Time Sync (ATU) History Graph

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1 Introduction

The Time Sync (ATU) History Graph is designed to give an advanced display of the historical time synchronisation performance of the recording devices in the IMS seismic monitoring network. It is important that clocks are synchronised between the various recording devices in the network, because unknown inter-clock differences directly and negatively impact the attainable accuracy of seismic event location, and in severe cases can even prevent the detection (association) of seismic events altogether.

2 Time Synchronisation

The IMS system synchronises device clocks by transmitting regular time synchronisation pulses to each device in the network; this mechanism of synchronisation is known as the Analogue Time Update or simply ATU. These pulses can be generated by a GPS receiver (in which case the system time will be synchronised to UTC) or by a standard serial port (a.k.a. COM port). Where local GPS receivers connected to each device are not feasible or possible (e.g. underground), ATU pulses can be distributed via a dedicated communications network, e.g. fibre optic cable, IMS DSL modems or using the Precision Time Protocol (PTP) over a switched network. IMS devices use these regular ATU pulses to resynchronise their clocks.

The interval at which the system generates ATU is configurable in Synapse, and is usually either 60 or 300 seconds (1 or 5 minutes) – IMS recommends 60 seconds. The setting is called Time Synchronisation Period, and is found under System Settings > Synapse Settings. Figure 1 shows an example of the Synapse Settings interface.

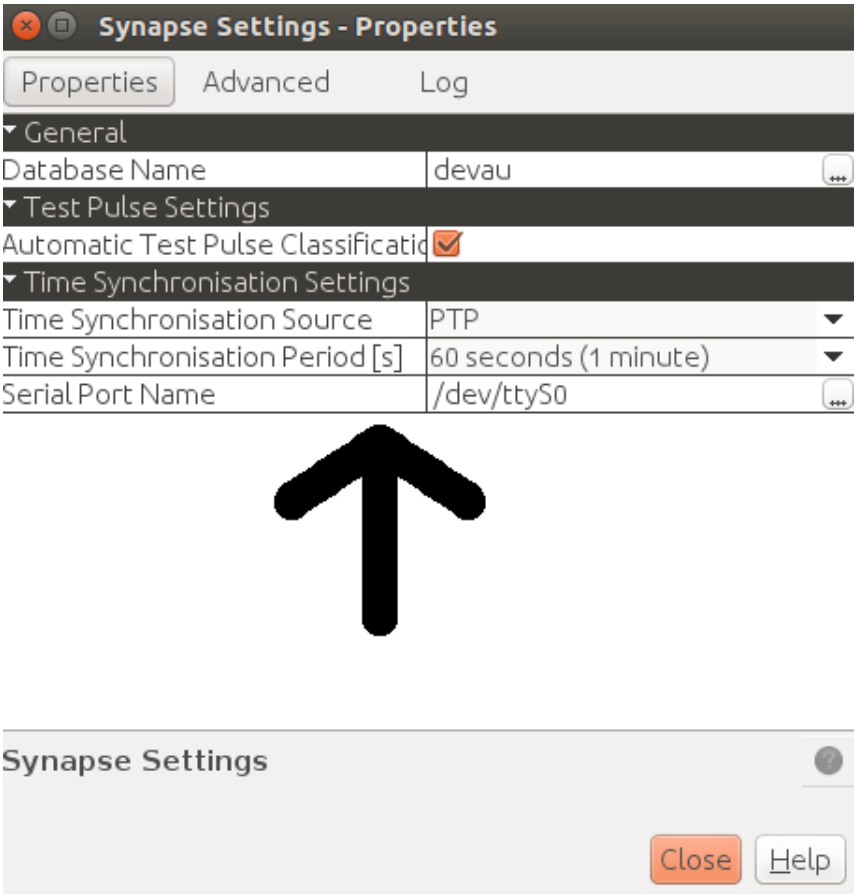

Figure 1: System Settings window.

3 How To Interpret the Graph

Once you have opened Synapse, you can view the Time Synchronisation (ATU) History Graph by selecting the icon at the top of the system viewer (figure 2).

Figure 2: System viewer toolbar.

An example of the ATU History Graph is shown in figure 3 with some of its features documented with annotations. The default view shows the time between successive ATU pulses in the last hour.

The x-axis represents local time, while the y-axis represents time between successive ATU pulses as measured by the same internal clock the device uses to time stamp seismic data.

The coloured dots located on the graph are the inter-ATU times measured by the devices over a particular time period, and are indicative of the devices' time synchronisation accuracy. Different colours represent different devices. The green line in the plot shows the Time Synchronisation (ATU) period as configured in Synapse as a reference. Dots should be close to this line, but their scatter need not be centred on this line.

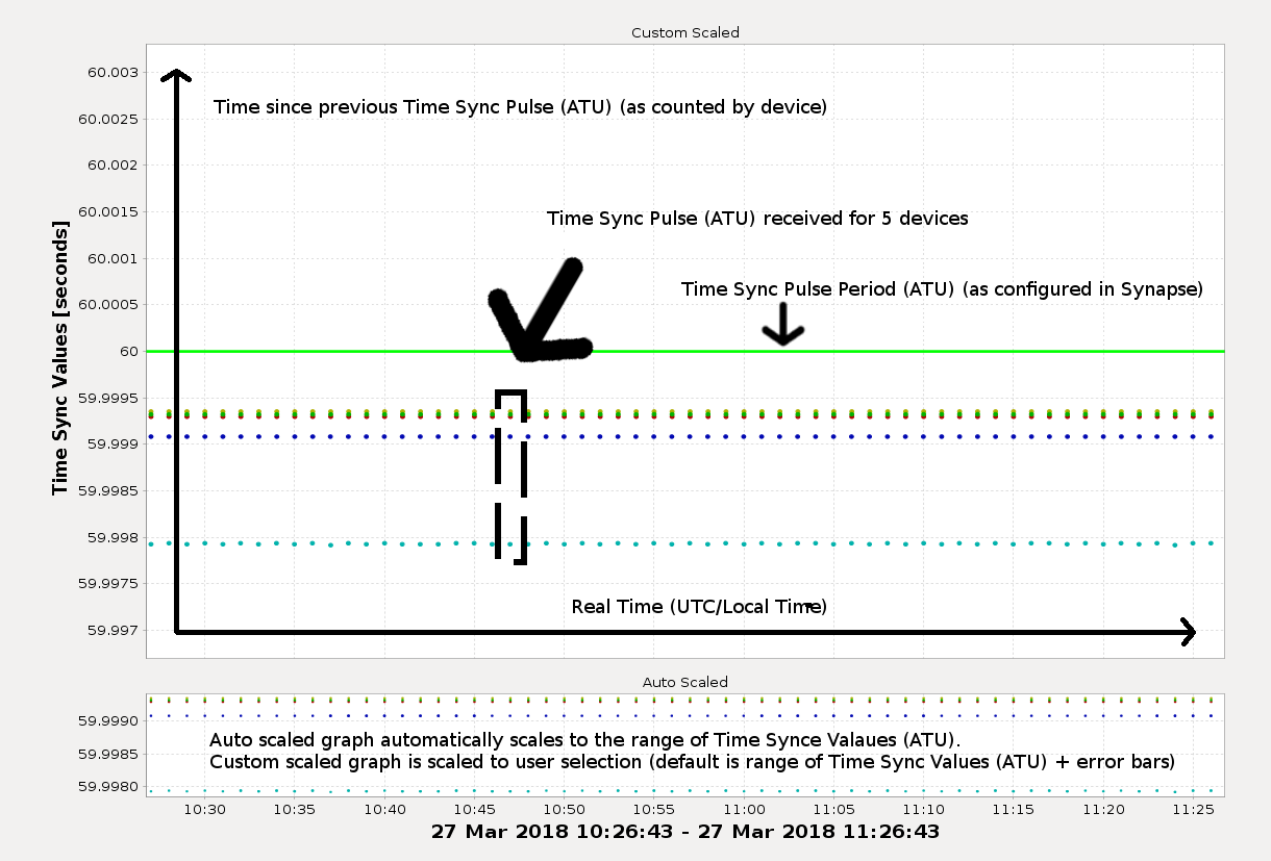

Figure 3: Time Synchronisation (ATU) History Graph with explanatory annotations.

3.1 Acceptable Time Synchronisation Performance

Some additional detail can be viewed by selecting the error bars icon located at the top of the Time Sync (ATU) History Graph window (figure 4).

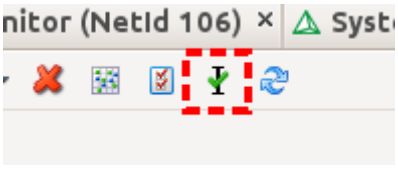

Figure 4: Error bars button.

Once enabled, the graph will display error bars located at each expected ATU pulse (refer to figure 5), i.e. every minute for a system with ATU period set to 60 seconds. The error bars will be centred on the 0'th second of every minute (for a 60 second ATU period) on the x-axis, and on the expected "true" ATU period on the y-axis. This true ATU period will simply be at the height of the green line on the y-axis for GPS/PTP enabled systems, but for non-GPS/PTP systems this will not necessarily be the green line (although it should be close to it), and it will likely be different for each ATU. How the true ATU period is estimated for non-GPS/PTP systems is beyond the scope of this document. Error bars for GS devices are shown as grey while black is used for netADCs.

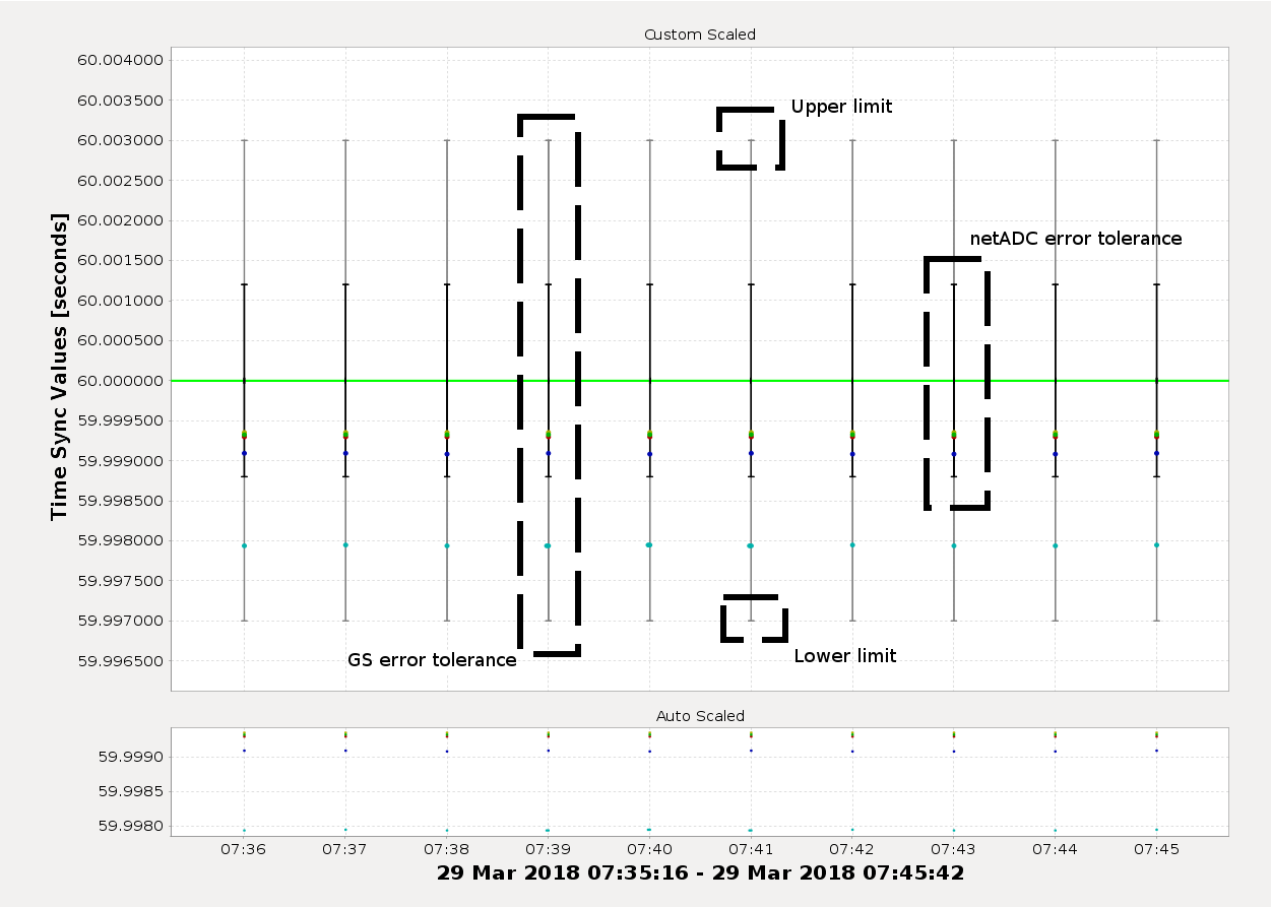

Figure 5: Error bars with explanatory annotations.

The error bars indicate the recommended upper and lower limits which each device's clock should meet to be considered within specification. Different colour error bars represent the different recommended error bounds for different kinds of devices; grey error bars apply to GSs while black bars apply to netADCs. As long as the dots are within this range, the system is operating normally. Outside this range could indicate power issues, false ATU pulses being received by the devices (e.g. due to electrical noise) or other issues.

3.2 Changing the Time Scale of the Graph

Located at the top of both windows, is an option to change the time scale (shown in figure 6). Changing this value, will adjust the date and time range displayed on the x-axis, and allow you to roll back in time to check on previous time synchronisation performance. This historic view can be useful for identifying intermittent issues, to determine trends or patterns and isolate possible causes. By default, the time range is set to 1 hour.

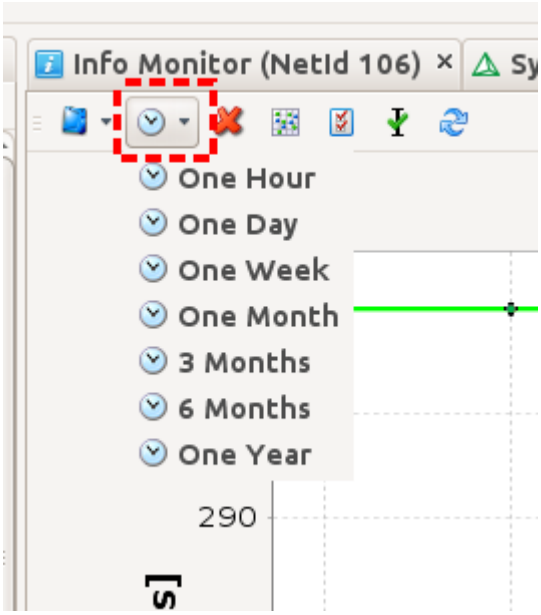

Figure 6: Time period drop down selection.

3.3 Displaying Corrected and Uncorrected Time Counter Periods

Another option available from the top panel is called "Corrected/Uncorrected TCP"; shown as either a red X icon (as in figure 7) when in uncorrected mode, or a green tick when in corrected mode. When Synapse receives acknowlegments of ATUs from devices it is able to compensate (correct) for reasonable timing offsets of each device's clock. The clock parameter that Synapse adjusts is called the Time Counter Period (TCP), and when adjusted the y-value of the dots on the graph will change. The aim being to move each dot to the expected true ATU value.

Figure 7: Corrected/Uncorrected TCP button.

This option switches between two different views:

1. Uncorrected TCP: the default mode where dots will likely display scattered y-values showing the differences in each device clock's Time Counter Period (TCP).
2. Corrected TCP: if all dots are within reasonable bounds of the true ATU period (i.e. within the error bounds indicated by the error bars described above), then all dots should collapse onto this single value. Devices outside of these bounds will remain in their original positions indicating that Synapse is unable to correct their clocks.

3.4 Refreshing the Graph

There is also a refresh button as shown in figure 8, it will refresh the data shown the plot.

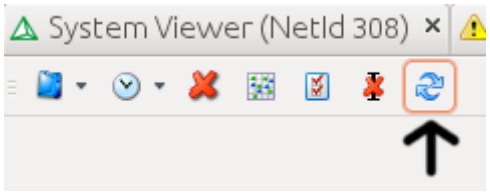

Figure 8: Refresh button.

4 Controlling and Configuring the Graph Settings

4.1 Graph Navigation

When you open the graph, it may be necessary to navigate to a different time range other than the default view. Especially if you want to focus on a specific point. There are multiple controls available to do this:

- Shift + drag left mouse – allows you to zoom in on a selected area over the local time range.

- Click + drag left mouse – allows you to zoom in on a selected rectangle.
- Shift + mouse wheel – allows you to zoom in or out over of the local time range.
- Ctrl + mouse wheel – allows you to zoom in or out over the time sync values.
- Ctrl + mouse wheel button – allows you to restore the default zoom level.

4.2 netADC/GS Selection

Some systems may have a large number of netADCs/GSs, which may make it more difficult to read the graph. In this case, deselecting netADCs/GSs from the information window will remove their data points from graph, making it easier to read (see figure 9).

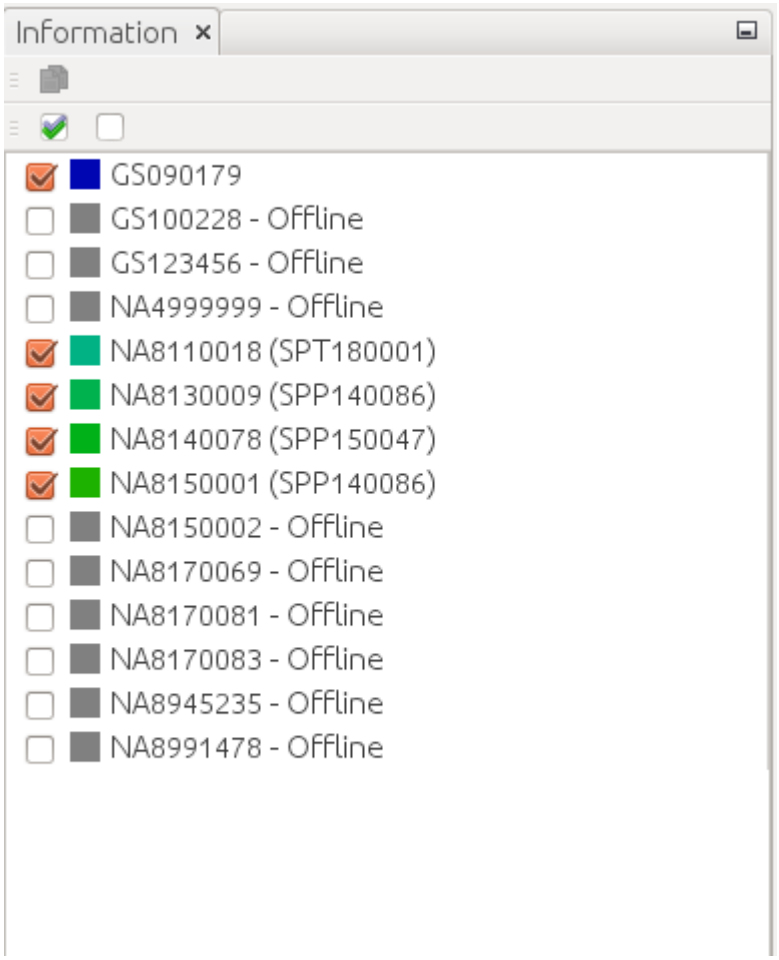

Figure 9: netADC/GS (de)selection.

4.3 Point/Step Graph

If you prefer, you can select to use the step plot instead of the default point plot. Simply select the box with a bunch of points inside (see figure 10) to toggle between point and step plots. This is useful to help spot points that are outside of the general area and may go unseen.

Figure 10: Point/Step graph toggle.

4.4 Settings

The Time Synchronisation (ATU) History Graph has a number of properties that can be adjusted. The properties sheet can be opened by selecting the icon with two ticks (shown in figure 11).

Figure 11: Graph properties button.

The options available are (see figure 12):

- Point size – adjust the size of each dot on the graph.
- Line thickness – adjust the thickness of the line when using the step plot.
- Format – adjust the number format of time sync values.
- Axis Label Front – adjust the font of the axis labels.
- Tick Label Font – adjust the font of the axis tick values.
- Plot View Type – adjust the plot view type between point and step.
- Show Plot Tooltips – enable/disable whether tooltips are shown when hovering over a point.
- Main Ranger Marker Colour – adjust colour of the ideal time sync values.

- Corrected TCP – corrected/uncorrected TCP values.
- Fixed Time Range – adjust the time range over which time sync values are viewed.
- Use Custom Time Range – enable/disable use of custom time range.
- Custom Time Range – the custom time range to view, if enabled.

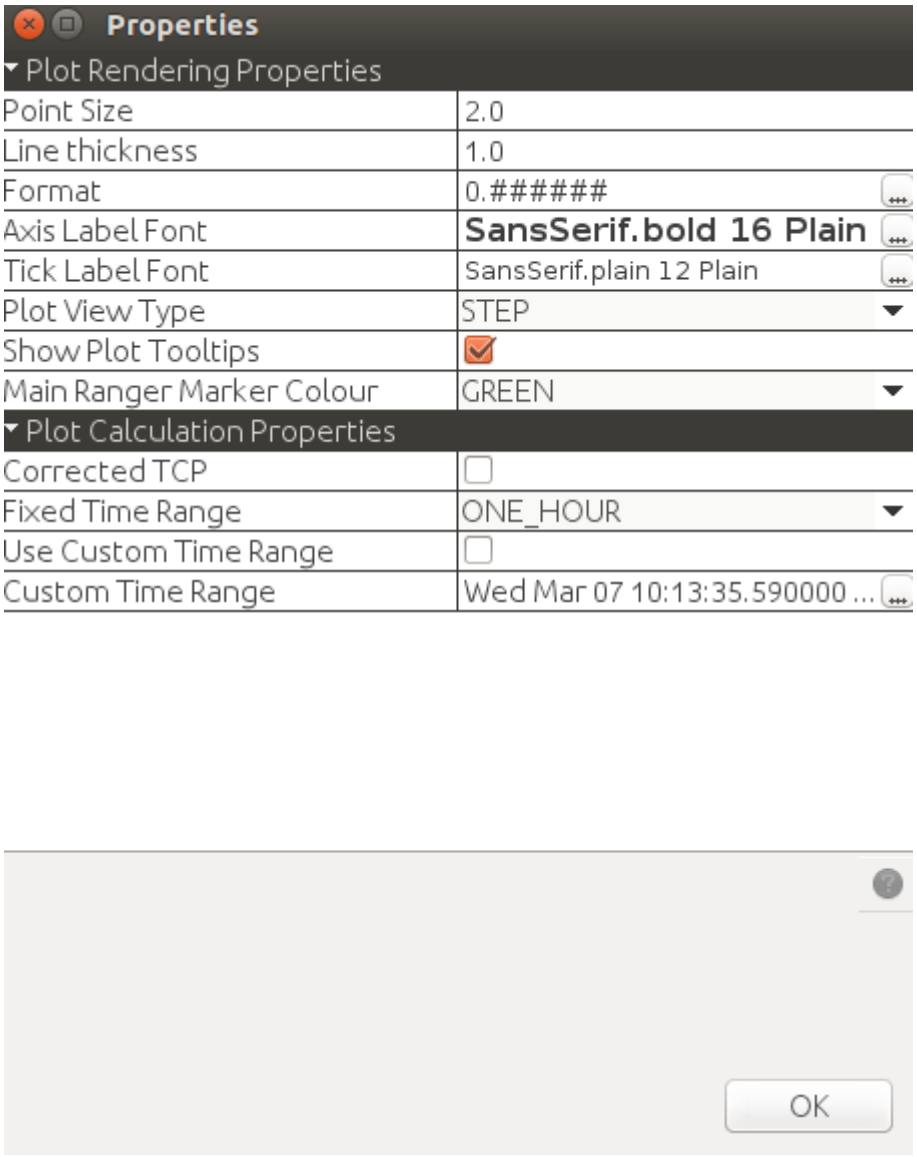

Figure 12: Graph properties window.

5 Examples

Below are some examples of acceptable (good) Time Sync Graphs and Time Sync Graphs displaying significant issues (bad).

5.1 Good Time Sync Graph

Figure 13 shows an example of a system displaying acceptable time synchronisation. The points are tightly grouped together (they may seem far apart but note the scale on the Y axis). The devices are all within their recommend error bounds and all points collapse onto the true ATU period when corrected mode is enabled.

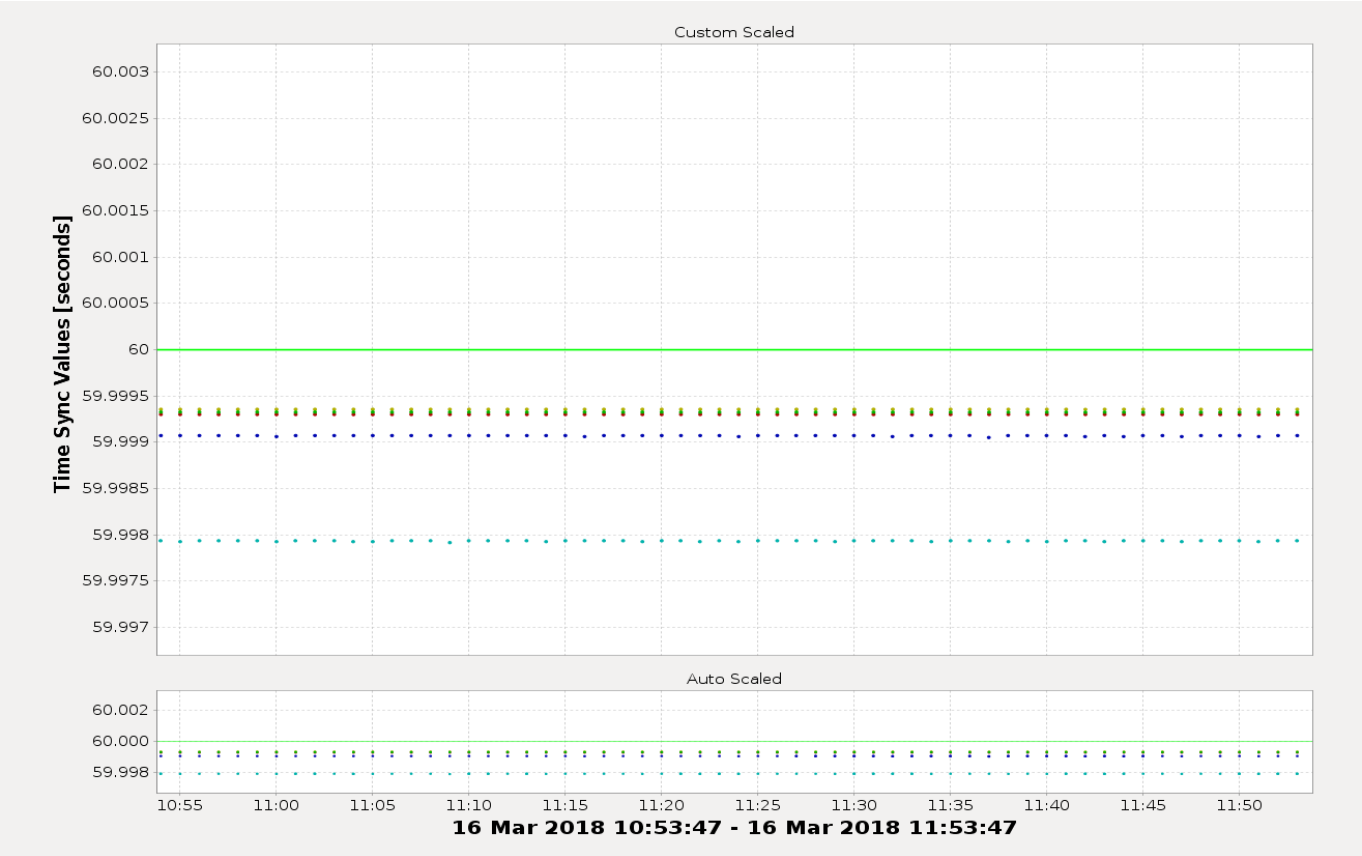

Figure 13: Example of a Good Time Sync Graph showing five devices with good time synchronisation.

with error bars enabled, allowing us to easily see if there is a problem by checking whether points are within the error bars.

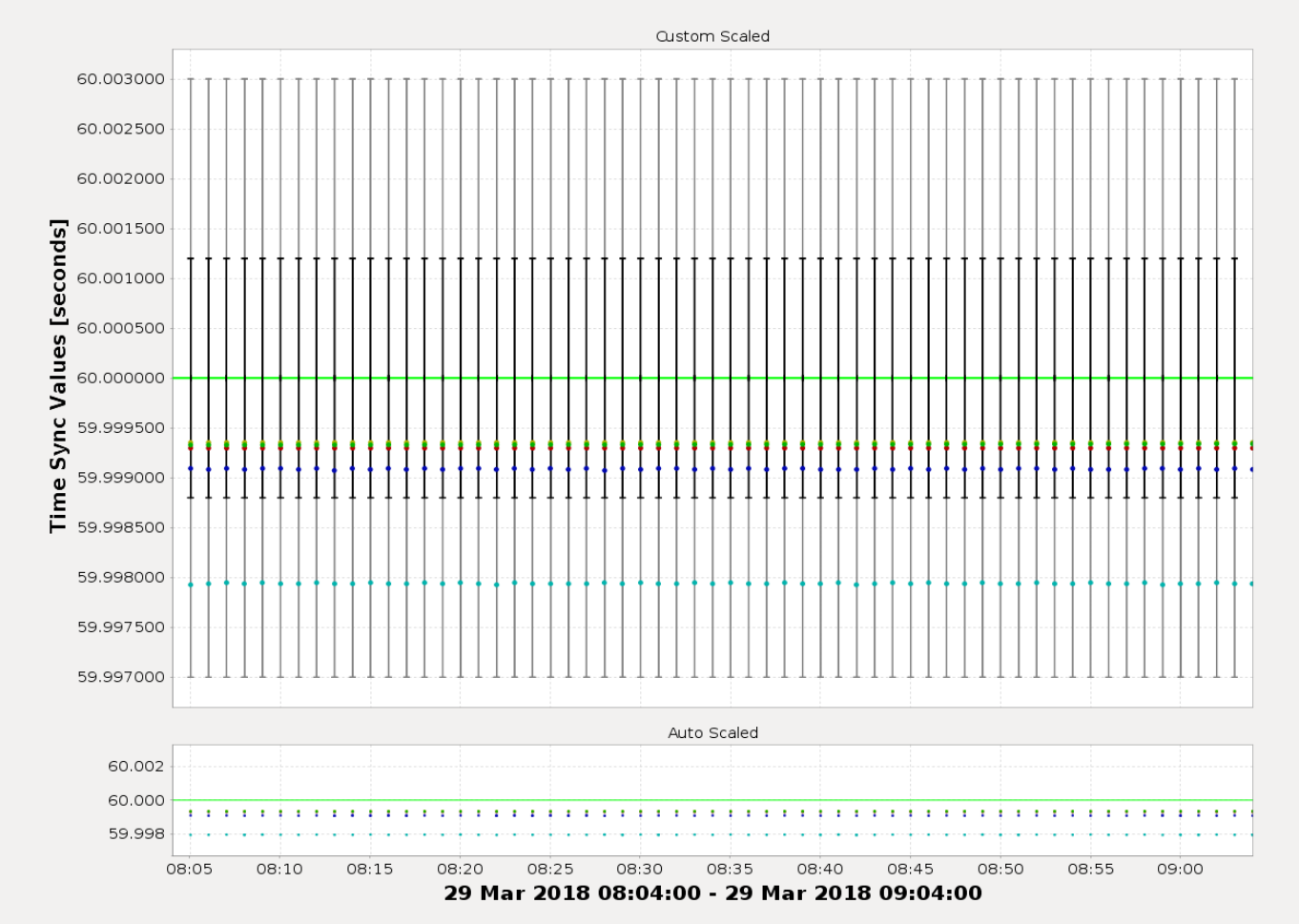

Figure 14: The same Good Time Sync Graph as figure 13 but with error bars displayed.

Figure 15 is the same graph again except with corrected TCP values enabled. All points for each ATU period collapse on top of one another and on to the green line, which indicates that Synapse is able to effectively and consistently correct for the timing errors.

Figure 15: Good Time Sync Graph with corrected TCP values.

5.2 Bad

Figure 16 is an example of a system with multiple time synchronisation issues. On the graph, points are widely scattered from nearly 0 seconds to over over 320 seconds on the y-axis, and randomly scattered on the x-axis (rather than close to the green line on the y-axis and on multiples of the ATU period on the x-axis).

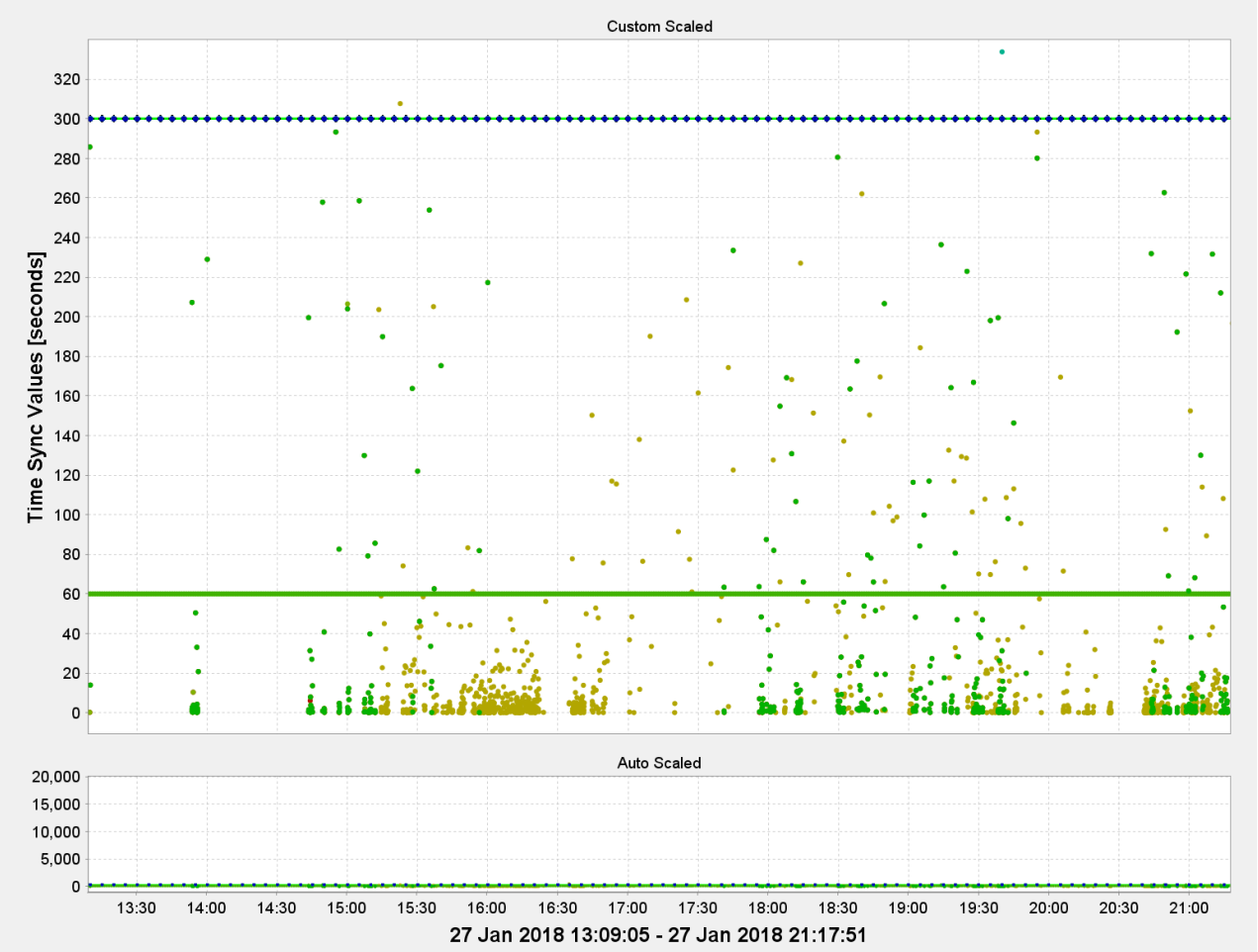

Figure 16: Example of a bad Time Sync Graph.

Change Control Record		
Date	Description	Revision
2018/04/17	Original document	0

Table 1: Change record