ABSTRACT

There is a common need to provide read access to data residing in SAS tables. This tutorial will introduce some components of SAS Integration Technologies, then show how to use these components to get SAS data into a MS Excel spreadsheet – in some cases, without the need for SAS on the user's computer. This tutorial is geared for any SAS programmer who has a good grasp of VBA.

There are few SAS programmers and/or analysts who have not heard the refrain ‘Can I have that in an Excel spreadsheet?’. And, once provided, the additional and inevitable refrain ‘Can you run it again with this one change?’. If you have SAS/Access for PC File Formats, generating the spreadsheets is not too big an issue, assuming you have time to make the change and run the programme. And if you do not have SAS/Access for PC File formats, then you have yet another layer of conversion, additional time, and of course the window of opportunity for errors to creep in. Many people turned to Dynamic Data Exchange (DDE) to try to alleviate these problems. In this paper I will introduce a more robust set of tools aimed at sharing data between SAS and non-SAS applications – SAS Integration Technologies.

INTEGRATION TECHNOLOGIES

New in SAS v8, Integration Technologies is a set of tools that allow you to access the power of the SAS system from a variety of programming environments – Java, Visual Basic etc.. In this paper, we will be looking at using some Windows desktop tools and components to access SAS. In particular, we will look at using Excel VBA as the client programming language, Microsoft’s Active Data Objects (ADO) as the data access component, and the SAS Integrated Object Model (IOM) to open SAS to the Excel client.

First, let us briefly examine the SAS Integrated Object Model (for a complete description of SAS Integration Technologies, and the IOM, refer to the SAS web site www.sas.com/rnd/itech/library). Figure 1 depicts the IOM Hierarchy; in this paper we will focus on the Workspace and the ADO/OLE DB components.
data model is used to share data between the client application and the SAS IOM server. The ActiveX Data Object (ADO) model is shown in Figure 2.

**MICROSOFT ADO**

In order to share data between SAS and Excel we will need to understand a bit about ADO. For the purposes of this paper there are two objects of interest – the Connection object and the Recordset object.

The Connection object provides properties to define the source of the data, and methods to manage the link between the client to the datasource. The Recordset object uses the Connection object to return data to the client. The Fields collection of the Recordset object provides data about the contents of the recordset.

**DO YOU HAVE ALL OF YOUR TOOLS?**

In order to follow the examples in this paper, you will have to have SAS v8.1 installed; as part of the installation procedure be sure the Integration Technologies components are installed. Microsoft Data Access Components (MDAC) v2.1 or higher should also be installed; normally this will be installed along with SAS Integration Technologies. The examples that follow were developed under Win NT 4.0 sp6 using SAS v8.1 and Excel 97 sr2.

In order to use the SAS IOM within Excel we will need to make sure that Excel has the proper references to the objects. To do this, start Excel and follow these steps:

1. From an empty spreadsheet open the Visual Basic Editor (Tools…Macro…Visual Basic Editor)
2. Create a new module (Insert…Module)
3. Add the references to the SAS IOM and the SAS Workspace manager (Tools…References – in the dialogue box, scroll down and select the SAS objects)
4. Add the references to the Microsoft ActiveX Data Objects (Tools…References – in the dialogue box scroll down to Microsoft ActiveX Data Objects and select the highest version available)

**DRIVERS, START YOUR ENGINES**

Let’s start with a simple connection and retrieval of data; in the first case we will retrieve the contents of the table `sasuser.shoes`. To keep the demonstration as simple as possible and to highlight the IOM components the Excel worksheet will not use common spreadsheet components such as forms and buttons. The first example will simply return the contents of `sasuser.shoes` and display the contents in the Excel immediate window. Let us examine each of the lines of code here (see Listing 1). NOTE: watch carefully for code that spans multiple lines. Although I have tried to catch all such spans and add the ‘line to be continued’ character _ (the underscore), the transfer from Excel
to the word processor may have led to word wrap, and consequently code that will not compile.

First, whenever using VBA modules, always set **Option Explicit**. This option requires you to declare all variables used. If this option is not set errors in the form of misspelled variables can easily creep into your programme. The next three declarations:

```vba
Dim swsSAS As SAS.Workspace
Dim rsSAS As New ADODB.Recordset
Dim swmWM As New SASWorkspaceManager.WorkspaceManager
```

declare these objects to be global to the module. The use of the **New** keyword indicates that the objects should be created when the programme starts. These objects were declared global to the module so they could be available to any function or subroutine within the module. The subroutine **Test** does all of the work in this module.

The command:

```vba
Set swsSAS = swmWM.Workspaces.CreateWorkspaceByServer("", 
VisibilityProcess, Nothing, ",", ",", xmlInfo)
```

creates a SAS workspace (swsSAS) on the local machine. The third parameter (the VBA keyword **Nothing**) indicates the SAS server is on the local machine. If the SAS server were to be located on another machine then an appropriate server definition would have to be passed.

The command (which should be on one line):

```vba
cnnIOM.Open "Provider=sas.iomprovider.1; SAS Workspace ID=" & swsSAS.UniqueIdentifier
```

opens the data connection between the SAS IOM server and the Excel client. The "Provider=sas.iomprovider.1" option indicates the particular SAS dataprovider we will be using (there are three available providers). The “SAS Workspace ID= & swsSAS.UniqueIdentifier” option tells the connection which workspace it is dealing with.

The command:

```vba
rsSAS.Open "sashelp.shoes", cnnIOM, adOpenDynamic, 
adLockPessimistic, ADODB.adCmdTableDirect
```

opens the SAS table sashelp.shoes for update. The connection object, cnnIOM, identifies where the data reside (a local SAS workspace), the adOpenDynamic keyword indicates the data are updateable.

A recordset can be positioned in one of three locations, before the first record or the beginning of the file (BOF), after the last record or the end of the file (EOF), or on an active record; if there are no records in the recordset you cannot move to an active record. A common way to test for an empty dataset is to see if both the BOF and EOF properties are true; if both properties are true, there are no records in the recordset. The statement

```vba
If Not (rsSAS.BOF And rsSAS.EOF) Then
```

then checks if there are any records in the recordset, proceeding only if there are records. There are a number of methods used to navigate a recordset; some of the common ones are:

- **MoveFirst** – move to the first record
- **MoveLast** – move to the last record
- **MoveNext** – move to the next record
- **MovePrevious** – move to the previous record

Within the conditional **If** statement, we loop through all of the records in the recordset, listing the contents in the VBA immediate window using the **Debug.Print** method.

```vba
rsSAS.MoveFirst
Do While Not rsSAS.EOF
  Debug.Print rsSAS!region, rsSAS!product, 
    rsSAS!subsidiary, rsSAS!stores, rsSAS!sales, 
    rsSAS!inventory, 
    rsSAS!returns
  rsSAS.MoveNext
Loop
```

After looping through all of the records, we close all of the objects we had opened and explicitly destroy them by setting them to **Nothing**. If objects are not properly closed and destroyed, the memory they occupied is not freed (memory leak) often resulting in your programme slowing drastically and possibly crashing altogether.

**FIELDS OF GLORY**

The example in Listing 1 allowed us to display the contents of the table sasuser.shoes; however, we had to explicitly identify all of the fields in the recordset. In the next example (Listing 2) we will see how to identify the fields in each record. The following code is the segment which lists the fields:

```vba
For Each fld In rsSAS.Fields
  Debug.Print fld.Name, fld.Type
Next
```

If you recall from the ADO hierarchy model (Figure 2) the recordset object has a **Fields** collection; this code is simply stepping through all of the fields in the collection. The **For Each** …. **Next** construct is a common method to iterate over a collection.

**WHAT’S UNDER THE HOOD?**

How do you find the options and properties for these objects we are using? If manuals were regularly distributed with software, you could read the manual. Now manuals are replaced with on-line help. Unfortunately, navigating the help files is not always easy or productive. Fortunately there is a way to get the methods and properties of the objects – the VBA object browser. Within the VBA editor select View… Object Browser; the shortcut key id F2 (Figure 3).
The example in Figure 3 shows the members (properties and methods) of the recordset object.

**LET'S EXCELERATE**

Now that we have been able to start SAS from our Excel spreadsheet, let's actually populate a worksheet (Listing 3). This example builds upon the previous one. We will iterate over the **Fields** collection to put out column headers (**fld.Name**). In addition we will check for character fields (**fld.Type = adWChar**) and set the column widths to be 2 characters wider than the actual (defined) width (**fld.DefinedSize + 2**). We will also bold the titles and set the cell border to a bottom underline. After displaying the column headers, we then process every record in the recordset as before; within each record we iterate over the **Fields** collection and populate the cells with the field value (**fld.Value**). After populating the worksheet, we move to the cell A2.

**SUBMIT**

Ok, we can read sasuser.shoes. My boss will really find those data useful!! Ok, maybe he will, maybe she won’t. But a **DATA Step**, that we know would be useful. In the next example (Listing 4) we use the **LanguageService** to submit a simple data step and return the results. As with the first example, the output will be displayed in the VBA Immediate window. The new piece to the puzzle is the line (the quoted part should all be on one line):

```sas
swsSAS.LanguageService.Submit _
"data a; do customer=1 to 0; quantity=customer*customer; pizza='Pepperoni'; output; end; run;"
```

This will create a dataset with 10 records and 3 variables. And now with the ability to submit SAS code we can add some real v8 power.

**THE CHEQUERED FLAG**

These examples have been kept simple to highlight a few of the aspects of SAS Integration Technologies. By no means are they exhaustive of the power of SAS Integration Technologies. However, they should start you on your way.

To get started you should have SAS with Integration Technologies installed on your desktop. Once you have the programmes working using a local SAS Server it is a matter of changing only a few options and you are ready to run the same programmes against remote SAS servers. To deploy your applications you need only the SAS Client components and the client application (e.g. Excel) on the desktop and SAS Integration Technologies components on the remote SAS Server.

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**REFERENCES**

For a complete overview of SAS Integration Technologies see [www.sas.com/rnd/itech/library](http://www.sas.com/rnd/itech/library)

Wrox Press, Birmingham

SAMS, Indianapolis IN
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LISTINGS

Listing 1
Option Explicit ' always set option explicit
Dim swsSAS As SAS.Workspace
Dim rsSAS As New ADODB.Recordset
Dim swmWM As New
SASWorkspaceManager.WorkspaceManager

Public Sub test()
Dim cnnIOM As New ADODB.Connection
Dim xmlInfo As String

' Create a local SAS workspace.
Set swsSAS =
swmWM.Workspaces.CreateWorkspaceByServer("", VisibilityProcess, Nothing, ",", ",", xmlInfo)

' Open a connection to the workspace
cnnIOM.Open "Provider=sas.iomprovider.1; SAS Workspace ID=" & swsSAS.UniqueIdentifier

' Associate the Recordset object with the SAS data set.
rsSAS.Open "sashelp.shoes", cnnIOM, adOpenDynamic, adLockPessimistic,
ADODB.adCmdTableDirect
If Not (rsSAS.BOF And rsSAS.EOF) Then
rsSAS.MoveFirst
Do While Not rsSAS.EOF
Debug.Print rsSAS!region, rsSAS!Product,
rsSAS!subsidiary, rsSAS!stores, rsSAS!sales,
rsSAS!inventory, rsSAS!returns
rsSAS.MoveNext
Loop
End If
rsSAS.Close
Set rsSAS = Nothing

End Sub

Listing 2
Option Explicit ' always set option explicit
Dim swsSAS As SAS.Workspace
Dim rsSAS As New ADODB.Recordset
Dim swmWM As New
SASWorkspaceManager.WorkspaceManager

Public Sub test()
Dim cnnIOM As New ADODB.Connection
Dim xmlInfo As String
Dim fld As Field

' Create a local SAS workspace.
Set swsSAS =
swmWM.Workspaces.CreateWorkspaceByServer("", VisibilityProcess, Nothing, ",", ",", xmlInfo)

' Open a connection to the workspace
cnnIOM.Open "Provider=sas.iomprovider.1; SAS Workspace ID=" & swsSAS.UniqueIdentifier

' Associate the Recordset object with the SAS data set.
For Each fld In rsSAS.Fields
Debug.Print fld.Name, fld.Type
Next

rsSAS.Close
Set rsSAS = Nothing
cnnIOM.Close
Set cnnIOM = Nothing
SwmWM.Workspaces.RemoveWorkspaceByUUID
swsSAS.UniqueIdentifier
SwsSAS.Close
Set swsSAS = Nothing
Set swmWM = Nothing
End Sub
```
Option Explicit ' always set option explicit

Dim swSAS  As SAS.Workspace
Dim rsSAS   As New ADODB.Recordset
Dim swmWM   As New SASWorkspaceManager.WorkspaceManager

Public Sub test()
Dim cnnIOM  As New ADODB.Connection
Dim xmlInfo As String
Dim count   As Integer
Dim fld     As Field
Dim row     As Long

' Create a local SAS workspace.
Set swSAS =
swmWM.Workspaces.CreateWorkspaceByServer("", VisibilityProcess, Nothing, ",", ",", xmlInfo)

' Open a connection to the workspace
cnnIOM.Open "Provider=sas.iomprovider.1; SAS
Workspace ID=" & swSAS.UniqueIdentifier

' Associate the Recordset object with the SAS data set.
rsSAS.Open "sashelp.shoes", cnnIOM,
adOpenDynamic, adLockPessimistic,
ADODB.adCmdTableDirect

' SELECT the first sheet and freeze the panes on the 2nd line
Worksheets("sheet1").Activate
Range("A2").Select
ActiveWindow.FreezePanes = True
If Not (rsSAS.BOF And rsSAS.EOF) Then
Worksheets("sheet1").Activate
Range("A1").Select
For Each fld In rsSAS.Fields
ActiveCell.Value = fld.Name
ActiveCell.Font.Bold = True
With ActiveCell.Borders(xlBottom)
    .LineStyle = xlContinuous
    .Weight = xlThin
End With
End If
If fld.Type = adWChar Then
Columns(ActiveCell.Column).ColumnWidth =
fld.DefinedSize + 2
Else
Columns(ActiveCell.Column).ColumnWidth = 12
End If
col = col + 1
ActiveCell.Next.Select
Next
rsSAS.MoveNext
row = 2
Do While Not rsSAS.EOF
ActiveSheet.Cells(row, 1).Select
For Each fld In rsSAS.Fields
    ActiveCell.Value = fld.Value
    ActiveCell.Next.Select
Next
row = row + 1
RsSAS.MoveNext
Loop
Range("A2").Select
End If
rsSAS.Close
Set rsSAS = Nothing
CnnIOM.Close
Set cnnIOM = Nothing
SwmWM.Workspaces.RemoveWorkspaceByUUID
swsSAS.UniqueIdentifier
SwsSAS.Close
Set swsSAS = Nothing
Set swmWM = Nothing
End Sub
```
Option Explicit ' always set option explicit
Dim swsSAS As SAS.Workspace
Dim rsSAS As New ADODB.Recordset
Dim swmWM As New SASWorkspaceManager.WorkspaceManager
Public Sub test()
Dim cnnIOM As New ADODB.Connection
Dim xmlInfo As String
' Create a local SAS workspace.
Set swsSAS = swmWM.Workspaces.CreateWorkspaceByServer("", VisibilityProcess, Nothing, "", "", "", xmlInfo)
' Use LanguageService
swsSAS.LanguageService.Submit "data a; do customer=1 to 10; quantity=customer*customer;
pizza='Pepperoni'; output; end; run;"
' Open a connection to the workspace
cnnIOM.Open "Provider=sas.iomprovider.1; SAS Workspace ID=" & swsSAS.UniqueIdentifier
' Associate the Recordset object with the SAS data set.
rsSAS.Open "work.a", cnnIOM, adOpenDynamic, adLockPessimistic, ADODB.adCmdTableDirect
If Not (rsSAS.BOF And rsSAS.EOF) Then
    For Each fld In rsSAS.Fields
        Debug.Print fld.Name
    Next
    rsSAS.MoveFirst
    Do While Not rsSAS.EOF
        Debug.Print rsSAS!CUSTOMER, rsSAS!QUANTITY, rsSAS!PIZZA, rsSAS!ORDERDATE
        rsSAS.MoveNext
    Loop
End If
rsSAS.Close
Set rsSAS = Nothing
cnnIOM.Close
Set cnnIOM = Nothing
swmWM.Workspaces.RemoveWorkspaceByUUID swsSAS.UniqueIdentifier
swsSAS.Close
Set swsSAS = Nothing
Set swmWM = Nothing
End Sub