Nationaal Lucht- en Ruimtevaartlaboratorium

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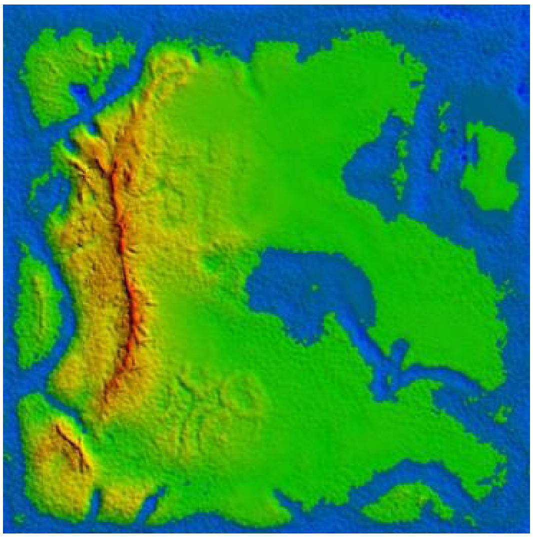
Executive summary

Missionland: The Creation of a Virtual Continent for Mission Simulation



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Problem area
Training via distributed mission simulation has the potential to enhance force readiness and operational effectiveness in coalition operation. An essential condition for an effective mission simulation environment is a correlating representation of the real-world natural and cultural environment in the distributed simulations. Correlating existing environment databases is costly, both in effort and in money, and the end result will always be hampered by technical incompatibilities. A generic and geo-unspecific, widely available simulation environment could overcome these problems.

Description of work
In 2008 the NATO RTO task group MSG-071 Missionland started. Its prime objective is to construct a coherent dataset of the static environment, from which databases can be constructed for a wide scope of simulators. As first step the task group started a user needs analysis by sending out a questionnaire to the stakeholders in participating nations. The answers were elaborated and these formed the base for the Missionland design. A sketch of the complete Missionland continent was drawn. This sketch formed the starting point for experiments in generating parts of the dataset. Several methodologies

This report is based on a presentation held at the IMAGE 2011 Conference, Scottsdale, AZ, USA, June 2011.

and approaches for generating the elevation data, the vector data and the imagery have been tried out. Different tools have been assessed on their potential of supporting the data generation for Missionland.

Results and conclusions

The task group created a design of the virtual continent Missionland and set a location in the North Atlantic Ocean for this new continent. The Missionland dataset will cover multiple climate zones, various elevation settings, coastal areas and large continuous land masses. The Missionland dataset will provide the users with terrain elevation data, vector data, 3D models, material coding and metadata. The task group has started to experiment with the Missionland data generation. It has evaluated different tools and there is not one single tool available that can handle the total generation of such a fictitious continent. However different commercial tools have been identified to produce parts of the data and the task group has also designed some custom tools to fill other gaps.

Applicability

With the experiences gained the task group could set up the final process for generating and delivering data for the Missionland dataset to generate. The identified tools, together with the custom designed tools forms a good framework for processing all the data.

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Missionland: The Creation of a Virtual Continent for Mission Simulation

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[1] XPI Simulation

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Summary

Training via distributed mission simulation has the potential to enhance force readiness and operational effectiveness in coalition operation. An essential condition for an effective mission simulation environment is a correlating representation of the real-world natural and cultural environment in the distributed simulations. Correlating existing environment databases is costly, both in effort and in money, and the end result will always be hampered by technical incompatibilities. A generic and geo-unspecific, widely available simulation environment could overcome these problems.

In 2008 the NATO RTO task group MSG-071 Missionland started. Its prime objective is to construct a coherent dataset of the static environment, from which databases can be constructed for a wide scope of simulators. These environment databases are generally needed for visual out-of-the-window and sensor views, as well as terrain servers and computer generated forces applications. The Missionland dataset will cover multiple climate zones, various elevation settings, coastal areas and large continuous land masses. This ensures a suitable environment for a large variety of applications, including training, tactics development, simulation based acquisition and concept development and experimentation. The Missionland dataset will provide end users with terrain elevation data, remote sensing imagery, ground imagery, vector data, 3D models, material coding and meta data. In support of the prime objective, there is the need to implement a deployment and continuation process to ensure proper use and continuation after the life of MSG-071. This includes guidelines and support in using Missionland.

This paper outlines the approach the Missionland task group takes in developing the dataset. It is discussed what an end user of Missionland can expect from the dataset and what kind of features and areas of interest the dataset will contain. It describes the process, technologies and tools the task group follows to develop the different kinds of data and shares the first experiences of the task group in generating the data.

Contents

Abbreviations

CDB	Common Data Base
CGF	Computer Generated Forces
COTS	Commercial Of The Shelf
DFDD	Data Format Design Document
EDCS	Environment Data Coding Specification
FACC	Features and Attributes Coding Catalog
FTP	File Transfer Protocol
GeoTIFF	Geospatial Tagged Image File Format
GIS	Geographical Information System
IPR	Intellectual Property Rights
ITED	Interactive Terrain Editor
L3DT	Large 3D Terrain
MSG	Modelling and Simulation Group
NATO	North Atlantic Treaty Organisation
PfP	Partnership for Peace
POC	Point Of Contact
RGB	Red Green Blue
RTO	Research and Technology Organisation
SAS	System Analysis and Studies
SEDRIS	Synthetic Environment Data Representation and Interface Specification
WAVE	Warfighter Alliance in a Virtual Environment
WGS	World Geodetic System

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1 Introduction

Imagine a whole new continent is planted in the middle of the Atlantic Ocean. It is a continent with a variety of climate and eco system types: arctic cold, tropical green, hot deserts and more are represented in this intriguing continent that is populated with a wide variation of cultures. The most interesting feature of this new continent is that it has a very enthusiastic and well-equipped Modelling & Simulation Geodata Office that is capable of delivering whatever data you need to enable simulated exercises on their continent. Everything is available - remote sensing imagery, ground imagery, terrain elevation data, detailed vector data and all required model libraries - to give your simulators a kick-start into (networked) simulation exercises on this continent.

The name of this new continent is *Missionland* and its creation was initiated in 2008 by the NATO Research and Technology Organisation (RTO) task group MSG (Modelling & Simulation Group)-071 Missionland. The aim of the Missionland task group is to create a common dataset of the static environment that can be used for simulation exercises. The focus is on the content itself, not on the way to store or represent it, as for example, the Synthetic Environment Data Representation and Interface Specification (SEDRIS) addresses. For more information on the approach of the Missionland task group see [1].

The paper starts with a short explanation on the background of Missionland. Then it will outline the user needs for the Missionland data set and describe the design of Missionland. Next the paper will discuss the products that will be included in the dataset. The paper finally presents some of the experiences the task group has gained in generating pieces of the dataset.

2 Background

Mission training is vital for military operators to successfully execute their mission. Simulation has been and is a versatile tool for these purposes. In the beginning of this millennium, mission training via distributed simulation was the topic of the day in the military training world. Since then, distributed mission simulation has been used more and more for military training, concept development and experimentation. These mission simulations make use of simulated environments, i.e. virtual representations of the real-world natural and cultural environment. Such environments contain dynamic elements, for example weather, time of day and moving vehicles; as well as static elements, for example vegetation, buildings and infrastructure. When performing distributed (joint) simulations a number of problems exist concerning the selection and use of a simulation environment. These problems can either be caused by the different requirements of the participating users or by different technical capabilities.

An example of such a problem is the different requirements on the level of detail for different forces, while the databases these forces use should still be correlated for the joint simulation. But even if the requirements on the environment database are the same, the difference between the technical implementation in two simulators might still make the reuse of the same simulation environment impossible. Creating different environments for each simulator has its own problems, as it is then required that these databases are correctly correlated with each other. Other limitations arise from a political point of view. For example the distribution of high resolution geographical data of a specific real world area to other countries is often subject to export restrictions due to national security issues.

The NATO RTO task group SAS(System Analysis and Studies)-034/MSG-001 demonstrated in 2004 with the Exercise First WAVE (Warfighter Alliance in a Virtual Environment) that training via distributed mission simulation has the potential to enhance force readiness and operational effectiveness in coalition operations [2]. The task group created a distributed mission training environment in which flight simulators and other crew stations in the nations were linked across a secure wide area network. For four days, operational crews planned and briefed daily coalition air missions then flew them in a common synthetic battle space and debriefed the outcome. Many technical, operational and training challenges were encountered and addressed, providing a rich source of experience and lessons, with many deficiencies identified and consequential lessons learned.

To ensure that the correlation issues between the simulator databases were minimized, the First WAVE Technical Task Team decided to use a common terrain database source which was used to generate the dedicated visual databases for each of the facilities. Normally, this is the best way to ensure the correlation of environment databases, but it is costly, both in effort and in money. In First WAVE, the Canadian organization Defence Geomatics undertook preparation of the common database, supported by a specialist database working group from the Technical Team. This group addressed issues including the selection of projections and imagery resolution, though this was in fact limited by the availability of source data at the resolution required [2].

These problems with the environment representation should be addressed but also the limited availability of source data due to security and political limitations should be addressed. Therefore it is preferable to create a generic and geo-unspecific simulation environment. Using a geo-unspecific environment, would also overcome the objections that result from using a real world area as basis for the simulation environment. And besides that, it also offers the advantage of combining geologically different environments in the same simulation environment. This makes a generic environment much more flexible in performing different types of missions within the same simulation environment.

3 User Needs

In 2008 the NATO RTO task group MSG-071 Missionland started. Its prime objective is to construct a coherent dataset of the static environment, from which databases can be constructed for a wide scope of simulators – from henceforth this coherent dataset is referred to as Missionland. As a basis for the Missionland user needs analysis, the task group developed and issued a questionnaire. The purpose of the questionnaire was to identify potential users and their requirements for Missionland. The Missionland questionnaire was sent out by the task group to relevant people within each country. The national Point of Contact (POC) was responsible for gathering the questionnaire results received and ensuring a wide as possible a distribution within their own military organization. The questionnaire answers were analyzed by the task group members for three different areas: the intended use of Missionland; the requirements for the datasets; and the development and maintenance of the datasets.

The respondents of the questionnaire show a good coverage over the nations participating in the Missionland task group and over the different branches of the armed forces (including research institutes). The level of experience with (international) distributed simulations varies a lot over the respondents, including novice and experienced users. Taking all the results together it can be concluded that the respondents to the questionnaire form a representative group to derive the user needs for the Missionland dataset from.

The primary intended use of the Missionland dataset will be training, both in distributed and stand alone simulations. In addition, concept development & experimentation and doctrine study are also areas where Missionland can be used.

To satisfy the priorities of the different branches in the armed forces, Missionland should contain at least the following five terrain types:

1. Coast
2. Mountains
3. Urban, eastern
4. Sea
5. Urban, western

The size of Missionland will have to be at least 1000x1000 km to satisfy most of the potential users, although it should be noted that there is also a significant group demanding an even larger area. The preferred size of Missionland seems not to be affected by the technical capabilities of the simulators, since most of them support database paging.
It is no surprise that the users expect the Missionland dataset to provide a complete range of products. But to be useable the absolute minimum that should be provided is:

- Maps
- Vector data
- Terrain texture
- Medium resolution elevation data
- Medium resolution aerial imagery
- Terrain feature models

Also when looking at the spectra that should be available in the Missionland dataset it can be concluded that the users expect a truly multi-spectral dataset, including not only visual data, but also infrared, radar, night vision and the data required for Computer Generated Forces (CGF) applications.

The users also clearly indicate they expect the Missionland dataset to contain underwater and atmospheric data. Of these bathymetry and sea bottom type are suggested most often, so this seems to be the absolute minimum that should be provided in Missionland. But also the salinity and temperature profiles are suggested multiple times, as these are important for sonic sensors. For the salinity and temperature profiles it can be discussed if these are within the scope of Missionland or not. Missionland aims to provide the geographical data for the static world and these items can be seen as dynamic data that changes between different scenarios. But the fact that users mention this data shows that they are important for the operational usage and therefore it should be discussed further where exactly the scope of the Missionland dataset is.

The majority of users expect that the Missionland dataset will be supplied using industry standards (e.g. shapefiles, geo-tiff, etc), but there are also requests for Common Data Base (CDB), SEDRIS and compiled OpenFlight. It should also be noted that the format or formats in which the dataset is delivered, does not have to be the format used internally by the task group. For the preferred classification schema for the data SEDRIS Environmental Data Coding Specification (EDCS) was mentioned most often, however the majority of the respondents was either indecisive or did not provide a response.

The Missionland dataset as delivered by the task group will only contain unclassified data, since it is a dataset of a fictitious terrain. However 45% of the respondents answered in the questionnaire that they expect Missionland to be a mixture of unclassified and classified data. The development of the dataset should be a continuous process.

More details about the user needs elicitation and the user requirements can be found in [3] and [4].

4 Missionland design

Based on the results of the user needs elicitation, the Missionland task group started to create the design of Missionland. The Missionland continent will be located in the middle of the Atlantic Ocean, because that is a real-world location that offers enough space for a new continent. Besides that, the Northern Atlantic Ocean seems a suitable location for a NATO activity Figure 1 gives a graphical representation about the Missionland location and the grid cells used.

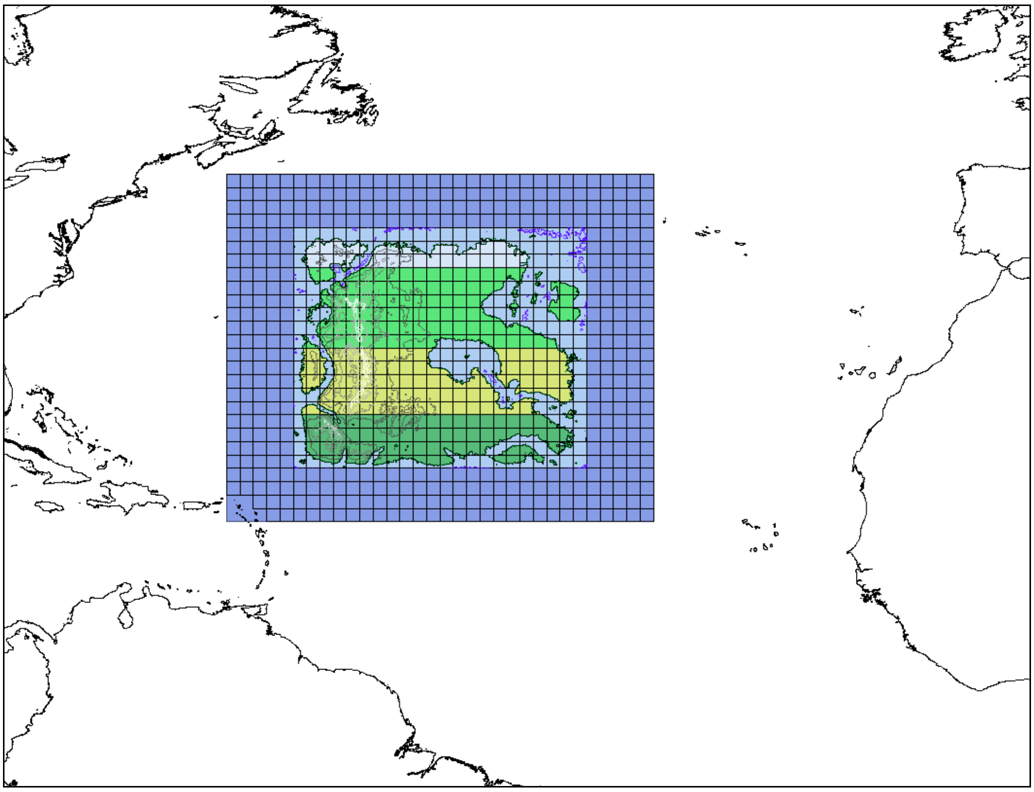

Figure 1: Missionland location

The outer ring of cells has been defined as ocean, to provide a gradual transition from the Missionland bathymetry to the real world bathymetry. Please note that in the south western corner a number of cells had to be removed due to the Caribbean islands located there. This results in an effective land area for the Missionland continent of circa 2000x2000 kilometres, with a sea zone around it of circa 400 kilometres in size (see Figure 1).

4.1 Climate zones

The Missionland continent will provide a wide range of climates. To ensure realistic transitions between these different climate zones and to assist in positioning the different areas on the Missionland continent a high-level definition of the climate zones has been defined (see Figure 2). The following climate zones have been defined: arctic, temperate, arid and tropical.

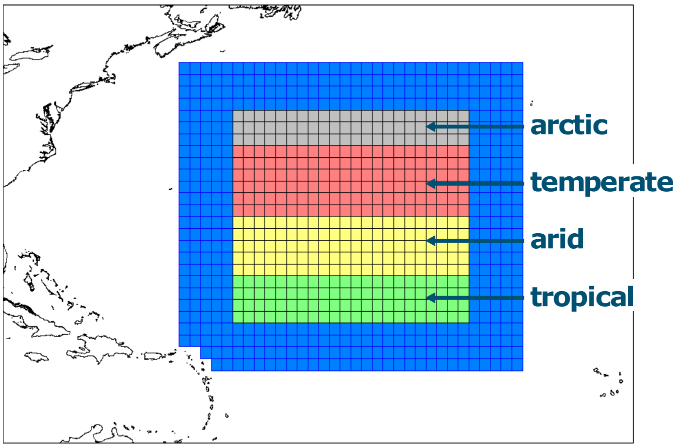

Figure 2: Missionland climate zones

4.2 Elevation profiles

The Missionland continent will provide a wide range of terrain characteristics. This is partly defined by the elevation profile of the terrain. To ensure that there is a realistic transition between the different elevation profiles, a high-level design of zones with a certain elevation profile has been defined (see Figure 3). The following elevation profiles have been defined: flat, hilly, mountainous and cliff/fjord.

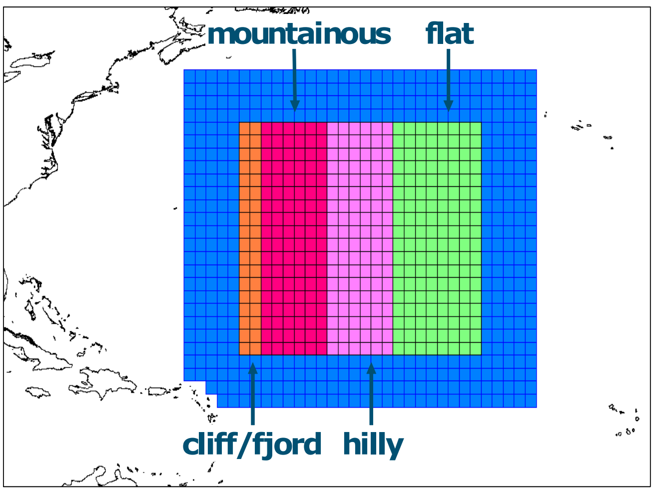

Figure 3: Missionland elevation profiles

4.3 Detailed design

Using this initial design, the Missionland task group is working on the detailed design. In this detailed design the requirements for the content of the dataset are described using the information gathered from the questionnaires. These requirements are stored in design diagrams. The diagram for the temperate zone is presented in Figure 4. In this diagram the features that should be present in the temperate zone are represented. Some of the features are an aggregation of more detailed features (e.g. urban area). Additional diagrams to zoom in on these requirements are available. For each of the features more detailed requirements or constraints (minimum length, depth, etc) can be included.

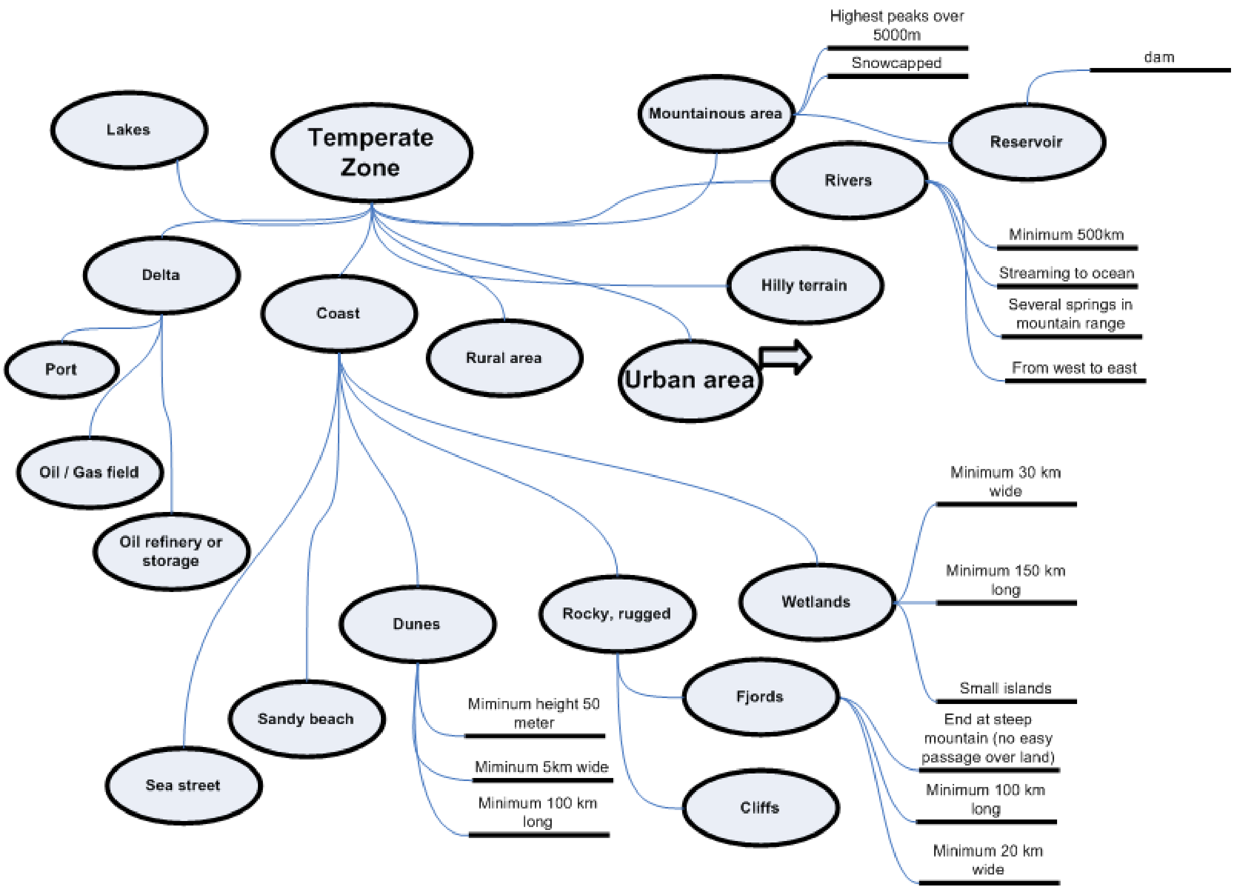

Figure 4: Temperate zone requirements

5 The Missionland Dataset

The dataset will contain a number of products: elevation data, vector data, 3D models, material textures, maps and imagery. To ensure that all the different products in the Missionland dataset remain correlated with each other, it is important to define which products are the core or master products. These master products can be edited directly when new content is added to the dataset, while all other products are derived from them. In the real world, imagery is usually used as the master, from which other data, like vector data, is derived. But since Missionland is a fictitious continent there is no imagery to start with. Therefore it is more practical to create the vector data first and derive the (multi-spectral) imagery products from the vector data, using a material library. Another benefit of generating the imagery is that features can be drawn into the imagery as well.

A side effect of this approach is also that the total size of the core Missionland dataset is kept down, since it does not contain the high resolution imagery. This imagery can be generated at the desired resolution when required. This means that the elevation data, vector data, feature library and material library will be the core products of the Missionland dataset. All other products are derived from those. Figure 5 gives a graphical overview of the different products in the Missionland dataset. All data is stored using geodetic coordinates (latitude and longitude) in WGS84.

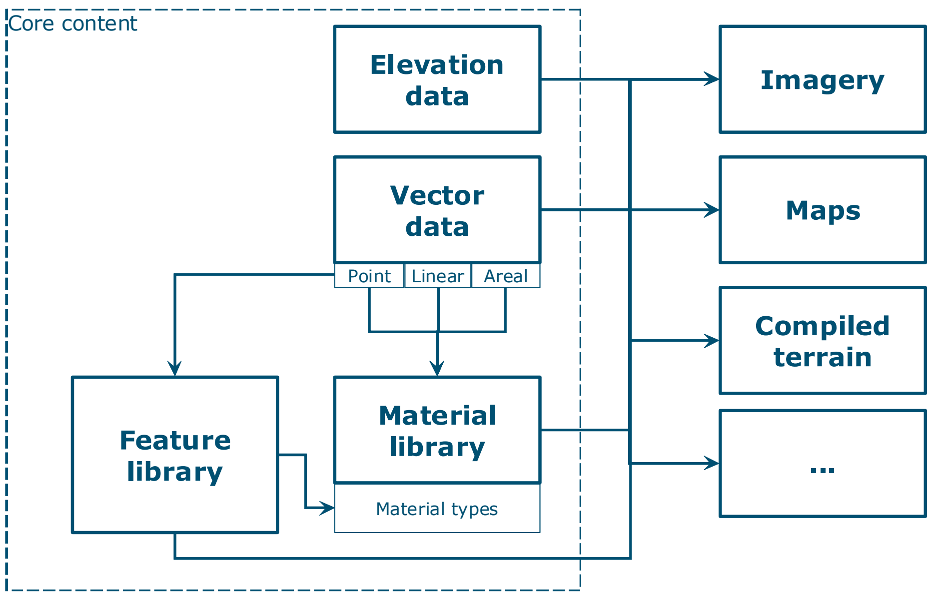

Figure 5: Missionland dataset

5.1 Core products

5.1.1 Elevation data

The elevation data defines the height of the terrain or the depth of the sea areas. The dataset contains different resolutions of the elevation data. The highest resolution elevation data is used for the areas of interest where land forces are employed, while areas of Missionland that are only observed from the air have a lower resolution. In future versions, the areas with high resolution data are expected to grow. Table 1 gives an overview of the resolution that is used for the different areas of Missionland. The elevation data is stored as one Geospatial Tagged Image File Format (GeoTIFF) file per geocell. The resolution of the GeoTIFF file varies between high and low resolution areas.

Table 1: Guidelines for resolution of elevation data

Area	*Resolution*
High resolution area	< 15 meter
Low resolution area	30 meter

5.1.2 Vector data

The vector data represents different features in the environment. Vector data consists of point, linear and areal features. The point features are used to define the location of objects, like a house. The linear features are used to define roads, rivers or power lines, while areal features are used to define areas with certain land cover types, for example forest or city, or to define the footprint of a building. Additional information of the feature is captured by the feature attributes. Examples of these feature attributes are the width of a road, the height of a building or the maximum load for a bridge. Table 2 gives examples of the different kinds of vector data that can be found in the Missionland dataset.

Table 2: Examples of vector data

Point	*Linear*	*Areal*
Feature model placement	Road	Land usage
Location of point of interest	Railroad	Water (lakes, sea)
	Country border	Administrative regions
	River	
	Coastline	
	Communication line	
	Pipe line	
	Contour line	

Vector data is stored as ESRI Shapefile (SHP). For the attribution either SEDRIS EDCS, Features and Attributes Coding Catalog (FACC) and Data Format Design Document (DFDD) coding will be provided for each feature or some Missionland specific schema will be used that can be easily translated into those commonly used coding schemas. The final decision on this has not yet been made.

5.1.3 Feature library

Man-made features, like buildings, bridges and light posts are represented by geometric 3D models in the Missionland dataset, as is also the case for vegetation objects like trees and bushes. The feature library contains all 3D feature models and their textures that are used within the static Missionland environment. 3D moving models are not part of the Missionland dataset. The positioning of these models at the locations where they are used in the environment is done using point vector features. 3D features are stored in the OpenFlight format and their textures in the Silicon Graphics Image RGB format. The material properties for the multi-spectral representation of the 3D feature models should be stored in accordance with the guidelines of the material library.

5.1.4 Material library

The material library contains the textures and additional sensor information for the different feature types in the vector data. Material textures are used to give the environment and objects the right representation. This can be in the form of a texture used by the visualization, but also by providing the right parameters to be able to generate a sensor image. The textures are stored in SGI RGB format. The format for storing the non-visual material attributes still has to be defined.

5.2 Derived products

Besides the core products, the end users of Missionland also require a number of products that can be derived from these core products. The derived products are discussed below.

5.2.1 Imagery

The imagery of Missionland will be generated from the core products. The land usage as defined in the vector data and the textures from the material library are the main inputs into this process. But also the elevation data is needed to make sure the effect of varying elevation is represented in the imagery. The same applies to the 3D feature models, they also need to be included in the generated imagery.

If real world data is used as the basis for a contribution to the Missionland dataset, real imagery might be available of this area. This imagery could then be used instead of generating imagery from the vector data.

5.2.2 Maps

The maps of Missionland will be generated mainly from the vector data. Elements like contour lines can be derived from the elevation data. Since real world maps are also generated from vector data, the process to generate the Missionland maps should be roughly the same.

Different types of end-users might require different types of maps, for example nautical or aerial charts. When creating the vector data it has to be ensured that the different kind of data required for these map types is available.

6 First experiences from generation of the Missionland dataset

This section describes the experiences with generating data for the Missionland dataset until now. Most effort has been spent on the elevation data until now, but also for the generation of the vector data and imagery first steps have been made already.

6.1 Elevation data

The task group first evaluated the possibilities to use procedural terrain generation techniques for the generation of the elevation data. The advantages of such techniques are that elevation data can be generated for a big continent using a limited amount of parameters in a relatively small amount of time, that elevation data can be generated at any desired resolution and that no political or IPR restrictions apply to the data [5][6].

The experience of the task group however was that there are not many tools available to generate procedural elevation data at the scale of an entire continent. Current procedural terrain elevation methods are hard to configure and control, which makes it hard to produce the intended results [5][7]. Another drawback with current methods is that the random nature of the algorithms does not model all the structures found in nature well enough to make the result indistinguishable from real areas. Structures that are hard to model are typically formed over many years of natural occurring phenomena like erosion. Unfortunately, implementations of erosion based methods run much slower than their procedural counterparts [6]. It may seem that current procedural methods and even erosion based methods are not able to produce elevation data that really look natural [8].

Another problem encountered is that it is difficult to generate procedural terrain with widely varying characteristics. Generating an environment with realistic mountainous, hilly and flat areas is almost impossible. Besides that, the generated procedural elevation data also does not represent large area geographic features well. Examples of such features are valleys or river systems.

To overcome the downsides of the procedural elevation data, the task group is using a blending technique. This means that pieces of real world elevation data are blended into the elevation data. If the right sample of the real-world elevation data is used, this results in much more realistic elevation data with the large area geographic features represented. However, this blending is a manual process and therefore requires more effort. Besides that the usage of real-world elevation sample can result is political or Intellectual Property Rights (IPR) restrictions, while Missionland aims to avoid those. More details about using these blending techniques can be found in [9].

Using the approach described above the task group has generated a set of 30 meter resolution elevation data for the entire continent using the Large 3D Terrain generator (L3DT) commercial tool. The task group is working on enhancing this dataset further with the blending approach. For this the Norwegian Defence Research Establishment FFI is developing a dedicated tool, Interactive Terrain Editor (ITED). ITED is not a procedural terrain generator, but it provides a user the ability to produce fictitious terrains with use of real-world elevation data [9]. Besides that, certain areas of interest are provided with higher resolution, at least 15 meter, elevation data.

6.2 Vector data

After the elevation data, the vector data is the next product of the dataset that the task group will generate. Since vectors of natural features need to follow the terrain elevation, the elevation data needs to be available first. Otherwise issues like a river flowing ‘up-hill’ or forests on steep mountain sides can occur. Currently the task group is still finishing the elevation data, so no vector data has been generated yet. However experimentation has been done to define the best approach to generate the vector data.

The process of generating vectors is somewhat iterative. For instance, once the line of a road is agreed, embankments and cuttings will be added to ensure the slope of the road is smooth. This is no different from the geo-engineering that occurs in the construction of a real road. Some tools, mainly the common GIS tools, do offer help in this process; however, their output must be checked for realism. Using geo data tools which allow automatic generation of water features such as streams, rivers and catchment areas based on terrain features appear to be a promising method of checking that elevation data is consistent. During the experimentation with the generation of vector data, the task group has found it useful to be advised by an expert in physical geography.

Given the size of the Missionland continent, the process of adding vectors will be a time consuming process that, at the moment, must be performed mainly manually. Only limited tool support is available for the generation of the vectors. However, it is not necessary to generate high density vectors over the whole continent; instead, to reduce the efforts of adding vectors it is possible to concentrate on areas where user activity might take place.

Another possible technique to provide a dense vector set is to take vector sets of real locations and conform them to the Missionland terrain. Clearly it is important to ensure the vector set matches the terrain approximately before manual work is used to alter the vectors to the terrain or vice versa.

6.3 Imagery

The imagery is the last product of the dataset that needs to be generated. Different approaches are available here. One approach is to use existing satellite imagery and blend them into the final imagery. One area where care has to be taken with this approach, and a significant area of difficulty, is to ensure that the imagery matches the elevation and vector data. For example, a valley in the image should match with the elevation data; otherwise, false cues are provided to the end user of the environment dataset.

Another approach is to use rule-based sets to generate imagery based on vectors and elevation data. This approach allows the imagery to be changed for the time of year, or for sensor imagery to be generated. It also permits adaptive alteration of the imagery to match terrain features and ensures consistent imagery colours across the continent, a problem if imagery uses conventional satellite photographs.

Presagis is working on this technology and it is expected to be available in their COTS terrain tools in the future.

7 Experiences and conclusions

In 2008 the NATO RTO task group MSG-071 Missionland started. Its prime objective is to construct a coherent dataset of the static environment, from which databases can be constructed for a wide scope of simulators. These environment databases are generally needed for visual out-of-the-window and sensor views, as well as terrain servers and computer generated forces applications. Based on inputs from military end users the Missionland task group has identified the user needs and requirements for a dataset of a virtual continent, named Missionland.

The task group created a design of the virtual continent Missionland and set a location in the North Atlantic Ocean for this new continent. The Missionland dataset will cover multiple climate zones, various elevation settings, coastal areas and large continuous land masses. This ensures a suitable environment for a large variety of applications, including training, tactics development, simulation based acquisition and concept development and experimentation. The Missionland dataset will provide end users with terrain elevation data, remote sensing imagery, ground imagery, vector data, 3D models, material coding and metadata.

The task group has encountered several issues in constructing the elevation data set, despite the promises of vendors the team has found that COTS tools to generate elevation data for such a large area simply do not exist. In addition the political requirement to avoid reusing pre-existing geo-data has led to the development of some novel solutions.

Storage of the data is also a problem as the team are separated geographically. The simplest solution to passing around the data set is of course the air shipment of large portable hard drives, however this is not a sustainable solution in the long term. The team is discussing an approach which splits the data into geocell (1 degree by 1 degree) segments, similar to the approach used in the Common Database (CDB) format to permit better control of the dataset, enable easier version management and reduce bandwidth for FTP access to the servers containing the data.

The task group has started to experiment with the Missionland data generation. The Missionland task group has evaluated different tools and there is not one single tool available that can handle the total generation of such a fictitious continent. However different COTS tools have been identified to produce parts of the data and the task group has also designed some custom tools to fill other gaps.

While this paper is technically oriented, some non-technical issues have also required careful consideration. The team have put together a document of the Use Conditions for the data set which provides a robust framework for accepting data, making changes and establishing ownership of the data so that it is freely available to use for NATO and PfP purposes, The team are using many sources of input data; these data sources have to be publicly available and royalty free to enable the final data set to be used freely by all interested parties.

8 Acknowledgements

The authors would like to thank all the members of the Missionland task group MSG-071 as Missionland is a cooperative effort of the contributing nations. Without their efforts and knowledge it was not possible to write this paper.

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