A data transfer protocol for forest fire statistics: Achieving interoperability among independent agencies

María Hernández, Susana Montero, David Díez, Paloma Díaz and Ignacio Aedo
Laboratorio DEI. Computer Science Department
Universidad Carlos III de Madrid
{mhjuan, smontero,ddiez,aedo,pdp}@inf.uc3m.es

ABSTRACT

The elaboration of statistics after a catastrophic situation allows us not only to analyze the economic, ecological and social impact of the event but also to improve the emergency management process. One compelling example of data collection for statistics is forest fires. The agencies involved in providing data have its own systems to collect data and mechanisms to send them, as well as, its data format for storing. Since such mechanisms are usually proprietary, and in order to normalize the exchange of data with statistics generating systems, a data transfer protocol should be used.

In this paper we present a data transfer protocol called Forest Fire Statistics Protocol (FFSP). This protocol aims at transmitting consolidated forest fire data between independent agencies. The data transferred are based on the Forest Fire Report Data Model. Both mechanisms are based on open standards providing both technical interoperability and a solution that might be developed once and fit the needs of all.

FFSP has been implemented as a web service over SOAP, SSL/TLS and TCP protocols.

Keywords

Interoperability among independent agencies, forest fire statistics, and data transfer protocol.

INTRODUCTION AND MOTIVATION

State agencies, in the course of their activities, are required to keep a running record. When these records are aggregated, they form the official statistics in an area of activity. The elaboration of statistics after a catastrophic situation allows us not only to analyze the economic, ecological and social impact of the event but also to improve the emergency management process. One compelling example of data collection for statistics is Forest Fires. Different international (v.g. UNECE/FAO, Joint Research Center of European Commission), national (v.g. United States Fire Administration, Australasian Fire Authorities Council, The Spanish Ministry of the Environment) and local (v.g. the Madrid Autonomous Region) agencies deal with collecting these data .

In Spain, the Ministry of Environment (national level), with the Ministry of Internal Affairs and the Autonomous Regions, is the administrative department in charge of the statistical treatment of the data provided by the Autonomous Regions (Royal Decree 1053/1985, 1985). Each Autonomous Region (local level) is in charge of gathering data on forest fire management from its local agencies that include Fire and rescue services (data owners and providers). These local agencies then send just the data required by national and internationals agencies (data consumers), thus following a hierarchical chain. The European Union (international level) collects the existing information on forest fires at country level. The statistics generation and data transfer among different territorial levels depend on the forest fire activity at stake. There are periods of time, in particular during the forest fire season, in which at local and national levels statistics might be elaborated quarterly or weekly whereas at international level just annual statistics are required (Forestry Law 43/2003, 2003). Apart from territorial levels and periods of time, and depending on the type of information provided by agencies, different kinds of statistic can be generated. Thus, there are statistics for describing what has happened (number of forest fires per region, number of fires per month), specific forest fires features (number of forest fires per origin of fire, number of hectares burned per region) and how responders have resolved forest fire

Reviewing Statement: This paper represents work in progress, an issue for discussion, a case study, best practice or other matters of interest and has been reviewed for clarity, relevance and significance.

emergency (duration of responses). Each of these agencies uses its own systems and mechanisms to collect data, as well as, its data format for storing.

The problem of bringing together individual, heterogeneous and distributed information across agencies boundaries is known as an interoperability problem. According to the European Interoperability Framework (European Comission, 2002), a first step to resolve an interoperability problem is to define standard protocols and data formats which are known as technical interoperability.

Following theses directives, and focused on forest fire emergencies, we proposed a Forest Fire Report Data Model (FFRDM) (Hernández, Montero, Díez, Aedo and Díaz, 2009) intended to become a data reference model for sharing and exchanging forest fire reports. The following step to assess if the FFRDM can be used as a common data format in the previous scenario is to provide an application-level protocol, called Forest Fire Statistics Protocol (FFSP), which guides the correct communication between parties. Moreover, since web-service architectures are based on a document-oriented model designed for interoperability at a document level, typically XML, and allow for processing data seamlessly across different software systems and platforms, the protocol has been implemented as a web service.

The advantages of the proposed solution are: providing a set of messages that make flexible and secure communication between parties according to their needs and data availability; and providing the tools for collecting information from independent agencies whilst keeping their internal processes and legacy systems intact.

Through the paper we introduce the design overview of the protocol by focusing on the messages provided. Then some details about the implementation of the web service are described and how the protocol is used in a scenario of use. Finally, our conclusions are shown.

DESIGN OVERVIEW FOR THE PROTOCOL

In order to design the protocol, some aspects should be considered.

- The protocol should be flexible enough to facilitate different types of communications depending on territorial levels involved, periods of time and available information. Data are already consolidated among parties in the same territorial level.
- The protocol should allow agencies to decide when and what data will be transferred.
- The protocol should report agencies whether any data is lost or missing in order to accomplish a particular type of statistics.
- The protocol should allow agencies to transfer data without replacing their own management systems or data storage.
- The implementation of the protocol should support a multilateral solution since agencies that participate in each territorial level are independent.

According to these concerns we have designed the Forest Fire Statistics Protocol (FFSP) as an application layer protocol that provides client/server communication between autonomous agencies (AG) and systems devoted to generating forest fire statistics (SGS). Since we are transferring documents data loss is not possible, even though time sensitive is not required.

In short, the protocol's behavior includes the following steps: (i) to start communication to initiate data transfer; (ii) to negotiate parameters to establish the requirements characteristics of communication; (iii) to transfer data; and (iv) to finish communication to close the transmission.

Figure 1 shows the finite-state machine for the FFSP. Rectangles represent states of the communication and the arrows represent transitions between such states.

- **CommunicationStarted**: SGS has received a *ClientSendRequest* message from an AG. This is the initial message for starting any transaction in our model.
- **ListParametersSent**: AG has received a *ServerSendResponse* message as response to a *ClientSendRequest* message. The former message contains information about the type of statistics that SGS is able to generate according to two independent parameters: periods of time and categories of data. The *ServerSendResponse* fields are:
    - Number of periods: number of elements included in the list Periods.

  - Periods: a list of available periods based on a set of values: weekly, quarterly, half-yearly, annual, biannual, lustrum, decade.
  - Number of statistics: number of elements included in the list.
  - Statistics: a list of available statistics based on a set of values: Basic, Full, Frequency, Resource, Victim, Fire_Notification, Topography, Origin, Fire_Type, Land, Full_Action_Manager, Response_Duration.

- **NegotiationStarted:** SGS has received a *ParamNegotiation* message from AG. This message includes the values selected by AG both for the period of time and for the categories of data.
- **NegotiationConfirmed**: AG has received a *ConfirmNegotiation* message to confirm that both parties agree with the parameters selected.
- **DataReceived**: SGS has received a *SendData* message that contains XML data according to Forest Fire Report Data Model.
- **ResponseSent**: AG has received a *ResponseData* message indicating if data received are valid or not according to the parameters selected during the negotiation state. In the case of not valid data the *SendData* message is discarded. After this message, AG can send more data for this transaction by sending other *SendData* messages. Moreover, AG can renegotiate the parameters by sending another *ParamNegotiation* message.
- **FinishReceived**: SGS has received a *FinishCommunication* message to terminate the communication.
- **Exit**: AG has received another *FinishCommunication* message from SGS. Moreover, this state is also reached when any error happens. In this case, an *Abort* message is sent to indicate the type of error.
- **Exception**: if at any point in the transaction a fatal error occurs the communication is aborted and the connection is closed. As shown in the legend of Figure 1, there are five kinds of errors.

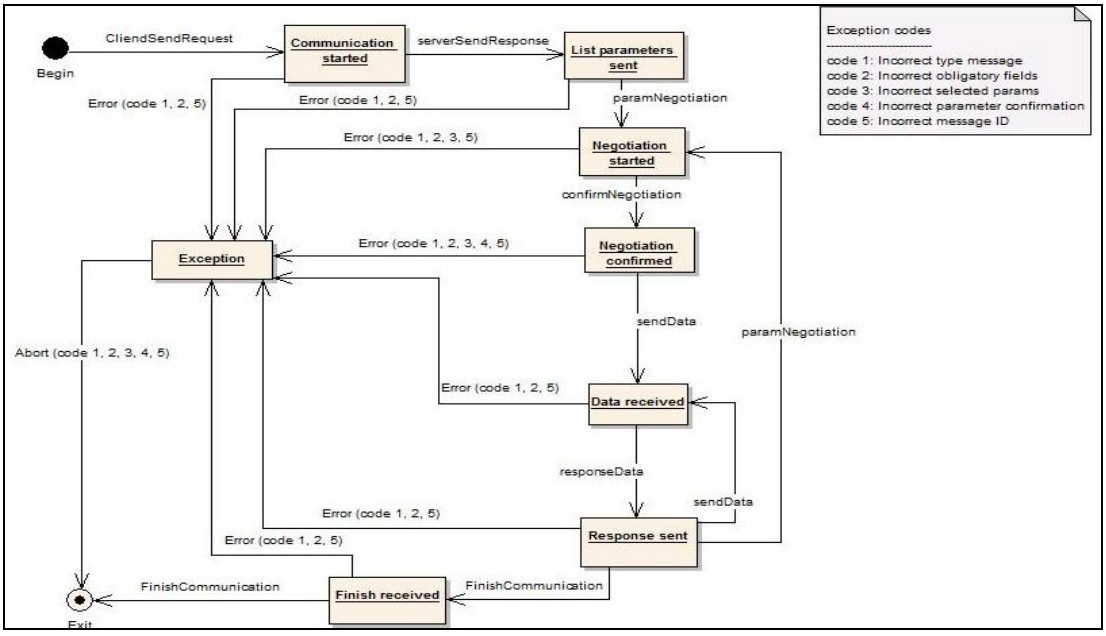

Figure 1. Protocol States Machine

PROOF OF CONCEPT

In order to demonstrate its feasibility the FFSP protocol has been implemented and tested in a real scenario.

Implementation

Among the different possible technologies to implement the protocol, the web service technology has been selected. Web services can implement a service-oriented architecture and their standards address interoperability

by providing XML-based standards and platform independent. These properties are very useful to transfer data between different systems which can be implemented with heterogeneous technologies, like it is our case.

The programming language chosen for the implementation has been Java and we have taken advantage of its technologies. Since the Forest Fire Reports Data Model was described as an XML schema, JAXB technology allows us to transform our data model into Java classes in order to facilitate data processing. In addition, with the purpose of ensuring authentication, integrity and non-repudiation of messages, we have included private keys and certificates for client and service by means of the Apache Rampart module for Apache Axis2 that implements the WS-Security OASIS standard.

The web service here implemented offers to clients various actions which represent the different types of messages of the protocol. These actions are included in the WSDL file that is available in (DEI lab, 2009). FFSP has been implemented over other protocols like SOAP, SSL/TLS and TCP.

Functionality Testing

In order to compose the scenario, three different systems have been used: SIU6, SIGAME and ESA6. SIU6 is an information system devoted to collecting data from fire services' action reports. SIGAME has been designed to improve the co-ordination of inter-agency donations in emergency situations within the context of the Spanish Civil Protection Mechanism (Montells, Montero, Díaz, Aedo and Castro, 2006). Finally, ESA6 is a system developed to generate emergency statistics following the requirements of the DGPCE according to the Royal Decree 1053/1985 (Royal Decree 1053/1985, 1985).

SIU6 and SIGAME have different proprietary data formats, which do not correspond with FFRDM. They work at different territorial level. SIU6 supports fire service (local level) whereas SIGAME is used by Autonomous Regions (national level). ESA6 is the service provider.

Regarding the implementation scenario, ESA6 is the service provider. SIU6 and SIGAME are the service consumers. In order to transfer data using the service, both systems have to implement FFRDM as a 'virtual model layer', mapping their local data model to the virtual model as part of the implementation. For SIU6 a web form has been developed. Users can decide the type of information to be sent by selecting a period of time and a kind of statistics in order to package the data required and start the communication with the web service. For SIGAME an internal module has been developed to map automatically the data since the information gathered about a forest fire is minimum with respect to FFRDM.

All these different features help us to test the granularity of FFRDM (specific vs. general data), the flexibility of the protocol (to validate data from different type of statistics), and if the use of data model together with the web service provide a multilateral interoperability solution.

Table 1 gathers the tests made in the scenario. Every emergency report should answer at least the questions: when, how long, where, how, and why. However, at the local and national levels other questions arise, such as how many victims there were, what resources were involved or what services took part. The first column of Table 1 shows the type of statistics we have to select in the protocol in order to answer the questions included in that cell. The second column shows the entities and data fields involved in that kind of statistics according to FFRDM. The third column shows the systems used in the test according to the available data.

Type of Statistics	**Data**	**Systems**
Basic When and where	ForestFire (initialDate,initialHour) EmergencyArea	SIU6, SIGAME
General When, where, victims and resources	Basic data Victim, Resource	SIU6, SIGAME
Forest_Fire_Specific When, where, why, how long, how size	Basic data Origin, FireType, Land, ForestFire, Topography	SIU6
Action_Manager When,where, how long, what services	Basic data InterventionServices, Responder	SIU6

Full When, where, how long, where, how size, why, what services, how many victims, what resources	FFRDM	SIU6

Table 1. Functionality Testing

CONCLUSIONS

This paper has described a Forest Fire Statistics Protocol that permits independent agencies responsible for managing information related to forest fires, to send different kinds of data. Data are characterized by the territorial level involved, the statistic period of time and the available information. The implementation of the protocol as a web service has provided an interoperable and distributed solution as shown in the proof of concept. Moreover, the flexibility of the Forest Fire Report Data Model to answer different questions related with forest fire reports has been proved.

Currently the web service here presented is just devoted to collecting data from different independent agencies, and the tasks of processing, interpretation, aggregation and presentation of the information are performed by statistics generation systems. Our preliminary results suggest that a web services architecture that provides the aforementioned functionalities might meet the needs of independent agencies with respect to statistics, and therefore avoiding the duplication of efforts.

ACKNOWLEDGMENTS

This work has been partly funded by the UIA4SIGE project (Ministry of Science and Innovation TSI2007-60388). SIU6, SIGAME and ESA6 are projects developed between Universidad Carlos III of Madrid and Spanish Civil Defense Organization (Spanish Ministry of Internal Affairs).

REFERENCES

1. DEI Lab. (2009) The Forest Fire Statistics Protocol description file, http://dei.inf.uc3m.es/~mhdez/ForestFireStatisticsService.wsdl
2. European Comission. (2002) European Interoperability Framework, recovered 10/10/2009, http://ec.europa.eu/idabc/servlets/Doc?id=19529
3. Forestry Law 43/2003. (2003) Forestry Law 43/2003 21st of November, Title 3, Chapter 2, Article nº 28, recovered 10/20/2009, http://www.boe.es/aeboe/consultas/bases_datos/doc.php?coleccion=iberlex&id=2003/21339 (Spanish)
4. Hernández, M., Montero, S., Díez, D., Aedo, I., Díaz, P. (2009) Towards an interoperable data model for forest fire reports, *ISCRAM 6th International Conference Information Systems for Crisis Response and Management, 1:208-213.*
5. Montells, L., Montero, S., Díaz, P., Aedo, I. and de Castro, J. (2006) SIGAME: Web-based system for resources management on Emergencies, *ISCRAM 3th International Conference Information Systems for Crisis Response and Management,* Newark (USA).
6. Royal Decree 1053/1985. (1985) Royal Decree 1053/1985, 25th of May, on management of statistics of actions of the fire extinction and rescue services, recovered 03/18/2008, http://www2.apabcn.cat/tecnica/renart/bases/pdfs/alcala/8507003.pdf (Spanish).