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MATLAB® Production Server™ Getting Started Guide

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#### Revision History

<table>
<thead>
<tr>
<th>Date</th>
<th>Edition</th>
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</tr>
</thead>
<tbody>
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</tr>
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<td>Online only</td>
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</tr>
<tr>
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<td>Online only</td>
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</tr>
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<td>Online only</td>
<td>Revised for Version 2.4 (Release R2016b)</td>
</tr>
<tr>
<td>March 2017</td>
<td>Online only</td>
<td>Revised for Version 3.0 (Release R2017a)</td>
</tr>
<tr>
<td>September 2017</td>
<td>Online only</td>
<td>Revised for Version 3.0.1 (Release R2017b)</td>
</tr>
<tr>
<td>March 2018</td>
<td>Online only</td>
<td>Revised for Version 3.1 (Release R2018a)</td>
</tr>
<tr>
<td>September 2018</td>
<td>Online only</td>
<td>Revised for Version 4.0 (Release R2018b)</td>
</tr>
<tr>
<td>March 2019</td>
<td>Online only</td>
<td>Revised for Version 4.1 (Release R2019a)</td>
</tr>
<tr>
<td>September 2019</td>
<td>Online only</td>
<td>Revised for Version 4.2 (Release R2019b)</td>
</tr>
<tr>
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<td>Online only</td>
<td>Revised for Version 4.3 (Release R2020a)</td>
</tr>
</tbody>
</table>
Licensing

Manage Licenses for MATLAB Production Server .................. 4-2
  Specify or Verify License Server Options in Server Configuration File .. 4-2
  Verify Status of License Server using mps-status .................. 4-2
  Forcing a License Checkout Using mps-license-reset ................ 4-3

Deploying an Application

Create a Deployable Archive for MATLAB Production Server ........ 5-2
  Create a Function In MATLAB ................................... 5-2
  Create a Deployable Archive with Production Server Compiler App ...... 5-2
  Customize the Application and Its Appearance ................... 5-3
  Package the Application ...................................... 5-3

Install and Start MATLAB Production Server ....................... 5-5
  Install MATLAB Production Server ................................ 5-5
  Install Network License Manager .................................. 5-5
  Install MATLAB Runtime ....................................... 5-6
  Specify the Default MATLAB Runtime ............................... 5-6
  Create a Server Instance ....................................... 5-6
  Configure a Server Instance .................................... 5-6
  Start a Server Instance ....................................... 5-7

Share a Deployable Archive on the Server Instance ................ 5-8

Create a Java Client Using the MWHttpClient Class ............... 5-9

Create a C# Client ............................................... 5-12

Create a C++ Client ............................................ 5-15

Create a Python Client .......................................... 5-20
Overview

- “MATLAB Production Server Product Description” on page 1-2
- “MATLAB Production Server Workflow” on page 1-3
MATLAB Production Server Product Description

Integrate MATLAB algorithms into web, database, and enterprise applications

MATLAB Production Server lets you incorporate custom analytics into web, database, and production enterprise applications running on dedicated servers or in the cloud. You can create algorithms in MATLAB, package them using MATLAB Compiler SDK™, and then deploy them to MATLAB Production Server without recoding or creating custom infrastructure. Users can then access the latest version of your analytics automatically.

MATLAB Production Server manages multiple MATLAB Runtime versions simultaneously. As a result, algorithms developed in different versions of MATLAB can be incorporated into your application. The server runs on multiprocessor and multicore computers, providing low-latency processing of concurrent work requests. You can deploy the server on additional computing nodes to scale capacity and provide redundancy.

Key Features

- Production deployment of MATLAB programs without recoding or creating custom infrastructure
- Scalable performance and management of MATLAB analytics and MATLAB Runtime versions
- Lightweight client library for secure access to analytics by enterprise applications
- Centralized analytic service accessible via the RESTful JSON interface or from .NET, Java®, C/C++, and Python® environments
- Web-based management dashboard for IT configuration and control
MATLAB Production Server Workflow

The following figure illustrates the basic workflow to deploy MATLAB code using MATLAB Production Server.

1. Create deployable archives.
   MATLAB users write MATLAB functions and compile them into deployable archives using MATLAB Compiler™ and MATLAB Compiler SDK.

2. Deploying the archives to an instance of the MATLAB Production Server.
   Server administrators take the deployable archives and deploy them into one or more instances of the MATLAB Production Server. In addition to adding the archive to a server's deployment folder, the server administrator might need to:
   - Install a server instance.
   - Set up licenses for a server instance.
   - Configure a server instance.
   - Install a MATLAB Runtime into a server instance.
3 Write client applications that use deployed MATLAB code on the server.

Application developers use MATLAB Production Server client APIs to write applications that use MATLAB code.

4 Install client applications on end-user computers.

Application installers distribute the client applications to the end-users.

See Also

More About
• “Install and Start MATLAB Production Server” on page 5-5
• “Server Overview”
Installation

- “Install MATLAB Production Server” on page 2-2
- “Download and Install the MATLAB Runtime” on page 2-3
- “Disable Windows Interactive Error Reporting” on page 2-4
Install MATLAB Production Server

Installing MATLAB Production Server is similar to installing other MathWorks® products.

1. Obtain a software license by purchasing the product or requesting a trial.
2. Download the installer from MathWorks Downloads.
3. Run the installer. Select MATLAB Production Server when the installer prompts you to select a product.

For standard installation, see “Install Products Using Internet Connection” (Installation and Licensing). For installation without an internet connection, see “Install Products Using File Installation Key” (Installation and Licensing).

Once the installation is complete, you can add the $MPS_INSTALL\script folder to your system PATH environment variable, where $MPS_INSTALL$ represents your MATLAB Production Server installation folder. This allows you to execute MATLAB Production Server commands such as mps-new at the command prompt without having to provide the full path to the script folder.

To use MATLAB Production Server, you must add the MATLAB Production Server license file to the network license manager. For more information, see “Install Network License Manager” on page 2-2.

To configure licenses for use on cloud platforms, see “Choose an Option to Activate Your License” (Licensing on the Cloud).

Install Network License Manager

The network license manager manages software licenses for MathWorks products. You typically install the license manager and MATLAB Production Server on different machines. To use MATLAB Production Server, you must add your MATLAB Production Server license file to the license manager.

To install the network license manager, select one of the following installation options.

- “Install Network License Manager with Internet Connection” (Installation and Licensing)
- “Install Network License Manager Offline” (Installation and Licensing)

If your organization already has a network license manager installed, simply add the MATLAB Production Server license file to it.

See Also
mps-setup | mps-start

More About
- “Install and Start MATLAB Production Server” on page 5-5
Download and Install the MATLAB Runtime

The MATLAB Runtime is a standalone set of shared libraries that enables the execution of compiled MATLAB applications or components on computers that do not have MATLAB installed. MATLAB Production Server requires a MATLAB Runtime instance to execute the deployed MATLAB applications that it hosts.

Note Download and install MATLAB Runtime from https://www.mathworks.com/products/compiler/mcr.

In order to host a deployable archive created with the Production Server Compiler app, you must install a version of the MATLAB Runtime that is compatible with the version of MATLAB that you used to create your archive.

For more information about the MATLAB compiler, including alternate methods of installing it, see “MATLAB Runtime” (MATLAB Compiler).

See Also
mps-setup | mps-start

More About
• “Specify the Default MATLAB Runtime for New Server Instances” on page 3-4
Disable Windows Interactive Error Reporting

If the system on which you are running MATLAB Production Server is not monitored frequently, you may want to disable Windows® Interactive Error Reporting, using the Don't Show UI Windows Error Reporting (WER) setting, to avoid processing disruptions.

Set Up

- “Create a Server” on page 3-2
- “Specify the Default MATLAB Runtime for New Server Instances” on page 3-4
- “Start a Server Instance” on page 3-5
- “Verify Server Status” on page 3-6
Create a Server

Before you can deploy your MATLAB code with MATLAB Production Server, you must create a server to host your deployable archive. A server instance is one unique configuration of the MATLAB Production Server product. Each configuration has its own parameter settings file (main_config), as well as its own set of diagnostic files.

Prerequisites

Before creating a server, ensure you have:

- installed MATLAB Production Server on your machine. For more information, see “Install MATLAB Production Server” on page 2-2.
- added the script folder to your system PATH environment variable. Doing so enables you to run server commands such as mps-new from any folder on your system.

You can run server commands from the $MPS_INSTALL\script folder, where $MPS_INSTALL is the location where MATLAB Production Server is installed. For example, on Windows, the default location is C:\Program Files\MATLAB\MATLAB Production Server\ver\script. ver is the version of MATLAB Production Server.

Procedure

To create a server configuration or instance from the command-line in an on-premise installation, enter the mps-new command from the system prompt. Specify the name of the server that you want to create as an argument to the mps-new command.

mps-new [path/]server_name [-v]

- path — path to the server instance and configuration that you want to create for use with the MATLAB Production Server product.

  If you are creating a server instance in the current folder, you do not need to specify a full path. Only specify the server name.

- server_name — name of the server instance and configuration that you want to create.

- -v — enable verbose output to get the information and status about each folder created in the server configuration.

For example, to create a server instance with the name prod_server_1 located in C:\tmp and using the verbose mode, run the following on your system command prompt.

C:\tmp>mps-new prod_server_1 -v

The command generates the following output.

prod_server_1/.mps_version...ok
prod_server_1/config/main_config...ok
prod_server_1/auto_deploy...ok
prod_server_1/x509...ok
prod_server_1/endpoint...ok
prod_server_1/log...ok
prod_server_1/old_logs...ok
prod_server_1/.mps_socket...ok
The UUID of the newly created instance is 4876f876-56a6-40ef-a4e3-96a69b39cb49

For more information on the folders created in a server configuration, see “Server Diagnostic Tools”.

See Also
mps-new | mps-service

More About
• “Install a Server Instance as a Windows Service”
• “Start a Server Instance” on page 3-5
Specify the Default MATLAB Runtime for New Server Instances

Each server instance that you create with MATLAB Production Server has its own configuration file that defines various server management criteria. Use the mps-setup command to set the default MATLAB Runtime for all on-premise server instances that you create. The mps-setup command line wizard searches your machine for installed MATLAB Runtime instances and sets the default path to the MATLAB Runtime for all server instances.

If you do not have MATLAB Runtime installed on your machine, you must install it first. For more information, see “Download and Install the MATLAB Runtime” on page 2-3.

To set the default MATLAB Runtime:

1. Open a system command prompt with administrator privileges.
2. From the command prompt, navigate to the MATLAB Production Server script folder and run mps-setup.

   Alternatively, add the script folder to your system PATH environment variable to run mps-setup from any folder on your system. The script folder is located at $MPS_INSTALL\script, where $MPS_INSTALL is the location in which MATLAB Production Server is installed. For example, on Windows, the default location for the script folder is C:\Program Files\MATLAB\MATLAB Production Server\ver\script\mps-setup, where ver is the version of MATLAB Production Server.
3. Follow the instructions in the command line wizard.

   The wizard searches your system for installed MATLAB Runtime instances and displays them.
4. Enter y to confirm or n to specify a default MATLAB Runtime for all server instances.

   If mps-setup cannot locate an installed MATLAB Runtime on your system, the wizard prompts you to enter a path name to a valid instance.

Run mps-setup in Non-Interactive Mode for Silent Install

You can also run mps-setup without interactive command input for silent installations. To do so, specify the path name of the MATLAB Runtime as a command line argument.

For example, on Windows, run the following at the system command prompt.

C:\>mps-setup "C:\Program Files\MATLAB\MATLAB Runtime\mcrver"

mcrver is the version of the MATLAB Runtime to use.

See Also
mcr-root | mps-setup

More About
• “Specify the MATLAB Runtime for a Server Instance”
• “Support Multiple MATLAB Versions”
Start a Server Instance

Follow the procedure below to start a server instance in an on-premise installation of MATLAB Production Server.

Prerequisites

Before attempting to start a server, verify that you have:

- Installed the MATLAB Runtime on page 2-3
- Created a server instance on page 3-2
- Specified the default MATLAB Runtime for the instance on page 3-4

Procedure

To start a server instance, complete the following steps:

1. Open a system command prompt.
2. Enter the `mps-start` command:

   `mps-start [-C path/]server_name [-f]

   where:

   - `-C path/` — Path to the server instance you want to create. `path` should end with the server name.
   - `server_name` — Name of the server instance you want to start or stop.
   - `-f` — Forces command to succeed, regardless or whether the server is already started or stopped.

   **Note** If needed, use the `mps-status` command to verify the server is running.

See Also

mps-new | mps-service

More About

- “Install a Server Instance as a Windows Service”
- “Share the Deployable Archive”
Verify Server Status

Use the `mps-status` command to verify the status of a server in an on-premise MATLAB Production Server installation.

**Procedure**

1. Open a system command prompt.
2. Enter the following command:

   ```bash
   mps-status [-C path/]server_name
   ```

   where:

   - `-C path/` — Path to the server instance. `path` should end with the name of the server to be queried for status.
   - `server_name` — Name of the server to be queried for status.

**Example**

To verify the status of a server instance `prod_server_1` located at `\tmp\prod_server_1`, type at the system command prompt

```
mps-status -C \tmp\prod_server_1
```

Output:

- If `prod_server_1` is running and operating with a valid license.

  ```
  \tmp\prod_server_1 STARTED
  License checked out
  ```

- If `prod_server_1` is unable to check out valid license.

  ```
  \tmp\prod_server_1 STARTED
  WARNING: lost connection to license server - request processing will be disabled at 2019-Jun-27 15:40:31.002137 Eastern Daylight Time unless connection to license server is restored.
  ```

  or

  ```
  \tmp\prod_server_1 STARTED
  ERROR: lost connection to license server - request processing disabled.
  ```

To verify whether the server has started or stopped after issuing `mps-restart` and `mps-stop` commands, use `mps-status`. 
License Server Status Information

In addition to the status of the server, `mps-status` also displays the status of the license server associated with the server you are querying.

<table>
<thead>
<tr>
<th>License Server Status Message</th>
<th>Message Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>License checked out</td>
<td>The server is operating with a valid license. The server is communicating with the License Manager, and the required number of license keys are checked out.</td>
</tr>
<tr>
<td>WARNING: lost connection to license server - request processing will be disabled at time unless connection to license server is restored</td>
<td>The server has lost communication with the License Manager, but the server is still fully operational and will remain operational until the specified <code>time</code>. At <code>time</code>, if connectivity to the license server has not been restored, request processing will be disabled until licensing is reestablished.</td>
</tr>
<tr>
<td>ERROR: lost connection to license server - request processing disabled</td>
<td>The server has lost communication with the License Manager for a period of time exceeding the grace period. Request processing has been suspended, but the server is actively attempting to reestablish communication with the License Manager. Request processing resumes if the server is able to reestablish communication with the License Manager.</td>
</tr>
</tbody>
</table>

See Also

`mps-restart` | `mps-stop`

More About

- “Health Check”
Licensing
Manage Licenses for MATLAB Production Server

Complete instructions for installing License Manager can be found in the MATLAB Installation Guide.

In addition to following instructions in the License Center to obtain and activate your license, do the following in order to set up and manage licensing for MATLAB Production Server:

Specify or Verify License Server Options in Server Configuration File

Specify or verify values for License Server options in the server configuration file (main_config).

You create a server by using the mps-new command.

Edit the configuration file for the server. Open the file server_name/config/main_config and specify or verify parameter values for the following options. See the comments in the server configuration file for complete instructions and default values.

- **license** — Configuration option to specify the license servers and/or the license files. You can specify multiple license servers including port numbers (port_number@license_server_name), as well as license files, with one entry in main_config. List where you want the product to search, in order of precedence, using semicolons (;) as separators on Windows or colons (;) as separators on Linux.

  For example, on a Linux system, you specify this value for license:

  ```
  --license 27000@hostA:/opt/license/license.dat:27001@hostB:./license.dat
  ```

  The system searches these resources in this order:

  1. 27000@hostA: (hostA configured on port 27000)
  2. /opt/license/license.dat (local license data file)
  3. 27001@hostB: (hostB configured on port 27001)
  4. ./license.dat (local license data file)

- **license-grace-period** — The maximum length of time MATLAB Production Server responds to HTTP requests, after license server heartbeat has been lost. See the network license manager documentation for more on heartbeats and related license terminology.

- **license-poll-interval** — The interval of time that must pass, after license server heartbeat has been lost and MATLAB Production Server stops responding to HTTP requests, before license server is polled, to verify and checkout a valid license. Polling occurs at the interval specified by license-poll-interval until license has been successfully checked-out. See the network license manager documentation for more on heartbeats and related license terminology.

Verify Status of License Server using mps-status

When you enter an mps-status command, the status of the server and the associated license is returned. The command is available only in an on-premise installation of MATLAB Production Server.

For detailed descriptions of these status messages, see “License Server Status Information” on page 3-7.
Forcing a License Checkout Using mps-license-reset

Use the mps-license-reset command to force the server to checkout a license in an on-premise MATLAB Production Server installation. You can use this command at any time, if you do not want to wait for MATLAB Production Server to verify and checkout a license at an interval established by a server configuration option such as license-grace-period or license-poll-interval.
Deploying an Application

• “Create a Deployable Archive for MATLAB Production Server” on page 5-2
• “Install and Start MATLAB Production Server” on page 5-5
• “Share a Deployable Archive on the Server Instance” on page 5-8
• “Create a Java Client Using the MWHttpClient Class” on page 5-9
• “Create a C# Client” on page 5-12
• “Create a C++ Client” on page 5-15
• “Create a Python Client” on page 5-20
Create a Deployable Archive for MATLAB Production Server

**Supported platform:** Windows, Linux®, Mac

This example shows how to create a deployable archive from a MATLAB function. You can then give the generated archive to a system administrator to deploy it on the MATLAB Production Server environment.

**Create a Function In MATLAB**

In MATLAB, examine the MATLAB program that you want to package.

For this example, write a function `addmatrix.m` as follows.

```matlab
function a = addmatrix(a1, a2)
    a = a1 + a2;
```

At the MATLAB command prompt, enter `addmatrix([1 4 7; 2 5 8; 3 6 9], [1 4 7; 2 5 8; 3 6 9])`.

The output is:

```
ans =
    2     8    14
    4    10    16
    6    12    18
```

**Create a Deployable Archive with Production Server Compiler App**

1. On the MATLAB Apps tab, on the far right of the Apps section, click the arrow. In Application Deployment, click Production Server Compiler. In the Production Server Compiler project window, click Deployable Archive (.ctf).

Alternatively, you can open the Production Server Compiler app by entering `productionServerCompiler` at the MATLAB prompt.

2. In the MATLAB Compiler SDK project window, specify the main file of the MATLAB application that you want to deploy.

   1. In the Exported Functions section, click +.

   2. In the Add Files window, browse to the example folder, and select the function you want to package.
Click **Open**.

The function `addmatrix.m` is added to the list of main files.

**Customize the Application and Its Appearance**

You can customize your deployable archive, and add more information about the application as follows:

- **Archive information** — Editable information about the deployed archive.
- **Additional files required for your archive to run** — Additional files required to run the generated archive. These files are included in the generated archive installer. See “Manage Required Files in Compiler Project” (MATLAB Compiler SDK).
- **Files packaged for redistribution** — Files that are installed with your archive. These files include:
  - Generated deployable archive
  - Generated `readme.txt`

  See “Specify Files to Install with Application” (MATLAB Compiler SDK).
- **Include MATLAB function signature file** — Add or create a function signature file to help clients use your MATLAB functions. See “MATLAB Function Signatures in JSON”.

**Package the Application**

1. To generate the packaged application, click **Package**.

   In the Save Project dialog box, specify the location to save the project.
2 In the Package dialog box, verify that Open output folder when process completes is selected.

When the deployment process is complete, examine the generated output.

- for_redistribution — Folder containing the archive `archiveName.ctf`
- for_testing — Folder containing the raw generated files to create the installer
- PackagingLog.txt — Log file generated by MATLAB Compiler

See Also
deploystool | mcc | productionServerCompiler

More About
- Production Server Compiler
- “MATLAB Function Signatures in JSON”
Install and Start MATLAB Production Server

In this section...

“Install MATLAB Production Server” on page 5-5
“Install Network License Manager” on page 5-5
“Install MATLAB Runtime” on page 5-6
“Specify the Default MATLAB Runtime” on page 5-6
“Create a Server Instance” on page 5-6
“Configure a Server Instance” on page 5-6
“Start a Server Instance” on page 5-7

This example shows how to install, configure, and start an instance of MATLAB Production Server in an on-premise installation. The example uses the command-line for server creation, configuration and startup.

1. “Install MATLAB Production Server” on page 5-5
2. “Install Network License Manager” on page 5-5
3. “Install MATLAB Runtime” on page 5-6
4. “Specify the Default MATLAB Runtime” on page 5-6
5. “Create a Server Instance” on page 5-6
6. “Configure a Server Instance” on page 5-6
7. “Start a Server Instance” on page 5-7

Install MATLAB Production Server

1. Download the installer from MathWorks Downloads.
2. Run the installer.
3. Select MATLAB Production Server from the product list.
4. When the installer asks where to install MATLAB Production Server, enter the name of an empty folder.
5. Once the installation is complete, add the $MPS_INSTALL\script$ folder to your system PATH environment variable. $MPS_INSTALL\script$ represents your MATLAB Production Server installation folder.

For more information about installation options, see “Install MATLAB Production Server” on page 2-2.

Install Network License Manager

You must add your MATLAB Production Server license file to the license manager.

1. Download the installer from MathWorks Downloads, if you do not already have it.
2. Run the installer.
3. When the installer prompts you to sign in, click Advanced Options > I want to install network license manager.

If your organization already has a network license manager installed, simply add the MATLAB Production Server license file to it.
Install MATLAB Runtime

MATLAB Production Server requires the MATLAB Runtime. You must install the MATLAB Runtime, if you do not have it installed on your system.

2. Run the MATLAB Runtime installer.

For more information, see “Download and Install the MATLAB Runtime” on page 2-3.

Specify the Default MATLAB Runtime

Use the mps-setup command to set the default MATLAB Runtime for all the server instances that you create.

To set the default MATLAB Runtime:

1. Open a system command prompt with administrator privileges.
2. Run mps-setup.

For more information, see “Specify the Default MATLAB Runtime for New Server Instances” on page 3-4.

Create a Server Instance

To create a server configuration or instance, enter the mps-new command from the system prompt. Specify the name of the server that you want to create as an argument to the mps-new command.

For example, to create a server instance with the name prod_server_1 located in C:\tmp and use the verbose mode, run the following on your system command prompt.

C:\tmp>mps-new prod_server_1 -v

For more information, see “Create a Server” on page 3-2.

Configure a Server Instance

After you create a new server instance, you must configure it. At a minimum, specify the following properties in the main_config server configuration file.

- license — Specify the host and port of the license server, typically 27000@license-server-host.
- mcr-root — Specify the path to the MATLAB Runtimes to use. You can set this property to use multiple MATLAB Runtimes. For more information, see “Support Multiple MATLAB Versions”.

For more information on editing main_config, see “Edit the Configuration File”.

For more information about installation options, see “Install Network License Manager” on page 2-2.
Start a Server Instance

To start the server instance that you created, enter the `mps-start` command from the system prompt. Specify the name of the server that you want to start as an argument to the `mps-start` command.

For example, to start a server instance with the name `prod_server_1` located in `C:\tmp`, run the following on your system command prompt.

```
C:\tmp>mps-start -C prod_server_1
```

For more information, see “Start a Server Instance”.

See Also

`mps-restart` | `mps-setup` | `mps-start` | `mps-status`

More About

- “Verify Status of License Server using mps-status”
- “Enable HTTPS”
Share a Deployable Archive on the Server Instance

To make your deployable archive available using MATLAB Production Server, you must copy the deployable archive into the auto_deploy folder in your server instance. You can add a deployable archive into the auto_deploy folder of a running server — the server monitors this folder dynamically and processes the deployable archives that are added to the auto_deploy folder.

To share the deployable archive created in “Create a Deployable Archive for MATLAB Production Server”, copy the deployable archive from the deployment project’s for_redistribution folder into the server’s auto_deploy folder.
Create a Java Client Using the MWHttpClient Class

This example shows how to write a MATLAB Production Server client using the Java client API. In your Java code, you will:

- Define a Java interface that represents the MATLAB function.
- Instantiate a proxy object to communicate with the server.
- Call the deployed function in your Java code.

To create a Java MATLAB Production Server client application:

1. Create a new file called MPSClientExample.java.
2. Using a text editor, open MPSClientExample.java.
3. Add the following import statements to the file:
   
   ```java
   import java.net.URL;
   import java.io.IOException;
   import com.mathworks.mps.client.MWClient;
   import com.mathworks.mps.client.MWHttpClient;
   import com.mathworks.mps.client.MATLABException;
   ```

4. Add a Java interface that represents the deployed MATLAB function.

   The interface for the `addmatrix` function

   ```java
   function a = addmatrix(a1, a2)
   
   a = a1 + a2;
   ```

   looks like this:

   ```java
   interface MATLABAddMatrix {
       double[][] addmatrix(double[][] a1, double[][] a2)
       throws MATLABException, IOException;
   }
   ```

   When creating the interface, note the following:

   - You can give the interface any valid Java name.
   - You must give the method defined by this interface the same name as the deployed MATLAB function.
   - The Java method must support the same inputs and outputs supported by the MATLAB function, in both type and number. For more information about data type conversions and how to handle more complex MATLAB function signatures, see “Java Client Programming”.
   - The Java method must handle MATLAB exceptions and I/O exceptions.

5. Add the following class definition:

   ```java
   public class MPSClientExample {
   }
   ```

   This class now has a single main method that calls the generated class.

6. Add the `main()` method to the application.
public static void main(String[] args) {

7 Add the following code to the top of the main() method:

double[][] a1={{1,2,3},{3,2,1}};
double[][] a2={{4,5,6},{6,5,4}};

These statements initialize the variables used by the application.

8 Instantiate a client object using the MWHttpClient constructor:

MWClient client = new MWHttpClient();

This class establishes an HTTP connection between the application and the server instance.

9 Call the client object's createProxy method to create a dynamic proxy:

You must specify the URL of the deployable archive and the name of your interface class as arguments:

MATLABAddMatrix m = client.createProxy(new URL("http://localhost:9910/addmatrix"),
MATLABAddMatrix.class);

The URL value ("http://localhost:9910/addmatrix") used to create the proxy contains three parts:
• the server address (localhost).
• the port number (9910).
• the archive name (addmatrix)

For more information about the createProxy method, see the Javadoc included in the
$MPS_INSTALL/client folder, where $MPS_INSTALL is the name of your MATLAB Production
Server installation folder.

10 Call the deployed MATLAB function in your Java application by calling the public method of the
interface.

double[][] result = m.addmatrix(a1,a2);

11 Call the client object's close() method to free system resources.

client.close();

12 Save the Java file.

The completed Java file should resemble the following:

```java
import java.net.URL;
import java.io.IOException;
import com.mathworks.mps.client.MWClient;
import com.mathworks.mps.client.MWHttpClient;
import com.mathworks.mps.client.MATLABException;

interface MATLABAddMatrix
{
    double[][] addmatrix(double[][] a1, double[][] a2)
    throws MATLABException, IOException;
}

public class MPSClientExample {

    public static void main(String[] args){

double[][] a1={{1,2,3},{3,2,1}};
double[][] a2={{4,5,6},{6,5,4}};

    MWClient client = new MWHttpClient();
```
try{
    MATLABAddMatrix m = client.createProxy(new URL("http://localhost:9910/addmatrix"),
    MATLABAddMatrix.class);
    double[][] result = m.addmatrix(a1,a2);
    // Print the magic square
    printResult(result);
}

try{

    // This exception represents network issues.
    System.out.println(ex);
}finally{
    client.close();
}

private static void printResult(double[][] result){
    for(double[] row : result){
        for(double element : row){
            System.out.print(element + " ");
        }
        System.out.println();
    }\
}

13 Compile the Java application, using the javac command or use the build capability of your Java
IDE.

For example, enter the following:

    javac -classpath "MPS_INSTALL_ROOT\client\java\mps_client.jar" MPSClientExample.java

14 Run the application using the java command or your IDE.

For example, enter the following:

    java -classpath .;"MPS_INSTALL_ROOT\client\java\mps_client.jar" MPSClientExample

The application returns the following at the console:

    5.0 7.0 9.0
    9.0 7.0 5.0
Create a C# Client

This example shows how to call a deployed MATLAB function from a C# application using MATLAB Production Server.

In your C# code, you must:

• Create a Microsoft® Visual Studio® Project.
• Create a Reference to the Client Run-Time Library.
• Design the .NET interface in C#.
• Write, build, and run the C# application.

This task is typically performed by .NET application programmer. This part of the tutorial assumes you have Microsoft Visual Studio and .NET installed on your computer.

Create a Microsoft Visual Studio Project

1. Open Microsoft Visual Studio.
2. Click File > New > Project.
3. In the New Project dialog, select the project type and template you want to use. For example, if you want to create a C# Console Application, select Windows in the Visual C# branch of the Project Type pane, and select the C# Console Application template from the Templates pane.
4. Type the name of the project in the Name field (Magic, for example).
5. Click OK. Your Magic source shell is created, typically named Program.cs, by default.

Create a Reference to the Client Run-Time Library

Create a reference in your MainApp code to the MATLAB Production Server client run-time library. In Microsoft Visual Studio, perform the following steps:

1. In the Solution Explorer pane within Microsoft Visual Studio (usually on the right side), select the name of your project, Magic, highlighting it.
2. Right-click Magic and select Add Reference.
3. In the Add Reference dialog box, select the Browse tab. Browse to the MATLAB Production Server client runtime, installed at $MPS_INSTALL\client\dotnet. Select MathWorks.MATLAB.ProductionServer.Client.dll.
4. Click OK. MathWorks.MATLAB.ProductionServer.Client.dll is now referenced by your Microsoft Visual Studio project.

Design the .NET Interface in C#

In this example, you invoke mymagic.m, hosted by the server, from a .NET client, through a .NET interface.

To match the MATLAB function mymagic.m, design an interface named Magic.

For example, the interface for the mymagic function:

```matlab
function m = mymagic(in)
    m = magic(in);
```

might look like this:
public interface Magic
{
    double[,] mymagic(int in1);
}

Note the following:

- The .NET interface has the same number of inputs and outputs as the MATLAB function.
- You are deploying one MATLAB function, therefore you define one corresponding .NET method in your C# code.
- Both MATLAB function and .NET interface process the same types: input type int and the output type two-dimensional double.
- You specify the name of your deployable archive (magic, which resides in your auto_deploy folder) in your URL, when you call CreateProxy("http://localhost:9910/magic").

Write, Build, and Run the .NET Application

Create a C# interface named Magic in Microsoft Visual Studio by doing the following:

1. Open the Microsoft Visual Studio project, MagicSquare, that you created earlier.
2. In Program.cs tab, paste in the code below.

```csharp
using System;
using System.Net;
using MathWorks.MATLAB.ProductionServer.Client;
namespace Magic
{
    public class MagicClass
    {

        public interface Magic
        {
            double[,] mymagic(int in1);
        }

        public static void Main(string[] args)
        {
            MWClient client = new MWHttpClient();
            try
            {
                Magic me = client.CreateProxy<Magic>(new Uri("http://localhost:9910/mymagic_deployed"));
                double[,] result1 = me.mymagic(4);
                print(result1);
            }
            catch (MATLABException ex)
            {
                Console.WriteLine("{0} MATLAB exception caught.", ex);
                Console.WriteLine(ex.StackTrace);
            }
        }
    }
}
```

Note: The URL value ("http://localhost:9910/mymagic_deployed") used to create the proxy contains three parts:

- the server address (localhost).
- the port number (9910).
- the archive name (mymagic_deployed)
catch (WebException ex)
{
    Console.WriteLine("{0} Web exception caught.", ex);
    Console.WriteLine(ex.StackTrace);
}
finally
{
    client.Dispose();
}
Console.ReadLine();

public static void print(double[,] x)
{
    int rank = x.Rank;
    int [] dims = new int[rank];
    for (int i = 0; i < rank; i++)
    {
        dims[i] = x.GetLength(i);
    }
    for (int j = 0; j < dims[0]; j++)
    {
        for (int k = 0; k < dims[1]; k++)
        {
            Console.Write(x[j,k]);
            if (k < (dims[1] - 1))
            {
                Console.Write(",");
            }
        }
        Console.WriteLine();
    }
}

3  Build the application. Click Build > Build Solution.
4  Run the application. Click Debug > Start Without Debugging. The program returns the following console output:

16, 2, 3, 13
5, 11, 10, 8
9, 7, 6, 12
4, 14, 15, 1
Create a C++ Client

This example shows how to write a MATLAB Production Server client using the C client API. The client application calls the `addmatrix` function you compiled in “Package Deployable Archives with Production Server Compiler App” (MATLAB Compiler SDK) and deployed in “Share a Deployable Archive on the Server Instance” on page 5-8.

Create a C++ MATLAB Production Server client application:

1. Create a file called `addmatrix_client.cpp`.
2. Using a text editor, open `addmatrix_client.cpp`.
3. Add the following include statements to the file:
   ```
   #include <iostream>
   #include <mps/client.h>
   ```

   **Note** The header files for the MATLAB Production Server C client API are located in the `$MPS_INSTALL/client/c/include/mps` folder where `$MPS_INSTALL` is the root folder which MATLAB Production Server is installed.

4. Add the `main()` method to the application.
   ```
   int main ( void )
   {
   }
   ```

5. Initialize the client runtime.
   ```
   mpsClientRuntime* mpsruntime = mpsInitializeEx(MPS_CLIENT_1_1);
   ```

6. Create the client configuration.
   ```
   mpsClientConfig* config;
   mpsStatus status = mpsruntime->createConfig(&config);
   ```

7. Create the client context.
   ```
   mpsClientContext* context;
   status = mpsruntime->createContext(&context, config);
   ```

8. Create the MATLAB data to input to the function.
   ```
   double a1[2][3] = {{1,2,3},{3,2,1}};
   double a2[2][3] = {{4,5,6},{6,5,4}};
   int numIn=2;
   mpsArray** inVal = new mpsArray* [numIn];
   inVal[0] = mpsCreateDoubleMatrix(2,3,mpsREAL);
   inVal[1] = mpsCreateDoubleMatrix(2,3,mpsREAL);
   double* data1 = (double *)( mpsGetData(inVal[0]) );
   double* data2 = (double *)( mpsGetData(inVal[1]) );
   ```

   ```
   for(int i=0; i<2; i++)
   {
   for(int j=0; j<3; j++)
   {
   mpsIndex subs[] = { i, j };
   mpsIndex id = mpsCalcSingleSubscript(inVal[0], 2, subs);
   data1[id] = a1[i][j];
   ```
data2[id] = a2[i][j];
}

Create the MATLAB data to hold the output.

int numOut = 1;
mpsArray **outVal = new mpsArray*[numOut];

call the deployed MATLAB function.

Specify the following as arguments:

- client context
- URL of the function
- Number of expected outputs
- Pointer to the mpsArray holding the outputs
- Number of inputs
- Pointer to the mpsArray holding the inputs

mpsStatus status = mpsruntime->feval(context, "http://localhost:9910/addmatrix/addmatrix",
numOut, outVal, numIn, (const mpsArray**)inVal);

For more information about the feval function, see the reference material included in the $MPS_INSTALL/client folder, where $MPS_INSTALL is the name of your MATLAB Production Server installation folder.

Verify that the function call was successful using an if statement.

if (status==MPS_OK)
{
}

Inside the if statement, add code to process the output.

double* out = mpsGetPr(outVal[0]);

for (int i=0; i<2; i++)
{
    for (int j=0; j<3; j++)
    {
        mpsIndex subs[] = {i, j};
        mpsIndex id = mpsCalcSingleSubscript(outVal[0], 2, subs);
        std::cout << out[id] << "\t";
    }
    std::cout << std::endl;
}

Add an else clause to the if statement to process any errors.

else
{
    mpsErrorInfo error;
    mpsruntime->getLastErrorMessage(context, &error);
    std::cout << "Error: " << error.message << std::endl;
    switch(error.type)
    {
    case MPS_HTTP_ERROR_INFO:


case MPS_MATLAB_ERROR_INFO:
    std::cout << "MATLAB: " << error.details.matlab.identifier
    << std::endl;
    std::cout << error.details.matlab.message << std::endl;
    case MPS_GENERIC_ERROR_INFO:
    std::cout << "Generic: " << error.details.general.genericErrorMsg
    << std::endl;
}
mpsruntime->destroyLastErrorInfo(&error);

14 Free the memory used by the inputs.
    for (int i=0; i<numIn; i++)
        mpsDestroyArray(inVal[i]);
    delete[] inVal;
15 Free the memory used by the outputs.
    for (int i=0; i<numOut; i++)
        mpsDestroyArray(outVal[i]);
    delete[] outVal;
16 Free the memory used by the client runtime.
    mpsruntime->destroyConfig(config);
    mpsruntime->destroyContext(context);
    mpsTerminate();
17 Save the file.

The completed program should resemble the following:
#include <iostream>
#include <mps/client.h>

int main ( void )
{
    mpsClientRuntime* mpsruntime = mpsInitializeEx(MPS_CLIENT_1_1);
    mpsClientConfig* config;
    mpsStatus status = mpsruntime->createConfig(&config);
    mpsClientContext* context;
    status = mpsruntime->createContext(&context, config);
    double a1[2][3] = {{1,2,3},{3,2,1}};
    double a2[2][3] = {{4,5,6},{6,5,4}};
    int numIn=2;
    mpsArray** inVal = new mpsArray* [numIn];
    inVal[0] = mpsCreateDoubleMatrix(2,3,mpsREAL);
    inVal[1] = mpsCreateDoubleMatrix(2,3,mpsREAL);
    double* data1 = (double *) (mpsGetData(inVal[0]) );
    double* data2 = (double *) (mpsGetData(inVal[1]) );
    for(int i=0; i<2; i++)
    {
        for(int j=0; j<3; j++)
        {
            mpsIndex subs[] = { i, j };
            mpsIndex id = mpsCalcSingleSubscript(inVal[0], 2, subs);
            data1[id] = a1[i][j];
            data2[id] = a2[i][j];
        }
    }
    int numOut = 1;
    mpsArray **outVal = new mpsArray* [numOut];
    status = mpsruntime->feval(context,
        "http://localhost:9910/addmatrix/addmatrix",
        numOut, outVal, numIn, (const mpsArray **)inVal);
"
if (status==MPS_OK)
{
    double* out = mpsGetPr(outVal[0]);
    for (int i=0; i<2; i++)
    {
        for (int j=0; j<3; j++)
        {
            mpsIndex subs[] = {i, j};
            mpsIndex id = mpsCalcSingleSubscript(outVal[0], 2, subs);
            std::cout << out[id] << "\t";
        }
        std::cout << std::endl;
    }
}
else
{
    mpsErrorInfo error;
    mpsruntime->getLastErrorInfo(context, &error);
    std::cout << "Error: " << error.message << std::endl;
    switch(error.type)
    {
    case MPS_HTTP_ERROR_INFO:
        break;
    case MPS_MATLAB_ERROR_INFO:
        std::cout << "MATLAB: " << error.details.matlab.identifier << std::endl;
        std::cout << error.details.matlab.message << std::endl;
        break;
    case MPS_GENERIC_ERROR_INFO:
        std::cout << "Generic: " << error.details.general.genericErrorMsg << std::endl;
        break;
    }
    mpsruntime->destroyLastErrorInfo(&error);
}
for (int i=0; i<numIn; i++)
    mpsDestroyArray(inVal[i]);
delete[] inVal;
for (int i=0; i<numOut; i++)
    mpsDestroyArray(outVal[i]);
delete[] outVal;
mpsruntime->destroyConfig(config);
mpsruntime->destroyContext(context);
mpsruntime->terminate();
}

18  Compile the application.

To compile your client code, the compiler needs access to client.h. This header file is stored in $MPSROOT/client/c/include/mps/.

To link your application, the linker needs access to the following files stored in $MPSROOT/client/c/<arch>/lib/:
Files Required for Linking

<table>
<thead>
<tr>
<th>Windows</th>
<th>UNIX®/Linux</th>
<th>Mac OS X</th>
</tr>
</thead>
<tbody>
<tr>
<td>$arch\lib</td>
<td>$arch/lib/</td>
<td>$arch/lib/</td>
</tr>
<tr>
<td>mpsclient.lib</td>
<td>libprotobuf.so</td>
<td>libprotobuf.dylib</td>
</tr>
<tr>
<td></td>
<td>$arch/lib/libcurl.so</td>
<td>$arch/lib/libcurl.dylib</td>
</tr>
<tr>
<td></td>
<td>$arch/lib/libmwmpsclient.so</td>
<td>$arch/lib/libmwmpsclient.dylib</td>
</tr>
<tr>
<td></td>
<td>$arch/lib/libmwcpp11compat.so</td>
<td></td>
</tr>
</tbody>
</table>

19 Run the application.

To run your application, add the following files stored in $MPSROOT/client/c/<arch>/lib/ to the application’s path:

Files Required for Running

<table>
<thead>
<tr>
<th>Windows</th>
<th>UNIX/Linux</th>
<th>Mac OS X</th>
</tr>
</thead>
<tbody>
<tr>
<td>$arch\lib</td>
<td>$arch/lib/</td>
<td>$arch/lib/</td>
</tr>
<tr>
<td>mpsclient.dll</td>
<td>libprotobuf.so</td>
<td>libprotobuf.dylib</td>
</tr>
<tr>
<td>$arch\lib</td>
<td>$arch/lib/libcurl.so</td>
<td>$arch/lib/libcurl.dylib</td>
</tr>
<tr>
<td>libprotobuf.dll</td>
<td>$arch/lib/libmwmpsclient.so</td>
<td>$arch/lib/libmwmpsclient.dylib</td>
</tr>
<tr>
<td></td>
<td>$arch/lib/libmwcpp11compat.so</td>
<td></td>
</tr>
</tbody>
</table>

The client invokes addmatrix function on the server instance and returns the following matrix at the console:

5.0 7.0 9.0
9.0 7.0 5.0
Create a Python Client

This example shows how to write a MATLAB Production Server client using the Python client API. The client application calls the `addmatrix` function you compiled in “Package Deployable Archives with Production Server Compiler App” (MATLAB Compiler SDK) and deployed in “Share a Deployable Archive on the Server Instance” on page 5-8.

Create a Python MATLAB Production Server client application:

1. Copy the contents of the `MPS_INSTALL\clients\python` folder to your development environment.
2. Open a command line.
3. Change directories into the folder where you copied the MATLAB Production Server Python client.
4. Run the following command.
   ```bash
   python setup.py install
   ```
5. Start the Python command line interpreter.
6. Enter the following import statements at the Python command prompt.
   ```python
   import matlab
   from production_server import client
   ```
7. Open the connection to the MATLAB Production Server instance and initialize the client runtime.
   ```python
   client_obj = client.MWHttpClient("http://localhost:9910")
   ```
8. Create the MATLAB data to input to the function.
   ```python
   a1 = matlab.double([[1,2,3],[3,2,1]])
   a2 = matlab.double([[4,5,6],[6,5,4]])
   ```
9. Call the deployed MATLAB function.
   ```python
   client_obj.addmatrix.addmatrix(a1,a2)
   ```
   ```python
   matlab.double([[5.0,7.0,9.0],[9.0,7.0,5.0]])
   ```
   The syntax for invoking a function is `client.archiveName.functionName(arg1, arg2, .., [nargout=numOutArgs])`.
10. Close the client connection.
    ```python
        client_obj.close()
    ```