Experiences in development and maintenance of Silence-GIS

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Abstract: Silence-GIS is a large scale noise management system build as an extension on ArcGIS 9.3.1. This system has been designed and developed for the Dutch Highway Authorities. The aim of the system is to support decisions on Dutch and European noise policy and to predict the effect of future measures on the noise exposure of the population in The Netherlands. The information needed to perform noise calculations was divided over different departments. There was a great need for standardization and integration of the different data sets. This was maybe the largest challenge of the Silence-GIS project. For the development an agile development method was chosen that involves the product owner during all the stages of the development. Terms were introduced like sprints, scrum meetings, backlog, burn down charts, pigs and chickens. To keep the system up to date contracts were made between the product owner and the parties that supplied the data. This paper gives insight in the challenges and benefits of Silence, the advantages of an agile development method and gives an overview of the system hardware, the IT infrastructure and the geographical database.

Keywords: Acoustics, GIS, Software, Development

1. Introduction

Too many people in Europe, particularly in The Netherlands are exposed to high noise levels in their living environment. Sometimes in such a way that it is considered to be a danger to public health. It is therefore the task of the authorities to develop noise policy, impose noise legislation, inform the public, manage noise issues and to reduce noise if necessary. To help the authorities meeting their obligations systems like Silence-GIS are developed and maintained.

Silence-GIS is a large-scale noise management system for the standardization of noise mapping, development of noise policy and action planning around highways on national and regional scale. The system is used and has been continuously updated since 2000. The latest version 3 of Silence-GIS is developed as a user interface (extension) on ArcGIS 9.3.1 with an Oracle database and the Predictor™ calculation core for calculations. Silence-GIS is used by the Dutch Ministry of Transport to support national scale noise policy and strategy. Silence-GIS aims to improve and standardize the manner in which government officials throughout the country produce and use noise mapping for policy related, strategic and trend studies. The application provides a means of standardization by enhancing the use of
the exact same input data, software environment and calculation standard. It introduces a new set of standard ways to predict noise levels, which is suitable both on a national and on a regional scale.

Some characteristics of the Silence-GIS system include:
• Fully virtualized Citrix environment for 20 users.
• Silence-GIS extension running under ArcGIS 9.3.1
• Oracle relational multi-user database with 495 tables, 30,000 polyline roads, 3250 polyline barriers/embankments, 3 million polygon buildings, datasets covering 15 years, size 100 Gb
• Hardware: Citrix server, ArcGIS server, Oracle database server, calculation server, calculation cluster. The Calculation cluster uses the Predictor calculation core and consists of 20 blades using the Predictor calculation client technology.

![Figure 1 – The Silence-GIS structure and user interface](image)

Seen from the users point of view, Silence-GIS is a tool for calculating the noise impact on the environment for a specific area and for a specific point in time. Silence-GIS provides functionality to select from an already filled database with information over 15 years. Both historical as well as future years are included. The database contains several types of data such as location of roads, traffic flow, buildings and demographic data. The result of a calculation is a noise map and is stored as an ‘alternative’ (scenario). An alternative can be used to determine the number of exposed people or dwellings. By comparing alternatives the effect of a future change can be estimated.

2. **Practical and technical challenges**

The complexity of a large scale noise management system (LSNMS) should not be underestimated. Setting up a LSNMS and maintaining it, is an extensive and complex project. An LSNMS can be considered as the whole of software, hardware infrastructure, data, people and procedures that allow organizations to setup and maintain noise management in order to support noise policy and strategy. For Silence-GIS this opposes all kind of challenges like:

• **Data quality**
  To assure the best data quality a structured process within the Silence-GIS project is in place by a data specialist and noise expert for each of the 15 datasets/sources used in the Silence-GIS system and is repeated on a yearly basis.

• **Data ownership**
  A yearly (market) review is done on available and suitable datasets for use in Silence. For each dataset a contract is setup between the supplier and the Dutch Ministry of transport. In some cases the dataset is delivered by another governmental organization. In the Netherlands this then is covered by Data-for-data contract (cost neutral). In the near feature, most datasets will be exchanged/obtained through the INSPIRE Geoportal.

• **Link datasets with different time stamps**
Different time stamps of datasets needed to be solved. When for instance the road network is available on December 2011, but the road types are not available at the same time this needed to be solved pragmatically. (see Figure 2).

- Link datasets with different geo stamp definitions
  Some datasets have a very defined absolute geometrical definition. Like locations of building polygons. However the location of road surfaces and barriers are defined relatively to the starting position of a road or to the location of hectometer signs along the road. In many cases however the distance between hectometer signs was not 100 meter. For this reason a fail safe algorithm for projecting data along roads had to be designed. (see Figure 3)

- Calculation time
  National scale calculation with billions of source-receiver combinations within a few hours/days. To deal with this large volumes we developed several tiling and optimizing techniques in the calculation tools.

- Recoverability
  Recoverability for calculations in a complex virtualized environment within a remote computer centre of the Dutch Ministry is needed. The Silence-GIS system should be able to recover from outages during calculations. Therefore the Predictor calculation client technique was used for multiple clients running as a service. This technique has proven itself while running large calculations for the European Noise Mapping projects. When a calculation client is (temporarily) not available, or switches off during a job other calculation clients will take over the unfinished jobs automatically.

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**Figure 2 – Example of update cycles for the data**

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**Figure 3 – Fail safe algorithm for projecting data along roads using hectometer signs**

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3. **Advantages of the agile development used**

To develop and maintain the latest version 3 of the Silence-GIS application and data, a flexible and agile development approach was chosen. The Scrum method was used which is quite established in the software industry (as a standard). By using this method more efficiency and flexibility in the total development process was gained. This flexibility is a key success factor for developing noise assessment / mapping systems. Legislation and calculations standards change rapidly as does technology and
requirements. Development cycles typically take a long time ranging from a month to almost a year. Due to this long cycle times, requirements and insights change along the way especially for a system as complex as Silence.

Scrum technology uses short development stages and a structured approach, based on requirements and communication within the project with stakeholders. Scrum has several ‘building bricks’ like a ‘backlog’ for managing requirements, short development stages called ‘sprints’ and clear role definitions.

Figure 4: Overview Scrum development method

Within the Silence-GIS project, the Scrum method is not rigorously integrated in the development, but only those building bricks are used that work best given the type of customer (a specialist and not an ICT project manager) and the type of organization. The used 'building bricks' are listed below and for each building brick an elaboration is given on how it is applied to the development of Silence.

Roles
Scrum identifies several roles for the projects being the most import ones: product owner, Scrum master and developers. For Silence-GIS the following roles are used within the team:

• Product owner: the main stakeholder of the project. Responsible for the end product and representing the end users. The product owner is heavily involved into the development process. For the Silence-GIS project, the project manager from the Dutch Ministry acts as the Product Owner and represents all the stakeholders within the Dutch Ministry;
• Scrum master: responsible for the coordination of the project in terms of facilitating the complete process and maintaining the dialog with product owner. For Silence-GIS the project manager development acts as a Scrum master and interacts between the product owner, software developers and other stakeholders;
• Developers and experts: developers and experts directly involved into the daily development and dedicated to the Silence-GIS project.

Typically a Scrum team has 5-10 members. Everyone on the project works together to complete the set of work they have collectively committed to complete within a development stage. Scrum teams develop a deep form of camaraderie and a feeling that “we’re all in this together.”

Product backlog and requirements
A software system is generally described in terms of requirements. A requirement is a precise description of a (small) part (feature) of the software system. A statement like 'the end results of the calculations for day, night and 24-hr value are shown in dB(A)' is an example of a requirement. These
small requirements make the development transparent and manageable. To define and store requirements we use a 'product backlog'.

At the start of the Silence-GIS development, the product backlog is a large database of requirements defined by an id, a description, the estimated time required to develop it and a status (open, tested, ready). The complete (sub)system is therefore decomposed into requirements and accompanying tasks. In general all the requirements are roughly equally in size and development effort. The decomposition of the Silence-GIS (sub)system into requirements is a very difficult task which is done by the developers together with the product owner and other involved experts. Estimation of time to develop requirements is based on experiences in previous development projects.

**Sprints**

The complete project is divided into fixed periods of 2-4 weeks called 'Sprints'. During this Sprint a defined set of features from the product backlog are designed, developed, tested and readied for deliverance. This set of features is defined at the start of the Sprint together with the product owner. This keeps the product owner involved, the product owner gets insight in the developed application up to that point and it is possible to decide on requirements based on internal/external developments, new insights and time constraints.

For Silence-GIS a ‘Sprint planning meeting’ is planned at the start of each sprint together with the product owner. Completed requirements are marked as ready and new requirements are selected for the new Sprint. And here is where the flexibility comes in, the product owner may decide to skip requirements or to add new requirements. In practice this has occurred several times for Silence-GIS due to:

- Changes in legislations, revisions which had to be implemented immediately into the application;
- Shown redundancy in features within the application. Features developed in previous Sprint already satisfied other requirements which still had to be developed. Superfluous features were identified and removed from the product backlog;
- Changes due to contingency factors; e.g. a version change in the core software package GIS led to revision of existing requirements and definition of new requirements;

Important part of Scrum are the evaluations and the ability to improve and optimize the (remaining) development process and product development. For Silence, this ‘learning ability’ is a continues part of the development process

**Daily Scrum meetings**

An important pillar of Scrum is team member involvement. Therefore a daily meeting is organized as a 'glue' between all the team members and to get an overview on the status of all pending developments within the current sprint. This is a stand-up meeting and takes approximately 5-10 minutes only. During this meeting each developer has to answer 3 questions:

- What has he done yesterday?
- Which problems have arisen?
- What is the planning for today?

For Silence, this meeting is held 2-3 times a week for practical reasons (availability of developers and developers on a remote site).

**Pigs and Chickens**

Occasionally it is allowed to have ‘Pigs and Chickens’ joining the Sprint definition meeting (before starting a new sprint). This means in general that other (sometimes less involved) stakeholders in the project are allowed to attend this meeting and to be informed on the status of the project. Pigs are allowed to participate actively in the discussions while Chicks are not (only observing and listening). For Silence-GIS this means that sometimes experts joins the meetings to bring in specific knowledge (e.g. acoustics) and acoustic consulted that just wants to be informed on the developments for noise assessment and noise mapping.
To keep control over the planning a so called Burndown chart is used. Each requirement contains an estimation on the required time to design, develop and test the feature described by the requirement. Each Sprint completes a defined set of requirements. This allows for estimating the completion time of a project. For Silence, a burndown chart is used on a weekly basis to monitor the project progress.

4. Conclusion

Setting up a large scale noise management system and maintaining it, is an extensive and complex continuous project. Due to changing requirements, data and legislation over time, it will never be a one off project. The Silence-GIS system has several stakeholders and interested parties. There is a great need for standardization and integration of the different datasets. This is maybe the largest challenge of the Silence project.

Scrum is used in 2011 for Silence-GIS version 3 developments and has really paid off. Of course the introduction of Scrum requires a new mind setting for both the client, expert and the development team and this takes some time to get used to. Currently the advantages of this approach are very visible and now Scrum is current practice.

The most important advantages of applying Scrum for Silence-GIS are:
• Developments are far better manageable in both time and effort. This has led to better control of budgets;
• Better involvement of the client in the process, not only in the beginning of a large development stage but more frequently and more in control;
• More flexibility during the development, changes in requirements could easily be implemented.

In 2012 the deployment of Scrum for Silence-GIS will be continued and also used in other related development projects.

For more information on Silence-GIS visit www.Silence.nl.