Virtual Printing Solutions with View in Horizon 6

VMware Horizon 6.x

TECHNICAL WHITE PAPER

vmware®

Table of Contents

Overview . . . 3
Printer Redirection . . . 3
Location-Based Printing . . . 3
Virtual Printing Compatibility Matrix . . . 4
Use Cases and Topology . . . 5
Printer Redirection . . . 5
Location-Based Printing . . . 6
Configuring Printer Redirection . . . 8
Install Virtual Printing on the View Master Image . . . 8
Configure the Client Device . . . 8
Configure Printer Redirection on Client Devices . . . 9
Configure Printer Redirection in Windows . . . 9
Configure Printer Redirection in Linux . . . 9
Configure Printer Redirection in Mac OS X . . . 9
Configure Printer Redirection on Thin Clients . . . 9
Setting Printing Preferences and Printing . . . 10
Set Preferences from a Desktop . . . 10
Set Preferences from a Hosted Application . . . 11
Configuring Location-Based Printing . . . 12
Configure IP-Based Printing . . . 12
Find Printer Information . . . 13
Element Size Limit Calculations . . . 14
Configure UNC-Based Printing . . . 14
Integration with Third-Party Printing Solutions . . . 16
Summary . . . 18
Authors and Contributors . . . 18
Additional Resources . . . 18
Appendix: Scripts for UNC-Based Printing . . . 19
Run On Connect1.txt . . . 19
Run On Connect2.txt . . . 19
Map-Network-Printer.txt . . . 19

Overview

Access to printers is an important requirement for all virtual desktop infrastructure (VDI) and hosted application environments. Typically, each desktop has been configured to access one or more network printers. In many scenarios, this arrangement is sufficient. In other cases, mobile users also need to connect to their View desktops from different locations, sometimes from outside the corporate network.

Regardless of the scenario, end users must be able to send print jobs to the nearest available printer. IT administrators also need an easy way to manage printers and printer drivers.

VMware Horizon® 6 satisfies both requirements with two advanced features for printing from View virtual desktops: printer redirection and location-based printing.

Printing from virtual desktops or virtual applications is called *virtual printing*. This paper discusses the types of virtual printing for View desktops, use cases, the data flow and topology, and how to configure printer redirection and location-based printing.

Printer Redirection

Printer redirection enables end users to send print jobs from a View virtual desktop to a network printer or to a printer locally attached to the user's client device. There is support for a wide range of client devices, including Windows and Linux PCs, Macintosh computers, and thin and zero clients. PCs and Macs need to run Horizon Client software, which redirects print jobs from the View desktop or hosted application to a network printer or a locally attached printer.

Network and locally attached printers are supported and displayed on the View desktop—either in the application print dialog or in the system control panel—so that end users can select the printer they want to use for a given print job. Network printers are accessed across the local network. Local printers can be attached to the USB, serial, or parallel ports of users' client devices.

Printer redirection is especially useful when

- End users connect from outside the corporate firewall, for example, working from home or a remote site, and there is no safe and direct way for the View desktop or application to access the users' local printers.
- Printers are directly connected to USB or serial ports on client devices and are not accessible from the corporate network.
- Branch office users manage their own printers and printer drivers.

With printer redirection, printer driver management is simplified for the IT administrator. The View desktop or RDSH server hosting the application is not required to have the printer driver as long as the printer driver is correctly installed on the client device.

Location-Based Printing

Location-based printing determines which printer to use based on the location of the end user's client device and the mapping rules specified by the IT administrator.

The location-based approach simplifies the user experience by limiting the number of choices in a corporate environment to the printers closest to the end user's current location. For example, suppose that when an end user connects to a View desktop from one floor of an office, the only printers available to that end user are on the same floor. When the end user moves to a different floor and logs in, the only printers available are located on that floor.

Print jobs in location-based printing are sent from the View desktop directly to the printer, which means that the printer driver must be installed on the View virtual machine master image in the data center.

There are two types of location-based printing:

- IP-based printing, using printer IP addresses to define mapping rules
- UNC-based printing, using Universal Naming Convention (UNC) pathnames to define mapping rules

Important: The use of UNC pathnames to identify printers is not supported in Horizon 6. However, for organizations that require UNC-based printing, this paper includes a script that can be used to implement UNC pathnames. *This script is not officially supported and is provided only as a reference*. This technique does not require the printer driver to be previously installed on the View master image.

Virtual Printing Compatibility Matrix

View in Horizon 6 supports several kinds of client devices. Both types of virtual printing solutions can be configured for end users who access View desktops from Windows, Linux, or Macintosh computers, or from thin clients.

For those end users who use zero or mobile clients, or HTML access, location-based printing is the only option.

Table 1 lists access methods and the applicable virtual printing solutions.

ACCESS METHOD	PRINTER REDIRECTION	LOCATION-BASED PRINTING
Windows desktop	✔	✔
Linux desktop	✔	✔
Mac desktop	✔	✔
Thin client	✔	✔
Zero client	✘	✔
Mobile client	✘	✔
HTML access	✘	✔

Table 1: Virtual Printing Solution Matrix for Horizon Clients

Because printer redirection requires that printer drivers be installed on client devices, it is not supported on zero clients, mobile clients, or HTML access. However, both printer redirection and location-based printing are supported on virtual desktops and virtual applications, including

- View desktops
- RDSH desktops
- Windows Server 2008 R2 and Windows Server 2012 R2 desktops
- Hosted apps

Use Cases and Topology

This section describes the use cases and topology for each type of virtual printing solution.

Printer Redirection

Printer redirection suits those end users working from home or outside the corporate network who want to send documents from a View desktop or a hosted application to a printer locally attached to their client device. Printer redirection is designed in particular for

- Users who work at home, or in hotels or customer offices, and use printers attached to their client devices
- Users who work in an office and rarely move from one location

Figure 1 shows a common printer redirection topology in a View environment.

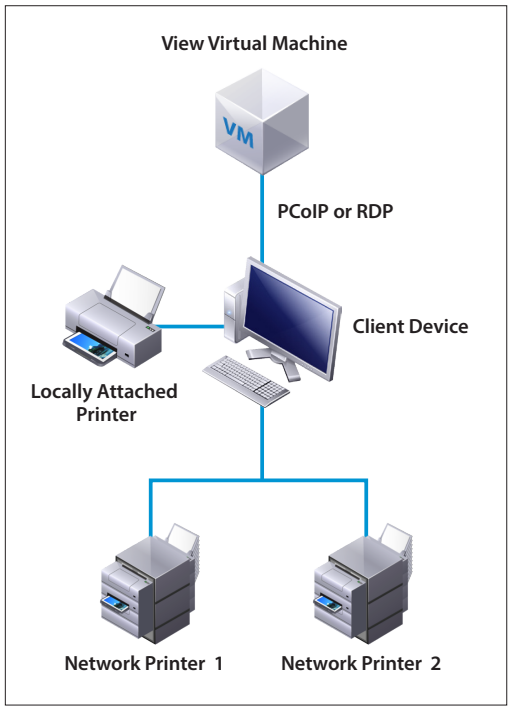


Figure 1: Printer Redirection

The client device is connected to multiple printers, including a locally attached USB printer and network-based office printers. The end user connects to the View desktop from the client device over PCoIP or RDP and can print documents to any of the printers illustrated.

The components and data transfer path for printer redirection are shown in Figure 2. There is no need to install a printer driver on the View master image.

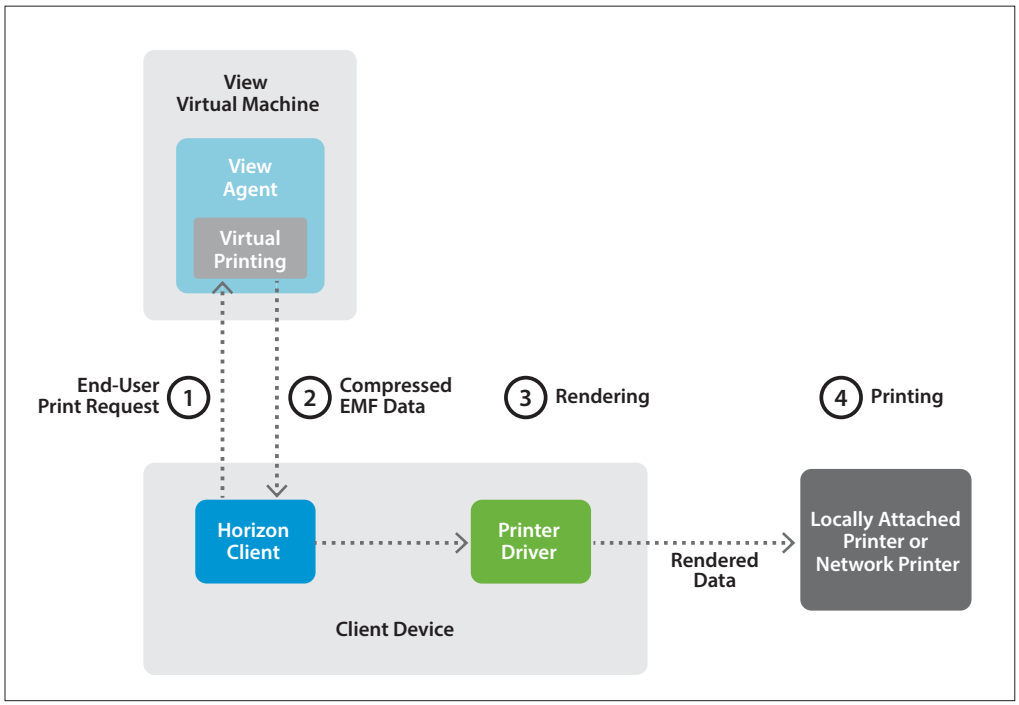


Figure 2: Printer Redirection Components and Data Transfer

In this scenario, the end user initiates a print request, which the Horizon Client sends to the View virtual machine. Virtual Printing, a component installed with the View Agent in the View master image, sends an Enhanced Metafile (EMF) back to the Horizon Client. The Horizon Client sends the EMF to the natively installed printer driver for rendering. The rendered data is then sent for printing to a locally attached printer or a network printer.

Location-Based Printing

Some end users have requirements that cannot be met by printer redirection. For example, doctors walk from one patient room to another in a hospital and need their print jobs to be executed on the nearest printer. Location-based printing allows them to retrieve their documents from any printer. They are not forced to use a specific printer every time.

The topology of location-based printing is illustrated in Figure 3.

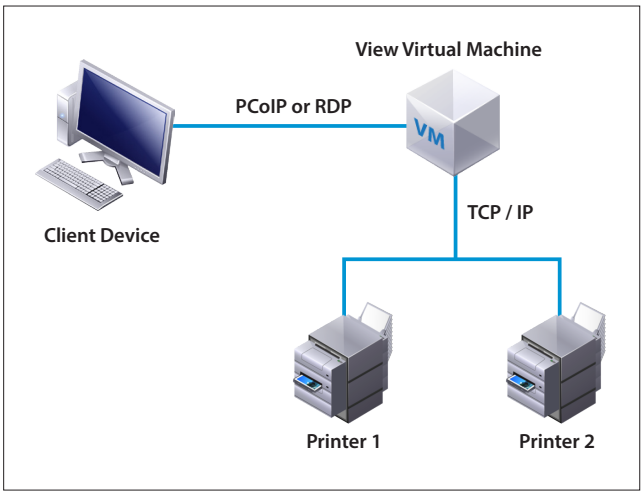


Figure 3: Location-Based Printing

Location-based printing differs slightly from printer redirection. The client device connects to the View virtual machine, which then connects to the printers. There are two types of location-based printing: IP-based and UNC-based printing.

Figure 4 illustrates the components and data transfer in IP-based printing.

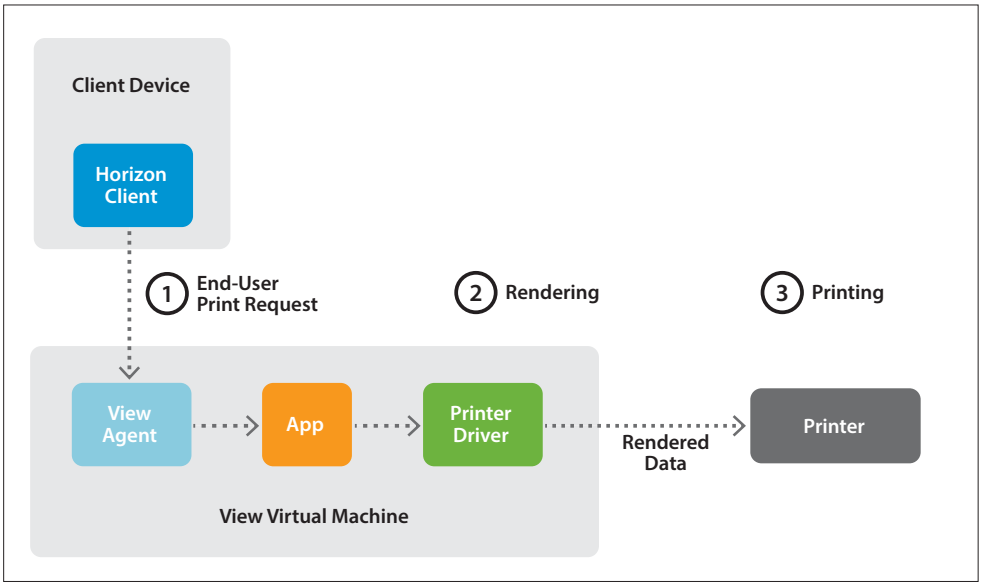


Figure 4: IP-Based Printing Components and Data Transfer

The end user sends a print request from an application on the View desktop. The application then sends the data to the printer driver on the View virtual machine for rendering. After rendering, the data is sent to the printer. The administrator can control the mapping between the client device and the printer by defining policies in the Active Directory or by using a script.

The key requirement of location-based printing is that the printers must be accessible from the View desktop or a hosted application, either directly or through mapping. Printers that cannot be accessed in either fashion, such as those used in offsite locations, need to be configured for printer redirection instead.

Configuring Printer Redirection

The tasks required to configure printer redirection are

1. Install Virtual Printing on a View master image.
2. Configure the client device to use printer redirection.

Install Virtual Printing on the View Master Image

View uses the Virtual Printing component of the View Agent to perform printer redirection.

To enable Virtual Printing from a View desktop, install the Virtual Printing component when you install the View Agent on the View master image.

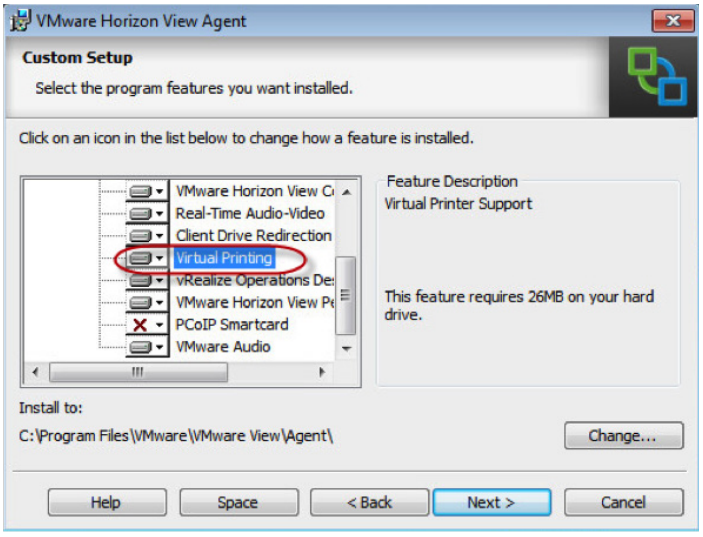
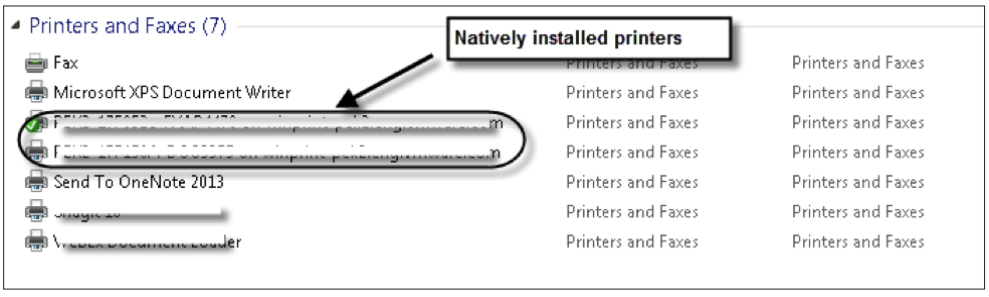


Figure 5: Virtual Printing Component

The Virtual Printing component redirects printers from the client device to the View virtual machine and compresses and sends data from the View virtual machine to the client device for printing on a locally attached or network printer.

Configure the Client Device

Before View redirects printers to the View virtual machine, confirm that printer drivers are installed on the client devices. The following screenshot provides an example:



After the printer drivers are installed, you can configure printer redirection on the client device.

Configure Printer Redirection on Client Devices

Configuring printer redirection varies by device type, therefore specific steps are provided in the following sections.

Configure Printer Redirection in Windows

To configure printer redirection for View on a computer running Windows, install the Horizon Client.

Configure Printer Redirection in Linux

To configure printer redirection for View on a computer running Linux:

1. Install the Horizon Client.
2. Install the `tpClient`.
3. Start the `tpClient`.

   Follow the steps in the README file in the `VMware-Horizon-tpClient-3.2.0-xxxxxxx.tar.gz` archive, which is included in the Horizon Client package, where `xxxxxxx` refers to the build number of the Horizon Client.
4. Start the Horizon Client to enable printer redirection.

   Note: Printer redirection in View has been thoroughly tested against Ubuntu 12.0.4. For other Linux OS distribution types, printer redirection should also work, but has not been tested.

Configure Printer Redirection in Mac OS X

To configure printer redirection for View on a Mac:

1. Install Horizon Client.
2. Enable the printing service in one of several ways:
   - Enable the printing service the first time you launch the Horizon Client.
   - Enable virtual printing before connecting to a remote desktop or an application.
   - Enable virtual printing after connecting to a desktop.

   Note: See VMware Horizon Client for Mac OS X Release Notes for detailed steps to enable the printing service in the Horizon Client on a Mac.

Configure Printer Redirection on Thin Clients

To configure printer redirection on a thin client:

1. Look up the configuration, according to the type of OS, in the VMware Compatibility Guide, which provides a list of thin clients that support printer redirection.
2. Select Printer Redirection under Custom Setup in the installation wizard, as shown in Figure 5.
3. Select one of the supported operating systems, such as WES 7 Embedded Thin Client.

Setting Printing Preferences and Printing

After you configure the View Agent on the View master image and the Horizon Client on the end user's client device, end users can set printing preferences both from the View desktop and from hosted applications.

Set Preferences from a Desktop

For connections to a View, RDSH, or Windows Server 2008 R2 or Windows Server 2012 desktop:

1. To see the default printer, open **Devices and Printers**.

   The printers attached to the client device are now redirected and listed on the View desktop.

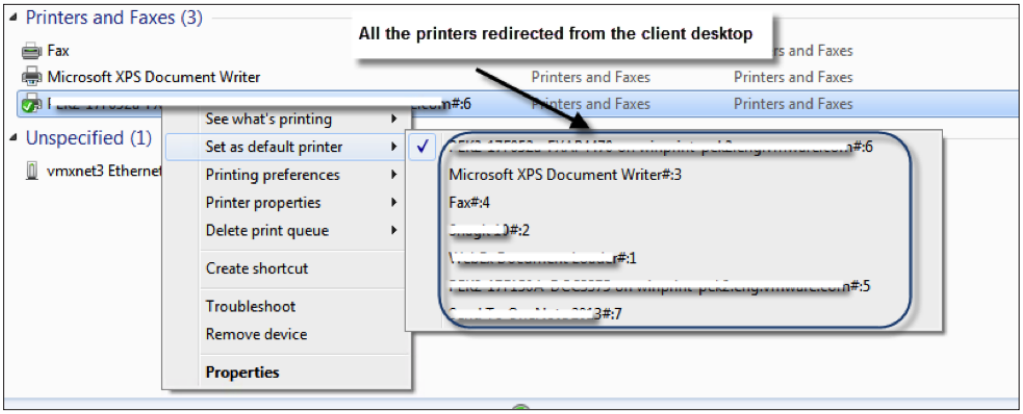
   Only the default printer from the client device is listed here.

   Note: There is a Postfix attached to the name of the redirected printer. The format of the Postfix is `"#:n"`, where *n* is a number.

2. To see all the redirected printers, right-click the listed redirected printer.

   All the printers redirected from the client device are listed. You can change the default printer and set printing preferences for each printer. These actions do not affect the printers when they are accessed directly from the client device.

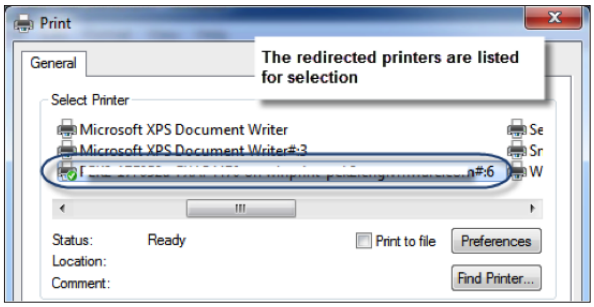
   The following example shows several printers redirected from the client device.



   Note: End-user modifications to a printer from a desktop remain in effect whenever that user submits a print job, regardless of application.

Set Preferences from a Hosted Application

For connections to a hosted application, end users can select a printer and set printing preferences while printing from the application. The following example shows the selection of a printer to print a text file from a hosted app. Printing preferences can also be changed from this dialog.



Note: End-user modifications to a printer from a hosted application remain in effect whenever the user submits a print job from that application, but do not apply to other applications.

Configuring Location-Based Printing

The following sections provide instructions for configuring the two types of location-based printing: IP-based and UNC-based printing.

Configure IP-Based Printing

Before configuring IP-based printing, install Virtual Printing and the printer drivers on the View master image in the data center. For specific instructions, see Install Virtual Printing on the View Master Image and the printer manual that the manufacturer supplies with the printer.

To configure IP-based printing in a View environment:

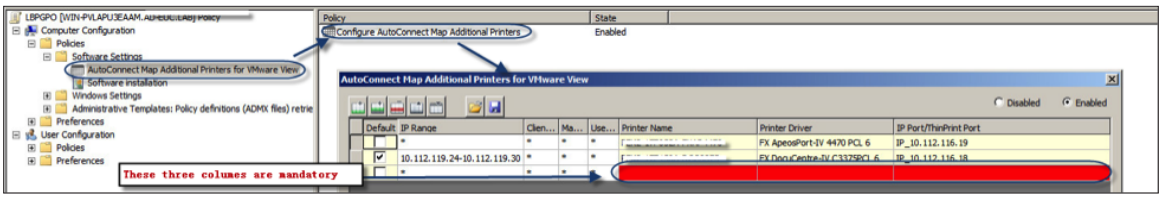
1. Register the location-based printing group policy DLL file in the Active Directory server that your View Connection Server uses. Alternatively, register the DLL file to the domain computer that you use to configure group policies.

   See *Register the Location-Based Printing Group Policy DLL File* in Setting Up Desktop and Application Pools in View.

2. Configure the mapping rules in the group policy.

   The mapping rules are defined in the Active Directory group policy setting, AutoConnect Map Additional Printers for VMware View. Refer to *Configure the Location-Based Printing Group Policy* in Setting Up Desktop and Application Pools in View.

   The following example shows mapping rules:



   The path of the group policy is *GPOName* > **Computer Configuration** > **Software Settings** > **AutoConnect Map Additional Printers for VMware View**, where *GPOName* is the name of the GPO you are editing.

3. Double-click **Configure AutoConnect Maps Additional Printers**.

   In the AutoConnect Map Additional Printers for VMware View dialog box, the table contains a mapping rule in each row, and eight columns. The meaning of each column is described in *Location-Based Printing Group Policy Setting Syntax* in Setting Up Desktop and Application Pools in View.

   Note: The last three columns: Printer Name, Printer Driver, and IP Port/ThinPrint Port, are mandatory. The backgrounds of these columns are red if they are empty. You cannot apply the modifications without completing these fields unless you delete this row.

   In the example, the third rule is deleted so that there are two rules applied. As a result, the network printer specified in the first row is mapped to a remote desktop for any client system. This occurs because asterisks appear in all of the translation rule columns. The network printer specified in the second row is mapped to a remote desktop only if the client system has an IP address in the range 10.112.119.24 through 10.112.119.30.

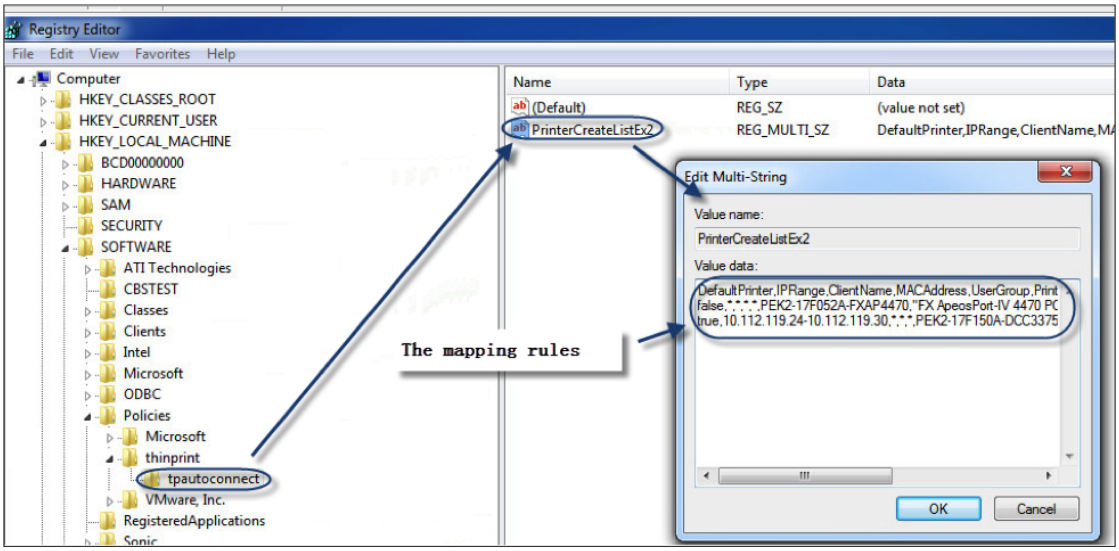
4. Reboot the View virtual machine, or go to the View virtual machine and run the following command to refresh the group policy:

   ```
   gpupdate /force
   ```

5. Run the following command from the View virtual machine to update the registry key:

   ```
   HKLM/SOFTWARE/Policy/thinprint/tpautoconnect/PrinterCreateListEx2
   ```

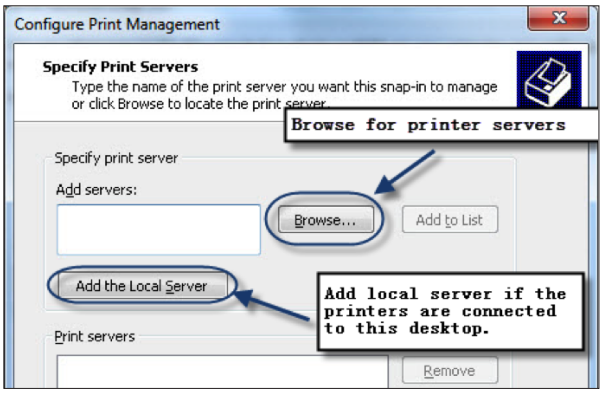
   The following example shows the result with the mapping rule configured in step 2 above:



Find Printer Information

Use the following steps to find the printer name, printer driver, and IP port or ThinPrint port:

1. Log in to a desktop where you can access the printers or print servers.
2. Click **Start** and run **MMC**.
3. In the file menu, select **Add/Remove Snap-in**.
4. Scroll down in the list and select the **Print Management** snap-in, and click **Add**.
5. In the dialog, click **Browse** to select the server that manages the printer you are looking for.
6. Click **Add to List**.
7. If the printer is connected to the desktop that you are using, click **Add the Local Server**.



8. Click **Finish**.
9. In the **MMC**, expand **Print Management** > **Print Servers** > <*your print server*>, and select **Printers**.

   The information for all of the printers is shown in the right panel.

Element Size Limit Calculations
The size of a standard format registry element value should not be larger than 1 MB. The group policy setting **AutoConnect Map Additional Printers For VMware View** from the Active Directory is loaded into the following registry key on the View virtual machine:

`HKLM/SOFTWARE/Policy/thinprint/tpautoconnect/PrinterCreateListEx2`

Consequently, the maximum size of the mapping rules is 1 MB. If the average length of each rule is 256 bytes, then the maximum number for one rule is about 5,000. If the single IP address is used in the mapping rules, then only 5,000 client devices can be involved in this configuration. For more information, see Registry Element Size Limits.

VMware recommends using the IP range in the rules rather than a single IP address in MAC addresses to reduce the number of required rules. If this method does not meet your requirements, there are third-party solutions, such as Cortado ThinPrint.

Configure UNC-Based Printing

To configure UNC-based printing for the printers that are local to the client device, follow the steps in Configure IP-Based Printing. You perform the configuration and use the name of the printer when it is mapped to the View desktop.

To configure UNC-based printing for network printers, follow these steps:

1. Go to the View master image that you use to create your automated pool.
2. Install Virtual Printing on the View master image.

   See Install Virtual Printing on the View Master Image.
3. Under the root directory on the C drive, create a CSV file that maps the client device name and printer UNC path.

   The following example shows a CSV file:

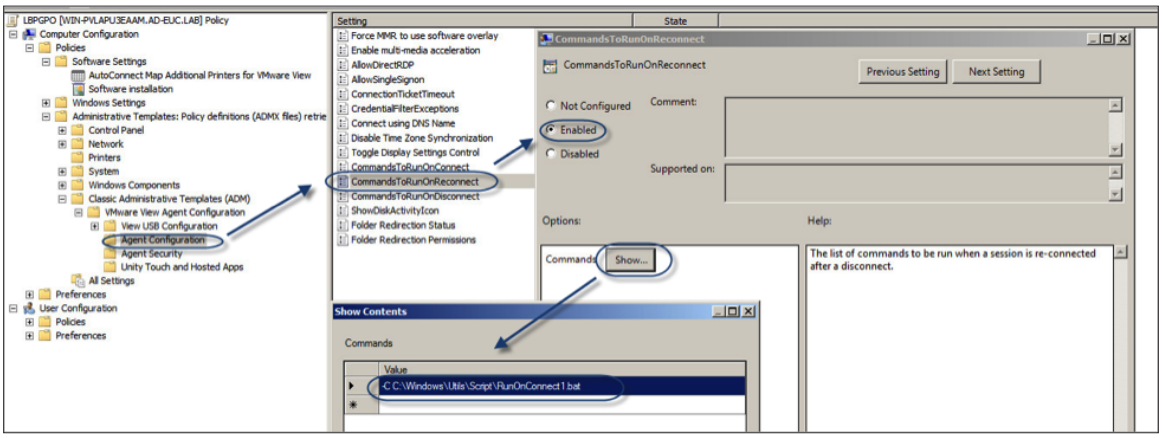
A	B	C
EndpointName	UNCPath	Default
[redacted]	[redacted]	Y
[redacted]	[redacted]	N
[redacted]	[redacted]	Y

   The first row contains the title of each column, and the remaining rows contain the mapping rules.

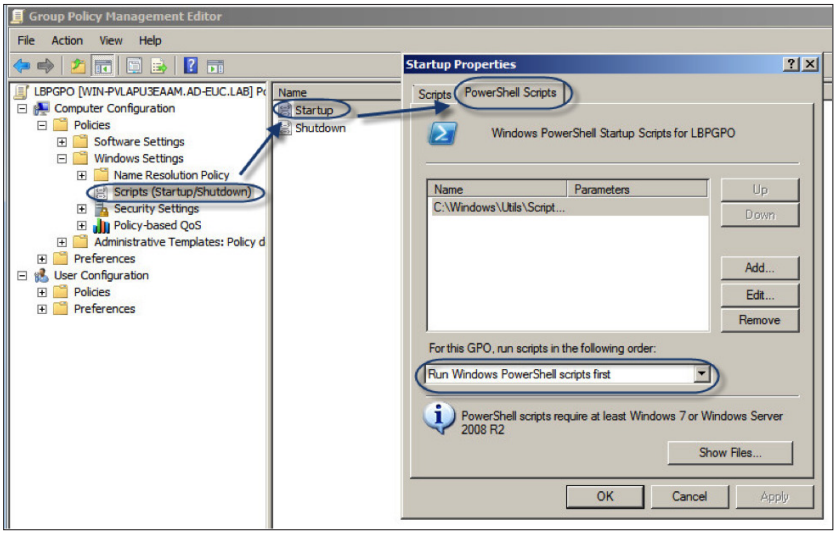
   There are three columns, showing the name of the client device, or endpoint, the UNC path for the printer, and whether the mapped printer is set as the default printer on the client device.
4. Create a new folder named `Script` in the `C:\Windows\Utils\` folder.
5. Copy the following three files into `C:\Windows\Utils\Script` from the Appendix: Scripts for UNC-Based Printing:

   - `RunOnConnect1.bat`
   - `RunOnConnect2.cmd`
   - `Map-Network-Printer.ps1`

6. Go to the Active Directory server that your View Connection Server uses or to the domain computer that you use to configure group policies.
7. Import the `vdm_agent.adm` template into the administrative templates of the GPO that your View desktops belong to.
8. Configure the **CommandsToRunOnReconnect** setting.



9. Configure the **Startup** script setting:
   a. Navigate to the **PowerShell Scripts** tab.
   b. Click **Add** to add the script `C:\Windows\Utils\Script\Map-Network-Printer.ps1` without any parameters.
   c. In the drop-down menu, select **Run Windows PowerShell scripts first**.
   d. Click **OK** to apply.



10. Go to the View master image and, from the command prompt, reboot or run `gpupdate /force` to refresh the group policy.
11. Create or recompose your View desktops from the View master image.

    For detailed instructions, see the VMware Horizon 6 Documentation.

Users can now connect to the View desktop from a client device from anywhere and use UNC-based printing.

Integration with Third-Party Printing Solutions

VMware supports integration with third-party printing solutions such as Cortado ThinPrint to cover cases when there are additional printing requirements, such as

- Central management of printer drivers
- Deployment of UNC-based printing for multiple branch offices

This section describes how the integration of View and Cortado ThinPrint works. This solution includes the following software from VMware and Cortado:

- View in Horizon 6
- Horizon Client
- ThinPrint Engine
- ThinPrint AutoConnect
- ThinPrint Management Center
- ThinPrint Client

Figure 6 illustrates one possible scenario for the integration between View and ThinPrint.

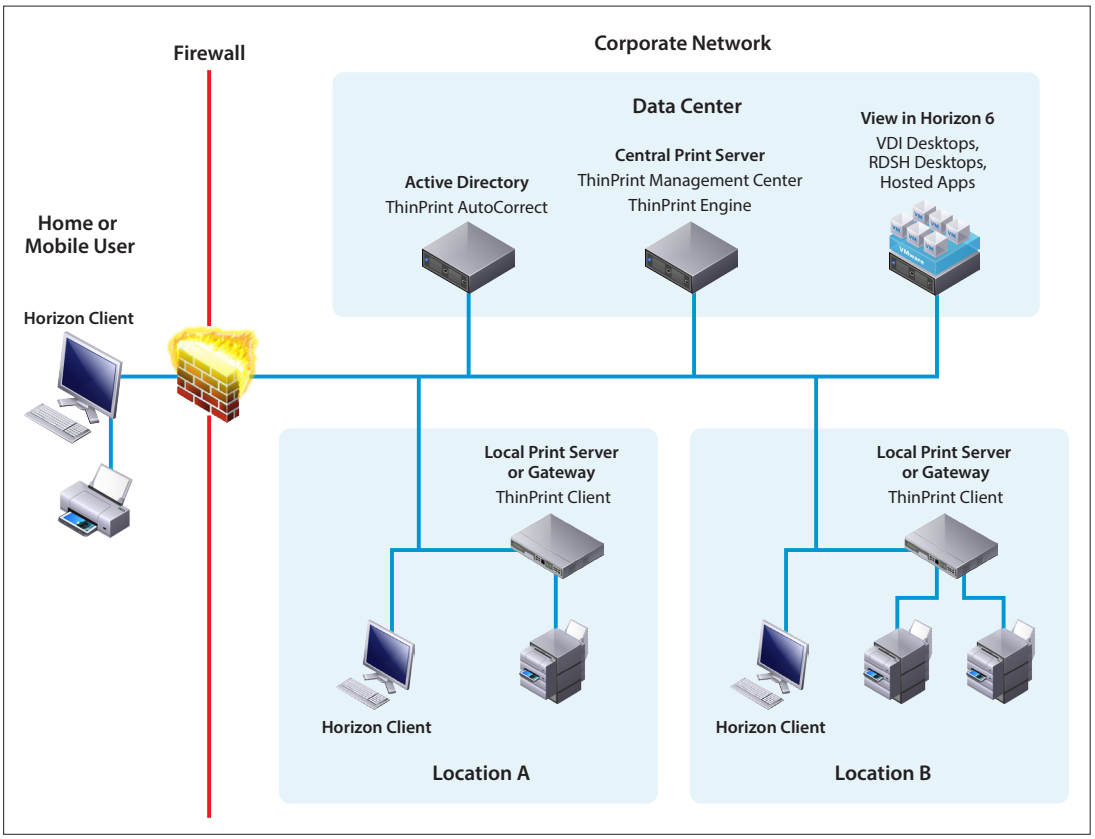


Figure 6: One Possible Integration Scenario for View with ThinPrint

The integrated solution has three main parts:

- Data center – All the servers, desktops, and domain controllers reside in the data center.
  - View desktops, RDSH desktops, Windows Server 2008 and Windows Server 2012 R2 desktops, and hosted apps
  - Central print server – ThinPrint Management Center and ThinPrint Engine
  - Active Directory with ThinPrint AutoConnect – Used to control the Group Policy Object
- Locations – A location is a logical concept. Each location has Horizon Client software, printers, and a local print server or gateway. Print jobs launched by the Horizon Client are handled by the printers in the same location.
- Home or mobile users – Users who initiate print jobs that are handled by their locally attached printers.

This solution uses driver-free printing. The central print server manages all of the printer drivers, so that neither View virtual machines nor client devices with Horizon Client software require separate printer drivers.

To set up this type of integration solution:

1. Set up View.

   See the VMware Horizon 6 Documentation.

2. Make sure that Virtual Printing is installed with the View Agent.

   See Install Virtual Printing on the View Master Image.

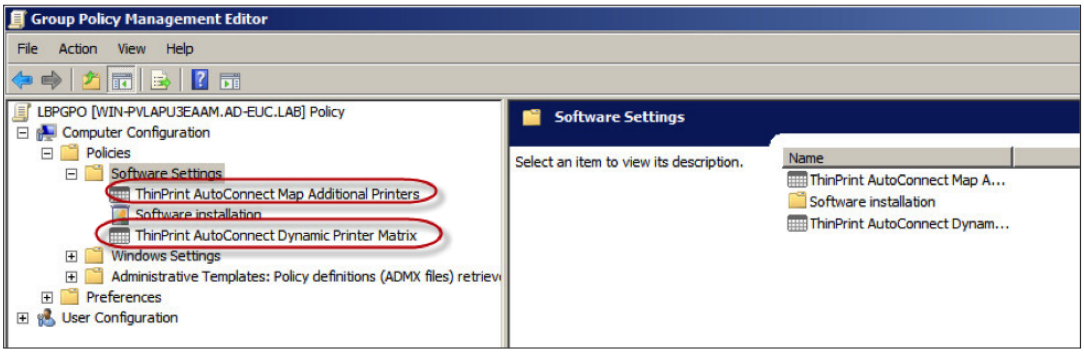
3. Set up and configure the ThinPrint environment, including the ThinPrint Central print server, ThinPrint Engine, and ThinPrint Management Center.

   See the ThinPrint Documentation Web site.

4. Install ThinPrint AutoConnect on the Active Directory.

   Two items are added to the Group Policy Objects after ThinPrint AutoConnect is installed:

   - ThinPrint AutoConnect Map Additional Printers
   - ThinPrint AutoConnect Dynamic Printer Matrix



Note: If you configure the location-based printing group policy DLL file before installing ThinPrint AutoConnect on the same Active Directory, the **AutoConnect Map Additional Printers for VMware View** item disappears. The **ThinPrint AutoConnect Map Additional Printers** item inherits the content of the table. For further details, see *Register the Location-Based Printing Group Policy DLL File* in Setting Up Desktop and Application Pools in View.

5. Configure the mapping rules using the Dynamic Printer Matrix and Map Additional Printers tables in the Group Policy Object.

For more information see the ThinPrint White Papers Web site.

Summary

This paper describes two types of virtual printing solutions: printer redirection and location-based printing. Details for each solution cover the use cases, the data flow and topology, and the configuration steps. Finally, the procedures for integration with a third-party solution are discussed to enable virtual printing integration between View and a third-party product such as Cortado ThinPrint.

Authors and Contributors

This paper was written by Judy Wu, End-User-Computing Senior Solution Engineer, VMware, who wishes to thank the following people for their contributions:

- Tony Huynh, View Product Line Manager, VMware
- Benjy Scoggins, End-User-Computing Senior Consultant, VMware
- Guang Shi, End-User-Computing Software Engineer, VMware
- T.J. Vatsa, End-User-Computing Principal Architect, VMware
- Yanchao Zhang, End-User-Computing Software Engineer, VMware
- Sam Zhao, End-User-Computing Technical Marketing and Enablement Manager, VMware
- Victoria Zheng, End-User-Computing Software Engineer, VMware
- Ben Chong, former End-User-Computing Group Product Manager, VMware

Additional Resources

Enhanced Metafile

Registry Element Size Limits

ThinPrint Web Site

VMware Compatibility Guide

VMware Horizon 6 Documentation

VMware Horizon Client Documentation

Appendix: Scripts for UNC-Based Printing

Use the following scripts to implement UNC-based printing.

Run On Connect1.txt

```
start /min C:\Windows\Utils\Script\RunOnConnect2.cmd
```

Run On Connect2.txt

```
powershell.exe c:\Windows\Utils\Script\Map-Network-Printer.ps1
exit
```

Map-Network-Printer.txt

```
##Globals
#$Printer_CSV = "C:\temp\printers.csv"
$Printer_CSV = "\\pmh-vmplcs-03\pcoip_logs$\Script\Printers.csv"
$Printers = @()
$Hostname = @()
$timer = @()
$MapPrinters = @()
$log = @()
$CurrentPrinters = @()
#Start program code
$timer = [Diagnostics.Stopwatch]::StartNew()
#Enumerate current connected printers
$CurrentPrinters = Get-WmiObject -Class Win32_Printer
#Unmap existing network printers
if ($CurrentPrinters) {
      foreach ($oldprinter in $CurrentPrinters) {
            if ($oldprinter.Name -match "\\") {
                  (New-Object -ComObject WScript.Network).
RemovePrinterConnection($oldprinter.Name)
                  $log += "Removing existing printer: " + $oldprinter.Name
                  $log = $log | Out-String
            } else {}
      }
} else {}
#Load the CSV List
if (!$(Test-Path $Printer_CSV)) {
```

```
        #Do nothing - file not found
             $log += "File: " + $Printer_CSV + " was not found on the file
system"
             $log = $log | Out-String
} else {
        $Printers += Import-Csv $Printer_CSV
}
#Determine the VDI Volatile Variables connecting endpoint hostname
$Hostname = Get-ItemProperty 'hkcu:\volatile environment'
$Hostname = $Hostname.ViewClient_Machine_Name
if ($Hostname -match ".parknet-ad.pmh.org") {
      $Hostname = $Hostname -replace ".parknet-ad.pmh.org"
} else {}
#Determine the printers to map based on hostname (if rules exist)
if ($Hostname) {
    if ($Printers | Where-Object {$_.EndpointName -match $Hostname}) {
          $MapPrinters = $Printers | Where-Object {$_.EndpointName -match
$Hostname}
    } else {
          #Do nothing - no policies found
          $log += "No printing policies found for " + $Hostname
          $log = $log | Out-String
    }
} else {
    $log += "Could not determine VDI connecting endpoint hostname"
      $log = $log | Out-String
}
#Map the printer(s)
if ($MapPrinters) {
    $Count = 0
    foreach ($Printer in $MapPrinters) {
          (New-Object -ComObject WScript.Network).
AddWindowsPrinterConnection($Printer.UNCPath)
        $log += "Mapping UNC printer: " + $Printer.UNCPath + " for endpoint '"
+ $Hostname + "'"
```

```
            $log = $log | Out-String
            $Count++
            #Check if the printer should be set as the default and if so, do it
            if ($Printer.Default -eq "Y") {
                  $MappedPrinterName = $Printer.UNCPath
                  $MappedPrinterName = $MappedPrinterName -split "\\"
                  $MappedPrinterName = $MappedPrinterName[3]
                  #Set printer as default in the system
                  (Get-WmiObject -Class Win32_Printer | Where-Object {$_.Name
-match $MappedPrinterName}).SetDefaultPrinter()
                  $log += "Setting UNC printer: " + $Printer.UNCPath + " as
default printer '" + $MappedPrinterName + "' in the system"
                  $log = $log | Out-String
            } else {}
    }
    if ($Count -gt 0) {
            $log += "Mapped " + $Count + " printer(s) "
            $log = $log | Out-String
    } else {}
} else {
    $log += "No policies to map..."
       $log = $log | Out-String
}
#Stop and write out console/log data
$timer.Stop()
$log += "[Script Execution Time(H:M:S): " + $timer.Elapsed.Hours + ":" +
$timer.Elapsed.Minutes + ":" + $timer.Elapsed.Seconds + "]"
$log = $log | Out-String
$log | Set-Content "C:\Temp\Map-Network-Printers.txt" -force
```

vmware®

VMware, Inc. 3401 Hillview Avenue Palo Alto CA 94304 USA Tel 877-486-9273 Fax 650-427-5001 www.vmware.com