



# Complex Spatial Data Visualization in AIMS: An Implementation for a Telco Giant

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Australia's biggest Telco has implemented a huge Autodesk® Infrastructure Map Server solution. It is "huge" not so much in the number of users, but around the quantities and complexities of their data. Join me for a walkthrough of this journey from design to implementation as we discuss many of the issues that we faced and explain how we resolved them. We cover some key decisions about architecture, data, user interface, customizations, and much more. Finally, we look at how some cool features offered by Google® have been integrated into the AIMS solution. This high-level presentation is appropriate for anyone who is interested.

## Learning Objectives

At the end of this class, you will be able to:

- Bring various spatial data into AIMS
- Configure the display of data in AIMS
- Bring externally supplied data, such as like Google and Bing® maps, into AIMS
- Apply some AIMS tuning techniques for better performance

## About the Speaker

I have worked in the IT industry for almost 20 years now, the last 8 of which have been with the Consulting arm of Autodesk Australia in Melbourne. In this time I've been instrumental in delivering a number of enterprise level solutions built on Autodesk software, with a variety of products including AutoCAD, Inventor, Mapguide and Topobase. Our target clients have generally been utilities, with an emphasis on Australia's largest - Telstra, the main Telco provider for the country. We achieved Australia's first implementation of Topobase at a Water Utility on the Australian east coast, which has included a large number custom enhancements provided by my team. Given the compact size of our group I wear many 'Role Hats' including Project Manager, Business Analyst, Test Analyst and on very rare occasions Coder. In all my years in IT, I can honestly say that I've found Autodesk the most exciting company I've worked with.

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## Introduction

I just want to start off by being clear that this is not a technical presentation. It's more of a journey for an implementation of Autodesk Infrastructure Map Server (AIMS) [aka: MapGuide] for our biggest Telco customer. That being said the learning objectives are slightly misleading because I don't intend to walk through in detail of 'First click this button, then select that option...' to set up your AIMS solution. Rather I will talk about our implementation and some of the hurdles we faced and overcame. I'll discuss customisations we have built as well as integrations with other systems and services. So now that I've set the scene, let's get started...

## A bit about the Customer

In Australia, all I'd have to do is say 'Australia's biggest Telecommunications Company' and everyone knows you're talking about Telstra. However around the world, this is probably not as well known. So to give you an idea of the size, previously Telstra was government owned and the *only* Telco provider for the whole of Australia. We aren't a big country population-wise (approx. 25 million people), but geographically speaking we're huge. I just did a quick comparison on Google maps and found Australia to be close to the same land mass as USA. The largest cities in Australia run along the Eastern coast of the country but the population is spread far and wide. Telstra did, and pretty much still does own all of the copper network servicing the country. They are also the biggest provider of Mobile Phone networks and are generally known to have the best coverage across the country, reaching 99% of the population, showing their dedication to their rural customers.

## And a bit about Autodesk Consulting

Autodesk is predominantly a sales company, however there is a little known division that I belong to called Autodesk Consulting. Many of the products in the Autodesk line-up allow for customisations with a rich API interface. We also have products that are highly configurable, allowing our customers to literally tailor a products behaviour to their own internal business processes. This is exactly the sort of work Autodesk Consulting does for our larger Enterprise customers. We analyse our customers requirements, define a solution and then configure, build & integrate that solution. Finally we assist in adoption to ensure a positive take-up of the new technology.

## **Telstra needed a web based GIS system**

Telstra is a company made up of many business divisions, with their own separate responsibilities. This in turn creates a multitude of systems and applications to manage their data. They recognized that it was difficult for employees to find the answers they were looking for with regards to mobile and landline network queries. The solution could not be found in one place and often it was required that specialist staff draw data from various sources together into a desktop application to view the data layered on top of each other to assist with these queries. To add to this was the cost associated with these desktop applications to do fairly straight-forward data visualization.

Telstra knew that they wanted a web based solution to bring all of this data together, so that there was a single point of truth that employees could turn to to do their network investigations. This type of application was seen as potentially a great asset to 'Front Of House' staff taking calls around network related issues.

## **AIMS fits the bill**

The Autodesk Consulting team were invited to demonstrate the functionality that the AIMS product had to offer. It was no secret that Telstra had been seriously considering Google as a possible solution, but were hesitant about releasing their highly confidential data to the cloud. The AIMS product supports external base map services from Google, Bing and Yahoo giving users that familiarity of map usage they get on their home computer. It also is a solution that is built on Telstra's own infrastructure, allowing Telstra to maintain control over their data. Some of the other 'out-of-box' selling points that AIMS offered was the support for multiple browsers, being IE, Firefox, Chrome and Safari. This isn't a huge deal for Telstra as their only supported browser is IE, however the fact that no browser plugin is required is a benefit because the installation of software to heavily locked down PC's is not an easy task to accomplish. AIMS also supports a multitude of spatial data formats through FDO connectors. Some of these connectors come with the product and are owned by Autodesk, however the majority are freely available from the Open Source community. Initially the intended audience of the solution was to number around 100 people, however Telstra foresaw that this number could easily grow. The Consulting team were able to highlight reasonably straight-forward scalable architecture that allowed Telstra to simply add more web servers as demand grew for the system. And finally, the business unit intending to set up the new system were quite familiar with the data they intended to publish. They were looking for a solution that would easily allow them to define how

the data should look and act, without requiring an IT team to do the translation for them. A few quick demonstrations of MapGuide Studio was all it took to highlight the simplicity of configuring AIMS.

## Some more requirements from Telstra

Apart from what I've already mentioned, let's run through a few more requirements that Telstra had for their new AIMS solution.

As I said earlier, Telstra has a vast number of applications managing their data. In some cases we had geospatial data in one system and the attribute information in another. These two pieces of information needed to be brought together joined into the one object.

The business also had occasions where the same data needed to be viewed different ways. Where the attribute data would need to drive how the object was displayed or even filtered out. For example, in a mobile network coverage map, a polygon might show how much coverage there is over a particular area, whereas in a slightly different map configuration the same polygon might show how many people would be affected if a mobile tower went out.

Even within the various business units at Telstra, data can be sensitive. Hence Telstra wanted the ability to control who sees what. Effectively they wanted to assign security to the solution to ensure only the correct data was made visible to right the people.

A number of the more technical users within the business unit wanted the ability to load their own spatial data into the web application, simply to overlay it with existing data. These one-off data loads were to be done with only recognized spatial formats that may have been sourced either internally or externally.

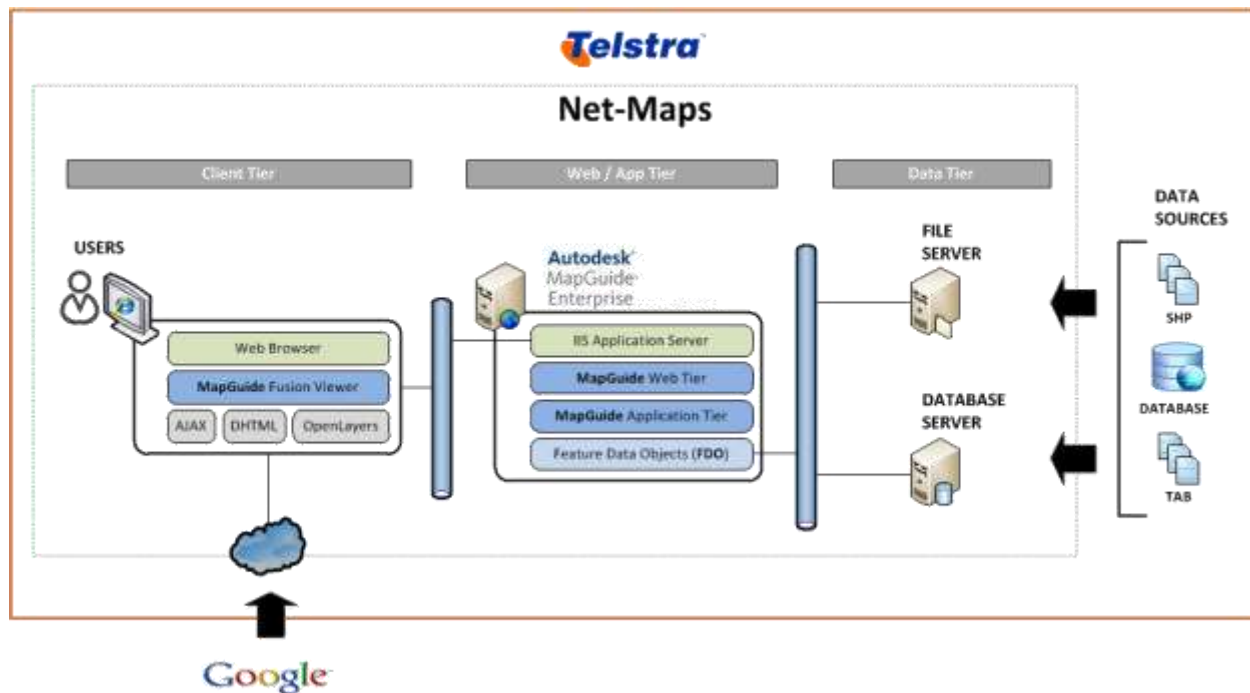
Telstra are also familiar with the Google Earth experience and were wanting the option of a similar experience for some of their data. Essentially mobile coverage maps draped over a contoured landscape would make it easier to see the reason for poor coverage caused by hills and valleys.

And finally the ability to search for network objects needed to be a simple process, whereby a user could say *'I need to find tower ABC'*.

There were actually a lot more requirements than what I've covered here. In fact there's a hefty 30 odd pages of requirements. However the ones above provide a good idea to what was eventually implemented.

## NetMaps is Born

Yes, NetMaps is the name given to the application we built. First off, let's have a look at the architecture...



We'll start from the right and then work our way to the left. We have a multitude of systems and data formats feeding into the NetMaps application for visualization. You can see in the diagram that we decided to create a data tier in which to store all of the incoming data. Now one of the fundamental highlights of AIMS is its ability to read data directly from a variety of source systems, so why create this data warehouse? Well we found that we occasionally needed to make changes to the data to make it readable by AIMS or more efficient for searching. Plus reading directly from another application has impact to that application. The different business units within Telstra that owned the data were no too happy about random data hits, or making changes to their data. Instead it was much easier to have a controlled, well documented interface between NetMaps and the feeding application that effectively produces a data replication we can then work with. A large portion of the data is sourced from Oracle-based systems and hence is replicated into the NetMaps Oracle database. The file based data quite often goes straight to the NetMaps fileserver, or on occasion is loaded into the database.

The middle tier is an Web or Application server on which AIMS resides. It reads from both the file and database server as its only data source. This server is also the key to NetMaps scalability. Should the user-base of the system grow significantly, then another server can be added, as a duplicate of this one. In Telstra, this has already happened and both web servers

sit behind a Load Balancer that distributes the incoming requests. The MapGuide Studio desktop application also directly accesses this server to allow for all the configuration changes. Note that whenever AIMS configuration changes are made, they must be applied to all Web servers. Fortunately AIMS provides an export/import utility so that this is not a manual process.

And finally on the client tier we have the web browser, which in Telstra's case is IE8. AIMS serves up the maps and data in a very efficient way such that most of the hard work is done by the server and the database and hence doesn't impact the network. In Telstra's implementation they are using Google base maps and hence the client machines must have access to the internet to draw on Google's services.

### Data Issues

With Telstra having data stored in various applications, it became apparent that quite often the geometry data had attribute information stored in a different system. These pieces of information needed to be brought together and made available to the users. AIMS does allow you to create these sorts of data joins, however we quickly found that it wasn't very efficient at doing these joins. So our solution was to load the two different data sources into our Oracle database. Then within the database we created views that joined the two or more tables together and allowed AIMS to see that view. Oracle is far more efficient at joining data in this way.

AIMS being a viewing application, the quality of the output is only as good as the data being fed in. And in Telstra's case, some of the data quality was not that great. By far the largest quantity of data comes from displaying their copper network. The source data is stored in text based files and we needed to write custom code to read it into our database, which was no easy task. To give you an example, every node or point type object was not stored as a point in the text file, it was represented as a series of lines. In the case of pit, which was represented as a circle on the screen, this was made up of 32 straight lines forming that circle. It looks like a perfect circle on the map, however it takes up a heap of data to make it. Fortunately Oracle's spatial indexes handle this very well, so the system still performs quite well. Other instances of poor data was evident in some of Telstra's spatial files, whereby polygons were not readable by FDO connectors. It seemed that the source application that created or maintained these files had no issue with the files, however the FDO connectors utilized by AIMS did. Once again some custom code was written to check for known issues, like too many vertices in a polygon or too many spatial objects in a file. Logging was produced to highlight the issues as well as conversion into SQLite format which that particular FDO connector had no issue with. And one final data quality issue was the occurrence of several tables in oracle with so many columns in them, that AIMS would error on trying to display attributes. So we had to work with the business

to try and weed out what was truly valuable for viewing and cut out the rest. Once we determined that, we simply created an Oracle view of the subset of columns and allowed AIMS to see that instead.

And one last data issue we had to work around. There was certain 'Mobile Network Coverage' polygonal data that Telstra had gathered which was to be displayed in both Metro and Country areas. Within the metro areas the polygons are small and numerous, whereas in country they are considerably larger and few and far between. To see the large polygons effectively, you need to be zoomed out a fair way. The issue here is that rendering the small polygons at this zoomed-out threshold is a considerable task for AIMS. It works very hard to render a heap of vertices that are not visible to the eye at distance. To make the spatial data less intensive to Render, we recommended creating a duplicate set of the data and running smoothing routines over the top of it. This essentially reduces the number of vertices in a polygon. The equations to do this smoothing can be readily found and there are a number of parameters that drive the level of smoothing. We were then able to have the intense data made available at the lower thresholds required for the Metro areas, and the smoothed data for higher zoom levels required in the Country.

### **Performance Issues**

I previously touched on how AIMS will render whatever data you provide it. It does not do any dumbing down of the spatial data the more you zoom out. As an Administrator you have complete control of what data can be seen at what zoom level. This was a concept that took a bit of getting used to at Telstra, where they had several datasets they wanted viewable at quite a high threshold. Even with restricting this data to certain user groups, the damage was done because we initially only had the one AIMS server. This meant that if one user requested the data, then the AIMS server would start churning away to render it for that user and effectively impact the performance of every other user on the system. So, the moral is, be very careful on how you theme your data. We made sure Telstra had a 'Sandbox' environment set up to test out their theming requirements before pushing them live.

Telstra being the typical large enterprise, it is difficult to say to them, just use the latest browser, or switch from IE to Chrome. They have a Standard Operating Environment that is difficult to bypass. The reason I'm touching on this is that the choice of Web Browser makes a difference to how AIMS performs. Telstra is on Microsofts Internet Explorer 8 and we've found that this is probably the worst performing out of all the major browsers. If you have a choice, Chrome or Firefox performs a lot better. Note that even IE9 shows significant improvements on IE8, but alas we were stuck on IE8 at Telstra.

So once again, custom code came to the rescue. We found that with Telstra's requirements they needed to have a large number of layers available the various user groups for viewing. These layers are controlled through a 'Legend Panel' and definitely this Legend performed quite poorly under IE8. AIMS creates the Legend icons on the fly as users zoom in and out of the Map. We found that by pre-creating all of the icons on a nightly basis, it alleviated much of the heavy lifting AIMS tried to do on the fly. The downside here is that you can't simply configure changes and have the Legend automatically updated.

And one last performance tip for IE8 was around using Google Base Maps. IE struggled with rendering the maps provided by Google and resulted in a very blocky, bit-by-bit display. As I mentioned before, other browsers like Chrome and Firefox handled this a lot better. So the solution was to put a browser within a browser. We used the 'Chrome Frame plugin' within IE and the whole user experience was immediately improved.

### Customisations

Much of the data being supplied to Telstra was sensitive and thus only to be provided to certain user groups. We enhanced AIMS to use windows authentications for anyone accessing the NetMaps URL. Anyone with NetMaps access had to belong to windows group that determined their access. Then within AIMS we simply created a Map for each Windows group, ensuring only the correct layers were configured and made available on that map.

AIMS does allow you to pretty much find and navigate to any themed item using a generic query form. Telstra found the form to be a little clumsy and also required the user to have an intimate knowledge of the underlying attribute data. Also, given some of the data quantities, a badly formed query could wreak havoc on the AIMS server. So we built them some custom search forms. Essentially they provided us with the exact types of Landline & Mobile network queries they wanted to run and we constructed the forms and appropriately indexed the data.

There are a couple of groups within Telstra who source their own spatial data and want to overlay it on existing Telstra data. Out of the box, AIMS does not allow you to do this. So we created custom functionality for users to load a variety of pre-defined spatial file formats that lasted for the duration of their session.

Telstra know that their data is not perfect and seized on the opportunity to use NetMaps as a data error reporting tool. We built some custom code that allows any user to pinpoint a data error for further investigation by an assigned team. This form captured the offending layer, as well as user comments outlining the perceived problem.



## Google Integrations

Out of the box, AIMS supports Google Base Maps, which includes satellite imagery too. But we've taken NetMaps that one step further and custom built in a bunch of other Google services.

Google Search is a powerful tool and especially useful for fuzzy address searching. So we built in a custom form that called this service, allowing the user to click on one of the results returned, which then takes them to the correct address location on the map.

Telstra also wanted Google Streetview to be incorporated, so we built in a right-click menu function that calls the service, providing the lat-lon coordinates of where the user right-clicked. This opened up a window in which the street view imagery was displayed for navigation. Telstra found that in most cases the Google data was sufficient for the user to see Network Towers which was the key focus of this function.

And the final one is a biggy. We incorporated the Google Earth plugin to NetMaps that allows the user to toggle between a 2D and 3D view, with the 2D being all AIMS and the 3D the plugin. The Telstra data is served up to the plugin via WMS from AIMS, which essentially drapes the network imagery over the top of the Google terrain data. Certain user groups require this additional view to help troubleshoot mobile network coverage issues due to the landscape.

## And in conclusion

Here are some words from Telstra themselves on the value of the NetMaps application...

Paul Roberts, Network Manager QLD, Networks & Access Technologies is responsible for the performance of the Next G® network in Qld country and his team have used NetMaps to speed up their decision making process. During the 2011 natural disasters in Queensland, Paul's team used NetMaps:

"During Cyclone Yasi we used the NetMaps tool extensively to give us a view of sites that were out of service in the cyclone affected regions" said Paul. "We could see which areas were impacted, which areas still had coverage, and based on this information we decided which mobile sites to restore first to give the fastest, and therefore maximising the benefit to our customers."

“Following the Brisbane floods, NetMaps helped us deploy the COW (cell on wheels) mobile base station at the Murphy’s Creek Disaster Management Centre in record time, ensuring telecommunications were restored for our customers” continued Paul.

As well as wireless engineers, this tool will be used by a variety of people in the company including operational Service Centres, field service technicians, planners and project managers. By presenting information from a variety of systems in a simple format, NetMaps makes it easier for our people to provide great customer experience.