TimeLine-Driven Collaboration with “T4 & Friends”: A Time-saving Approach to OpenVMS Performance

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This OpenVMS Technical Journal article gives you the background story on TimeLine Collaboration (**TLC)**, sketches the universal ingredients of a timeline-driven approach to OpenVMS performance, highlights the original and the current capabilities of the “upstream” and “downstream” **Friends of T4**, and details the central role played by growing reservoirs of TimeLine Collaboration format data.

We provide many concrete examples of the ways in which the graphical representations of timeline performance data can help solve a variety of performance concerns by extracting the meaning and value from the collected data. Numerous examples drawn from the OpenVMS GS1280 Proof Point Project (P3) have been included. We will show how you can benefit by getting started along a similar timeline-driven path beginning with T4 data collection and how you can customize this to meet your specific needs. The timeline-driven path is one that promotes collaboration by means of the efficient collection, sharing and exchange of vital performance data.

So Much Data, So Little Time, So Much at Stake.

It began three years ago with the creation of a timeline data extraction tool named **T4** (Total Timeline Tracking Tool). **T4** converted previously recorded MONITOR data into a reusable text file in Comma Separated Value (**CSV**) format. Since then, HP OpenVMS Engineering has been evolving, improving, and extending the value of T4. For example, we created a T4 kit that added vital timeline data from other independent sources to the generated MONITOR data. We continued by developing an interconnected series of timeline-driven tools, techniques, and tables that help extract the maximum value from the timeline data. These included features for automating the creation of detailed timeline history, for synchronizing performance data captured from independent sources, for readily adding new timeline collector sources, and for rapidly visualizing and reporting on timeline behavior.

This growing collection of cooperative capabilities has proven to be universal in scope and readily extendable while fostering and encouraging a collaborative approach to any performance situation. These developments, now codenamed **T4 & Friends**, have produced visible productivity improvements and dramatic time-saving for OpenVMS Engineering’s performance efforts including our extensive cooperative performance work with customers and partners. T4 & Friends is all about the time efficient creation and use of timelines including: their capture, charting, synchronization, comparison, visualization, sharing and especially collaboration.

TimeLine Collaboration (TLC) Format

The **T4 & Friends** approach has, as its central core, a single, common, uncomplicated, universal format that we have chosen for representing the timeline statistical values that have been collected or extracted. We refer to this as **T**ime**L**ine **C**ollaboration (**TLC**) format. The T4 extractor for MONITOR data generates TLC output. In addition to its extractor for MONITOR data, the T4V3x kit now includes five other collectors and extractors. Each generates output in TLC-format.

Better yet, any upstream collector or extractor can do the same and readily store its vital timeline data in TLC-format. These will be the upstream “**Friends of T4”.** There are also downstream “**Friends of T4”** that take TLC-format data and carry out value-adding actions such as synchronizing data from independent sources, visualizing timeline changes, comparing data from two different time periods, applying expert rules, or graphically reporting results.

Widening Use Among the OpenVMS Community

Not surprisingly, a growing number of OpenVMS customers and partners have seen these benefits first hand and have begun to follow our lead. They have done this by turning on their own historical timeline data collection, by generating data in TLC-format (beginning with the base T4V3x kit), by turning on their own new collectors or extractors that generate TLC-format data, and by structuring their own unique timeline-driven approach.

Components of our **T4 & Friends** developments and growing banks of historical data in the core **TLC-fo**rmat are now routinely employed on some of the largest, most important OpenVMS production systems around the world including vital systems receiving our highest Gold and Platinum Support Levels.

Access to the T4V3x Kits

The latest T4V33 kit that supports creation of historical timeline data now ships with OpenVMS Alpha Version 7.3-2 making this essential foundation block for collaborative, timeline-driven performance work more readily and widely accessible in 2004 to OpenVMS customers. The T4V32 kit is available for public web download for those running earlier versions of OpenVMS on AlphaServer systems. For many, the easiest way to obtain T4's capabilities is to use HP Services' **System Health Check** (**SHC**) offering for OpenVMS. SHC now includes a T4-driven collection of TLC-format data coupled with a growing list of expert rules that assess system performance health based on that data.

The Background Story: Timeline-Driven Performance Work

Timelines Are Key. Timelines Apply Universally.

While this has not always been the case, timelines are now at the center of most performance work we undertake today within OpenVMS Engineering. This applies to our internal efforts as well as our many interactions with customers and partners. These include:

- Tuning
- Stress testing
- Benchmarking runs
- System sizing estimates
- Checking for unexpected side effects
- Spare capacity evaluation and estimation
- Troubleshooting and bottleneck identification
- Dealing with reported cases of performance anomalies
- Validating that recommended changes really made a difference
- Estimating the headroom added by the newest models of hardware
- Characterizing the relative performance behavior of new versions of software

Timeline Charts Have Explanatory Power.

One of the most important ways that a timeline-driven approach improves any performance project is that timeline data are naturally and inherently graphical. It is always possible to make your performance findings visible to yourself (for analysis). It then becomes possible, post-analysis, to select a small set of key visual outputs and craft a **visual performance explanation** to share with others. This is especially powerful when the analyst can sit side-by-side with one or more interested parties and explain a carefully selected visual timeline while pointing to the natural features of the graphic and interacting with the other viewers. The interested parties in these cases could just as easily be technical or non-technical, because visual explanation has been proven to work well with both audiences.

NOTE

The graphs shown in the examples and the conclusions presented as to what they mean come from a thorough analysis of a much larger set of data and the observation of the timeline behavior of many many variables. The charts shown and the conclusions don't stand on their own. We fully expect that different analysts looking at the same timeline data might come to a somewhat different set of conclusions. The beauty of the approach presented in this document is that the timeline data so gathered and saved in timeline history data banks is readily reusable and is intended for collaborative use. It serves as the core reference point on which to build, discuss, and defend a set of hypotheses that help explain the patterns observed in the data. Our assumption is that that we always save the underlying core timeline data so we can return to it in case any question arises or if we decide to re-analyze the situation based on new information that has come our way.

Figure 1 gives a simple example of the potential explanatory power of timeline graphics.

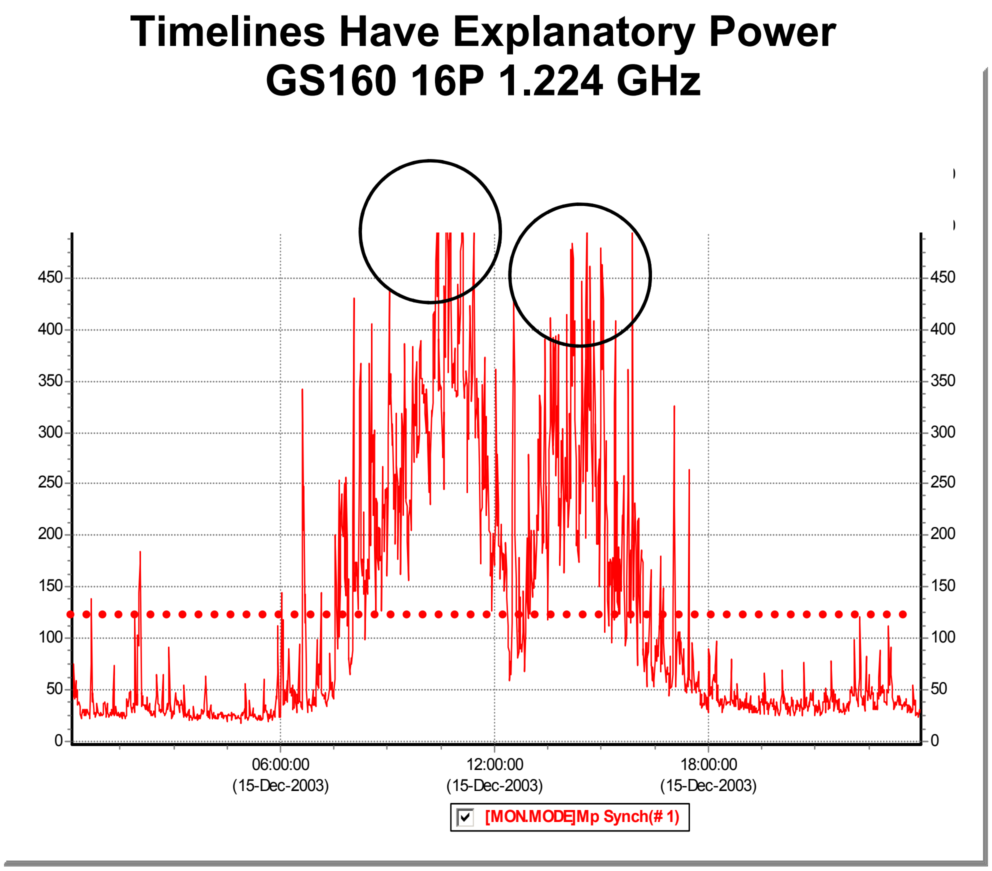


Figure 1 – Timelines Have Explanatory Power

MPsynch on a large GS160 system with 16 CPUs. Note the circled morning and afternoon peak periods and the lunchtime lull. A timeline graph such as this makes it easy to zoom in and focus your attention on the peak periods. The average, as shown by the dotted line, is about 120%. Use of the average would of course be very misleading for a metric that behaves in this fashion.

Timelines Are Everywhere. Timelines Are Us. Timelines Foster Collaboration.

Almost every stakeholder (and everyone we might need to communicate with) is already familiar and can easily grasp timeline graphics. Most of us have already seen innumerable stock market price charts and other examples of timeline graphics. Visual timeline processing is a powerful built-in human skill that requires virtually no training to tap.

Within OpenVMS Engineering, we have time and again found that the more we use timelines for our performance work, the better, faster, and easier it becomes for us and for everyone else involved to understand a given performance issue.

Timelines Are Old Hat, But…

Of course, the importance of timelines and their central role in conducting effective system performance work has been known for many years. It's nothing new.

The reasons for widespread timeline use are far ranging: Real systems are complex. The workload mix on live production systems can change radically in the course of a few minutes. Here are a few questions, answers, and example graphics to clarify this point.

QUESTION: How can you identify when those changes occur or which mix is in play when a bottleneck appears?

ANSWER: Timelines graphics can help bring this story and the necessary distinctions into sharp focus.

Figure 2 gives a simple example how a timeline graph can reveal changes in mix.

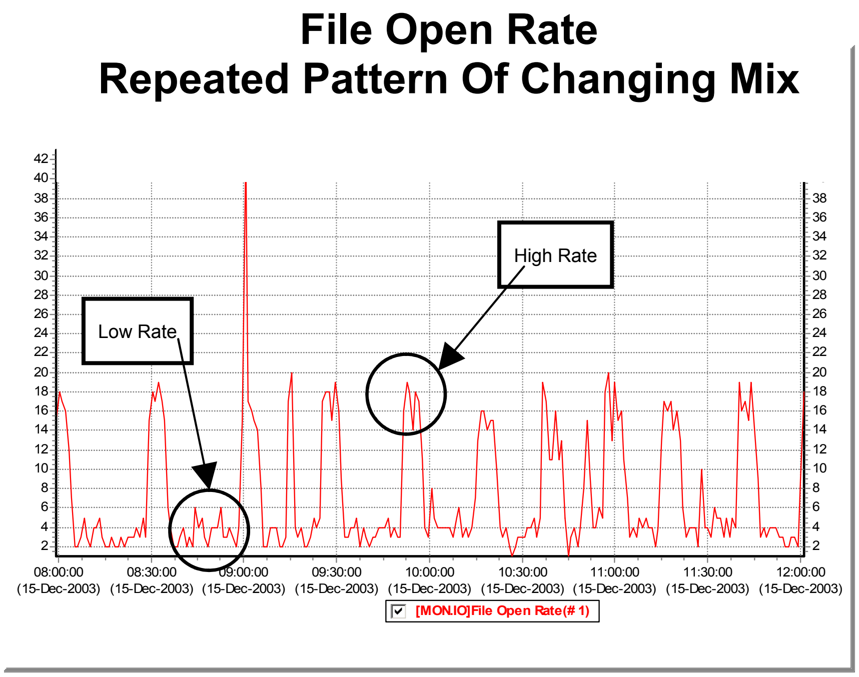


Figure 2 - Change in Mix

From the same large GS160 system, we have zoomed in on the period between 8 AM and Noon and focused on the metric for File Open Rate.

Note the repeated, somewhat regular way that the mix of work changes between a low rate and high rate. During the same period, other key variables such as Buffered I/O rate showed a much reduced range of variation in behavior.

QUESTION: Resource bottlenecks may last only for a few minutes at a time. How can you find those periods and zoom in for further analysis? How will you know which resources are most related to system slowdowns?

ANSWER: Timelines literally let you see when the peak periods begin and end for every measured resource. By comparing those peaks for the resource to the periods when slowdowns were noticed, you can detect whether there is a plausible relationship between the observed peak and the slowdown.

Figure 3 shows both the way in which the graphics reveal trends in the data and the specific way you can use a graph to identify the most important periods for further, detailed inspection. Identifying the peak period is essential if we want to avoid the danger of being misled by average values.

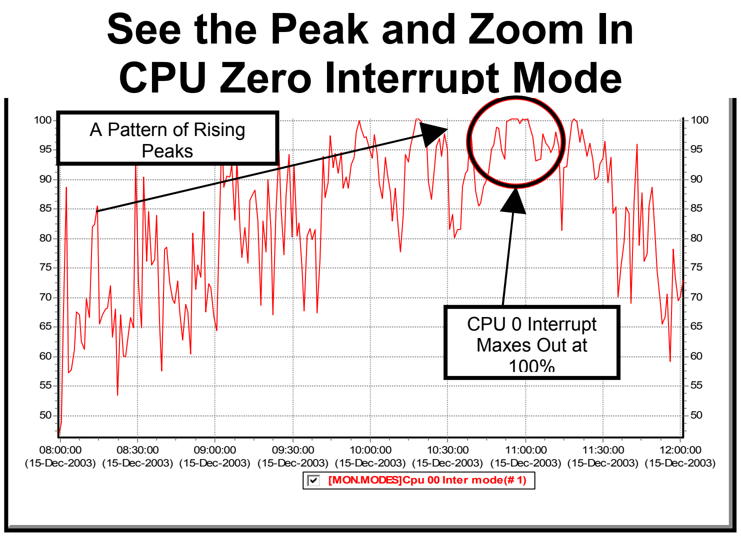


Figure 3 – See the Peak and Zoom in

Watching CPU zero interrupt use during the period from 8 AM to Noon, we can readily see the peaks getting higher and higher until just before 10 AM when we hit 100% for the first time. This vital metric maxes out for a sustained period around 11 AM and has dramatic impact on other key variables as shown in the next chart.

Other types of charts can be constructed using timeline data as a base. Scatter plots sometimes prove invaluable for highlighting patterns that may not be obvious from the time series view. Figure 4 is a simple example of the ways in which scatter plots sometimes bring hidden patterns into view.

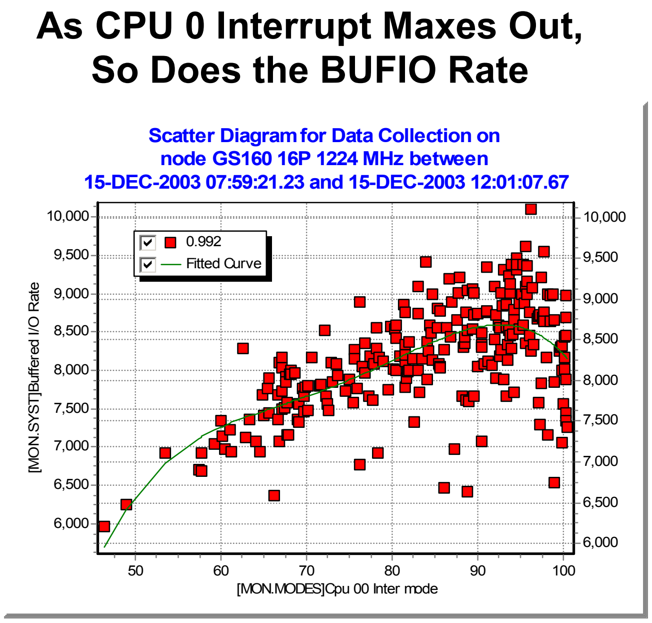


Figure 4 – As CPU 0 Interrupt Maxes out, So Does the BUFIO Rate

This chart is a scatter plot for CPU 0 Interrupt (X-axis) compared to the BUFIO rate (Y-axis) for the period from 8 AM to Noon. Some non-linear effects can be read from this graph. As CPU 0 Interrupt gets closer and closer to 100%, each increment is capable of driving fewer and fewer added Buffered I/Os.

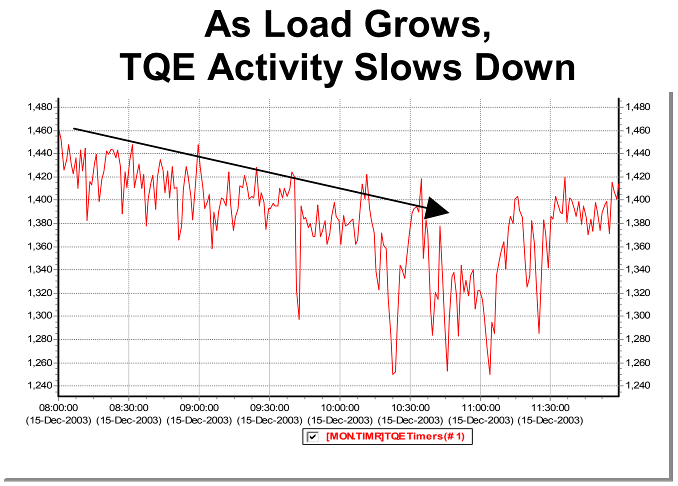


Figure 5 -- As Load Grows, TQE Activity Slows Down

Side effects: As Interrupt load on CPU 0 and Buffered I/O goes up, we notice that in the same period, TQE activity actually slows down. It's quite likely [but not certain] that the actual demand on TQE services actually increased during this same period. If so, any users dependent on TQE processing would have experienced increased response time while those busy doing Buffered I/O monopolized scarce (zero sum) resources such as CPU Zero interrupt.

QUESTION: Something that improves performance for one class of users may have the side effect of hurting another class of users. How can you clearly see both sides of the story?

ANSWER: Multi-dimensional timelines can often help bring this picture of side effects into clear focus. Figure 5 above draws from the same data as the previous examples and shows that Timer Queue Entry (TQE) activities appear to slow down as the total system load increases.

Figure 6 shows the scatter plot of for TQE under the influence of rising CPU busy. In this case, we see both a reduction in TQE activity and a non-linearity in the shape of the curve.

TQE Drops as CPU Busy Rises

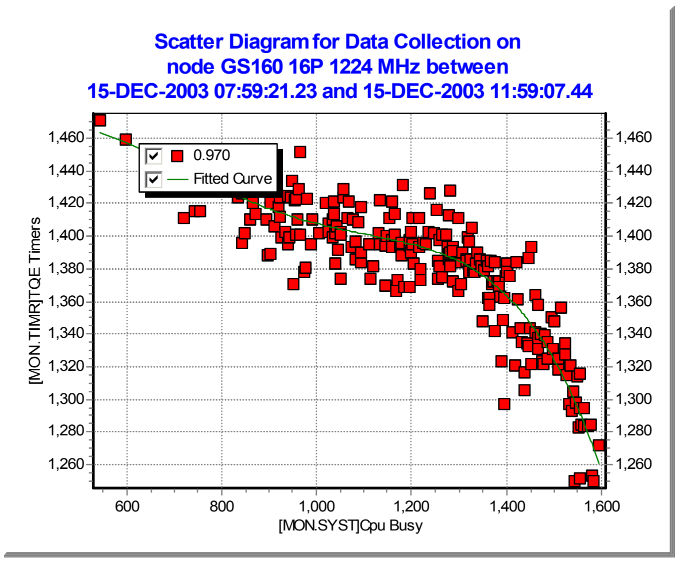


Figure 6 -- TQE Drops as CPU Busy Rises

Another way to look at the side effects equation is with scatter plots. The scatter plot of TQE rate (Y-Axis) vs. CPU Busy (X-Axis) shows a clear and steady reduction in TQE activity as CPU Busy approaches its maximum of 1600% for this system.

Seven Limiting Factors

Historically, as OpenVMS has evolved over the past twenty-five+ years, many expert performance analysts have used timeline-driven approaches with excellent effect. A number of tools and capabilities have grown up to help support this work. Some analysts have made fine use of the timeline capabilities that are built into existing tools. Others have harvested timeline data in their own unique ways and rolled their own downstream tools for manipulating, graphing and reporting with good results.

While there is nothing new in saying that timelines are essential to success, in OpenVMS Engineering, we found that our desire to conduct timeline-driven, collaborative performance work with our customers was impeded by seven key factors.

Factor 1. There was substantial risk that vital timeline performance data would not automatically be collected on customer systems before a performance issue arose. Collection would start only after some problem or issue appeared and the time to solution was systematically delayed.

Factor 2. The best of the existing tools for timeline capture, analysis, and reporting were frequently unavailable on the system in question or for use by those who most needed them.

Factor 3. Where the timeline tools were available and where timeline histories were captured, it was still common to discover severe productivity limits and a high time cost of using these expert tools effectively. In these cases, there was much we might have done for analysis or reporting that was left undone or incomplete due to real world time and cost constraints on these activities.

Factor 4. There was a substantial startup cost to learn to take advantage of the complexity of the best of the existing timeline tools. Effective use for analysis and reporting typically required achieving a rather high level of expertise. For many systems that had the tools, their local ability to do first level analysis was severely impeded by these expertise constraints.

Factor 5. To a large degree, the best of the existing tools imposed limitations on analysis and reporting to those fixed and unchanging capabilities that had been designed into the tools in the first place. Only those willing and able to program new capabilities on top of the existing set were able to invent new approaches.

Factor 6. The data created from one set of collectors did not play well with data from other important collectors. This incompatibility substantially limited sharing of data and extendibility of methods.

Factor 7. There appeared to be several ways in which the existing timeline tool set was still wed to 1980's technologies and mindset. The 1980's was a period when memory, disk, and CPU power was rather more scarce and expensive than today. It was also a time when human expertise was both more abundant and less costly.

Abundance & Scarcity. Computing Power is Abundant. Time is Scarce.

We noted especially how existing built-in and handcrafted timeline capabilities failed to take full advantage of the current abundant desktop and mobile computing power. In our new century, it is nearly universally true that desktop and laptop personal computing power is overflowing. Meanwhile, the scarcest resource for performance analyst work today always seems to be the analyst's personal time. System managers and performance engineers have less time to handle more complexity on an ever-increasing number of systems.

Improving Our Timeline-Driven Work. Improving How We Use Our Own Personal Time.

Over the past three years, OpenVMS Engineering has been looking for new and improved ways to make timelines even more useful in our own performance work. We were especially interested in the idea of being able to use any new approaches wherever and whenever we needed them on all customer and all internal OpenVMS systems. We needed universal tools and methods.

We also had a keen interest for developing new approaches that would make our work more and more productive, that would take full advantage of the abundance of desktop computing power, and that would compensate as best as possible for the scarcity of our own time. Consequently, we have developed and evolved our timeline-driven approaches with these two simultaneous goals in mind:

1. Be highly sensitive to questions of an analyst's use of their scarce time.
2. Freely use abundant resources to save time.

Not wanting to re-invent the wheel, we have also kept our eyes open for other universal timeline tools and techniques that might work cooperatively and collaboratively together and that also kept the scarcity of analyst time clearly in mind. The T4 & Friends path we have taken stands squarely on the shoulders of those who have come before.

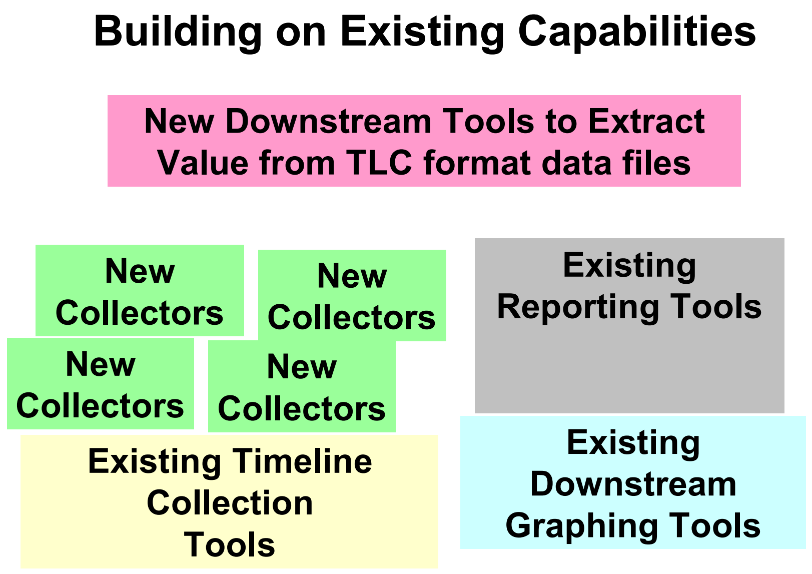

Building on Existing Capabilities
New Downstream Tools to Extract Value from TLC format data files
New Collectors
New Collectors
New Collectors
New Collectors
Existing Reporting Tools
Existing Timeline Collection Tools
Existing Downstream Graphing Tools

Figure 7 -- Building on Existing Capabilities

Many of the building blocks for timeline collaboration are already in place, readily available, and easy to get started. Because of the universal TLC-Format data, new capabilities can be added as needed with incremental investments.

If a Tree Falls in the Forest …

Just as there are many different types of trees in a mature forest, important timeline data of many different kinds exist for the taking on all systems. It is the raw material needed to carry out any performance assignment. Response time and throughput metrics for essential business transactions represent an especially important type of data that's potentially collectable. When this kind of data is available, it almost always plays a fundamental and primary role in any performance work that follows.

Missing Data

Unfortunately, the natural state of affairs is that response data and other key timeline data that can help you most with your performance concerns is available only for a fleeting instant. Some of the most vital classes of data are never even collected. In many cases, crucial events transpire and essential information about those events is not even counted.

Private Formats

In other cases, timeline data is saved and stored in some complex internal or private format and then accessible only in a restrictive fashion using a non-extendable and often time-consuming set of methods. For example, MONITOR is a great tool for capturing a wide swath of important timeline data and saving it in its own internal format as a MONITOR.DAT file. Unfortunately, MONITOR's built-in tools for downstream processing of the timeline patterns captured in these DAT files are limited.

Over Reliance on Averages

Another problem can arise even when the timeline data is dutifully collected. If the only use of the data is to roll it into long-term averages, the underlying time-dependent complexity will be hidden forever. These averages or the total counts since the system was last booted may be readily available, but how that important quantity changed over time is lost. Without detailed timeline data taken at an appropriate resolution, you will never know when peaks or valleys occurred, how long they lasted, how high they reached or how low they fell, or how steady or erratic the overall behavior has been. And you will never be able to examine which factors moved together during the peaks – a known key to unraveling and revealing possible cause and effect relationships.

The Incredible Disappearing Timeline

We commonly see many collector tools that capture essential timeline data, display it to a screen in text format, or sometimes even use a striking graphical format, and then destroy earlier timeline data as each new sample arrives. It's what I call "The Incredible Disappearing Timeline." This screen data can be exceedingly handy for anyone who is watching in real time. However, a few seconds or a few minutes later that screen data is lost forever. Perhaps some key facts are gleaned and remembered by those individuals who are watching intensely, or a screen print is captured of a particularly revealing sample. Sadly, if you walk away and something important happens, you will simply miss it. Worse, even when we literally tie ourselves to the console, we can monitor only a small number of items at a time – typically between about 3 and 7 items for ordinary mortals. If something interesting happens in a vital statistic we are not fortunate enough to be watching (it could even be on the screen), we are simply out of luck. Some clumsy workarounds to this problem do exist. For example, you might automatically write/log the scrolled screen display to an output text file. Later on, you can review that text output. If you find yourself doing this all the time, you will likely be tempted to write a program that parses the text and extracts the timeline information you need.

This default state of affairs for carrying on a timeline-driven approach to performance work leaves a lot to be desired. There is a timeline analogue to the question:

"If a tree falls in the forest and no one is there to hear it, does it make a sound?"

QUESTION: If vital timeline data from many different independent and important sources is ready for harvesting, and no one is there to catch any of it and save it, can this data ever help you at all in your performance work?"

ANSWER: Maybe the timeline data for each source makes a sound when it falls uncaught, but no one will ever hear of it again.

Down The Drain

Lots of **Potential Value** Flowing Continuously

Figure 8 – Performance Data Going Down the Drain

If you don't capture, funnel, and store key timeline data into a long-term, reusable depository, there will be nothing coming out the other end of the funnel when you need it most.

Lost or **Unrecoverable Value** if it Slips Through Your Fingers

Timeline Data is the Raw Material for All Complex Performance Work.

Unless key timeline data is captured at appropriately detailed resolution, time-stamped, archived for historical reference, and converted to a publicly reusable format, it is likely to be lost forever, subsumed into long term (and often misleading) averages, or only available for experts through rigid, time-consuming, non-extendable interfaces, or clumsy, time-consuming workarounds.

Half of the work with T4 & Friends has centered on solving this set of problems – capturing the raw timeline data and saving it in a readily reusable, sharable format so it's latent potential would be available when needed.

T4V1: The Original T4 – A Good Beginning is Half the Work

T4 (originally an acronym for **T**om's **T**errific **T**imeline **T**ool) is the name given to an internally developed OpenVMS performance tool. The original T4V1, written in DCL, was an automated **extractor** of the latent timeline data previously hidden within MONITOR.DAT files.

T4V1 converted MONITOR's natural timeline data for about thirty key statistics into a two-dimensional timeline table. Each row represented exactly one sampling period and each column represented exactly one of the key statistics.

The original T4V1 capability then saved the two-dimensional timeline data in a readily reusable Comma Separated Value (CSV) file. In CSV format, the resulting file was then suitable for further analysis and graphing with tools such as Microsoft® Excel (one of the first universally available downstream "**Friends of T4**").

In what follows, we will refer to the CSV files created by T4 collection as **TLC** (**T**ime **L**ine **C**ollaboration) **format files**. Collectors other than T4 can readily create timeline files in **TLC-for**mat. Then they can also benefit from the full range of available downstream timeline tools that have been designed to extract the maximum value from this very special kind of data.

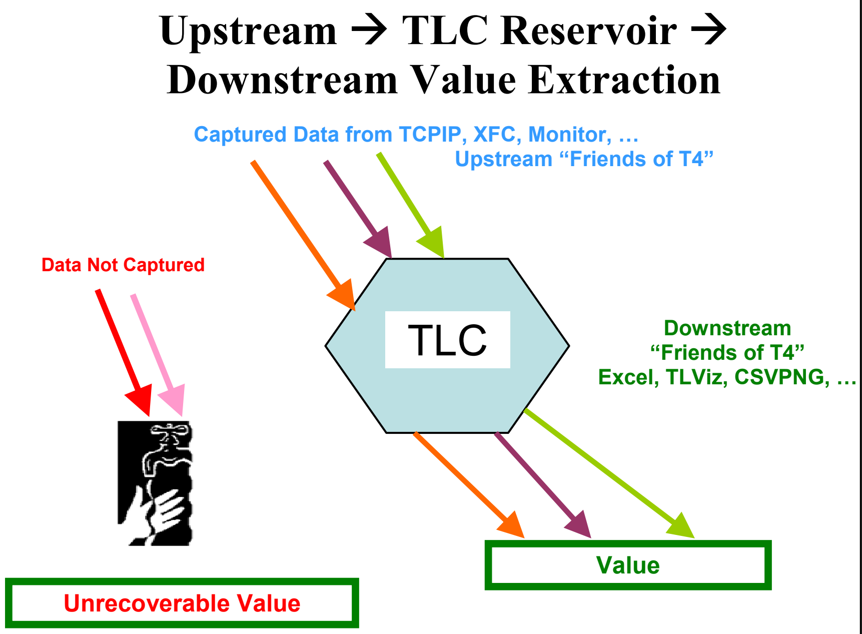

Upstream → TLC Reservoir → Downstream Value Extraction
Captured Data from TCPIP, XFC, Monitor, …
Upstream "Friends of T4"
Data Not Captured
TLC
Downstream "Friends of T4" Excel, TLViz, CSVPNG, …
Value
Unrecoverable Value

Figure 9 – Creating Value from Timeline Data

Data collected upstream from many sources (for example MONITOR, TCP/IP, ORACLE collectors or extractors) is channeled into a TLC reservoir and deposited for long-term historical storage. Later, selected TLC data is drawn off and fed into downstream tools to extract value. Any number of upstream collectors can be added as they become available. Each such collector further raises the potential value of the TLC data bank. Unfortunately, if key statistics do not have their timeline behavior captured, the potential value of that timeline behavior is unrecoverable. Downstream tools such as Excel, TLViz, and CSVPNG can be used to extract value from TLC historical depositories, as you will see with the many examples that follow.

While what we accomplished with T4V1 and our first use of TLC-format files may sound somewhat simplistic, it nevertheless produced a surprisingly large order of magnitude productivity gain for our performance work within OpenVMS Engineering. Our first use was with some collaborative customer benchmark tests we were conducting. We were comparing the performance of the GS140 to the GS160 on a complex workload that simulated actual load variations and that exhibited intricate time-dependent behavior.

We wanted to compare relative performance of the two systems during relatively short-lived peak periods. We had discovered that the averages over the entire test did not adequately explain the behavior during these peak periods. We knew we had to examine the time-series behavior to fully understand what was happening.

The original T4V1 automated what had been a clumsy and time-consuming manual process. We had previously been forced to use this expensive manual approach to visualize the relationships in time-dependent changes among the most important OpenVMS variables. Unfortunately, because of time constraints, there were many important cases where we did not have the luxury to carry out these expensive manual steps regardless of how much they might have helped.

Because **any** OpenVMS system could record and save periodic sample data in MONITOR.DAT files, once we had the original T4V1 extractor, we could turn that MONITOR data into a universal TLC-format that permitted ready and rapid visualization of that system's time series behavior. Every OpenVMS system could now create timeline data in a universally re-usable format with a relatively modest effort – a big step forward for us.

We fed TimeLine Collaboration (TLC) format CSV data from MONITOR into Excel. Then, we were able to use Excel's graphing capabilities to examine the time-varying nature of thirty important OpenVMS system performance variables. We had pre-selected these 30 variables for a proof-of-concept trial of the T4 and TLC approach.

More Than Just MONITOR Data. Timelines Work With Business Data.

On this same benchmark, we used a combination of DCL, the OpenVMS SEARCH utility, and a customer utility that reported on cumulative application performance and rigged a rudimentary way to capture and save timeline results for customer response time and throughput of key transactions – these were the vital business statistics that the customer was using to evaluate the results of this benchmark project.

By putting these two streams of timeline data together into a single spreadsheet and graphing the relationships between response, throughput, and key system variables, we were able to complete a thorough analysis of the benchmark and its peak period behavior that otherwise would have been unachievable. Figure 10 gives an example of how bringing business and system data together adds to our understanding.

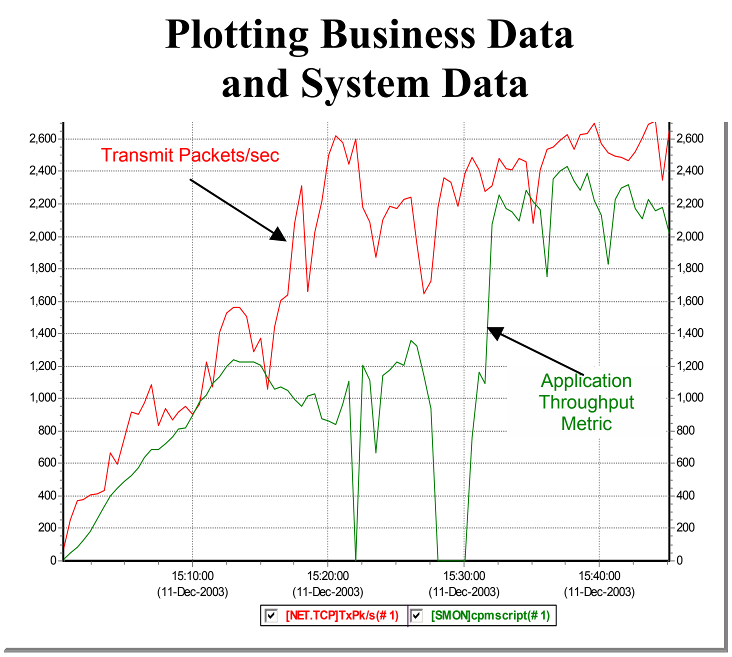


Figure 10 -- Plotting Business Data and System Data

This chart is taken from an intense benchmark. The Red Timeline represents TCP/IP packets transmitted per second. The Green Timeline represents an important customer measure of throughput. Note how they both track each other until about 15:15 and then again after 15:30. However in the 15 minutes in between, throughput for the customer throughput metric falls off sharply and in fact goes to zero on several occasions. A chart like this will tell you (rather loudly) that something very important happened in those 25 minutes. These kinds of graphical results serve as wake-up calls. It's likely you will want to or need to learn more about what really happened so you can explain the drop in throughput. This would be a time to review the other timeline statistics in your TLC data for the same period.

Since that first benchmark and proof-of-concept of T4 and TLC, a lot has happened. What we are now calling "T4 & Friends" has taken on a central role in OpenVMS Engineering's performance work – especially our collaborative efforts with OpenVMS customers and partners. This has been especially so when dealing with complex, live, mission-critical production workloads on the largest OpenVMS systems.

T4 and Friends includes the many subsequent improvements, extensions and elaborations to the original timeline data extractor and collectors combined with a growing set of downstream capabilities for extracting even more value from the universal TimeLine Collaboration (TLC) files so created.

T4 & Friends today includes many different synchronized collection utilities gathering literally hundreds of columns of important performance data and saving it in a universal TLC-format. T4 & Friends also includes a growing list of capabilities and methods for manipulating, analyzing, learning about, charting and reporting on TLC data contained in ready-to-use CSV files.

With the successful use in this first benchmark project, the Original T4 and the subsequent post-processing with Excel was added as a standard part of our OpenVMS Engineering performance tool kit and found wider and wider use as time went on.

The ability to turn important OpenVMS MONITOR performance data from any OpenVMS system into a visual timeline graphic was one of the key driving forces in the early development of the Original T4.

We have traveled far since these early steps with T4 including the development of highly automated and time-saving approaches for comparing two sets of data in a series of single Before-and-After graphs. Figure 11 is an example of one such chart. We will return to this idea later in more detail, for example in Figures 25 and 26.

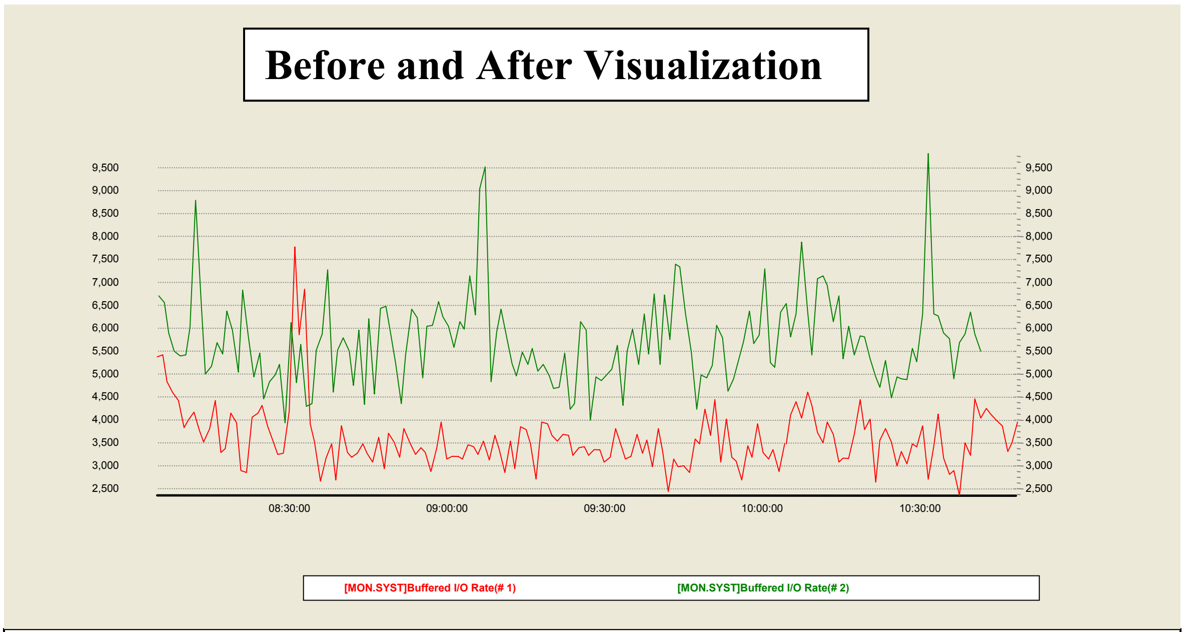


Figure 11- Before-and-After Visualization

In this example, we have mapped timeline data for Buffered I/O (a throughput variable in this particular case) taken from two different runs. This is a classic **before-and-after** comparison. It's one of the many downstream steps you can take once your data is transformed into the readily viewable TLC-Format. Note in this example how the throughput rate for the Green timeline regularly exceeds the Red timeline by approximately 1.5X. Try estimating this yourself using visual comparison and visual math.

Using the T4 Tool Kit to Get Started with TLC

What is in the T4 Tool Kit?

The original T4 extractor has since evolved into version T4V32 and version T4V33 kits. Each kit consists of collectors, extractors, synchronizers and other capabilities. We'll use "T4" or "T4V3x" or "The T4 Kit" to refer collectively to these current versions.

The T4 Kit has now become a mainstay of all OpenVMS Engineering performance work. This includes widespread use as part of collaborative projects with customers and partners on their most important systems. Most recently, the T4 kit proved to be an essential data gathering arm that fed the success of the GS1280 Performance Proof Point (P3) Project (as presented in the November 2003 ENCOMPASS webcast).

Six Collectors – More than a Dozen Views

Over the past three years, T4 has evolved and improved so that it now draws data from **six different independent sources** and literally hundreds of variables, giving us a more complete view of the underlying performance drivers that can impact OpenVMS systems. Each collection source produces its own two-dimensional TLC-format table as output. The six collectors offer more than a dozen separate views of data, each view with its own unique set of individual metrics.

Other enhancements in the T4 kit include automation of historical archiving, automated integration and synchronization of the separate TLC-format CSV files, DCL-driven control programs suitable to individual customization, and the optional ability to Zip and mail resulting TLC data. These added features have continued to make the T4 kit an ever more useful productivity enhancer and time saver for anyone interested in OpenVMS performance.

Because of the straightforward structure of the DCL code for launching and managing six collectors, new collectors can be added and synchronized quite readily as they become available.

Accessing the T4 Kit.

The T4V32 kit is now publicly available for download from the web at

http://h71000.www7.hp.com/OpenVMS/products/t4/index.html

The T4V33 kit is now shipping automatically in the **SYS$ETC** directory in OpenVMS Alpha Version 7.3-2. Both T4V32 and T4V33 are suitable for AlphaServer systems running Version 7.2-2 or higher.

For earlier versions on Alpha and for use on VAX, the T4V2A version (written in DCL) is available from the OpenVMS freeware CD at:

http://h71000.www7.hp.com/freeware/freeware50/t4/

Versions of T4 collection will also be provided for use on HP OpenVMS Industry Standard 64 Evaluation Release Version 8.1 for Integrity Servers.

System Health Check (**SHC**) has added T4-based timeline collection, analysis and reporting to its extensive list of OpenVMS capabilities. SHC is offered by HP Services' Mission Critical and Proactive Services and is widely used on customer OpenVMS systems with Gold and Platinum Support.

The latest SHC version for OpenVMS includes new performance rules based on the TLC data captured by T4. SHC is a suite of assessment tools and services that provide a thorough, broad assessment of customers' computing environment by identifying security, performance, configuration and availability problems before they can impact the customers' critical operations. SHC assessments are executed against sets of best practice system management rules.

Those OpenVMS AlphaServer customers already signed on to the SHC service have the option of using the embedded T4 kit to turn on historical timeline data collection and archiving on their systems. For more information on SHC check out:

http://www.support.compaq.com/svctools/shc/

Increasing T4 Kit Use on Production OpenVMS Systems

With this widening public availability, many OpenVMS customers and partners have taken the T4 kit and begun applying it. Some are using it with default settings to create performance histories for their most important OpenVMS nodes. Others are taking advantage of the kit's natural extendibility and have been customizing it for their own use with excellent personal results. We are starting to receive feedback outlining some of our customers' most useful extension ideas. We plan to consider these for possible inclusion in future versions of the standard T4 collection and historical archiving kit.

Collect First, Ask Questions Later.

There's the old saying from Western Cowboy movies about "'shooting first and asking questions later." We feel the same way about collecting and saving timeline data, about turning on timeline history creation now and deciding later how best to use it, and about how best to leverage the **TLC** (**T**ime**L**ine **C**ollaboration) format data so collected.

Don't Delay.

There are many ways one might create readily reusable TLC historical data for your OpenVMS systems. Pick the one that works best for you. Whatever you decide, we strongly suggest you don't delay in beginning a TLC collection process. For a wide variety of OpenVMS system statistics, the T4 kit is readily available for this purpose and we suggest you consider it as one of your options to get a quick start.

We recommend you collect and save TLC data even if you are not going to look at the data right away or anytime soon, or even if you don't know yet what you want to look for.

We recommend you collect TLC data even if you don't yet have the ideal downstream tools you have dreamed of to post-process this data into graphs and charts and squeeze the maximum value out of it.

We recommend you collect TLC data even if you don't have anyone locally available who is a whiz at Excel or at SQL queries or at writing your own special new utilities that extract value from TLC data by building on top of existing graphical or statistical packages.

Business Statistics Deserve the Very Best Treatment.

We recommend that you also begin to build TLC collectors or extractors for your most important business metrics and add these into the historical mix. In many cases, these statistics are the ones that are most important to your success. They deserve the very best treatment.

Like other statistics, the timeline behavior of essential business statistics will change over time, will show peaks and valleys and perhaps sudden dramatic changes, repeated cyclical patterns, or unusual erratic behavior.

If you are not already capturing this timeline behavior for your business metrics, the value you might have extracted is unrecoverable. We suggest you find a way to get some kind of timeline capture turned on as soon as is practical for you. Building your own collector that directly generates TLC data would be the most desirable choice if it turns out to be at all possible.

You may already be capturing timeline business data and saving it in a non TLC-format. If, however, this vital data has for all practical purposes proven inaccessible to you due to time, money, complexity, access, or expertise, we suggest you consider finding a way to extract a TLC version of that data and integrate it with our other key TLC metrics.

Compatible Use of TLC with Other Timeline Utilities

Some of you may already be collecting timeline history in non-TLC-formats using other OpenVMS utilities. This is great. Don't stop. Continue to use these tools and the timeline data they provide to extract value that benefits your systems.

In addition, please note, that a substantial number of customers and partners are already successfully creating TLC data (using the low-overhead, non-disruptive T4 kit) on systems that are running other performance timeline collection software. The T4 kit's low overhead at its default setting of 60-second sampling means that you can use it virtually anywhere, including in conjunction with these other performance tools.

Once you turn on TLC collection on your most important systems, we believe you will discover that the TLC approach based on T4 & Friends offers you capabilities that enhance and extend any you may already be using – especially in the areas of saving your precious time and letting you look at some key performance variables not otherwise available.

We would enjoy learning about your experiences and impressions as you follow up on some of these ideas. You are welcome to forward your thoughts on TimeLine Collaboration to the author.

An Automatic Payoff of Substantial Size

Once you begin creating TLC histories, you dramatically change your ability to collaborate with and communicate with OpenVMS Engineering and with OpenVMS Ambassadors about the performance issues that are most important to you. While there are some other wonderful performance tools out there, within OpenVMS engineering we have radically diminished their use. Wherever possible, we have switched to TLC based on T4 & Friends for our collaborative efforts with customers and partners.

Wherever possible, we have switched to TLC for our collaborative efforts

The main reasons are the ease of T4 collection, the increasing number of new upstream collectors that extend our view, and the growing power of the downstream Friends of T4. Together, this combination helps us generate more and better TLC data and extract more value from the accumulating reservoir of results. We have found this approach to be an order of magnitude more efficient for us in our personal time use. We think you will find similar savings to be true for you once you get started.

The TLC-based model is open-ended and readily extendable, as you will learn below. This will simplify synchronization with your most important business data and with data from other collectors and extractors.

For all these reasons, when it comes to timeline data we recommend that you "Collect first and ask questions later". You won't be sorry.

What is TLC-format Data?

Two-Dimensional TimeLine Collaboration Tables

TLC-format data is simply a two-dimensional table of timeline data saved in CSV (Comma Separated Value) format. These files obey a few basic rules. By convention, each row represents **exactly one** time interval; each column represents **exactly one** important performance variable. The first column, known as "Sample Time", contains the date and time at the end of each interval. Think of these files as being in **TLC Normal Form** (**TNF**)

WARNING: Not all CSV files are in TNF. For example, files which generate multiple rows of data for a given time period do not satisfy the TNF requirement of exactly one row per sample period. Such files are in CSV format, but cannot be readily graphed by tools such as Excel. The timeline data is there, but further time-consuming programming or manipulation is required to make it useful. If you want your timeline data to be readily and immediately re-usable by downstream Friends of TLC such as Excel, you must make sure that it obeys the basic rules above.

For historical reasons, many TLC-format files have a total of four header lines with the important fourth line being the column header. In these files, the first line contains comment information in a CSV format. The second line contains only the calendar date at the start of sampling. The third line contains only the time of day for the first sample. Future versions may loosen these rules about headers and make them more universal – in particular by making the second and third lines optional. If you are going to create new TLC-format files, consider sticking with the original T4-style format for now, as all of the downstream friends of TLC-format data are then fully available to you.

Sample Time	Variable 1	Variable 2	Variable 3	Variable 4	…
10:21	37	58	107	19	
10:22	44	51	128	12	
10:23	29	74	103	25	

TLC Normal Form (TNF) - A fragment of a TLC-format two-dimensional table

A Standard, Widely Accepted, Universal Output Format

The widely used CSV file format is the current output standard for TLC-format two-dimensional tables. What this means is that a wide range of existing tools ranging from spreadsheets to databases have **built-in capabilities** for reading TLC-format files automatically. This opens the door for the full power of these already available tools to be applied to any TLC-format data. This can be extremely handy if you or someone on your team happens to be a whiz with Excel or an SQL giant.

Conversion to or from other useful two-dimensional timeline formats is also readily possible with minimal programming. The two-dimensional underlying format is a completely universal way to represent any and all timeline data from any source.

Open-Ended, Synchronizable Data

The standard CSV format means that data from other important timeline sources can be integrated and synchronized whenever it becomes available. By definition, each TLC-format CSV file contains internal timestamps that allow the possibility for later synchronizing timeline data from multiple independent sources.

Synchronization is especially helpful in making sense of the most complex performance situations

Our experience within OpenVMS Engineering tells us that synchronization is especially helpful in making sense of the most complex performance situations. The current T4V32 and T4V33 kits contain a utility (APRC – APpend ReCord) and the DCL code to drive it that automatically combines the timeline data from the current set of six independent timeline collectors in the kit while carrying out some rudimentary synchronization steps.

Readily Programmable Data

The easy to read and understand CSV format also means that new tools can be written that load the TLC-format data into memory with zero or minimal programming. Then, precious programming time can be employed in carving out new capabilities and methods. These could cover the range of examining, manipulating, graphing, analyzing, or reporting on the timeline data.

Ready programmability is not a theoretical property of TLC. Our experience in OpenVMS Engineering and in HP Services over the past three years has yielded impressive results with the creation of tools such as TLViz and CSVPNG and other downstream Friends of T4 as we will learn below.

A Universal Approach

By obvious convention, the T4 kit turns all of its timeline data into TLC-format CSV files. The good news is that it is possible and not difficult for **any** collector of timeline data to automatically create T4-style or TLC-format output on the fly as each timeline sample is captured. For example, four of the six current collectors directly generate their timeline output in CSV format.

This is, as they say, an SMP problem: a Simple Matter of Programming (or perhaps a Simple Matter of Priorities).

Alternatively, timeline data in **any other internal format** can (without huge difficulty) be extracted and converted into TLC-format – another “SMP” problem. The T4 kit includes an extractor that creates timeline columns for logins and logouts. This extractor uses the log data time-stamped in the standard OpenVMS Accounting Log File, searching that file for logins and logouts, accumulating the numbers for each sample period, and then writing the records to the CSV file row by row. This extractor is quite interesting in that it also adds some extra value on the way out by counting the number of logins and logouts of short duration, for example those less than 1 minute in length and those less than 5 minutes in length.

The kind of approach we used with the OpenVMS Accounting Log is readily replicatable to other log files. It could be applied to a whole raft of other collection utilities to extract selected variables not otherwise available and to turn their timeline data into the universal TLC-format.

Follow-up Questions for Timeline Data in Log files

The questions below may help you identify some opportunity areas to extract vital log file data that is not readily available to you today.

Question 1. What vital timeline data relevant to the mission critical purposes of your OpenVMS systems is currently locked inside some log file to which you have potential access?

Question 2. What is the internal format of that log file?

Question 3: What would be the estimated cost to build an extractor that grabbed key statistics from that file and turned them into TLC-format data?

NOTE: This log file data might now be captured by another system such as the one that supports your company's telephone exchange. Many systems log each transaction with a time-stamped record. Don't overlook this potentially invaluable source of vital performance data that can complement TLC data from other sources.

Timeline Data in Text Files

Another possibility, albeit a somewhat clumsy one, is to capture timeline data as a series of repeated time-stamped entries in a text file and then later automate the parsing and processing of that file to turn key metrics into CSV format. This is important if there are impediments to working directly on the collector program to have it write out the TLC-format CSV file itself. We have done this quite successfully with a number of prototype collectors to capture some vital stats that would otherwise not have been easily available to us in timeline format. While messy, this kind of collector can be readily and speedily constructed whenever needed at modest cost.

Follow-up Questions for Timeline Data in Text Files

The questions below may help you identify some opportunity areas for you to first create and then extract vital data from text files where such data is not readily available to you today in a reusable format.

Question 1. What statistics that are vital to the operation of your OpenVMS systems might you capture as time-stamped entries in a text file? For example, you might do this using a DCL script with a timer loop and an embedded call on an application command that gives total throughput counts for key functions.

Question 2. What's the estimated cost to you to build a suitable extractor to parse this text file and transform the vital statistics into a TLC-format?

Because the TLC-format CSV files are but one of many possible universal ways to format timeline data, note that other SMP programs could be readily constructed (as needed) to transform any TLC-format data into a chosen alternative universal format such as XML or a set of Oracle, Rdb, or MySQL tables.

The Bottom Line for TLC-Format Data is that it is Readily Reusable

TLC-format data can be used as a universal approach to timeline data. Any timeline data from any source (including but not limited to any OpenVMS performance data collector) can be converted to TLC-format data.

Many have already taken up the call. TLC-format collectors or extractors have been written for performance data from Oracle, Rdb, and from customer business statistics such as response time, throughput, internal application queueing, or even such things as sales volume attained by clerks using the OpenVMS system. More collectors and extractors generating TLC-format data are sure to follow as the universal T4 & Friends timeline-driven approach and its benefits become more widely known among the OpenVMS community.

The bottom-line payoff from TLC data is that it is ***readily reusable*** in ways that promote communication and collaboration. This means that it is:

- Readily programmable for new purposes as they are thought up.
- Readily or even instantly viewable.
- Readily synchronizable with other TLC data sources.
- Readily comparable to other TLC data sets.
- Readily extractable into reduced form.
- Readily sharable.
- Readily publishable in documents, presentations, and to the web.

T4 & Friends – What is Available Today?

As use of the T4 tool kit proliferated, as more and more TLC-format histories were generated, and as the range of uses of the T4 tool kit and TimeLine Collaboration (TLC) format two-dimensional timeline tables widened, it became clear that capabilities beyond those offered by Excel's processing of CSV files could prove immensely helpful. Within OpenVMS Engineering, we discovered quite quickly that not everyone who wanted to use a timeline-driven approach was comfortable with using Excel as his or her main post-processing, value-extraction engine.

With more and more valuable timeline data beckoning, a growing number of other tools, methods, techniques, and approaches have evolved and have proven successful in helping OpenVMS Engineering enhance our timeline-driven approach to performance. We have come a long way from the Original T4.

Here's an abbreviated summary of current capabilities (as of early 2004) to give you a taste for ways in which T4 & Friends might prove directly useful to you.

The T4 Tool Kit (T4V32 and T4V33)

The T4V32 and T4V33 tool kits are a good place to start your exploration of T4 & Friends. See the Readme.txt file in the kit for full details. These kits include scripts that automate historical timeline collection using six separate collectors or extractors, as well as utilities for synchronization, mail distribution, and near real-time snapshots.

You can examine the Readme.Txt file and download the T4V32 tool kit from http://h71000.www7.hp.com/OpenVMS/products/t4/index.html

The T4V33 tool kit is now shipping with the release of OpenVMS Alpha Version 7.3-2. You can find the kit in the SYS$ETC directory.

T4V3x collection can be a useful adjunct to your existing performance management program, and it co-exists peacefully and with low overhead with all other major OpenVMS performance data collectors. Whatever performance collectors you depend on today, we recommend that you also consider turning on low overhead T4 history creation.

Creation of such a TLC history will automatically open the way for your improved collaboration with OpenVMS Engineering in the future, whenever this might be valuable, useful, or even necessary for you. Of course, as you learn more about T4 & Friends, you will also find that your growing T4 timeline history (building automatically day by day) will powerfully extend your ability to manage performance on your most important systems and complement your existing performance capabilities and tools.

The T4V3x kit includes the T4EXTR.EXE utility – a classic example of a timeline extractor. T4EXTR converts the raw MONITOR.DAT files to CSV format and generates literally hundreds of columns of data. T4EXTR can be used manually as needed to re-examine the same raw MONITOR data and extract additional and more detailed columns of data. For example you can use it manually to find out about specific named process use or about RMS use for files for which you have turned on RMS monitoring. This utility includes several options for customizing and selecting which columns you wish to generate (ALL, CPU, DISK, PROCESS, SCS, RMS).

Two DCL scripts,T4$CONFIG and T4$COLLECT (called "HP_T4_V32" in the T4V32 kit), map a default approach for collecting data every day and transforming it into TLC-format CSV history files. Because these are written in straightforward DCL, many T4 Kit users have already found these scripts to be readily customizable for specific local purposes. These scripts allow you to automatically launch all current collectors and then to combine data from the different collectors into composite CSV files.

These scripts provide low overhead monitoring by using a default 60-second sampling interval. They also include a rough automatic synchronization of data from different collectors, some rudimentary storage management, optional mailing, and, most importantly, the automatic creation of a detailed long-term timeline history for that OpenVMS node in TLC-format.

The current list of collectors/extractors in the kit includes:

- MONITOR (T4EXTR)
- XFC
- Dedicated lock manager
- TCP/IP system wide traffic
- Network adapters traffic (you can request one collector for each such adapter)
- Login and logout activity (using the standard accounting log and an associated extractor)

The combination of MONITOR and T4EXTR alone deliver more than a dozen different views of OpenVMS performance, each view with many independent statistics. For example, the **SYSTEM View** includes such statistics as CPU IDLE, MPSYNCH, KERNEL, BUFFERED IO; and the **LOCKING View** includes such statistics as CONVERTS and ENQUEUES.

Customizing the T4 Tool Kit Scripts

As you look at the T4 kit's two controlling DCL scripts and the ways in which each new collector is included, you will likely conclude that adding your own new collector (for example, one for your most important business statistics) will be a relatively straightforward extension whenever you are ready to do so. You won't be sorry if you consider making some investment in understanding the capabilities of these two DCL scripts.

Industry Standard or Other Widely Available Friends of TLC-format Data

With the Original T4 extractor, we fed its output data in TLC-format CSV files into Excel. Then we tapped Excel's many capabilities for manipulating the columns of timeline data, for calculating averages and percentiles, and for creating a virtually infinite variety of individually customized timeline graphics representing the findings of our analyses. This proved a great advantage to those experienced with Excel and provided an immediate positive visual payback for our investment in the MONITOR to TLC extractor program.

Since then, others have taken TLC data (including, but not limited to T4 captured data) and fed it into a variety of databases (Microsoft® Access, Oracle 9i, Oracle Rdb, MySQL). They then used their expertise with those tools to query and report on the growing storehouse of timeline data.

Others have used OpenVMS utilities such as FTP, MAIL, COPY, Zip, Unzip, Uuencode and appropriate DCL wrappers to move their TLC data exactly to where they wanted it for further processing. TLC-format CSV files typically benefit from relatively high compression ratios when being zipped for transfer.

TLC data have been transformed into WMF (Windows Meta File) graphic files and then imported into Microsoft® Word or PowerPoint for explaining the results. Various drawing and annotation tools come in handy in customizing the results. The illustrations in this article are an example of what you can do with the additions of arrows, text boxes, or circles.

TLC data has been converted to PNG (Portable Network Graphics) images and embedded in HTML web pages. Using Apache Web Server, Mozilla and PHP (all running on OpenVMS), TLC-format graphical outputs can now be published on demand to the web by those comfortable with OpenVMS' extensive web-based capabilities.

Bottom Line – Readily Reusable

Any TLC-format CSV file from **any** source is **instantly usable and readily reusable** by widely known, widely available utilities for analysis, reporting, data transfer, or publishing. TLC tables can be readily converted to graphic timeline images and the images to industry standard graphic output formats such as WMF and PNG. These images, in turn, can be incorporated in desktop publishing documents or even published dynamically to the web. In other words, once key timeline data is converted to the universal TLC Normal Form (**TNF**), everything we can imagine doing with this timeline data is possible and some of those things are immediately available for the asking.

Figure 12 gives a highly simplified picture of the direct transformation from TLC-format data to visual image.

[MON] Sample Time	**[MON.MODE] Mp Synch**	**[MON.MODE] Kernel Mode**
10:09:42	270	188
10:10:42	301	192
10:11:43	230	169
10:12:43	278	178
10:13:43	321	202
10:14:43	316	215
10:15:43	329	218
10:16:43	414	215
10:17:44	418	188
10:18:44	384	181
10:19:44	352	200
10:20:44	463	208
10:21:45	466	210
10:22:45	505	224
10:23:45	433	227
10:24:45	503	213
10:25:46	341	217
10:26:46	391	209
10:27:46	342	242
10:28:46	346	215
10:29:46	344	212
10:30:47	326	199
10:31:47	285	199
10:32:47	275	190

The Direct Transformation From TLC Data to Visual Timeline Graphics

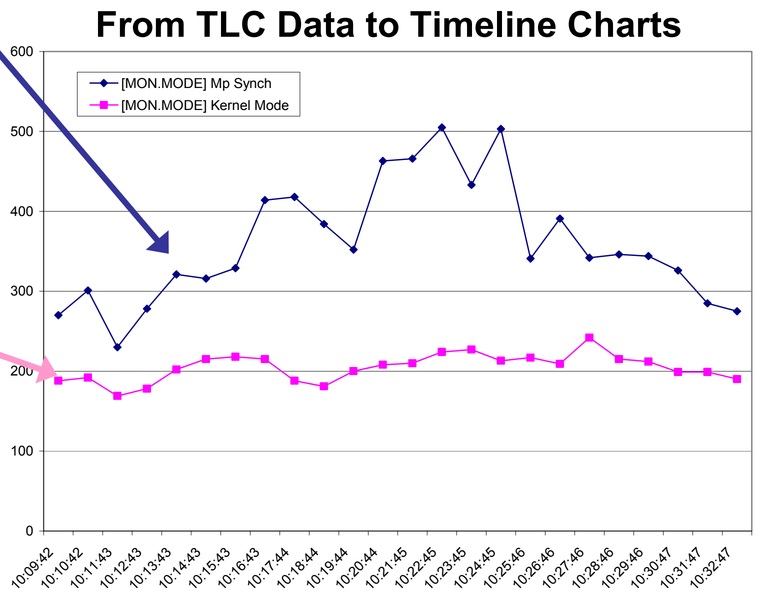


Figure 12 – The Direct Transformation from TLC Data to Visual Timeline Graphics

The three-column table at the left of this chart is a fragment of a TLC data file created by a T4 collection kit. The timeline graph at the right is a direct mapping from the columns of data into visual format created in less than a minute using Excel. TLC data is instantly visualizable.

HP-Developed Downstream Utilities

The "upstream" collection of performance timeline data and the filling of a large reservoir of online storage with TLC history files are, of course, not ends in themselves. As the reservoir of TLC data grows, the **potential** value of that data bank grows with it. To turn that potential value into actual value requires selectively drawing off some of the data and flowing it downstream into mechanisms whose very purpose is to extract that value.

TLC tables can be readily converted to graphic timeline images and the images to industry standard graphic output formats

Excel was our first such downstream tool, and its use with TLC data created a powerful proof point. It demonstrated the large potential value of historical timeline data when saved in a readily reusable format. Since then, HP has undertaken a series of independent development efforts of downstream utilities to help extract even more value from performance timeline data saved in TLC-format. These include: extensions to the System Health Check offering from HP Services, and two other **internal use** HP utilities.

- A productivity-enhancing, interactive, timeline visualization tool (TLViz).
- A powerful command-line driven tool for manipulating and charting TLC data (CSVPNG).

System Health Check Service. Automated T4 collection is now a standard part of the improved System Health Check (SHC) service used by many OpenVMS customers. The new SHC automatically runs a T4 collection, creates TLC-format CSV files, applies a set of expert rules, and then reports and graphs the results as part of the overall SHC output. So if you are already using SHC, you are already making good use of and benefiting from T4 collection. For more information about SHC, please contact your local HP Services representative or check out: the following web site:

http://www.support.compaq.com/svctools/shc/

TLViz and CSVPNG. TLViz stands for TimeLine Visualizer, and CSVPNG stands for an automatic CSV to PNG (Portable Network Graphics) converter. TLViz and CSVPNG are interesting in their own right as well as being an excellent demonstration of the wide range of possible value-extracting downstream uses that can be made of TLC-format data. We have used these extensively with tremendous effect. They have dramatically changed the way OpenVMS Engineering does its most important performance work. These tools have demonstrated how easy it is to unlock some of the value captured by TLC-format universal timelines.

Once key timeline data is converted to TLC, everything we can imagine doing with this timeline data is possible and some of those things are immediately available for the asking.

TLViz (TimeLine Visualizer) – A Visual Demonstration of What's Possible

TLViz is an excellent example of what we mean by a "friend of T4." TLViz is an **internal** tool developed and used by OpenVMS Engineering to simplify and dramatically speed up the analysis of TLC-format CSV files and to assist the subsequent reporting and sharing of our findings with others.

The combination of T4 timeline-driven collection and TLViz has literally changed our lives in OpenVMS Engineering. TLViz is a Microsoft® Windows PC utility (written in Visual Basic and using TeeChart software as its graphics engine). TLViz permits the analyst to carry out the most common graphical functions on these large timeline data sets with the fewest possible keystrokes when compared with alternative methods that we have tried. Within OpenVMS, we estimate that TLViz personally gives us an order of magnitude speedup and productivity increase in our own analysis work with this kind of highly multi-dimensional timeline data drawn from multiple sources. Figure 13 is an example of a TLViz output that tells a powerful before-and-after story.

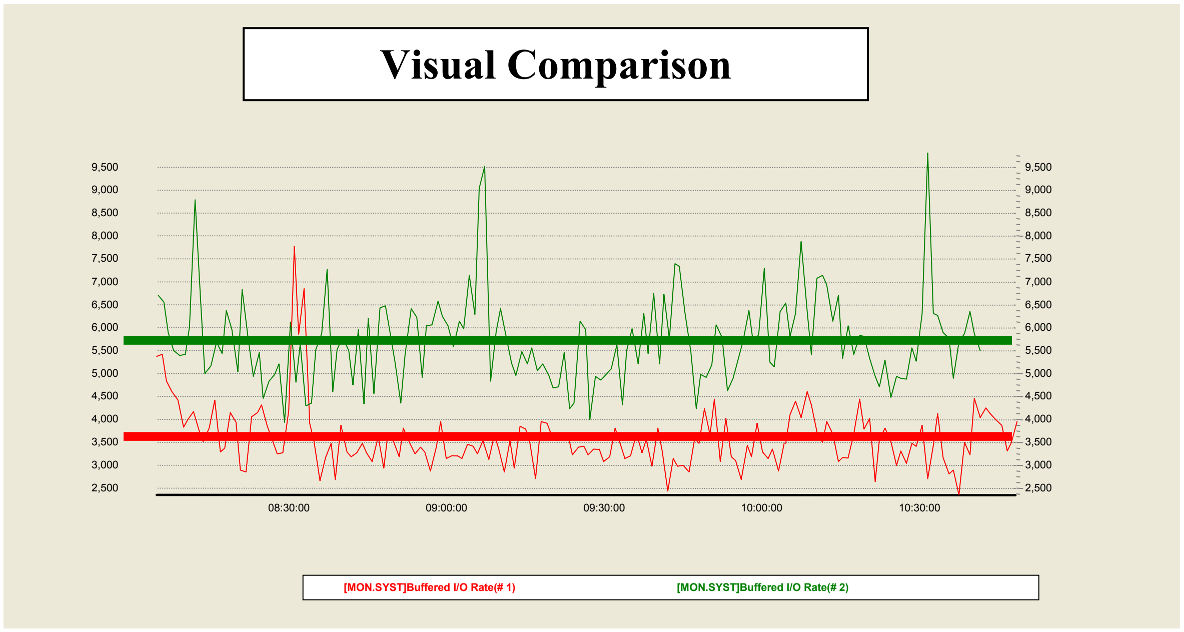


Figure 13 – Before-and-After Visualization

This graph is an example of one of many possible outputs that can be generated by TLViz. The solid red and green lines were manually added later to aid the visual comparison process and add to the chart's visual explanatory power. They were drawn by hand to represent the approximate average value for the two different cases. We did this based on visual inspection and visual approximation of "typical" behavior during the period. Of course, because all the underlying data for each of the plotted timeline points is still available in the TLC-Format files for these two measurement periods, the actual exact average could be readily computed and plotted as needed.

When TLViz opens up a TLC-format CSV file, the names of each performance variable appear in a standard Windows selection box. The names of the performance variables are drawn from the column header for each column of timeline data in the TLC file. By simply clicking once on the performance variable in which you are interested, the visual timeline graph for that variable appears immediately in the graphing window.

With the CTRL-key held down, you can decide exactly which set of variables to map together. Or you can use the arrow keys to move, one graph at a time, through the literally hundreds of variables – getting a quick overview of the underlying patterns – all in a matter of minutes.

TLViz includes features such as mouse-driven zoom, scrolling, stacking, unstacking, correlating, automatic scatter plots between pairs of variables, column arithmetic, and saving a zoomed-in selected set of rows and a subset of the selected columns to a new, more compact TLC-format CSV file.

Reporting with TLViz

Whenever you see a display you want to save, TLViz lets you add your own title and then export it to a named WMF file for later use. Consider creating a special sub-directory for each analysis session where you can conveniently save the graphs you generate. This feature has proven to be a powerful memory aid. It is also a wonderful collaboration feature as these WMF files often form the basis for the creation of reports and presentations (further downstream) that will share the results of analysis with a wider audience. TLViz allows several other output formats for these graphics. We have found through experience that the WMF outputs work the best. They offer clean graphics with no perceptible loss of resolution, they work well with the standard Microsoft tools such as PowerPoint, and they are relatively well compressed compared to other formats. Documents and presentations containing many such graphical elements also tend to show excellent further compression when these files are zipped for transfer.

TLViz also allows you to open up to five TLC-format CSV files. It then automatically overlays the results for you each graph you select. For example, selecting the column header for Buffered I/O Rate, TLViz would graph the Buffered I/O Rate timeline for each of the currently open files. Figure 14 shows a simple example of this feature.

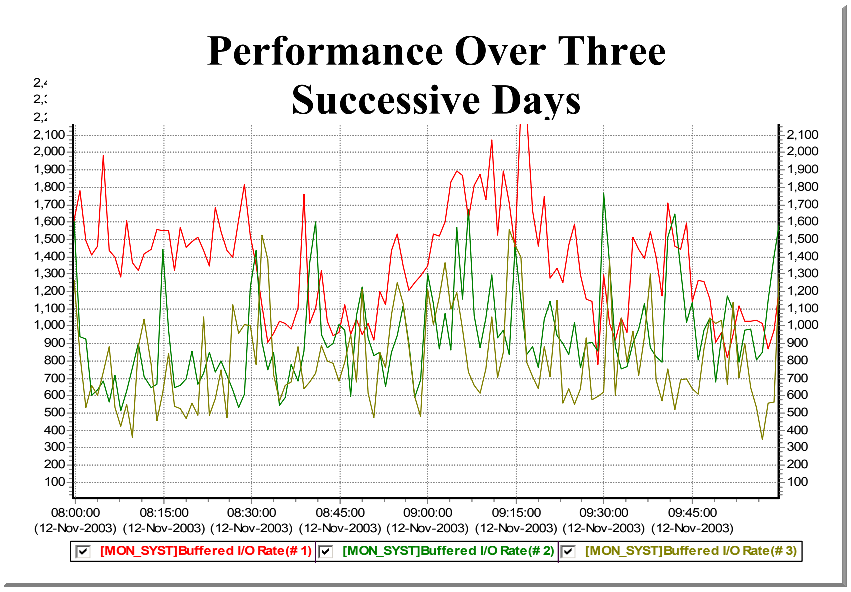


Figure14 – Performance Over Three Successive Days

Comparing Buffered I/O between 8 AM and10 AM over three successive days on the same system, it's clear that the throughput was highest on the first day (Red). The second and third days were about the same, with a slight edge to the second day (Green).

Before-and-After with TLViz

Arguably, the most useful case we have seen is using TLViz' multiple file open feature to do rapid **Before-and-After** analysis when the system under investigation has experienced some form of important change – for example, a significant slowdown on a live production system. This could also be useful for looking at upgrades to new versions of software or hardware, for quantifying the benefits from a series of tuning changes, or for understanding the impact on key resources caused by the introduction of a new application workload.

T4 collection tools, TLC-format data and TLViz' Before & After feature, were instrumental in the success of our GS1280 "Marvel" Performance Proof Point (P3) approach as presented at the ENCOMPASS webcast in November 2003. We plan to apply a similar P3 approach (built on T4, TLC, TLViz, CSVPNG and other friends of T4) to new performance situations. Performance proof points are popular because they help us all more clearly understand and more accurately quantify the actual benefits of performance change. A P3 approach lets us set expectations more precisely for performance improvements. We see near term application of the P3 approach as customers with heavy TCP/IP loads and scaling bottlenecks on large production systems upgrade to OpenVMS Alpha Version 7.3-2 and TCP/IP Version 5.4 with its new scalable kernel option.

If you haven't already tried a visual before-and-after approach to look at differences captured in timeline data, we cannot recommend it to you too strongly. A very similar Before-and-After approach can be achieved with CSVPNG, with Excel, or other similar tools. The key to success is to be careful selecting suitable sample days to be **representative** of the before-and-after, and then looking at many independent graphical comparisons. If something has changed by as much as 5%, it will show up in the graphs in a way you won't be able to miss.

Synergy between T4 Collection, TLC-format Data, and TLViz

As we noted earlier, the standard format for TLC data includes several header rows. The first such row is reserved for comment information saved in a CSV format. The latest T4V3x tool kits make good use of this first row of the TLC table to store details about the measured OpenVMS system. These include:

- The AlphaServer node name
- The version of OpenVMS in use
- The version of TCP/IP in use
- The number of CPUs
- The amount of memory employed
- The sampling interval used
- The version numbers of the T4 kit components.

TLViz makes these background details captured at the time of measurement available to the viewer through use of a "Properties" selection from the "File" pull-down menu.

TLViz' Properties feature works for any file in TLC-format. So if you begin to create your own TLC files with your vital business metrics, remember to put background information relevant to that data in the first row, so that it will be available for future review. This might include version numbers of key application or database software or other attributes and properties that are highly specific to your business environment.

Other Uses of TLViz' Multiple File Open Capability

In addition to the powerful before-and-after visualization, TLViz' multiple file open capability can also be used to compare and contrast performance as it changes from Monday to Friday. It can also be used to examine the relative load on different nodes in an OpenVMS cluster for a given day.

Side-by-Side Collaboration Using TLViz

TLViz has proven to be a remarkably powerful tool for side-by-side collaboration. It has allowed us, in selected cases, to have two or three performance analysts work together analyzing a particularly complex problem. The GUI interface, the ability to point to graphical details on the screen, to make suggestions for adjusting what to look at and then seeing the new picture in a few seconds has led to some excellent synergistic problem solving.

TLViz has also proven to be a great way to share results with others quickly without producing a formal report. The basic model looks like this. Having previously studied the situation and noted the important factors, an analyst can use TLViz to project important graphs one by one to the audience. Audience questions can trigger the analyst to shift gears and bring up a graph or a series of graphs that helps answer the question, and then resume with his or her presentation. When you are presenting interactively and live to an audience, the ability to point at features as needed and as driven by the discussion can often add an incredible benefit beyond what can be pre-packaged in a report that cannot possibly anticipate every question. Think of it as a blackboard or whiteboard with built-in automation.

The success of these collaborative approaches with TLViz has a lot to do with the speed at which new graphs can be created. TLViz offers a model GUI design that has transformed the most important activities you might want to carry out on timeline data and timeline graphs into single keystrokes or mouse clicks.

CSVPNG – Command-Line Driven Capabilities

CSVPNG (CSV to HTML and PNG converter) is a newer, command-line driven utility with many options. CSVPNG runs on both OpenVMS and in DOS on Windows PCs. Like TLViz, it allows you to directly open one or more TLC-format CSV files. Its original capability, which led to the CSVPNG name, allows it to open a TLC-format data file, specify a set of selected columns to be graphed, and then to automatically generate an HTML page with PNG embedded graphics for each selected column. Figure 15 is one of many outputs possible through use of CSVPNG.

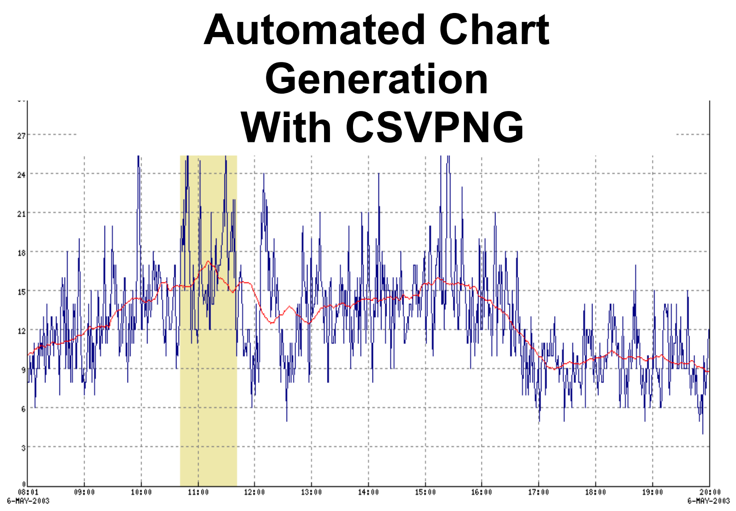


Figure 15 –Automated Chart Generation with CSVPNG

This sample output from CSVPNG shows a moving average for MPsynch in red and the peak one hour period for MPsynch in the shaded area. The individual MPsynch samples are shown in blue.

CSVPNG includes the following capabilities:

- Graphing multiple variables in a single chart
- Opening multiple TLC-format files and overlaying the results
- Calculating and displaying moving averages
- Identifying peak periods
- Carrying out correlation calculations
- Performing column arithmetic
- Applying user-written expert rules.

CSVPNG also has powerful capabilities for "slicing and dicing" a TLC-format data file and producing a much more compact file as output. For example, you could use it to select only the data from the peak one hour period and reduce it further so it outputs only your personal favorite list of 17 performance variables.

Because it is command-line driven, CSVPNG is programmable and already some have demonstrated how CSVPNG combined with Apache Web Server, Mozilla, and PHP (all running on OpenVMS) could dynamically publish T4 timeline graphs from an OpenVMS web-enabled server node. We have even seen demonstrations of near real-time graphical reporting by combining all these tools.

We expect that CSVPNG will become much more widely used for our OpenVMS Engineering performance work in the coming year as we all become more familiar with the full range of its capabilities and potential for extracting value from TLC data. It's not hard to predict that CSVPNG is likely to be at the leading edge of our continuing enhancements to the TLC approach in this coming year.

Use of Internally Built Tools Outside of OpenVMS Engineering

TLViz and CSVPNG have dramatically changed the way OpenVMS Engineering does its most important performance work as visual diagnostic tools, as visual collaboration tools, as visual presentation tools, and as incredible productivity enhancers and time savers during analysis and reporting.

Seeing our success, a number of customers and partners have made their own business case for gaining access to these tools and are reporting back to us the productivity gains they have achieved by using them. If you are interested in learning more about TLViz or CSVPNG, please send your request for more information to the author, steve.lieman@hp.com .

If you already feel you have a strong business case for gaining access to either of these *internal-to-HP* "Friends of T4", please forward your request to the author.

As an analogue to the saying "if you build it, they will come", with TLC-format data, we believe that "if you collect it, they will build." TLViz and CSVPNG demonstrate that once you place important data in universal, readily programmable form, it truly is an SMP problem to take the next incremental steps.

Consequently, we will not be surprised to see other powerful downstream utilities come into existence over the coming months to do even more magical things with the rich storehouse of data now being accumulated.

Other Friends of T4

Building Your Own Downstream Tools

TLViz and CSVPNG are powerful proofs of the concept that the universal data in TLC-format timeline files is readily programmable in ways that start to squeeze the value from this rich timeline data source. Many other uses of this data are possible and potentially even more valuable. We hope some of you will consider constructing your own downstream tools that extract further value from TLC-format data and that you will share the results of your success with us.

It's important to note that both TLViz and CSVPNG did not burst, full-fledged onto the scene. They both started with a basic set of capabilities and then added new features based on feedback from early users. Both of them built upon existing very powerful graphical utilities and did not try to duplicate those capabilities but rather just provided an interface to expose the power of graphing to everyone without further programming.

Refer to the section detailing TLC-format data for the definitions you will need to start building these tools. Further details are available in the README.TXT file included in the latest T4V3x tool kits.

And while you are thinking about what tools you can build, don't forget to turn on your TLC timeline history collection today if you haven't already done so. That way, you'll have the detailed TLC history data you need once your new tools are ready.

Other T4 Style Data Collectors

As we noted earlier, the current T4V32 or T4V33 umbrella utilities actually drive six independent collectors or extractors and then later combine, integrate, and synchronize data from all of them into a single, consolidated TLC-format CSV file with literally hundreds of individual variables represented. T4V3x automates a consistent start time, end time, and sampling interval for all six streams of data. We plan to add new standard collectors to future versions of T4Vxx as these become available.

Even better, **anyone** with important performance data can write their own TLC-format collector or extractor and create their own completely universal TLC-format CSV files in TLC Normal Form (**TNF**).

The minute that you turn your key performance data into universal **TNF**, all of the old and all of the new and evolving downstream capabilities for manipulating, analyzing, graphing, and reporting automatically become available to you. For example, you might consider converting application response time data for key business transactions into a reservoir of TNF data and then reaping the downstream benefits.

Even better, if you follow some simple, standard rules for TLC-format collectors (see next section for details), your newly minted data will line up with and synchronize with and be combinable with all the data from the standard T4 collection utilities and with any other collector that also plays by these same rules. We have barely scratched the surface.

Synchronization Reveals Relationships that Truly Matter

We simply cannot stress how important and valuable the synchronization of data from multiple collectors can be for any type of performance situation with which you will be faced in the coming year. This is especially true when business data such as response time or application throughput can be combined with underlying system statistics, with network statistics, and with database statistics. The ability to rapidly identify cause and effect relationships that really matter is increased many fold. Identification of the most important time periods to zoom in on is also greatly aided by bringing multiple views of data into play.

Although the TLC based T4 & Friends approach is relatively new, many important unique collectors have already been built and integrated with T4V32 data with excellent results by those who have taken that path. These include:

- Key Oracle statistics from Oracle 7, 8, and 9
- Key Rdb statistics
- Customer application response data
- Customer application throughput data

Several OpenVMS customers have already created single composite pictures of performance on their most important mission-critical systems that include their vital response data, their key database statistics, and the full set of current T4V32 statistics from its six collectors. They have used the standard APRC utility included in the T4V3x kit for this purpose.

APRC simplifies combining and synchronizing data captured from multiple sources and is as readily available for your specially built collector as it is for the current six standard T4V3x collectors.

When it comes to TLC-format collectors, literally anything you can think of is possible. We're hoping to see many such new TLC-format collectors pressed into useful service and (where possible) shared in the coming months.

Many important statistics do not yet have their own, easy to use collector. Can you help?

Don't forget to turn on your TLC timeline history collection today.
The minute that you turn your key performance data into universal TNF, all the downstream capabilities for manipulating, analyzing, graphing, and reporting automatically become available to you.

Building Your Own TLC-format Collector

Here are the rules you will need to follow so that your TLC-format collector will generate data that can be synchronized with other TLC-format data sources.

Your collector requires four input parameters:

- Start time
- End time
- Sample interval duration (default for T4V3x is 60 seconds)
- Output file name for TLC-format data in CSV format

No Drift Make sure that your collector's samples do not drift later and later. This insures that your collector will have exactly the same number of samples for a given measurement session as other **no-drift** TLC collectors. Unfortunately, some collectors we have known do in fact drift. For example, there are some collectors where each sample starts some given number of seconds (for example 60 seconds after the end of the previous one). Because it always takes at least a small amount of time from the beginning to the end of each sample, the next sample actual completes in the specified number of seconds plus a little more after the end of previous sample. Over time, these small delays mount up and drift occurs. While in most cases, you can live with this, drifting makes synchronization more difficult. For new collectors, drifting must definitely be avoided for best results. **Good News:** The long-standing drift experienced by those using MONITOR has been eliminated with OpenVMS Version 8.1. Those running OpenVMS Alpha Version 7.3-2 or earlier will experience some MONITOR drift and should be prepared to deal with it by exercising caution downstream during analysis. A workaround is available for use on earlier versions of OpenVMS. Please contact the author for details if you feel this would be helpful to you.

There will be a number of header rows (currently 4 for historical reasons). The first row of TLC-format files includes important comments about the measurement session in a CSV format. The second row has the calendar start date of the measurement. The third row has the start time of the first sample.

The last (currently 4th) header row will be the column headers naming the individual variables being measured. This will also be a comma-separated list of values. The first column header in this row, by convention, includes the text "Sample Time" for TLC-format data files.

Many TLC collectors and extractors have used an initial text string in square brackets to identify the collector. For example, the collector for XFC data uses "[XFC]" as its initial string for each measured dimension such as Read I/Os per second. Similarly, many TLC collectors or extractors that have multiple views include the view name in the initial bracketed string. For example, MONITOR has many views such as SYSTEM, IO, LOCKING, and PAGING. The starting string for the MONITOR SYSTEM view would look like: "[MON.SYST]". This would be followed by the metric name, for example "Buffered I/O Rate". While this convention is not mandatory for TLC-format data, it has proven useful in practice. For example, more than one collector might use the same text string such as "I/ O per second" for one of its metrics. Without the initial string identifying the collector, you would end up with duplicate column names.

Each sample period will generate exactly one row in the output. These samples will start in the fifth row using the current definitions for TLC-format

Note:
The idea of one row per sample period is absolutely vital if you want to create readily reusable and instantly visualizable results.

Commas will separate entries for each measured variable. If a particular variable is not available for a sample, a comma will be written nevertheless as a place holder for that variable. This insures that each logical column of data in the resulting two-dimensional table lines up and represents exactly one variable. In other words, the Nth variable always will end up in the Nth+1 column

The first column will have the date and time as its data value. We have chosen the convention that the time of a sample represents the time **at the end of the sample period**. To insure proper synchronization of data from multiple sources, make sure that you also use the interval end time as your timestamp value.

Ideally, samples from each TLC collector will start on major time boundary consistent and modular to its chosen sampling interval. For example, when using sixty-second sampling, it proves helpful to start exactly on a one-minute boundary. Ideally, samples will follow a **No Drift** pattern and, therefore they will be evenly spaced, without any missing samples. Where samples from multiple independent collectors are available, it will also be helpful if they all start and end at the same time and use the same sampling rate. By making collection properties uniform, downstream synchronization is more readily realized. However, the world is often imperfect, samples are missed, collectors drift, starting times may differ, and so on. When extracting value downstream from reservoirs of TLC data, it always pays to be on guard for imperfections in the gathered data. This is a fruitful area for future TLC enhancements and improvements.

Wherever possible, limit the TLC files you create to a maximum of 255 columns since Excel and MS ACCESS have a 255-column limit. Tools such as TLViz and CSVPNG can easily handle a much larger number of columns (1000 or more). If you consider building your own downstream tool to extract value from TLC files, it will be best if you make sure that you can handle higher numbers of columns. We have already introduced and are looking into some further changes in T4 kit collection to keep its standard number of columns generated under Excel's 255-column limit. Excel offers some useful features that are not available in other tools, and it’s always best when we don’t have to reinvent the wheel.

Rules for generating output files for extractor programs are identical. With extractors, the actual data collector may be **event driven and continuous** rather than having a start time, end time, interval approach to collection. For example, T4V3x uses time-stamped event data from the continuously collected accounting log file to compute the number of logins and logouts in a given period and then writes the result to its TLC-format data file.

In many cases, new TLC-format collectors and extractors have been written in rather short order. For example, the first Oracle 7 collector prototype with about 20 key variables was completed overnight. Other collectors have started with a small number of variables collected in version 1 and then readily added new metrics to the collection process as time went on.

What collector do you want to build?

Techniques for TLC-format Data

Let's say you have begun to create daily timeline TLC-format CSV files for your most important systems and that you have even written a few of your own collectors to capture and save a timeline history of your most important business metrics. What kinds of things can you do with data like this that help you manage your performance situation even better than in the past?

The three primary reasons for wanting to capture timeline data in the first place are the assumptions that:

1) Key performance metrics vary over time.

2) The mix changes in unpredictable ways.

3) Averages can often be misleading.

Now that you have timeline data, the obvious first step is to observe how all your key indicators change over time. For most people this means converting the columns of data in TLC-format into visual, colorful, easy to understand graphs.

Graphing Single Indicators, One by One

It's of course possible to create very complicated timeline graphs with dozens of variables represented. There is so much data, so little time, and so much at stake. We have found that the place to begin in almost all situations is to look at the shape and pattern of the timeline curve for each key variable you have collected. We recommend that **Step One** simply be: graphing single metrics one at a time as shown in Figure 16.

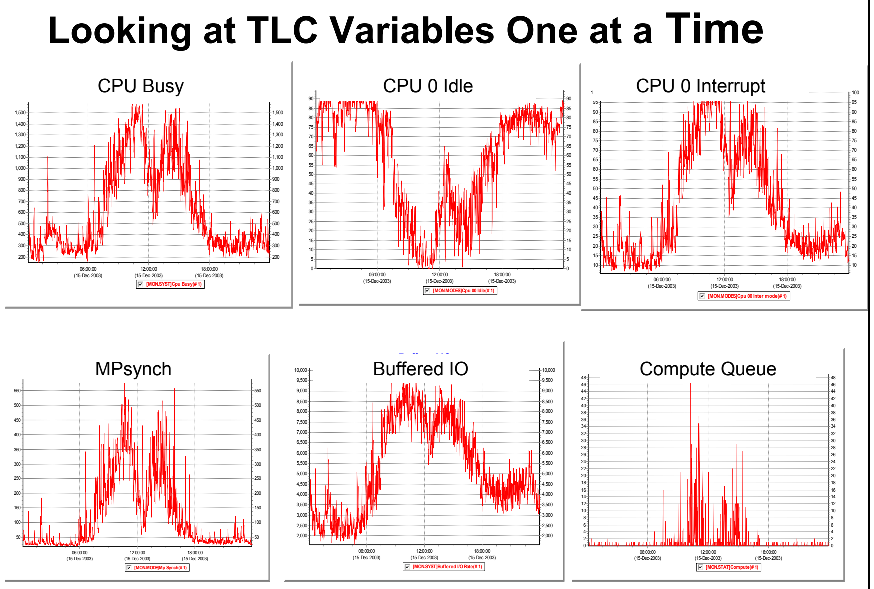


Figure 16 – Looking at TLC Variables One at a Time

Here we use Edward Tufte's concept of **"small multiples"** (see Envisioning Information, Graphics Press, 1990) to look at six key performance variables - one at a time, and all at the same time. These were taken over a 24-hour period from T4 data on a heavily loaded GS160 system with 16 CPUs. Note how four graphs show similar morning and afternoon peaks and lunchtime lull, while the CPU Zero Idle graph shows a reverse pattern. This data was captured as part of our GS1280 Proof Points Program and shows the "Before" case. This particular signature pattern (high MPsynch, heavy interrupt on CPU zero, high buffered I/O rate) is a classic sign of a system that is likely to benefit substantially upgrading to the GS1280.

Here's what to look for: You are going to look for peaks and valleys and their duration. You might attempt to visualize an average value. Be on the watch for short-lived spikes of behavior and whether these show some kind of periodic repetitive pattern. Also, watch for square-wave patterns and pay attention to rising and falling trends. We've already shown an example of visualizing the average and quite a few examples of peaks and valleys. The next two illustrations (Figures 17 and 18) show examples of these two cases: a systematic short-lived spike and a repeating square-wave pattern.

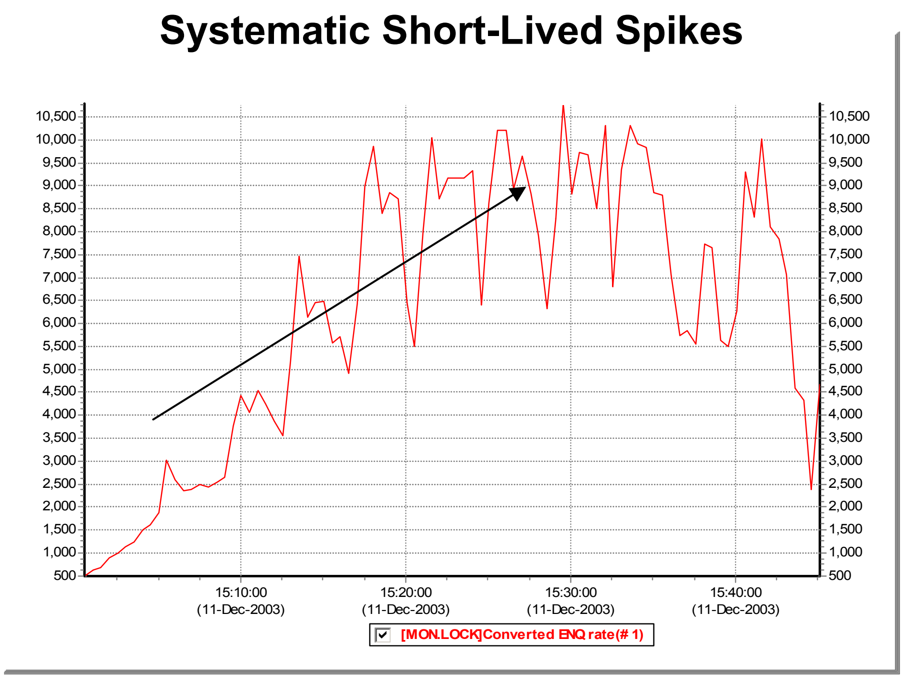


Figure 17 – Systematic, Short Lived Spikes

This chart shows the Converted Enqueue Rate from a heavy benchmark run. The peaks occur about 4 minutes apart and last for multiple samples (30- second sampling in this case). The valleys also come about 4 minutes apart but typically last for only a single sample. Systematic spikes like this are important, because they usually signal some significant underlying cyclical behavior. Also notice the rising trend from 15:00 to 15:30.

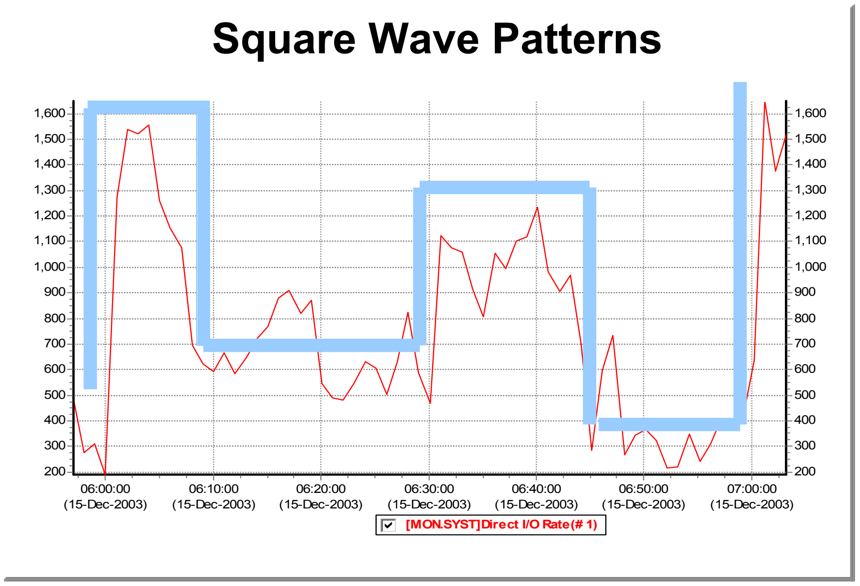


Figure18 – Square Wave Patterns

Square waves are frequently important in performance analysis activities. They typically indicate the start and end of distinct periods – periods when ***"THE MIX"*** of the type of work has changed or where sudden changes in load have kicked in. We have found in our analysis that it's often useful to focus on only one such period at a time. Identification of square wave behavior for key variables gives you the information you need to make sure you are not averaging data from distinct periods together. This chart shows several successive, measured, square-wave patterns with the Red Timeline. The pale blue hypothetical square wave is shown for reference. Real data is messy, but with a little practice, it's pretty easy to identify these kinds of square wave patterns. SUGGESTION: Check back on some of the previous graphs to see what other square waves you can discover.

Plugging in Local Intelligence

There will always be some data and information and background intelligence about your system that is not captured by any one of your current set of TLC-format collectors. For example, perhaps Monday is always the busiest day of the week for you because a certain kind of backlog builds up every weekend. Or your disk activity is highest Friday night, because that's when you always do your full backups. Or your company just ran a full-page nationwide advertising spread that has quadrupled your call volume on your inquiry line.

Because it is your system and your local intelligence information, you and your local colleagues are likely to be the only ones who are aware of this very special kind of data. As you are looking at the metrics collected, you will want to bring this very specific local knowledge into the picture as you try to make sense of what you are seeing.

As you move from graph to graph, it's often useful to posit hypotheses that try to explain and connect the patterns you are beginning to see and relate them to your specific knowledge of the local system.

Quite often a similar pattern will appear in many graphs, for example, a predictable lowering of activity during the lunch hour, and a gradual tapering off at the end of the day, followed by a heavy load when overnight processing jobs kick in, followed by an early morning quiescent period before the workday begins. Figure 19 is an example of how you might use timeline charts to identify similar patterns

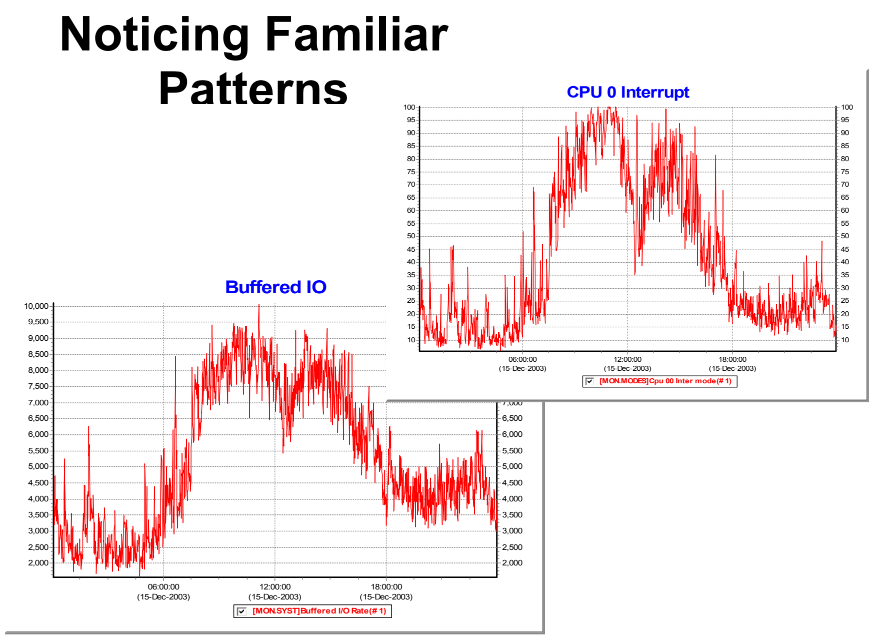


Figure 19 – Noticing Familiar Patterns

Here we examine Buffered I/O and CPU Zero Interrupt activity for a full 24-hour period. The obvious morning and afternoon peaks and lunchtime lull we have already discussed. Look closer in these charts, and you will notice the slight but steady increase in load from 9PM till about 11:15 PM, and a sharper drop off before midnight. You will also notice that the load from 6PM to midnight is higher and more stable than the load from midnight to 6AM. These patterns are important. They can help you know where and when to look and assist you in identifying unique periods of behavior that would benefit from individual analysis rather than being clumped or averaged with other dissimilar periods.

Forming More Complex Pictures

After you have taken stock of key variables one by one, you have mentally prepared yourself for the next step and are ready to create more complex pictures of the data to test your hypotheses. The natural thing to do here might be to graph several variables together at the same time and see if their shapes overlap or move more or less to the same rhythm. You may want to zoom in on peak periods to have a closer look at the behavior at that time. In some cases, you may want to stack several metrics together to create a composite view.

With the right downstream tools such as TLViz, this analysis work can be done independently or collaboratively. Groups of two or three can work simultaneously on the toughest problems. In our small group work within OpenVMS Engineering and with our customers, we have repeatedly proven the collaborative benefits that accrue when you the have real-time ability to work directly with the TLC data to: visualize timeline patterns, point out graphical details to each other, discuss openly their meaning and significance, and propose and then check out hypotheses by graphing other related data.

You might also want to try scatter plots between two related metrics. When doing this, keep your eye peeled for non-linear relationships (see Figures 20 and 21) that might reveal a potential bottleneck. You might also watch for signs of multi-modal distributions of these two variables indicating that the "mix" had changed.

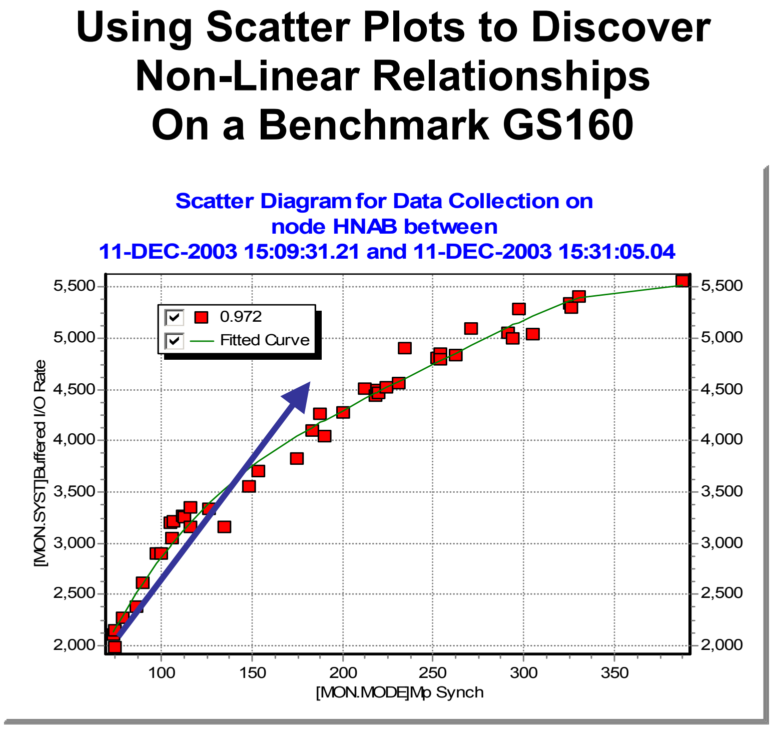


Figure 20 – Using Scatter Plots to Discover Non-Linear Relationships On a Benchmark GS160

Sometimes it's helpful to suppress the time-dependent aspect of TLC data when looking for relationships between metrics. Scatter plots often provide a new view that's not obvious when looking only at the individual timelines. In this chart from a GS160 benchmark run, we plotted Buffered I/O against MPsynch and discovered substantial non-linear behavior. The red squares represent the individual samples plotted. The green line is a curve fitted to the data points. The blue arrow has been added to point out the direction that linear behavior would have taken. Non-linear behavior like this is often a sign of diminishing returns. In our GS1280 Proof Point Project, this pattern proved another signature for recognizing systems that would benefit from upgrades to the GS1280.

Using Scatter Plots to Discover Non-Linear Relationships On a Live GS160

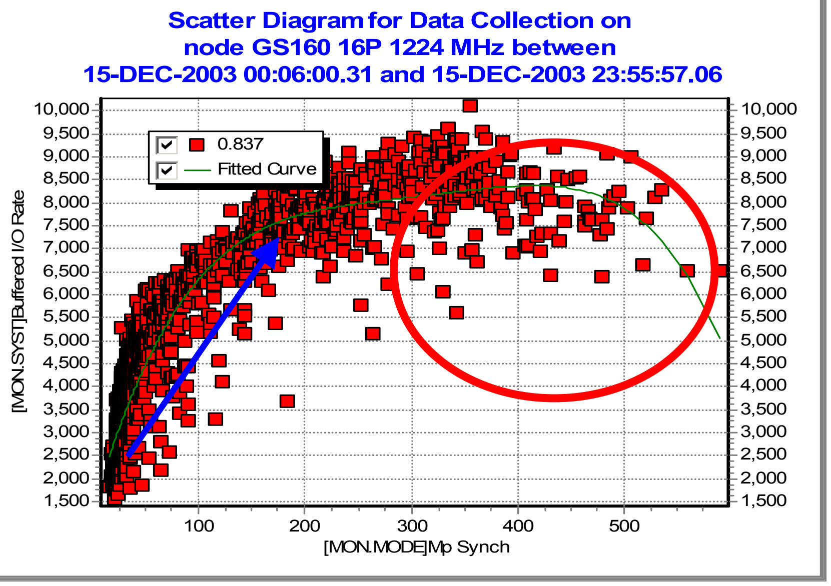


Figure 21 – Using Scatter Plots to Discover Non-Linear Relationships on a Live GS160

This chart plotting Buffered I/O against MPsynch from a live, heavily loaded production GS160 system is even more revealing. The red squares again represent the individual samples plotted, the green line is a curve fitted to the data points, and the blue arrow points out estimated linear behavior. The red circle has been added to bring your attention to what happens when MPsynch pushes past 300%. Notice that the maximum achievable Buffered I/O rates actually begin to diminish. This particular system benefited mightily from its upgrade to the GS1280 as a result of the GS1280's proven ability to handle MPsynch demands so much more efficiently than previous hardware platforms.

If the data is quite erratic, you might want to create a moving average to smooth things out. That way, the overall pattern might be more easily detected. Figure 22 gives an example of how moving averages can sometimes simplify the overall picture.

Smoothing with Moving Averages

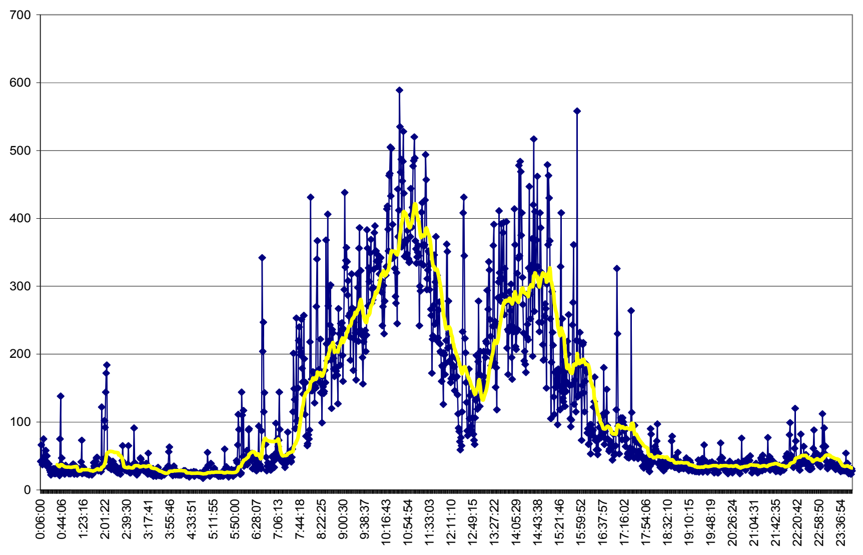


Figure 22 – Smoothing with Moving Averages

This chart created with Excel shows rather erratic MPsynch data from the production GS160 as a blue timeline with a 30-minute (noticeably smoother) moving average added in yellow.

When you see an irregular pattern like this, you might also want to consider capturing data more frequently to see if there is some underlying, explainable, square-wave pattern at work

Or, you might want to do some column arithmetic (for example, divide metric 1 by metric 2 to create a new normalized metric). This can sometimes prove extremely revealing and help you better understand the points when the mix changes.

For example, if you took total CPU busy and divided by the rate of business transactions per second, you would get a metric that represented CPU consumption per transaction (see Figure 23). Typically, you will want to represent this value in either milliseconds or microseconds used per transaction. Of course, it may not be technically correct that all those CPU cycles actually are directly used for the measured transactions but that does not invalidate this approach. When the mix stays about the same, our experience shows that the ratio of CPU to transactions would also stay about the same. When the mix changes, the ratio will often change, sometimes radically. When the mix returns to the original value, the ratio will change back to its original value and range. This can produce some striking square wave patterns that are clear visual indicators of a changing mix.

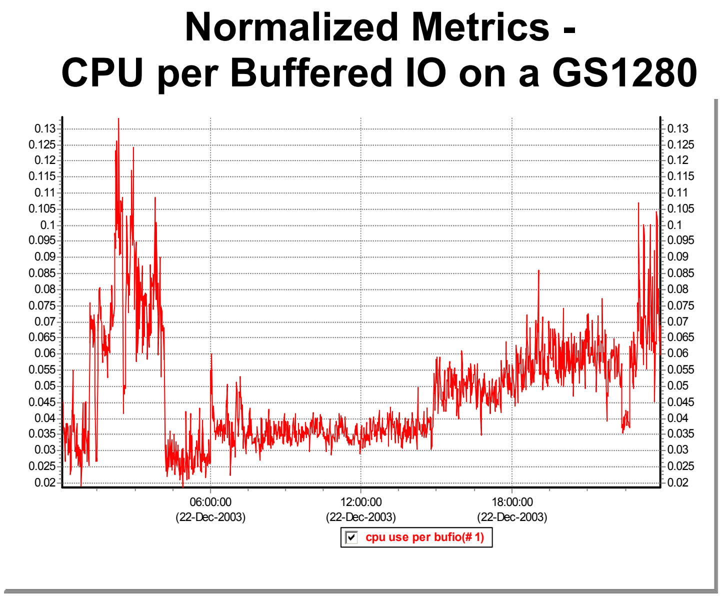


Figure 23: Normalized Metrics – CPU Per Buffered I/O GS1280

This chart shows the normalized metric of CPU (in hundredths of a second) per Buffered I/O on a large production GS1280 system. This is an excellent example of normalized metrics exhibiting square wave patterns that then let you see when the load and mix have taken a dramatic change. Notice the very steady behavior from 7AM until about 3PM and the radically different behavior from Midnight to 6AM. The steady daytime pattern is a strong indicator that the overall mix of activity stayed nearly the same despite what we know from other charts to be rather large swings in load, morning peaks, lunchtime lulls and so on.

The overnight picture is a strong indicator of a series of changes in the overall mix of work.

Figure 24, puts the normalized CPU per BUFIO data to good use by combining it with the Before-and-After technique to reveal patterns that might otherwise have not been detected.

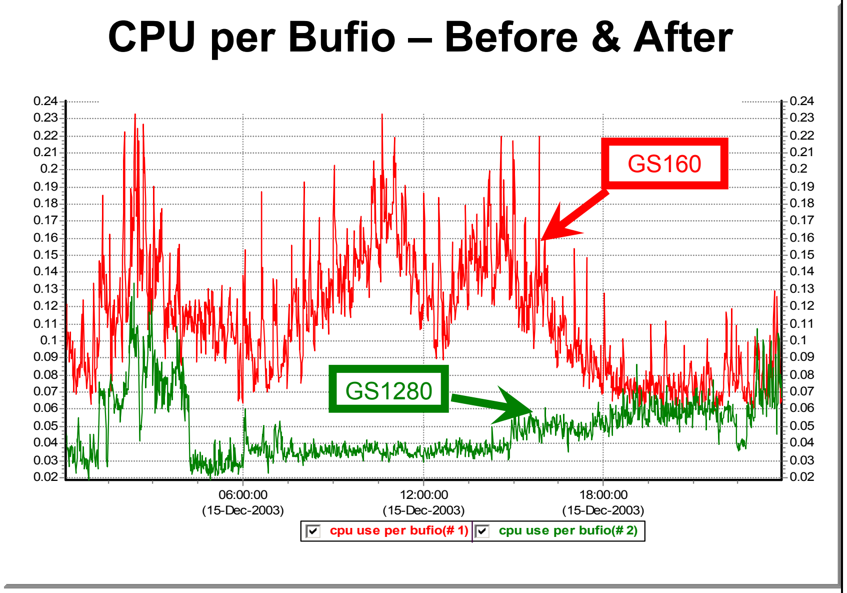


Figure 24: Before-and-After with Normalized Metrics

This before-and-after chart shows the same normalized metric of CPU per Buffered I/O (in hundredths of a second) for a GS160 that was upgraded to a GS1280. This chart will repay careful study. Note how the lunchtime lull pattern appears for the GS160 (red) but not for the GS1280, despite the fact that from throughput metrics such as BUFIO per second we know that both systems had very the classic lunchtime lull loading pattern. What hypotheses can you come up with that explain this difference?

Visual Memory – Your File System is Your Friend

As you go along, you will find that certain graphs you create stand out and tell an important part of the story you are forming in your mind. You are going to want to save these graphs. These might be saved as named files in WMF, PNG, GIF, JPEG or some other convenient graphic format for later reference. If you are working in a tool like Excel, you can save the key graphs on their own separate and named worksheets. Whatever tool you are using for analysis, remembering the most important graphs is an absolutely key step of any such project.

For example, most of the timeline charts in this report were created using TLViz to generate named WMF files. These files were later inserted onto individual PowerPoint slides. Titles, arrows, and circles, were added as further annotation to produce a slide that could then be inserted into the Word document for this article. The time-saving properties of TLViz to help you find exactly the graphs you want (the graphs that tell the story about what is happening), coupled with time-saving ways that TLViz can help you remember this story have proven indispensable on this project as they have on dozens of others over the past several years.

When you are done with your analysis, you will often find that you have a dozen or more such graphs and that you can come back to a data set, weeks later, and remember where you left off in pretty short order by reviewing your full set of visual reminders of the work you have already done.

Reporting on Your Findings

Once you have completed your analysis, you will often have a need to present your results to others inside and outside your organization. This usually works best when you select a simplified subset of your visual memory system that fits your audience. Different audiences quite commonly have different needs. What succeeds and communicates well with a technical audience of performance experts might not work as well for a non-technical audience, for example, those with application access to the system who depend on its rapid response to get their job done.

While you may have used dozens of graphs to figure out, in depth, what actually happened, once your analysis is complete, perhaps only two or three graphs with accompanying captions and explanation will be needed to make your case with others. The remainder of your collection of graphs will be there as a visual reminder that can be called on as a strong backup for the case you are making whenever further proofs are needed.

You may wish to come back and customize or annotate the graphs or create new copies for these purposes, but you will likely find that a wide audience of both technical and non-technical people will readily understand your handful of timeline graphical explanations.

Bottom line: TLC-format data and the timeline graphs that flow readily from them can be a powerful visual story-telling mechanism that will get your point across with maximum effect in the minimum time. This can be done in documents and PowerPoint presentations. With a tool such as TLViz, the key timeline data sets can also be shared visually and interactively to tell the story and to foster further discussion with audiences large and small.

Understanding Change: The Power of Before-and-After

With TLC-format data collected and saved in a historical archive each day, you are perfectly positioned to deal with the changes over time on your most important systems. These changes could be intentional such as upgrades to new software versions, or such things as inexplicable slowdowns that have been thrust on you from who knows where.

We have found a simple Before-and-After technique to be incredibly powerful and full of explanatory magic in these situations. The basic method is to use local knowledge of the system in question to select a ***representative*** day from "BEFORE" the change, and a ***representative*** day from "AFTER" the change.

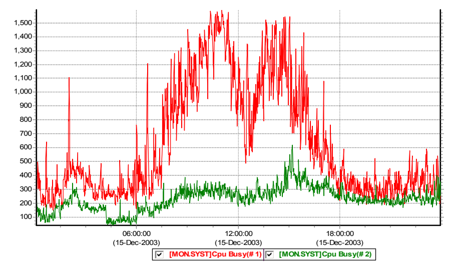
NOTE: What a ***representative*** day mean is, of course, always subjective and often difficult to assess. Making good choices depends on explicit knowledge of what's happening on site with the systems being measured. Until you have proven experience that your assessment of "***representative"*** is accurate, we advise a cautionary approach where you would sanity check your results by selecting several days from each period and examining and comparing before-and-after results of each of the days within each period.

The data for key indicators from the Before-and-After TLC-format data sets could then be overlaid, one metric at a time.

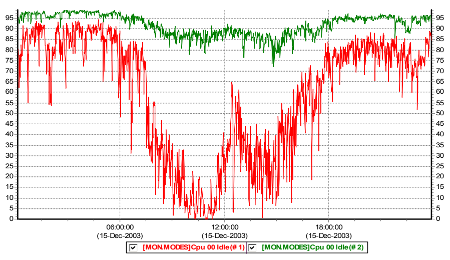
The overlay of exactly two timelines brings into play our powerful human abilities for visual averaging, for visual comparison, for visual arithmetic, and for visual hypothesis formation and sanity checking. If something has changed that impacts performance, that difference will show up clearly in the overlaid before-and-after timeline graphs for at least some (but probably not all) of the key metrics. And the metrics where the changes are most dramatic will invariably give you clues to what is really going on and why. Figures 25 and 26 on the next two pages give examples of the power of this approach drawing from two GS1280 proof points.

The Power of Before & After Upgrading a GS160 to a GS1280

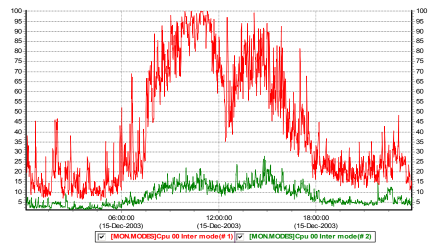
CPU Busy



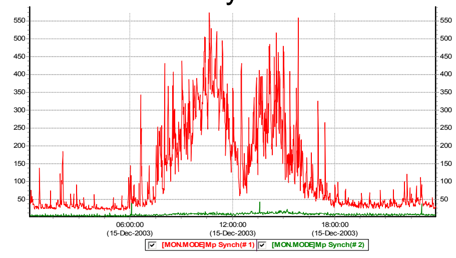
CPU 0 Idle



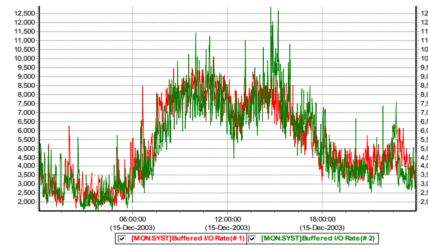
CPU 0 Interrupt



MPsynch



Buffered IO



Compute Queue

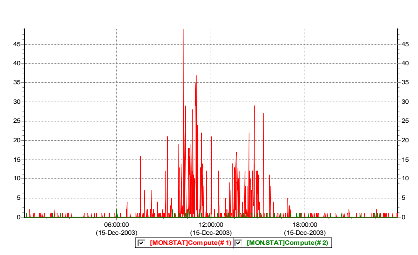


Figure 25 -- The Power of Before & After: Upgrading a GS160 to a GS1280

This set of charts shows the amazing night and day differences we observed when a heavily loaded GS160 (red) was upgraded to a GS1280 (green). This set of charts represents one particular classic case we have seen over and over as part of our GS1280 Proof Points Project (P3). Note the huge drop in CPU busy during the peak periods (UPPER LEFT), the virtual disappearance of MPsynch and its non-linear effects (BOTTOM LEFT – the green line for the GS1280 is almost invisible on the bottom of the chart), and the creation of substantial spare capacity on CPU 0 (UPPER CENTER). In this case, the underlying workload demand had not changed during the upgrade so the Buffered I/O chart (BOTTOM CENTER) shows virtually identical behavior. What's happened here is that substantial spare capacity (perhaps 3X or more) for additional future work has been created by the upgrade and this customer can now begin adding load to this system to match the needs of their growing business.

The Power of Before-and-After: Part II Another Classic Signature Pattern

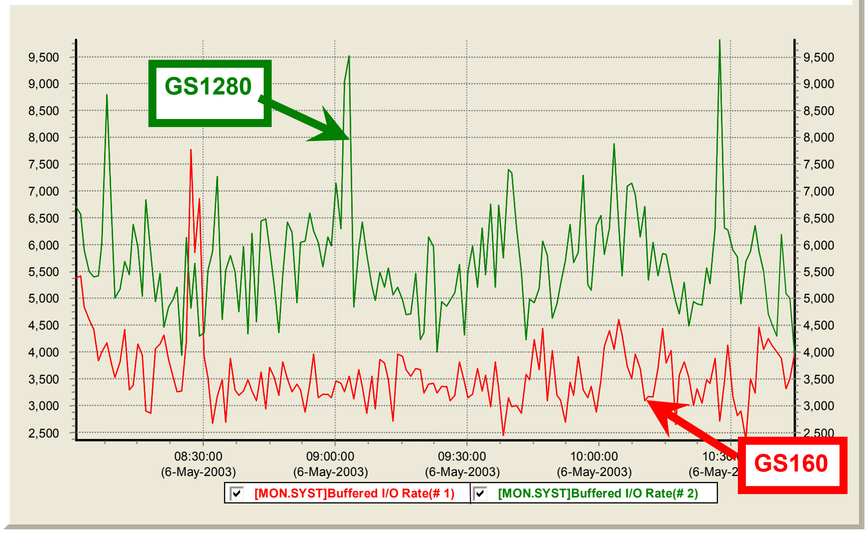


Figure 26: The Power of Before-and-After - Part II – Another Classic Signature Pattern

Again, drawing from our GS1280 P3 work, we compare changes in Buffered I/O throughput for a production system upgrade from a GS160 to a GS1280. In this case, the GS160 was maxed out, and the customer already had a substantial backlog of demand during the peak periods that just could not be completed in a timely manner. With the upgrade to the GS1280 came not only large increases in spare capacity (as shown in the previous example), but also an immediate payback in higher throughput (approximately 1.5X) to handle the existing workload backlog.

If you haven't already tried the before-and-after technique, we strongly recommend that you check out how this approach can help you more fully understand the changes taking place on your most important systems.

The GS1280 Performance Proof Points (P3) Project borrowed heavily and benefited mightily from this approach as demonstrated with many of the examples shown in this article. For more details about the GS1280 P3, please contact the author.

Other Uses of TLC Data

Problem Solving After the Fact with T4 History

Those who remember the past are not condemned to repeat it.

If you have a case of an unintentional slowdown, it's possible that that the slowdown has been gradual and that no one had noticed or complained until now. By selecting a number of older data sets and comparing them to the current performance, it is often possible to pinpoint the exact day when the change began to creep in. This can help you figure out what the primary cause was that triggered the slowdown by checking your system logs for that time period to see what changes were introduced.

Your history of TLC-format data on your most important mission critical systems can help you determine exactly when a problem first surfaced (after the fact). This is yet another reason to turn on timeline collection in advance. You'll never know when you will need it next. Those who remember the past are not condemned to repeat it.

TLC Data is Ripe for Further Analysis

In addition to all the wonderful graphical things you can do with the column upon column of TLC-format data, these columns of numbers are wonderful raw materials for a host of powerful analytical, mathematical approaches to performance.

For example, using a tool such as Excel, you can find averages, medians, minimum, maximums, and percentiles of any stripe with relative ease. You can compute moving averages of any duration or have them automatically graphed. You can create histograms with varying bucket sizes or carry out extensive column arithmetic to develop important normalized data.

Using Excel or CSVPNG, you can add up CPU busy or Direct I/O rate across all nodes in a cluster.

With Excel, CSVPNG, and TLViz you can also carry out linear correlation and discover which metrics appear to be most closely related to each other in behavior. With any of these three tools and other similar tools, you can zoom in on a particularly interesting peak period and recalculate correlation for that window.

With Excel, you can discover the peak hour or peak half hour for a particular variable. CSVPNG lets you automate the peak hour calculation.

And if there are certain systematic calculations that you find useful to repeat with each data set, the same data will readily yield to customized programming in the language of your choice once you decide what works best for you.

If you have a many-month history of TLC-format data for all the nodes in your cluster, you might want to consider analyzing changing trends that are showing up day-by-day, week-by-week and month-by-month. No automatic tools exist as yet to transform TLC data in this fashion but such capabilities appear to be just one or two short steps away.

Once you have data in **TNF**, the possibilities for analysis are endless and only limited by the interplay of your time, your imagination, your aptitude with Excel, SQL, and other available tools, and your programming skill to craft new tools.

From TNF to TNF

One of the other important things you can do with TLC-format data is to transform one TimeLine Collaboration Normal Form (**TNF)** file into another. For example, you might want to automatically select only a handful of key metrics from each standard T4 CSV file and create a new file that showed only those metrics. Or, you might want to see only the time period from 9:30 to 11:00 and save a new file that included only those 90 rows of data. Or, you might want to carry out both row and column trimming to create a particularly compact new data set of the most important variables for the most important time period.

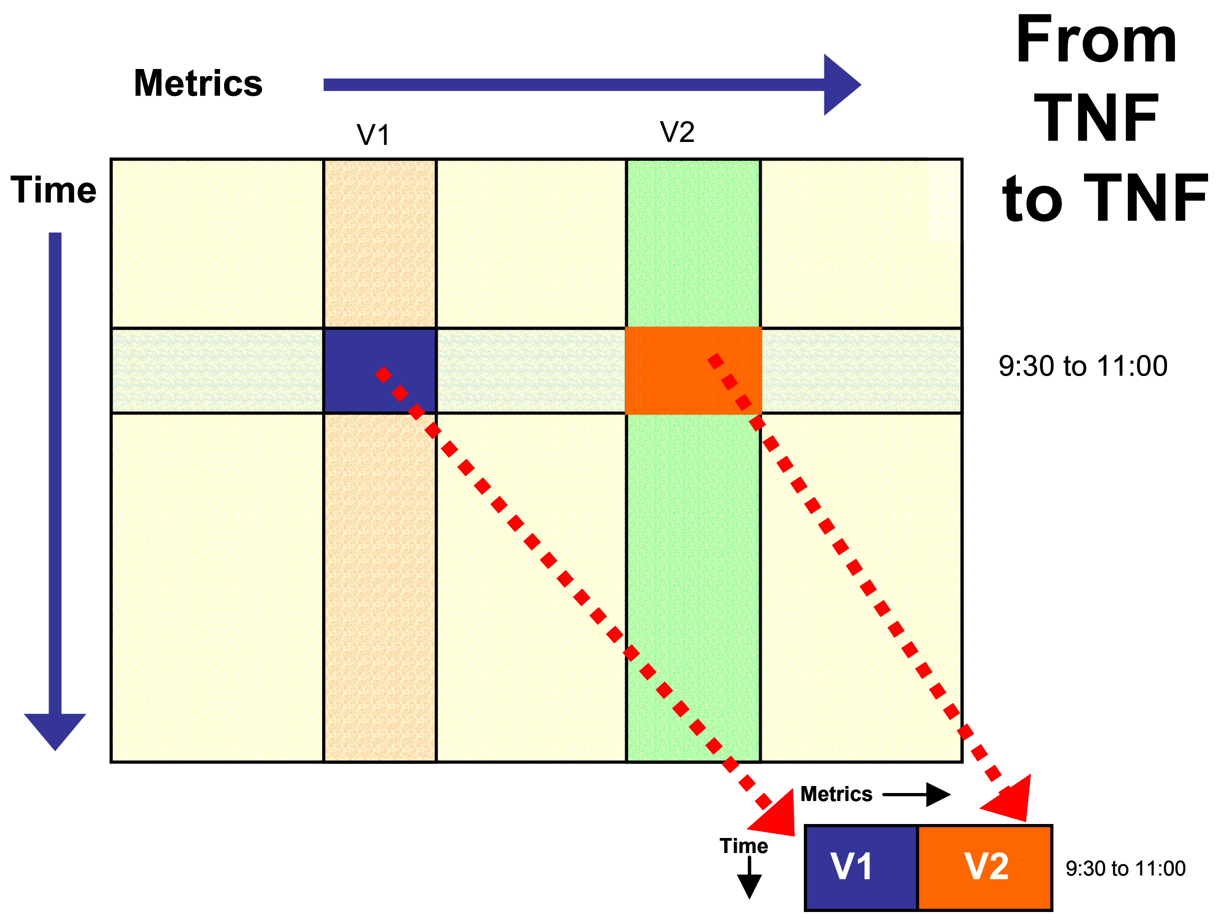


Figure 27: From TNF to TNF

Here we schematically illustrate the process of transforming one large TNF file into another, much smaller file. The total time might be a full day, but we are interested only in the period from 9:30 to 11:00. The total file might contain hundreds of metrics, but our interest lies only in the two metrics, V1 and V2. This kind of approach can be particularly useful when dealing with data from a large number of systems or when wishing to exchange key data sets with others using email or web access.

All these kinds of steps are readily programmable when you start with files in TLC Normal Form. These newer, more compact files are well suited to email or for upload to central depositories for long-term archival storage.

When doing analysis and reporting, we have found that by trimming down our files to their key elements, the later portions of our analysis work are enhanced and speeded on their way.

In manipulating these files, we have talked earlier about combining and synchronizing rows of data drawn from a series of TLC-format data files. This happens automatically during the standard T4V3x collection step. The same idea could be used to create a composite file that showed key statistics from all nodes on a cluster as well as the aggregate across the cluster.

For other purposes, you might want to consider creating new TLC-format data by appending new rows to the bottom of an existing file. For example, you might try combining all the data for a full week of 60-second samples into a super-sized file containing 7 TIMES 1440 (or 10,800) rows of data.

The possibilities for downstream manipulation of TLC-format files to meet special new purposes are virtually unlimited.

What Customers and Partners and OpenVMS Engineers Have Already Done

OpenVMS customers, partners, ambassadors, and engineers have already carved out some of the possibilities for downstream use of TLC-format data. Here is a short list of some of the paths already in use or where the proof-of-concept has been demonstrated.

- **Near real-time data** – Harvesting data from collectors in near real-time, updating TLC-format CSV files, feeding the results to automatic graphing programs, and publishing them to the web on OpenVMS servers.
- **Consolidation** – Consolidating TLC-format data from dozens of systems and making it readily available at a central location to simplify and reduce the cost of performance management.
- **Massive Synchronization** – Integrating TLC data from T4V3x tool kit with Oracle TLC data, customer TLC response data, and customer TLC throughput data into a single, powerful, multi-dimensional composite picture of OpenVMS performance on mission critical production systems.

Possible Collaborative Improvements in the Future

Many opportunities await. While we have been making improvements and additions for over 3 years, there appears to be a long list of opportunities for squeezing even more value out of the T4 & Friends collaborative approach by adding new and important collectors to extend the standard collection kit, by crafting new downstream tools, and by encouraging an ever widening number of OpenVMS customers to join the party.

Some possibilities for the coming year include:

- Automatic trending over time (weekly, monthly, or yearly trends).
- Automatic consolidation and reporting of cluster-wide data.
- Development of a growing collection of expert rules for automatically examining large storehouses of collected data.
- Automation of central depositories for those with many systems to manage.
- Built-in capabilities for near real-time reporting.
- Built-in hooks to simplify publishing to the web.
- A whole host of new and powerful collectors that give us visibility into vital, but currently missing data and the addition of some of these new data streams to an updated T4 collection kit.
- Integrating some key collectors such as one for Rdb into the standard kit.
- More powerful capabilities for creating explanatory visual stories.

- Automatic report generation.
- Simplified adding of customer business timeline metrics to the standard T4 kit.

We would love to hear your ideas, plans, and accomplishments at extracting more and more value from TLC-format data.

Summary

Thanks to the widening use of the available T4 tool kits, we are now seeing steadily filling reservoirs of valuable TLC data on more and more OpenVMS production systems. Coupled with the increasingly numerous and powerful downstream Friends of T4, these databanks have so far produced dramatic, visible productivity gains for OpenVMS Engineering, for OpenVMS Ambassadors, and for an increasing number of OpenVMS customers and partners. The net result has been a dramatic improvement in our ability, our speed and our productivity in extracting real value from performance timeline data.

Progress in advancing this universal timeline-driven performance work on OpenVMS continues. Significant contributions are now beginning to flow in from our customers, partners and ambassadors. The year 2004 holds promise that we can build on the gains achieved in the past three years with our universal collaborative approach to OpenVMS Performance issues.

With the public availability of T4V2, T4V32, T4V33, and SHC, all OpenVMS customers and partners can now begin to join in, benefit from the advances, and contribute to future enhancements in collection and in value extraction.

The following points are worth noting:

✓ Any important source of timeline data can be harnessed to produce potentially synchronizable TLC data (either directly or by later extraction).

✓ TLC data is readily reusable and readily programmable.

✓ Complex systems exhibit complex, time-dependent behavior that often can best be understood by visually examining that behavior.

✓ The timeline graphics created in this way are accessible and understandable by both technical and non-technical viewers. The timeline graphics encourage communication, discussion, and collaboration among all the interested parties. We have found that tools such as TLViz make it possible for those with the most at stake in maintaining good system performance to conduct a first level review of the data on their own, and to question results presented to them, even if they are not themselves performance analysis experts.

✓ The growing reservoirs of TLC data mean that when questions arise, it’s always possible to go back to the actual data for second opinions and further analysis.

✓ The time-saving T4 & Friends approach described in this article and all of the upstream and downstream tools we have developed have grown out of this set of principles combined with the central idea to use the currently abundant resources so as to conserve the scarcest resource – our personal time.

Acknowledgements – The Human Friends of T4

The rapid evolution of T4 & Friends owes its success to the work and creativity of many individuals. This has been a powerful on-going collaborative effort by the human “Friends of T4” including Tom Cafarella, Kevin Jenkins, Ian Megarity, Pat McConnell, Chris Brown, Matt Muggeridge, Paul Lacombe, Pat Moran, Michael Austin, Grant Hayden, Norm Lastovica, Debess Rogers-Grabazs, Guy Peleg, a whole raft of OpenVMS Ambassadors including Ray Turner, Dave Foddy, Kevin Fitzpatrick, Aage Ronning, and Jiri Kaspar.

Many, many others have played or are still playing active roles in the process. This includes: Sue Skonetski, David Klein, Kent Scheuler, Tom Moran, Peter Provencher, John Defilippo, Jim McLaughlin, Craig Showers, Christian Moser, Greg Jordan, Richard Bishop, Melanie Hubbard. Thank you all. Your efforts have really made a difference for OpenVMS.

Here’s a brief rundown on some individual contributions to this evolving story.

Tom Cafarella (OpenVMS Engineering) wrote the Original T4 extractor tool in DCL. This gave us the proof-of-concept that we needed to continue. Tom has been an active user of T4 and TLViz and has recently created a prototype no-drift workaround for the current versions of MONITOR.

Ian Megarity and Kevin Jenkins (both from OpenVMS Engineering) demonstrated that with some effort, the Original T4 was reusable by porting it to a new system they were studying. Ian Megarity wrote the first code for combining TLC-format CSV files from different sources and built many new TLC-format collectors to grab key performance statistics not available from MONITOR. Ian then went on to create the powerful T4EXTR utility for squeezing even more timeline data out of MONITOR.DAT files. He followed with T4V32 and T4V33, greatly extending the scope of variables transformed into TLC-format tables with a total (today) of six TLC-format collectors, automated history creation, and many other advances you will find when you download the latest kit.

Kevin Jenkins actively applied each new T4 & Friends capability as he worked with OpenVMS customers on their most important performance concerns. His ideas on possible extensions and improvements often showed up in the next generation T4 kits and everyone benefited.

Ian Megarity amazed us all within OpenVMS Engineering when he revealed his Windows-based TLViz program for analyzing, graphing, and visually reporting on TLC-format data. It proved to be an instant success. It gave the analyst at least an order of magnitude productivity gain compared to doing similar analysis, graphing and visual reporting using a tool such as Excel. Many important activities that take multiple complex sets of keystrokes and mouse actions with Excel have been replaced by single simple keystrokes or single mouse clicks with fantastic time-saving benefits to the analyst.

Kevin Jenkins was again an early adopter and vigorous advocate of TLViz in his work. He found himself frequently opening up a pair of TLViz windows and comparing the graphs from one TLC-format data set with the graphs from a second TLC-format data set. Kevin’s suggestion to Ian to let TLViz open up more than one data set and to overlay the timelines automatically has to rank as the single best T4 & Friends idea so far. Ian implemented this idea, literally overnight for the first prototype, and the resulting extremely powerful and easily generated ***Before-and-After*** graphs have proven they are worth their weight in gold for analysis and for explaining findings to others.

Pat McConnell (OpenVMS Engineering Performance Group Supervisor) has been another early adopter of T4 & Friends and a key management supporter of the work we have done. Pat has also prototyped several new tools and developed proofs of concept for new approaches to managing TLC data and making the best use of it. Pat has been instrumental in supporting advanced development efforts and experiments for possible new T4 collectors and extractors. In his own performance work in the eBusiness space, Pat has experimented with automated report writing driven by TLC data with output of text and graphs created in PDF. Pat has also begun to integrate the wider use of T4 collection into our QTV testing prior to release of new versions of OpenVMS.

Chris Brown (OpenVMS Director of Strategy) was an early and continuing management supporter of our T4 and TLC work as we used and developed successive versions of T4 while troubleshooting serious customer performance problems. Chris has been active in encouraging customers to turn on T4V3x collection, so as to improve OpenVMS Engineering's abilities to collaborate with these customers about their most serious performance issues and concerns.

Matt Muggeridge (OpenVMS Engineering, Networking) turned the idea of creating a TLC-format collector for key TCP/IP data into reality in a few short weeks and worked with Ian Megarity to integrate this new collector into the standard T4V3x kit. Matt's work is a perfect model for how to build a new collector on top of existing capabilities of your particular layer of software and then design it so it fits like a glove with the T4 rules of the game. Matt has also been an active user of T4 collection as part of his network performance work, including a willingness to experiment with some of our barely tested new versions.

Pat Moran (HP Mission Critical Proactive Services and also an OpenVMS Ambassador) has made a tremendous recent contribution to the T4 & Friends repertoire with the creation of his command-line driven CSVPNG utility for massaging and creating new value out of TLC-format data sets. The powerful set of features and capabilities Pat has built into CSVPNG are sure to make this relatively new Friend of T4 into a big winner in the coming year. Pat has also done excellent proof-of-concept work with the use of PHP, APACHE, MOZILLA and CSVPNG to publish TLC-format data to the web and to explore doing this not only for historical data but also for near real time data as well.

Paul Lacombe (OpenVMS Engineering Director) provided the T4 team the management support and commitment and encouragement we needed to continue to develop and enhance T4 & Friends as a natural part of our day-to-day jobs. In the early days of T4, all of the OpenVMS engineers involved reported up to Paul and that made a big difference. Now, thanks to Paul's support, many others outside Paul's group are plugged in and are contributing to the evolving process. We are now, together, extracting more and more value from the TLC data being created on some of the most important and most mission-critical systems in the world.

Michael Austin (Cerner, Remote Hosted Operations) has proven how readily our best customers and partners can customize the basic T4 kit pieces and harness the power for their own special needs. Michael is doing amazing things with TLC data and with a variety of ever more powerful downstream tools. These are useful in their own right and serve as a demonstration and proof-of-concept for further extensions and elaborations to the base-level capabilities in the future. Michael has also made numerous suggestions for possible future enhancements to T4 collection and for useful downstream capabilities. For more details on what Michael is thinking about and doing related to T4, launch a GOOGLE GROUP search on "T4 VMS Austin" or on "What is T4 and what can it do for you"

Grant Hayden (Oracle) built the proof-of-concept Oracle Timeline collector, literally overnight. Thank you Grant for building the first TLC-format, database collector. Working together with Oracle and with one of our customers, we integrated data from this Oracle TLC collector with customer business data on sales volumes and with T4 collected system data from OpenVMS. This combination helped us delve deeply into a particularly complex and difficult set of performance problems.

Norm Lastovica (Oracle) demonstrated how TLC-format CSV files could be readily extracted from data captured by Rdb's standard monitoring utility RMU /SHOW STAT. As part of a collaborative Rdb-VMS benchmarking project, we have been making excellent recent use of this extractor --merging the Rdb TLC data with TLC data from T4 to create a more complete picture of our tests.

Debess Rogers-Grabazs (OpenVMS Engineering Performance Group) built many of the risky experimental and advanced development tools to test proof-of-concept for some of our next generation TLC collectors, extractors, and downstream value extraction utilities.

Guy Peleg (OpenVMS Engineering and an OpenVMS Ambassador) proved to be an active user of T4 and TLViz with a willingness to test some of our most experimental versions. Guy has had excellent success in using T4 and TLViz as a powerful customer collaboration tool.

A whole raft of OpenVMS Ambassadors were early adopters and supporters of T4 including Ray Turner, Dave Foddy, Kevin Fitzpatrick, Aage Ronning and Jiri Kaspar and many more.

Sue Skonetski deserves special thanks for helping us share the T4 story and the evolving TLC capabilities with so many customers and partners at Technical Updates and Bootcamps over the past two years. Those interactions helped provide much of the material for this article. Thank you, Sue.

David Klein and Kent Scheuler (Cerner) – Dave and Kent were early adopters of T4 collection/extraction technology in their Performance Benchmarking lab. Dave and Kent have also been instrumental in the rollout of a Cerner unique timeline-driven approach that makes use of underlying T4V3x capabilities.

Tom Moran and Peter Provencher (OpenVMS Engineering) – Tom and Peter were active users of T4 technology in our HP/Cerner performance lab. This lab is a crucible for performance work with extremely heavy workloads and many unique and stressful tests. The continuous use of T4 technology in this lab built up a huge number of hours of airtime use for T4V32 collection and increased our confidence in the robustness and safety of using T4 collection more widely.

John Defilippo and Jim McLaughlin (OpenVMS Engineering) actively encouraged widespread use of T4 collection among the Cerner customer base and within Cerner itself. Lots of the success of our collaborative efforts to advance Cerner's unique timeline-driven approach to performance rests on John and Jim's shoulders.

Craig Showers (OpenVMS Engineering Customer Capabilities Lab). Craig has been an active voice encouraging those customers and partners who come in and use his extensive lab facilities to include a T4 timeline-driven component in the work whenever performance concerns were involved in the testing, Craig has been instrumental in spreading the word about the value of T4 to many new customers and partners.

Christian Moser (OpenVMS Engineering) deserves credit for his amazing work building a series of trace-based event collection tools that run in SDA and capture detailed views of vital, low-level OpenVMS performance metrics. These include, for example, his Spinlock Trace utility which can measure such things as which spinlocks are held for the highest percentage of time. We are exploring ways to begin to roll up this data (now that it has been revealed by Christian's trace tools) into a timeline-based approach, so we can examine the relationships between spinlock activity, other OpenVMS statistics and any other key metrics captured by other TLC-format collectors. Watch this space in the future for some more about this promising area of activity and collaborative synergy. Christian has also just added a No-Drift fix to MONITOR for OpenVMS Version 8.1, correcting this long-standing shortcoming.

Greg Jordan (OpenVMS Engineering) for his extension adding the ANALYZE capability to the Spinlock Trace utility. This automated some messy calculations and made key spinlock metrics such as IOLOCK8 hold time percentage immediately visible. We're now experimenting with a prototype TLC-format extractor that takes output from SPL ANALYZE and turns it into TLC-format CSV files.

Richard Bishop (OpenVMS Engineering) for his very recent addition to SDA of a WAIT command in OpenVMS Version 8.1. In the future, this will make the writing of TLC-format collectors that feed on SDA data much simpler, much more readily controllable at very high resolution, and substantially lower overhead. We anticipate we will be creating some prototype collectors that take advantage of this new feature as part of our performance work for OpenVMS on HP Integrity Servers. Because SDA has visibility into many important OpenVMS metrics that tools such as MONITOR never even dreamed of, there is lots of future potential to tap.

Melanie Hubbard has joined the T4 & Friends family in the last few months and has had the opportunity to help a growing number of OpenVMS customers using Oracle to consider putting T4V3x to use on their systems in a variety of different situations.

If I have forgotten to mention your contribution, my apologies. Please drop me a line and let me know so I can update this historical record and correct it in future work.

For More Information

For more information about T4 & friends, or if you have interest in gaining access to some of our internal downstream tools, please contact the author at steve.lieman@hp.com.