Centralized data management in the demining world : the Tiramisu Repository Service

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1. Introduction

Demining is a dangerous activity. It is also a complex series of operations, ranging from satellite images study to the practical disposal of unexploded ordnances. Whether it is operated by national authorities or by mandated private companies it requires a good economy and an efficient management to achieve its task over time and proceed by priority order.

Every year new tools and methods are proposed and tested for this never efficient enough discipline lacking of means and time. Efficient or not these tools are essentially addressing specific tasks, field mine detection, personal equipment, GIS, management, …

Each task is more and more efficiently operated and the whole activity has become more and more complex, so that a missing link has appeared right in the center of the set: a way to manage and integrate all the valuable information produced all along the line of operations.

As a demining toolbox producer the TIRAMISU project has introduced the idea of centralizing the information produced at each step and used by its tools in a specific structure, free to use and open to any other tools.

2. Questions

- What data/info does a 15-25 year demining mission handle?
- How is the data/info communicated between actors in the demining mission?
- Is the data/info (and if so how is it) evolving over time?
- How do we assure traceability in the data/info over time?
- Is it possible to supplement sensor data to improve quality assurance and liability?
- What are the "lowest common denominators" regarding this data/info?
- When there is a lot of data/info… How do we easily find what we are looking for?
- Is it possible to safeguard that the data does not fall into the "wrong hands"?
- Who is in charge of the data/info?

3. Description

More than a software, what we actually propose is an operational standard for data storing and exchange between all the contributors of a local demining organization. The objective is to address all the questions and needs expressed above, and to improve the security on the field by providing accurate and exhaustive information, as well as the overall efficiency of the management.

Practically, the Tiramisu Repository Service (TRS) is a database with geographical capabilities, working in a client-server architecture and in which different tools store and read data. The inner structure is made of tables in which the data are organized so as to ensure the efficiency of the whole system and to secure the storage. It will be hosted in an office on a desktop computer and will have its robust, battery-driven field lighter version for accompanying the field missions. So the TRS centralizes the information and makes it available to all the tools whenever and wherever they need it.

As in the usual IT world what we call a standard is *a normative specification of a technology or methodology,* applicable here to the IT demining operations. Its objective is to guarantee a universal compatibility between different systems developed independently.

In the text below we will distinguish two different versions of the TRS:

- the National repository hosted in the national demining headquarter,
- and the Field-TRS which is hosted on a rugged Unix-box (or perhaps even on a laptop) and used outdoor.

What tools are involved

We consider different types of tools to benefit from the data repository:

The data producers

These are expected to be, by nature, the main data providers.

- The sensors:
  Sensors are producing information related to the UXO detection; usually they produce a signal when encountering a potentially hazardous object. After a field screening information has been produced which could be advantageously stored. This information is basically 'where' the UXO's are, when they were detected and by what system. Tiramisu is also developing a companion device called the TCP Box [1] that will provide a high precision location and a time stamp, which is designed to communicate the data generated by the sensors and transfer them to the repository. Consequently the UXOs data will be kept as well as the precise delineation of the places without any UXO's.

- The GIS data and operations [2]:
  The repository includes the support of geographical data type, vectors and rasters. Basic geographical data (e.g. satellite or aerial images, digital terrain model or topographic maps) as well as geographical data, resulting from Advanced General Survey (AGS) and Non-Technical Survey (NTS) can be stored and accessed from regular GIS softwares (QGis, GVsig, ArcGIS, MapInfo, GRASS, …). The functionalities of the repository itself allow also the direct GIS processing.

- The 'human' information sources:
  Expertise and population survey are also a source of information that will be stored in the repository through some interface, like web-based interface.

- The field observations:
  During the field work and/or during the inspection missions data will be collected regarding the possible presence of UXO's or assessing the suspected hazardous areas (SHA) determined by previous operations. Storing this information will allow for improving the already stored information and will generate a useful feedback.

- The regional geographical information:
  Besides the data generated by the demining activity other information can be stored, as the communication networks, the regional topology, the soil coverage, the cadastre, … This general information is useful for the general management of the demining activities.

- UXO's description databases and other international demining oriented databases.

The data users

Any actor of a Mine action Center (MAC) is a possible data user, including those who are also data providers. The data stored in the repository can feed specific tasks and can be used for general reporting of the ongoing or past work. Whatever the schedule of the successive demining operations, the data produced at each step is always available, even if the operations are interrupted by long periods of inactivity. Moreover the data stored in one local unit can be easily centralized in the headquarter.
As stated above the data is also useful for preparing field missions and a snapshot of the repository can be transferred to the Field-TRS to make the previous information available on the field.

- Different tools can use data produced elsewhere.
  The TRS replaces in this case the numerous files produced for storing and exchanging data and always likely to be duplicated, with all the problems of incoherences between the versions of the same file, or lost in a file system complicated by the succession of operators.

- The management:
  can take advantage of a centralized architecture for reporting or statistical study of the activity and the efficiency of the tools involved. The different databases of the MAC's antennas can be merged into a single structure.

- The engineers:
  can use the stored data to study carefully the

situation and develop better procedures or new functionalities.

How it works, what it does, what it does not

The main function of the TRS is to store and share the data generated during all the demining operations in a predefined structure designed to cover all the aspects of the activity in an efficient and secure way. The TRS aims at supporting the regular activities - not to do any of them - and to enhance their efficiency by ensuring a better data exchange between all the actors.

- GIS side
  Strictly talking the GIS side can be considered as a module providing the specific structure for the AGS and the NTS, coming from the development made in the TIRAMISU project on this topic. Aerial and satellite images would be stored after initial and very specialized processing, as well as the general geographic information and the SHA resulting from the NTS tools. The storage of the detected mines is more related to the field detection side, but the NTS could also process information stored in documents giving the mine positions.

- Sensors side
  Sensors are usually not designed for communicating with a database server, therefore their data will reach the TRS via the TCP-Box, which transfers the sensor data wireless from technical survey – attached with a timestamp and a geo-coordinate – to the field repository service (TRS).

- Others (Management)
  By keeping track of the activities and results, the TRS is an obvious excellent source of information for documentation, reporting and decision support. This aspect is nevertheless left aside for later development, once the essential ones are done. These functionalities will be efficiently be handled by web interface, but many systems could be used to query the database and synthesize its content.

- Data exploration and Interaction between people, tools and data flow

- Direct connection, web interface or MaXML for standardized data exchange

Technical installation description

Technically speaking the TRS is characterized by :

- a client - server architecture, based on the DBRMS PostgreSQL, which is a professional standard available with an open-source license.

- a compliance with most of the operating systems (Windows, Linux, Mac, …)

- Multi-users access control: PostgreSQL provides infinite possibilities of access rights tuning

- GIS efficient with the PostGIS extension: PostGIs is the spatial extension of PostgreSQL. It provides the support of geographical data types and hundreds of functions for GIS processing.

- web interface for displaying purpose and exchange: the OGC web-based communication protocols (WMS, WFS, WPS, WCS) will also be implemented.

- open for free further developments: as a SQL and PostGIS system the TRS offers the ability to query the database and to develop custom functions, without the need for any extra license.

Scalability / Openness / Adaptability

Because of the openness of the TRS, it is possible and highly desirable that other actors, among which the MAC, develop their own functionalities to enrich the TRS capabilities. As it is said above there are different ways to interact with the TRS and as long as the authority in charge of operating the system allows it by defining the access rights, anything is possible. Moreover the add-ons developed by third parties could easily be shared between the different actors.

4. Scenario

To illustrate the role of the TRS here's a simple scenario of hypothetic successive demining operations:

1. Limited-size satellite images or aerial photos over a mine contaminated suspected area and/or vectorial delimitations/characterizations of SHA (= Suspected Hazardous Areas resulting of the remote sensing analysis) are stored in the TRS by analysts using Land Impact Survey Tools,

2. and transferred to a field device (tablet or laptop) for exploration purpose. [Result: a SHA is identified and reported to a field device.]

3. In the field a report is generated (possibly with T-IMS), then stored in National TRS.

4. The geographical material and the field report are used for further analysis. The analysis result with the image(s) – now probably augmented with drawings/markings from the analysis staff – is stored in the TRS.

5. The analysis result is used for decision makers to task a Technical Survey Team (TST) to enter the area. The task is defined in an order generated from data stored in the TRS.

6. A "snapshot" with the relevant data is transferred from the National-TRS to the Field-TRS.

7. During Technical Survey, the sensor data of the mine detector(s) with position and timestamp are stored in Field-TRS.

8. Map layers for image and sensor data are generated to show this data in the GIS and browser based in the field on the tablet PC of the Head of the Technical Survey Team, combined with the tracks.

5. Implementation strategy

Due to its modular structure (GIS, sensors, management, …) the TRS can be initiated with a minimum of functionalities and grow with the adjunction of new ones. A demonstration version is being developed within the TIRAMISU project with a very limited number of sensors and a set of GIS functions. After this initial step new tools will be added.

6. Schematic technical description

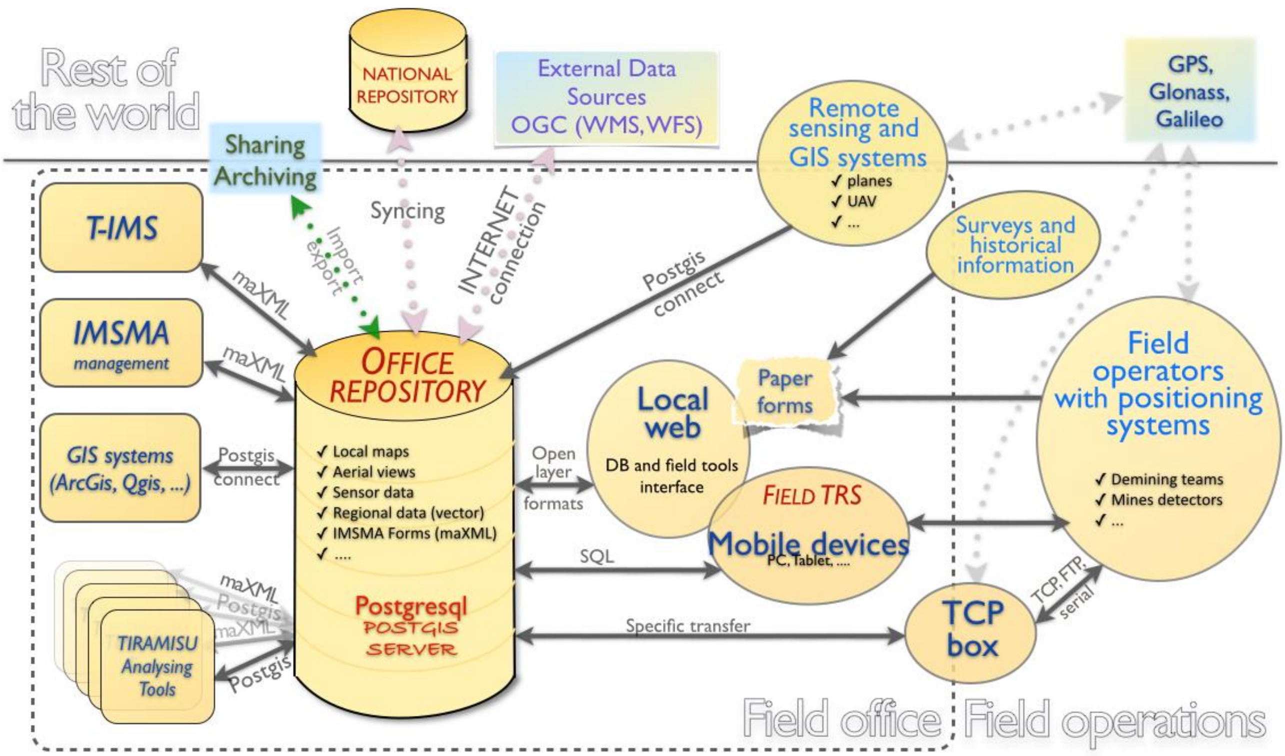

Figure : the mine action data workflow with the TRS

Description of the elements in the graph

- **IMSMA**
  We imagine here a possibility to interconnect IMSMA with our TRS for sharing data, but this is only a technical possibility not a project yet. It would be an interesting feature for the MAC users.

- **GIS**
  systems Having a PostGIS server allows to process the data with many different GIS software, like (among many) QGis which is a free software and offers tools to execute PostGIS functions, or ArcGIS which is a proprietary software and for which an institution like the GICHD has developed tools like MASCOTT to compute action priorities and which uses geographical data. TRS allows the users to keep their own GIS system, as long as they respect the standards (see below).

- **Analyzing tools**
  As TIRAMISU is developing tools - not only GIS tools - TRS is their source of data and storage system. Any tool will be able to access any kind of required data with the same easiness without having to wait look for it. This should open the possibilities for all the developers. After the end of Tiramisu, other developers, like people working in MACs, will be able to easily create new tools, for instance with the PostGIS functions, and share them with whoever they want.

- **External data sources**
  We consider here the possibility to download data from external sources whenever an internet connection is available. This could be mines data, maps, or any useful existing database..

- **Local Web**
  A local web interface will be set up to allow users to easily enter data coming from sources that don't use a standard

communication protocol. This means that users can manually or semi-automatically import data.

- **Remote sensing and GIS systems**, like aerial images or specific geographic data will be imported in the TRS.

- **Surveys and historical information** the information collected from the population and/or from military archives or others mays also be used to describe the hazards and this information can therefore be stored in the TRS through a web interface.

- **The sensors** used in the fields will also of course produce data to store in the TRS, while these can also receive data (like soil texture, geo-references, previous results...) from the TRS in order to be tuned before the detection work. This is likely to be done through a box (the TCP box) which will make the interface between the sensors and the TRS.

- **GPS, Glonass, Galileo**: In the field the sensors get their positioning from any of the three possible satellite systems.

- **Sharing and archiving**: The database can be shared, or a snapshot can be exported in a "central" TRS, supposedly at the national level. This allows large scale analyses to be made by the national authorities. There must also be a backup system to protect the data. Finally it is also possible to load some data into the TRS through the same dumping/restoring feature.

Using the TRS

The final user will not have to «work» himself on the TRS. TRS will be hidden and used by the software that connects to it when necessary. It is exactly the same situation for IMSMA which has also a storing system in a relational database, while the regular user can't «see» it.

Nevertheless it is possible for «power» users to act directly with the database functions and develop new tools, even in a MAC, since it only requires knowing the SQL language and the GIS functions. The developers, like the partners in TIRAMISU, have to design their tools so that the data retrieving and storing will be done in the TRS.

7. References :

[1] D.Schmidt, Waizmann, G., Peters, N., (2013): *Bluebot – Navigation and communication capabilities for robots in harsh environments*, In: Proceedings of 7th IARP RISE-ER' 2013, St.-Petersburg, Russia, pp 385-390

[2] Peeters et al., *Data Management for the Advanced General Survey and Non-Technical Survey Tools*, The 10th International Symposium "Humanitarian Demining 2013"- 23rd to 25th April 2013, Šibenik, Croatia, pp 79-82