

Writing a Resource Based (Adaptive) Server Agent

Technical Note

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1 Document Purpose

This document outlines how to create your own load balancing server agent to use in conjunction with the resource based (adaptive) Virtual Service (VS) scheduling method, which is one of the VS **Scheduling Method** choices in the VS **Standard Options**. This document focuses primarily on the requirements for creating and configuring such agents on arbitrary server operating systems (for example, the protocol used by the agent to communicate load values to the LoadMaster), and less on the mechanics of generating a load value using specific Operating System (OS) utilities. Nevertheless, this document presents simple examples of implementing and deploying a server agent on both a Windows and Linux system.

In the remainder of this document, the resource based (adaptive) scheduling method is referred to simply as adaptive scheduling.

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2 Custom Server Agents and Adaptive Scheduling

Do the following on every Real Server in a Virtual Service before selecting adaptive scheduling on the Virtual Service:

1. Deploy an HTTP server whose endpoint (IP address and port) is accessible to the LoadMaster.

2. Write and install a 'server agent' that runs periodically and does the following:

   a) The agent queries the server operating system for system load statistics.

   b) The agent then uses the load values obtained from the operating system to arrive at an integer value indicating the system load. Under normal circumstances, this will be an integer between 1 and 100 with higher numbers indicating a higher load. Other integers can be returned for special conditions (see the table below).

   c) Finally, the agent places the integer value (and nothing else) in a file underneath the root directory of the HTTP server running on the Real Server.

If the application is OK and ready to service requests, set the Real Server load value in the file returned by the HTTP server to the same integer value (1-100) on each server, for example, **50**. This will result in a round-robin between the servers. If the servers have different levels of resources, set them higher or lower as appropriate.

If the application is down, set the Real Server load number to 101. This marks the server as down in the User Interface (UI).

> When you first enable adaptive scheduling and there is no HTTP server running on the Real Server, the Real Server weight is set to 100 (heavily loaded).

On the LoadMaster side, you can then select adaptive scheduling on the Virtual Service, which enables the following behavior:

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- The LoadMaster periodically performs an HTTP GET to retrieve the file populated with the integer load value from each Real Server in the Virtual Service.
- Until the LoadMaster successfully retrieves an integer load value from a Real Server, it is considered unavailable (dynamic weight = 0).
- Once a load value is obtained for a Real Server, the LoadMaster modifies the dynamic weight of the Real Server, according to the table below.

Agent Response	Action Taken	Description
No HTTP Response	**Dynamic Weight = 0**	If the LoadMaster gets no response when it attempts to get the file containing the load value, then the Real Server is assumed to be unavailable and it is marked down. This is done by setting the server's dynamic weight to 0 so that no new connections are sent to it. Currently open connections are not affected. This typically happens when either the Real Server is unavailable, or the required HTTP server is not responding to the query from the LoadMaster.
File does not exist	**Dynamic Weight = 100**	If the HTTP server is running on the Real Server and responds to the LoadMaster's query, it may send a response that indicates the file requested does not exist. In this case, the server is assumed to be available, it is marked up, and the server dynamic weight is set to 100.
File is empty	**Dynamic Weight = 100**	If the HTTP server is running on the Real Server and responds to the LoadMaster's query with an empty file (the file contains no data at all), the server is assumed to be available. It is then marked up and the server dynamic weight is set to 100.
File contains a non-integer value	**Dynamic Weight = 100**	If the file returned by the HTTP server running on the Real Server contains a non-integer value, then the server is assumed to be available. It is then marked up and the server dynamic weight is set to 100.
< 0	**Dynamic Weight = 100**	If the file returned by the HTTP server running on the Real Server contains a negative integer value (for example, -1), then the server is assumed to be available, it is marked up, and the server dynamic weight is set to 100.

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0	**Switch to the round robin scheduling method**	If the file returned by the HTTP server running on the Real Server contains an integer value of 0 (zero), this forces the LoadMaster to temporarily fall back to using the round robin scheduling method until the server agent returns a value other than 0 on a subsequent query. This return value is intended to be used in a situation where the server agent code cannot for some reason arrive at a valid integer value to return to the LoadMaster. This might happen if, for example, the server is not responding to the queries from the agent for load values.
1-100	**Dynamic Weight set appropriately**	If the file returned by the HTTP server running on the Real Server contains an integer value between 1 and 100, this is interpreted as a percentage of fully loaded (1=lowest load, 100 = fully loaded). The LoadMaster sets the dynamic weight appropriately: the higher the number returned by the server agent, the lower that the dynamic weight of the server is set to. The value 100 represents that the server's actual load is below 90% (as per the sample script) therefore the LoadMaster is sending a percentage of requests to the server. The scripts provided in this document are sample scripts and it is up to you in which situation you want to stop sending new traffic to the loaded server by setting load values either 101 or 102. To avoid a situation where a server reporting 100 still gets a percentage of requests, you should modify the script so that it returns 101 or 102 if the server is fully loaded by your definition. For example, you can configure the script that 101 load value is returned when the actual load on the server is >=80%.
101	**Dynamic Weight = 0**	If the file returned by the HTTP server running on the Real Server contains an integer value of 101, the server is considered to have reached its maximum load and it is marked as down. The server dynamic weight is set to 0 so that no new connections are sent to it. Only the active connections are served and no new connections are directed to this server.
102	**Dynamic Weight = 0 plus optional connection drop**	If the file returned by the HTTP server running on the Real Server contains an integer value of 102, the Real Server gets disabled. The LoadMaster will drop all currently open connections if the **Drop connections on RS failure** option is enabled (in **System Configuration > Miscellaneous Options > L7 Configuration**).

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> 102	**Dynamic Weight = 0**	A return of 103 or greater is treated the same as a return of 101.

On any Real Server operating system, a straightforward manner in which to implement a server agent is to write a shell script or executable program that runs periodically using a standard system scheduler, like **cron** on Linux systems or the **Task Scheduler** on Windows systems. This script would use standard utilities to generate the load value and place it in a file under the HTTP server root.

Such a script could be as simple as this Linux bash script.:

```
#! /bin/bash
top –l1 | awk ‘/CPU Usage/ {printf “%d\n”, $7} > /<path>/load
```

The above uses the top command and a short **awk** script to copy the current CPU load value in a file – the **<path>** above specifies the path to the root of an HTTP server on the Real Server. The file name ‘load’ is the default file name retrieved by the LoadMaster. [This and other adaptive load balancing options are located in the User Interface (UI) under **Rules & Checking > Check Parameters > Adaptive Parameters**.]

Alternatively, you could instead write a Common Gateway Interface (CGI) program or any other program that the HTTP server can be configured to run when the LoadMaster sends a GET for the required file to the HTTP server. This program would generate the integer load value when the LoadMaster requests the file from the server and the HTTP server would return it to the LoadMaster.

There are advantages and disadvantages to either approach. For example:

- Using a static file populated using a cron job is a simple and easy-to-maintain option, but also means that the data in the file could be stale when it is accessed by the LoadMaster. The interval at which the load value is generated should be based on the known performance profile of the server.
- Using a program that runs each time the LoadMaster checks performance means that you will get the most accurate data, but the server agent itself could contribute to system load if CPU, Disk I/O, and network performance were all being continually checked by the server agent.

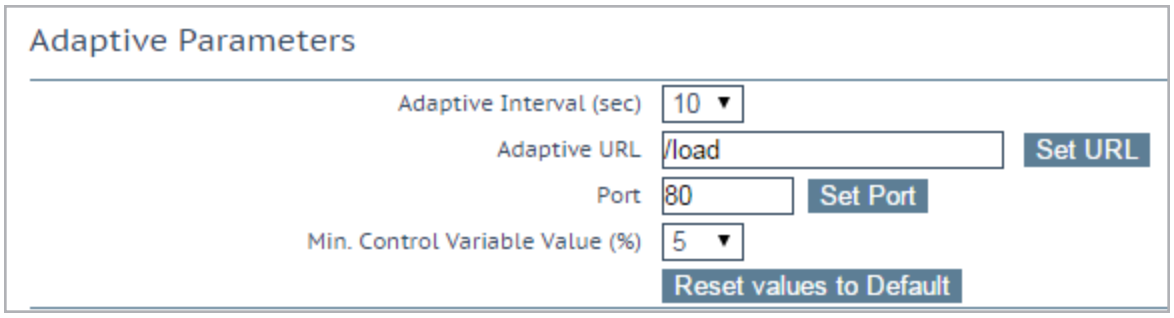
The approach you choose most likely depends on the needs of your configuration and the tools you typically use.

In terms of internal processing, a server agent can be as complicated as you like, depending on your application. If your application is completely CPU-intensive, then a simple script like the two-line bash script above may be enough. But, if your application also generates significant disk I/O or network-traffic, you will probably want to consider the load on those resources in addition to CPU usage to get a more detailed view of server performance.

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2.1 Adaptive Parameters in the LoadMaster WUI

You can access the **Adaptive Parameters** in the LoadMaster Web User Interface (WUI) by going to **Rules & Checking > Check Parameters**. The **Adaptive Parameters** section only shows on this screen if the **Scheduling Method** of at least one Virtual Service is set to **resource based (adaptive)**.



Adaptive Interval (sec)

This is the interval, in seconds, at which the LoadMaster checks the load on the servers. A low value means the LoadMaster is very sensitive to load, but this comes at a cost of extra load on the LoadMaster itself. **7** seconds is a good starting value. This value must not be less than the HTTP checking interval.

Adaptive URL

The Adaptive method retrieves load information from the servers using HTTP inquiry. This URL specifies the resource where the load information of the servers is stored. This resource can be either a file or program (for example Adaptive Agent) that delivers this information. The standard location is **/load**. It is the server's job to provide the current load data in this file in ASCII format. In doing so, the following must be considered:

An ASCII file containing a value in the range of 0 to 100 in the first line where 0=idle and 100=overloaded. As the number increases, that is, the server becomes more heavily loaded, the LoadMaster will pass less traffic to that server. Hence, it 'adapts' to the server loading.

If the server becomes 101% or 102% loaded, a message is added to the logs.

The file is set to **/load** by default.

The file must be accessible using HTTP.

The URL must be the same for all servers that are to be supported by the adaptive method.

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> This feature is not only of interest for HTTP-based Virtual Services, but for all Services. HTTP is merely used as the transport method for extracting the application-specific load information from the Real Server.

Port

This value specifies the port number of the HTTP daemon on the servers. The default value is **80**.

Min. Control Variable Value (%)

This value specifies a threshold below which the balancer will switch to static weight-based scheduling, that is, normal Weighted Round Robin. The value is a percentage of the maximum load (0-50). The default and the minimum value is **5**. The minimum is **5** because if it is below 5 it would be better to use weighted round robin.

An example scenario of when adaptive scheduling is applied is as follows:

- There are two Real Servers, adaptive scheduling is selected, and the **Min. Control Variable Value** is set to **30**.
- If the agent returns a value < 30, the scheduling is treated as weighted round robin.
- If the agent returns a value of > 30, the scheduling is treated as adaptive.

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3 Sample Linux Agent Script

The following script is an example of gathering load information on CPU and memory, and then combining them into a single integer value that the LoadMaster can use for adaptive scheduling. It is written as a bash shell script and is intended to be run on a Linux server using a privileged crontab file. See the Linux manual pages for bash, crontab, and the commands used in the script to gather the required statistics.

This script is intended solely as an example, although it could be used in a demonstration or proof of concept of how to configure adaptive scheduling.

```
#! /bin/bash
#
# Very simple adaptive server agent program, intended to be run via a root
# or similarly privileged crontab(1) entry to periodically populate
# the file LoadMaster expects to be available via HTTP on the Real Server.

#### DEFAULTS
# This is the default filename expected by LoadMaster. This setting must
# match what's on "Rules & Checking > Adaptive Parameters" in the LM WUI.
LOAD_FILE_PATH=/load
# This is the default doc root of apache2 on an ubuntu server, and where
# we'll place the 'load' file defined above for LoadMaster to GET.
DOCROOT=/var/www/html
# Define the weights to be used for CPU and Memory.
# Change these numbers to indicate the percentage weight that each
# statistic should carry when figuring the overall load value to
# return to LoadMaster. By default, these are set to 0.25 for CPU and 0.75
# for Memory, so the effect of the weighting is apparent. Weights must
# add up to 1.
CPUweight=0.25
MEMweight=0.75
#### GET MEMORY STATS
# Get memory usage from the free(1) command using a simple awk command and
# calculate the percentage of memory used. Since the shell does integer
# arithmetic only, we'll use bc(1) to do the math.
MEMtotal=`free | awk '/Mem:/ {print $2}'`
MEMstatus=$?
MEMused=`free | awk '/Mem:/ {print $3}'`
MEMload=`echo "scale=3;( $MEMused / $MEMtotal ) * 100" | bc`
# Round the answer to the nearest integer
MEMloadrnd=`echo "$MEMload + 0.5" | bc`
MEMloadrnd=`echo "scale=0; $MEMloadrnd/1" | bc`
#### GET CPU LOAD
# Note: Some version of top(1) report avg. CPU usage since time of last
# reboot in the first iteration, so we'll take the second iteration value.
CPUidletop=`top -b -n2 -d.2 | awk '/%Cpu/ {print $8}'`
CPUidle=`echo $CPUidletop | cut -d" " -f2`
CPUload=`echo "scale=3;100 - $CPUidle" | bc`
CPUstatus=$?
# Round the answer to the nearest integer
CPUloadrnd=`echo "$CPUload + 0.5" | bc`
```


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```
CPUloadrnd=`echo "scale=0; $CPUloadrnd/1" | bc`
#### CHECK IF STATS ARE A VALID % (between 1 and 100)
# VALID_STATS=1 means stats are valid.
# if stats are not valid, we want to return 0 to LM to disable adaptive
# LB and use round robin until a different value is received.
VALID_STATS=1
if [ $MEMloadrnd -lt 1 -o $MEMloadrnd -gt 100 -o $CPUloadrnd -lt 1 \
       -o $CPUloadrnd -gt 100 ]
then
       VALID_STATS=0
       RETURNED_LOAD=0
fi
#### CALCULATE THE WEGHTED AVERAGE OF $CPUload AND $MEMload.
# Only do this if stats were valid - i.e., $VALID_STATS=1.
if [ $VALID_STATS -eq 1 ]
then
       RSload=`echo "( $CPUweight * $CPUloadrnd ) + \
              ( $MEMweight * $MEMloadrnd )" | bc`
       RSloadrnd=`echo "$RSload + 0.5" | bc`
       RSloadrnd=`echo "scale=0; $RSloadrnd/1" | bc`
       RETURNED_LOAD=$RSloadrnd
fi
#### DETERMINE IF WE SHOULD RETURN 101 OR 102.
# Returning 101 or 102 in the case of a highly loaded system is somewhat
# a matter of policy. In this example, we'll return 101 (take the server
# out of rotation) when stats are valid AND the aggregated load value
# is above 90%, to allow more resources to become available. If the
# aggregate load goes above 96%, we'll return 102 (which takes the server
# out of rotation AND drops all current connections). Presumably, once
# more resources are available, load values will decrease, and the
# server agent will return a lower value on a subsequent run.
if [ $VALID_STATS -eq 1 -a $RSloadrnd -gt 90 ]
then
       RETURNED_LOAD=101
elif [ $VALID_STATS -eq 1 -a $RSloadrnd -gt 96 ]
then
       RETURNED_LOAD=102
fi
#### PUT THE LOAD VALUE IN THE FILE.
# If stats were not valid above, then return 0 -- this disables adaptive
# scheduling and uses round robin instead; else, return the computed load.
if [ $VALID_STATS -eq 0 ]
then
       RETURNED_LOAD=0
fi
echo $RETURNED_LOAD > ${DOCROOT}${LOAD_FILE_PATH}
#### PRINT EVERYTHING TO STDOUT FOR DEBUGGING
# This allows for running the script from the command line to test in
# your environment -- or, if the script is run via cron, cron will
# capture the output and email it to you so you can debug any issues.
# Once you're happy the script is working properly, comment these lines
# out to avoid being emailed output by cron every time the script runs.
echo RETURNED_LOAD = $RETURNED_LOAD
echo RSload = $RSload
echo RSloadrnd = $RSloadrnd
echo MEMweight = $MEMweight
echo MEMtotal = $MEMtotal
echo MEMused = $MEMused
echo MEMload = $MEMload
echo MEMloadrnd = $MEMloadrnd
echo MEMstatus = $MEMstatus
```


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```
echo CPUweight = $CPUweight
echo CPUidle = $CPUidle
echo CPUload = $CPUload
echo CPUloadrnd = $CPUloadrnd
echo CPUstatus = $CPUstatus
#### EXIT with appropriate status
if [ $VALID_STATS -eq 1 -a $MEMstatus -eq 0 -a $CPUstatus -eq 0 ]
then
# success
       exit 0
else
# error
       exit 1
fi
#### EOF
```


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4 Sample Windows Agent Script

The following script is similar in function to the Linux script presented in the previous section, but is written in Windows PowerShell rather than the Linux bash shell and uses Windows Management Instrumentation (WMI) commands to do the job of gathering performance data. The script can be set to run periodically as a Windows Task and assumes that there is an already running IIS server on the Windows Real Server that will respond to the GET request from the LoadMaster for the load value file created by the server agent.

This script is intended solely as an example, although it could be used in a demonstration or proof of concept of how to configure adaptive scheduling.

```
#
# Very simple adaptive server agent program, intended to be run via a
# Task Scheduler Task with system level privileges, to periodically
# populate the file LoadMaster expects to be available via HTTP on the
# Real Server.
#### DEFAULTS
# This is the default filename expected by LoadMaster. This setting must
# match what's on "Rules & Checking > Adaptive Parameters" in the LM WUI.
$LOAD_FILE_PATH="\load"
# This is the default root of a Windows IIS server. Change this to match
# the location where your HTTP server will require the load file (above)
# to be placed so that LoadMaster can access it using an HTTP GET request.
$DOCROOT="\inetpub\wwwroot"
# Define the weights to be used for CPU and Memory.
# Change these numbers to indicate the percentage weight that each
# statistic should carry when figuring the overall load value to
# return to LoadMaster. By default, these are set to 0.25 for CPU and 0.75
# for Memory, so the effect of the weighting is apparent. Weights must
# add up to 1.
$CPUweight=0.25
$MEMweight=0.75
#### GET MEMORY STATS
[int]$MEMtotal=(Get-WmiObject -Class win32_
operatingsystem).TotalVisibleMemorySize
[int]$MEMfree=(Get-WmiObject -Class win32_operatingsystem).FreePhysicalMemory
[int]$MEMused=$MEMtotal - $MEMfree
$MEMloadpct=($MEMused / $MEMtotal).tostring("P")
[int]$MEMload=($MEMused / $MEMtotal * 100)
#### GET CPU LOAD
$CPUload=Get-WmiObject win32_processor | select -Expand LoadPercentage
$VALID_STATS=1
$RETURNED_LOAD=1
if ( $MEMload -lt 1 -or $MEMload -gt 100 -or $CPUload -lt 1 -or $CPUload -gt
100 )
{
```


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```
        $VALID_STATS=0
        $RETURNED_LOAD=0
}
#### CALCULATE THE WEGHTED AVERAGE OF $CPUload AND $MEMload.
# Only do this if stats were valid - i.e., $VALID_STATS=1.
if ( $VALID_STATS -eq 1 )
{
        [int]$RSload=( $CPUweight * $CPUload ) + ( $MEMweight * $MEMload )
        $RETURNED_LOAD=$RSload
}
#### DETERMINE IF WE SHOULD RETURN 101 OR 102.
# Returning 101 or 102 in the case of a highly loaded system is somewhat
# a matter of policy. In this example, we'll return 101 (take the server
# out of rotation) when stats are valid AND the aggregated load value
# is above 90%, to allow more resources to become available. If the
# aggregate load goes above 96%, we'll return 102 (which takes the server
# out of rotation AND drops all current connections). Presumably, once
# more resources are available, load values will decrease, and the
# server agent will return a lower value on a subsequent run.
if ( $VALID_STATS -eq 1 -and $RSload -gt 90 )
{
        $RETURNED_LOAD=101
}
elseif ( $VALID_STATS -eq 1 -and $RSload -gt 96 )
{
        $RETURNED_LOAD=102
}
#### PUT THE LOAD VALUE IN THE FILE.
# If stats were not valid above, then return 0 -- this disables adaptive
# scheduling and uses round robin instead; else, return the rounded load.
if ( $VALID_STATS -eq 0 )
{
        RETURNED_LOAD=0
}
echo $RETURNED_LOAD > $DOCROOT$LOAD_FILE_PATH
#### PRINT EVERYTHING TO STDOUT FOR DEBUGGING
# This allows for running the script from the command line to test in
# your environment. Once you're happy the script is working properly,
# comment these lines out.
echo "VALID_STATS = $VALID_STATS"
echo "RETURNED_LOAD = $RETURNED_LOAD"
echo "MEMload = $MEMload"
echo "MEMloadpct = $MEMloadpct"
echo "CPUload = $CPUload"
#### EXIT with appropriate status
if ( $VALID_STATS -eq 1 )
{
# success
        exit 0
}
else
{
# invalid stats -- error
        exit 1
}
#### EOF
```


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