



White Paper

Handling Large Models with Trimble Quadri

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Introduction

This white paper provides an overview of- and guidance on best practice on *handling large models in Quadri*.

Quadri, and *Quadri Desktop* and *Novapoint* are products of Trimble.

Trimble delivers software and services for infrastructure covering the entire lifecycle from planning and design, through construction and finally maintenance.

Background

The *Quadri Model* is the underlying format used by Quadri desktop. The model is based on the ISO 19100 standards and supports both open standards such as LandXML, GML and IFC and the necessary proprietary formats for the Infrastructure industry.

Together, Quadri Desktop and the Quadri BIM server are built to gather all pertinent information about a given infrastructure design. This means that Quadri can be used as the Collaboration platform in which all disciplines are represented in the same complete model. For this reason models can end up being quite large, and there are practical limits to the model size of model with which the system can cope.

Thus there are two key questions:

- What is meant by “large”?
- How can model size be limited?

This white paper provides answers to these questions. There is not always a simple answer, since the model can be large in a number of different ways and the system envelope can therefore be pushed in different directions. The intention is that the reader will understand more having read this document, and will also be in a better position to control model size with the help and advice described in the following sections.

A requirement for today’s solution is that the entire model is downloaded from the Quadri server to a local Quadri *workset*-- i.e. a local copy of all data relating to the project being worked on. Trimble is currently working on improvements to Quadri that require only a *partial* download of the complete model. Once this work is complete, many of the challenges presented in this paper will be solved.

What do we mean by large?



The Quadri model enables the sharing of data between applications, e.g. allowing both road and railway designers to work within the same terrain model. The Quadri model can gather *all* information from the design process, making it a multi-disciplinary collaboration model. As a consequence the model can become large, and take longer to open and to navigate in Quadri Desktop.

The Model's Dimensions

In this context Dimensions refer to the *vectors* along which the model can grow. To better understand the factors affecting size-- and thus performance, the following dimensions can be analyzed:

1. Geographical extent (measured in units of area)
2. The number of objects in the model
3. Geometric density (number of points/polygons per object)
4. The number of object-to-object associations
5. The number of tasks
6. The number of file attachments (to tasks and features)
7. The topological complexity of the underlying network (number of nodes)

It is the sum of the above dimensions that decide whether the model as a whole is computationally heavy or not. For example, a model can cover a wide geographical area but at the same time contain few and optimized objects and thus have acceptable performance. To provide a better understanding of each dimension's effects, each dimension is described in the following section.



Geographical Extent

The greater the geographical extent of the model, the more time it takes to search and perform queries and thus the lower the performance.

Number of Objects

The greater the number of objects the longer time it takes to iterate through them. System performance is affected more by the number of objects than by geometric density per object. For example, a model consisting of one million single-point objects will perform much worse than a model with a single one million-point object.

Geometric Density

The greater the geometry per object, the heavier the model becomes. However, a single object (for example a terrain model) containing 12 million triangles can be efficiently handled by the system. Many high-geometry objects create a high load on memory, network, CPU and storage resources and thus can have a negative impact on performance.

Number of Associations

The model can either be *flat* as with a layered structure in a CAD file, i.e. with few associations and hierarchical connections, or it can be *deep* containing connections in a multi-level hierarchy. For example, Water & Sewer objects typically have associations within a manhole, and between a manhole and in- and outgoing pipes. The same applies to objects related to geotechnical surveys. The greater the number of relations between objects in the model, the more resources are required by the system to handle the model.

Number of Tasks

As with the above dimensions, the greater the number of tasks the heavier the model will be and performance will be consequently degraded. While not impacting 3D viewing, this factor nonetheless affects download/upload time, viewing in explorer, search, storage sharing etc.

Number of File Attachments

A high number of file attachments will have a negative effect upon model performance. Some tasks automatically receive an attachment when created, such as road, water & sewer, railway, tunnel and area planning. These additional files provide information which the tools require to perform their respective tasks.

Network Complexity

Functionality added in 2018 allows the underlying transport network topology to be represented in the model. The greater the complexity of the network the heavier the model becomes, thus affecting performance. The complexity is proportional to the number of nodes in the network.

Summary

It is the combination of all the above elements that together can have varying impacts on model performance. It is therefore difficult to define the absolute limits of the system. The availability of local resources, network capacity and server side resources also have a part to play.

In large projects it is always wise to be economical with data.

Methods for Reducing Model Size

The table below specifies some techniques for keeping model size as low as possible for optimal workflow.

Method	Effect on system
<p>Mapping data: Avoid importing unfiltered vector-based mapping data with thousands of objects. E.g. use a separate project to build up a model of existing situation, and import the result to your design model.</p> <p>Note this is general advice, otherwise see more specific actions further down this list.</p>	<p>Minimizing the number of objects in the model.</p>
<p>Ground surface model from contour lines: Generate ground surface models outside of the model and import the result, but not the contour lines.</p> <p>For example: Import SOSI contour lines into a local Quadri model; Create the ground surface model; Import only the ground surface into the model to be shared.</p> <p>Step-by-step method:</p> <ol style="list-style-type: none"> 1. Establish a single-user model and import the SOSI files containing the objects to be 	<p>Fewer objects in the model-- through keeping the SOSI contour lines outside.</p> <p>Contour lines can be manifold and computationally heavy to process, and do not always lend much to design tasks. The number of objects in the model can be reduced by omitting them.</p>

<p>used as the calculation basis for the ground surface.</p> <ol style="list-style-type: none"> 2. Draw the boundary lines of the areas in question in AutoCAD. Import these into the model as “boundary lines” such that the terrain surface is divided into smaller sections. 3. Create a Ground Surface task and use the outer boundary limits from point 2 above. 4. In the Trimble Quadri Model, select Import and choose the Quadri model created in point 1. Open Choose objects and choose the Ground Surface task created in point 2. 5. The actual import task can be deleted, however the result object-- the ground surface, should be retained. <p>The Import task cannot be recalculated within the Quadri model to which they have been imported. From the task properties it is possible to observe that they do not have input-data objects. Any changes have to be made in the single-user model created and consequently re-imported.</p>	
<p>3D Buildings based on Norwegian SOSI-Buildings:</p> <p>Use the same techniques as in the point above: Create a single-user model and import SOSI files. Use Roof Surface and 3D Buildings (extend the profile to the outer walls as result data, as described in the course material).</p> <p>Import the result to the Quari model, do not include other building information.</p>	<p>Fewer objects in the model (through omitting SOSI building objects).</p>
<p>WMS and Orthophoto:</p> <p>Use WMS or orthophoto as backgrounds instead of vector-based mapping data.</p>	<p>Fewer objects in the model.</p>
<p>Divide into smaller ground surface sections:</p> <p>The way in which ground surface section(s) are built up has consequences for calculation speed. Novapoint handles a seamless patchwork of ground surface sections which together comprise the terrain model.</p> <p>Avoid triangulation of an excessively large surface e.g. 45 million points from a laser scan, or contour lines (e.g. from an entire municipality).</p>	<p>The calculation basis is limited and therefore the performance of calculation is improved.</p>

<p>It would be better to divide the terrain into sections, intersecting-areas or “areas of interest”. In this way there is no need to include more items than necessary in the calculation basis.</p> <p>Create a boundary line for the various sub-sections as shown in the example on the right in which the road path is divided into sections.</p> <p>Thus it is best not to choose all ground surface objects as the calculation basis, but rather the areas of interest (the task result) affected.</p>	
<p>Limiting the area to import: Novapoint allows limiting the area to import. This can be done after objects have been converted and be done through Dynamic query-- Area. This functionality has the following limitations:</p> <ul style="list-style-type: none"> • Any possible topology and associations will be invalidated; • Geometry intersecting the boundary lines will not be cut, the entire object will be imported; • Surfaces that have insertion points within the imported area will be imported; those outside the area will not. <p>Due to the above limitations, it is recommended to divide the areas in advance such that the SOSI files are already sectioned before import. Buildings and contour lines in particular can be resource-consuming, thus it is wise to minimize import of areas containing these objects. For example import only the buildings in the area of interest and use orthophoto/WMS for visualizing buildings otherwise.</p>	<p>Fewer objects in the model.</p> 
<p>Detailed design data: Avoid importing all information from designed buildings, bridge construction, barriers etc. that can be highly detailed.</p> <p>Import only data that is critical for collaboration between the different disciplines, and can possibly cause geometric clashes and significant costs during the building phase.</p> <p>The import task retains information about the layer that was imported last, and it is straightforward to make adjustments to what is</p>	<p>Fewer objects and details in the model.</p> 

<p>imported. Start with importing a little in the beginning.</p>	
<p>Choose a selection as specific as possible: It can be tempting to choose a calculation basis for a task that includes everything (i.e. the entire model). This can lead to errors in the result model and reduce performance of the calculation.</p> <p>This also applies to presentations-- plan, 3D and cross sections. It is not advisable to include more in the selection that is of interest.</p> <p>In particular choosing the whole model as the basis for short sections in larger models will not be effective.</p>	<p>Faster calculation and presentations.</p> <p>For presentations this means faster uploads and navigation.</p>
<p>Choose efficient drawing rules: The presentation setup can have a significant effect on system performance. Changing to a simpler drawing rule can be the solution if navigation is slow.</p>	<p>Faster navigation.</p>
<p>Seek expert advice regarding terrain modelling: It is recommended that work with the existing situation for large models is done by professional companies specializing in Geomatics. These experts will take into account the advice in the above list.</p>	<p>Establishment of terrain model with a minimum of information, but nonetheless preserving the necessary precision and level of detail.</p>



Advanced Methods

Dividing the project into sub-projects

One Quadri model may contain several projects. The projects share features along with a common feature catalogue and coordinate reference system, but each project has its separate process information. Thus far this approach has not been suggested as long as each project has its own contract with associated requirements for specific access control.

If a given large project can be divided into meaningful geographical areas, with well-defined borders then this technique can be applied-- with support from Trimble. All users will have access to all sub-projects, though would typically work with one sub-project at a time.

To view an entire section, download one workset per sub-project into the same binder in Quadri Desktop. This will allow the entire model to be viewed.

The challenge with this approach is that process information cannot be shared between projects and sub-projects, even when belonging to the same model. The subdivision of a large project into manageable sections is fundamental to successful infrastructure design projects with Quadri.

Engineering domain model for one or more disciplines

The Quadri model can be used as the collaboration platform within which all information from all disciplines can be gathered.

The challenge can be when the model becomes large. In this case the Quadri model can also be used as the discipline model for one or a limited number of disciplines. The data is thus sent to "another place" for collaboration.

System Requirements

Working with large models places demands on computing resources such as local disk storage, RAM, CPU, network bandwidth and graphics card.

Trimble updates system requirements for Novapoint and Quadri on a regular basis and these can be found on the respective user support web pages here:

http://help.novapoint.com/doku.php?id=en:np:miscellaneous:system_requirements:start

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