Solutions for Enabling Lifetime Customer Relationships

Pitney Bowes Software

Focusing in on Spatial Precision

Options and implications for improving the precision of your data

WHITE PAPER:

PITNEY BOWES SOFTWARE TECHNOLOGY

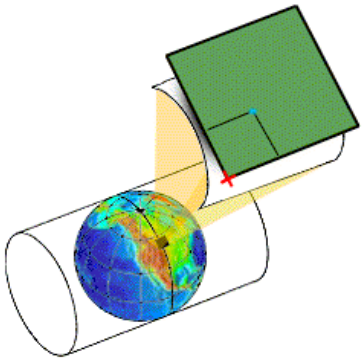
Focusing in on Spatial Precision

Options and implications for improving the precision of your data

ABSTRACT

THE ADVANCES OF SPATIAL TECHNOLOGY IN RECENT TIMES HAVE BEEN IMPRESSIVE. EQUALLY IMPRESSIVE ARE THE GROWING NUMBER OF STORIES ACROSS MANY INDUSTRIES OF WHERE SPATIAL TECHNOLOGY HAS DELIVERED SIGNIFICANT EFFICIENCY GAINS AND DRIVEN BUSINESS TO NEW LEVELS. YOU WOULD BE FORGIVEN BY ASSUMING THAT THE FOUNDATIONS WITH WHICH ALL OF THIS NEW FOUND SPATIAL POWER WERE SAFE AND SOUND. IN GENERAL THEY ARE, BUT MANY USERS MAY NOT HAVE AN APPRECIATION OF HOW SPATIAL DATA IS STORED AND WHAT THE RAMIFICATIONS ARE IF SPATIAL DATA IS STORED INCORRECTLY. IN THIS PAPER WE WILL EXPLORE HOW TO TUNE YOUR MAPINFO PRODUCTS TO GET THE BEST SPATIAL PRECISION TO MEET YOUR BUSINESS NEEDS.

THE MOST BASIC COMPONENT OF ANY SPATIAL SYSTEM (GIS) IS THE SPATIAL DATA THAT DEFINES THE MAP FEATURES. THIS SPATIAL DATA COULD NOT EXIST WITHOUT THE COORDINATE SYSTEMS THAT ARE USED TO SPECIFY THE LOCATION INFORMATION. COORDINATE PRECISION IS A MEASURE OF STORING SPATIAL DATA AS PRECISELY AS POSSIBLE. OF COURSE, THIS CAN BE NO MORE PRECISE THAN THE ORIGINAL DATA PROVIDED. PRECISION IS A MEASUREMENT OF HOW ACCURATELY YOU CAN STORE AND RETRIEVE THE SPATIAL DATA AND HAS NOTHING TO DO WITH THE QUALITY OF THE DATA. THE NUMBER OF RELIABLE DIGITS IN YOUR COORDINATE IS TERMED SIGNIFICANT DIGITS. PRECISION IS MEASURED IN TERMS OF THESE SIGNIFICANT DIGITS.

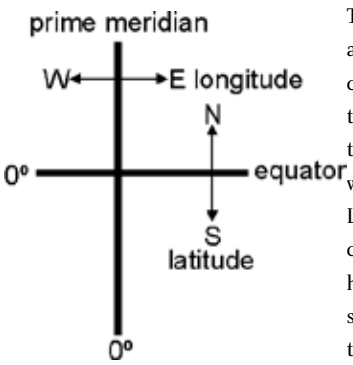


THE KEY TO ESTABLISHING THE CORRECT SPATIAL PRECISION FOR YOUR REQUIREMENTS IS PLANNING.

Gaining superior map precision

One question that is raised again and again is "How can I obtain a higher level of precision from MapInfo Professional?". This question is usually followed by, "Why not use 64bit data precision like some other systems?". To answer these questions, it is first necessary to understand how MapInfo software stores spatial data.

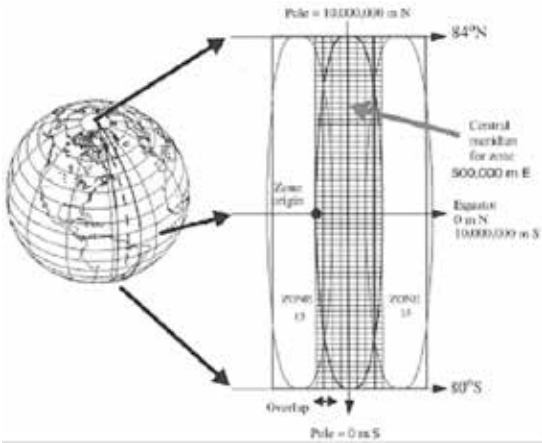
You would think it was just a case of writing out numbers such as 153.34125 and -26.21435 to a file. This method would work but it would be very inefficient and slow. What MapInfo Professional does is store all data written to file in single-precision 32 bit integers. A 32bit integer is able to hold a whole number from 0 to well over 2 billion. When a table is read back in, MapInfo Professional converts this integer data back into its real world coordinates and stores it in memory as 64 bit floating point numbers. This may sound like a lot of work but it is in fact how most systems that deal with large numbers work.



The precision is affected by what coordinate system the data is read in to. For example, when using Latitude/Longitude coordinates, you have to be able to store numbers in the range of -180 to +180 and from -90 to +90. This means the largest number we need is 360. Actually, for mathematical reasons, the range -1000 to +1000 is used, which makes 2000 the largest number. If you then divide this range by the 2 billion possible from the 32bit integer, you get 0.000001 of a degree (about 100 millimetres).

The point to remember here is that this is the default world coordinate system. As will be explained below, MapInfo Professional has a method by which you can improve this level of precision. Very few applications of GIS ever need the entire World down to sub millimetre accuracy. Typically, GIS users work within a much smaller area such as a state, local government area or even a single town. We refer to this as "bounded coordinates".

Without the User realising it, all MapInfo spatial data layers are bounded. As we saw above, the default World projection is bounded by +/- 1000. This is called "implicit bounding" as there is no mention of the coordinate range. All projections have implicit bounding.



Take the Mapping Grid of Australia: MGA (a UTM projection which is commonly used in Australia). It is a 6 degree wide band that wraps around the world. When you select the projection from a dialog, you select a particular zone (eg a 6 degree band) for either the northern or southern hemisphere. The bounds here are 10,000,000m to the north (the Equator) and 0m at the 80 degrees south latitude. The projection is also 1,000,000 metres wide with a centre at 500,000m.

Using the same method as above, this projection has a numerical range of 10,000,000. When divided by 2 billion the precision is 0.005 of a metre (half a centimetre).

Focusing in on Spatial Precision

Options and implications for improving the precision of your data

BACKGROUND

To obtain higher precision, MapInfo Professional also supports "explicit bounding" where the user can manually specify the coordinate bounds. You get a glimpse of this when you create a Non-Earth table where you are prompted to specify the minimum and maximum coordinate extents. You can also use "explicit bounding" to modify any of the standard projections. When you do this you specify a smaller range for your coordinates. The smaller the range, the higher the precision. For example,

- Brisbane, Australia is bounded by the UTM coordinates 7,000,000 (North), 6,930,000 (South), 470,000 (West) and 530,000 (East). The maximum range here is 70,000m. Divide this by 2 billion and you get 0.000035 of a metre accuracy. This is 0.035 of a millimetre accuracy. Applying bounds in a similar manner to cover all of Australia equates to approximately 2.5 millimetres of precision.

- Japan is bounded by the coordinates 24˚ (North), 46˚ (South), 122˚ (West), 146˚ (East). The approximate precision then available to a user, assuming JGD2000 is used as the datum, is 1 millimetre.

You can use explicit bounding whenever you want to store spatial data to a higher level of accuracy. However, you can't add bounds to an existing layer and expect the data to become more accurate. The same coordinate will be there after you add the Bounds. Only when you add new data or edit existing data will you be able to utilise the higher precision.

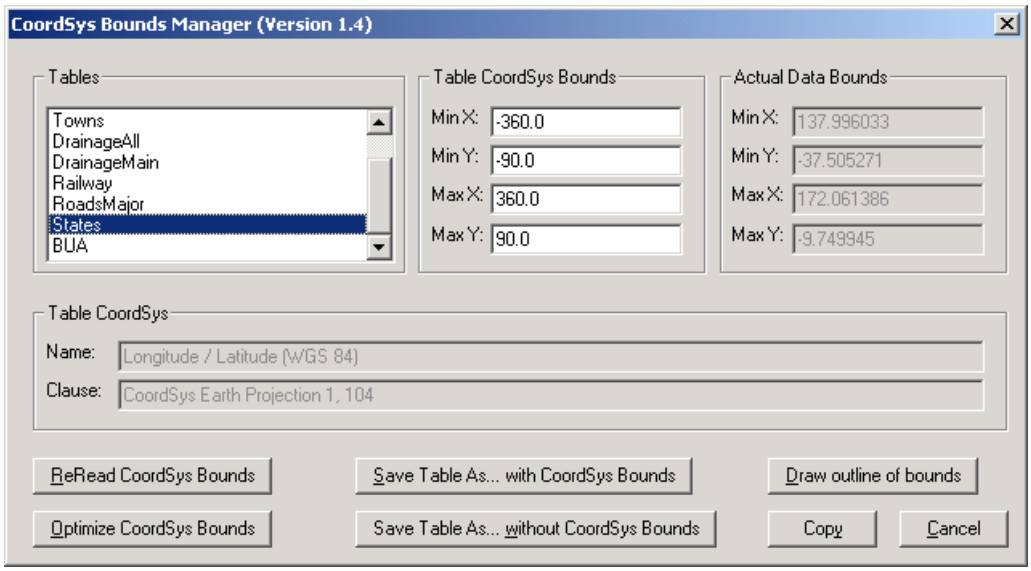
LETS GO THROUGH THE PROCESS

So, how do you create a table with explicit bounding? The first thing you need to do is determine the coordinate range that meets your requirements. Remember that once bounds are set for a layer, that layer can't store spatial data outside the bounds. If for example you are a local government authority, you might set the layer bounds to be 10km outside your authority boundary.

Even if you set the layer bounds to be 100km larger, you would still obtain a much higher level of coordinate precision than probably what is required. If you are a state government department, you may use a Lat/Long projection with bounds set to just outside the state boundary.

Next you create your tables as normal, setting the desired projection. To apply the bounds to the table, run the MapBasic application CoordSys Bounds Manager look in the Tools menu and click on Tool Manager). This application shows a list of the currently opened layers. The selected layer's bounds are displayed as shown below.

You can manually key in bounds or use the Optimise CoordSys Bound button to read it from the data already



THE KEY TO ESTABLISHING THE CORRECT SPATIAL PRECISION FOR YOUR REQUIREMENTS IS PLANNING.

in the layer. Finally, you save a new copy of the table. A good approach is to create a new empty table with explicit bounds set. Then for any new tables you create, make them from a copy of this empty file (tip: use the Create New Table command).

Sometimes you may receive data from other systems in MIF/MID format. Depending on the source, this data may have more precision than can be handled by the standard implicit projection. For example, the MIF/MID file exported from another system in GDA projection may have 3 decimal places. If you just import it into MapInfo Professional you will end up with data to 2 decimal places. An alternative, enabling full precision to be retained, is to open the MIF file in any text editor and add the appropriate projection settings (including Bounds) to the header section. Then, when the data is imported, you will have 3 decimal place precision as in the original data.

32 bit versus 64 bit integers

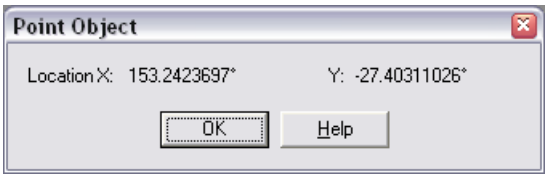
Pitney Bowes Software has chosen to use the 32bit integer for external storage instead of 64bit integer because it offers a good balance between efficiency and precision.. The use of 32bit integers for storage also means that MapInfo spatial data is stored in half the space as the equivalent 64bit data. Not only is this more efficient, it also means that data loads and displays much more quickly.

Storing data with a higher level of precision is only appropriate when the source data is supplied with a comparable level of precision. In any case, MapInfo Professional can handle higher precision data if the user desires. The users need to be fully aware of the options available and how to implement them in order to achieve the required level of precision.

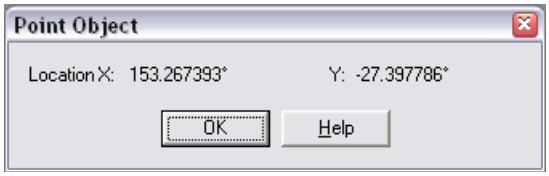
How to View Data at High Precision

As shown above, MapInfo Professional has the ability to store data at a higher precision if required. The next step is to view the coordinates. In the map (right) are two sets of points. The green points were placed into a table that has bounds set while the orange points were placed into an unbounded table. Using the Select Tool, you can double click on the points to see their coordinates. Below the map are two screenshots showing the coordinates from a point on the map. The first shows the coordinates as seen from a point in the Bounded table. The second shows the coordinates from a point in the UnBounded table. Note that the UnBounded table shows only 6 decimal places while the Bounded table shows 7 or 8 decimal places.

Next you may want to view the coordinates in a browser window. It is at this point that most users get into difficulty. This is because MapInfo Professional will always display FLOAT type fields rounded to a set number of decimal places. This unfortunately means the user doesn't get to see all of the decimal places. The way to overcome this is to use the DECIMAL type for the coordinate fields. In the Modify Table Structure dialog (on page 6) you can see how the Lat/Long fields are set to store 12 digits with 8 after the decimal place.



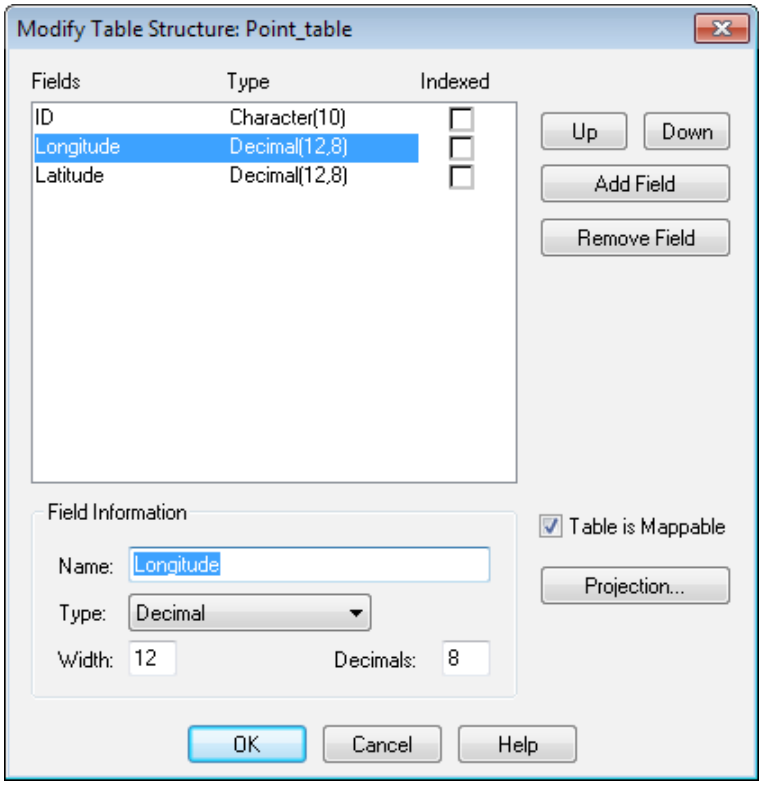
Bounded Table



UnBounded Table

Focusing in on Spatial Precision

Options and implications for improving the precision of your data



Once you have the table structure set correctly, you then need to update these fields with the coordinates from the objects. The recommended way to do this is to use the Coordinate Extractor tool that is supplied with MapInfo Professional. This tool is found in the Tool Manager (in the MapInfo Professional 'Tools' menu). As its name suggests, the Coordinate Extractor automates the updating of two columns with the coordinates of the object's centroid. When using this tool you have the option to specify the coordinate system to use. This is very important as we must use the table's native coordinate system because it is a bounded system.

Below is the browser for the Bounded table after the Coordinate Extractor has been run. Note how the coordinates use eight decimal places as they did in the example using the Select tool on the previous page.

An alternate method is to use the Table Update Column command. You can populate the coordinate fields with the CentroidX(obj) and CentroidY(obj) of the object. Unfortunately, this method also has a trap that can produce less accurate results.

ID	Longitude	Latitude
	153.24236967	-27.40311026
	153.28440897	-27.45190744
	153.33245351	-27.49981838
	153.36748609	-27.58547314

THE KEY TO ESTABLISHING THE CORRECT SPATIAL PRECISION FOR YOUR REQUIREMENTS IS PLANNING.

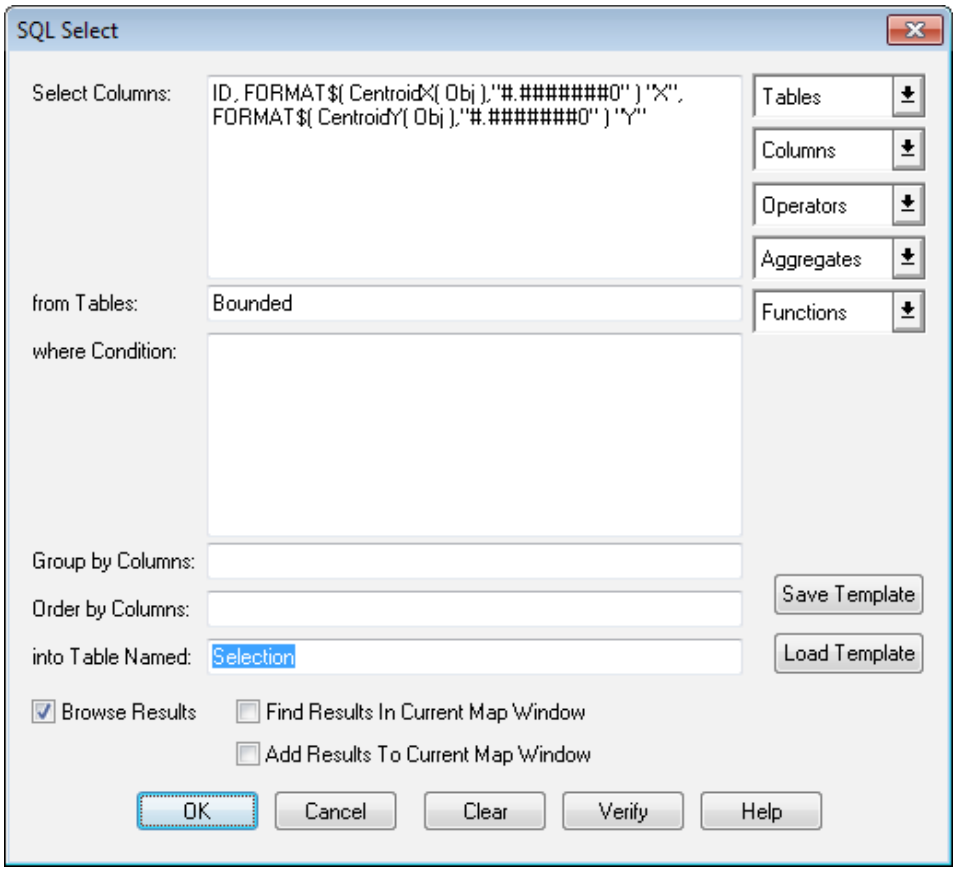
This approach uses the MapInfo Professional session projection and not the projection of the table. To retrieve the full coordinate data you must set the session projection to the projection of the table that the objects are in. This can be done from either the Options > Preferences > Map Window dialog or by typing the coordinate system clause into the MapBasic window (as shown above right). The browser window (right) shows the results of using the Update Column method without setting the projection to a coordinate system with the bounds specified.

ID	Longitude	Latitude
	153.24237000	-27.40311000
	153.28440900	-27.45190700
	153.33245400	-27.49981800
	153.36748600	-27.56547300

The zeros at the end of these values indicate that the full number of available decimal places was not used.

The final method for displaying coordinates is to do an SQL query and display the coordinates in temporary fields created in the SQL statement. Once again, you must make sure to set the session coordinate system to the bounded projection first.

Below, the SQL Select dialog box is being used to obtain coordinates.

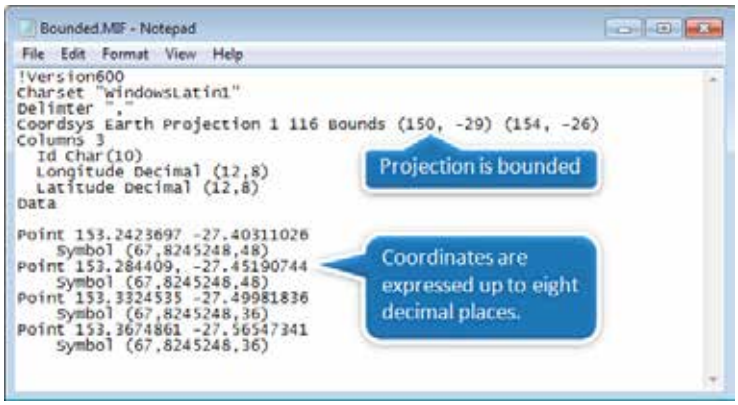


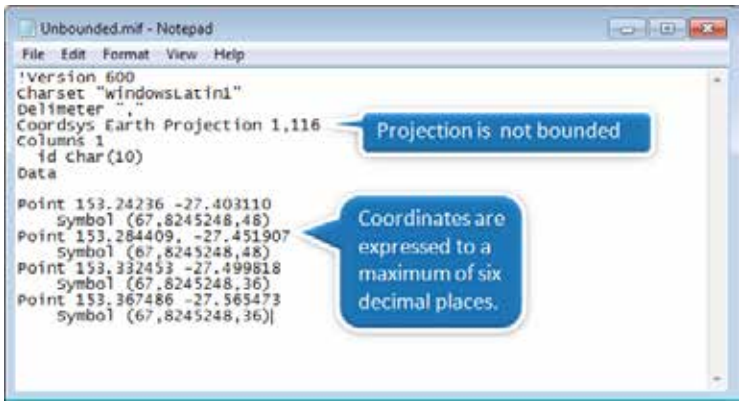
Focusing in on Spatial Precision

Options and implications for improving the precision of your data

HIGH PRECISION EXPORTING

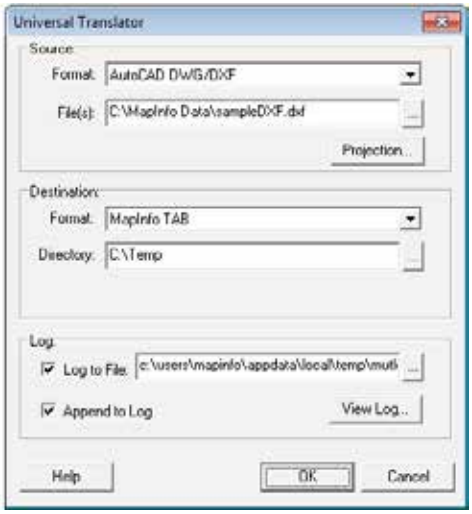
MapInfo Professional has a number of methods for exporting data to allow it to be used in other systems. Two commonly used methods are MIF/MID and Autocad DXF. The Table > Export command will maintain the accuracy of the coordinates as they are exported to MIF/MID. This is shown below with the two examples of MIF export. The first contains the Bounded table with the higher precision coordinate values. The second contains the UnBounded table with only 6 decimal places of precision.

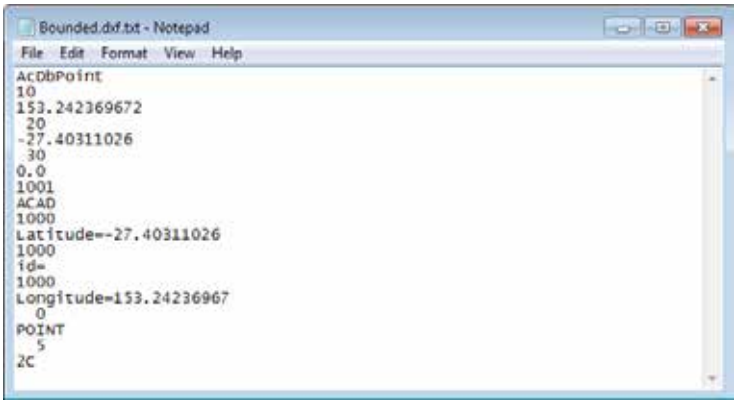




When exporting to DXF from a bounded table, you cannot use the standard Table > Export command (even if you set the session coordinate system) as this will round your data to 6 decimal places. Instead you must use the Universal Translator tool (in MapInfo Professional v11.5 or earlier versions) or the FME Quick Translator tool (first appearing in MapInfo Professional v12.0). Because this tool actually runs outside of MapInfo Professional, it obtains the coordinate system data from the table itself and not the MapInfo session coordinate system. The screen shot on the following page shows the Universal Translator and the FME Quick Translator tool. Below this is a sample of the output in Notepad. Note that the coordinates are in the higher precision.

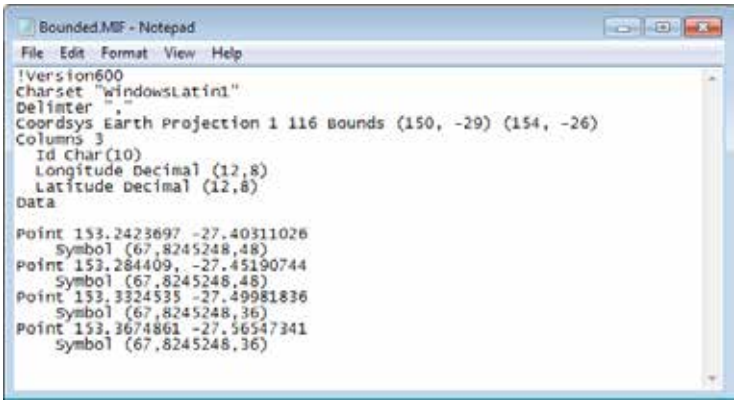
THE KEY TO ESTABLISHING THE CORRECT SPATIAL PRECISION FOR YOUR REQUIREMENTS IS PLANNING.





HIGH PRECISION IMPORTING

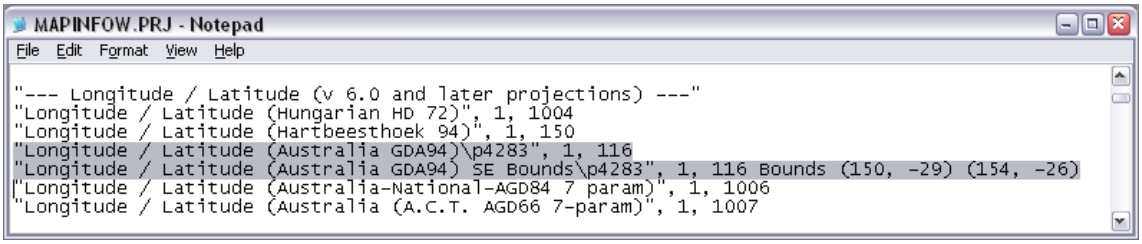
Import is similar to exporting in that MapInfo Professional handles the MIF/MID format with no problems but you



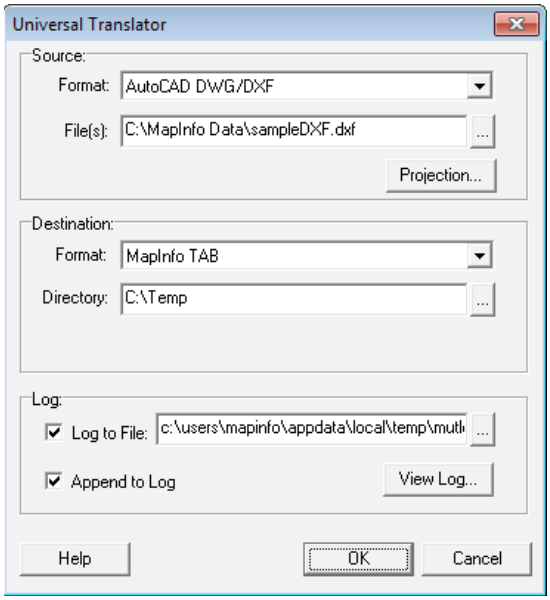
must still use the FME Quick Translator (or the MapInfo Universal Translator) for DXF. The important point on MIF/MID is that the file already contains the coordinate information in its header section.

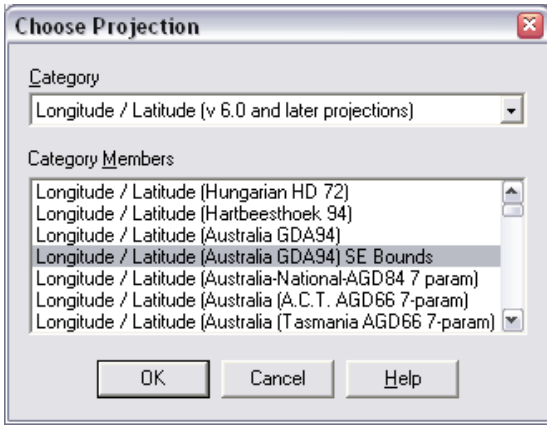
As shown in the example, the session coordinate system is specified at the top of the MIF/MID file. If your MIF/MIF file is created by a system other than MapInfo Professional and it supplies more than 6 decimal places in the coordinates, then you will need to make sure the coordinate system includes a bounds statement. If required, this can be added manually using any text editor.

When importing DXF using the Universal Translator, the user will be required to select the required projection from a standard projection picker dialog. For this reason you will need a projection with bounds on it already entered into the MapInfo Projection definition file (MAPINFOW.PRJ). The MAPINFOW.PRJ file can be found in the MapInfo application directory and it can be edited using any text editor. Below is an example of a bounded projection (GDA94) added to the MAPINFOW.PRJ file.



Below is a screen shot of the Universal Translator dialog box set to import DXF into MapInfo TAB. Note the Projection button at the bottom right of the Source section. This button displays the Choose projection dialog which now has the Bounded projection available for the user to select.





SUMMARY

Hopefully you will see there are many options to consider when exploring your spatial data precision options in the MapInfo product line. The key to establishing the correct spatial precision for your requirements is planning. With the correct planning you can identify the right steps to take to ensure your data is stored and maintained at the appropriate precision to meet your needs, now and in the future.

MORE INFORMATION

The MapInfo Professional User's Guide includes an appendix with comprehensive information on the elements of a coordinate system.

Visit go.pbinsight.com/miprodocs

"The MapInfo Professional"

Subscribe to "The MapInfo Professional" monthly journal for tips, tricks, techniques and advice on using MapInfo Professional.

http://go.pbinsight.com/miprosignup

The MapInfo Professional Monthly journal

The first edition of this white paper appeared in 2006. The current edition was revised in 2012 and 2013.

Every connection is a new opportunity™

Pitney Bowes Software

UNITED STATES

One Global View
Troy, NY 12180
1.800.327.8627

pbsoftware.sales@pb.com

INDIA

Pitney Bowes Software India Pvt. Ltd. C-28-29, 5th Floor, Tower-B, Logix Cyber Park,Sector 62, Noida, UP 201307, India

+91.120. 4026000

pbsoftware.india@pb.com

EUROPE/UNITED KINGDOM

The Smith Centre
The Fairmile
Henley-on-Thames,
Oxfordshire RG9 6AB
United Kingdom

+44.800.840.0001
+44.1491.416.600

pbsoftware.emea@pb.com

ASIA PACIFIC/AUSTRALIA

Level 7, 1 Elizabeth Plaza
North Sydney NSW 2060

+61.2.9437.6255

pbsoftware.australia@pb.com
pbsoftware.singapore@pb.com

11838_01_13

93545 EMEA 1307