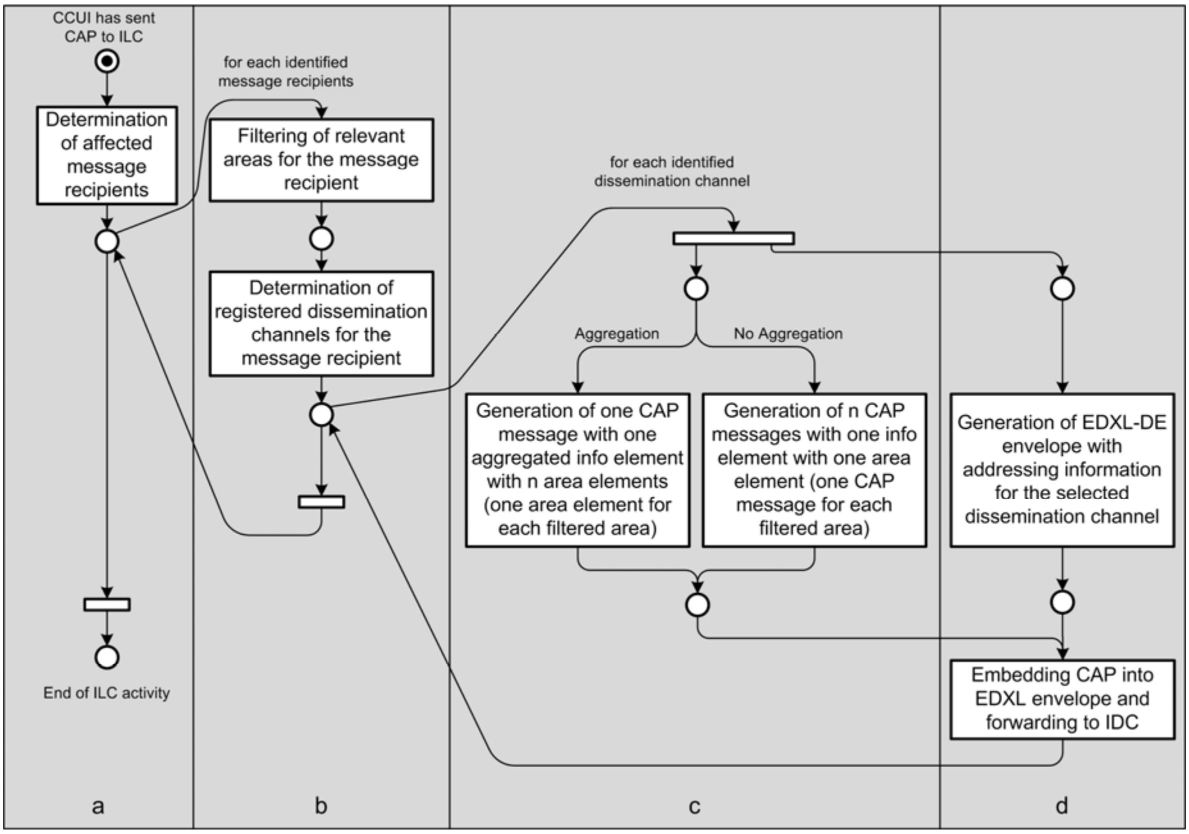

Figure 7. Generation of user-specific warning messages in Information Logistics (Notation: Petri Net)

The implemented information logistics comes with the following advanced characteristics to improve the message generation and reception process:

- Aggregation of warning messages: A message consumer registered to more than one area of interest would receive one warning message for each area. This could lead to spam-like message flooding, frustrating the message recipient. The aggregation functionality aggregates all warning messages addressed to the same message consumer. Inside the message templates, the event and area specific attributes like geocode or time of arrival are concatenated.
- Sub-region-Aggregation: Political subdivisions are hierarchically ordered. A message recipient registered for a certain region would be informed several times if more than one area of lower order is affected. This could also lead to unintended message flooding. Instead, one warning message will be generated with hazard specific attributes based on worst-case combinations of all sub-regions, e.g., the highest EWH of all affected lower level regions is taken as the super-region.
- Translation of CAP criticality values: The CAP standard includes pre-defined values for each criticality element, e.g., "Extreme", "Severe", "Moderate", "Minor" and "Unknown" for severity. Using these terms in the placeholders generates language-breaks in non-English messages. This could lead to confusion and misinterpretation. Therefore, translations of these values are used within placeholders.
- CAP-Include: Message recipients have the option to receive the full CAP document in addition to the generated template-based message.

A comparison of a prepared template and the corresponding generated CAP elements is given in Table 1. It outlines how the initial template with its placeholders is converted into a threat-specific warning message.

	Template in database	Generated CAP elements
Headline	Alerta de tsunami	<headline>Alerta de tsunami</headline>
Description	Inminente llegada de un tsunami. Ubicación <Dews:AffectedLocation type="HASC"/>: ETA=<Dews:MinTimeOfArrival/>, max SSH=<Dews:MaxSeaSurfaceHeight/>, Certeza=<Dews:Certainty/>, Gravedad=<Dews:Severity/>, Urgencia=<Dews:Urgency/>.	<description>Inminente llegada de un tsunami. Ubicación TH.PG.TT.Khok Kloi: ETA=2010-06-03T09:45:22+0000, max SSH=5.43, Certeza= probable, Gravedad = extrema, Urgencia = prevista.</description>
Instruction	Proclame fase de alerta 2. Informe al público y autoridades locales. Prepárese para la llegada del tsunami. Observe continuamente la evolución de la situación.	<instruction>Proclame fase de alerta 2. Informe al público y autoridades locales. Prepárese para la llegada del tsunami. Observe continuamente la evolución de la situación.</instruction>

Table 1. Comparison of message template as stored in the ILC database (left column) with the generated CAP elements (right column) enriched with situation -specific attributes such as location, time of arrival and wave height

CONCLUDING REMARKS

The concepts of information logistics presented here have been validated in project-internal and public live demonstrations. In particular, the support of arbitrary languages in combination with UTF gained much attention (Figure 8b). This has been a major requirement of project partners from Thailand, Sri Lanka and Indonesia. Furthermore, the generation of user-tailored warning messages using adequate terminology in combination with the selected level of detail based on template placeholders has been assessed positively.

Figure 8. Examples of generated tsunami warnings during live DEWS demonstrations. a: SMS in the English Language informing local rescue services with basic instructions. b: email in the Tamil language including geocode, estimated time of arrival and estimated maximum wave height for the affected territory.

Future research will focus on the coupling of the system with dissemination channels that provide broadcast functionality. Although the communication of area geometry has been incorporated, it could not be tested within the project. Such channels will disseminate their warnings (e.g., SMS) to all recipients in range without considering user preferences such as language. This behaviour foils the efforts spent on generating user-tailored warning messages, but it is often the only way to reach all parts of the population. Whilst the primary focus of the overall project was on the development of a tsunami EWS for the Indian Ocean, the components have been designed and implemented to serve as a reference architecture for EWS in general, independent of hazard type and region. The generic nature of the ILC leverages this approach. Other hazard types can be addressed within the ILC by defining new message types and new message templates. Adaptions can be made by providing new plug-ins to the CCUI to integrate hazard or sensor specific semantics. Analogously, new dissemination channels can be operated by providing adapters to the IDC.

Besides demonstrating the DEWS as a national EWS, the system was also demonstrated as a Wide Area Centre (WAC) serving as a communication network within the national EWS. Hereby, DEWS followed the IOC guidelines such as the communication of thread zones, which has been realised by communicating with affected areas via CAP using geocodes. Further efforts will be spent on this type of centre to centre communication in the TRIDEC project (an integrated project funded in the 7th FP of the EC, http://www.tridec-online.eu), which aims among others for the development of a demonstrator serving in the IOC North East Atlantic and Mediterranean Tsunami EWS (NEAMTWS) network.

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