

Epic Hyperspace Deployment on MetaFrame Presentation Server Scalability Analysis

Citrix Systems, Inc.

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Introduction

Epic Systems Corporation (Epic®) provides healthcare management software that integrates financial and clinical information across inpatient, ambulatory, and payer technology systems. Epic's software offerings include scheduling and registration tools, billing and managed care administration applications, inpatient and outpatient core clinical systems, electronic medical records applications, and applications for managing hospital pharmacy, emergency, surgery, radiology, laboratory, and intensive care departments. Organizations that access the Epic Hyperspace® user interface through the Citrix Access Suite enjoy the following benefits.

Time Savings: Rapid deployment

Predictable Performance: For remote and WAN users

Simplified Administration, Training and Support: Lower help desk costs and training costs, improve security, and simplify user experience with single sign-on and advanced MetaFrame Presentation Server features such as Shadowing

Increased Productivity: Increase clinician productivity with web-based access that is appropriate to user roles

Controlled and Centralized Management Environment: Minimal desktop management required for upgrades

Access from Anywhere: Provide physicians, nurses and staff with easy and secure remote access to information from anywhere, from any device, over any network

Reduce TCO (Total Cost of Ownership): High performance from existing devices and connections; lower the cost of IT and greatly improve scalability, adaptability, and predictability

Application Integration: Integrate Epic Hyperspace into an existing access solution

Access for Business Continuity and Connectivity for Remote Offices: Such as application development performed in other countries

The objective of this whitepaper is to provide scalability results when running Epic Hyperspace via MetaFrame Presentation Server 3.0. The results are obtained from the Epic Hyperspace testing cycle, which is a combination of Cadence and EpicCare workflows. The target audiences for this whitepaper are MetaFrame Presentation Server Architects, System Integrators, and Project Managers looking to design and capacity plan a MetaFrame Presentation Server farm deploying Epic Hyperspace.



Executive Summary

The scalability study for Epic Hyperspace provides MetaFrame Presentation Server Architects, System Integrators, and Project Managers with data to help design and capacity plan a MetaFrame Presentation Server environment. This study also provides a description of the testing environment as well as the workflow executed to gather the scalability numbers. Leveraging the methodology and workflows used in this analysis, similar testing scenarios can be performed to benchmark future or alternative hardware platforms.

Citrix Consulting leveraged a proven methodology, which typically yields conservative results, to assess the server scalability of a MetaFrame Presentation Server hosting Epic. After a baseline was established on the server, groups of users were incrementally added to the server as system resources were monitored for potential bottlenecks. Throughout the duration of the test an actual user logged on to the systems and validated the performance of the environment before new users were added.

Another generally accepted approach, that is typically used within the Healthcare industry, is to preload a large number of user sessions on a MetaFrame Presentation Server and systematically launch workflows within the sessions. Preloading user sessions reduces the resource strain experienced for new logins by the MetaFrame Presentation Server and may skew results. Citrix Consulting leveraged the more conservative approach when conducting this analysis.

During the scalability analysis, automated user sessions were launched on a MetaFrame Presentation Server that executed a combination of workflows using two common modules, Cadence and EpicCare. During the testing cycle, the server exhibited 2.5% total processor utilization increase and 43 MB memory consumption per user, resulting in a maximum of 37 users per server for this particular workflow and environment configuration.

As a best practice, Citrix recommends that MetaFrame administrators cap user load on a server when the average resource utilization reaches 80% to 90%. The threshold accounts for the periodic CPU spike experienced during normal system usage as well as providing a buffer for unexpected or scheduled server operations, such as virus scanning or backups. In some instances, organizations may choose to increase or decrease the acceptable threshold based on application characteristics and redundancy requirements.

An average processor utilization of 80% to 90% for the Epic Hyperspace testing cycle correlates to 30 to 34 active ICA sessions; an average memory consumption of 80% to 90% for the testing cycle correlates to 63 to 67 active ICA sessions. Therefore, the limiting factor that determined the maximum number of users per server was processor utilization. Throughout the test, a manual user session was run to ensure the usability and performance of the system. As the thresholds were reached, acceptable performance levels were maintained.

Testing Environment

This section describes the elements of the testing environment used throughout the Epic Hyperspace testing cycle.

Hardware Specifications

The following chart identifies the server names involved in the Epic Hyperspace testing cycle, their role, and their hardware specifications.

Server Role	Hardware
Citrix License Server	VMware GSX Windows 2000 server image
Microsoft SQL 2000	Single 1 GHz Processor; Windows 2000 Server; 256 MB RAM
Citrix MetaFrame Presentation Server 3.0	HP ProLiant BL30; Dual 3.2 GHz Processor (Hyper-threading Enabled); 4 GB RAM; HP SmartArray 5i Raid Controller (100% Read); Raid 1 (Mirror); 15k RPM Drives
Zone Data Collector	VMware GSX Windows 2000 server image
Linux Caché Database	VMware Image

Windows 2003 Environment

All servers were built by Epic with Windows Server 2003 following recommendation from the respective vendors. One hundred test user accounts were configured with a mandatory profile; each with its own corresponding client name. The production database used by Epic requires a unique client name for each user. All Windows Server 2003 systems were updated using Microsoft Windows Update with all the latest Critical Updates and Services Packs installed that were suggested by Microsoft Windows Update. Finally, anti-virus software was not installed on the MetaFrame Presentation Servers in the testing environment.

MetaFrame Presentation Server Configuration

MetaFrame Presentation Server was installed with default options and server drives were not remapped; client drive mapping and client audio mapping were both disabled for the Epic Hyperspace testing cycle. Version 8.1 of the ICA client was used for testing. Additionally, on the client machines the Webica.ini file was configured to 'Never Ask Again'. This prevented the Client File Security Status window from appearing after the launch of each ICA session and enabled Visual Test automation.



Figure 1 - Client File Security Window



Rational Visual Test Configuration

Rational Visual test is an automation application that is used to perform functional testing of client/server applications based upon a wide variety of user interface technologies. Visual Test allows administrators to test each application component under varying conditions and provides test cases for common objects such as menus, lists, bitmaps, and specialized test cases for objects specific to the development environment. Reference the following URL for further information on Visual Test, <http://www-306.ibm.com/software/awdtools/tester/robot/index.html>.

A login script, written in VB Script, was used to launch the Visual Test application with the proper parameters to begin the workflows. Based on client name, the VB Script would launch the Cadence Workflow or the EpicCare Workflow. The Visual Test application would launch the proper workflow after a user logged in to the MetaFrame Presentation Server.

Epic Hyperspace Configuration

The Fall 2004 base release of Epic Hyperspace was installed on the MetaFrame Presentation Server according to Chapter 14, Citrix/Terminal Server Setup, of the *Epic Workstation Setup Guide*[†]. After Epic Hyperspace was installed, an application compatibility script was created on the MetaFrame Presentation Server. The application compatibility script completes the following tasks:

- Creates a folder on the C: drive based on the %ClientName% variable
- Ensures that a unique epic.cli file is created in this location
- Substitutes the P: drive for this folder
- Assigns a unique workstation ID to each workstation, using the workstation manager utility

Refer to the Appendix for more details on the application compatibility script.

The Epic database was hosted on Linux VMware session for the Epic Hyperspace testing cycle. This allowed the test facilitators to roll back changes made to the database in a timely fashion. Hosting the Epic database on a VMware image did not seem to have an impact on the Epic Hyperspace testing cycle results. However, for production environments it is not recommended to host the application database on a VMware image; the production database normally runs on a dedicated Unix or VMS server

Workflow Configuration

The workflow used during Epic Hyperspace testing cycle is a combination of Cadence and EpicCare workflows. The steps included in each workflow are described below.

Cadence® Workflow

This workflow first runs a report to display the Arrival List. It then creates two appointments for a selected patient and cancels them at the end to allow for multiple runs of this workflow with minimal data preparation and destruction.

EpicCare® Workflow

This workflow opens a selected patient chart and reviews several historical aspects of the existing chart including Office Visits, Orders, Medications, and Results. A new contact is then created for that patient where standard patient information is gathered such as vitals, complaints, nursing notes, and allergies. The encounter then continues to add to the patient problem list and through several tools, such as flowsheets, a diagnosis is

[†] The *Epic Workstation Setup Guide* is obtained from the Documentation CD-ROM that ships with the Epic Hyperspace software.



determined, an immunization is added and the level of service is calculated for the encounter. A letter is composed and then accepted; finally the encounter itself is accepted.



Epic Hyperspace Scalability and Utilization

This section details the scalability results of Epic Hyperspace on MetaFrame Presentation Server during the Epic Hyperspace testing cycle. This section provides graphs and data that explicitly show the impact that each user had on the processor and memory while running the Epic Cadence and EpicCare modules.

Measurements

Server performance activity was monitored and recorded during the testing cycle. An administrator remained logged into the MetaFrame Presentation Server in order to ensure acceptable responsiveness within the application during the testing cycle. After every ten users were logged onto the MetaFrame Presentation Server, the administrator obtained qualitative and subjective measurements of the server's performance.

The Microsoft performance monitoring utility, Perfmon, was used to record the server performance activity throughout the testing cycle. The following list contains the performance counters that were recorded during the Epic Hyperspace testing cycle[‡].

- **LogicalDisk(_Total):** % Disk Time
- **LogicalDisk(_Total):** % Free Space
- **Memory:** Available Bytes
- **Memory:** Pages/sec
- **Network Interface:** Bytes Total/sec
- **Paging File:** % Usage
- **PhysicalDisk(_Total):** Current Disk Queue Length
- **Process(_Total):** Working Set
- **Processor(_Total):** % Interrupt Time
- **Processor(_Total):** % Processor Time
- **Processor(0):** % Processor Time
- **Processor(1):** % Processor Time
- **Processor(2):** % Processor Time
- **Processor(3):** % Processor Time
- **System:** Context Switches/sec
- **System:** Processor Queue Length
- **Terminal Services:** Active Sessions

Utilizing Rational Visual Test to perform the test added a negligible overhead to the MetaFrame Presentation Server. The scalability results directly correlate to 40 users logging into a MetaFrame Presentation Server and simultaneously following the Cadence and EpicCare workflows. It is important to note that Epic Hyperspace is a single threaded

[‡] Only the % Processor Time (Processor), Available Bytes (Memory), and Active Sessions (Terminal Services) performance counters were submitted for analysis.

application; therefore all processors were monitored individually during the testing cycle to ensure that process load balancing was occurring.

Processor Scalability Results

The percentage of Processor Time was logged throughout the Epic Hyperspace testing cycle, with the results charted below. The amount of the total processor consumed increased steadily as user sessions increased on the MetaFrame Presentation Server. The trendline indicates an increase of approximately 2.5% processor utilization per active ICA session; and the baseline processor utilization during the testing cycle was 5.7%. The baseline processor utilization level is the amount of CPU consumed by the server without user load. The following figure illustrates the processor utilization as a function of user load.

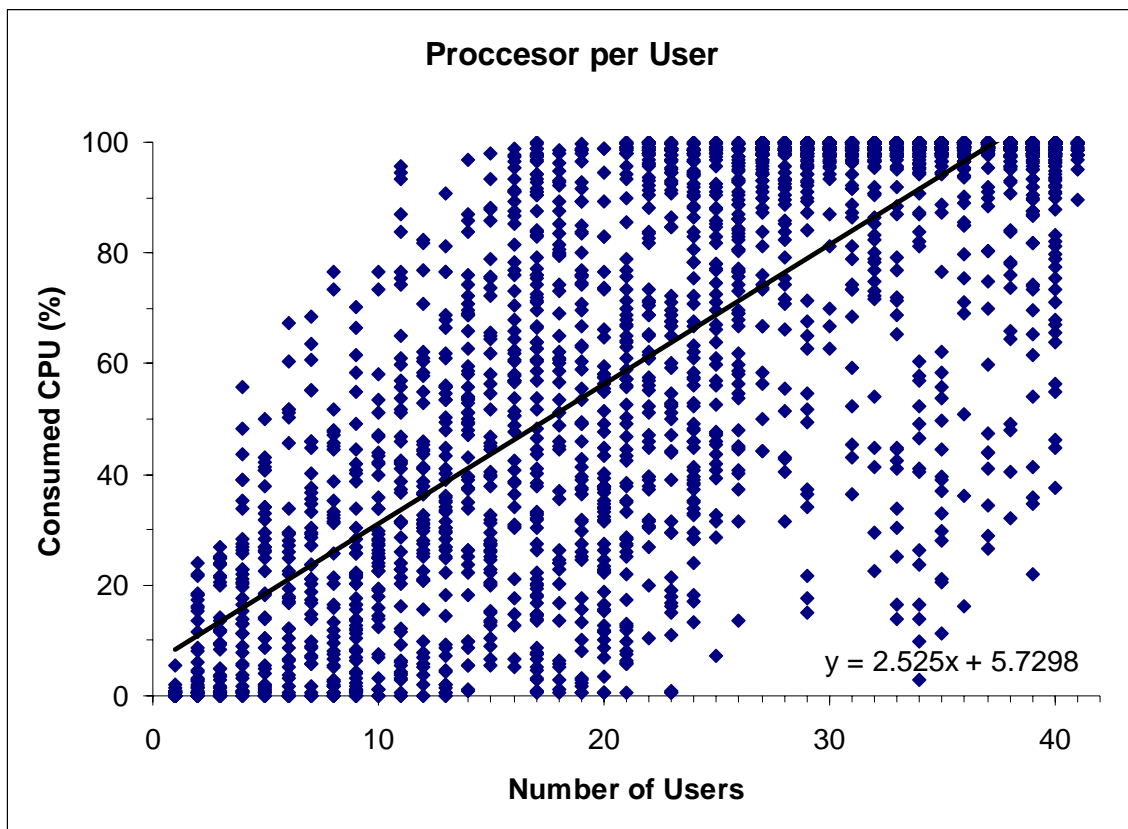


Figure 2: Processor Utilization Chart

Citrix Consulting recommends that MetaFrame administrators cap user load on a server when the average resource utilization reaches 80% to 90%. An average processor utilization of 80% for the Epic Hyperspace testing cycle correlates to 30 active ICA sessions, while 90% correlates to 34 active.

Memory Scalability Results

The amount of memory consumed on the MetaFrame Presentation Server was tracked throughout the testing cycle and is presented in the chart below. The following graph shows the amount of consumed memory, in megabytes, as active ICA sessions were added to the server. As the number of ICA sessions was increased, the amount of memory consumed also increased; this was expected behavior. The trendline shows an increase of 43 MB per user with a

baseline memory consumption of 547 MB. The baseline memory consumption level is the amount of memory consumed by the server without a user load.

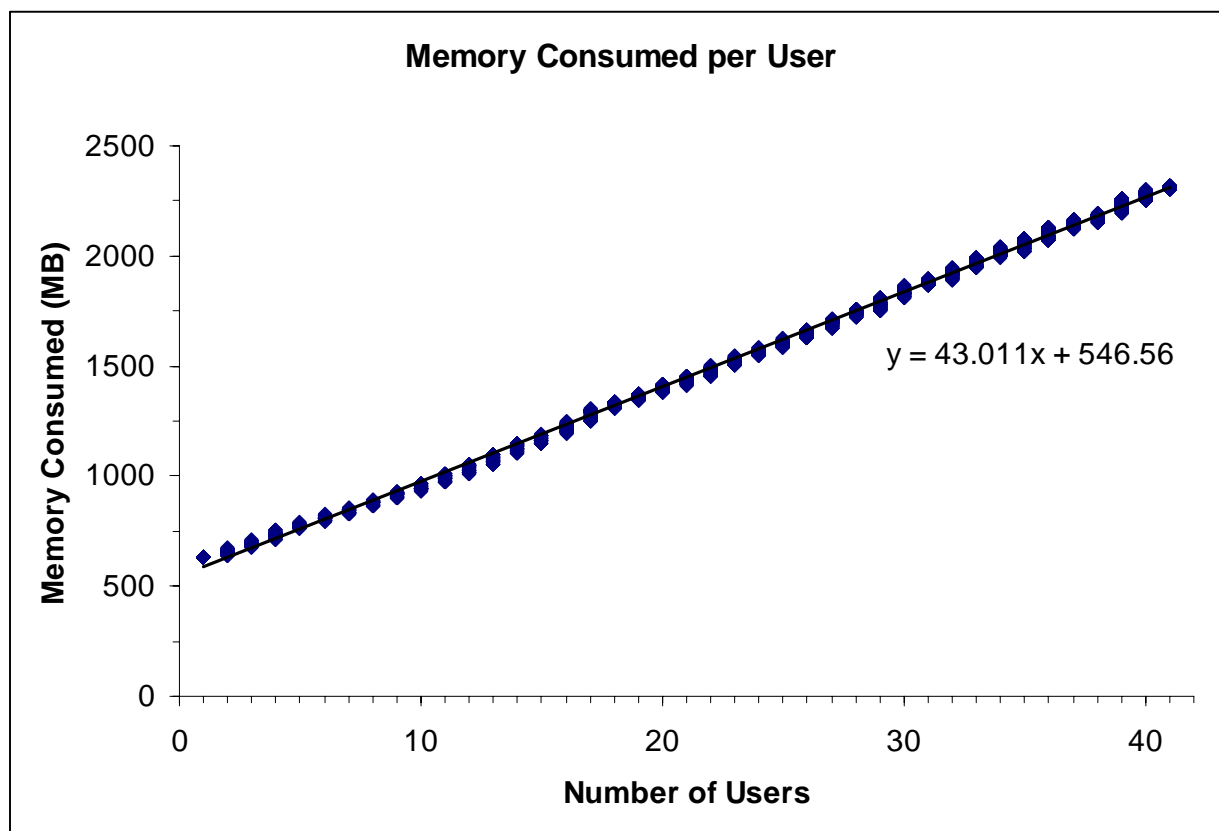


Figure 3: Memory Consumption Chart

Citrix Consulting recommends that MetaFrame administrators cap user load on a server when the average resource utilization reaches 80%. An average memory consumption of 80% for the Epic Hyperspace testing cycle correlates to 63 active ICA sessions.

Results Conclusion

Data analysis for the Epic Hyperspace testing cycle show each user consumed 2.5% of the processor and 43 MB of memory. A trendline, using a least squares fit, was employed to determine processor and memory consumption. Based on the results of the scalability analysis servers should be closely monitored as they reach 30 to 34 active concurrent sessions, which follows the recommendation that MetaFrame administrators cap user load on a server when the average resource utilization reaches between 80% and 90%. The threshold for processor utilization is reached with less users than the memory threshold. Therefore the processor utilization per user is the limiting factor and dictates a benchmark of 30 to 34 users per MetaFrame Presentation Server.

Processor and memory utilization have the greatest overall affect on the performance of a MetaFrame Presentation Server. Sometimes there is a bottleneck in another server resource which can cause an artificial increase in processor and memory utilization. The other performance counters were monitored as they are the resources that are most likely to cause a bottleneck. The results of the performance counters measured during the testing cycle did not show signs of approaching a bottleneck and therefore will not be subject to further data analysis.



Summary

This whitepaper provided scalability results when accessing Epic Hyperspace over MetaFrame Presentation Server. The results were obtained from the Epic Hyperspace testing cycle automated with the Rational Visual Test tool. Using the results provided in the whitepaper, MetaFrame Architects and Project Managers can better plan capacity when deploying the Epic Hyperspace application via MetaFrame Presentation Server 3.0.



Appendix: Epic Hyperspace Compatibility Script

The following application compatibility script is executed by each user on login; it was used during the Epic Hyperspace testing cycle. The application compatibility script is written in VB Script.

Option Explicit

```
dim oSessionInfo, oFSO, oWshshell, oNet
```

```
set oSessionInfo = CreateObject("EpicPCSWtsApi.SessionInfo")
```

```
set oFSO = CreateObject("Scripting.FileSystemObject")
```

```
set oWshShell = CreateObject("WScript.Shell")
```

```
set oNet = CreateObject("WScript.Network")
```

```
Const PFP = "C:\Epic\PFP\"
```

```
Const PFPMASTER = "C:\Epic\PFP!\Master\"
```

```
Const EPIC_CLI = "EPIC.CLI"
```

```
Const WSMGR = "C:\Epic\WsMgr\WsMgr70.exe"
```

```
Const WSM_DIRECT = " /d /i"
```

```
Const WSM_WTS = " /WTS"
```

```
Const WSM_VERBOSE = " /V"
```

```
Const WSM_OK = 0
```

```
Const WSM_ERR = 1
```

```
Dim sSessionID,sClientID,sWSMGR,sComputerName,sPFP,sCliMaster,sSessionEnv,sCliName
```

```
Dim rc, sfdMasterCli
```

```
'Build PFP path based on Server session id
```

```
    sSessionID=oSessionInfo.SessionID
```

```
    sCliName=GetEnvVarValue("ClientName")
```

```
    sPFP=oFSO.BuildPath(PFP,sSessionID)
```

```
    If not oFSO.FileExists(oFSO.BuildPath(sPFP, EPIC_CLI)) Then
```

```
        PostMsg "Creating PFP folder for session" & sSessionID
```

```
        oFSO.CreateFolder(sPFP)
```



```
Else
    PostMsg "PFP OK. Already created for session" & sSessionID
End If

oFSO.CopyFile oFSO.BuildPath(PFPMaster,"*."),sPFP

'Substitute P: for the PFP folder
rc = oWshShell.run("subst P: " & sPFP,0,True)
PostMsg "Create P: drive. (" & CStr(rc) & ")"

'Check to see if ClientName is defined in WSM tables
rc = oWshShell.Run(WSMGR & WSM_WTS,,True)
'rc = oWshShell.Run(WSMGR & WSM_VERBOSE,,True)
If rc = WSM_OK Then
    'ClientName is defined in WSM tables
    'No other processing is needed
    PostMsg "Workstation ID assigned by workstation manager."
Else
    'WSM tables did not contain the client name
    'Assign a dynamic, yet unique ID
    sComputerName=oNet.ComputerName
    sClientID = AssignDynamicID(sComputerName, sSessionID)
    oWshShell.Run WSMGR & WSM_DIRECT & sClientID,0,True
    PostMsg "Workstation ID dynamically generated as " & sClientID
End If

Function AssignDynamicID(cn, sid)
    Select Case cn
        Case "Metaframe Server Name"
            AssignDynamicID="EC11" & right("00" & sid, 2)
        Case Else
            AssignDynamicID="ONEEDACLIENTID"
    End Select
End Function
```



```
End Function

Sub PostMsg(Msg)
    Dim sMsg

    sMsg = WScript.ScriptName & "." & Msg
    WScript.Echo sMsg

End sub

function GetEnvVarValue(EnvVar)
    dim oShell, oEnv
    set oshell = CreateObject("Wscript.Shell")
    set oEnv = oShell.Environment("Process")
    GetEnvVarValue = oEnv(EnvVar)

    set oShell = Nothing
    set oEnv = Nothing

end function
```



Citrix Consulting™



851 West Cypress Creek Road Fort Lauderdale, FL 33309 954-267-3000 <http://www.citrix.com>



5301 Tokay Blvd. Madison, WI 53711-1027 608-271-9000 <http://www.epic.com>

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