
VA Enterprise Design Patterns: End-to-End Application Performance Monitoring (APM)

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APPROVAL COORDINATION

Date:

Tim McGrail
Deputy Director (Acting)
ASD Technology Strategies

Date:

Paul A. Tibbits, M.D.
DCIO Architecture, Strategy and Design

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0.1	04/18/14	Joseph Brooks	ASD TS SOA APM Design Pattern Lead
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1 INTRODUCTION

1.1 Background

Numerous programs within the Department of Veteran Affairs (VA) have developed or acquired applications in a stove-piped fashion, resulting in the proliferation of duplicative software solutions that provide redundant functionality, such as application performance monitoring (APM), to the enterprise. The duplicate systems that need to consume APM functionality drive up the total costs of operations (TCO) and increase the system management burden throughout VA. Additionally, this duplication has resulted in situations where APM covered only specific aspects of monitoring related to typical business transactions, such as Java Virtual Machine (JVM) execution, back-end database or web service calls, or messages traversing a COTS middleware product such as WebSphere MQ. APM was inherently not end-to-end and provided challenges to evaluating the attainment of IT objectives in VA.

Figure 1 depicts a traditional monitoring approach that is focused on specific domains that are covered by different APM toolsets. This approach is considered bottom-up and does not provide full visibility into the entire business transaction between the end user and back-end services. Individual IT support teams using disparate APM toolsets do not work collaboratively, creating inefficiency and longer mean time to repair (MTTR) to support business needs and IT objectives.

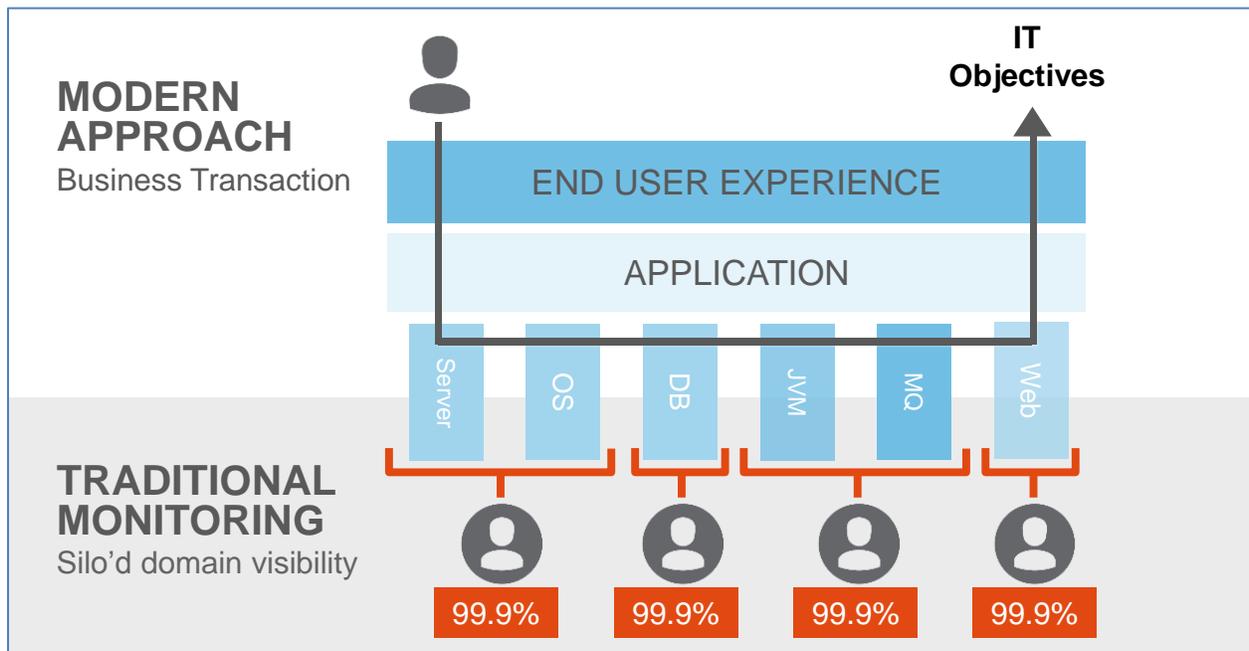


Figure 1 – Traditional Monitoring Approach Providing Visibility to Specific Domains of a Typical Business Transaction

Industry best practices recommend that end-to-end APM should take a top-down approach focusing on the whole application stack. Currently, programs have control over which data centers to use for hosting their applications, but these data centers do not offer the full end-to-end APM capabilities that are offered for applications hosted by the VA's enterprise data centers (e.g., Austin Information Technology Center (AITC)), leveraging the enterprise IT infrastructure used to support enterprise shared services (ESS).

1.2 Business Need

There is a need for reduced TCO and secure information sharing due to the use of enterprise IT infrastructure investments made by VA to support the development all new applications. Using this infrastructure will reduce the proliferation of redundant capabilities that increase development and support costs, and pose security risks to VA. The purpose of this document is to provide high-level guidance to programs on how to leverage end-to-end APM capabilities already provided by the enterprise IT infrastructure, which support Enterprise Shared Services (ESS). Specifically, this document will guide programs to use the APM capabilities provided by the VA Enterprise Messaging Infrastructure (VA eMI) in a Service-Oriented Architecture (SOA) environment and coordinate with appropriate stakeholders in OI&T Service Delivery and Engineering (SDE) Enterprise Operations (EO) early in the development lifecycle to ensure that applications are properly monitored using end-to-end APM instrumentation.

In addition to a financial perspective, there are other justifications for integrating applications with enterprise infrastructure services that leverage end-to-end APM. The table below outlines these benefits broken down by *justification themes*.

Justification Theme	Benefits
Availability vs. Performance Monitoring	<ul style="list-style-type: none"> • Enhanced visibility into the behaviors of distributed systems and how to correlate and resolve various incidents • Reduction in the time to first alert for a performance incident • Performance monitoring capability across protocols like HTTP and JMS and platforms such as Java, .NET and MUMPS
Resolving Application Incidents and Outages	<ul style="list-style-type: none"> • Enabling efficient tracking and resolving performance issues • Separate responses for availability and degradation incidents • More effective use of the monitoring tool infrastructure through active capacity reporting and planning
Improving Application Software Quality	<ul style="list-style-type: none"> • Decreased overall time-to-market for new software systems • Confirmed accuracy and utility of load testing during development

	<ul style="list-style-type: none"> Improved production experience based on a consistent set of KPIs
Pre-production Readiness and Deployment	<ul style="list-style-type: none"> Validation of low overhead of agent and transaction definitions Supports definition of the monitoring dashboards and reporting.
Managing Service Level Agreements (SLAs)	<ul style="list-style-type: none"> Enhanced relationships with business owners Enables reliable transactions that are defined and focused Accurate and rapid performance and capacity forecasting
Enhancing the Value of the Monitoring Tool Investment	<ul style="list-style-type: none"> Decreased time-to-market schedule Optimal use of existing and proposed monitoring technology Evolved skill sets and competencies of technical staff
Proactive Monitoring	<ul style="list-style-type: none"> Achieve proactive management by catching performance problems during QA and UAT (DevOps) Enhance triage of performance problems Enhance overall software quality from the operations perspective
Trending and Analysis	<ul style="list-style-type: none"> Increased use of the monitoring environment Establish comprehensive capacity management planning practices Establish more capable triage technical practices
Single-View of Service Performance (Dashboards)	<ul style="list-style-type: none"> Real-time view of business service performance Visibility into application component interactions and the end-user experience

Table 1 – Justification Themes (Source: *APM Best Practices: Realizing Application Performance Management* by Michael J. Sydor, 2010, ISBN-10: 1430231416)

1.3 Scope

This document applies to all new applications that integrate into VA’s enterprise IT infrastructure. It is intended for all applications that consume enterprise shared services (ESS) and share data with VA and its partners, regardless of end-user device. This guidance in this document will apply to both COTS software (including open-source) acquisitions as well as applications developed internally within VA.

1.4 Intended Audience

This document is meant to be used by all IT PMOs that are developing new applications that are deployed into production within VA’s IT infrastructure. These applications are device-independent,

and encompass the acquisition of COTS software (including open-source solutions) and custom application code intended to meet data sharing requirements utilizing enterprise data stores.

1.5 Document Development and Maintenance

Developed collaboratively with stakeholders from OIT Product Development (PD), Office of Information Security (OIS), Architecture, Strategy and Design (ASD), and Service Delivery and Engineering (SDE), design patterns guide and synchronize the development of system designs to drive the realization of a common technology vision, as documented in the VA Enterprise Technology Strategic Plan (ETSP). This document will be reviewed and updated as needed to account for additional feedback from stakeholders as well as lessons learned from enterprise design pattern implementation. Updates will be coordinated with the Government Lead for this document, who will facilitate stakeholder coordination and subsequent re-approval. Major updates of this document will require formal re-approval per the approval chain listed in the “Approval Coordination” section.

2 DESIGN PATTERN OVERVIEW

This document provides enterprise-level guidance on how applications can leverage end-to-end APM capabilities by using Enterprise Shared Services (ESS) integrated into the VA SOA support infrastructure. This Design Pattern supports the OneVA Enterprise Technology Strategic Plan (ETSP) vision for the expanded use of ESS, helping VA improve information security, achieve information agility, and reduce total cost of ownership (TCO).

2.1 Enterprise Application Performance Management

APM involves the monitoring and management of performance and availability of software applications, taking into account the entire application architecture. APM strives to detect and diagnose application performance problems to maintain an expected service level agreement (SLA) between clients and services via the monitoring of key performance indicators (KPI). This monitoring helps translate application-specific IT metrics into business meaning (i.e., value) for the application stakeholders.

Gartner defines APM as a process with five objectives:

- Tracking, in real time, the execution of the software algorithms that constitute an application.
- Measuring and reporting on the finite hardware and software resources that are allocated to be consumed as the algorithms execute.
- Determining whether the application executes successfully according to the application owner.
- Recording the latencies associated with the execution step sequences.
- Determining why an application fails to execute successfully, or why resource consumption and latency levels depart from expectations.

Measuring the transit of traffic from user requests to data and back again is part of capturing the end-user-experience (EUE). The outcome of this measure is referred to as Real-time Application

monitoring (aka Top Down monitoring), which has two components, Passive and Active. Passive monitoring is an agentless appliance implemented using network port mirroring. A key feature to consider in this solution is the ability to support multiple protocol analytics (e.g., XML, SQL, PHP) since most companies have more than just web-based applications to support. Active monitoring consists of synthetic probes and web robots predefined to report system availability and business transactions. Active monitoring is a complement to passive monitoring; together, these two components help provide visibility into application health during off peak hours when transaction volume is low. The following figure from Gartner outlines the areas of focus for each dimension and describes their potential benefits.

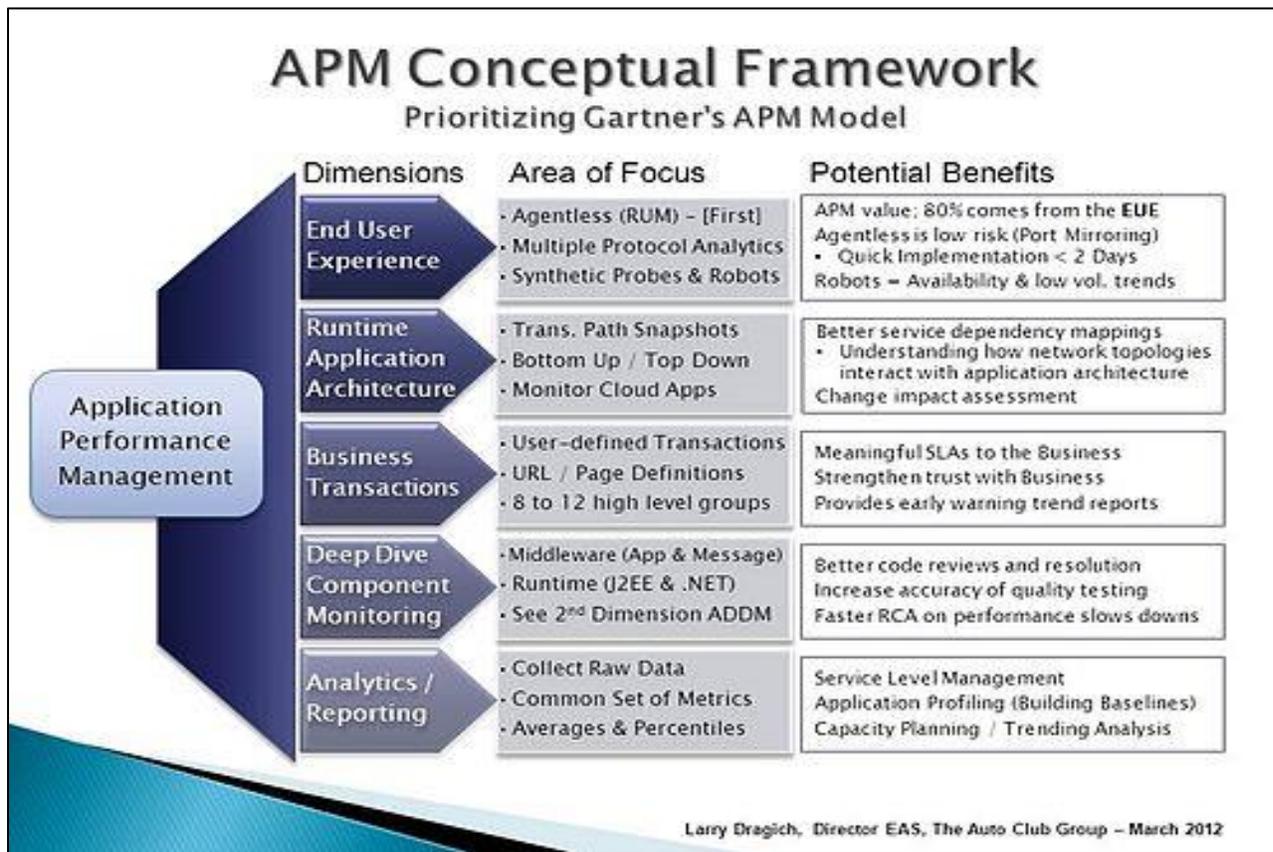


Figure 2 – APM Conceptual Framework According to Gartner Research

2.2 Use of Enterprise Shared Services

APM capabilities will monitor the performance of applications that consume Enterprise Shared Services (ESS) using the IT infrastructure hosted by enterprise data centers. ESS architecture guidelines and governance processes are managed by VA's Office of Information and Technology (OI&T), Architecture, Strategy, and Design (ASD), ESS Center of Excellence (CoE). Details about ESS are

found on the OneVA Enterprise Architecture ESS [website](#). APM is considered to be a platform capability that constitutes the SOA support infrastructure “backplane,” and it does not represent a specific business service, per the following ESS architecture layer construct:

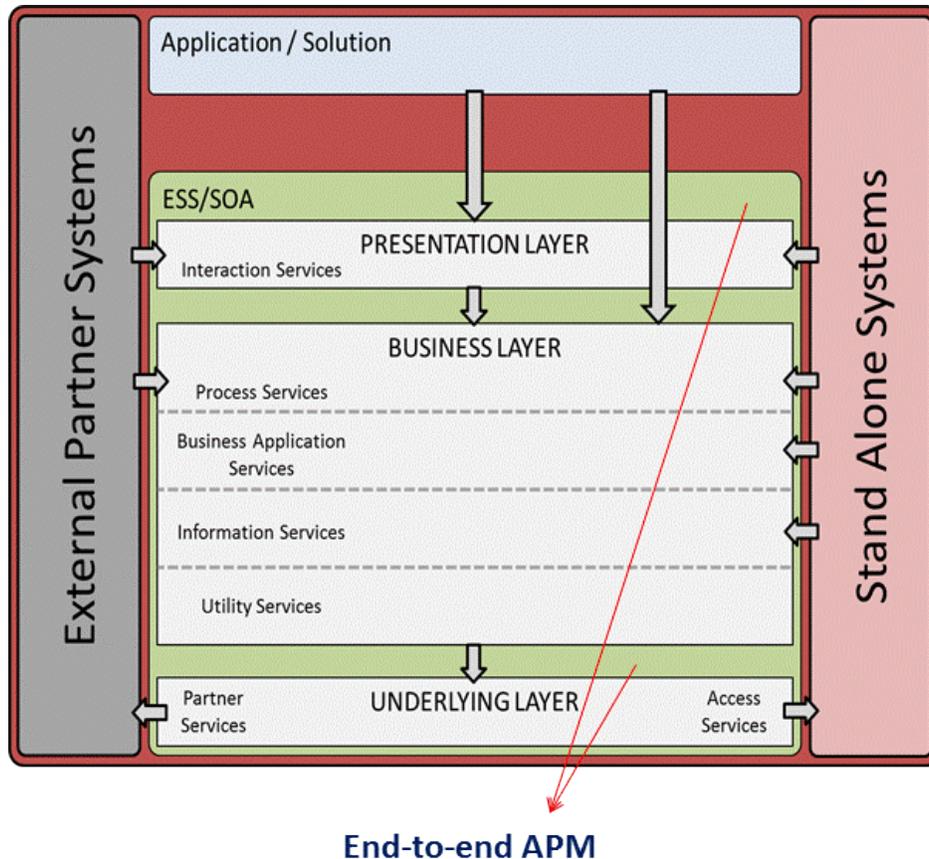


Figure 3 – APM as Represented within the ESS Layered Architecture Construct (Based on Open Group SOA Reference Architecture)

APM monitors both front-end and back-end performance associated with common utility services that are shared across numerous applications meeting diverse business requirements. Per the ESS Strategy document and ESS CoE Charter, new applications consuming ESS will coordinate with the ESS CoE and follow applicable architecture guidelines provided by the CoE to ensure proper integration with ESS. APM is regarded as a cross-cutting concern and is not confined to a specific layer in the application architecture. With regard to service architecture modeling, APM will be referenced in platform architecture models using standards that are included in the technology models (as documented in the ESS Modeling Style Guide). These models will be used to develop service-specific architecture models for ESS in alignment with business capabilities and drivers. APM also integrates with existing Business

Process Monitoring (BPM) and Business Activity Monitoring (BAM) software in the eMI, which integrates with utility services to monitor business transactions, including workflows and Business Process Execution Language (BPEL) orchestrations.

3 DESIGN PATTERN DESCRIPTION

3.1 Core Concepts

End-to-end APM provides a single solution for VA applications that intelligently manages performance, availability and capacity for complex application infrastructure in on-premise, cloud or hybrid environments. It helps the enterprise meet the demanding service levels (as captured in service-level agreements (SLAs)) required of SOA-based applications and provides end-to-end visibility from services, applications, middleware and infrastructure. The concept diagram below (source: IBM) depicts the types of services commonly provided by the suite of infrastructure tools that provide APM capabilities.

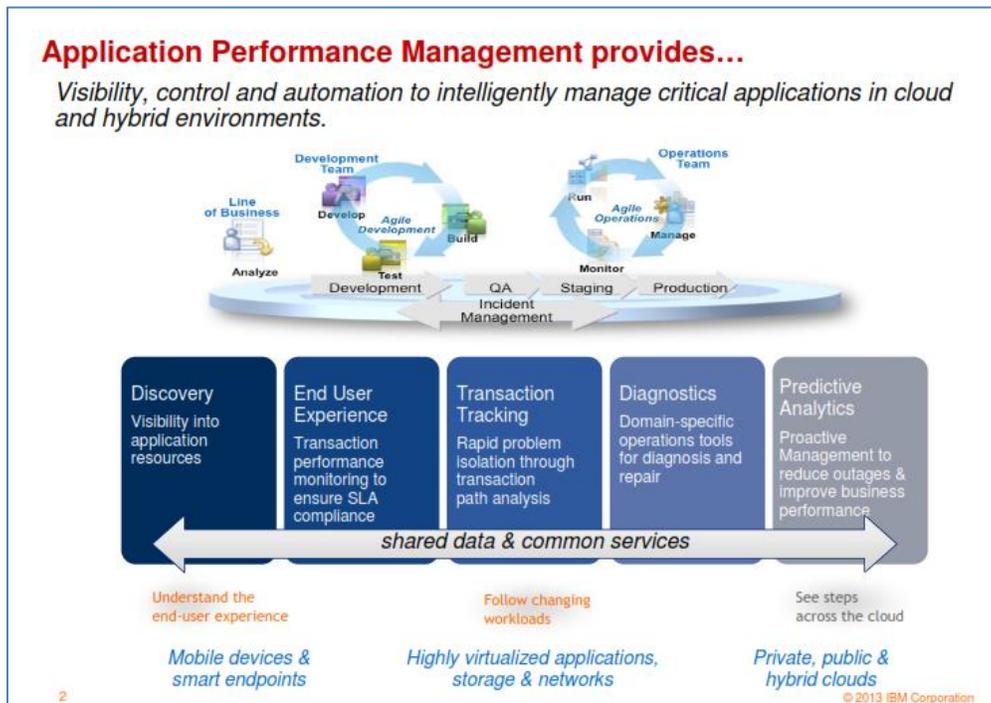


Figure 4 – End-to-end VA APM Capabilities and Transaction Visibility Conceptual Overview

Tools that provide end-to-end APM are currently available for applications that interface with the eMI are deployed at all VA data centers. These tools are currently being used for a wide variety of applications, as described in the Use Case Description Document provided in Appendix C. Collaboratively, they deliver a holistic view into all user transactions across the IT infrastructure to understand the health, availability, service impact and end-user experience of critical applications, allowing programs to proactively diagnose and resolve problems

while optimizing the performance of mission critical services. APM monitors all transactions as they navigate the infrastructure and automatically links those transactions to the dependent application, network and infrastructure components to provide a view of application health, enable prioritization of incidents based on service impact and quickly pinpoint problems across disparate technology silos.

3.2 Common Technical Capabilities

Once an application is deployed into the VA IT infrastructure and hosted at a data center it is integrated with the APM capability provider. There are a set of common attributes applied to multiple use cases (see Appendix C) that constitute a generalized approach to leveraging end-to-end APM among ESS in the VA SOA. End-to-end APM is illustrated by the following context diagram that describes enterprise APM products currently deployed by SDE Enterprise Operations (EO) at AITC:

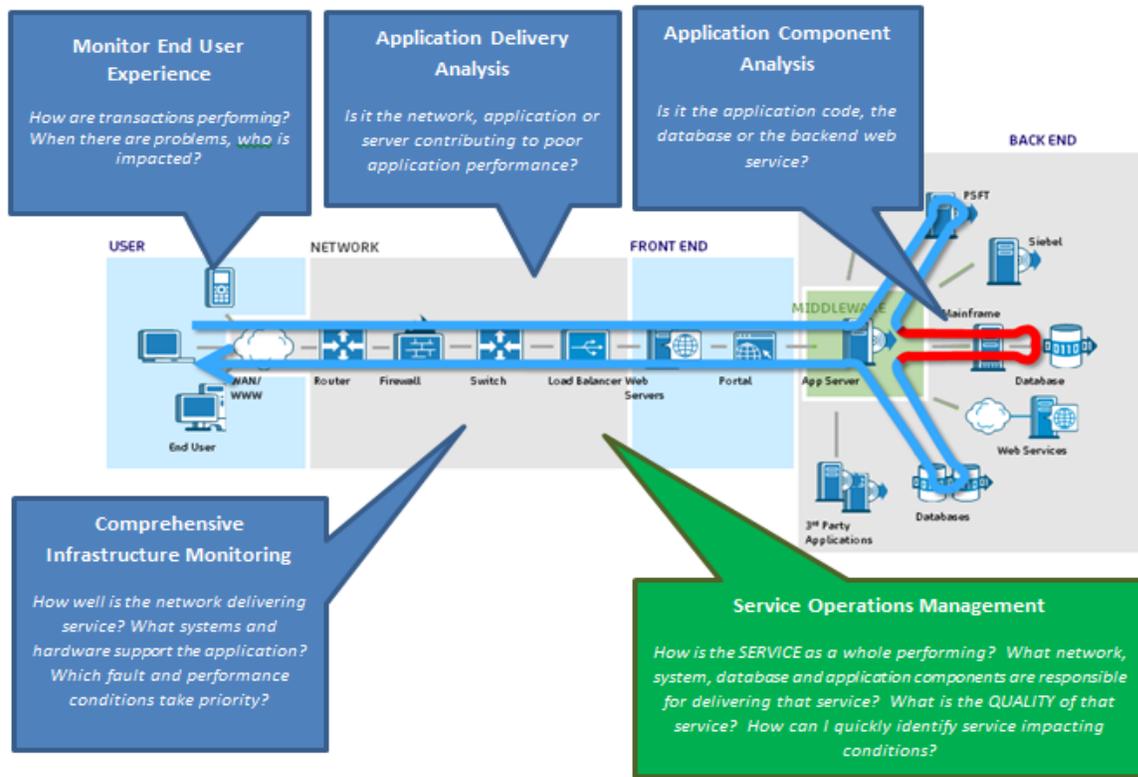


Figure 5 – Illustration of End-to-end Monitoring Capabilities that Provide Monitoring from the End User to Back-end services and Databases

Below are the key APM capabilities from the unified set of tools available to consumers of ESS via the eMI.

End-user Experience Monitoring – Ensure exceptional end-user experience and consistently high service levels that meet business objectives by monitoring all end-user transactions (including the use of web and non-web services) 24x7 operations with low overhead. APM accurately measures end-user transaction performance to ensure applications are delivering against SLAs, business objectives and third-party Software-as-a-Service (SaaS) vendor commitments with regard to application-specific Key Performance Indicators (KPI).

Application Behavior Analytics – Discover anomalous application behavior automatically and proactively alert IT operators of potential problems that could disrupt performance. The instrumentation tools provided by EO automatically mine the vast repository of rich data created by APM and, within hours of setup, can start determining anomalous behavior in components, providing a view of potential issues between related components.

Smart triage – Reduce downtime and optimize the performance of veteran supporting services by proactively identifying, diagnosing and resolving performance problems before they impact end users. The EO-provided APM tools map all transactions to the dependent infrastructure in real-time for a single view of application health, business process flow and the entire transaction path to quickly triage issues, help eliminate problem resolution guesswork and accelerate mean time to repair.

Rapid root-cause diagnosis – Improve IT productivity and control costs by quickly and accurately diagnosing problems occurring deep within the application and infrastructure. End-user experience monitoring capabilities are unified with behavior analytics and deep-dive problem diagnosis features to understand performance issues in context, pinpoint failures and speed problem resolution. Rapid problem identification and resolution often can be accomplished without impacting end users and disrupting services.

Business-centric management – Assure high-value transactions receive the highest service levels by understanding problems in business context to identify critical transactions that may be at risk, prioritize problem resolution efforts, dispatch the right resources and fix the problems that impact functionalities or key end users. Performance and availability information is presented in business terminology, providing application health metrics that can be easily understood by non-application experts and easily communicated to business users.

APM unifies end-user experience and network performance monitoring through a single appliance that provides a single source of truth on how network behavior affects the end-user experience, making it faster and easier to identify, diagnose and resolve transaction problems caused by the network. Unified end-user experience monitoring also helps VA to understand how infrastructure components affect service quality and how effective the network is at delivering applications to users. APM provides application-aware infrastructure monitoring for any TCP-based application without desktop or server agents to deliver a consistent and common set of response-time metrics, mitigate risks from planned

changes and unexpected events and resolve problems faster. By providing the TCP-level view of applications running over the network and from tier-to-tier within the data center, it enables rapid troubleshooting of network and performance bottlenecks and provides insight into the duration, frequency, pervasiveness and severity of problems. An understanding of normal performance is established via automatic, intelligent baselines, which when deviations are detected, diagnostic data can be gathered that helps further enable faster resolution of performance problems. All of this information is accessible from a single, flexible APM dashboard for rapid troubleshooting and triage.

3.3 Application of Design Pattern

3.3.1 Basic Flow of Events

The business process model below shows a prescriptive flow for how end-to-end APM should work within the VA enterprise:

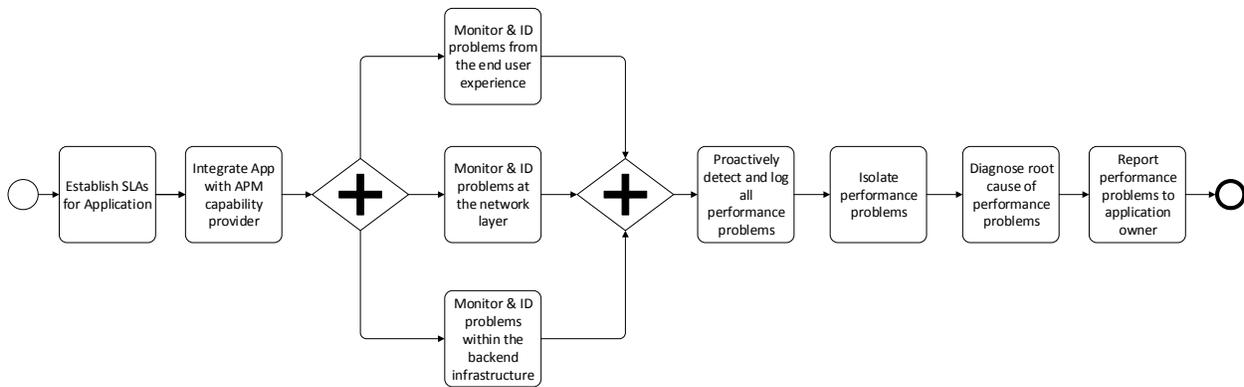


Figure 6 – Process Flow for End-to-End APM Starting with Integration of Application into the IT Infrastructure, Identification of Problems, and Reporting of Problems to Application Owners

The basic flow of events between application owner and infrastructure (e.g., APM capability provider) actors, discussed in further detail in the Use Case Description Document (Appendix C) is as follows:

1. Application owner establishes appropriate key performance indicators (KPIs) for the application in pre-production, including service-level agreements (SLAs) between service consumers and providers
2. Application owner deploys application into the VA IT infrastructure production environment and integrates with APM capability provider
3. APM capability provider monitors all business transactions traversing the entire VA IT infrastructure:
 - a. Monitor and identify problems associated with the application layer (e.g., end-user experience) (See Appendix C for specific attributes)
 - b. Monitor and identify problems associated with application delivery over the network (see Appendix C for specific attributes)

- c. Monitor and identify problems associated with the backend infrastructure (e.g., application servers, web services, or databases) (see Appendix C for specific attributes)
4. APM capability provider proactively detects and logs all performance problems in each part of the infrastructure (Parts 3a-c)
5. APM capability provider isolates performance problems detected in Step 5
6. APM capability provider diagnoses root cause of performance problems in Parts 3a-c
7. APM capability provider reports performance problems to application owner

End-to-end APM tools provide user experience, networking and back-end infrastructure monitoring capabilities. The IT infrastructure of VA provides a standard enterprise set of monitoring tools for both pre-production development and hosted application operations, with enterprise licenses available for each tool. Development operations monitoring would isolate problems in the code such as a SQL statement and application operations monitoring would isolate problems in the operations environment. As part of the development process, programs develop monitoring plans developed in conjunction with the System Design Document (SDD). Monitoring dashboard specifications, methods and thresholds would be delivered as part of the application production delivery.

3.3.2 Proactive Planning for APM

The full array of enterprise APM capabilities, summarized in the previous section, is readily available to all programs and contracts at VA. To date, APM has been an afterthought for all VA applications and the means of measuring performance and key performance indicators (KPIs) have been left until the system is in the hands of SDE Enterprise Operations staff. APM must be part of the software design just as the definition of KPIs tied to quantifiable performance standards should be. The KPIs must all be vetted in a pre-production test environment that exercises not only the application functionality but also the service and performance monitoring to validate the monitoring. This will ensure that the application meets the SLA standards defined as part of the software specifications.

Projects must coordinate infrastructure support and conduct operations support planning as business requirements are established during the PMAS planning phase (Milestone 0). SDE EO must be consulted by integrated project teams (IPTs), and coordinate with the IPTs early in the development lifecycle to establish KPIs that will be used to monitor application performance. The IPTs must establish a monitoring plan with known KPIs, parameters and interfaces that should be specified in the SDD and evaluated at PMAS Milestone 1. In addition, projects need to coordinate the implementation of the web services so that they can be monitored with back-end monitoring systems. From the experiences of SDE, projects establish a common set KPIs that applications need to monitor, control and track relative to indicating application or system poor performance or equipment outage.

Below is the list of common KPIs that are established as the project completes the design and detailed engineering specifications prior to Milestone 2. It is strongly recommended that IPTs begin discussions with SDE during the planning phase to begin planning for the appropriate KPIs that will be needed to evaluate how the application will satisfy the business requirements. The following are some baseline characteristics of KPIs that projects will need to consider when incorporating APM into solution architecture.

- Message queue length
- Transaction or message throughput rate
- Transaction response time (end to end – either from/to human end user or another server)
- Database query response time
- Event management states
- Memory management and garbage collection behavior
- File I/O abnormalities
- Percentage of free storage space available
- Percentage of network retransmissions
- Network round trip time
- Network connection time
- SNMP connection failure (indicates complete equipment unavailability)
- Memory management patterns (e.g. JVM Heap)

Applications must be load tested in pre-production environments. APM must be available in these environments to measure expected performance and identify potential issues. Programs must collaboratively work with EO to identify which of these common KPIs or any other KPIs their applications needs to monitor during the development and testing phase to mitigate any performance risks when the application goes into production.

Appendix A. DEFINITIONS

Key Term	Definition
Enterprise Shared Service	A SOA service that is visible across the enterprise and can be accessed by users across the enterprise, subject to appropriate security and privacy restrictions.
Service	A mechanism to enable access to one or more capabilities, where the access is provided using a prescribed interface and is exercised consistent with constraints and policies as specified by the service description.
Service Oriented Architecture	A paradigm for organizing and utilizing distributed capabilities that may be under the control of different ownership domains. It provides a uniform means to offer, discover, interact with and use capabilities to produce desired effects consistent with measurable preconditions and expectations.
Service-Level Agreement	<p>An agreement between two parties regarding a particular service. They contain quantitative measurements that:</p> <ul style="list-style-type: none"> • Represent a desired and mutually agreed state of a service • Provide additional boundaries of a service scope (in addition to the agreement itself) • Describe agreed and guaranteed minimal service performance
Key Performance Indicator	<p>Performance metrics that target service provider organization objectives that are either both tactical and strategic. Usually these metrics are used to measure:</p> <ul style="list-style-type: none"> • Efficiency and effectiveness of a service • Service operation status <p>It should be noted that not all metrics automatically become Key Performance Indicators. KPIs must be bound to the organization or service goals and must drive continuous improvement and efficiency.</p>

Appendix B. ACRONYMS

Acronym	Description
AITC	Austin Information Technology Center
APM	Application Performance Monitoring
ASD	Architecture, Strategy and Design
BPEL	Business Process Execution Language
BAM	Business Activity Monitoring
BPM	Business Process Monitoring
CoE	Center of Excellence
COTS	Commercial Off-the-Shelf
eMI	Enterprise Messaging Infrastructure
EO	Enterprise Operations
ETSP	Enterprise Technology Strategic Plan
IPT	Integrated Program Team
JVM	Java Virtual Machine
KPI	Key Performance Indicator
MTTR	Mean Time to Repair
PD	Product Development
PMAS	Project Management Accountability System
SDE	Service Delivery and Engineering
SLA	Service Level Agreement
SNMP	Simple Network Management Protocol
TCO	Total Cost of Ownership
XML	Extensible Markup Language

Appendix C. USE CASE DESCRIPTION DOCUMENT



VA APM from End-to-End Use Case

The purpose of the Use Case Description Document is to provide lower-level technical information associated with specific aspects of the end-to-end process flow for accomplishing APM. It is intended for all applications that utilize the VA's common IT infrastructure and interface with enterprise services.

Appendix D. APPLICABLE REFERENCES AND STANDARDS

This Enterprise Design Pattern is aligned to the following VA OI&T references and standards applicable to all new applications being developed in the VA, and are aligned to the OneVA ETA:

#	Issuing Agency	Applicable Reference/Standard	Purpose
1	VA OIS	VA 6500 Handbook	Directive from the OI&T OIS for establishment of an information security program in the VA, which applies to all applications subject to APM.
2	VA ASD	Vista Evolution Design Pattern – COTS Application and Non-COTS Applications	Provides references to the use of end-to-end application performance monitoring as part of the integration with SOA support infrastructure services. These documents are intended to standardize and constrain the solution architecture of all healthcare applications in the VA.
4	VA ASD	Enterprise Application Architecture (EAA) Section 4	Provides technical underpinnings for cross-cutting development concerns for VA applications, including system monitoring and Business Activity Monitoring (BAM)
5	VA ASD	Enterprise Application Architecture (EAA) Section 4.10	The System Management Tower describes the mechanisms that are provided at each level to manage the services provided at that layer. The EAA layer model describes a series of virtual services that are provided at each layer in the architecture. The services described in the Systems Management Tower are the management services that the developers of the services in the corresponding virtual services layer can assume will be available to support the management and reporting of services at their level.
6	VA ASD	SOA Technical Framework (SOA-TF) Section 5	Provides technical underpinnings for cross-cutting development concerns for VA applications, including system monitoring and Business Activity Monitoring (BAM)
7	VA ASD	ESS Strategy Document and Directive	Provides the overarching strategy for developing, deploying, and managing ESS throughout the VA
8	VA ASD	OneVA Enterprise Technology Strategic Plan (ETSP)	Appendix C Systems Management: Long-term vision (2013-2017) calls for “end-to-end monitoring of all infrastructure and applications (UNMCs/VISNs/Rds/etc)
9	VA ASD	OIT Infrastructure Architecture	<ul style="list-style-type: none"> • Outlines the current operating environment at VA Data Centers and a summary of the specifications that should be used for any new, enhanced or replacement IT systems being planned. • Provides a list of instrumentation/monitoring products that exist and may be used (based on business/technical requirements) for the monitoring, proactive detection, triage and diagnosis of performance problems in complex, composite and Web production application environments within VA’s Data Centers.

Appendix E. IDENTIFIED CURRENT PAIN POINTS IN APPLICATION PERFORMANCE

SDE EO has identified key pain points in performance for new VA applications. These are closely linked to the load and capacity testing capabilities which enable measurement of these items prior to production. Mitigation of these pain points would remove 90% of the performance issues that operations encounter according to EO. In general, degraded performance on a new application is due to the application and not the infrastructure. For any major application, it is not uncommon to experience six months of poor performance and stability prior to the production system becoming what it should have been when it was first deployed to production. The following are the pain points identified by SDE EO that can greatly reduce poor performance in production.

- Java Heap issues are one of the primary problems of new systems in production because of inadequate load testing of the applications. EO has a performance monitoring tool that will observe Java Heap behavior and recommend the optimum Java Heap settings to try to minimize the pain of all projects using the “out of the box” heap settings that work in development but not in production.
- Stuck threads typically do not manifest in pre-production without rigorous load testing. These are also expected with any new production application.
- Poorly written SQL queries are, by far, the single biggest application performance issue. This is often tied to developers not recognizing what database indexing is required to optimize the query return. EO also has many projects using Hibernate to generate queries but the projects do not understand how to optimize the queries produced in Hibernate.
- Production database size often causes application performance problems because testing is conducted against small test databases instead of the real-sized production-like database. Therefore, performance is great in pre-production but lackluster in production.