



VMware vCenter™ Operations Enterprise: Automated Operations Management for Your Enterprise

TECHNICAL WHITE PAPER

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Introduction

Operations management disciplines are converging in the cloud. Performance and capacity management are becoming inseparable due to the dynamic nature of converged infrastructure. Traditional tools and processes designed for siloed, static physical infrastructures don't provide the automation and control needed to effectively manage highly virtualized and private cloud environments. From the global leader in virtualization and cloud infrastructure, VMware vCenter™ Operations Enterprise is designed to dramatically simplify and automate operations management. Our integrated and evolutionary approach uses patented analytics to provide the intelligence and visibility needed to proactively ensure service levels in dynamic virtual and cloud environments.

Customer satisfaction and your bottom line today increasingly depend on complex, mission-critical services and applications without any enterprise-wide view of system health or reliable early means of detecting performance problems. Not knowing what is wrong, and why, before it matters can result in lost business, reduced customer satisfaction and high opportunity costs.

VMware vCenter Operations Enterprise is a breakthrough in automated performance analytics for enterprise IT systems and business processes. VMware vCenter Operations Enterprise's real-time analytics deliver three pillars of value: **Smart Alerts™**, which inform you *when to pay attention* to emerging problems and *what to pay attention to* in order to *avoid* major performance problems; real-time performance analysis that displays in powerful **role-based performance dashboards**; and in-depth, **on-demand analytics** for long-term enterprise system capacity planning and optimization.

VMware vCenter Operations Enterprise provides these benefits to your enterprise:

- Smart Alerts notify you of emerging application problems long before users or classic monitoring tools notice issues.
- Smart Alert summary analyses help you to understand the behavioral context of emerging problems—their full impact and root cause—so they can be resolved by the right person with minimal resources and without the all-hands-on-deck bridge calls.
- Automatic 'health' scores help you to understand, in real-time, the healthy operation of your enterprise from a datacenter, application, silo, individual resource, or any desired perspective.
- Auto-pilot performance dashboards establish a single 'truth' from which all constituencies in your organization can speak a common language—executives, business owners, IT silo owners, network operating center (NOC) engineers, etc.
- On-demand analytics reduce your dependency on the 'tribal knowledge' of a handful of individuals and optimize your enterprise objectively based on analytically determined capacity trends, as well as behavioral and correlation analytics.

What Sets vCenter Operations Enterprise Apart?

The foundation for providing this value is vCenter Operations Enterprise's robust architectural design which supports the explosive growth in both size and complexity being experienced in today's IT infrastructures, while simultaneously leveraging current investments in classic IT monitoring. Specifically, the vCenter Operations Enterprise architecture provides the following:

- **Leverages Existing Classic Monitoring** – VMware vCenter Operations Enterprise can easily tap into existing, classic monitoring tools and analyze the raw performance metrics already being collected by them. This includes pulling raw, time-series metric data directly from tools such as IBM Tivoli, HP OpenView, HP Business Availability Center (BAC), EMC|SMARTS, vCenter, open source monitoring tools, custom monitoring tools and many others.
- **Data Agnostic** – VMware vCenter Operations Enterprise has the ability, out of the box, to analyze any performance metric data regardless of what it represents because it is inherently *vendor and data agnostic*. This means vCenter Operations Enterprise can analyze network metrics, server metrics, application metrics, user experience metrics, transaction data, batch data or even non-IT metrics, such as business performance data that is associated with a service. VMware vCenter Operations Enterprise can contextually correlate and holistically analyze any performance data you currently collect or seamlessly expand its analysis if your classic monitoring tools grow over time.

- **Application Agnostic** - VMware vCenter Operations Enterprise is completely learning-based and does not use static application ‘templates’ or ‘models.’ There is no need to manually ‘tune’ so-called ‘best-practices’ for your *applications*. Instead, vCenter Operations Enterprise uses an array of statistical techniques to remain entirely *application agnostic*. VMware vCenter Operations Enterprise’s design approach works just as well for off-the-shelf applications as it does for highly customized one-off applications.
- **Highly Scalable Analytics** - VMware vCenter Operations Enterprise can support the collection and analysis of more than 10 million unique performance metrics (+10,000,000) even with a commodity-sized server. This scalability applies regardless of whether the metrics are from a single, massive business service or many smaller services.
- **Architectural Flexibility** - VMware vCenter Operations Enterprise can employ ‘*remote collectors*,’ allowing it to efficiently and securely tap into sources of raw performance data across highly firewalled environments or geographically separated multidatacenter deployments.
- **Customizable Dashboards** - VMware vCenter Operations Enterprise presents the results of its various analyses through performance dashboards, which can be easily configured, shared and consumed in real-time. VMware vCenter Operations Enterprise employs Web 2.0 drag-and-drop techniques to design dashboards, while providing industry standard role-based access control (RBAC) capabilities to insure the appropriate information is presented to each user—from executives to first responders.
- **Console Integration** - VMware vCenter Operations Enterprise is not limited to presenting its results in the vCenter Operations Enterprise dashboard. It can also provide the results of its analysis (e.g., Smart Alerts, application/component health scores, etc.) to existing tools for seamless integration with your current organizational workflow tools and procedures.

Analytics Foundation – Dynamic Thresholds

The foundation of vCenter Operations Enterprise’s analytics is the sophisticated manner in which the normal behavior of each performance metric is determined. As described above, vCenter Operations Enterprise has the ability to analyze any performance metric, and experience with millions of metrics from our customers indicates that they behave in widely disparate ways. Because of this, it would be entirely inadequate to use a single method or algorithm to characterize normal behavior as many other management tools do. (Typically, they falsely assume a metric’s distribution follows a classic ‘normal bell-shaped curve,’ and allow for metric-based alerting when a metric reaches a certain number of standard deviations away from average.)

Instead, vCenter Operations Enterprise continuously leverages a variety of methods, running them against each other to produce an optimal hour-by-hour range of normal behavior, or a Dynamic Threshold (DT), for each performance metric.

To illustrate the sophistication of vCenter Operations Enterprise’s approach, here is a summary of the methods applied when determining any metrics normal behavior:

- Linearly behavior detection (e.g., some forms of disk utilizations)
- ‘Two state’ (e.g., on/off) behavior detection (e.g., availability measurements)
- Discrete value behavior detection (e.g., ‘number of database user connections,’ ‘number of active JMWs,’ etc.)
- Cyclical pattern behavior detection tied to calendar cycles (e.g., weekly, monthly, etc.)
- Cyclical pattern behavior detection for non-calendar patterns (e.g., multimodal)
- Non-time-series, ‘sparse’ data behavior detection (e.g., daily, weekly, monthly ‘batch’ data)

Figure 1 illustrates the learned DT for a performance metric, in this instance a Super Metric™ that represents the average number of hits measured on all Web servers (‘Avg Hits’) for a particular public-facing application (more about vCenter Operations Enterprise’s unique Super Metric capability later in this document). Note the hour-by-hour adjustment to the upper and lower gray area surrounding the blue line (the actual metric values). This gray zone DT was determined solely by vCenter Operations Enterprise’s sophisticated assessment of the history of the metric’s performance—no rules, templates or preconceived notions of its behavior.



Figure 1. Example Dynamic Threshold

One other illustrative point seen in the example image is the narrower DT range for the ‘off-peak’ hours of the day for this metric versus the wider DT range during the ‘peak’ hours of the day. VMware vCenter Operations Enterprise determined automatically that the variability of the measured values for this metric during the ‘off’ hours of the day was low and thus it could afford to narrow the band of expected behavior accordingly, while in contrast, the historical variability of the measurement during ‘peak’ hours suggested a need to widen the band. To do otherwise, would result in unnecessary ‘false-positive’ indications, or conversely, a loss of sensitivity to abnormal conditions.

BENEFIT: VMware vCenter Operations Enterprise’s sophisticated DT capability allows for the automatic and precise analysis of *any* type of data—network data, operating system data, application data, user experience data, transaction data, batch data, business data, etc.—whatever data is being collected by your classic monitoring tools. With this flexibility, vCenter Operations Enterprise can then analyze any type of application—classic n-tier applications, batch applications, custom applications, etc.—no rules or templates are required.

Smart Alert Analytics

With a firm understanding of metric-level DTs, what they represent and vCenter Operations Enterprise’s ability to detect individual abnormally behaving metrics, let’s discuss how vCenter Operations Enterprise leverages this sensitivity to underlying abnormal conditions to provide performance insights through its auto-pilot performance dashboards, Smart Alerts and on-demand analytics.

Intuitively, it is clear that when problems are building in an application or service, the first signs will be revealed in the abnormal behavior of the performance metrics associated with that application. With the appropriate level of sophistication in detecting these metric-level abnormalities, it is possible to observe the overall level of abnormality experienced by an application and use this observation as an early warning to the initial emergence of problems. This is, in fact, the primary function of vCenter Operations Enterprise’s Smart Alerts, which provide early warnings when your critical application or business service is experiencing - *in aggregate* - many more abnormally behaving metrics than is *typically* experienced by your application.

It is important to recognize that vCenter Operations Enterprise is not telling you that any one metric or a hard-wired set of metrics is behaving abnormally. In fact, a production application will *always* have some number of metrics that are behaving abnormally at any given time. Or course, this is to be expected and is really inconsequential system ‘noise.’ VMware vCenter Operations Enterprise is capable of learning an application’s typical ‘noise’ level. When vCenter Operations Enterprise detects significant abnormal behavior exceeding its expected ‘noise’ level, a Smart Alert is sent warning that a problem is developing with the application—telling you to *start paying*

attention. Smart Alerts can be consumed in a variety of ways, including vCenter Operations Enterprise alert summary dashboards or by email. They can also be sent to your system management console of choice to support existing processes.

VMware has heard time and again from its customers how effective this form of Smart Alert is as an early warning indicator. They receive Smart Alerts of emerging problems early enough to allow them to prevent impact to end users. They move from reactive to proactive, no longer learning of problems directly from their end users.

The vCenter Operations Enterprise screenshots below show examples of excessive abnormality for a production application. Specifically, Figure 2 shows along the vertical 'y-axis' a plot of the number of metrics violating their DTs as time progresses. (In this case, the application was a classic n-tier application with performance metrics from the Web server, application server and database server tiers, along with user response time and business performance data, however, this technique is applicable to any application.) The lower image shows a more granular view around the peak in abnormalities. Note the displayed 'noise-level' (red line). Once vCenter Operations Enterprise detects this line is crossed, it sends an application-level, early warning Smart Alert telling the recipient to pay attention.

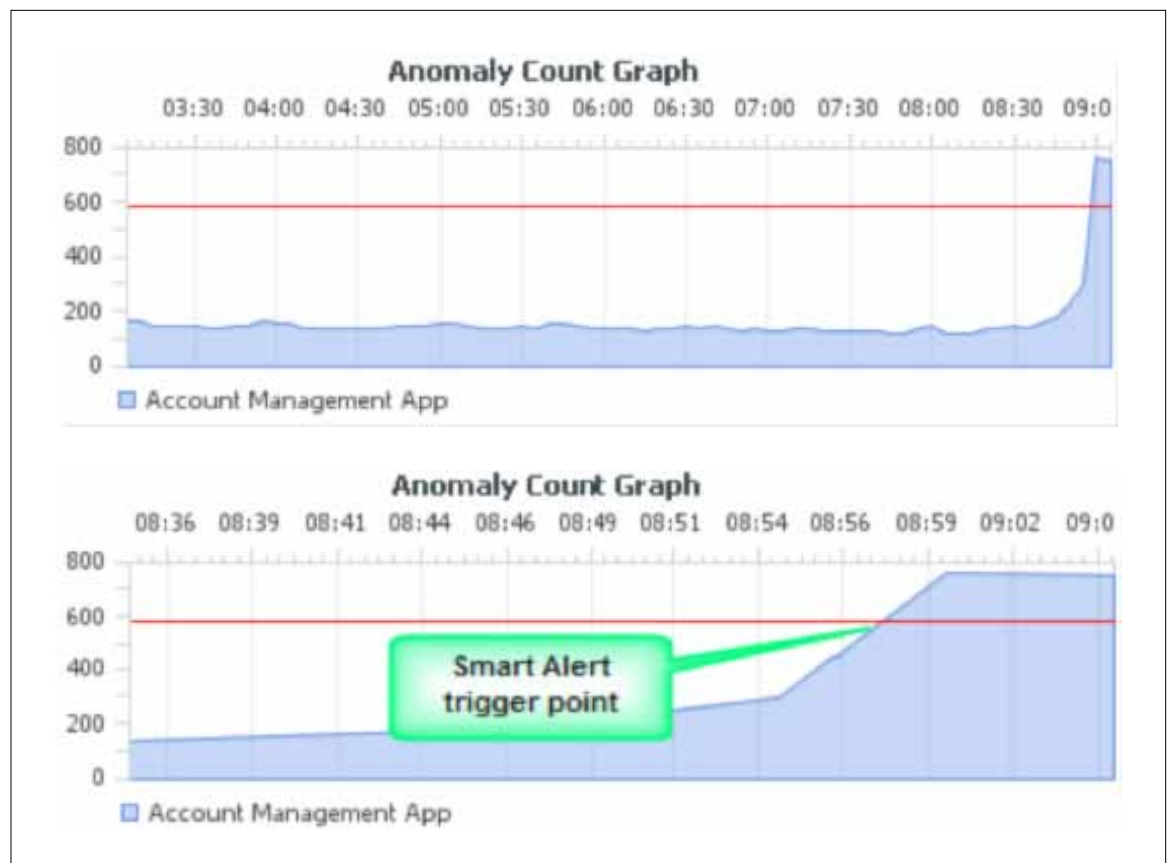


Figure 2. Volume of abnormality and computed noise level. The lower image shows a more granular view.

So having indicated when to pay attention to the early emergence of application problems, how does vCenter Operations Enterprise determine the impact and root cause, and how is this presented? Figure 3 shows an example vCenter Operations Enterprise Smart Alert summary page, which includes the reason for the Smart Alert. (There are a variety of reasons vCenter Operations Enterprise will generate a Smart Alert. In this instance, an 'early warning' Smart Alert is indicating 'too many abnormalities'—the example illustrated in Figure 2.) The alert summary immediately shows how the affected application is being impacted (the section in the lower-left portion of the summary page). The section on the right side of the summary page shows the results of vCenter

Operations Enterprise's root cause algorithm that has analyzed the underlying misbehaving tiers/resources/metrics to conclude where your attention should first be directed. In the example illustrated by Figure 3, vCenter Operations Enterprise has determined that the 'database tier' is the root cause tier and that the important metrics to be investigated are the database 'number of deadlocks | sec,' as well as the 'work queue lengths.' (Note that vCenter Operations Enterprise indicates just to the right of each metric how these metrics were originally collected—in this case HP SiteScope.)

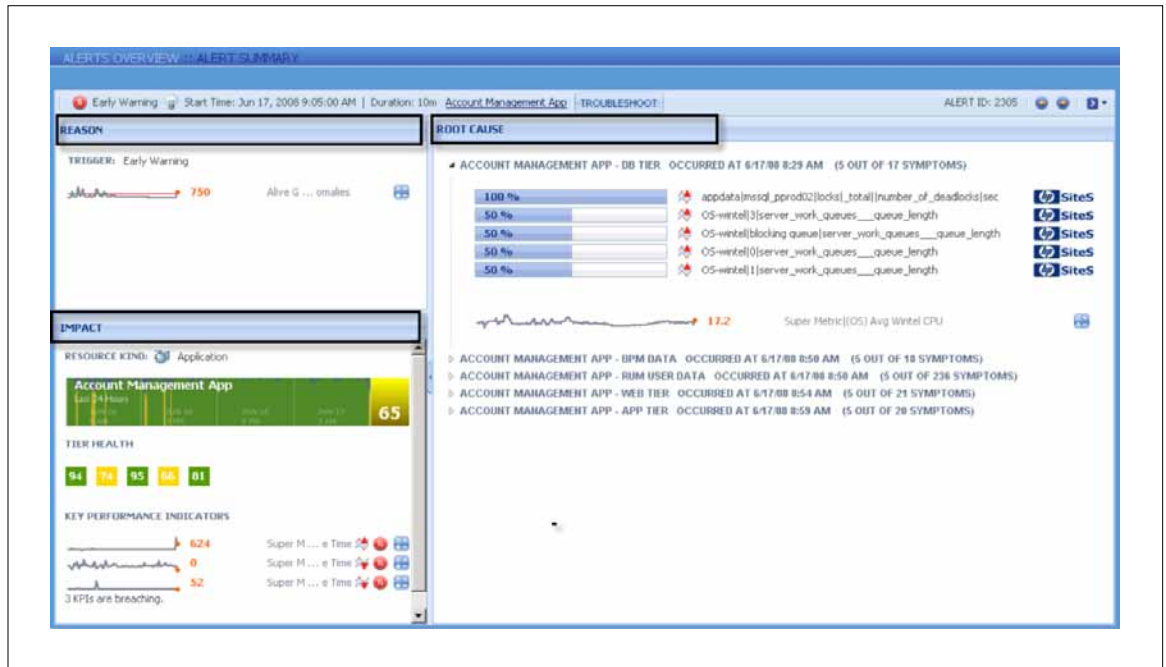


Figure 3. VMware vCenter Operations Enterprise determines root cause.

VMware vCenter Operations Enterprise offers additional detailed information if the user wishes to 'drill down.' For example, Figure 4 shows a mash-up view that allows the user to see important events that are coincident with the emerging problem. These can include change events, such as new software deployments, hardware re-sizing or (un)scheduled maintenance. Figure 5 illustrates a building timeline of 'misbehavior' in the top image, showing which metrics became abnormal first. The second image in Figure 5 shows how individual, user-selected metrics can be graphed side by side. All of these views (and more) are available for a deeper analysis beyond the information presented in the alert summary page.

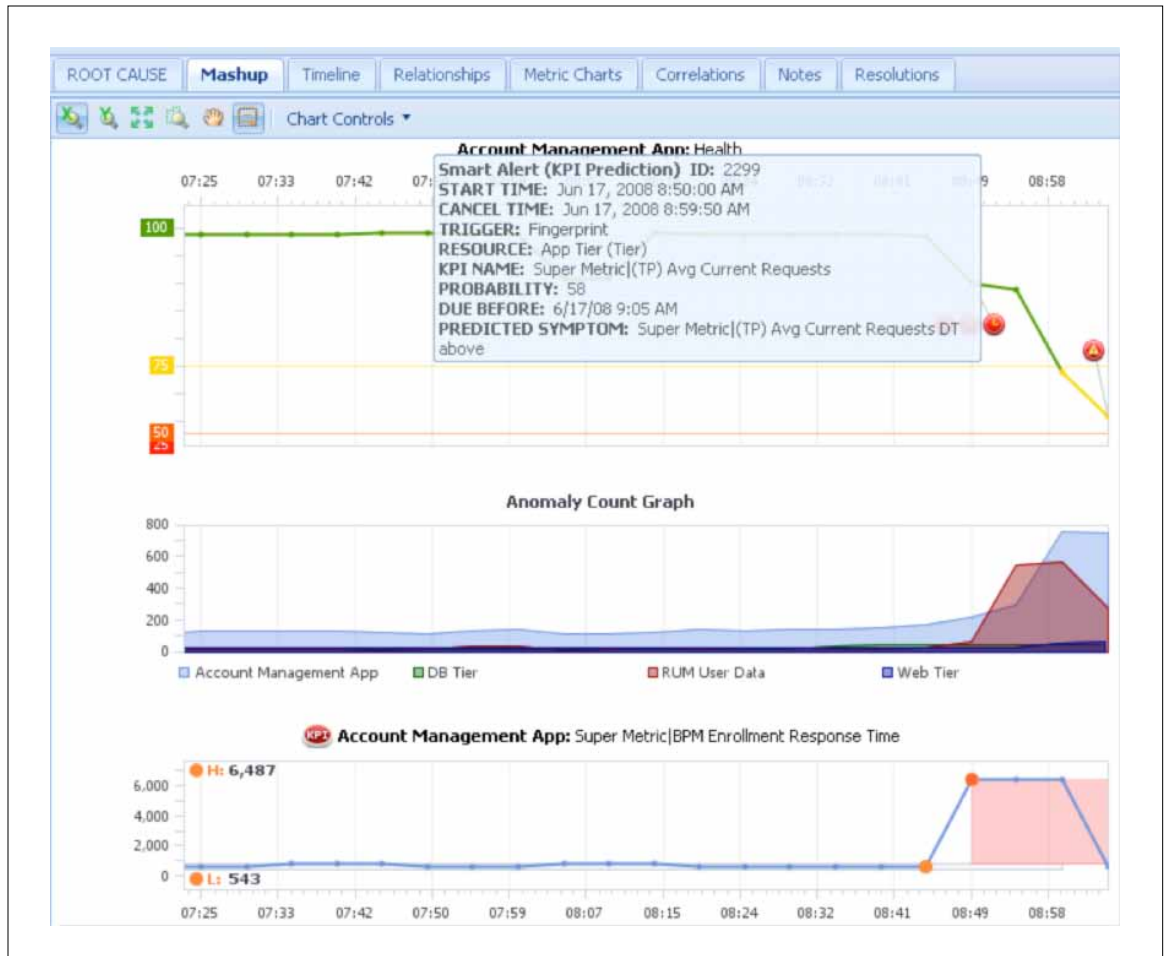


Figure 4. Mash-up view

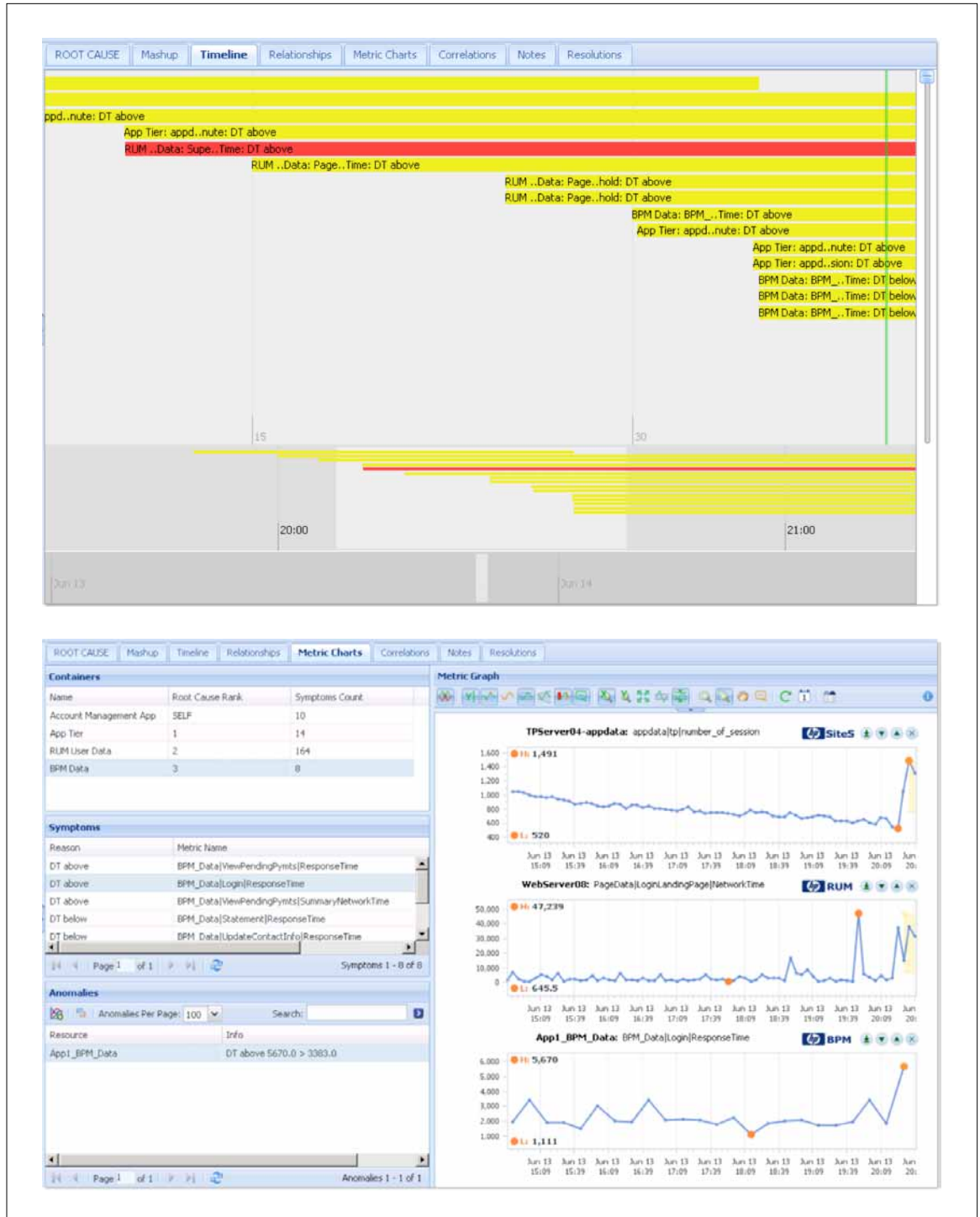


Figure 5. Timeline and metric views

BENEFIT: VMware vCenter Operations Enterprise's Smart Alerts warn of performance problems long before customers notice or classic monitoring tools can alert you. Smart Alerts identify the person best equipped to resolve the emerging problem and arm that person with information (not just data) that allows for quick remediation, if not outright problem avoidance.

Auto-Pilot Performance Dashboards

Knowing that vCenter Operations Enterprise’s Smart Alerts will warn when particular attention must be paid to an emerging performance problem in your environment, IT operations staff can now comfortably interact with vCenter Operations Enterprise’s performance dashboards to gain proactive insight into the healthy operation of the IT landscape. By way of an analogy, think of the comfort the pilot of a commercial airplane has in mid-flight viewing the plane’s various dials and gauges knowing that the plane’s ‘auto-pilot’ will clearly warn should he/she need to take control of the plane. In this same way, vCenter Operations Enterprise Smart Alerts are always letting you know if you need to ‘take control.’ The various users of vCenter Operations Enterprise can interact with the performance dashboards as an effective window into the real-time health of the devices, silos and applications that comprise the entire enterprise.

VMware vCenter Operations Enterprise’s role-based performance dashboards leverage the analysis of individual metric behaviors to determine the health of an enterprise in part or as a whole—the health of individual servers and devices, the combined health of a collection of devices (e.g., technology silos like a ‘Web tier’ or a set of databases, etc.), or even the health of an entire application or business service. In fact, the flexibility of the vCenter Operations Enterprise architecture allows for the automatic calculation of health for any desired ‘container’ of resources. These ‘health scores’ are presented in a variety of visualizations that are consumable by different constituencies, such as level-1 staff working in a 24/7 NOC, a senior engineer tasked with identifying and resolving problems, application owners eager to gain insight into the on-going performance of their mission-critical services or executives desiring a high-level view of their enterprise.

Figure 6 includes some visualizations taken from screenshots of vCenter Operations Enterprise that illustrate the various methods of consuming the health scores produced by vCenter Operations Enterprise. Typically, both a numeric representation, as well as a color-coded representation of health is manifested, but in some instances just the color is displayed. In large environments, this allows for the presentation of what can be a massive amount of data in easy to digest information formats. (The ‘heat-map’ views are good examples of this color-only presentation of ‘health.’)

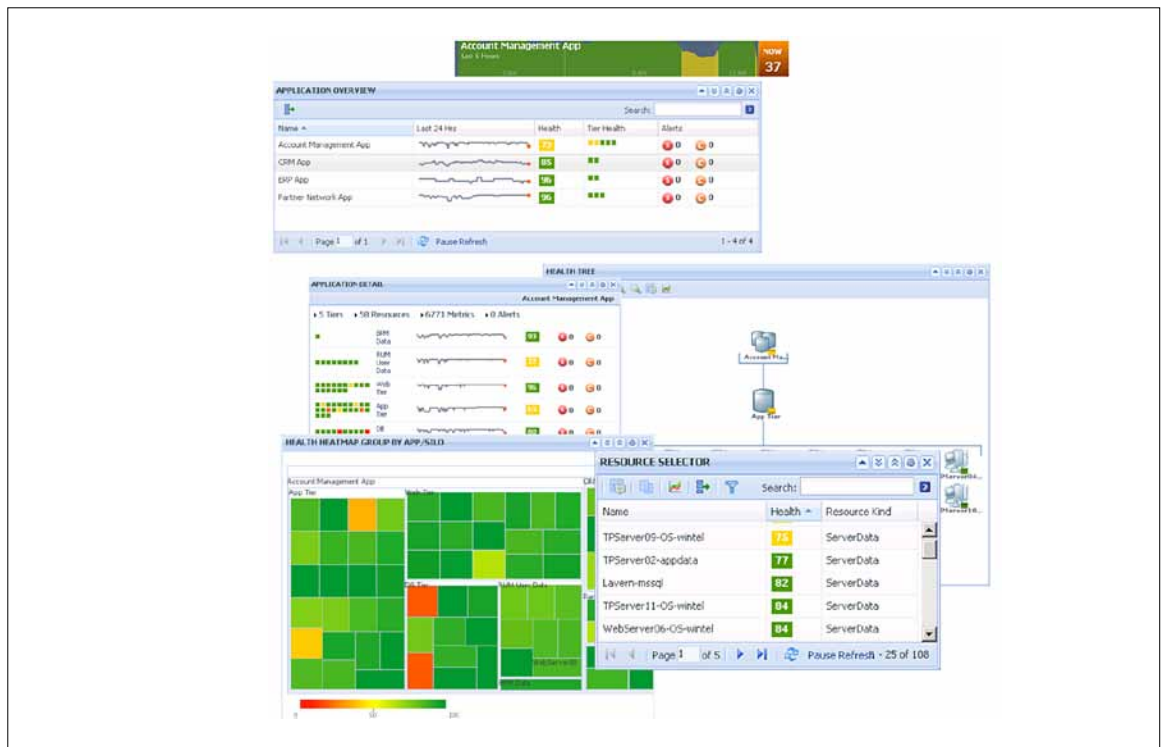


Figure 6. Various visualizations of the vCenter Operations Enterprise ‘health score.’ VMware vCenter Operations Enterprise analyzes health for all elements: servers, devices, groups of servers (‘tiers’), entire applications, a group of applications, etc.

These visual panels, or widgets, can be combined/filtered by authorized users of vCenter Operations Enterprise to form any number of interactive dashboards with absolutely no programming and no heavy training required. Through intuitive drag-and-drop interaction with the vCenter Operations Enterprise interface, authorized users can design new dashboards, publish them to users/roles (full RBAC is part of vCenter Operations Enterprise's capability) or create dashboard 'templates' that can be optionally shared with other users/roles. When this visual flexibility is combined with vCenter Operations Enterprise's ability to analyze data for any/all sources of performance data, the result is a universal frame of reference, or a common language, through which effective team collaboration can be realized. No longer will application server owners, database administrators or network engineers be limited to their own views of the world. Instead, the various technology owners can have common insight into the normal behavior of their world and a common score card, or health score, to reference and compare against all other technology components that together comprise the business service or application. Figure 7 shows a few examples of role-based performance dashboards.

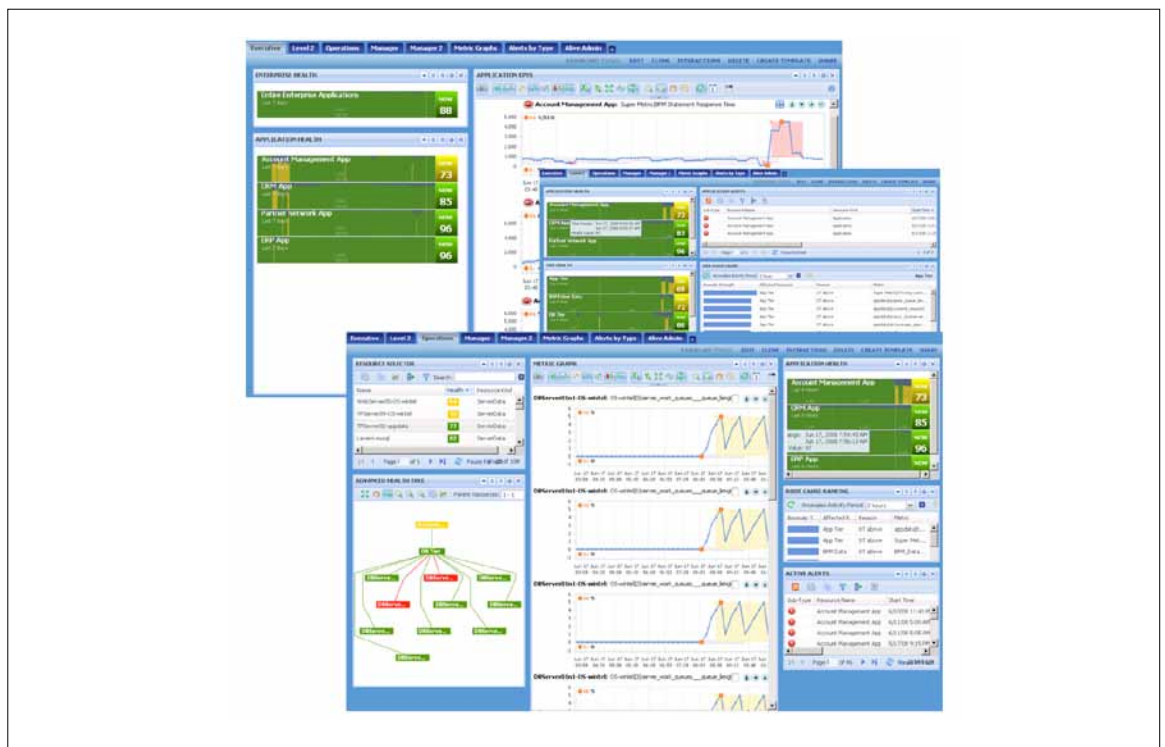


Figure 7. A few examples of complete vCenter Operations Enterprise role-based performance dashboards. VMware vCenter Operations Enterprise allows for the combination of any number of visual widgets to create any desired dashboard—no programming required! Only GUI drag-and-drop techniques.

It is instructive to note that these visual dashboards are not necessarily the method by which users are alerted to major problems within their critical business services—that is the role of vCenter Operations Enterprise's Smart Alerts. Instead, the primary purpose of these dashboards is to provide real-time insight into the on-going performance of these services and how this performance relates to the learned behavior of the silos and IT elements that support the services.

BENEFIT: VMware vCenter Operations Enterprise's role-based performance dashboards provide unprecedented real-time information regarding the health of all aspects of the IT landscape—applications, technology silos, individual resources and even the normal behavior of individual metrics. With this unified understanding of performance behavior, organizations have a common frame of reference, or a common truth, for collaboration on performance-related issues.

On-Demand Analytics

VMware vCenter Operations Enterprise's on-demand analytics offer the ability to gain a deep understanding of the learned behavior patterns of your applications and supporting IT systems, allowing IT staff to optimize the operation infrastructure supporting mission-critical applications.

IT staff can gain insight into the overall behavior trends of their IT resources. They can gain insight into resources that have been behaving the most poorly over time, the technology tiers of an application involved in the most problems or which problems are systematic and occur most frequently. This level of insight can then be leveraged to avoid or more proactively respond to problems.

Figure 8 shows an example of how vCenter Operations Enterprise manifests the 'most problematic' or 'most volatile' resources. This same technique can be used to determine not just problematic resources, but problematic technology tiers/silos or even the most problematic applications.

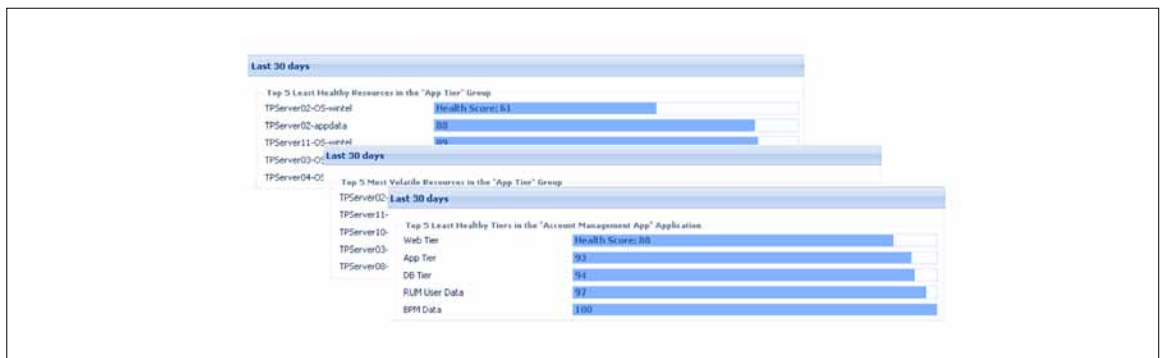


Figure 8. A few examples of on-demand analytics showing the least healthy or most volatile resources and/or technology 'tiers'

Another on-demand analysis that can be leveraged to optimize IT operations is the ability to see side by side the behavior of separate 'tiers' of technology. Figure 9 shows the level of abnormality (i.e., the number of abnormally behaving performance metrics) for a complete application ('Account Management App') and the various technology silos that comprise the application ('database tier,' 'application tier,' and 'Web tier'). Note how vCenter Operations Enterprise is able to illustrate which tier's abnormal behavior began to 'spike' first ('database tier') and which tiers were later affected by the emerging problem.



Figure 9. An example of cross-silo examination of misbehaving applications. Each chart represents the 'number of abnormally behaving metrics.'

BENEFIT: VMware vCenter Operations Enterprise's on-demand analytics give insight into the relationships between resources/tiers/applications in order to optimize the performance of your mission-critical IT systems.

Summary

VMware vCenter Operations Enterprise is able to holistically analyze the performance of your IT landscape in order to provide unprecedented insight into the health of your mission-critical applications and services. VMware vCenter Operations Enterprise provides value during the immediacy of emerging application-level problems through its early warning **Smart Alerts** and its accompanying impact and root cause symptom analysis. VMware vCenter Operations Enterprise provides valuable insight during the routine operation of your applications with its flexible, easy to configure and easy to consume **role-based performance dashboards**. VMware vCenter Operations Enterprise offers **on-demand analytics** to gain insight into relationships and long-term trends that can be used to optimize the performance of your enterprise. VMware vCenter Operations Enterprise is truly the future of performance management for your enterprise.

