

MATLAB EXPO 2016

KOREA

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등록 하기 matlabexpo.co.kr



Integrating MATLAB Analytics into Business-Critical Applications

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Problem statement

- **Democratization:** Is it possible to make the results and insights from these analytics available to all stakeholders in an organization?
- **Agility:** Is it possible to accelerate the development of data analytics?
- **Production:** Is it possible to build data analytics algorithms in a scalable manner that is suitable for production usage and rigor?

Nothing new...

In 1454 Gutenberg put his press to commercial use...

The printing press was an important step towards the democratization of knowledge [...]

Now that more people had access to knowledge both new and old, more people could discuss these works [...]

On the other hand, the printing press was criticized for allowing the dissemination of information which may have been incorrect.



https://en.wikipedia.org/wiki/Printing_press

Taking MATLAB analytics into production

Development

- Lightweight processes
- Visualization
- Access to data
- Expressive language
- Integration with best-in-class tools

Taking MATLAB analytics into production

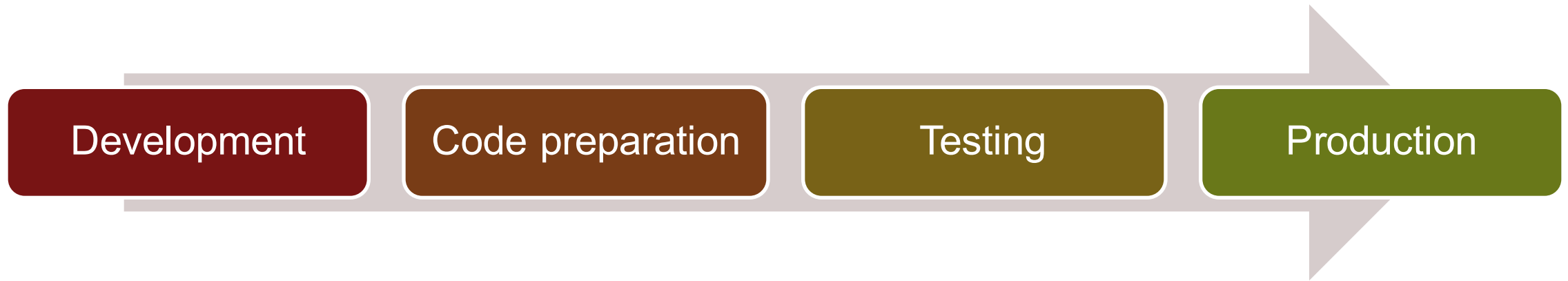
Development

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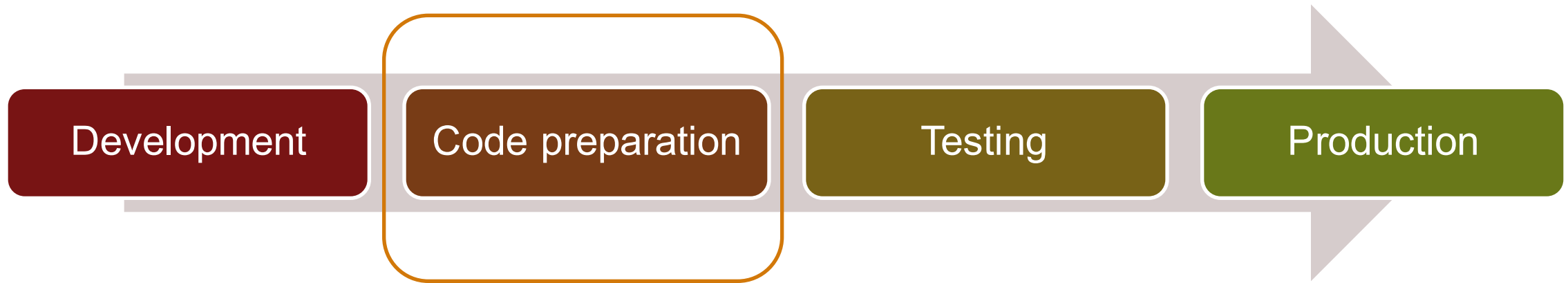
Production

- Reliability
- Maintainability
- Usability
- Extendibility
- Portability
- Readability

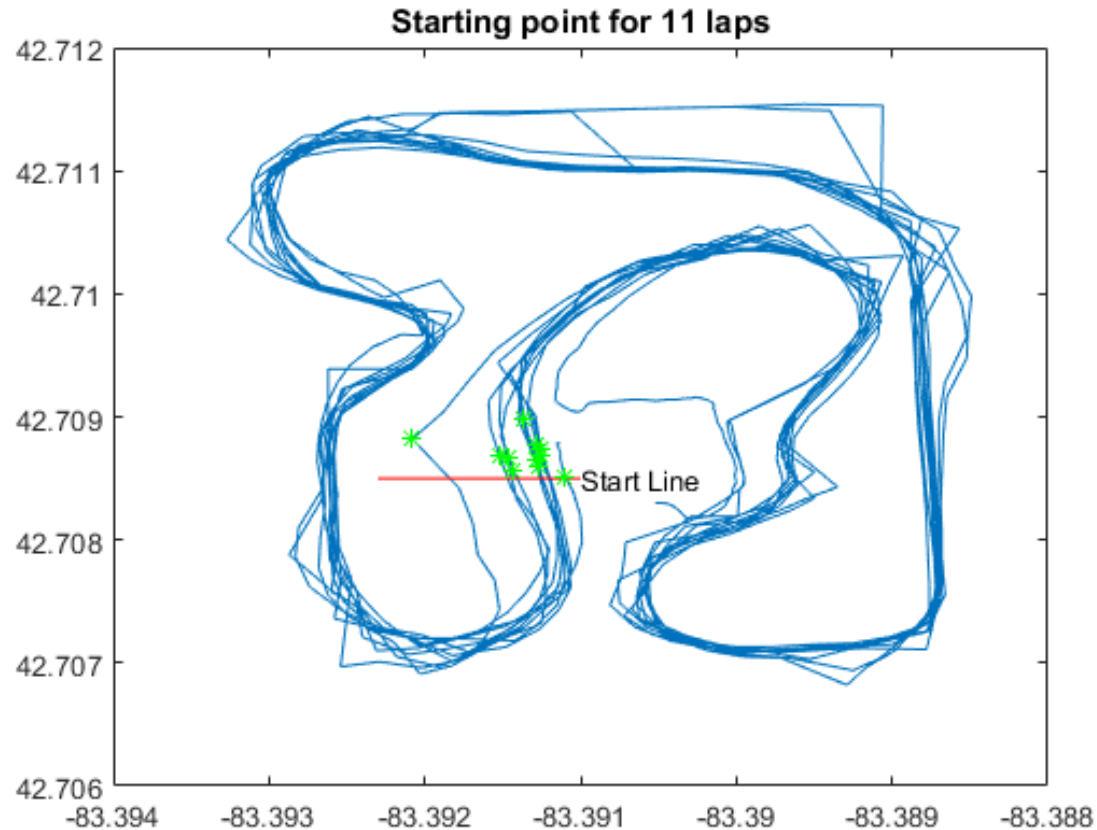
Taking MATLAB analytics into production



Taking MATLAB analytics into production



Example: code preparation



Task: Make analytics developed in MATLAB available to Excel users

Input: Time series from race track

- Time stamp
- Latitude
- Longitude
- RPM
- Forward acceleration
- Lateral acceleration

Output: Lap statistics

- Lap number, start and duration
- Statistics per lap: max RPM, max forward acceleration, max lateral acceleration

Example: code preparation

Analyse lap data

Contents

- Load data
- Can we detect periodicity?
- Plot trajectory
- Start line: use data tip, and then export to workspace
- Find points where we cross the line
- Loop through laps to construct lap number, start and duration
- Compute Lap Statistics using FINDGROUPS/SPLITAPPLY

What needs to be deployed?

- Access to initial data: NO
- Exploratory calculations: NO
- Exploratory visualisation: NO
- Interactive parameter tuning: NO
- Computation of lap stats: YES

Example: code preparation

```
for n = 1:N
    LapStart(n,1) = data.FrameTime(laps(n));
    LapDuration(n,1) = data.FrameTime(laps(n+1)-1) - data.FrameTime(laps(n));
    lapno(laps(n):laps(n+1)) = n;
    LapName{n} = ['Lap ' num2str(n)];
end
LapStats = table( LapName, LapStart, LapDuration )
```

LapStats =

LapName	LapStart	LapDuration
'Lap 1'	13:59:42.159	00:01:35
'Lap 2'	14:01:18.406	00:01:33

Still to address:

- Interleaved data access, processing and visualisation
- What should be the input/output of the deployed functions?
- What are the code dependencies?
- Performance optimisation

Code preparation step 1: decouple code layers

Presentation
(Client)

Logic
(Algorithm)

Data

Code preparation step 2: fit into production context

Presentation
(Client)



Logic
(Algorithm)

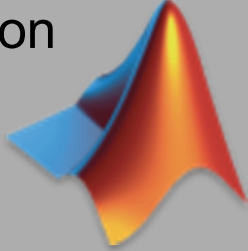


Data



Code preparation step 2: fit into production context

Presentation
(Client)



Microsoft Excel

Web



Logic
(Algorithm)

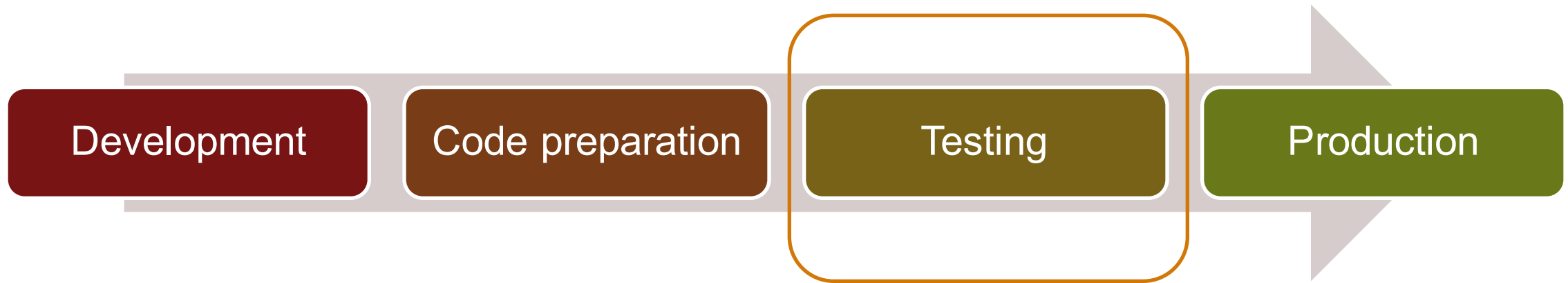


Data

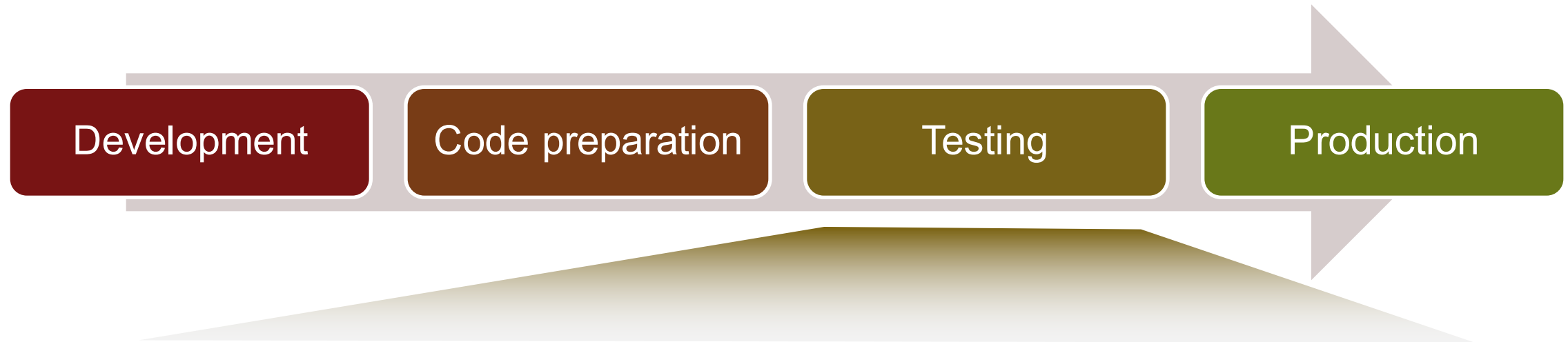


- Layers
 - tools, scale, performance
- Interfaces
 - types, scale, performance
- Dependencies
 - state, configuration

Taking MATLAB analytics into production

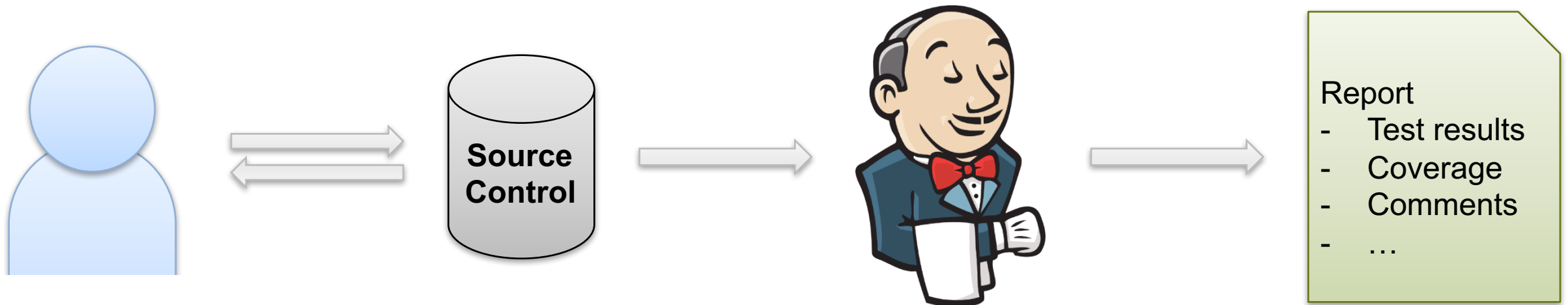


Testing: is it just a stage?

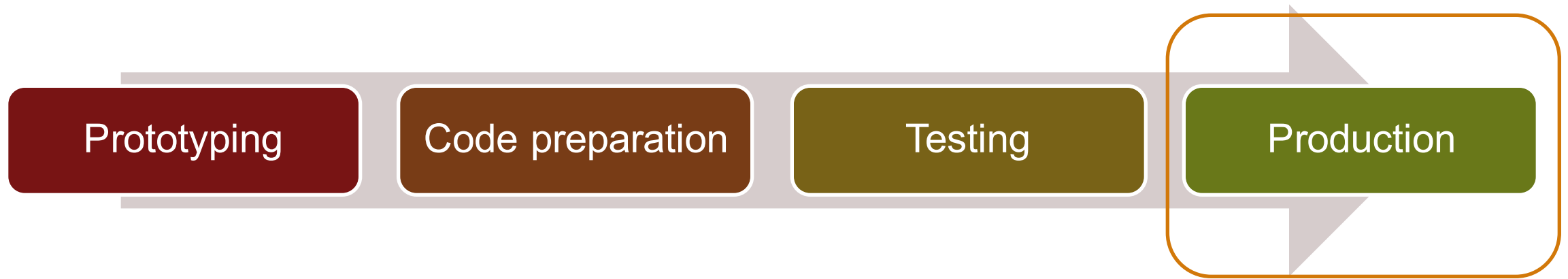


- Check whether results “look” correct
- Write a script to check if results are within predicted bands
- Write code to check whether results stay the same after code optimization
- Write a formal suite of tests covering your code
- Run tests automatically
- User acceptance
- Operations

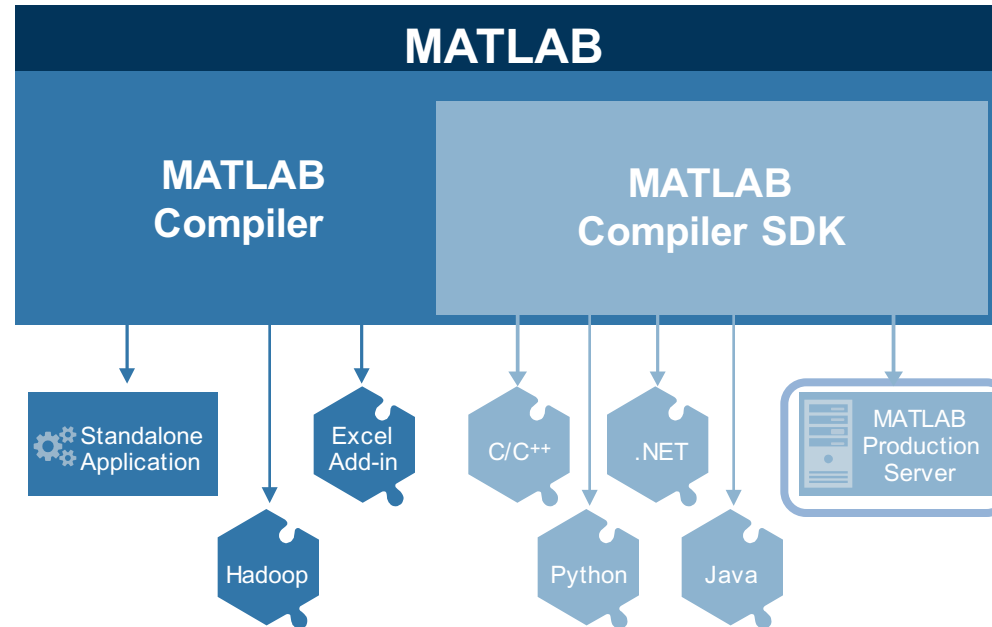
Example: testing



Taking MATLAB analytics into production



MATLAB deployment targets

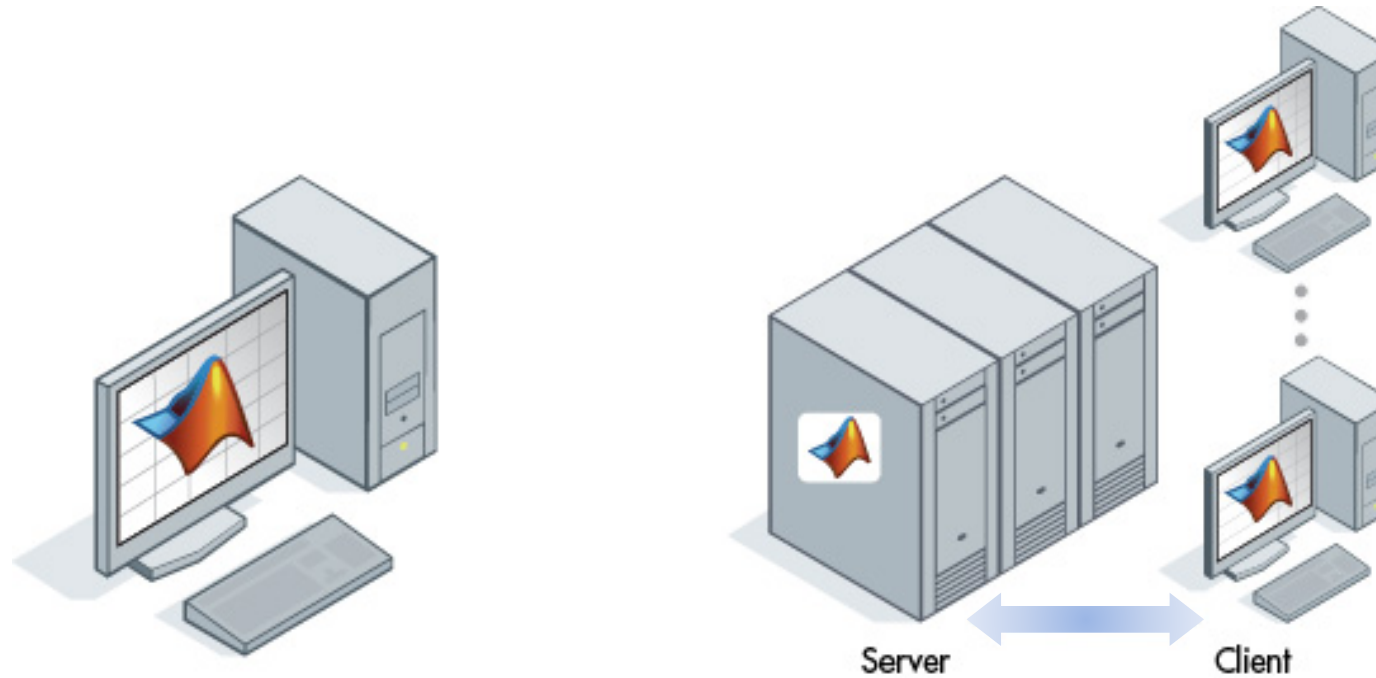


MATLAB Compiler enables sharing MATLAB programs without integration programming

MATLAB Compiler SDK provides implementation and platform flexibility for software developers

MATLAB Production Server provides the most efficient development path for secure and scalable web and enterprise applications

The range of application platforms



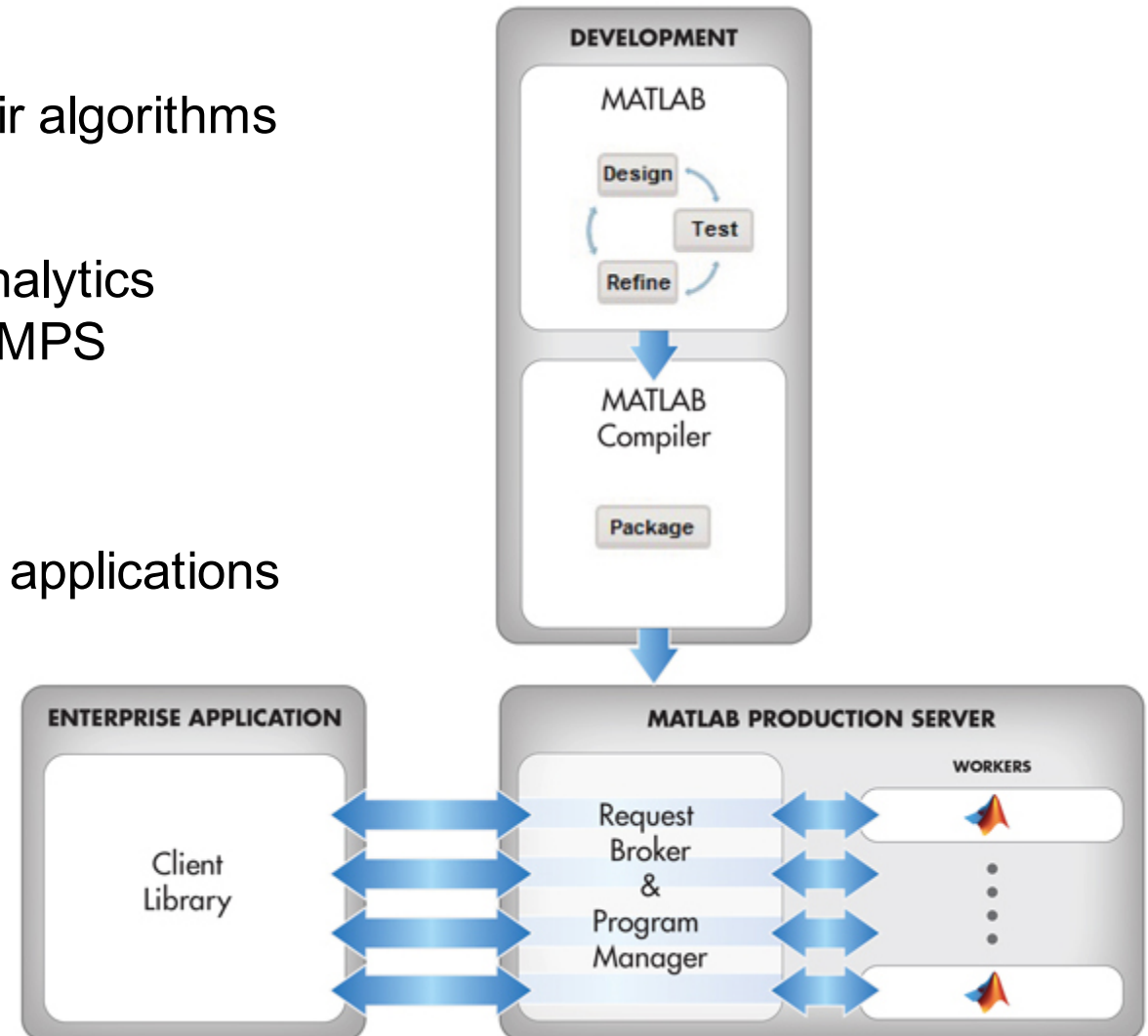
Standalone Applications

Web and Enterprise Applications

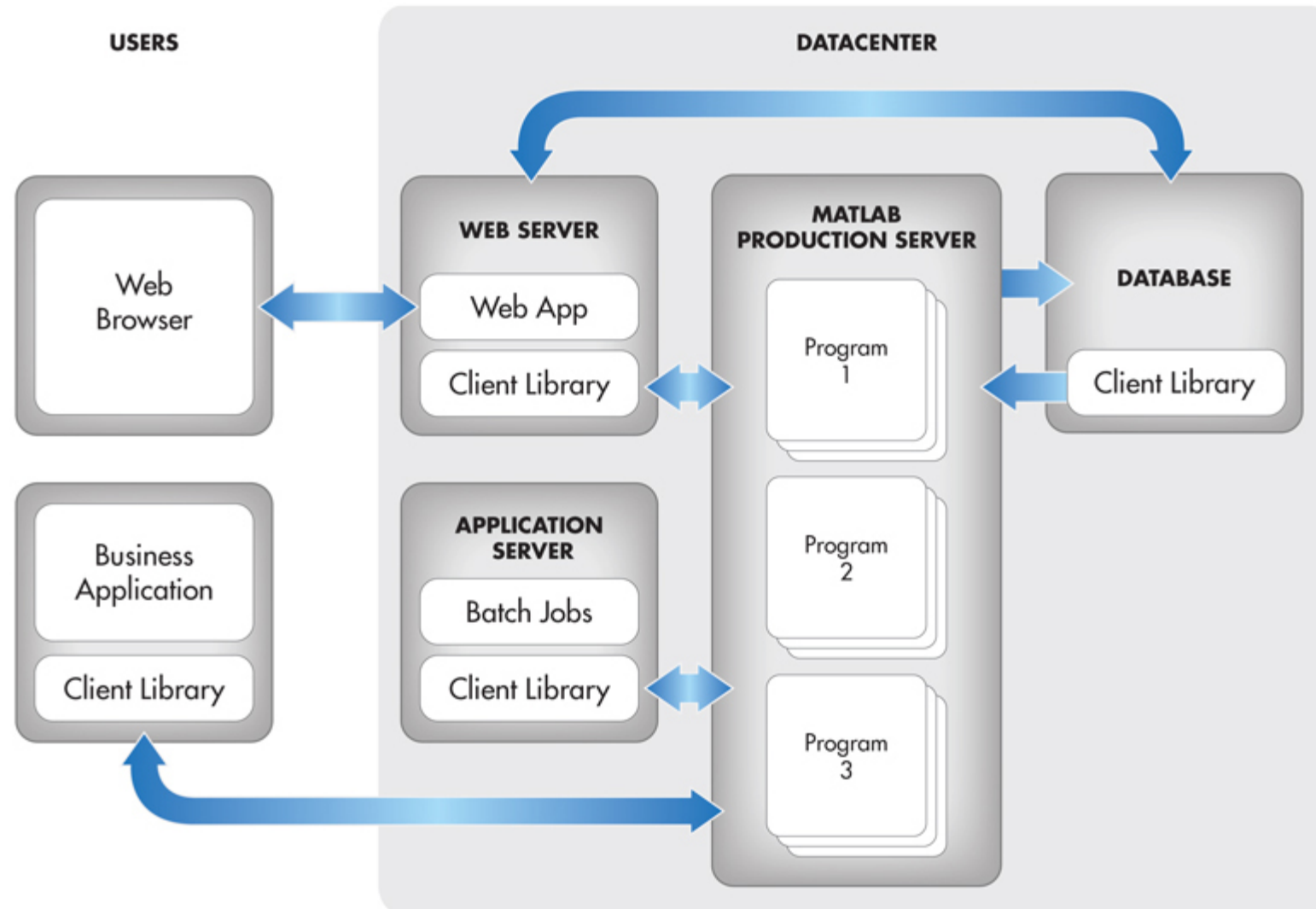
	Scale of Distribution
	Application Complexity
	Enterprise Integration

Production Deployment of MATLAB Programs

- Algorithm developers
 - MATLAB to design, test, and refine their algorithms
- System administrators
 - manage the deployment of MATLAB analytics within a production environment using MPS
- Application developers
 - integrate the lightweight client libraries included with MPS into their enterprise applications



Integration with Enterprise Applications



Develop and Test Framework – for MATLAB Production Server



The figure displays the MATLAB Compiler SDK interface for the 'PortOpAssetAlloc.prj' project. The top toolbar includes buttons for 'COMPILER', 'TEST', 'Breakpoints', 'Stop', and 'Close Test'. The 'Port' field is set to '9910'. Below the toolbar, the 'SERVER CONFIGURATION' section shows the 'Server Address' as 'Accepting client connections on: http://localhost:9910/PortOpAssetAlloc'. The 'SERVER ACTIONS' section includes 'SERVER CONFIGURATION', 'SERVER ACTIONS', and 'CLOSE' buttons. The 'Server Requests' section contains a table with 6 rows of requests, each with an ID, Function, and Status. The 'Server Log' section shows a list of log messages from 'Mon Apr 13 18:17:25 EDT 2015' to 'Mon Apr 13 18:18:09 EDT 2015', detailing the server's startup and connection handling process.

Server Address

Accepting client connections on: http://localhost:9910/PortOpAssetAlloc

Server Requests

ID	Function	Status
0	[token, ~] = initSession (assetSel, lb, ub, initPort, cashRate, cashMin, cashMax, isCVarR, turnover, cvarProbLev	Complete
1	[risk, ~] = computeEfficientFrontier (token, nPort)	Complete
2	[frontierImg, portPixelsX, portPixelsY] = visualizeFrontier (token, deployType, imageWidth, imageHeigh	Complete
3	[imageData] = visualizePortfolioSimulation (token, portIdx, useCached, deployType, imageWidth, imag	Complete
4	[imageData, alloc, labels] = visualizePortfolioComposition (token, portIdx, deployType, imageWidth, im	Complete
5	[imageData] = visualizePortfolioHistory (token, portIdx, deployType, imageWidth, imageHeight)	Complete
6	[wts, ret, std, var, cvar, ratio, maxdd, sdv] = computePortfolioStats (token, portIdx, probLevel)	Complete

Input

Name	Size	Bytes	Class
token	1x16	32	char array
portIdx	1x1	8	double array
deployType	1x9	18	char array
imageWidth	1x1	8	double array
imageHeight	1x1	8	double array

Output

Name	Size	Bytes	Class
imageData	1x5646	11292	char array
alloc	5x1	40	double array
labels	5x1	638	cell array

Server Log

```

Mon Apr 13 18:17:25 EDT 2015: bound to '[:,]:9910'
Mon Apr 13 18:17:25 EDT 2015: Starting
Mon Apr 13 18:17:25 EDT 2015: Started successfully
Mon Apr 13 18:17:25 EDT 2015: Starting
Mon Apr 13 18:17:25 EDT 2015: Waiting for a connection on port 9910
Mon Apr 13 18:17:25 EDT 2015: Started successfully
Mon Apr 13 18:17:25 EDT 2015: Listening for connections
Mon Apr 13 18:18:09 EDT 2015: Accepted connection from [::ffff:127.0.0.1]:57868 (socket = 6320)
Mon Apr 13 18:18:09 EDT 2015: Waiting for a connection on port 9910

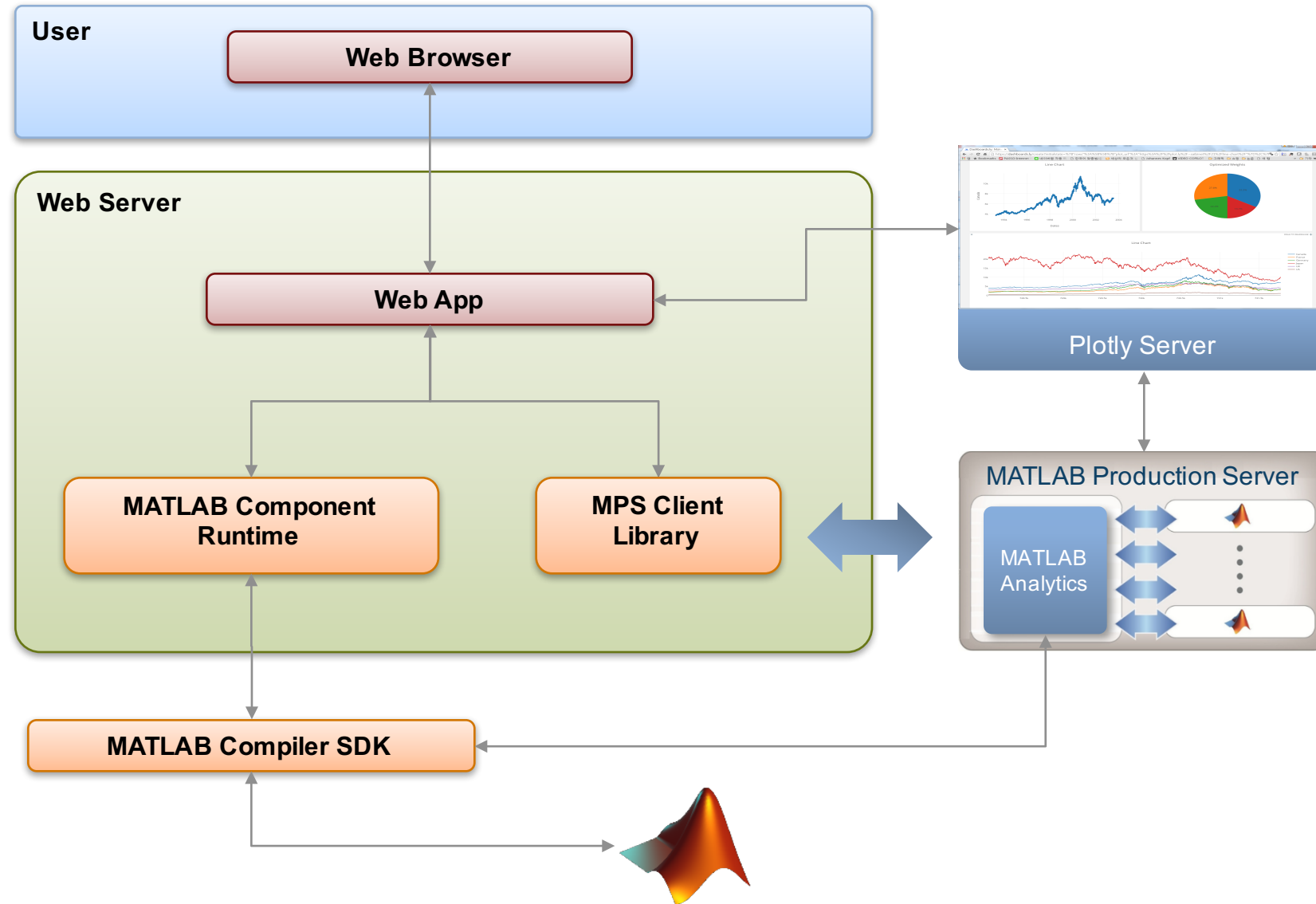
```

Reference Architecture

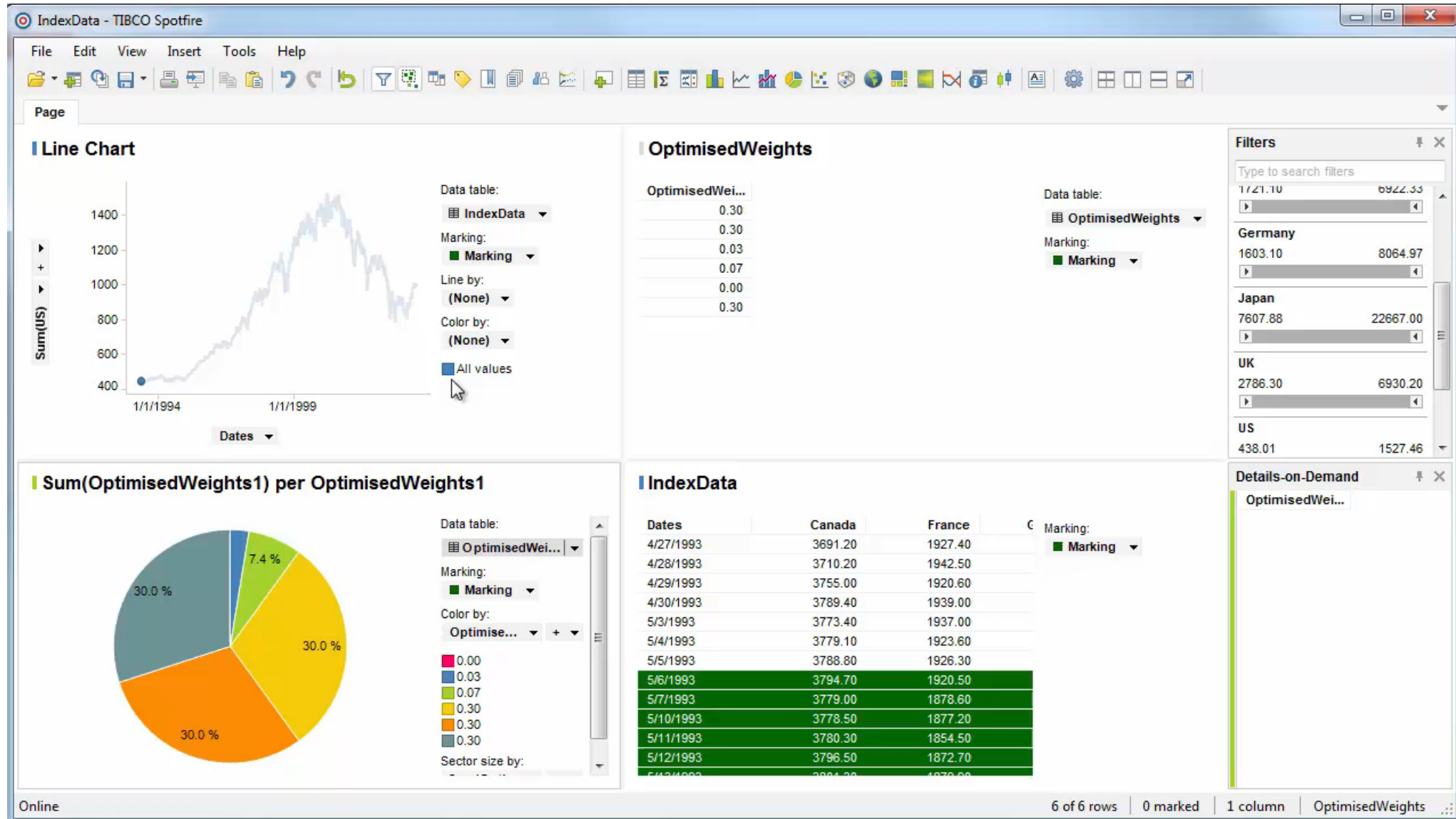
MATLAB analytics with Data Visualization tools



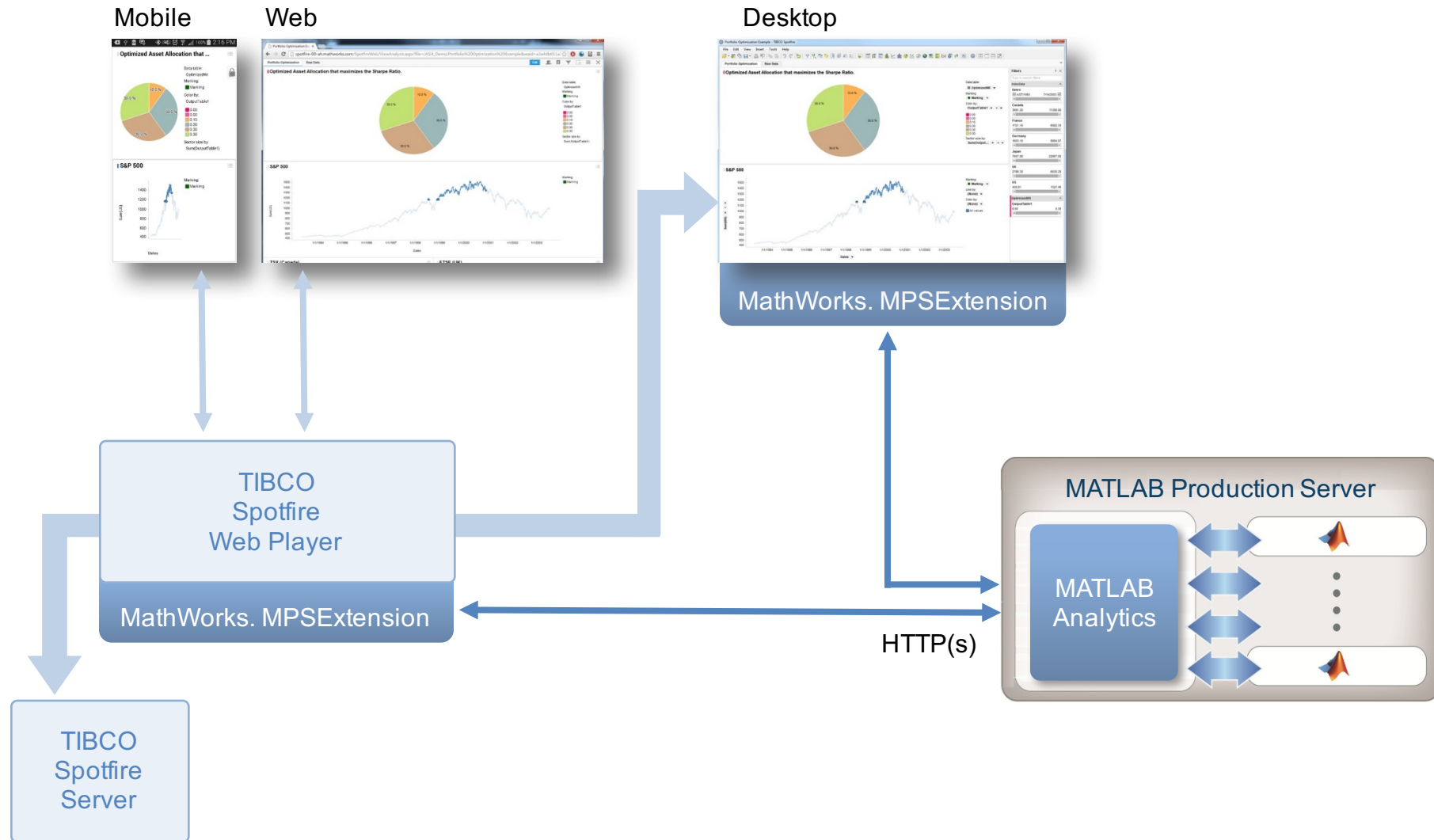
Reference diagram for Plotly



MATLAB analytics with TIBCO Spotfire



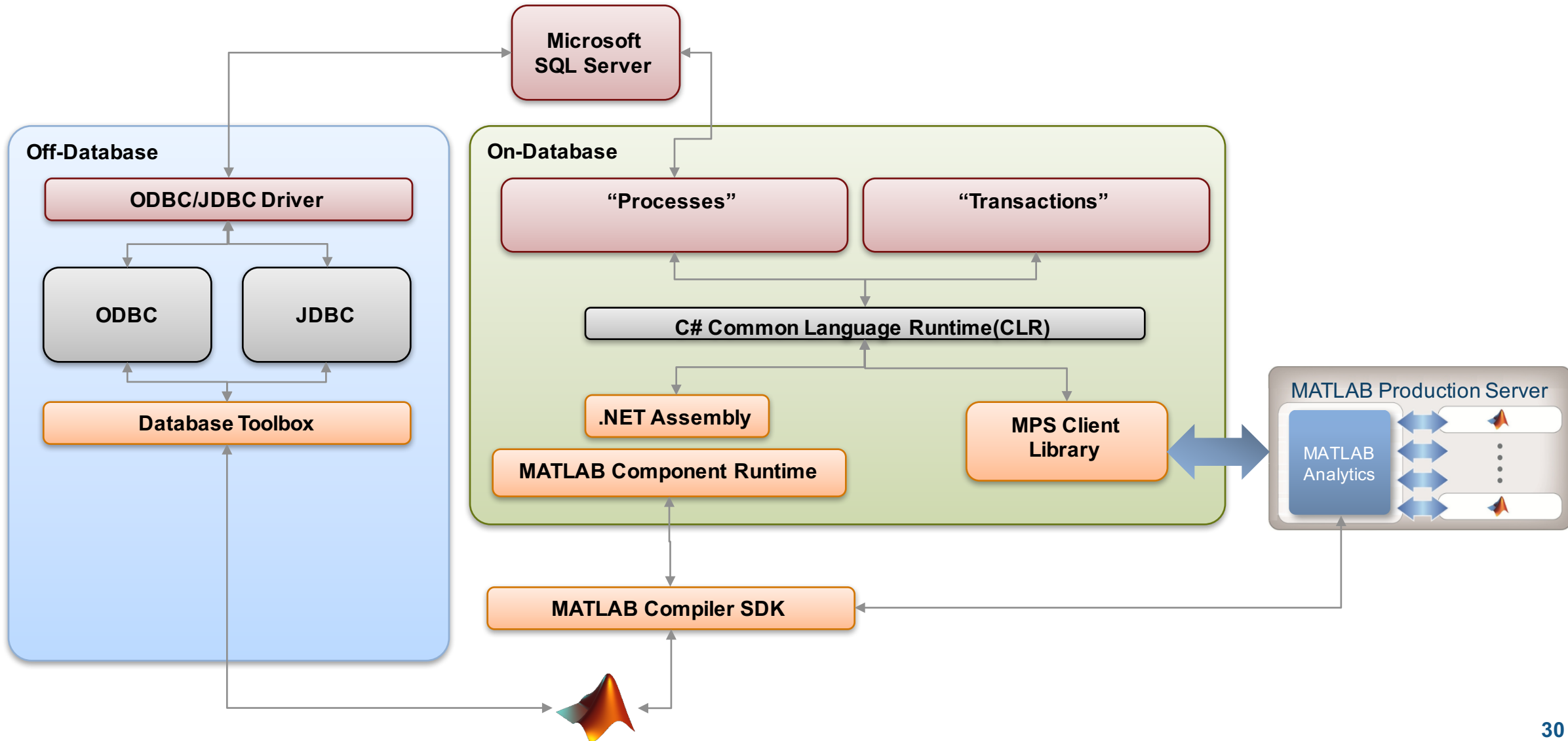
Reference diagram for TIBCO Spotfire



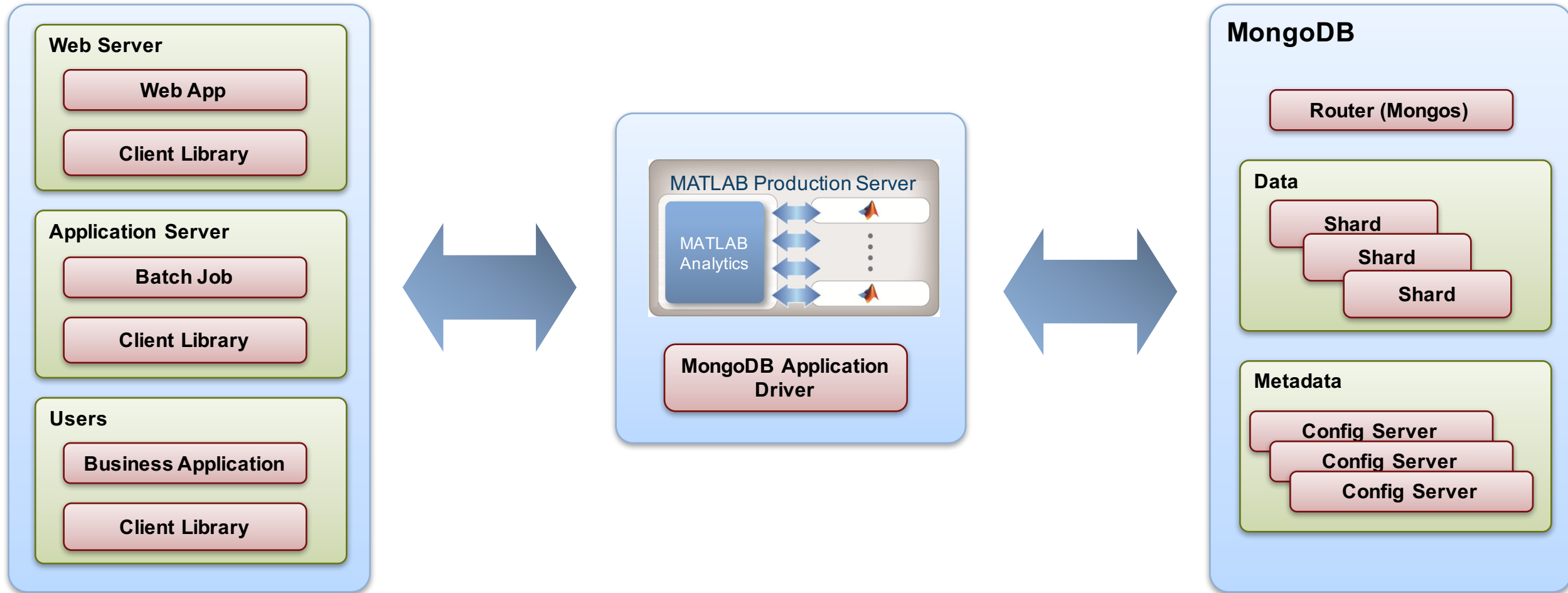
Reference Architecture

MATLAB analytics with SQL / NoSQL

MATLAB analytics with Microsoft SQL Server



MATLAB analytics with MongoDB



MATLAB analytics with Microsoft SQL Server

```

Editor - C:\Work\BHP\work\SQLServerDemo\app\functions\KSDensityDemo.m
1  function [g] = KSDensityDemo(varargin)
2  % KSDENSITYDEMO Demonstration of computation of KSDensity in deployment
3  % This function is intended to be deployed in the MATLAB Production Server
4  % as a demonstration of calling MATLAB analytics via SQL Server.
5  %
6  % Generate a mixture of two normal distributions, and compute the
7  % estimated inverse cumulative distribution function at a specified set of
8  % values.
9
10 % Auth/Revision: Arvind Hosagrahara
11 % Copyright 2013 The MathWorks Consulting Group
12 % $Id: KSDensityDemo.m 185 2013-09-03 21:58:24Z ahosagra $
13
14 x = [randn(30,1); 5+randn(30,1)];
15 yi = linspace(.01,.99,99);
16 g = ksdensity(x,yi,'function','icdf');
17
18 end %function

```

1

```

sp_configure 'clr enabled', 1;
GO
RECONFIGURE;
GO

```

2

```

CREATE ASSEMBLY MATLABClient
AUTHORIZATION dbo
FROM N'C:\Program Files\MATLAB\MATLAB Production Server
Local\R2015a\client\dotnet\MathWorks.MATLAB.ProductionServer.Client.dll'
WITH PERMISSION_SET = UNSAFE
GO

```

3

```

using MathWorks.MATLAB.ProductionServer.Client;

MWClient client = new MWHHttpClient();

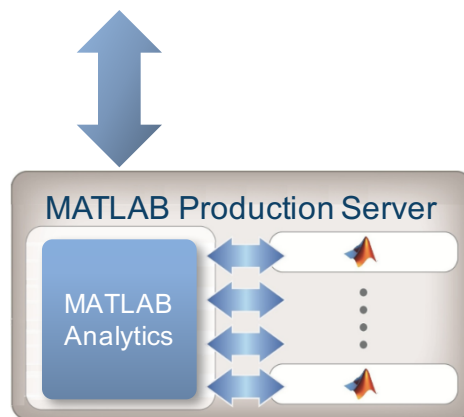
// Attempt to connect to MPS and call the MATLAB functionality
try
{
    // Create the Proxy interface for the MPS component
    KSDensityDouble mSq = client.CreateProxy<KSDensityDouble>(new
                                                                    Uri("http://localhost:9910/KSDensity"));
    ksDensity = mSq.KSDensityDemo(); // Call the method
    // Marshal and return the results
}

```

elapsed_ms

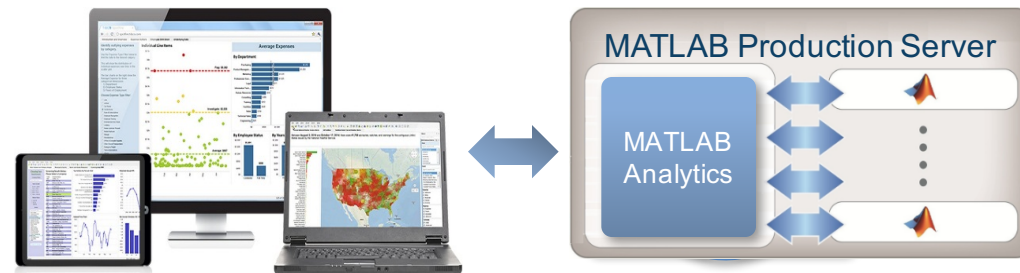
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Integration with production systems: benefits

Rapid development and deployment of MATLAB analytics	MATLAB
Analytics expressed in MATLAB with nearly all available toolbox functionality	MATLAB Compiler SDK MATLAB Production Server
Robust, scalable analytics available to entire organization	Microsoft Excel, Plotly, Spotfire, SQL server, MongoDB, etc.



Conclusions: MATLAB analytics in production

- Democratization: Yes.
 - Integrate analytics with enterprise systems
- Agility: Yes.
 - Access and explore data from within MATLAB during prototype development
 - Establish process allowing rapid iterations between ideas and production system
- Production Quality: Yes.
 - MATLAB products and services provide a single-stack solution when used with supporting technologies to address production data analytics demands

Taking MATLAB analytics into production

