



Summer University Value Archive Expert

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1 *About Vexpert*

INTRODUCTION



A Siemens Company

Introduction (1)

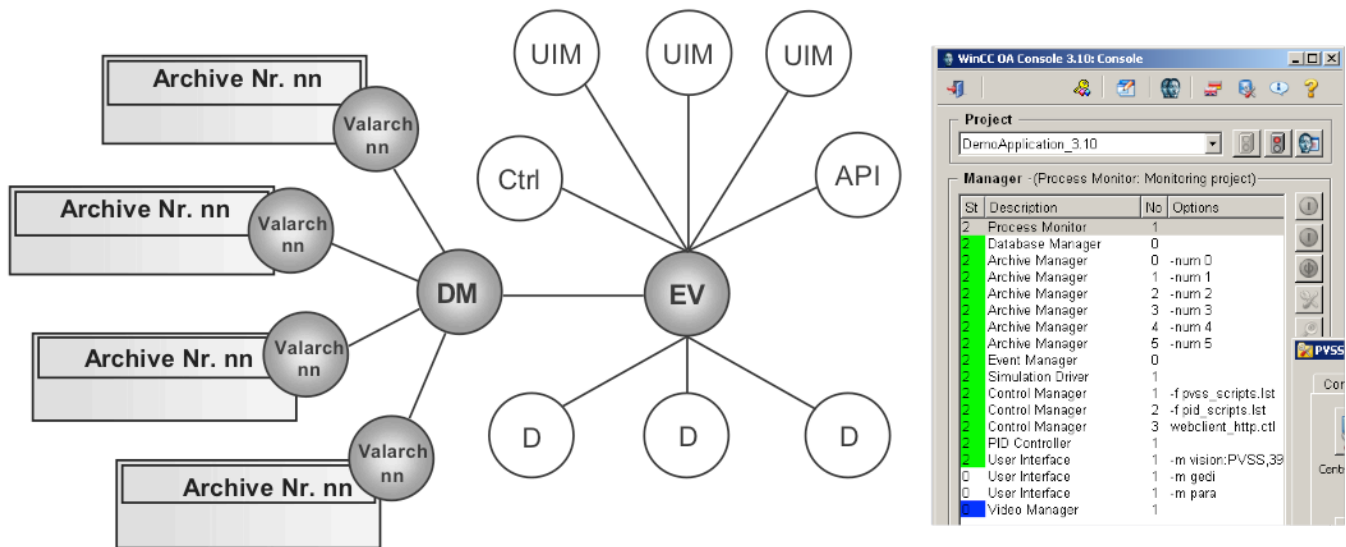
WinCC OA

- **Motivation:**

WinCC OA's archive function stores both fast- and slow-changing values in the same file by default. A file switch is triggered only by time or an overflow of data. Thus, one fast value can create many new files, wasting space allocated to other datapoints until compression is applied.

- **Solution:**

The Value Archive Expert (Vexpert wizard) compares historical data to guideline parameters set by the user. Datapoints can easily be moved to other archives to optimise their storage in future.



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An archive file receives data from an archive manager.

When a DPE changes, the RAIMA database updates the current value, and the archive manager appends the new value to the corresponding file. The appropriate archive manager for a particular DPE is set in the DPE's `_archive` config (e.g. `nazTemperatureInside._archive.1._class`).

A DPE can be stored in any archive, but no more than one at a time. If a DPE's config is changed, the historical data remains in the original files: past values are not transferred. This means that the list of DPEs in an archive file may change over time.

There is also an internal datapoint (e.g. `_ValueArchive_1`) for each archive, which stores a list of historical files generated by that archive manager. 10 datapoints are provided by default.

Archives may be inactive, if the internal datapoint is present but no archive manager is configured. The manager must have the same number as the corresponding datapoint: e.g. `-num 6` for `_ValueArchive_6`.

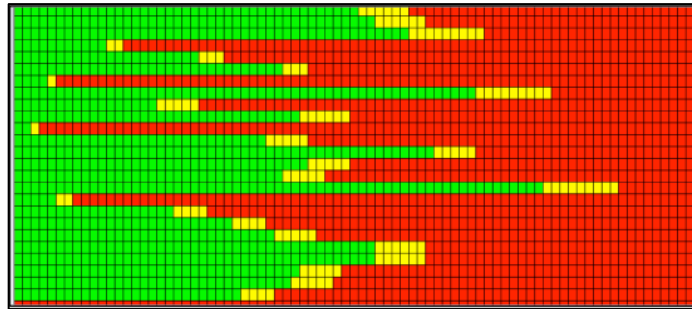
Adding or removing managers is done on the Console panel. Vexpert makes the relationship between internal datapoints and archive managers clear, and allows managers to be added or removed directly from the wizard. To do so manually, use:

Console > Append Manager



Archive Files (3)

WinCC OA



- Saved values
- Correction values
- Free space (heap)

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The diagram above shows the structure of an archive file. New archive files may be generated the same day if the heap size is exceeded by any one DPE.

Archives are stored as a memory-mapped flat file, with no indexes and direct access to each historical value. This allows fast access and simple addressing, but results in large files.

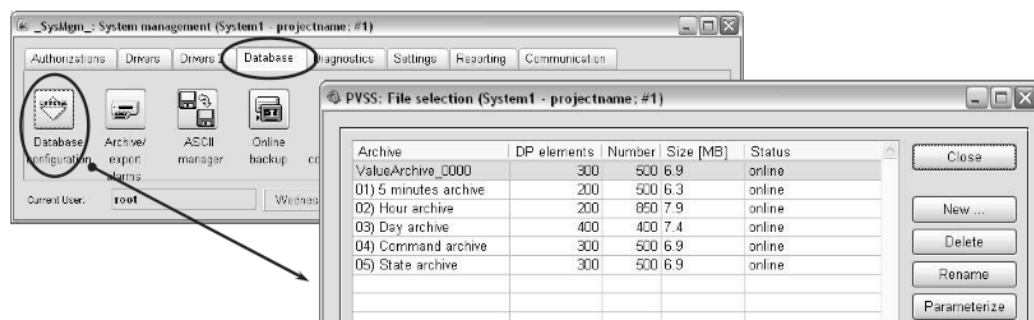
File size is related to the number of DPEs in an archive. In the worst case, if one fast-changing DPE shares an archive with many slow DPEs, the fast one causes many large files to be created. These files are filled with blank space, as no new value has been read from the other DPEs.

The statistics available for an archive file are the start time, end time, DPE name, and number of values. From this, it is possible to calculate the rate of change of the DPE. Change rates in Vexpert are represented upside-down: 119 means 119 seconds per value, rather than values per second. This is since guidelines are more intuitive in this format than values/hour or otherwise.



Archive Datapoints (4)

WinCC OA



At present, the panel to a new archive's internal datapoint is not easy to access. It is located in:

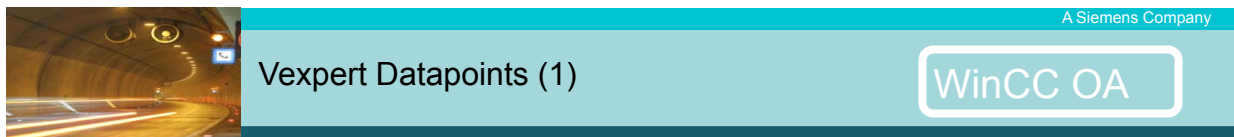
System Management > Database Configuration

When an archive manager with the corresponding number of that datapoint is running, the Status column changes to **online**. Parameters are set using the **Parameterize** button. These are much more detailed than those available through the Vexpert wizard, and may be appropriate for experienced clients. For detailed control of compression and backup media, the original panel should be used.

Because archive managers read values from their corresponding internal datapoints, the manager should be deleted before the datapoint.

2 *Vexpert Config Panel*

VEXPERT DATAPPOINTS



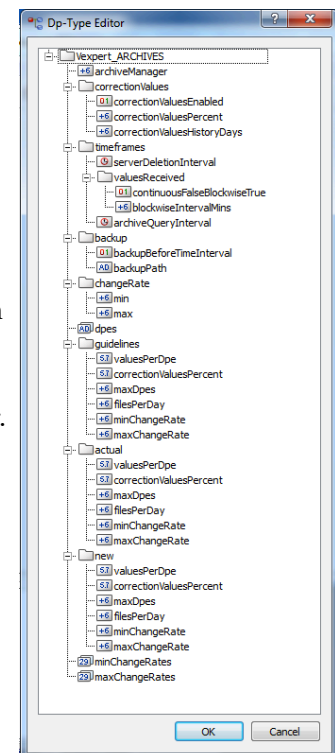
Archive properties are stored all over the place: an archive manager sitting in the Console, an internal datapoint with settings to govern the manager, and a config on the datapoint to be archived. What can be done to clean this up?

Make a new datapoint! At first, one would assume that making the problem worse is the last thing you want to do. But actually, the Vexpert_ARCHIVES datapoint type is designed to unite the previous properties into a single point of reference. It also means that wizard settings do not directly affect the archives until they are applied, so there is always a **Cancel** option.

The integer **archiveManager** is the archive manager number (e.g. -num 6) and the number of the internal datapoint (**_ValueArchive_6**).

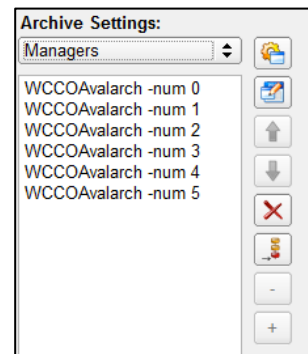
The **dyn_string dpes** stores names of DPEs with this archive number.

The change rate is calculated from the number of values over a time period. This time period is the duration of a historical archive file. Sometimes there are different numbers of values, so the change rate varies for a single DPE. **dyn_int minChangeRates** and **maxChangeRates** track the change rate range when several files are examined. **changeRate int min** and **max** are the overall range of change rates for all DPEs.





The config panel is used to set the datapoint elements **correctionValues**, **timeframes**, and **backup** parameters. The effect of implementing the changes is summarised in the **new** values. That allows the modifications to be cancelled before applying them to the real archive. The **guidelines** are pre-defined, and can only be modified using Para. The **actual** values, representing the current state of the archive, are written by the VExpert Optimisation Panel.



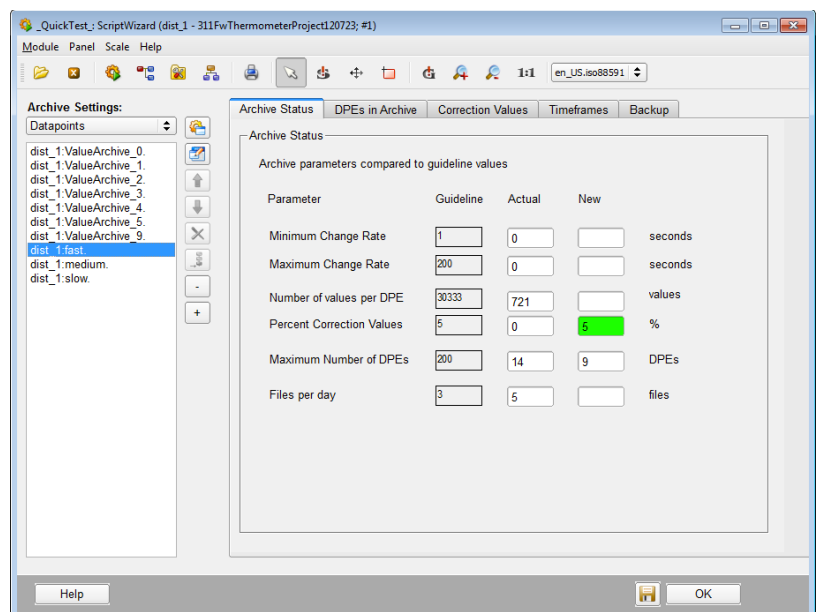
When the config panel opens, a selection list on the top left allows either Datapoints or Managers to be modified. Selecting Managers replaces the list with a corresponding list from the Console of all archive managers.

Two buttons to the right of the list are then enabled, allowing managers to be added or removed directly from the configuration panel. This is much easier than switching to the console and ensuring your new archive number is correct!

When the Datapoints option is selected, the manager add and remove buttons are disabled. Instead, the add and remove buttons for datapoints are enabled! It is also possible to rename datapoints or change the associated archive number using the upper two buttons on the right of the selection list.

The Archive Status tab compares the present archive with guidelines set using para. There is also a New column for showing the effect of changes made in the other tabs, so the user may choose whether to save or not.

A colour scheme of **green** (OK), **yellow** (<20% deviation) and **red** (>20% deviation) is applied to the new fields.





Archive Parameters (3)

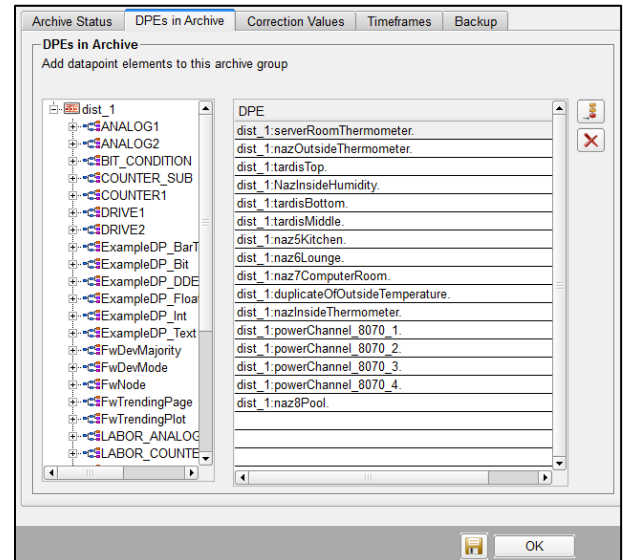
WinCC OA

Remaining tabs allow the user to customise archive parameters. The new values for this are stored in the appropriate datapoint of the VExpert_ARCHIVE datapoint type.

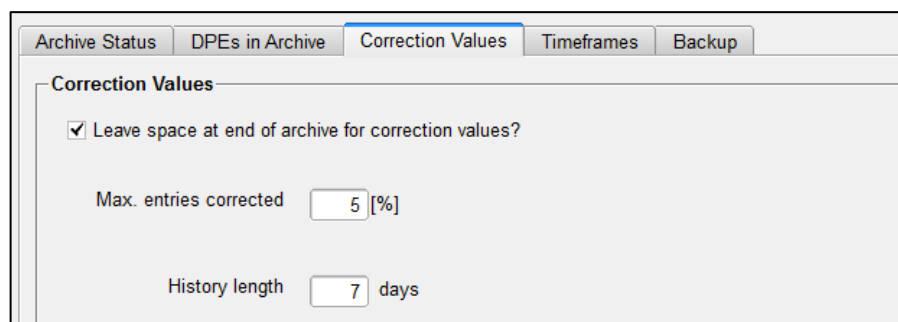
The DPEs in Archive tab allows DPEs to be added to a particular archive. They can be added and removed using the buttons on the right-hand side, or copied from the DP tree with drag and drop.

Before this wizard, editing a datapoint's **_archive** config entry met this need. There was no way to easily display all DPs in an archive on a table, like this.

Another important point to remember: it is possible to Cancel your changes. So don't forget to click Save before OK!



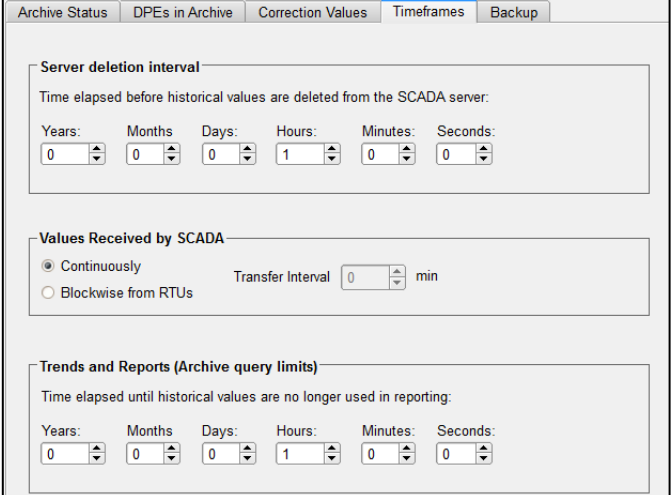
The parameters for Correction Values are simple: should the archive file be made larger to account for correction values, and if so, by what percent? Correction values cannot be added after Level 2 compression, so the history length is also entered on this tab.



Timeframes include the length of time historical values are kept on the server, before they are automatically deleted. In order not to lose data, is it suggested to have a Backup path enabled later.

Values may be received from RTUs in a continuous stream, or in a blockwise manner with a regular transfer interval. The transfer mode is selected here.

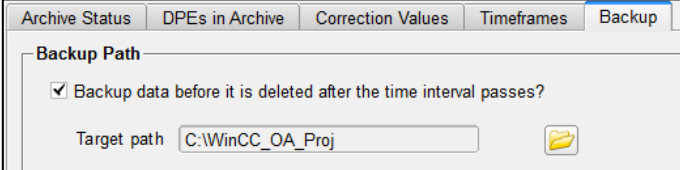
Reports also have their own timeframe, over which historical values are needed. This is also entered here.



The 'Timeframes' tab is active, showing three sections:

- Server deletion interval:** A section titled 'Time elapsed before historical values are deleted from the SCADA server:' containing spinners for Years (0), Months (0), Days (0), Hours (1), Minutes (0), and Seconds (0).
- Values Received by SCADA:** A section with two radio buttons: 'Continuously' (selected) and 'Blockwise from RTUs'. A 'Transfer Interval' spinner is set to 0 min.
- Trends and Reports (Archive query limits):** A section titled 'Time elapsed until historical values are no longer used in reporting:' containing spinners for Years (0), Months (0), Days (0), Hours (1), Minutes (0), and Seconds (0).

Finally, backups ensure that the data is stored safely after it is removed from the SCADA server. The path is entered on the last tab, including a folder browser.



The 'Backup' tab is active, showing the 'Backup Path' section:

- A checked checkbox labeled 'Backup data before it is deleted after the time interval passes?'.
- A 'Target path' text field containing 'C:\WinCC_OA_Proj' and a folder browser icon to its right.

3 *Optimisation Panel*

ARCHIVE TESTING



Opening the Optimisation Panel presents the somewhat intimidating table view below. Why are there so many big **red** warnings? Actually, this is normal behaviour.

When a whole archive is checked against guidelines, some extreme values wreak havoc with the statistics. In this example, a 5-minute file from configuration had 700 values for some DPs, resulting in a very fast change rate: one value every 0.x seconds. The end time is obviously out of range, because the archive is still active. The last file has no end time!

The rest of the panel is nevertheless still helpful to understand. The value archive is selected from the selection list. One or more files within that selection may be selected for a partial inspection against the guidelines.

Guidelines and current values are the same as those on the Configuration Panel. Displaying them here at the bottom of the optimisation panel allows the user to select a range of historical archive files in the left-hand column, and see how they compare to the guidelines.

Archive Optimisation

Choose archive:

Files

- All
- 2012.08.13.-00.30.30
- 2012.08.12.-00.30.30
- 2012.08.11.-00.30.30
- 2012.08.10.-00.30.30
- 2012.08.09.-00.30.30
- 2012.08.08.-00.30.30
- 2012.08.07.-00.30.30
- 2012.08.06.-00.30.30
- 2012.08.05.-00.30.30
- 2012.08.04.-00.30.30
- 2012.08.03.-00.30.30
- 2012.08.02.-00.30.30
- 2012.08.01.-00.30.30
- 2012.07.31.-00.30.30
- 2012.07.30.-00.30.30
- 2012.07.29.-00.30.30
- 2012.07.28.-00.30.30
- 2012.07.27.-00.30.30
- 2012.07.26.-00.30.30
- 2012.07.25.-00.30.30
- 2012.07.24.-00.30.30
- 2012.07.23.-00.30.30

Archive

Start Time: 2012.01.30 03:00:30.000

End Time: 1970.01.01 01:00:00.000

Last statistics update: 2012.08.29 23:35:37.910

Datapoint element	Max Values	Min Change Rate	Max Change Rate	Group
dist_1:serverRoomThermometer.	721	0	119	
dist_1:nazOutsideThermometer.	546	0	158	
dist_1:nazInsideThermometer.	101	0	1329	
dist_1:tardisTop.	549	0	157	
dist_1:NazInsideHumidity.	546	0	158	
dist_1:tardisBottom.	542	0	159	
dist_1:tardisMiddle.	548	0	157	
dist_1:naz5Kitchen.	542	0	159	
dist_1:naz6Lounge.	547	0	86399	
dist_1:naz7ComputerRoom.	544	0	158	
dist_1:powerChannel_8070_1.	1	0	86399	
dist_1:powerChannel_8070_2.	1	0	86399	
dist_1:powerChannel_8070_3.	1	0	86399	
dist_1:powerChannel_8070_4.	1	0	86399	
dist_1:naz8Pool.	721	0	119	

Summary

Min Change Rate	Max Change Rate	Values per DPE	Number of DPEs	Files per Day
Current: 0 s	0 s	721	15	5
Guidelines: 1 s	200 s	30333	200	3

Make It Better

The view may be refreshed if necessary. Because of the statistical errors described earlier, selecting a range of files is the recommended use of this panel.

The table shows the names of DPEs in the selected archive file. Max Values should be the maximum number of values per DPE per file, which is summarised in the guideline below. This is also used to calculate the minimum change rate: more values means fewer seconds per value. The min and max change rates are the same when a single file is selected, but sometimes differ if several files are inspected.

Group is the magic of the VExpert project. Based on compliance to the guidelines, a recommendation of the most appropriate guideline for a DPE is presented in this column. This is not always the present archive shown in the selection list on the top left; DPEs may fit the guidelines of another archive better. They are not moved yet, but only after the user clicks the Make It Better button below.

QuickTest: archiveOptimisationWizard.pnl (dist_1 - 311FwThermometerProject120723; #1)

Module Panel Scale Help

en_US.iso88591

Archive Optimisation

Choose archive: ValueArchive_1

Files

- 2012.06.08.-00.30.30
- 2012.06.07.-00.30.30
- 2012.06.06.-00.30.30
- 2012.06.05.-00.30.30
- 2012.06.04.-00.30.30
- 2012.06.03.-00.30.30
- 2012.06.02.-00.30.30
- 2012.06.01.-00.30.30
- 2012.05.31.-00.30.30
- 2012.05.30.-00.30.30
- 2012.05.29.-00.30.30
- 2012.05.28.-00.30.30
- 2012.05.27.-00.30.30
- 2012.05.26.-00.30.30
- 2012.05.25.-00.30.30
- 2012.05.24.-00.30.30
- 2012.05.23.-00.30.30
- 2012.05.22.-00.30.30
- 2012.05.21.-00.30.30
- 2012.05.20.-00.30.30
- 2012.05.19.-00.30.30
- 2012.05.18.-00.30.30
- 2012.05.17.-00.30.30

Archive

Start Time: 2012.05.21 02:30:30.000

End Time: 2012.05.24 02:30:29.000

Last statistics update: 2012.08.29 23:36:14.060

Datapoint element	Max Values	Min Change Rate	Max Change Rate	Group
dist_1:serverRoomThermometer.	721	119	119	fast
dist_1:nazOutsideThermometer.	721	119	158	fast
dist_1:nazInsideThermometer.	147	587	855	medium
dist_1:tardisTop.	721	119	157	fast
dist_1:NazInsideHumidity.	721	119	158	fast
dist_1:tardisBottom.	721	119	159	fast
dist_1:tardisMiddle.	721	119	157	fast
dist_1:naz5Kitchen.	721	119	159	fast
dist_1:naz6Lounge.	721	119	157	fast
dist_1:naz7ComputerRoom.	721	119	158	fast
dist_1:powerChannel_8070_1.	1	86399	86399	slow
dist_1:powerChannel_8070_2.	1	86399	86399	slow
dist_1:powerChannel_8070_3.	1	86399	86399	slow
dist_1:powerChannel_8070_4.	1	86399	86399	slow

Make It Better

Min Change Rate Max Change Rate Values per DPE Number of DPEs Files per Day

Current 119 s 86399 s 721 15 5

Guidelines 1 s 200 s 30333 200 3

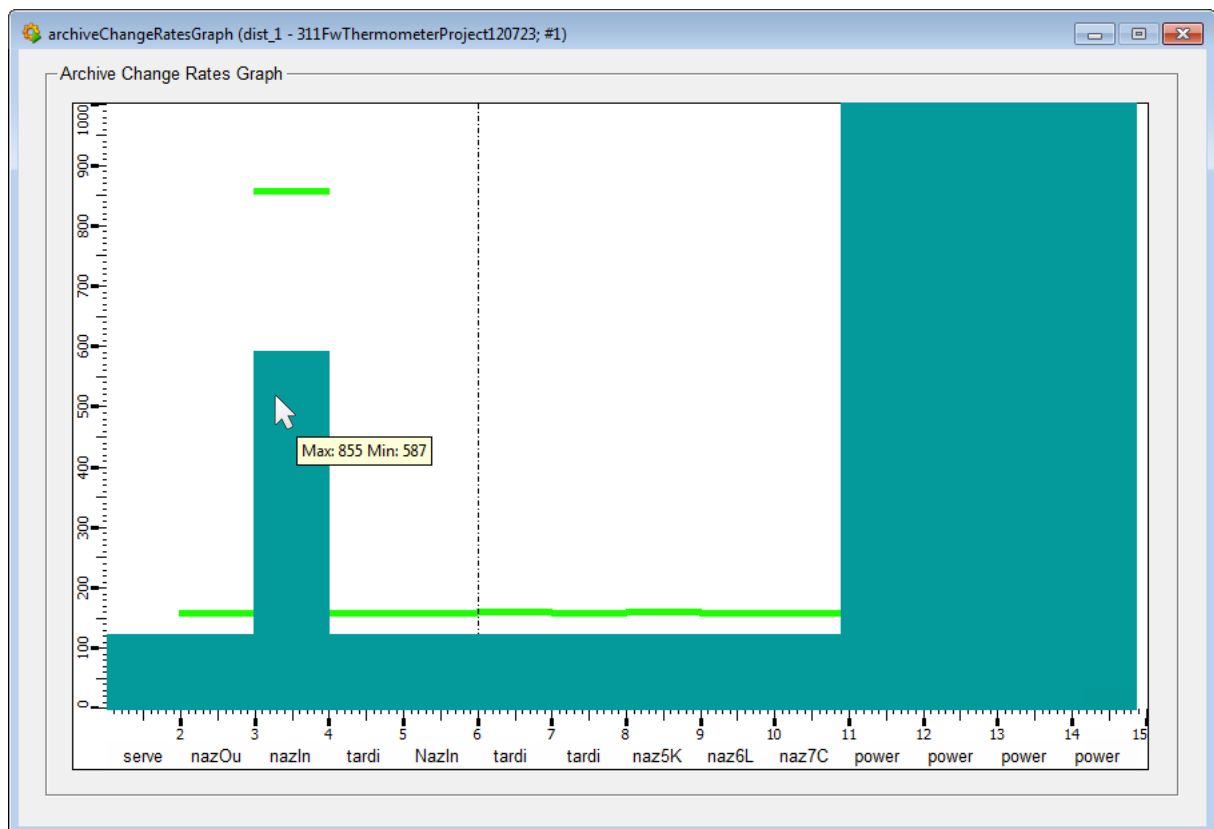


Bar trend (2)

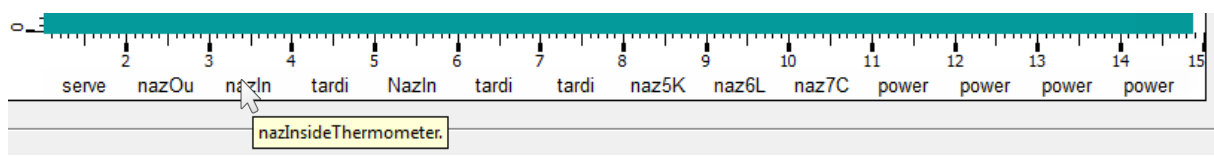
WinCC OA

The table view is very powerful. But if there are many DPEs to inspect, it could become difficult to read. Therefore, VExpert implements a bar trend displaying the same data. The turquoise bars display the change rate data, with the solid bar showing the minimum change rate, and the green unfilled bar showing the minimum.

Change rate values for the bar are also displayed in a tooltip. Hovering the mouse cursor over one of the solid bars displays the maximum and minimum values.



The same tooltip feature also applies on the x-axis, where DPE names are displayed. Only the first few characters are shown at first, but hovering over reveals the full name. The y-axis is the change rate in seconds per value. Auto-scaling this causes very slow change rates (e.g. one value per day = 86399 seconds) to make the rest of the chart appear flat in comparison.





Make It Better (3)

WinCC OA

So, the user interface looks good. Rob Jellinghaus, part of the ill-fated Xanadu hypertext project, told Wired magazine: "The front end is the most important thing". But did that distract from the purpose of this project: intelligently moving datapoints to the most appropriate archive?

Not at all: the Make It Better button brings this whole project together. Pressing it moves the DPEs to the most appropriate archive according to their change rates. This can be confirmed in the Config Wizard, if both windows are open at the same time. As well as adding the DPE to the new archive, it is removed from the previous, so that duplicate values are not stored in two different archives.

The screenshot shows the 'Archive Optimisation' window in WinCC OA. The 'Choose archive:' dropdown is set to '_ValueArchive_1'. The 'Archive' section shows a table of datapoint elements with their Max Values, Min Change Rate, Max Change Rate, and Group. The 'Make It Better' button is visible at the bottom right of the main window.

The 'DPEs in Archive' dialog is open, showing a list of DPEs. The 'dist_1:nazInsideThermometer.' DPE is highlighted, and its group is 'medium'. A red arrow points from the 'Make It Better' button to this DPE.

Datapoint element	Max Values	Min Change Rate	Max Change Rate	Group
dist_1:serverRoomThermometer.	721	119	119	fast
dist_1:nazOutsideThermometer.	721	119	158	fast
dist_1:nazInsideThermometer.	147	587	855	medium
dist_1:tardisTop.	721	119	157	fast
dist_1:NazInsideHumidity.	721	119	158	fast
dist_1:tardisBottom.	721	119	159	fast
dist_1:tardisMiddle.	721	119	157	fast
dist_1:nazKitchen.	721	119	159	fast
dist_1:nazLounge.	721	119	157	fast
dist_1:naz7ComputerRoom.	721	119	158	fast
dist_1:powerChannel_8070_1.	1	86399	86399	slow
dist_1:powerChannel_8070_2.	1	86399	86399	slow
dist_1:powerChannel_8070_3.	1	86399	86399	slow
dist_1:powerChannel_8070_4.	1	86399	86399	slow
dist_1:naz8Pool.	1	86399	86399	slow

The 'DPEs in Archive' dialog shows the following DPEs:

- dist_1:serverRoomThermometer.
- dist_1:nazOutsideThermometer.
- dist_1:tardisTop.
- dist_1:NazInsideHumidity.
- dist_1:tardisBottom.
- dist_1:tardisMiddle.
- dist_1:nazKitchen.
- dist_1:naz6Lounge.
- dist_1:naz7ComputerRoom.
- dist_1:powerChannel_8070_1.
- dist_1:powerChannel_8070_2.
- dist_1:powerChannel_8070_3.
- dist_1:powerChannel_8070_4.
- dist_1:naz8Pool.

The 'medium' group is selected in the dialog.

4 *Future work*

IMPROVEMENTS



VExpert successfully makes archive management a pleasure to the user, rather than a complex chore. However, it can continue to be developed.

The Make It Better algorithm is currently based on the change rates of values. Including the maximum archive file size (500 MB) in this calculation may be necessary for larger examples. Checks should also be included to ensure that new archives update at a different time, to reduce load on the data manager.

Import and export presents new challenges. Moving the panels and library file was all that was necessary to show how this project can be included in an implementation case. However, the change from ISO to Unicode encoding meant that the whole user interface needed to be re-written when adding a UTF-8 panel into an ISO project. Similar problems could arise.

A smoothing wizard with access to the driver and archive manager would allow the user to modify the change rate. Showing the user the effect of their modifications in real-time using trends would provide excellent usability. However, this is not yet implemented in VExpert.

Compression settings are read and written with the Config panel, and are compared to guidelines. Specifying new intervals than the default is possible by adding and removing datapoints on the Config panel. Compression parameters have not yet been integrated into the Make It Better button, however. Checks for those settings would be a helpful addition.