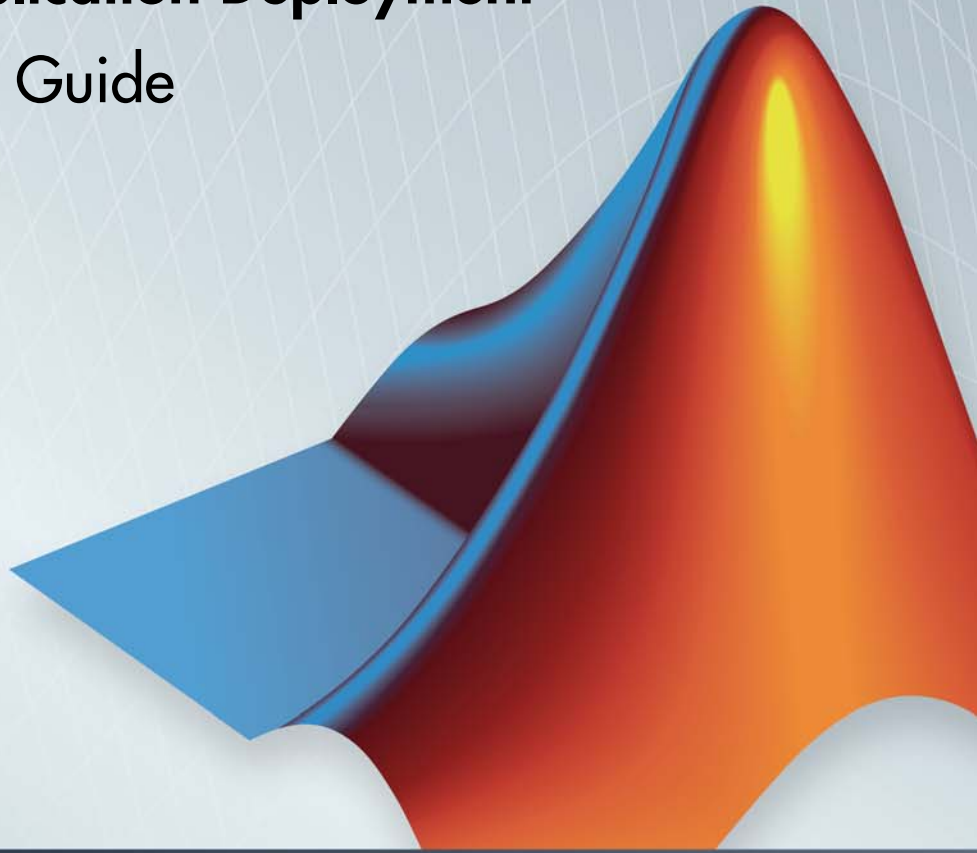


MATLAB® Application Deployment

Web Example Guide

R2013a



MATLAB®



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MATLAB® Application Deployment Web Example Guide

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The MATLAB Application Deployment Web Example Guide

MATLAB® Compiler™, MATLAB Builder NE™, MATLAB Builder JA™, and MATLAB Builder EX™ take MATLAB functions and expose them in a language-specific manner that can be deployed to users who do not have MATLAB installed.

When deploying a MATLAB application in a Web-based environment, the number of possible architectural configurations, programming languages, operating systems, Web servers, and frameworks can be intimidating, especially if you are new to Web deployment.

The goal of the *MATLAB Application Deployment Web Example Guide* is to provide a series of templates demonstrating how to successfully implement the possible configurations available in the Web deployment space.

Access the guide by clicking the **PDF Documentation** link from any of the following product Documentation Centers:

- MATLAB® Compiler™
- MATLAB Builder™ NE
- MATLAB Builder JA

Use the *MATLAB Application Deployment Web Example Guide* to:

- Learn about the components of a Web deployment environment.
- Review an architectural configuration of a typical Web deployment implementation and how the components in the configuration work together.
- Reference specific models for performing the most common to the most complex deployment tasks, such as:
 - Creating a deployable function
 - Hosting the component delivered by the MATLAB Programmer using J2EE and .NET Web technologies
 - Displaying complex data types (arrays, matrices) on a Web page

- Enabling scalability through stateless services used with MATLAB Builder JA or MATLAB Builder NE
- Deploying applications through implementation of SOAP Web services

Who Should Use This Guide?

Many skill sets are involved in deploying MATLAB® applications.

These skills sets include the MATLAB Programmer (usually a scientist or engineer), a Business Services Developer and front-end Web developer (programmers responsible for interfacing with languages and frameworks such as Java and .NET, as well as developing Web page content), and the end user, who consumes the final product.

Since it is sometimes confusing to determine who should perform what task in a large installation, this guide's structure is role based. In other words, the tasks that belong to each role are listed in separate sections or chapter. This organization enables more novice users to focus only on the tasks related to their area of expertise and enables advanced users to customize a list of tasks pertinent to their own area of expertise.


For more information on these roles and skill sets and how they work together to successfully deploy a Web application, see the section "Lifecycle of a Deployed MATLAB Web Application" on page 2-2.

Commonly Used Software and Preliminary Setup Information

In this section...
<p>“MATLAB Programmer” on page 1-5</p> <p>“Integration Experts (Middle-Tier Developer and Front-End Web Developer)” on page 1-6</p> <p>“End User” on page 1-7</p>

MATLAB Programmer

MATLAB Programmer


Role	Knowledge Base	Responsibilities
 <p>MATLAB programmer</p>	<ul style="list-style-type: none"> • MATLAB expert • No IT experience • No access to IT systems 	<ul style="list-style-type: none"> • Develops models; implements in MATLAB • Uses tools to create a component that is used by the .NET developer

- MATLAB®
- Financial Toolbox
- MATLAB Compiler
- MATLAB Builder JA
- MATLAB Builder NE


Note Many of the examples in this guide use the software listed here. It is not likely you will use all of the software listed here.

Integration Experts (Middle-Tier Developer and Front-End Web Developer)

Middle-Tier Developer

 Middle-tier developer	<ul style="list-style-type: none">• Little to no MATLAB experience• Moderate IT Experience• Expert at business logic and services tier• .NET expert• Minimal access to IT systems• Expert at .NET Web frameworks• Expert at Web services	<ul style="list-style-type: none">• Integrates deployed component with the rest of the .NET system by converting MATLAB data types (MWArrays) to the .NET Business logic objects
--	--	--

Front-End Web Developer


Role	Knowledge Base	Responsibilities
 Front-end Web developer	<ul style="list-style-type: none">• No MATLAB experience• Minimal IT experience• Expert at usability and Web page design• Minimal access to IT systems• Expert at ASPX	<ul style="list-style-type: none">• As service consumer, manages presentation and usability• Creates front-end applications• Integrates MATLAB code with language-specific frameworks and environments• Integrates WebFigures with the rest of the Web page

- MCR (MATLAB® Compiler™ Runtime)
- Microsoft IIS 5
- Microsoft .NET Framework

- Java™ SDK (Software Developer Kit) 1.5 or later
- Java JRE (Java Runtime Environment) 1.5 or later
- Apache Tomcat™ 5 Web Server
- Apache Axis2™ Web Services Engine
- PHP server-side hypertext preprocessor 5.2.3 or later
- NUSOAP PHP class add-in

End User

End User

Role	Knowledge Base	Responsibilities
 End user	<ul style="list-style-type: none"> • No MATLAB experience • Some knowledge of the data that is being displayed, but not how it was created 	<ul style="list-style-type: none"> • In Web environments, consumes what the front-end developer creates • Integrates MATLAB code with other third-party applications, such as Excel

- Microsoft Office™ 2003 or later
- Microsoft Office™ Web Services Toolkit

Web 101: An Introduction to Web Concepts and Terminology

Lifecycle of a Deployed MATLAB Web Application

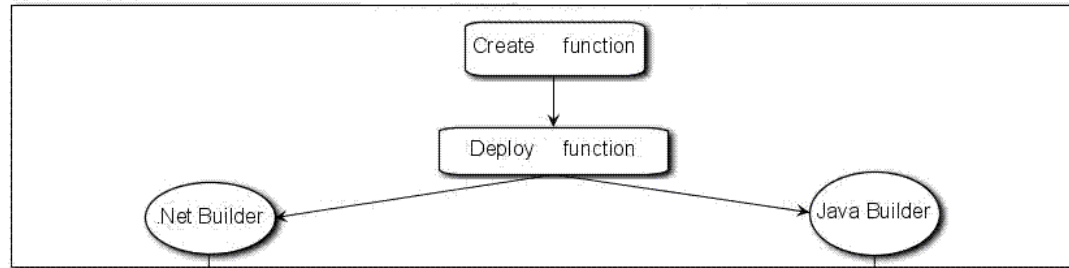
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“Introduction” on page 2-2
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“MATLAB Programmer” on page 2-5
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Introduction

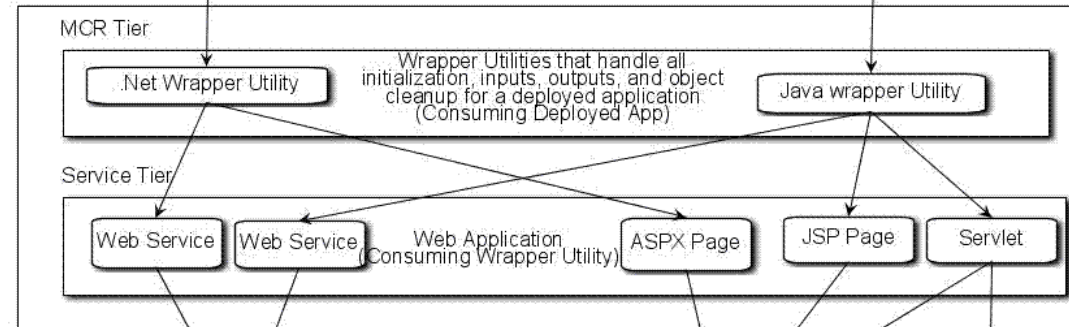
How does a single piece of MATLAB code become a deployable, portable, robust, scalable Web application? Through skillful deployment by a number of people in an organization, each playing distinct and significant roles.

The following diagrams depict the supported implementation and architectures available when using MATLAB application deployment products.

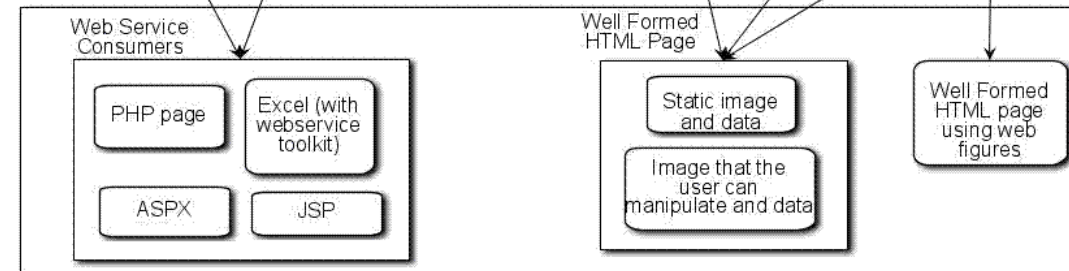
MATLAB Tier

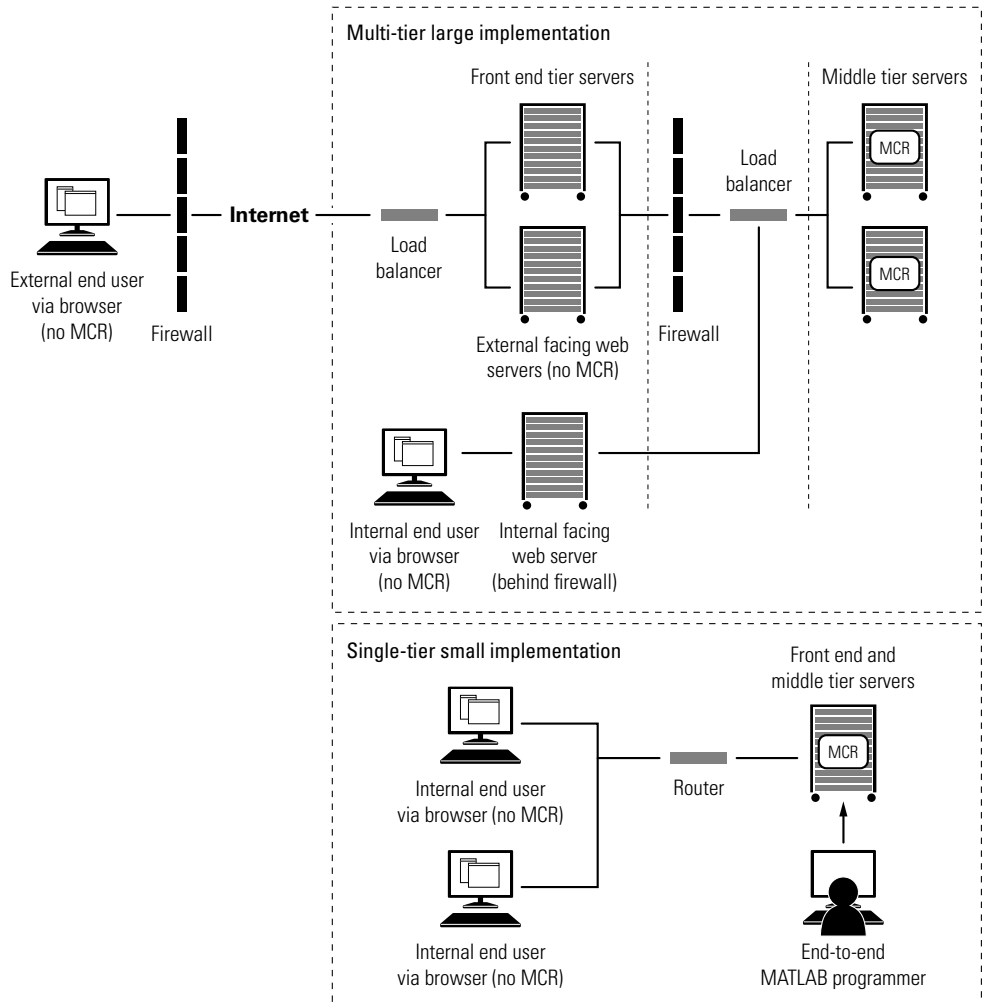


Middle Tier



Client Tier





MATLAB Web Application Environment


The fundamental goal of the Application Deployment products (MATLAB Compiler and the builders) is to enable work that has been accomplished within MATLAB to be deployed outside the MATLAB environment. This is accomplished with the MATLAB Compiler Runtime (MCR), which is a set of libraries that runs encrypted MATLAB code.

In a Web application, the builder products allow integration of the MCR at the server tier level. This enables end users to execute MATLAB applications over the Web without installing client software.

WebFigures is a client and server technology that further extends this capability by enabling end users to interact with a MATLAB figure in much the same way as they use an axis within MATLAB. The WebFigures functionality of MATLAB Builder JA and MATLAB Builder NE allows users limited to Web access the ability to dynamically interact with MATLAB figures.

MATLAB Programmer

MATLAB Programmer


Role	Knowledge Base	Responsibilities
 MATLAB programmer	<ul style="list-style-type: none">• MATLAB expert• No IT experience• No access to IT systems	<ul style="list-style-type: none">• Develops models; implements in MATLAB• Uses tools to create a component that is used by the .NET developer

The first phase in a deployed application's life begins when code is written in MATLAB by a MATLAB programmer, whose objective is sharing it with other people either within or outside of the organization. To accomplish this objective, the programmer uses MATLAB Compiler. MATLAB Compiler makes MATLAB code usable by people in vastly different environments who may not have knowledge of MATLAB or the MATLAB language.

When MATLAB Builder JA (for Java language) or MATLAB Builder NE (for Microsoft .NET Framework) is installed along with MATLAB Compiler, MATLAB functions can be encrypted and wrapped in Java or .NET interfaces. The MATLAB programmer takes these deployable components and gives them to the middle-tier developer.

Middle-Tier Developer


Middle-Tier Developer

 Middle-tier developer	<ul style="list-style-type: none">• Little to no MATLAB experience• Moderate IT Experience• Expert at business logic and services tier• .NET expert• Minimal access to IT systems• Expert at .NET Web frameworks• Expert at Web services	<ul style="list-style-type: none">• Integrates deployed component with the rest of the .NET system by converting MATLAB data types (MWArrays) to the .NET Business logic objects
---	--	--

At this point in the deployment lifecycle, integration is usually required in order to make the deployed application work with the existing applications in the organization. The Business Services Developer installs these deployable applications along with the proper version of the MCR, and converts MATLAB data types to native language data types so they can be used without any coupling to MATLAB in other tiers of the installation architecture. When the Java or .NET component is called, it will instantiate the MCR to execute the underlying MATLAB code. Once these services are exposed (either as Web services or through an API) Front End Developers can connect to them and use them.

Front-End Web Developer


Front-End Web Developer

Role	Knowledge Base	Responsibilities
 Front-end Web developer	<ul style="list-style-type: none">• No MATLAB experience• Minimal IT experience• Expert at usability and Web page design• Minimal access to IT systems• Expert at ASPX	<ul style="list-style-type: none">• As service consumer, manages presentation and usability• Creates front-end applications• Integrates MATLAB code with language-specific frameworks and environments• Integrates WebFigures with the rest of the Web page

Front-end Web developers are typically responsible for user-visible functionality and know little about under-the-covers implementation. Their primary concern is the stability and security of the organization's data within the confines of a firewall. Once the front-end Web developers create some mechanism for exposing the application functionality to the end user, it is up to the end user to complete the lifecycle by interacting with the application to perform some task or solve some business problem. End users typically achieve this through a Web browser.

Server Administrator

Server Administrator

 Server administrator	<ul style="list-style-type: none">• No MATLAB experience• IT Expert• Understands server architectures• Understands language-specific frameworks and environments	<ul style="list-style-type: none">• Manages uptime of production servers• Ensures that services are scalable enough to meet SLA requirements• Maintains multiple versions of the MCR and Deployed component versions
--	---	--


Server Administrator (Continued)

		<ul style="list-style-type: none">• Manages framework versions
--	--	--

Server administrators are responsible for keeping the servers up and running, meeting the IT department’s commitments to the rest of the organization as outlined in SLA agreements. They are not MATLAB experts and may or may not know much about integrating deployed applications in various computing environments. However, they are expert in understanding which versions of which computing environments (JREs and .NET frameworks, for example) can co-exist and run stably in order to achieve the end-user’s desired results.

End User

End User

Role	Knowledge Base	Responsibilities
 End user	<ul style="list-style-type: none">• No MATLAB experience• Some knowledge of the data that is being displayed, but not how it was created	<ul style="list-style-type: none">• In Web environments, consumes what the front-end developer creates• Integrates MATLAB code with other third-party applications, such as Excel

End users may use the Web site or may interact with the business tier directly. In this case, an example of a common activity would be when a financial analyst accesses a business tier Web service and a complex Microsoft® Excel® model. Or, they access an internal Web site, performing specific tasks not available to their customers.

End-To-End Developer

The end-to-end developers are virtual “one-stop shops.” They are MATLAB experts, but are also skilled in many of the areas of expertise as the middle-tier developer and front-end Web developer, though their level of expertise may vary over their many areas of responsibility. To this end, this guide presents

examples of comprehensive deployment tasks scoped specifically to the time and resource constraints typically faced by end-to-end developers.


MATLAB Programmer Tasks

- “Programming in MATLAB” on page 3-2
- “Deploying MATLAB Code with the Builders” on page 3-6

Programming in MATLAB

In this section...
“MATLAB Programming Basics” on page 3-2
“Returning MATLAB Data Types” on page 3-3

MATLAB Programmer

Role	Knowledge Base	Responsibilities
 MATLAB programmer	<ul style="list-style-type: none">• MATLAB expert• No IT experience• No access to IT systems	<ul style="list-style-type: none">• Develops models; implements in MATLAB• Uses tools to create a component that is used by the .NET developer

MATLAB is an interpreted programming environment. You can execute functions directly at the command prompt or through an editor in saved files. Methods may be created, having their own unique inputs and outputs. When deploying a MATLAB function to other programming environments, such as .NET and Java, you must contain your MATLAB code within functions. MATLAB Compiler does not allow you to use inline scripts.

The following examples demonstrate how to perform basic MATLAB programmer tasks for deployed applications; they do not attempt to represent every way a MATLAB programmer can interface with MATLAB. Upcoming topics demonstrate how to use various data types in deployed applications. For more specific information about any of these data types, your product User’s Guide.

MATLAB Programming Basics

Creating a Deployable MATLAB Function

Virtually any calculation that you can create in MATLAB can be deployed, if it resides in a function. For example:

```
>> 1 + 1
```

cannot be deployed.

However, the following calculation:

```
function result = addSomeNumbers()  
    result = 1+1;  
end
```

can be deployed because the calculation now resides in a function.

Taking Inputs into a Function

You typically pass inputs to a function. You can use primitive data type as an input into a function.

To pass inputs, put them in parentheses. For example:

```
function result = addSomeNumbers(number1, number2)  
    result = number1 + number2;  
end
```

Returning MATLAB Data Types

MATLAB allows many different deployable data types. This section contains examples of how to work with figures. For an in-depth explanation of how to work with MATLAB primitive data types, see the MATLAB External Interfaces documentation.

MATLAB Figures

Often, you are dealing with images displayed in a figure window, and not just string and numerical data. Deployed Web applications can support figure window data in a number of ways. By using the WebFigures infrastructure (see “About the WebFigures Feature” in the MATLAB Builder JA documentation or “WebFigures” in the MATLAB Builder NE documentation), the respective builder marshals the data for you.

Alternatively, you can take a snapshot of what is in the figure window at a given point and convert that data into the raw image data for a specific image type. This is particularly useful for streaming the images across the web.

Returning Data from a WebFigure Window

WebFigures is a feature that enables you to embed dynamic MATLAB figures onto a Web page through a Builder JA or Builder NE component. This concept can be used with any data in a figure window.

As in the following example, you close the figure before the code is exited so that the figure does not “pop up,” or appear later, in the deployed application. You do not need to specify any reorientation data when using WebFigures. If the figure is attached to the rest of the infrastructure, it will automatically pass, resize, and reorient accordingly.

```
%returns a WebFigure reference containing the
%data from the figure window
function resultWebFigure = getWebFigure
    f = figure;
    set(f,'Color',[.8,.9,1]);
    f = figure('Visible','off');
    surf(peaks);
    resultWebFigure = webfigure(f);
    close(f);
end
```

Returning a Figure as Data

This approach is typically used for instances where WebFigures can't be used, or in a stateless application.

```
%We set the figure not to be visible since we are
%streaming the data out
%Notice how you can specify the format of the bytes,
% .net uses unsigned bytes (uint8)
% java uses signed bytes (int 8)
%This function allows you to specify the image format
%such as png, or jpg
function imageByteData = getSurfPeaksImageData(imageFormat)
```

```

    f = figure;
    surf(peaks);
    set(f, 'Visible', 'off');
    imageByteData = figToImStream(f, imageFormat, 'uint8');
    close(f);
end

```

Reorienting a Figure and Returning It as Data

Sometimes you want the function to change the perspective on an image before returning it. This can be accomplished like this:

```

%We set the figure not to be visible since we are
%streaming the data out
%Notice how you can specify the format of the bytes,
% .net uses unsigned bytes (uint8)
% java uses signed bytes (int 8)
%This function allows you to specify the image format
%such as png, or jpg
function imageData =
    getImageDataOrientation(width, height, rotation,
                           elevation, imageFormat)
    f = figure('Position', [0, 0, width, height]);
    surf(peaks);
    view([rotation, elevation]);
    set(f, 'Visible', 'off');
    imageData = figToImStream (f, imageFormat, 'uint8');
    close(f);
end

```

Deploying MATLAB Code with the Builders

Writing the MATLAB code is only the first step when deploying an application. You must next determine how the application is structured. Although you might have a large amount of MATLAB code that needs to run within a component, typically only a small number of entry points need to be exposed to the calling application. It is best to determine these entry points and to make sure all inputs and outputs are necessary before deploying a Web application. The best practice is to ensure the MATLAB files that contain methods have the same name as the MATLAB file for all entry points.

For examples using the MATLAB Deployment Tool (`deploytool`), see “WebFigures” in the MATLAB Builder JA documentation and “Magic Square” in the Getting Started article in MATLAB Builder NE documentation.

It is also possible to use the MATLAB® Compiler™ `mcc` command to build components. See the `mcc` command reference page in any of the builder products for more information.


Middle-Tier Developer Tasks

- “Working with the Business Service Layer” on page 4-2
- “Creating a DAO for Deployment” on page 4-6
- “Hosting a DAO on a Web Server” on page 4-15

Working with the Business Service Layer

In this section...
“About the Business Service Layer” on page 4-2
“About the Examples” on page 4-4

Middle-Tier Developer

 Middle-tier developer	<ul style="list-style-type: none">• Little to no MATLAB experience• Moderate IT Experience• Expert at business logic and services tier• .NET expert• Minimal access to IT systems• Expert at .NET Web frameworks• Expert at Web services	<ul style="list-style-type: none">• Integrates deployed component with the rest of the .NET system by converting MATLAB data types (MWArrays) to the .NET Business logic objects
--	--	--

About the Business Service Layer

Note For comprehensive end-to-end implementations of the concepts in this chapter, see Appendix A, “Sources for More Information”.

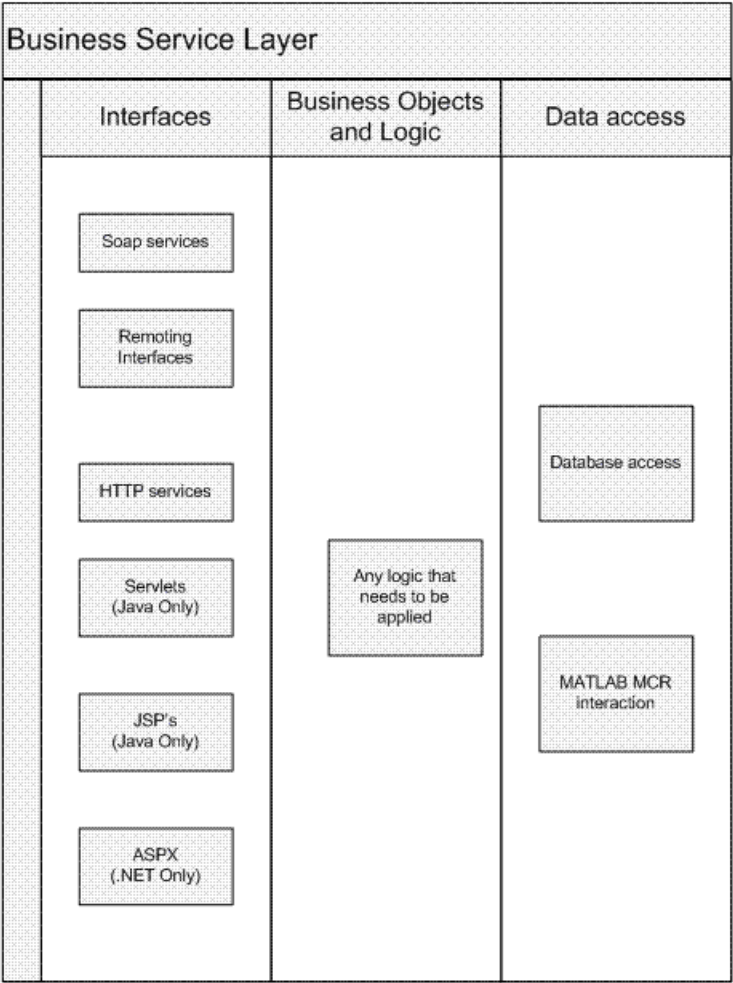
Most software contains a *business service layer*, which is a set of interfaces, business objects (and logic to manipulate them), and mechanisms for data access that run the core business.

A typical business service layer contains the following sublayers:

- Interfaces — Typically the business service layer can implement several different interface types which all interact with common data elements and common business objects, all using the same business logic. Software and

related services used to access business data from native or Web clients include:

- SOAP services
- Remoting interfaces
- HTTP services
- Java servlets
- JSPs (for Java®)
- ASPX (for .NET)
- Business Objects and Logic — This is business data expressed in the form of objects along with the logic to manipulate the objects. This data is loaded by a combination of inputs from the interfaces and data from the data access layer.
- Data Access — This layer links to all lower-level data such as databases, where access into a deployed application would typically take place. Your generated component fits into this category, as it can be used as a mechanism through which to access the MATLAB Compiler Runtime (MCR).



Elements of the Business Service Layer

About the Examples

Depending on the size and complexity of an implementation some of these elements can overlap. The examples in this documentation assume direct communication from the interfaces into the DAO (data access object or wrapper utility) that you create.

All examples in this document are coded as stateless (with the exception of the MATLAB Builder JA™ WebFigures example) and are scalable. Servers can be added or augmented by a load balancer for performance tuning.

Tip To scale MATLAB Builder NE WebFigures, use the .NET Distributed Session setting. This enables all machines in your Web farm to use the same session.

Creating a DAO for Deployment

To access business objects in .NET and Java environments, you must write a data access class or classes.

The code in these examples represents what exists within the data access section of an application since it bridges across MATLAB data and data types and Java and .NET data types.

Note In these examples, a fake component generated using the MATLAB builder products called `deploymentExamples` is used. Assume it has been imported.

Initializing a Component

Use these examples as a framework for initializing a component.

.NET

```
DeploymentExamples.DeploymentExamples deployment = null;
try
{
    deployment = new DeploymentExamples.DeploymentExamples();

    //*****
    /**Use your deployment code here
    /** (See examples below)
    //*****
}
finally
{
    deployment.Dispose();
}
```

Interacting with a Component

You interact with a component by passing inputs to a deployed application or producing MATLAB output from a deployed application. All of these examples fit where the comment block resides in “Initializing a Component”

on page 4-6 and the same component class is used. The Java and .NET Builder infrastructure handles data marshaling when passing parameters to a component. Data conversion rules can be found in the MATLAB builder documentation. If a specific data type is required, you can use the `MWArray` objects and pass in the appropriate data type.

Converting an Integer to a MATLAB Data Type

Some of the ways to pass inputs to a deployed applications are demonstrated in these examples:

.NET

```
int n = 3;
MWNumericArray x = new MWNumericArray(n, true);
```

Converting Array Data to a MATLAB Data Type

Arrays can be converted to several different MATLAB data types. An example of converting a String array into a cell array follows:

.NET

```
String[] array =
{
    "Jordan Robert",
    "Mary Smith",
    "Stacy Flora",
    "Harry Alpert"
};

int numberOfArrayElements = array.Length;
int numberOfArrayColumns = 1;

MWCellArray cellArray =
    new MWCellArray(
        numberOfArrayColumns,
        numberOfArrayElements);
for (int i = 1; i < array.Length + 1; i++)
{
```

```
        cellArray[i] = array[i - 1];  
    }
```

Converting a List to a MATLAB Data Type

A list can be converted to several different MATLAB data types. An example of converting a List of Strings into a cell array follows:

.NET

```
List<String> list = new List<String>();  
list.Add("Jordan Robert");  
list.Add("Mary Smith");  
list.Add("Stacy Flora");  
list.Add("Harry Alpert");  
  
int numberOfArrayElements = list.Count;  
int numberOfArrayColumns = 1;  
  
MWCellArray cellArray =  
    new MWCellArray(  
        numberOfArrayColumns,  
        numberOfArrayElements);  
int i = 1;  
foreach (String currentElement in list)  
{  
    cellArray[i] = currentElement;  
    i++;  
}
```

Converting Name Value Pairs to a MATLAB Data Type

.NET (Dictionaries)

```
Dictionary<String, int> dictionary =  
    new Dictionary<String, int>();  
dictionary.Add("Jordan Robert", 3386);
```



```

dictionary.Add("Mary Smith", 3912);
dictionary.Add("Stacy Flora", 3238);
dictionary.Add("Harry Alpert", 3077);

int numberOfElements = dictionary.Count;
int numberOfColumns = 1;
String[] fieldnames = { "name", "phone" };
MWStructArray output =
    new MWStructArray(
        numberOfElements,
        numberOfColumns,
        fieldnames);

int i = 1;
foreach (String currentKey in dictionary.Keys)
{
    output[fieldnames[0], i] = currentKey;
    output[fieldnames[1], i] = dictionary[currentKey];
    i++;
}

```

Getting MATLAB Numerics from a Deployed Application

This code resides in the try block for an initialized component (see “Initializing a Component” on page 4-6).

.NET

```

MWNumericArray result = (MWNumericArray)deployment.getNumeric();
int resultInt = result.ToScalarInteger();

```

Getting MATLAB Strings from a Deployed Application

.NET

```

MWCharArray result = (MWCharArray)deployment.getString();
String resultString = result.ToString();

```

Getting MATLAB Numeric Arrays from a Component

.NET

```
MWNumericArray result =  
    (MWNumericArray)deployment.getNumericArray();  
Double[] doubleArray =  
    (Double[])result.ToVector(MWArrayComponent.Real);
```

Getting Character Arrays from a Component

.NET

```
// Note that since MWCharArray doesn't have a  
//     ToVector method, it is necessary  
//     to iterate through and get a single  
//         dimension for the output.  
//     MWCharArray result =  
//         (MWCharArray)deployment.getStringArray();  
char[,] resultArray = (char[,])result.ToArray();  
char[] outputArray = new char[resultArray.GetLength(1)];  
for (int i = 0; i < resultArray.GetLength(1); i++)  
{  
    outputArray[i] = resultArray[0, i];  
}
```

Getting Byte Arrays from a Component

.NET

```
MWNumericArray result =  
    (MWNumericArray)deployment.getByteArray();  
byte[] outputByteArray =  
    (byte[])result.ToVector(MWArrayComponent.Real);
```

Getting Cell Arrays from a Component

.NET

```
MWCellArray result = (MWCellArray)deployment.getCellArray();

List<Object> outputList = new List<Object>();
Object[] outputArray = new Object[result.NumberOfElements];
for (int i = 0; i < result.NumberOfElements; i++)
{
    outputArray[i] = result[i + 1];
    outputList.Add(result[i + 1]);
}
```

Getting Structures from a Component

.NET

```
MWStructArray result = (MWStructArray)deployment.getStruct();

Dictionary<Object, Object> output =
    new Dictionary<Object, Object>();
for (int i = 0; i < result.FieldNames.Length; i++)
{
    output.Add(result.FieldNames[i],
        result.GetField(result.FieldNames[i]));
}
```

Getting a WebFigure from a Component and Attaching It to a Page

.NET

For more information about WebFigures, see “WebFigures” in the MATLAB Builder NE documentation. The first two lines of code will not do anything if executed directly. It needs a WebFigureControl on a front end page that is called WebFigureControl1. If you are not using a local WebFigureControl

and want to simply return the WebFigure in the current response object, use this code, for example:

```
WebFigure webFigure = new WebFigure(deployment.getWebFigure());
WebFigureControl1.WebFigure = webFigure;

//First, attach the webfigure to one of ASP.NET's caches,
// in this case the session cache
Session["SessionStateWebFigure"] = webFigure;
//Now, use a WebFigure Utility to get an HTML String that
// will display this figure, Notice
// how we reference the name we used when attaching it
// to the cache and we indicate
// that the Attach type is session.

String localEmbedString =
    WebFigureServiceUtility.GetHTMLEmbedString(
        "SessionStateWebFigure",
        WebFigureAttachType.session,
        300,
        300);
Response.Write(localEmbedString);
```

Getting Encoded Image Bytes from an Image in a Component

.NET

```
public byte[] getByteArrayFromDeployedComponent()
{
    MWArray width = 500;
    MWArray height = 500;
    MWArray rotation = 30;
    MWArray elevation = 30;
    MWArray imageFormat = "png";

    MWNumericArray result =
        (MWNumericArray)deployment.getImageDataOrientation(
            height,
            width,
```

```
        elevation,  
        rotation,  
        imageFormat);  
    return (byte[])result.ToVector(MWArrayComponent.Real);  
}
```

Getting a Buffered Image in a Component

.NET

```
public byte[] getByteArrayFromDeployedComponent()  
{  
    MWArray width = 500;  
    MWArray height = 500;  
    MWArray rotation = 30;  
    MWArray elevation = 30;  
    MWArray imageFormat = "png";  
  
    MWNumericArray result =  
        (MWNumericArray)deployment.getImageDataOrientation(  
            height,  
            width,  
            elevation,  
            rotation,  
            imageFormat);  
    return (byte[])result.ToVector(MWArrayComponent.Real);  
}  
  
public Image getImageFromDeployedComponent()  
{  
    byte[] byteArray = getByteArrayFromDeployedComponent();  
    MemoryStream ms = new MemoryStream(myByteArray, 0,  
        myByteArray.Length);  
    ms.Write(myByteArray, 0, myByteArray.Length);  
    return Image.FromStream(ms, true);  
}
```

Getting Image Data from a WebFigure

The following example shows how to get image data from a WebFigure object. It also shows how to specify the image type and the orientation of the image.

.NET

```
WebFigure figure =
    new WebFigure(deployment.getWebFigure());
WebFigureRenderer renderer =
    new WebFigureRenderer();

//Creates a parameter object that can be changed
// to represent a specific WebFigure and its orientation.
//If you dont set any values it uses the defaults for that
// figure (what they were when the figure was created in M).
WebFigureRenderParameters param =
    new WebFigureRenderParameters.figure);

param.Rotation = 30;
param.Elevation = 30;
param.Width = 500;
param.Height = 500;

//If you need a byte array that can be streamed out
// of a web page you can use this:
byte[] outputImageAsBytes =
    renderer.RenderToEncodedBytes(param);

//If you need a .NET Image (can't be used on the web)
// you can use this code:
Image outputImageAsImage =
    renderer.RenderToImage(param);
```

Hosting a DAO on a Web Server

After you construct your DAO, you need to expose the wrapped service(s) via the Web.

There are many things to consider with regards to exposing the service. For example, a JSP is not suited for binary streaming since the J2EE infrastructure already wraps the output stream. In each of the following sections, some basic concepts that can be used in a realistic system are demonstrated. Typically, the response is not simply dumped to the output stream, but instead wrapped in a more complex XML document or Web service. Using these templates as a guide, you can extend these examples using similar patterns. For each of these examples, refer to the DAO class defined in “Creating a DAO for Deployment” on page 4-6. This DAO takes care of MATLAB specific data conversion and data clean-up tasks.

Hosting a .NET DAO with ASPX

Initializing the DAO

Before a DAO can be used, it must be initialized. The basic template to initialize a .NET DAO looks like this:

```
using System;
using System.Data;
using System.Configuration;
using System.Web;
using System.Web.Security;
using System.Web.UI;
using System.Web.UI.WebControls;
using System.Web.UI.WebControls.WebParts;
using System.Web.UI.HtmlControls;

public partial class _Default : System.Web.UI.Page
{
    protected void Page_Load(object sender, EventArgs e)
    {
        Examples.Examples examples = new Examples.Examples();
    }
}
```

```
        /*******  
        /**This is where the examples would be pasted in  
        /*******  
        //for Examples:  
        int integer = examples.getIntFromMWNumericArray();  
        Response.Write("int: " + integer);  
  
        examples.dispose();  
    }  
}
```

Interacting with the DAO

Some examples of how to use the DAO with various data types follow:

Numeric

```
int integer = examples.getIntFromMWNumericArray();  
Response.Write("int: " + integer);
```

String

```
String stringResult = examples.getStringFromMWCharArray();  
Response.Write("String: " + stringResult);
```

Double Array

```
double[] doubleArray =  
    examples.getDoubleArrayFromMWNumericArray();  
Response.Write("Double Array: ");  
for (int i = 0; i < doubleArray.Length; i++)  
{  
    Response.Write("Array index(" + i + "): " + doubleArray[i]);  
}
```

Character Array

```
char[] charArray = examples.getCharArrayFromMWCharArray();  
Response.Write("Char Array: ");  
for (int i = 0; i < charArray.Length; i++)
```



```
{
    Response.Write("Array index("+ i +"): " + charArray[i]);
}
```

Cell Array to Array

```
Object[] array = examples.getArrayFromCellArray();
for (int i = 0; i < array.Length; i++)
{
    Response.Write("Array index("+ i +"): " + array[i]);
}
```

Cell Array to List

```
List<Object> list = examples.getListFromCellArray();
foreach (Object currentObj in list)
{
    Response.Write("List Item: " + currentObj);
}
```

Structure

```
Dictionary<Object, Object> dictionary =
    examples.getDictionaryFromStruct();
Response.Write("Structure Array: ");
foreach (Object currentKey in dictionary.Keys)
{
    Response.Write("Key: " + currentKey + "    Value: " +
        dictionary[currentKey]);
}
```

Byte Array

```
byte[] byteArray = examples.getByteArrayFromMWNumericArray();
Response.Write("Byte Array: ");
for (int i = 0; i < byteArray.Length; i++)
{
    Response.Write(byteArray[i]);
}
Response.BinaryWrite(byteArray);
```

Raw Image Bytes

```
byte[] rawImageBytes =
    examples.getImageByteArrayFromMWNumericArray();
Response.BinaryWrite(rawImageBytes);
```

Raw Image Bytes with Reorientation

Note This example allows you to perform similar functionality to what WebFigures performs, but in a manual implementation. It is one of many ways you can implement this functionality in a stateless manner.

```
int height = Convert.ToInt32(Request.Params.Get("height"));
int width = Convert.ToInt32(Request.Params.Get("width"));
int elevation =
    Convert.ToInt32(Request.Params.Get("elevation"));
int rotation = Convert.ToInt32(Request.Params.Get("rotation"));
String imageFormat = Request.Params.Get("imageFormat");
byte[] rawImageBytes =
    examples.getImageByteArrayFromMWNumericArrayWithOrientation(
        height,
        width,
        elevation,
        rotation,
        imageFormat);
Response.BinaryWrite(rawImageBytes);
```

WebFigure

```
// In this example, we use a WebFigure Utility to get an HTML
// String that
// will display this figure, Notice
// how we reference the name we used when attaching it to the
// cache and we indicate
// that the Attach type is session.
String localEmbedString =
    WebFigureServiceUtility.GetHTMLEmbedString(
```

```

        "SessionStateWebFigure",
        WebFigureAttachType.session,
        300,
        300);
Response.Write(localEmbedString);

```

Deploying the ASPX

You deploy an ASPX using the **Publish** functionality in Microsoft® Visual Studio. Visual Studio puts all of your code, along with any code your project depends upon, in a folder.

Hosting a DAO Using a .NET Web Service

Setting Up the Root Web Service Class

When creating Web services within .NET, simply create a new Web site (or use an existing site), and add an item of type **Web Service** to it. This will generate the root class in which you place your methods.

Interacting with the DAO

Each of these methods would be placed in the Web service class as methods.

Numeric

```

[WebMethod]
public int getInt()
{
    Examples.Examples examples = new Examples.Examples();
    int integer = examples.getIntFromMWNumericArray();
    examples.dispose();
    return integer;
}

```

String

```

[WebMethod]
public String getString()

```

```
{
    Examples.Examples examples = new Examples.Examples();
    String stringResult = examples.getStringFromMWCharArray();
    examples.dispose();
    return stringResult;
}
```

Double Array

```
[WebMethod]
public double[] getDoubleArray()
{
    Examples.Examples examples = new Examples.Examples();
    double[] doubleArray =
        examples.getDoubleArrayFromMWNumericArray();
    examples.dispose();
    return doubleArray;
}
```

Double Matrix

Since .NET Web services can't support multidimensional arrays, convert what is returned from MATLAB Builder NE into a jagged array, as follows:

```
[WebMethod]
public double[][] getDoubleMatrix(int argMagic)
{
    Examples.ExamplesImpl examples =
        new Examples.ExamplesImpl();

    double[,] doubleMatrix =
        examples.getDoubleMatrixFromMWNumericArray(argMagic);

    int arraySize = (int)doubleMatrix.GetUpperBound(0) + 1;
    double[][] outputMatrix = new double[arraySize][];

    int upperOuter = 0;
    for (int i = 0; upperOuter < arraySize; i++)
    {
        double[] subArray = new double[arraySize];
```

```

        int upperInner = (int)doubleMatrix.GetUpperBound(1) + 1;
        for(int j = 0; j < upperInner; j++)
        {
            subArray[j] = doubleMatrix[i, j];
        }
        outputMatrix[i] = subArray;
    }

    examples.dispose();
    return outputMatrix;
}

```

Character Array

```

[WebMethod]
public char[] getCharArray()
{
    Examples.Examples examples = new Examples.Examples();
    char[] charArray = examples.getCharArrayFromMWCharArray();
    examples.dispose();
    return charArray;
}

```

Byte Array

```

[WebMethod]
public byte[] getByteArray()
{
    Examples.Examples examples = new Examples.Examples();
    byte[] byteArray = examples.getByteArrayFromMWNumericArray();
    examples.dispose();
    return byteArray;
}

```

Raw Image Bytes

```

[WebMethod]
public byte[] getImageByteArray()
{

```

```
Examples.Examples examples = new Examples.Examples();
byte[] rawImageBytes =
    examples.getImageByteArrayFromMWNumericArray();
examples.dispose();
return rawImageBytes;
}
```

Raw Image Bytes with Reorientation

```
[WebMethod]
public byte[] getImageByteArrayWithOrientation(
    int height,
    int width,
    int elevation,
    int rotation,
    String imageFormat)
{
    Examples.Examples examples = new Examples.Examples();
    byte[] rawImageBytes =
        examples.getImageByteArrayFromMWNumericArrayWithOrientation(
            height,
            width,
            elevation,
            rotation,
            imageFormat);
    examples.dispose();
    return rawImageBytes;
}
```

Deploying the Web Service

Microsoft Visual Studio® does all of the work involved with generating Web service artifacts. Once you have created methods, just run the service. A tester page is displayed that shows you the location of the WSDL. You can then test each method.


Front-End Web Developer Tasks

- “Working with the Front-End Layer” on page 5-2
- “Creating a WebFigure on an ASPX Page” on page 5-7
- “Working with Static Images” on page 5-11
- “Displaying Complex Data Types Including Arrays and Matrices” on page 5-15
- “Using Web Services” on page 5-23

Working with the Front-End Layer

In this section...
“About the Front-End Layer” on page 5-2
“About the Examples” on page 5-5

Front-End Web Developer

Role	Knowledge Base	Responsibilities
 Front-end Web developer	<ul style="list-style-type: none">• No MATLAB experience• Minimal IT experience• Expert at usability and Web page design• Minimal access to IT systems• Expert at ASPX	<ul style="list-style-type: none">• As service consumer, manages presentation and usability• Creates front-end applications• Integrates MATLAB code with language-specific frameworks and environments• Integrates WebFigures with the rest of the Web page

About the Front-End Layer

Note For comprehensive end-to-end implementations of the concepts in this chapter, see Appendix A, “Sources for More Information”.

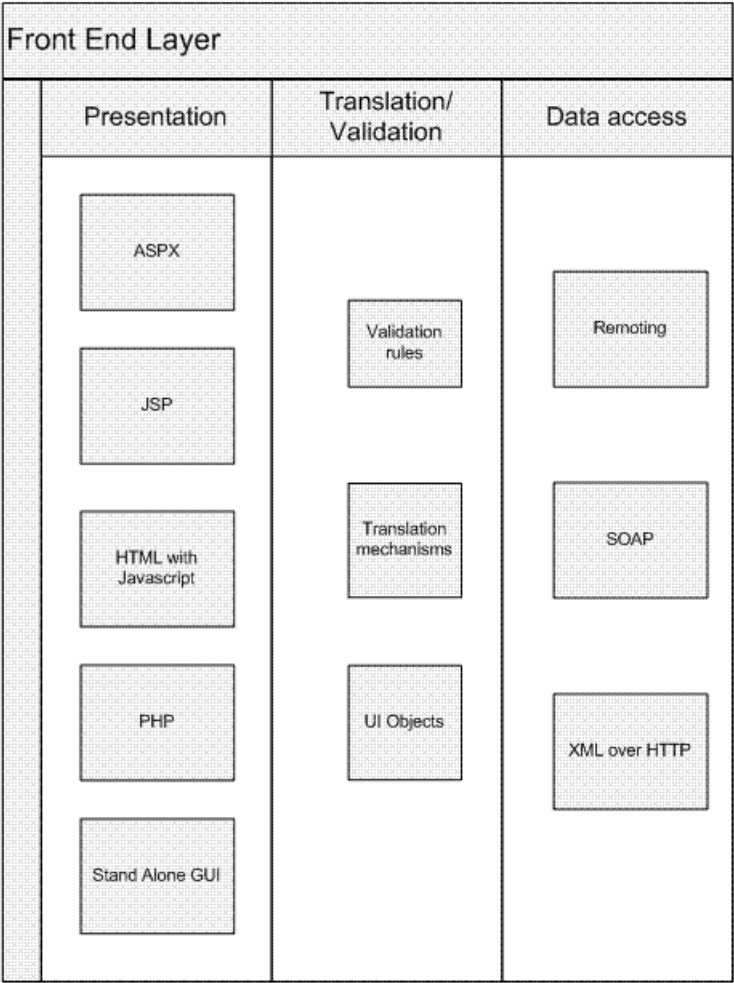
In well-designed multi-tier application architectures, the *front-end layer* presents data to the end user and validates the user’s input. This is accomplished by accessing data acquired at lower-level architectural tiers to the user and taking in user inputs, validating them, and then sending them to the lower-level tiers for processing.

The data within this layer reside on servers that are almost always outside of the corporate firewall and therefore, accessible by everyone. Consequently, security and stability are integral to the front-end layer, and it is important

to isolate implementation details outside of this layer so people cannot determine how your site is architected.

A well-designed front-end layer has data access, translation and validation, and presentation functions separated into individual logical code sections. This increases an application or Web site's maintainability since you can change where the data originates or the format that it arrives in without changing user-visible code.

A typical front-end layer contains the following sublayers.



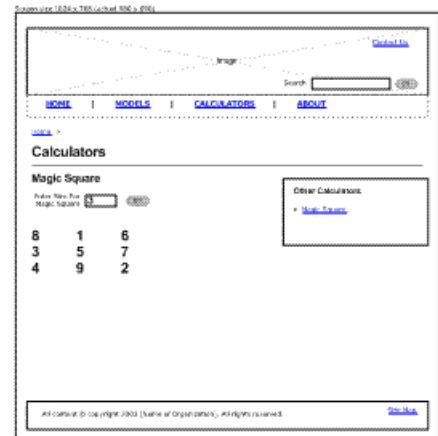
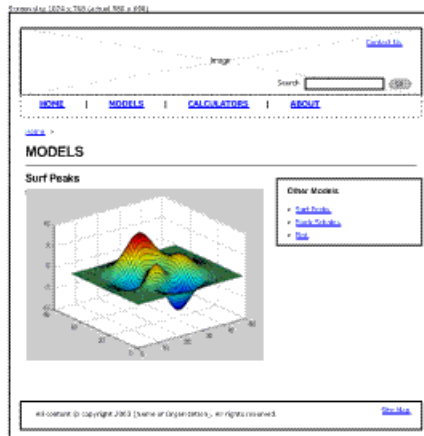
Elements of the Front End Layer

- Data Access — This sublayer pulls data in from middle-tier services like databases, where access into a deployed application would typically take place. Among the technologies used to transmit data at this sublayer are:
 - Remoting interfaces
 - SOAP services

- XML over HTTP protocol
- Translation/Validation — Data is passed from the data access sublayer to the translation sublayer and translated into objects used for data presentation. Since these objects represent what the user sees (rather than the underlying business logic) they are very lightweight and easy to maintain. This is also where any validation would occur to ensure that values are in a proper state for processing.
- Presentation — This layer uses the data in the business objects to display information on a Web site. Any user input actions are validated in the objects and, if needed, callbacks to the middle layer occur to retrieve updates based on the user input.

About the Examples

Dealing with MATLAB data is, for the most part, no different then dealing with other Web data except for the fact that dynamically generated images may be involved. The examples in this document are not meant to show how to build a Web site, but rather to demonstrate what types of building blocks are needed to work with MATLAB data in an existing Web site. Most of these examples can be integrated directly into larger applications containing JSP, HTML, or ASPX code.



Surf Peaks and Magic Square Application Integration

The following two templates show how you can integrate applications built with MATLAB products into a larger application. In each case, there is a small area in the interface where your applications exist after the user enters input (if only a mouse click).

In the left template, it is possible to have a simple `IMG` tag, where the `src=` is a servlet from the middle tier that dumps out the image data. It is also possible to use an interactive AJAX component embedded in a subframe, or to use embedded WebFigures.

In the right template, clicking the **Go** button triggers the page to validate that the value in the input box is valid, and then sends that data to the middle tier service which returns a two-dimensional array. It is the front-end layer's job to format this data and present it properly.

In the examples that follow, these concepts are simplified and focus on how the communication occurs within the middle layer, and how some typical data translations are performed.

Creating a WebFigure on an ASPX Page

There are several ways to use WebFigures on a Web page with .NET:

- Using the `WebFigureControl` locally in design mode (the easiest approach)
- Using the `WebFigureControl` remotely in design mode
- Returning an HTML string from the ASPX code behind which embeds the WebFigure into a page.
- Using a `WebFigureControl` directly from the ASPX code without utilizing the designer.

In each case, the `WebFigure` object is stored in the Web server's cache. The JavaScript that executes the client calls back to the server for updates and, using the cached `WebFigure`, new updates are sent back to the client. For more information on these examples, see “WebFigures” in the MATLAB Builder NE documentation.

For information on how to create the `WebFigureControl` in Microsoft Visual Studio, see “Quick Start Implementation of WebFigures”.

Using the WebFigureControl Locally in Design Mode

- 1 Drag a `WebFigureControl` from the Microsoft Visual Studio Toolbox to an ASPX page in design mode. This automatically adds a reference to `WebFigureService` to your Web site.
- 2 Edit the code behind the site to attach the figure to the control, as follows:
 - **C#:**

```
using MyComponent;
using MathWorks.MATLAB.NET.WebFigures;

protected void Page_Load(object sender, EventArgs e)
{
    MyComponentclass myDeployedComponent =
        new MyComponentclass();
    WebFigureControl1.WebFigure =
        new WebFigure(myDeployedComponent.getKnot());
}
```

```
}
```

- **Visual Basic:**

```
Imports MyComponent
Imports MathWorks.MATLAB.NET.WebFigures

Protected Sub Page_Load(ByVal sender As Object,
                        ByVal e As System.EventArgs)
    Handles Me.Load

    Dim myDeployedComponent As _
        New MyComponentclass()
    WebFigureControl1.WebFigure = _
        New WebFigure(myDeployedComponent.getKnot())
End Sub
```

Using the WebFigureControl Remotely in Design Mode

- 1 Drag a WebFigureControl from the Microsoft Visual Studio Toolbox onto an ASPX page in design mode.
- 2 Edit the **Properties** for this figure to point it to a Web site that has webfigureservice installed and that has attached a WebFigure to the cache. This can either be done using code as shown below or by using the Properties window in the designer.

```
//This is the name that was used on the server
// when attaching the WebFigure
WebFigureControl1.Name = "UserPlot";

//By not setting this value it will try and use
// the current web site for all redirection calls
WebFigureControl1.Root = "";

//If you didn't set this or if it was set to unknown
// this would instruct the WebFigureService to look
// through the diferent caches for a WebFigure with
// this specific name.
WebFigureControl1.Scope = WebFigureAttachType.session;
```

Returning an HTML String from ASPX Code to Embed the WebFigure into a Page.

This example is very similar to what you can find in the “WebFigures” article in MATLAB Builder NE documentation, but this example also uses the DAO. The middle tier code in “Hosting a .NET DAO with ASPX” on page 4-15 is repeated here:

```
WebFigure webFigure = new WebFigure(deployment.getWebFigure());

//First we attach the webfigure to one of ASP.NET's caches,
// in this case, the session cache
Session["SessionStateWebFigure"] = webFigure;

//Now we use a WebFigure Utility to get an HTML
// String that will display this figure, Notice
// how we reference the name we used when attaching
// it to the cache and we indicate
// that the Attach type is session.
String localEmbedString =
    WebFigureServiceUtility.GetHTMLEmbedString(
        "SessionStateWebFigure",
        WebFigureAttachType.session,
        300,
        300);
Response.Write(localEmbedString);
```

Using a WebFigureControl Directly from ASPX Code Without Using the Designer.

To use the WebFigure object directly from an ASPX page, manually write the code that would otherwise be automatically added to the ASPX page. Writing the code creates a WebFigure object with your object’s parameters, as in the following example. UserPlot is the name of the Web object that was placed in the cache by the middle tier.

```
<%@ Register Assembly="WebFiguresService, Version=2.8.1.0,
        Culture=neutral, PublicKeyToken=e1d84a0da19db86f"
        Namespace="MathWorks.MATLAB.NET.WebFigures.Service"
        TagPrefix="cc1" %>
```

```
<cc1:WebFigureControl
    ID="WebFigureControl1"
    runat="server"
    Height="328px"
    Width="399px"
    Root=" "
    Scope="session"
    Name="UserPlot"
/>
```


Working with Static Images

There are several options when dealing with images through a component.

You can simply save the image from the MATLAB code to a drive somewhere using print functionality (the front end references the physical file directly). This is not ideal since the middle tier is behind the firewall (and the front end is in front of it), incurring possible security concerns with where the files reside.

Using Java, you can return a Java image object from MATLAB and use it directly from the JSP or servlet by saving it to disk or converting it to a byte stream.

Using a Static Image in a ASPX Page

Using ASPX Image objects is almost identical to using HTML IMG tags. In this case, simply set the ImageUrl (the source of image) to be the ASPX page created in “Deploying the ASPX” on page 4-19. You can also point to a Java middle-tier servlet that hosts the image.

```
<asp:Image
  ID="Image1"
  runat="server"
  ImageUrl=
    "http://localhost/Examples/Tester.aspx?function=
      imageBytesFromMWNumeric" />
```

Interacting with Images Using JavaScript (for .NET or Java)

Although is a good solution for most component models, sometimes a lightweight solution is needed that you can customize for specific tasks.

JavaScript can be employed to dynamically request new images depending on user input. Since JavaScript is not Java, it does not require that Java Runtime be installed. JavaScript runs in a client's browser and does not require a Java Web server. You can use this lightweight implementation with any of the builders. This example uses the Raw Image Bytes with Reorientation example in and . It waits for the user to instigate a movement with the mouse (a mouse-drag “event”) and, when the events occur, calls the

server to get a new image of the new orientation. This example, while simple, can be extended to do many other types of image interactions.

```
<iframe
  src ="DynamicFigure.html?url=
    http://localhost:8080/Examples/ExamplesServlet?function=
    imageBytesFromMWNumericWithOrientation"
  width="700"
  height="700">
</iframe>
```

DynamicFigure.html is an AJAX application that takes in a parameter (the base function that returns an image) and accepts different orientation values:

```
<%@ page contentType=
    "text/html;charset=UTF-8" language="java" %>
<%@ page isELIgnored ="false"%>
<html>
  <head>
    <title>AJAX Figure Manipulation</title>
    <script type="text/javascript">
      var rotationDegree = 0;
      var elevationDegree = 0;
      var startDragX = 0;
      var startDragY = 0;
      var mouseisdown = false;

      function getParam(name)
      {
        var start=location.search.indexOf("?"+name+"=");
        if (start<0) start=location.search.indexOf("&"+name+"=");
        if (start<0) return '';
        start += name.length+2;
        var end=location.search.indexOf("&",start)-1;
        if (end<0) end=location.search.length;
        var result='';
        for(var i=start;i<=end;i++) {
          var c=location.search.charAt(i);
          result=result+(c=='+'?' ':c);
        }
      }
    </script>
  </head>
  <body>
    <div>
      <img alt="A 3D figure manipulation interface showing a wireframe cube and a sphere. The cube is rotated and the sphere is positioned above it. The interface includes a 3D coordinate system with x, y, and z axes." data-bbox="251 394 896 875"/>
    </div>
  </body>
</html>
```

```

    }
    return unescape(result);
}

function updateView()
{
    var urlStr = getParam("url") + "&" +
        "imageFormat=png" + "&" +
        "rotation=" + rotationDegree + "&" +
        "elevation=" + elevationDegree + "&" +
        "width=" + contentBox.clientWidth + "&" +
        "height=" + contentBox.clientHeight;

    var requestedImage =
        document.getElementById('currentImage');
    requestedImage.src = urlStr;
    requestedImage.style.visibility = 'visible';
}

function stopDragging(updateX,updateY)
{
    rotationDegree +=
        Math.round(((startDragX -
            updateX)/2)%360);

    elevationDegree +=
        Math.round(-(startDragY -
            updateY)/2);

    updateView();
}
</script>
</head>

<body onresize='updateView();'>
<form name=exf1>
    X Drag <input type=text name=x value="0">
    Y Drag <input type=text name=y value="0">
</form>

<div style='position:absolute; background:

```

```
        url("matlab.gif"); left:0; right:0;
        width:100%; height:100%;'>

</div>

<div id='contentBox'
style='position:absolute; background:
        url("transparent_pixel.gif");
left:0; top:0; background-color:
        <%= request.getParameter("color") %>;
width:100%; height:100%; overflow:hidden;'
onmousedown="mouseisdown = true; startDragX=event.clientX;
        startDragY=event.clientY;"
onmouseup="mouseisdown =
        false;stopDragging(event.clientX, event.clientY);
        document.exf1.x.value=0; document.exf1.y.value=0;"
onmousemove="if(mouseisdown)
        {document.exf1.x.value=event.clientX-startDragX;
        document.exf1.y.value=event.clientY-startDragY;}">
</div>
<script type="text/javascript">
    updateView();
</script>
</body>
</html>
```

Displaying Complex Data Types Including Arrays and Matrices

You typically translate raw matrix array data to a form of displayable output. This section provides examples using Java and .NET.

Working with ASPX Page Data

The following examples use basic ASPX pages and can be incorporated into a large enterprise site.

The easiest way to output a matrix is to iterate the array and then convert it into an HTML table. Unfortunately, this approach is not maintainable for large volumes of data, but is worth exploring in this example, assuming you have communicated with the middle tier and received a two-dimensional array of data. Assuming you have a label on the ASPX page called `MatrixLbl`, here is the code to output the matrix:

```
int size = 5;
double[][] magicSquare = getMagicSquare(size);

String temp = "";
temp += "<table border=0 cellpadding=4
        cellspacing=4 style='margin: 16px;'>";

for (int i = 0; i < size; i++)
{
    temp += "<tr>";
    for (int j = 0; j < size; j++)
    {
        temp += "<td>" + magicSquare[i][j] + "</td>";
    }
    temp += "</tr>";
}
MatrixLbl.Text = temp;
```

Using ASP.NET to Integrate with WYSIWYG Controls

ASP.NET provides a number of streamlined methods to place a grid of data on a Web page, such as mapping the data into a DataTable and referencing the DataTable from an ObjectDataSource's Select method. By choosing this option, you promote reuse and also maintain separation between the application's visualization and logic.

You must first place a GridView onto a page, and then "bind" it to a data source. By using an Object data source, you allow an object to dynamically get the data from some location (like a middle tier), and put it into a DataTable. Once this is done, the GridView will automatically display it.

Here is an example of using the Select method in your business object:

```
public DataTable getMagicSquare(int size)
{
    //Gets the matrix from the web service.
    double[][] magicSquare = getMatrix(size);

    //Create an empty data table to put the matrix data in.
    DataTable table = new DataTable();

    //Since we know its a square add as many
    // columns as there will be rows.
    for(int i = 0; i<size; i++)
    {
        table.Columns.Add();
    }

    DataRow row;
    //Iterate each element in the array creating a row out of each
    for(int i = 0; i < size;i++)
    {
        //create a row from the table to put the data in
        row = table.NewRow();
        //Iterate each element in the inner array and put
        // them into the row
        for (int j = 0; j < size; j++)
        {
```

```
        row[j] = magicSquare[i][j];  
    }  
  
    //Add the row to the table  
    table.Rows.Add(row);  
}  
return table;  
}
```

Note If you are using Handle Graphics® functions with ASP.NET, you may need to enable interaction between IIS and the desktop. For information about how to accomplish this, see the related workaround in the “Diagnostic Messages” section of the MATLAB Builder NE User’s Guide.

Working with ASP.NET Using the Visual Studio Wizard

This section demonstrates how to perform the implementation described in “Working With ASP.NET” when using the Visual Studio wizards and a typical Web page application. Perform the following steps to set up the data source, bind it to a load method, and bind the method’s input parameter to the text box.

Below is an input text box and a generic grid component from a Web page. The grid component is connected to the ObjectDataSource.

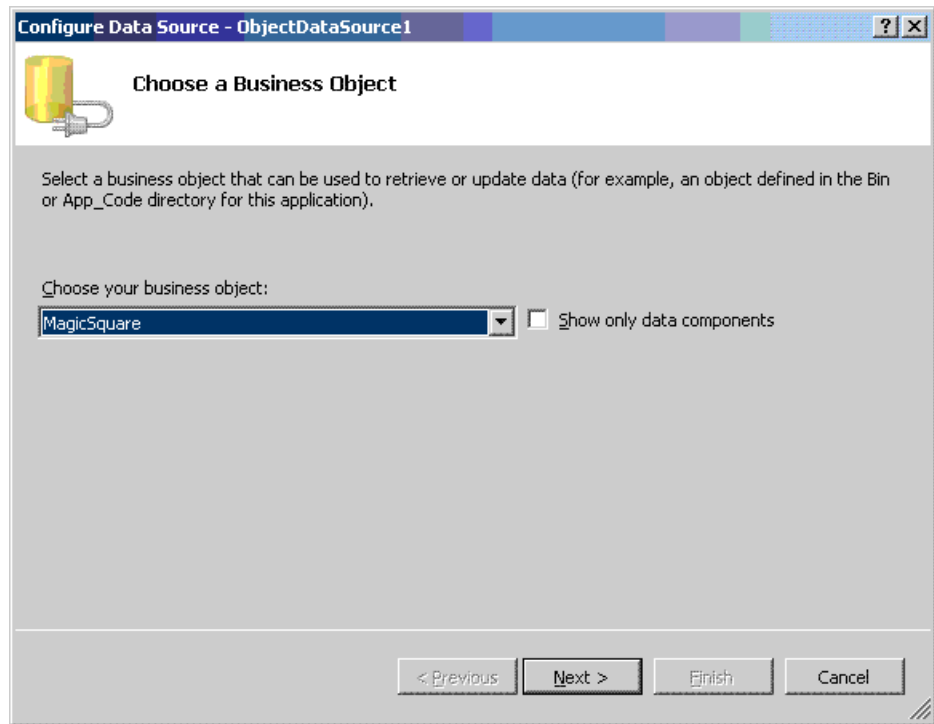
Enter size of magic square

abc	0	abc
abc	1	abc
abc	2	abc
abc	3	abc
abc	4	abc

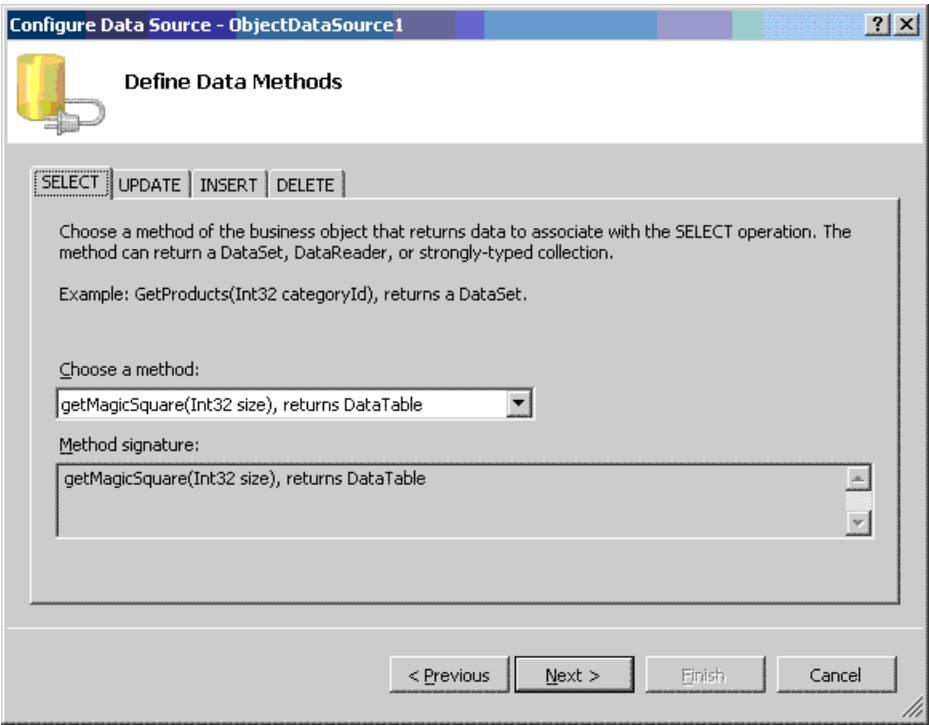
ObjectDataSource - ObjectDataSource1

Build Square

- 1 Start Visual Studio and configure the data source with the wizard.
- 2 Choose the business class that contains your methods for the object.



3 Select the method that returns a data table containing the data to display.



- 4 Since the method requires an input, bind it to the control that contains the value and set the default.

Configure Data Source - ObjectDataSource1

Define Parameters

The wizard has detected one or more parameters in your SELECT method. For each parameter in the SELECT method, choose a source for the parameter's value.

Parameters:

Name	Value
size	TextBox1.Text

Parameter source: Control

ControlID: TextBox1

DefaultValue: 5

[Show advanced properties](#)

Method signature:

getMagicSquare(Int32 size), returns DataTable

< Previous Next > Finish Cancel

The finished application looks like this.

Enter size of magic square

17	24	1	8	15
23	5	7	14	16
4	6	13	20	22
10	12	19	21	3
11	18	25	2	9

Build Square

5 Click the **Build Square** button to reselect the grid data.

Note If you are using Handle Graphics functions with ASP.NET, you may need to enable interaction between IIS and the desktop. For information about how to accomplish this, see the related workaround in the “Diagnostic Messages” section of the MATLAB Builder NE User’s Guide.

Using Web Services

Displaying Web Services Images and Data in PHP

If your installation has a strong investment in PHP front ends, consider using them to display Web Services running MATLAB applications.

As long as your business tier services output data in a generic nonlanguage-specific manner (as most of the examples in this document support), you can embed that output within any Web front end. This example demonstrates how to use SOAP Web services to embed an image onto a PHP page:

```
//References a soap library and loads the WSDL.
include("lib/nusoap.php");
$soapclient = new soapclient
('http://localhost:3465/
    SurfPeaksWebServiceServer/Service.asmx?WSDL',
    true);

//If we had any parameters to pass
// we would add them to this array.
$params = array();

//Calls the service with the parameters.
$result = $soapclient -> call("SurfPeaksWebService", $params);

//Gets the encoded response out of the result object.
$base64EncodedResult = $result["SurfPeaksWebServiceResult"];
//Decodes and displays the result.
echo base64_decode($base64EncodedResult);

//Unloads the soap client.
unset($soapclient);
```

You can use this technique to access data services, as well:

- 1 Install PHP 5.2.3 into IIS 5, if needed (the installer lets you specify the server type).

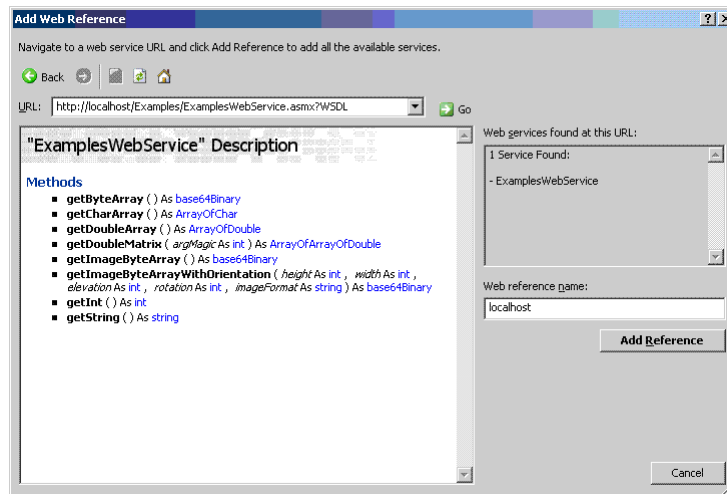
- 2 Download NUSOAP and place it on the instance path.

You should be able to use any SOAP add-in. However, note that the call syntax may change slightly. Consult the add-in documentation for further information.

Displaying Web Services Images and Data in .NET

In “Working with the Business Service Layer” on page 4-2, you exposed several methods as SOAP Web services. To use these methods from the front end, add a reference to them in your Visual Studio project by adding a **Web Reference**:

- 1 In Visual Studio, right-click the project name and select **Add Web Reference**.
- 2 In the **URL** field, enter the path to your WSDL.
- 3 Click **Go**. The resulting dialog resembles this.



Notice how all of the methods exposed earlier are displayed.

- 4 To add these methods to your project, click **Add Reference**.

- 5** To use any of the methods, instantiate the Web service by executing code similar to:

```
localhost.ExamplesWebService webService =  
new localhost.ExamplesWebService();
```

- 6** Access any of the methods on the Web service as you would any other .NET object. Here are some examples:

```
int intValue = webService.getInt();  
string stringValue = webService.getString();  
double[] doubleArray = webService.getDoubleArray();  
double[][] magicSquare = webService.getDoubleMatrix(size);  
char[] charArray = webService.getCharArray();  
byte[] byteArray = webService.getByteArray();  
byte[] imageByteArray = webService.getImageByteArray();  
byte[] imageByteArrayWithOrientation =  
webService.getImageByteArrayWithOrientation( 500,  
                                              500, 20, 30, "png");
```



Server Administrator Tasks

- “Managing a Deployment Server Environment” on page 6-2
- “Hot Deployment” on page 6-10
- “Working with Multiple Versions of the MATLAB Compiler Runtime (MCR)” on page 6-11

Managing a Deployment Server Environment

In this section...
“The Server Administrator’s Role in Deployment” on page 6-2
“An Overview of Deployed Applications” on page 6-3
“Installing the MATLAB Compiler Runtime (MCR)” on page 6-3
“Loading the MATLAB Compiler Runtime (MCR)” on page 6-5
“Scaling Your Server Environment” on page 6-6
“Ensuring Fault Tolerance” on page 6-8

Server Administrator

 Server administrator	<ul style="list-style-type: none">• No MATLAB experience• IT Expert• Understands server architectures• Understands language-specific frameworks and environments	<ul style="list-style-type: none">• Manages uptime of production servers• Ensures that services are scalable enough to meet SLA requirements• Maintains multiple versions of the MCR and Deployed component versions• Manages framework versions
---	---	---

The Server Administrator’s Role in Deployment

In many organizations, integration developers do not handle actual production systems. Instead, a group of people that have access to these systems and manage various applications running on shared hardware take responsibility for this task.

System management requires ensuring that one set of applications does not affect another and also managing version conflicts that arise. Another concern of the server administrator is monitoring system up-time. The following sections discuss the nuances of the deployment products and what the server administrator role needs to do to ensure a successful deployment.

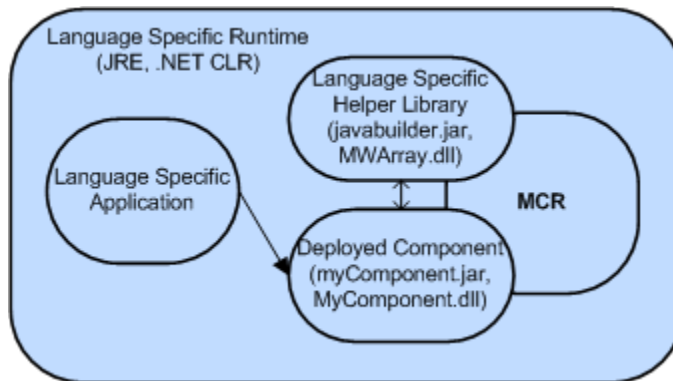
It provides different methods of dealing with common issues that can affect stability and performance.

An Overview of Deployed Applications

You can compare the relationship between compiled Java code and the JRE to the relationship between a compiled MATLAB program and the *MCR*. To execute Java code, you need a compatible version of the JRE on the system to execute it.

The deployment products, similarly, provide the compiled MATLAB application with a language-specific wrapper. The MCR provides the run-time infrastructure that runs deployed applications. It is made up of mostly native code.

When a deployed application integrates with a .NET or Java application, it resembles the figure “An Integrated Deployed Application.”



An Integrated Deployed Application

In this figure, you can see how the MCR (a large native code base) exists within the outer process of the frameworks. This coexistence can cause issues, as illustrated later in this chapter.

Installing the MATLAB Compiler Runtime (MCR)

Because the MCR provides the run-time infrastructure that runs deployed applications, it is a large application made up mostly of unmanaged code.

It comprises an almost full copy of MATLAB, only distributable. It has no desktop and only executes encrypted code generated by the MATLAB Compiler and builders. For a deployed application to function against the MCR, you include references to specific directories on your Windows®, Linux®, or Mac OS X path. For more information, see End User Installation with the MATLAB Compiler Runtime (MCR).

The MATLAB Compiler Runtime (MCR) Installer

The MCR Installer ships with MATLAB. You obtain it from the MATLAB programmer who originally compiled the application. The version number of the MCR Installer is the same as the version number of MATLAB. The platform you install it on is the same as the platform on which MATLAB runs. The installer places the MATLAB libraries in a configurable location and, on Windows, automatically updates the system path.

You sometimes run a deployed component on a different platform than where it originated (especially for the Java target). To port across platforms, you need a version of the MATLAB installer for your target platform.

Helper Library Locations

For both MATLAB Builder NE, and MATLAB Builder JA, a Helper Library ships with the MCR. This library contains information for communicating with the MCR. It also communicates with helper utilities and data types implemented by the wrapper code. Using these wrappers, you can convert your data to and from MATLAB data types.

.NET

For .NET, the Helper Library resides at the following location:

- `mcrroot\toolbox\dotnetbuilder\bin\win32|win64\vmajor.minor\MWArray.dll`
— Contains MATLAB data type wrappers, utilities, and MCR communication utilities
- `mcrroot\toolbox\dotnetbuilder\bin\win32|win64\vmajor.minor\WebFiguresService.dll` — Contains WebFiguresService, WebFigureControl, , and WebFigure rendering utilities)

Note *vmajor.minor* denotes the version of the .NET framework. See *MATLAB Builder NE Release Notes* for a list of supported framework versions.

Note *mcrroot* is the MCR's installation directory.

Both of these libraries install into the Global Assembly Cache (see “Using Global Assembly Cache (Global.asax) to Create WebFigures at Server Start-Up”) automatically when you install the MCR. Although they reside in the GAC, you reference them from Microsoft Visual Studio during development. If you are using the `WebFigureControl` from within Visual Studio, drag the `WebFiguresService.dll` into the toolbox.

You can have multiple versions of this library in the GAC.

Loading the MATLAB Compiler Runtime (MCR)

Because deployed applications use the MCR at runtime, the MCR must be loaded and running. The MCR loads when a class in a deployed component is instantiated for the first time.

MCR loading can take anywhere from 10 seconds to over a minute (if the MCR resides on a network). To ensure a consistent user experience for Web applications, load the MCR at server start-up time, rather than upon first use, by instantiating a class as part of the server initialization.

.NET

In ASP.NET Web applications, create a Global Assembly Cache (`Global.asax`) using this code:

```
<%@ Application Language="C#" %>
<script runat="server">
    void Application_Start(object sender, EventArgs e)
    {
        // Code that runs on application startup
```

```
        myComponent.MyComponent comp =  
            new myComponent.MyComponent();  
    }  
</script>
```

For more information about the `Global.asax` file, see “Using Global Assembly Cache (`Global.asax`) to Create WebFigures at Server Start-Up”.

Note You do not need to dispose of the component. With MATLAB Builder NE, you utilize the garbage collector to clean up these objects, even though they reference native components.

Scaling Your Server Environment

There are two methods to achieving scalability:

- “Calculation Scaling” on page 6-6
- “Session Scaling” on page 6-6

Calculation Scaling

Calculation scaling involves increasing computer resources to scale and improve performance for a specific calculation. In MATLAB, the Parallel Computing Toolbox™ enables your MATLAB code to use features built into the MATLAB Language. These features tie into a profile and enable your functions to run in parallel. Parallel processing can drastically speed up the execution of a function.

There are multiple strategies towards make your applications scalable—one is done by writing your MATLAB code to scale to a parallel computing algorithm. You may ultimately have calculation scaling as well as “Session Scaling” on page 6-6 to optimize performance.

Session Scaling

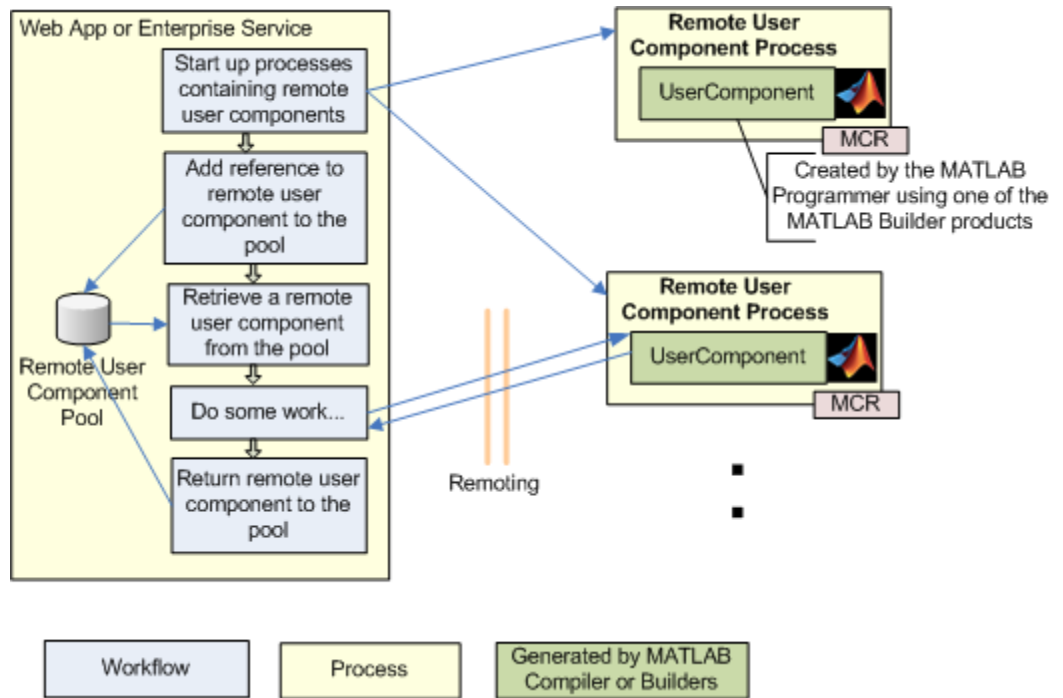
Session scaling involves enabling the maximum number of users while minimizing performance degradation.

Many session scaling issues arise because the MCR is single threaded. A single-threaded application prevents two users from doing work that involves the MCR at the same time. One user must wait for the other to finish before continuing. This wait can prove to be substantial if one user is performing a resource-intensive task while the other is attempting a quick calculation.

To workaround the situation, enable multiple MCRs to service requests as they arrive. Run several MCRs in separate processes; one process per MCR. Using this technique, you can create a separate server process that receives requests, runs the requests against one of the processes, and returns the result.

In one solution, servers reside in a third-party grid managed by a tool that spawns processes for each instance. Alternatively, you create your own pooling solution and manage these processes manually. For either approach, you accomplish the communication using either Java RMI or “Creating a Remotable .NET Component” because deployed components and data types can be serialized.

In most cases, MATLAB code executes quickly, and you do not need to do anything to get your desired level of performance. As a best practice, start with a single MCR. As your usage grows, add in a scaling layer as needed. Adding another layer involves minimal client changes.



Remote Scaling

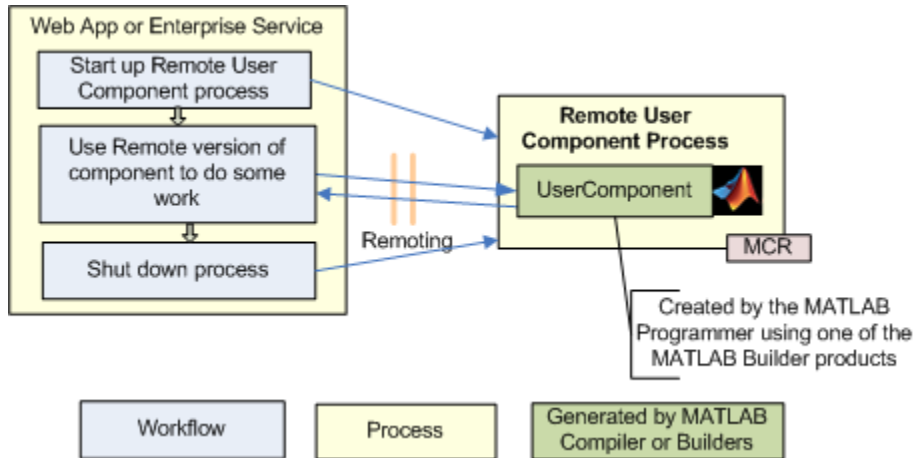
Ensuring Fault Tolerance

In your default scenario, avoid using the MCR in the same process as the rest of your application. The MCR is a large complex native application running inside your applications process. If the MCR runs in the same process, you cannot ensure fault tolerance in the compiled application. To ensure that it does not affect the outer process, move it to its own process and pass the data back and forth.

Remoting provides the ideal solution, as discussed in “Scaling Your Server Environment” on page 6-6. Remoting allows you to start up a process whose only job is to start the MCR and run requests against it. Starting this process enables lightweight access from the client.

Both MATLAB Builder NE and MATLAB Builder JA have features that allow you to auto-convert MATLAB data types into Java or .NET data types. This

auto-conversion frees you from running an MCR where the client process executes, yielding a robust more application.



Using Remoting to Achieve Fault Tolerance

Hot Deployment

Hot Deployment entails replacing running application source code “on-the-fly.” The server automatically migrates end users to this new code without the user experiencing an outage.

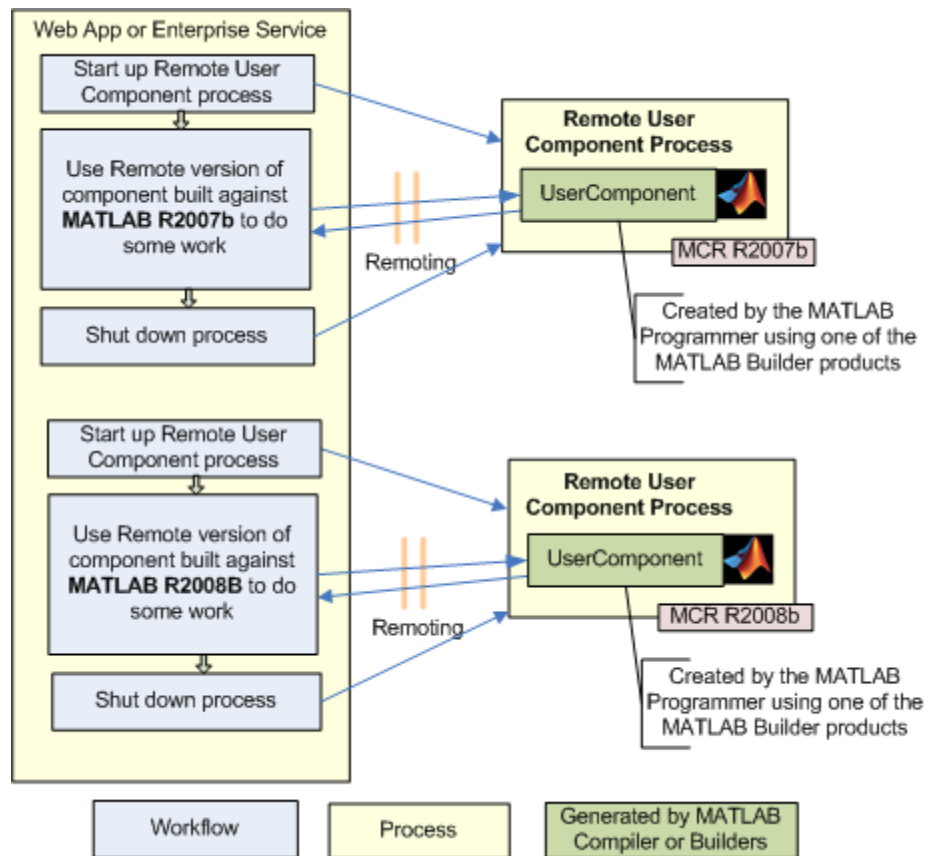
.NET

MATLAB Builder NE supports Hot Deployment of deployed components in either:

- The WebDev server (the version of IIS built into Microsoft Visual Studio)
- IIS itself

Working with Multiple Versions of the MATLAB Compiler Runtime (MCR)

You can run two applications from the same Web server that link against Deployed components built in different versions of MATLAB. To do so, create server processes for each application. You reference the applications, using remoting, back to the server. By using remoting, you ensure that one version of the MCR Libraries loads into any given process.



Using Remoting to Workaround Multiple Versions of the MCR


End User Tasks

- “Working with Content” on page 7-2
- “Example Tasks” on page 7-3

Working with Content

End users access the business logic through tools such as Microsoft Excel or a Web page on the front-end tier. The end user sees only the resulting data and has no need (or need to know) the implementation used to create it.

End User

Role	Knowledge Base	Responsibilities
<div> End user</div>	<ul style="list-style-type: none">• No MATLAB experience• Some knowledge of the data that is being displayed, but not how it was created	<ul style="list-style-type: none">• In Web environments, consumes what the front-end developer creates• Integrates MATLAB code with other third-party applications, such as Excel

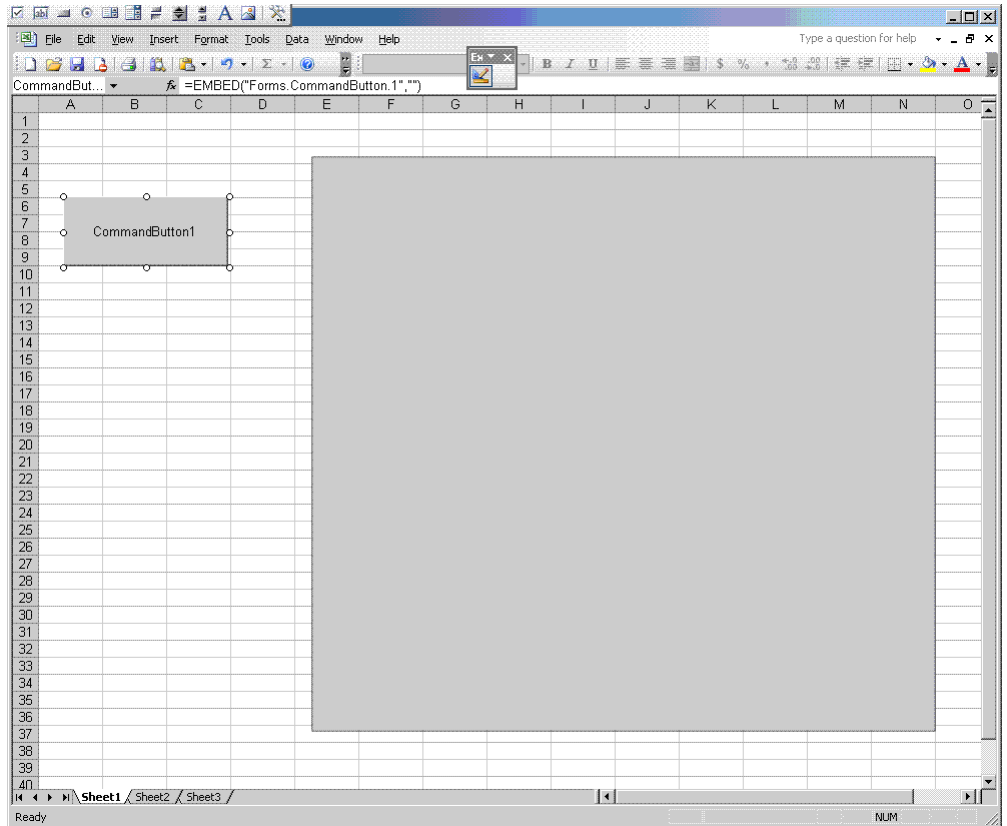
Example Tasks

The example in this section consumes the Web service created in . With this type of application, you can use the same Web service to display many different front ends. You can use data stored in Microsoft Excel and pass it to a Web service to generate dynamic data-driven images.

Microsoft Excel Web Service Client Standalone Application

To construct a Microsoft Excel interface to the Web service:

- 1** Download and install the Microsoft Office Web Service Toolkit from Microsoft, if you haven't already.
- 2** Start Microsoft Excel.
- 3** Open a new worksheet.
- 4** Using the **Control Toolbox**, create an Excel graphics window by dropping and dragging an **Image**.
- 5** Drag a **Command Button** into the window. You use this button to trigger the Web service call and load the graphic. At this stage, the window looks like this.



6 Double-click the **Command Button** button and the VBA editor starts.

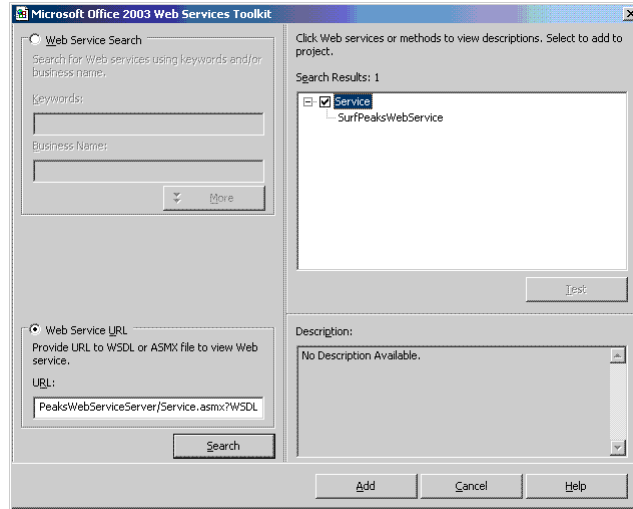
7 Select **Tools > Web Service References**.

Note The **Web Service References** option is available only if you install the Microsoft Office Web Service Toolkit.

8 In **Web Service URL**, type the WSDL that was referenced in “Using Web Services” on page 5-23:

`http://localhost:3465/SurfPeaksWebServiceServer/Service.asmx?WSDL`

- 9 Click **Search** to query the Web service. The result resembles this.



- 10 Select the appropriate service in the **Search Results** pane and click **Add** to bind it to your project. Notice that a Class Module is created called `clsWS_Service`. This module will be used by the button action to retrieve the data.
- 11 In the worksheet, for the method `CommandButton1_Click()`, add and save the following code:

```
Sheet1.Image1.Picture = Nothing

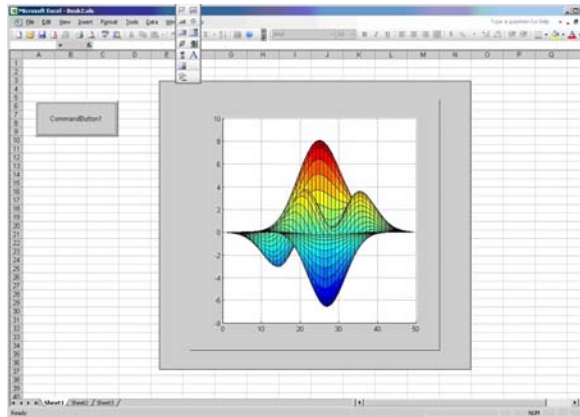
Dim value() As Byte
Set module = New clsWS_Service
value = module.wsm_SurfPeaksWebService

'Saves byte() data from web service to a file
Dim intFileNumber As Integer
intFileNumber = FreeFile
Open "c:\temp1.png" For Binary As #intFileNumber
Put intFileNumber, , value
Close #intFileNumber
```

```
'Loads the saved picture into the image
Sheet1.Image1.Picture = LoadPicture("c:\temp1.png")
```

- 12** Click the command to display the following in the graphics pane of your worksheet.

Tip You may need to close Microsoft Excel and reopen it to see the graphic.



End-to-End Developer Tasks


- “Role of the End-To-End Developer” on page 8-2
- “Magic Square Calculator On the Web” on page 8-5
- “Creating an End-to-End Web Application” on page 8-7

Role of the End-To-End Developer


Each chapter in this guide is focused on tasks that are performed in order to deploy applications from the perspectives of various types of users. This is done by providing snippets of code that a person in a particular role can use to solve a particular problem within the context of some larger application. While this approach makes sense for most users, sometimes a single user is fulfilling *all* roles, and often this person is relatively new to some of the roles. For example, sometimes an expert MATLAB programmer is asked to put something they’ve worked on up to the Web for others to consume. They may never have used Java or .NET before.

This chapter is aimed specifically at users playing the role of the “one-stop shop” and will go through in relative detail all of the steps needed to build an application from the ground up and get it running successfully.

MATLAB Programmer

Role	Knowledge Base	Responsibilities
 MATLAB programmer	<ul style="list-style-type: none">• MATLAB expert• No IT experience• No access to IT systems	<ul style="list-style-type: none">• Develops models; implements in MATLAB• Uses tools to create a component that is used by the .NET developer


Middle-Tier Developer

 Middle-tier developer	<ul style="list-style-type: none">• Little to no MATLAB experience• Moderate IT Experience• Expert at business logic and services tier• .NET expert• Minimal access to IT systems	<ul style="list-style-type: none">• Integrates deployed component with the rest of the .NET system by converting MATLAB data types (MWArrays) to the .NET Business logic objects
--	---	--


Middle-Tier Developer (Continued)

	<ul style="list-style-type: none">• Expert at .NET Web frameworks• Expert at Web services	
--	--	--


Front-End Web Developer

Role	Knowledge Base	Responsibilities
 Front-end Web developer	<ul style="list-style-type: none">• No MATLAB experience• Minimal IT experience• Expert at usability and Web page design• Minimal access to IT systems• Expert at ASPX	<ul style="list-style-type: none">• As service consumer, manages presentation and usability• Creates front-end applications• Integrates MATLAB code with language-specific frameworks and environments• Integrates WebFigures with the rest of the Web page

Server Administrator

 Server administrator	<ul style="list-style-type: none">• No MATLAB experience• IT Expert• Understands server architectures• Understands language-specific frameworks and environments	<ul style="list-style-type: none">• Manages uptime of production servers• Ensures that services are scalable enough to meet SLA requirements• Maintains multiple versions of the MCR and Deployed component versions• Manages framework versions
---	---	---

End User

Role	Knowledge Base	Responsibilities
 End user	<ul style="list-style-type: none">• No MATLAB experience• Some knowledge of the data that is being displayed, but not how it was created	<ul style="list-style-type: none">• In Web environments, consumes what the front-end developer creates• Integrates MATLAB code with other third-party applications, such as Excel

Magic Square Calculator On the Web

The examples in this chapter demonstrate a Magic Square Calculator application that allows users to input a size for a magic square. It shows the matrix, as well as a surface plot of the matrix. This surface plot doesn't represent anything, but it demonstrates how to handle numerical data as well as visualization data.

The applications built in this chapter are not complex multi-tiered applications. Rather, these applications represent the product of the least number of steps required to build a working Web application quickly. The concepts demonstrated in this chapter can be extended into a robust, scalable Web application using techniques from other chapters in this guide.

The `getMagicWebFigure.m` MATLAB function, which runs the Magic Square calculator, is as follows. It is based on the popular Magic Square `getMagic` function:

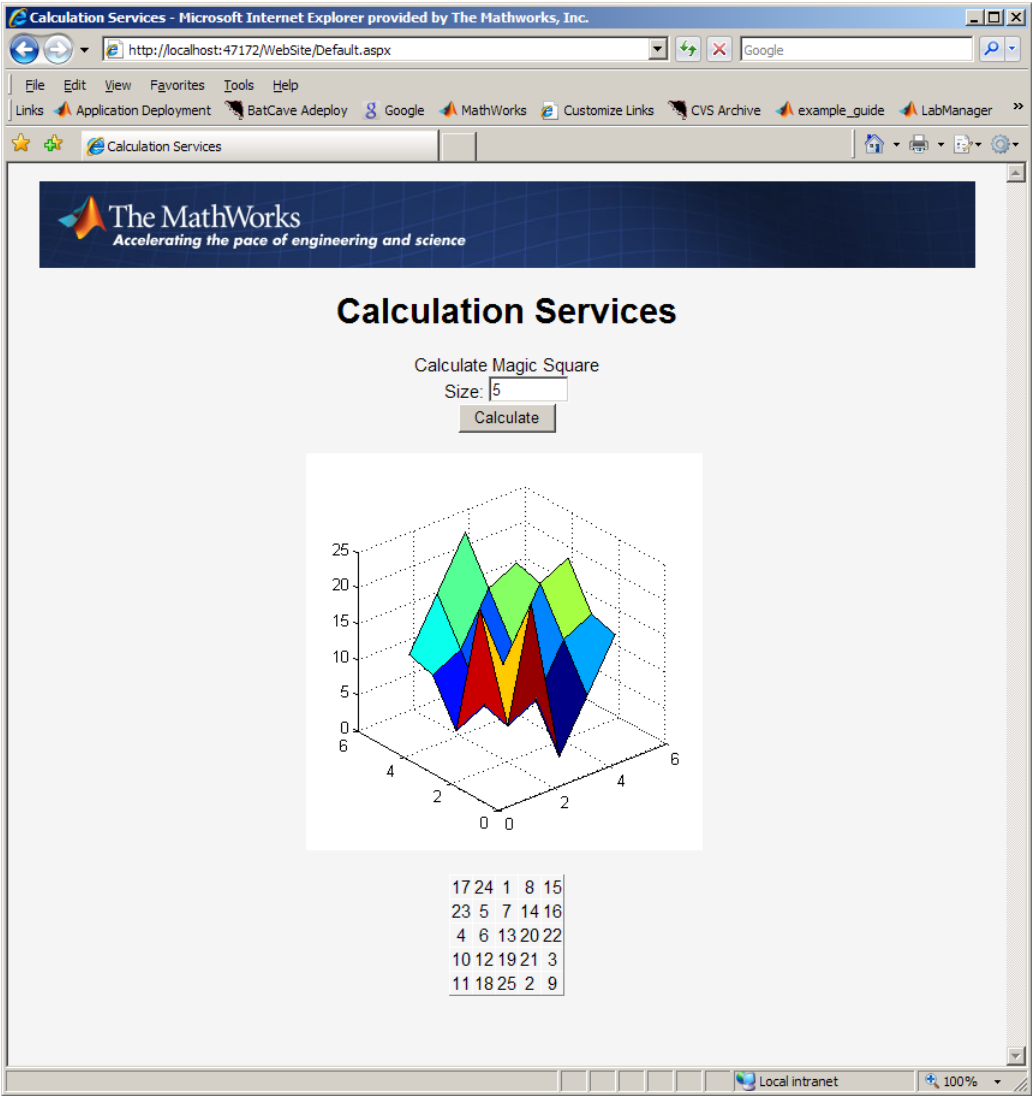
getmagic.m:

```
function magicOutput = getMagic(x)
    magicOutput = magic(x);
end
```

getMagicWebFigure.m:

```
function figureOutput = getMagicWebFigure(x)
    f = figure;
    magicOutput = magic(x);
    surf(magicOutput);
    set(gcf, 'Color', [1,1,1])
    figureOutput = webfigure(f);
    close(f);
end
```

The Magic Square Calculator application, when built, looks like this.



Magic Square Calculator Application Presented on the Web

Creating an End-to-End Web Application

Creating a .NET Web Application, End-to-End

To create the Magic Square Calculator using .NET, you must create:

- 1 The MATLAB Builder NE DLL file that is generated by compiling MATLAB code using MATLAB, MATLAB Compiler, and MATLAB Builder NE.
- 2 The `DataTable` implementation that converts the magic square output into something that an `ObjectDataSource` can use in a `GridView` Control.
- 3 The ASPX page and the code behind it. This page is responsible for taking in user input, displaying the controls, and handling page events.

Preparing Your Example Application

- 1 Ensure you have a supported .NET Framework installed and Microsoft Visual Studio or later. See the *MATLAB Builder NE Release Notes* for a list of supported framework versions.
- 2 Ensure the version of the MCR you have installed is the same version as the MCR running with MATLAB when the application was built. If you are unsure, check with your MATLAB programmer or whoever initially deployed the components. See the MATLAB Compiler User's Guide reference pages for details on the `mcrversion` command.
- 3 Make note of the folder where the MCR is installed. It will be used later when starting the applications.
- 4 Create the code for the `DataTable` implementation:

```
using System;
using System.Data;
using System.Configuration;
using System.Web;
using System.Web.Security;
using System.Web.UI;
using System.Web.UI.WebControls;
using System.Web.UI.WebControls.WebParts;
```

```
using System.Web.UI.HtmlControls;
using Examples;
using MathWorks.MATLAB.NET.Arrays;

public class MagicSquare
{
    //This class gets the data from the generated component and loads
    // it into a data structure that can be automatically used by an
    // ObjectDataSource in a GridView Control
    public DataTable getMagicSquare(int size)
    {
        //Instantiate the deployed component
        MagicCalc calc = new MagicCalc();

        //Convert the size into an MWArray so it can be passed in
        MWArray input = size;

        //call the getMagic function to get the matrix
        MWNumericArray output = (MWNumericArray)calc.getMagic(input);

        //Convert the matrix to a .NET double array
        double[,] magicSquare =
            (double[,])output.ToArray(MWArrayComponent.Real);

        //Create an empty data table to put the matrix data in.
        DataTable table = new DataTable();

        //Since we know its a square add as many
        // columns as there will be rows.
        for(int i = 0; i<size; i++)
        {
            table.Columns.Add();
        }

        DataRow row;
        //Iterate each element in the array creating a row out of each
        for(int i = 0; i < size;i++)
        {
            //create a row from the table to put the data in
            row = table.NewRow();
        }
    }
}
```

```

        //Iterate each element in the inner
        // array and put them into the row
        for (int j = 0; j < size; j++)
        {
            row[j] = magicSquare[i,j];
        }

        //Add the row to the table
        table.Rows.Add(row);
    }
    return table;
}
}

```

5 Create the code for the ASPX page:

```

<%@ Page Language="C#" AutoEventWireup="true"
    CodeFile="Default.aspx.cs" Inherits="_Default" %>

<%@ Register
    Assembly="WebFiguresService,
        Version=2.8.1.0, Culture=neutral,
        PublicKeyToken=e1d84a0da19db86f"
    Namespace="MathWorks.MATLAB.NET.WebFigures.Service"
    TagPrefix="cc1" %>

<!DOCTYPE html
    PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN"
    "http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">

<html xmlns="http://www.w3.org/1999/xhtml" >
    <head id="Head1" runat="server">
        <title>Calculation Services</title>
        <link rel="Stylesheet" type="text/css"
            media=all href="./StyleSheet.css" />
        <link href="StyleSheet.css"
            rel="stylesheet" type="text/css" />
    </head>
    <body>
        <form id="form1" runat="server">

```

```

<div style="text-align: center">
    <table width="760" cellpadding="0"
        cellspacing="0">
        <tr>
            <td>
                </td>
            </tr>
        </table>
        <br />

        <h1> Calculation Services</h1>

        <asp:Label
        ID="Label3"
        runat="server"
        Text="Calculate Magic Square">
        </asp:Label>
        <br />

        <asp:Label
        ID="Label4"
        runat="server"
        Text="Size: ">
        </asp:Label>

        <asp:TextBox
        ID="TextBox3"
        runat="server"
        Width="61px">
        5
        </asp:TextBox>
        <br />

        <asp:Button
        ID="Button2"
        runat="server"
        OnClick="Button2_Click"
        Text="Calculate" />
    
```

```

<br />

        <br />

        <cc1:WebFigureControl
ID="WebFigureControl1"
runat="server"
Height="330px"
Width="330px" />
        <br />

        <br />

        <asp:ObjectDataSource
            ID="ObjectDataSource1"
            runat="server"
            SelectMethod="getMagicSquare"
            TypeName="MagicSquare">

            <SelectParameters>
                <asp:ControlParameter
                    ControlID="TextBox3"
                    DefaultValue="5"
                    Name="size"
                    PropertyName="Text"
                    Type="Int32" />
            </SelectParameters>
        </asp:ObjectDataSource>
        <asp:GridView
            ID="GridView1"
            runat="server"
            DataSourceID="ObjectDataSource1"
            ShowHeader="False">
        </asp:GridView>
    </div>
</form>
</body>
</html>

```

6 Create the code behind the ASPX page:

```
using System;
using System.Data;
using System.Configuration;
using System.Web;
using System.Web.Security;
using System.Web.UI;
using System.Web.UI.WebControls;
using System.Web.UI.WebControls.WebParts;
using System.Web.UI.HtmlControls;
using Examples;
using MathWorks.MATLAB.NET.WebFigures;
using MathWorks.MATLAB.NET.Arrays;

public partial class _Default : System.Web.UI.Page
{
    private MagicCalc calc = new MagicCalc();
    protected void Page_Load(object sender, EventArgs e)
    {
        MWArray input = Int32.Parse(TextBox3.Text);
        WebFigureControl1.WebFigure =
            new WebFigure(calc.getMagicWebFigure(input));
    }
    protected void Button2_Click(object sender, EventArgs e)
    {
        MWArray input = Int32.Parse(TextBox3.Text);
        WebFigureControl1.WebFigure =
            new WebFigure(calc.getMagicWebFigure(input));

        ObjectDataSource1.Select();
    }
}
```

Building Your Example Application

Build your application and deploy it using the version of IIS built into Microsoft Visual Studio as follows:

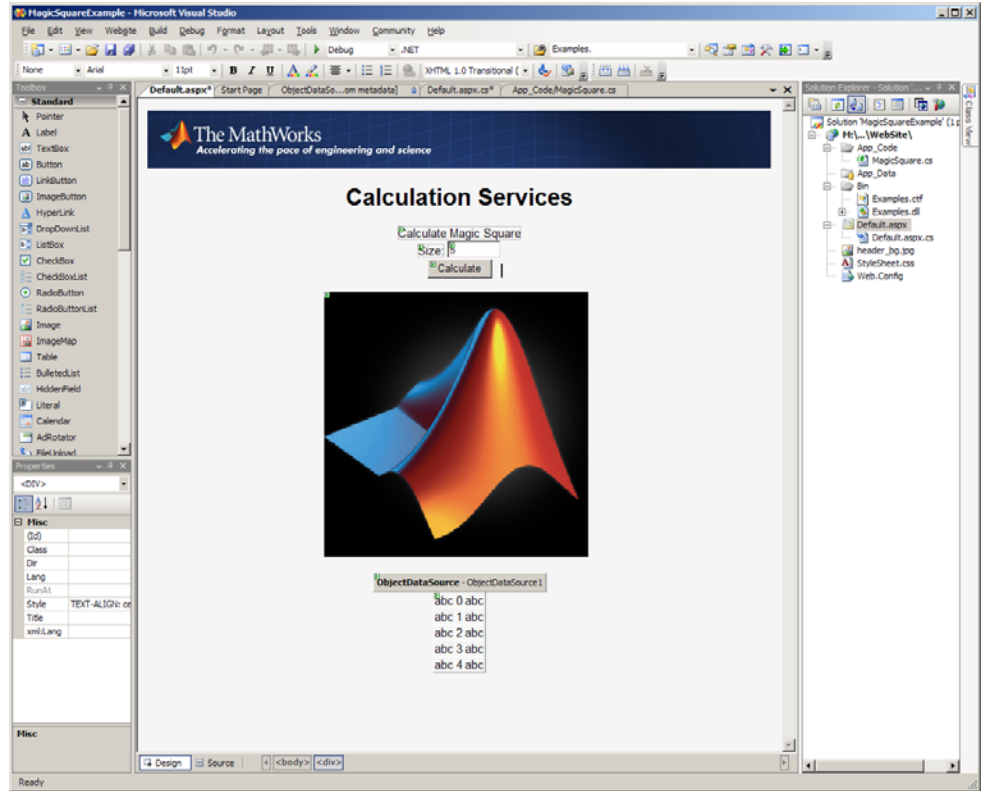
- 1 From the root of your projects folder, open the **WebSite** folder.

- 2** Build the component in MATLAB using the `mcc` command:

```
mcc -W "dotnet:Examples,MagicCalc,0.0,private"  
-d ".\mcode\output" -T "link:lib"  
-v  
"class{MagicCalc:.\mcode\getMagic.m,  
    .\mcode\getMagicWebFigure.m}"
```

This command creates a file in the `WebSite\mcode\output` folder called `Examples.dll` (this will be referenced from the Visual Studio project in the next step).

- 3** Open Microsoft Visual Studio and select **File > Open > Web Site**.
- 4** Browse to the `WebSite` folder and open it.
- 5** Confirm that `Examples.dll` is added correctly as a reference. If there were any errors or issues adding it, delete it and add a new reference to the DLL you built in the `WebSite\mcode\output` folder.



Microsoft® Visual Studio® Designer View of the Magic Square Calculator

- 6 Select **Build > Build Solution**. You should build with no errors. If there are errors, ensure that:
 - The MCR is installed.
 - Examples.dll has been added as a reference in your project.
- 7 When you have built successfully, select **Debug > Start Debugging**. A local IIS server starts and opens your page inside of it.

Sources for More Information

Other Examples

Use these links for more information on other Web examples of possible interest:

MATLAB Builder NE

Other examples using MATLAB Builder NE include:

Black-Scholes

MATLAB Central Black-Scholes Web Application for .NET

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