Department of Veterans Affairs

Medical Appointment Scheduling System (MASS)

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Initial Infrastructure Analysis Plan



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Table of Contents

[1 Introduction 1](#_Toc433659310)

[1.1 Scope 1](#_Toc433659311)

[1.2 Purpose 1](#_Toc433659312)

[2 Background 1](#_Toc433659313)

[2.1 Epic Hardware Specification 1](#_Toc433659314)

[2.1.1 Overview of the System 1](#_Toc433659315)

[2.1.2 Process Inputs 1](#_Toc433659316)

[2.1.3 Process Filters 1](#_Toc433659317)

[2.1.4 Process Outputs 2](#_Toc433659318)

[2.2 Process Features and Definitions 2](#_Toc433659319)

[2.2.1 Performance Profiles 2](#_Toc433659320)

[2.2.2 Scalability 3](#_Toc433659321)

[2.2.3 Operational Database Server Scalability 3](#_Toc433659322)

[2.2.4 Hyperspace Scalability 3](#_Toc433659323)

[2.2.5 Web and Service Scalability 3](#_Toc433659324)

[2.3 Process Details 3](#_Toc433659325)

[2.3.1 Application Sizing Assessment 3](#_Toc433659326)

[2.3.2 Citrix Sizing Assessment 4](#_Toc433659327)

[2.3.3 Avoid Onsite, Independent Scalability Testing 4](#_Toc433659328)

[2.3.4 Independently Validate Scalability Testing On-Site 5](#_Toc433659329)

[3 Analysis Step 2: Virtustream Enterprise Cloud Specification 6](#_Toc433659330)

[3.1 Overview 6](#_Toc433659331)

[3.1.1 Process Inputs 6](#_Toc433659332)

[3.1.2 Process Filters 7](#_Toc433659333)

[3.1.3 Process Outputs 7](#_Toc433659334)

[3.2 Process Features and Definitions 8](#_Toc433659335)

[3.2.1 Custom Appliances 8](#_Toc433659336)

[3.3 Process Details 8](#_Toc433659337)

[3.3.1 Process Inputs 8](#_Toc433659338)

[3.3.2 Process Outputs 8](#_Toc433659339)

[3.4 Process Features and Definitions 9](#_Toc433659340)

[3.5 Process Details 9](#_Toc433659341)

[3.5.1 Pilot to National Transition – Floor Space 9](#_Toc433659342)

[4 Document Summary 10](#_Toc433659343)

[Appendix A Acronyms A-1](#_Toc433659344)

[Appendix B Epic Hardware Guide Summary Alpha Site B-1](#_Toc433659345)

[Appendix C Epic Hardware Guide (most current) C-1](#_Toc433659346)

List of Tables

*This will be completed as part of the final release.*

List of Figures

*This will be completed as part of the final release.*

# Introduction

The Department of Veterans Affairs (VA), Veterans Health Administration (VHA) is facing unprecedented challenges providing prompt access to care. The Veterans Health Information Systems and Technology Architecture (VistA) Scheduling application is an aging system with limited extensibility to provide patient-centric and resource-based scheduling in support of advanced care delivery models. To address this challenge, the Veteran experience is enhanced through an improved scheduling process utilizing Epic’s Cadence Scheduling software. Cadence provides resource supply management, increased usability, additional Veteran engagement opportunities, and greater access to care for our nation’s Veterans.

The enterprise-wide Medical Appointment Scheduling System (MASS), enabled by Cadence, will manage the appointment lifecycle, improve clinical resource management, and inform VHA management at all organizational levels with real-time business, resource utilization and demand, supply, and quality service metrics intelligence. To be successful, The MASS implementation will aim to exceed defined critical Success Criteria measurements. The implementation will address critical challenges for stakeholder and user adoption across the enterprise, seamless integration with the more than 126 unique VistA instances, and preserve local autonomy while introducing nationally standardized rules and workflows.

## Scope

To address the requirements of TO 0001, TeamSMS will initiate the 60-day (41 business days) MASS Initial Site Assessment and Planning for Pilot activities. The actions outlined under this TO include analyzing and identifying business and user needs. Implementation plans will be developed across all identified work-streams to guide successful and measureable implementation of Cadence at the proposed Pilot site.

The Task Order (TO) 0001 Performance Work Statement (PWS) scope calls for the development of a comprehensive series of plans that detail the overall project plan, schedule, and detailed success criteria designed to successfully perform implementation of the Epic Cadence Scheduling software and related Infrastructure and Integration at one Pilot-site. During the Planning state, TeamSMS shall identify and prepare Project Management Accountability System (PMAS) and ProPath artifacts for the MASS Pilot-site implementation, including the initial version of 18 plans.

## Purpose

This document provides an overview of the process in use for estimating infrastructure resources required to implement the VA MASS Commercial off the Shelf (COTS) installation according to the solicitation requirements. The process described here is a well-established, repeatable process with defined input and output parameters and can be used to re-estimate resources whenever input parameters change, or become more certain.

# Background

*This will be completed as part of the final release.*

An important distinction for VA Mass infrastructure analysis is that it is implemented using a mature, established process maintained and updated by the COTS vendor, Epic, which allows them to accurately specify hosting requirements for new and existing customers. This process is based on Epic’s extensive historical collection of application response metrics and end user satisfaction metrics gathered from their installed base over decades of operational support. This establishes with high certainty the range for application performance metrics that are necessary to provide a good end user experience.

These application performance metrics, derived from user experience, are then used as criteria in Epic’s extensive performance lab simulations. These simulations test combinations of Epic releases, Operating Systems and Hardware under different loads in order to create hardware profiles. These profiles are then used to create a hardware specification based on existing or predicted load on the system.

This document will detail this process that results is a recommended hardware configuration from the COTS vendor, and also provide details of how this is translated into cloud resource requirements, which include determining the additional resources to handle security and availability requirements as well as supporting infrastructure including the cloud management layer itself.

## Epic Hardware Specification

*This will be completed as part of the final release.*

### Overview of the System

*This will be completed as part of the final release.*

### Process Inputs

*This will be completed as part of the final release.*

The process requires the following inputs:

* Volume/Frequency of Transactions
  + The number of scheduling transactions on the system. This can be extrapolated from the number of schedulers, patients, and number of appointments as well as gathering information from existing scheduling applications.
* Number of Concurrent Schedulers
  + The maximum number of schedulers expected to be simultaneously using the system.
* Number of Concurrent Providers/Read-Only Accounts
  + The maximum number of Providers or other medical staff who are looking up schedules but not primary responsible for scheduling activities.

### Process Filters

*This will be completed as part of the final release.*

Along with process inputs, Epic gathers process filters which limit the possible results from the process. These can be any requirements influencing the results, such as preferences or regulatory constraints. For the VA these include only using components such as O/S’s and databases that are technical reference model (TRM) compliant.

### Process Outputs

*This will be completed as part of the final release.*

The process produces the following outputs:

(Summarize the findings from the epic hardware guide, then point to the completed hardware guide as an appendix/attachment).

## Process Features and Definitions

*This will be completed as part of the final release.*

### Performance Profiles

*This will be completed as part of the final release.*

Performance in Epic is defined as the cumulative performance of all components that contribute to the application response time as experienced by a user on the system. Response time is measured in the context of a workflow step, which is defined as the total lapsed time starting from when an end user initiates an activity that requires the application to perform an action, to the time that the system turns control back over to the end user. These are actions such as filing an appointment, or changing a screen. This is accomplished using an Epic tool called the Response Time Tracker (RTT), which is embedded in Hyperspace and measures the actual response time experienced by an end user while executing defined workflow steps. This tool is always on for predefined workflow steps, for every user, for every environment.

By correlating this data to user satisfaction measures Epic has defined a target for each response time measure necessary to facilitate a good end user experience. These values are programmed into the Response Time Tracker and if the actual timing of a workflow exceeds the predefined threshold, an exception is logged in the tool along with specific information relating the performance exception including User, Workflow Step, Department, Citrix server, workstation, time, and length of the executed step.

While this is useful for troubleshooting, the most relevant key performance indicator (KPI) for evaluating overall performance is the exception percentage, which is also calculated and stored in the RTT. Exception percentage represents the rate at which exceptions occur per executed workflow step and this metric can be viewed as both a standalone value and as a trend over time. Issues with performance can exist for a variety of reasons, and the RTT is designed to identify and provide information about the issue but not find root causes. For example, a trend of all workflow steps increasing or being higher than expected may be a sign that some component of the system needs more resources. On the other hand a single workflow step having an issue could be caused by poor application build or poor software design. Regardless, RTT is the basis for measuring performance and providing the information to identify the root cause of issues.

This tool is an obvious value-add for Epic customers managing a real time environment, but its value in infrastructure analysis is that it enables Epic the ability to develop performance profiles for a variety of hardware and software configurations using the exact same methodology by which customer installations are measured. By setting up testing scenario’s, and applying a uniform load, using a special database to simulate realistic user transactions, Epic is able to collect accurate response times and develop a library of performance thresholds for different hardware and software configurations. There is an entire performance testing team at Epic responsible for keeping this library up to date with the latest hardware and software configurations, which are in turn used to generate a hardware specification which is known to support the required performance for the system based on the system load, which is calculated from the process inputs.

### Scalability

*This will be completed as part of the final release.*

Scalability is defined as the number of concurrent activity that a system can handle before a noticeable impact can be observed on performance information. All of the individual components in the epic solution are designed to scale, either by adding additional nodes, or adding more hardware resources in whatever area is identified as a bottleneck. This allows customer to adjust for increased system load, either system expansion or addition of new functionality. Different levels of the stack have different scalability solutions; this section will address the major system components.

### Operational Database Server Scalability

*This will be completed as part of the final release.*

The Epic operational database has a unique scalability model, mostly because it is designed to allow scaling up on a single database instance before having to split into a distributed network of database servers, this is similar to most commercial database platforms. The simplest and most economical way to scale is to allocate more CPU and RAM to the database. Eventually this will not be an option, so the next way to scale is by provisioning a tier of application servers to perform caching operations in front of the database server, these handle process specific activity and dramatically increases database throughput while still running on a single database server. If that capacity is exceeded, then the database is migrated to a distributed network of database servers which scale through increasing the size of the database farm. Based on the input parameters to date, it is not expect that the VA will exceed the scalability which is achievable on a single stand-alone database server.

### Hyperspace Scalability

*This will be completed as part of the final release.*

Hyperspace is Epic’s integrated user interface. Hyperspace is delivered to the end users through Citrix XenApp running in a clustered Citrix Farm. The Citrix farm can be scaled by adding additional virtual and physical infrastructure to meet additional load. The largest Epic Citrix farm today is hosting approximately 50,000 concurrent connections, and the VA is not expected to exceed this capacity.

### Web and Service Scalability

*This will be completed as part of the final release.*

The Epic web and service tier components are all designed to run in application clusters running behind a load balancer. These clusters can be expanded by adding additional server nodes, and if necessary additional load balancers.

## Process Details

*This will be completed as part of the final release.*

### Application Sizing Assessment

*This will be completed as part of the final release.*

The output is of the process is the Epic hardware recommendation, which is based on their planned application scope, and the estimates of activity volume. For this project, the activity volume is based on Government provided estimate of Annual Scheduled Visits.

The provided system sizing is based on Epic’s performance of synthetic scalability tests on the latest server models, OS versions, Caché versions, and Epic versions, as those become available. Scalability tests start from relatively low activity levels and end when a system fails to meet acceptable performance limits. Epic will not size a system at a load level that demonstrated degraded end-user performance in the lab. End users must have excellent response times and our system sizing model is based on that principal.

The scalability tests allow Epic to provide hardware configurations based on customer provided visit metrics. These hardware configurations are used by customers to purchase hardware before go-lives, during scheduled hardware refresh cycles, and when system activity load is expected to change due to expansion. Epic monitors system utilization at live customer sites. As new servers and new software versions are installed in customer production environments, TeamSMS compare our sizing model against real world data to further refine our synthetic model. This is then incorporated into future system sizing. This iterative process has a team of over 30 people dedicated to the process.

Epic measures database activity using a term Global References per second (GREFs). The operational database server we are proposing for the pilot can support up to 2.9 million GREFs on a single Epic deployment. For the full national roll-out we will provision a larger server that is capable of scaling to 7.0 M GREFs, and then re-provision the original database server as a server in TeamSMS Citrix farm. Based on the information provided by the VA we expect your system at full rollout to be just under 4 M GREFs on the current Epic version.

### Citrix Sizing Assessment

*This will be completed as part of the final release.*

*Todo: Need section detailing the Citrix sizing assessment, number of sessions per VM, number of VM’s per host etc. Reference the Epic Citrix Best Practices WhitePaper.*

### Avoid Onsite, Independent Scalability Testing

*This will be completed as part of the final release.*

Attempts to replicate the Epic scalability testing outside of Epic is a long and expensive process, which in the best case scenario is going to provide comparable results to the existing Epic process. For this reason, TeamSMS has not provided the personnel or budget to duplicate this effort on-site. However, it is possible for VA personnel to visit the Epic facility and observe and participate in the current round of testing.

These tests leverage a combination of a scrambled copy of a longstanding customer environment, upgraded to the current released version of Epic and a suite of homegrown Epic tools. The customer database is crucial to this process; it captures real world utilization of the system which gives the most accurate reflection of post-release metrics. Generic test data has not been able to simulate this level of accuracy, and has failed to produce consistently reliable results. Unfortunately, the patient database, even though it is de-identified, is not owned by Epic and is not allowed to be shared with third parties.

Generated test databases have been found to have a high rate of error, and produce poor results, and it would take considerable time for the VA to build up their own database with enough size and complexity to be able to replicate this level of internal testing. At that time there will be enough run-time performance data to use for decision making that the scalability testing results would be of nominal value.

Epic has an obligation to all our customers to provide accurate, relevant information concerning the performance and scalability testing of our application and stands behind our hardware recommendations based on our own scalability testing. That said, it is expected as part of our standard implementation plan that customers will validate performance in their own environments prior to system go-live.

### Independently Validate Scalability Testing On-Site

*This will be completed as part of the final release.*

A validation of the sizing assessment occurs after infrastructure stand-up but prior to system go-live. Epic recommends the following.

*Todo:RTT Tracking – All workflows within acceptable parameters / Production less than 1% exception rate.*

TeamSMS will perform integration testing, where our system will generate a variable number of interface messages to determine the impact on other systems at the VA. Additionally, TeamSMS can receive messages from those systems to determine the filing process into Epic. Our incoming interfaces are able to be throttled based on system consumption, so they can be prevented from impacting end user performance.

TeamSMS will perform storage testing on the production SAN used for the Operational database up to 150% of expected IO load. This will allow us to validate the storage will meet the needs of the project before go-live. The tool used is an Epic provided tool that replicates the level of random read and sequential writes that occur on our database for a given load.

TeamSMS will be able to isolate individual Citrix servers during the testing phase and validate the number of users we expect per VM can use the system without experiencing performance issues. TeamSMS is not planning to go beyond the testing needed for a single virtual machine (VM).

# Analysis Step 2: Virtustream Enterprise Cloud Specification

*This will be completed as part of the final release.*

## Overview

*This will be completed as part of the final release.*

TeamSMS has proposed cloud architecture to provide hosting for the Epic Application. Our Cloud partner, Virtustream specializes in Enterprise Cloud deployments and has developed a reliable internal process for sizing, deploying, and operating private cloud environments. The analysis phase starts with defining the functional requirements and application infrastructure requirements. These represent the process inputs, and then Virtustream develops a model cloud environment selecting the applicable components based on the functional requirements specified, and then sizes the Compute/Storage and RAM based on the Application Requirements. This model represents a process workflow by which functional requirements are translated into design requirements for the cloud environment.

This process provides both the sizing assessment and infrastructure requirements for the infrastructure layer including Disaster Recover and Business Continuity Plan.

### Process Inputs

*This will be completed as part of the final release.*

The process requires the following inputs:

* Application Infrastructure Requirements
  + The Epic Hardware Guide.
* Backup and DR/COOP functional requirements
  + Inherited from VA Handbook 6500/FISMA 800-53 R4/Epic DR and COOP plan
* Regulatory Functional Requirements
  + FISMA 800-53 Rev4
  + HIPAA
  + TIC 2.0
* Assumptions
  + Datacenter Location
  + Number and purpose of Cloud Security Zones
  + Requirements for DMZ

### Process Filters

*This will be completed as part of the final release.*

Along with process inputs, process filters are provided to limit the scope of the cloud specification. In this case, these filters include any unique design requirements, such as not utilizing any TRM disallowed components.

### Process Outputs

*This will be completed as part of the final release.*

The process produces the following outputs:

* Detailed ROM
  + Details the cloud resource utilization estimates based on the Virtustream model, this is used to determine the number of physical resources that must be specified in the design phase.
* Architectural Assumptions:
  + Number of concurrent Citrix users
  + Physical servers required defined by:
    - Type, Quantity, Cores, RAM ,CPU, Purpose, Data Center Location, Server Pool
  + Virtual Servers required:
    - Area, Application Service, Quantity, vCPU, vRAM, Resource Pool, Phase, Location, Server Pool
  + Primary Site Storage Array Requirements:
    - Drive Area/Pool, Storage Usage, Server, Usable Space (GB), Backup Frequency, Backup method (i.e. San Based Clone), Storage Tier
  + Secondary Site Storage Array Requirements:
    - Drive Area/Pool, Storage Usage, Server, Usable Space (GB), Backup Frequency, Backup method (i.e. San Based Clone), Storage Tier
  + Storage IO Projects and Requirements
    - Per Item
      * Drive Area / Pool
      * Read IOPS
      * Read Throughput (MB/sec)
      * Write Operations per 80-Second Write Burst
      * Write Volume per 80-Second Burst (MB)
      * Write IOPS
      * Write Throughput (MB/sec)
      * Minimum SAN Write Cache Requirement (MB)
      * Average Read Response Time Requirement (ms)\*
      * Average Write Response Time Requirement (ms)
      * 15K RPM Drive Count Requirement for IO
      * 10K RPM Drive Count Requirement for IO
    - Per Group
      * Production
      * Reporting Environment
      * Disaster Recovery
      * Cognito Clarity RDBMS
* DataCenter Specification
  + Specifies Rack configuration, # of racks, power requirements and data connectivity requirements. Serves as an input to the last step in the analysis process.
  + Specifies required physical security controls which must be implemented on-site to meet regulatory requirements.

## Process Features and Definitions

*This will be completed as part of the final release.*

### Custom Appliances

*This will be completed as part of the final release.*

In the Epic Hardware Guide, Epic specifies very strict requirements for the database server which could not be met using shared resource pools, which is how Virtustream generally plan to provisions resources. To accommodate this request, Virtustream has included dedicated database appliances in their cloud specification which exactly match the Epic Hardware specification for these servers, including processor model and revision. Likewise, Epic’s recommended Citrix Server Specifications were also matched exactly. Strict adherence to the Epic Hardware Guide’s recommended server configuration maintains traceability to the Epic performance and scalability testing and avoids introducing potential sources of error.

## Process Details

*This will be completed as part of the final release.*

TeamSMS plans to provision space at Centurylink Datacenters in Sterling, VA and Chicago, IL where physical hardware is racked and connected.

### Process Inputs

*This will be completed as part of the final release.*

The process requires the following inputs:

* Virtustream Datacenter Specification
* Regulatory Requirements
  + FISMA 800-52 Rev4
  + HIPAA

### Process Outputs

*This will be completed as part of the final release.*

The process produces the following outputs:

* Datacenter Cage.

## Process Features and Definitions

*This will be completed as part of the final release.*

## Process Details

*This will be completed as part of the final release.*

### Pilot to National Transition – Floor Space

The physical floor space, high security cage, and security controls will be sized according to the requirements for National Deployment, but racks and power will be limited to Pilot site implementation. The cost for additional floor space is negligible compared to the risk that we lose contiguous floor space and have to re-locate the environment in order to expand.

# Document Summary

*This will be completed as part of the final release.*

Summarize the process, how with changing assumptions, we can re-run this process and generate new Design Criteria, which then we run the Design process to update our entire infrastructure plan.

###### Acronyms

| Acronym | Description |
| --- | --- |
| COTS | Commercial off the Shelf |
| GREF | Global Reference per second |
| IIB | IBM Integration Bus |
| KPI | Key Performance Indicator |
| MASS | Medical Appointment Scheduling |
| MRT | Mapped Record Testing |
| PMAS | Project Management Accountability System |
| PWS | Performance Work Statement |
| RTT | Response Time Tracker |
| SME | Subject Matter Expert |
| TO | Task Order |
| TRM | Technical Reference Model |
| VA | Department of Veterans Affairs |
| VHA | Veterans Health Administration |
| VistA | Veterans Health Information Systems and Technology Architecture |
| VM | Virtual Machine |

###### Epic Hardware Guide Summary Alpha Site

This will be completed as part of the final release.

###### Epic Hardware Guide (most current)

This will be completed as part of the final release.