

MATLAB EXPO

Kubernetes와 컨테이너화 된 마이크로 서비스에
클라우드 네이티브 MATLAB 기능을 배포하기

엄준상 부장, 매스웍스코리아





Optimizing cost with Simulation and Digital Twins

Carl Wouters

[Link to User Story](#)

Frontier Advisors Develops Web-Based Platform for Portfolio Analytics

“MATLAB and MATLAB Compiler SDK enabled us to rapidly deliver a sophisticated portfolio analytics web application with confidence that it will return accurate results extremely quickly, ensuring a highly usable and stable platform for our clients.”

— Lee Eriera, Frontier Advisors



» [Learn about Frontier Advisors Technology](#)

Challenge

Provide clients with an industry-first web platform for portfolio modelling and analytics

Solution

Use MATLAB to develop and test analytics modules, and use MATLAB Compiler SDK to deploy them into a production .NET environment

Results

- Quantitative development decoupled from interface development
- Stable, responsive system deployed
- Rapid delivery of new features enabled

[Link to User Story](#)

Konkuk University

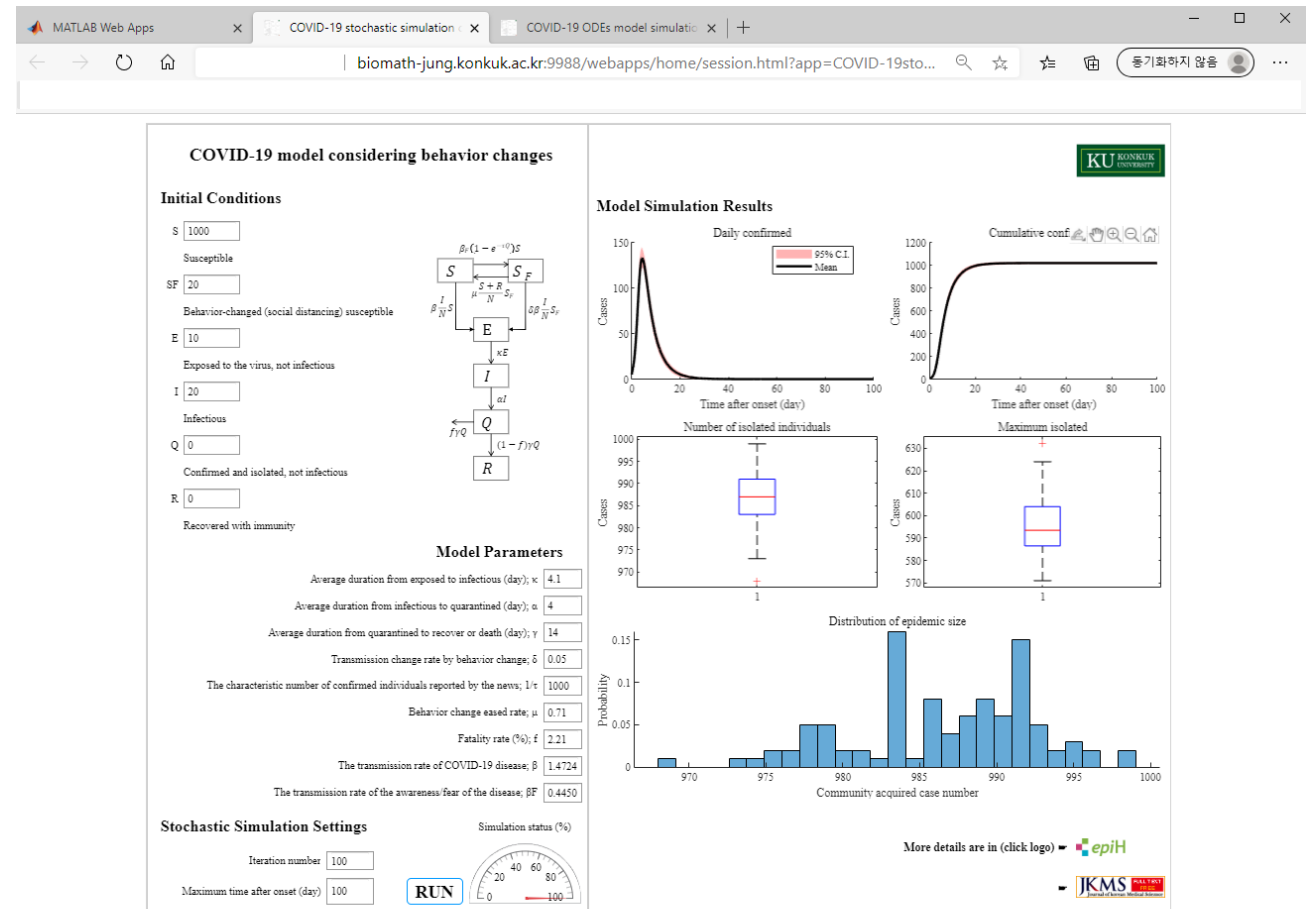
Forecasts COVID-19 trend and effects of social distancing for KDCA

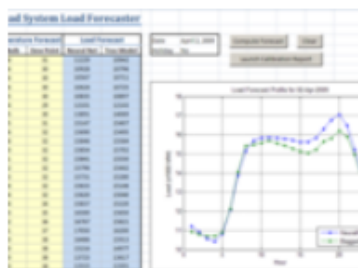
Professor Eun ok Jung has developed a SEIR model using MATLAB.

She predicts infection rate in South Korea and provides scientific background for KDCA.

The model is published using MATLAB Web App Server, and freely accessible from browser.

For her profound contribution, she received the honor of a President's Commendation from President award on April 21, 2020.





Electricity Load and Price Forecasting Webinar Case Study

version 1.7.0.1 (12.3 MB) by [Ameya Deoras](#)

Slides and MATLAB® code for the day-ahead system load and price forecasting case study.

★★★★★ (25)

30.7K Downloads ⓘ

Updated 01 Sep 2016

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Overview

Functions

Examples

Reviews (25)

Discussions (79)

Electricity Load & Price Forecasting/

[importData.m](#)

Electricity Load & Price Forecasting/Load/

[fetchDBLoadData\(startDate, endDate\)](#)

[genPredictors\(data, term, holidays\)](#)

[loadForecast\(date, temperature, isH...](#)

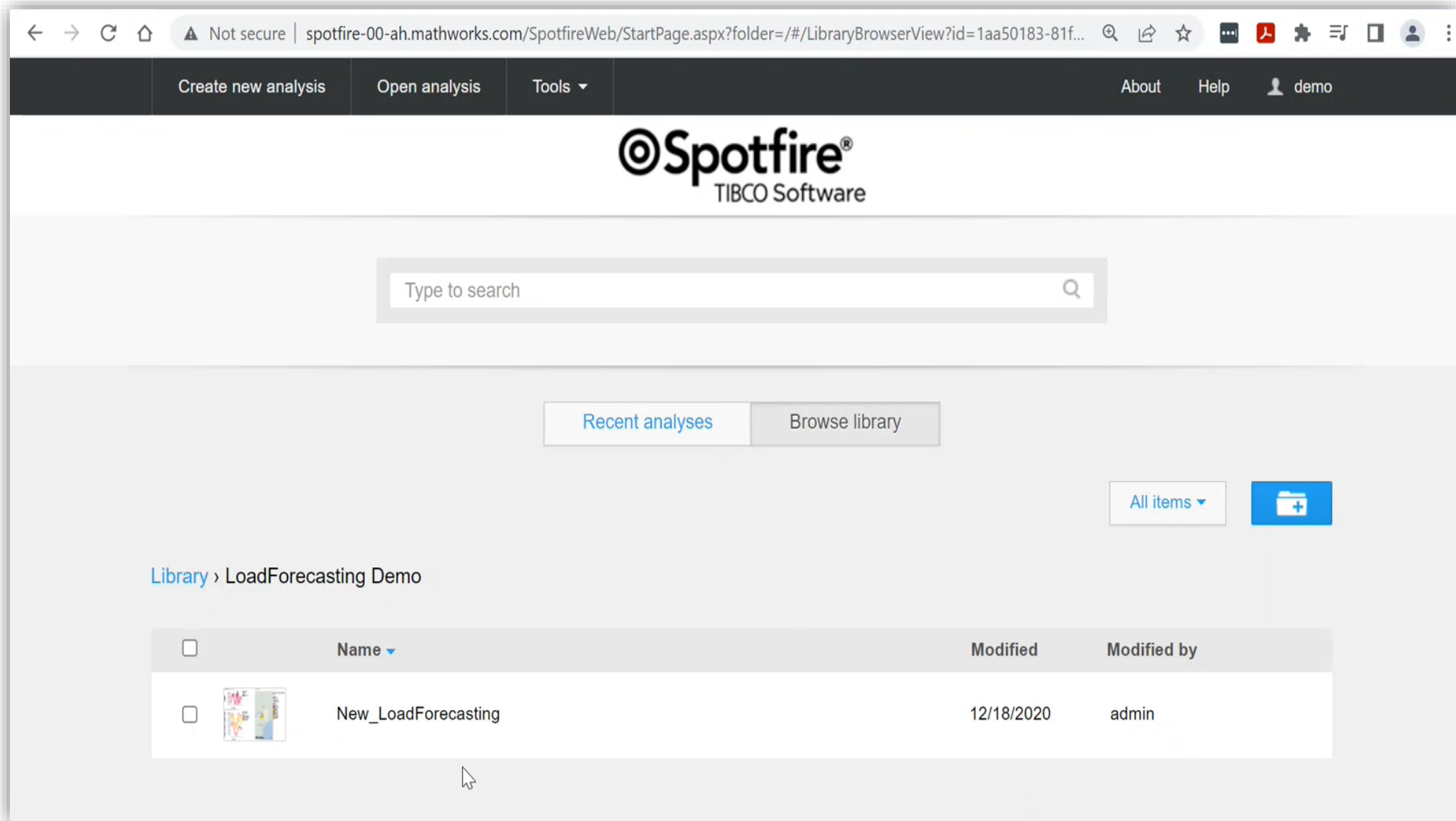
[TreesInDetail.m](#)

Electricity Load & Price Forecasting/


```
function y = loadForecast(date, temperature, isHoliday)
% LOADFORECAST performs a day-ahead load forecast using a pre-trained
% Neural-Network or Bagged Regression Tree model
%
% USAGE:
% y = loadForecast(model, date, hour, temperature, isWorkingDay))

% Process inputs
date = datenum(date);
if date < 7e5 % Convert from Excel numeric date to MATLAB numeric date if necessary
    date = x2mdate(date);
end
```

Load forecasting deployed on MATLAB Production Server

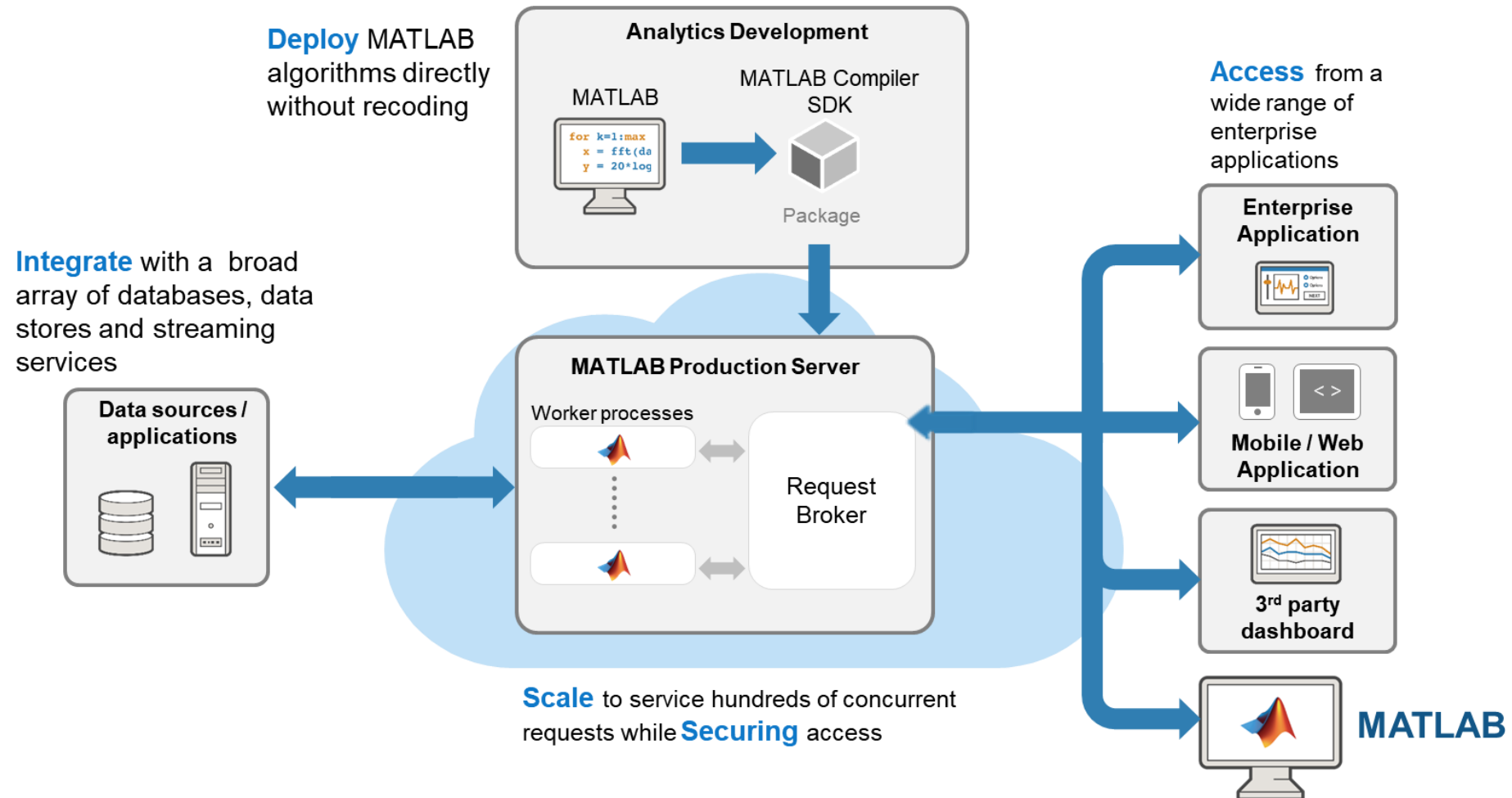


The screenshot displays the Spotfire web interface within a browser window. The address bar shows the URL: `spotfire-00-ah.mathworks.com/SpotfireWeb/StartPage.aspx?folder=/#/LibraryBrowserView?id=1aa50183-81f...`. The interface includes a top navigation bar with links for 'Create new analysis', 'Open analysis', 'Tools', 'About', 'Help', and a user profile 'demo'. The main header features the Spotfire logo and 'TIBCO Software'. Below this is a search bar with the placeholder text 'Type to search'. Two buttons, 'Recent analyses' and 'Browse library', are visible. On the right, there is a dropdown menu for 'All items' and a blue button with a plus icon. The breadcrumb path 'Library > LoadForecasting Demo' is shown. A table lists the contents of the library:

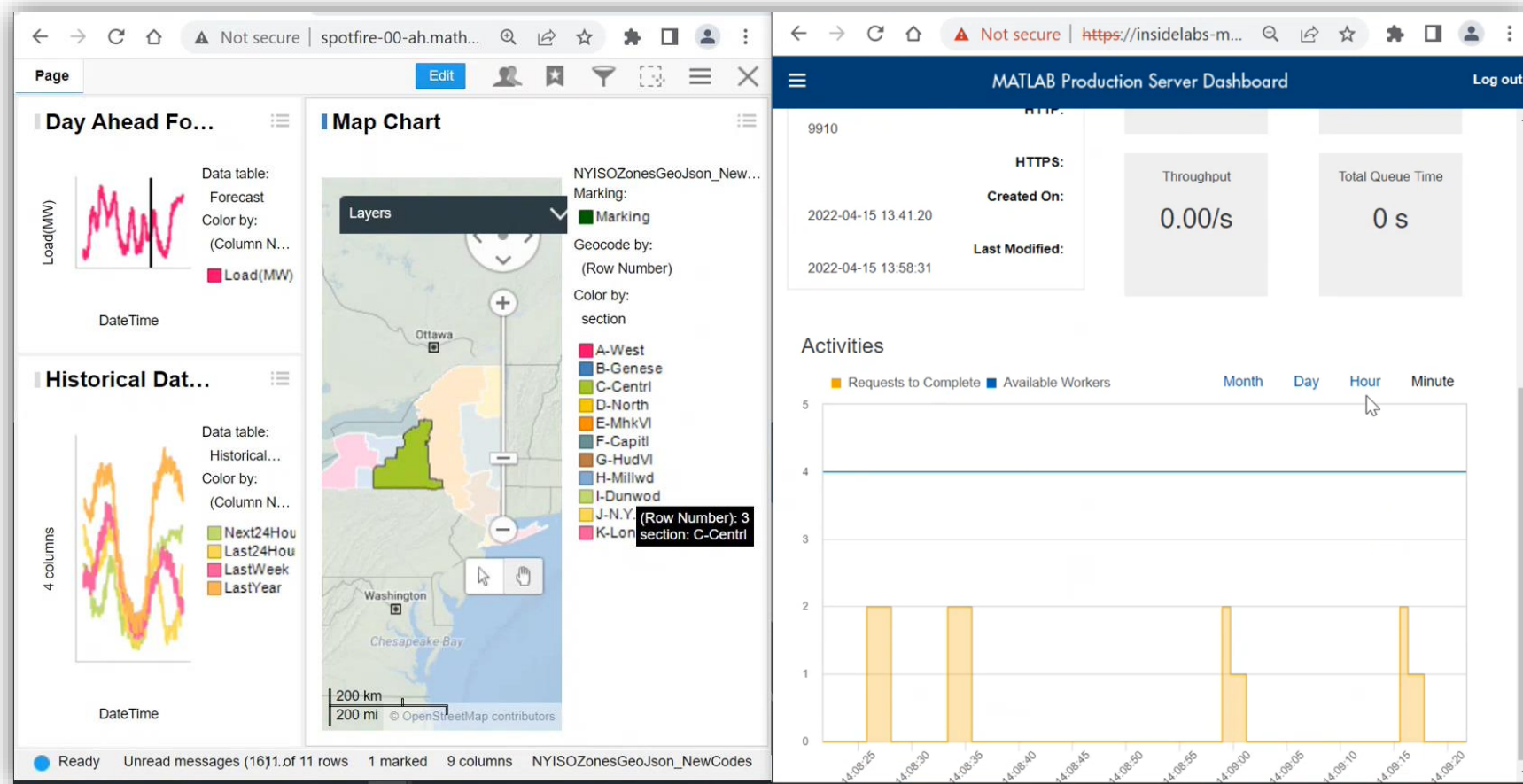
<input type="checkbox"/>	Name ▾	Modified	Modified by
<input type="checkbox"/>	 New_LoadForecasting	12/18/2020	admin

[Spotfire extension for MATLAB Production Server](#)

Deploy MATLAB & Simulink models using MATLAB Production Server



Understanding resource utilization using production server dashboard



Size your MATLAB Production Server

What to consider ?

Accessibility

- Data
- Models
- APIs
- CI/CD

Infrastructure

- Compute
- Memory
- Security
- Network Access

Maintenance & Recovery

- Health Check
- Backup
- Server management

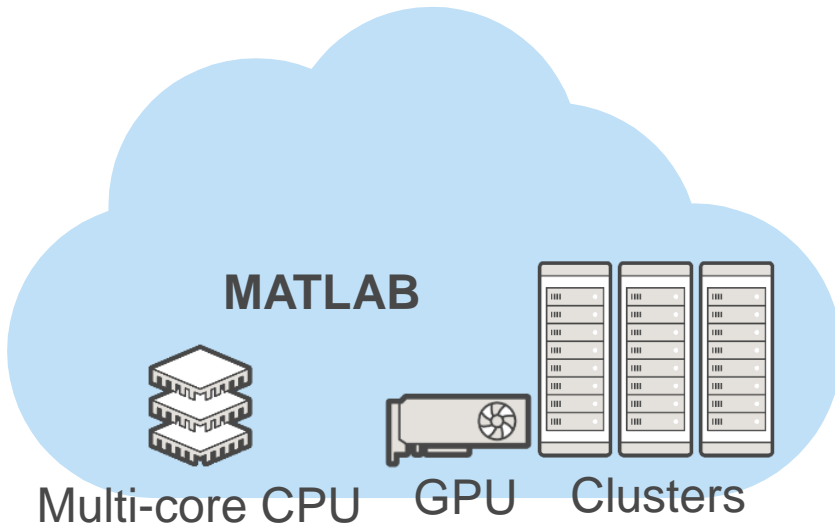
Scalability

Vertical

Bigger/Smaller server
High up-front cost **vs** risk of
running out of resources

Horizontal

Number of nodes required concurrently
Load balancing across nodes/VMs
Regional and Global LBs



Either way requires high maintenance if you keep on-premise !

Key Takeaways

- Deploying MATLAB algorithms into cloud-native webservices using MATLAB Production Server
- Comparing VM based and Container based provisioning of MATLAB Production Server
 - Selecting deployment strategy based on requirements
 - Available reference architectures
- New Kubernetes-hosted MATLAB Production Server is
 - Performant
 - Resilient
 - Provides on-demand scaling

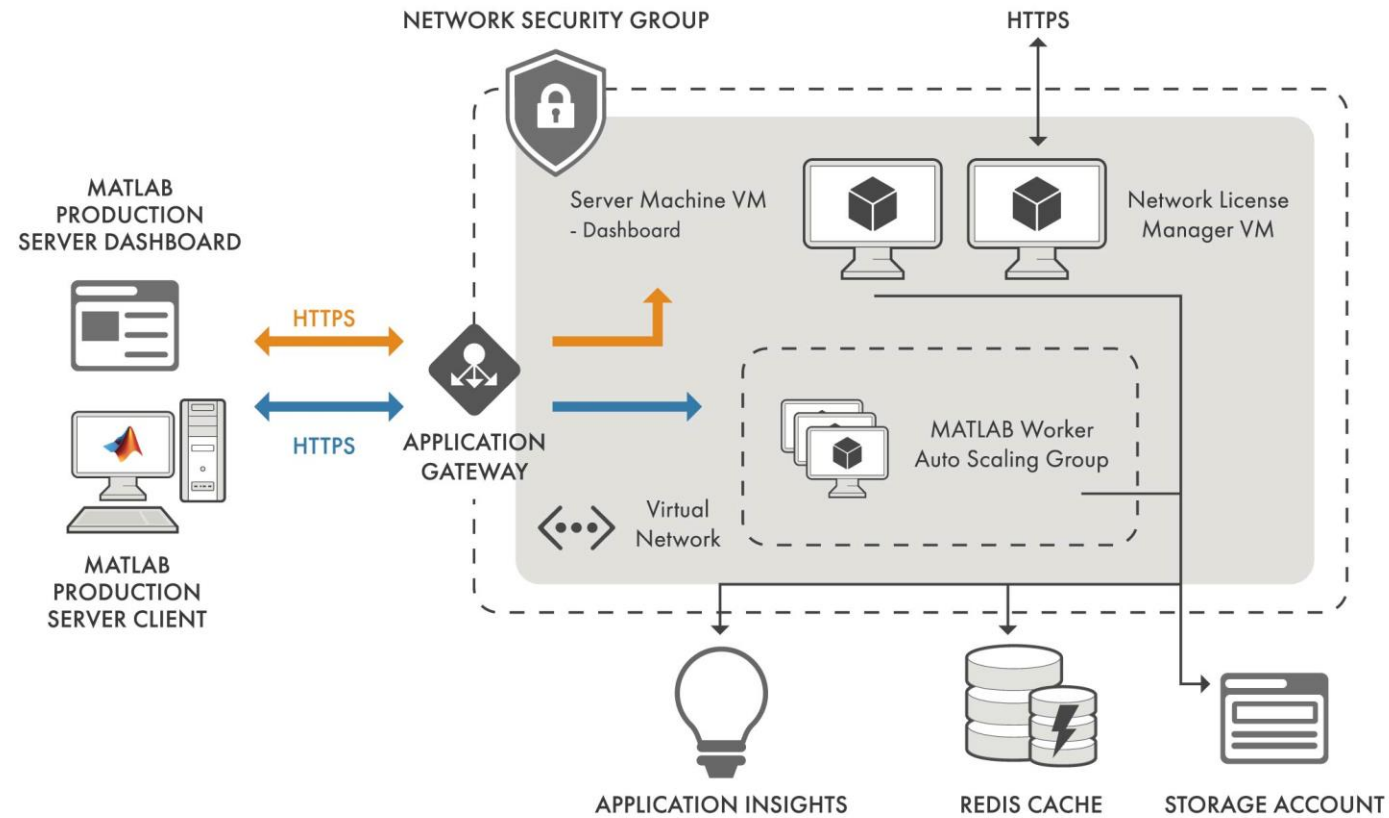
Marketplace products can be provisioned and purchased directly from Azure

The screenshot displays the Azure Marketplace interface. At the top, there's a blue header with the Microsoft logo, 'Azure Marketplace' text, an 'Apps' dropdown, a search bar, and a 'More' dropdown with a heart icon. Below the header, a left sidebar lists various categories: 'Browse apps', 'Get Started', 'Analytics', 'AI + Machine Learning', 'Azure Active Directory apps', 'Blockchain', 'Compute', 'Containers', 'Databases', 'Developer Tools', 'DevOps', 'Identity', 'Integration', 'Internet of Things', 'IT & Management Tools', 'Monitoring & Diagnostics', and 'Media'. The main content area features filter tabs for 'Trials', 'Operating System', 'Publisher', 'Pricing Model', and 'Product Type', all currently set to 'All'. A 'Reset filters' link is present. Below the filters, it states 'Results in All apps for matlab (4)'. Four product cards are shown, each with the MATLAB logo and a description:

- MATLAB (BYOL)**
By MathWorks
MATLAB® is a programming platform designed for engineers and scientists.
Price varies
Buttons: 'Get it now' and a heart icon.
- MATLAB Production Server (BYOL)**
By MathWorks
MATLAB Production Server is an application server for MATLAB analytics.
Price varies
Buttons: 'Get it now' and a heart icon.
- MATLAB Parallel Server (BYOL)**
By MathWorks
MATLAB Parallel Server™ scales MATLAB® programs and Simulink® simulations to clusters.
Buttons: 'Contact me' and a heart icon.
- MATLAB Production Server (PAYG)**
By MathWorks
MATLAB Production Server is an application server for MATLAB analytics.
Price varies
Buttons: 'Get it now' and a heart icon.

representative here or request a trial license.

VM based reference architecture for MATLAB Production Server



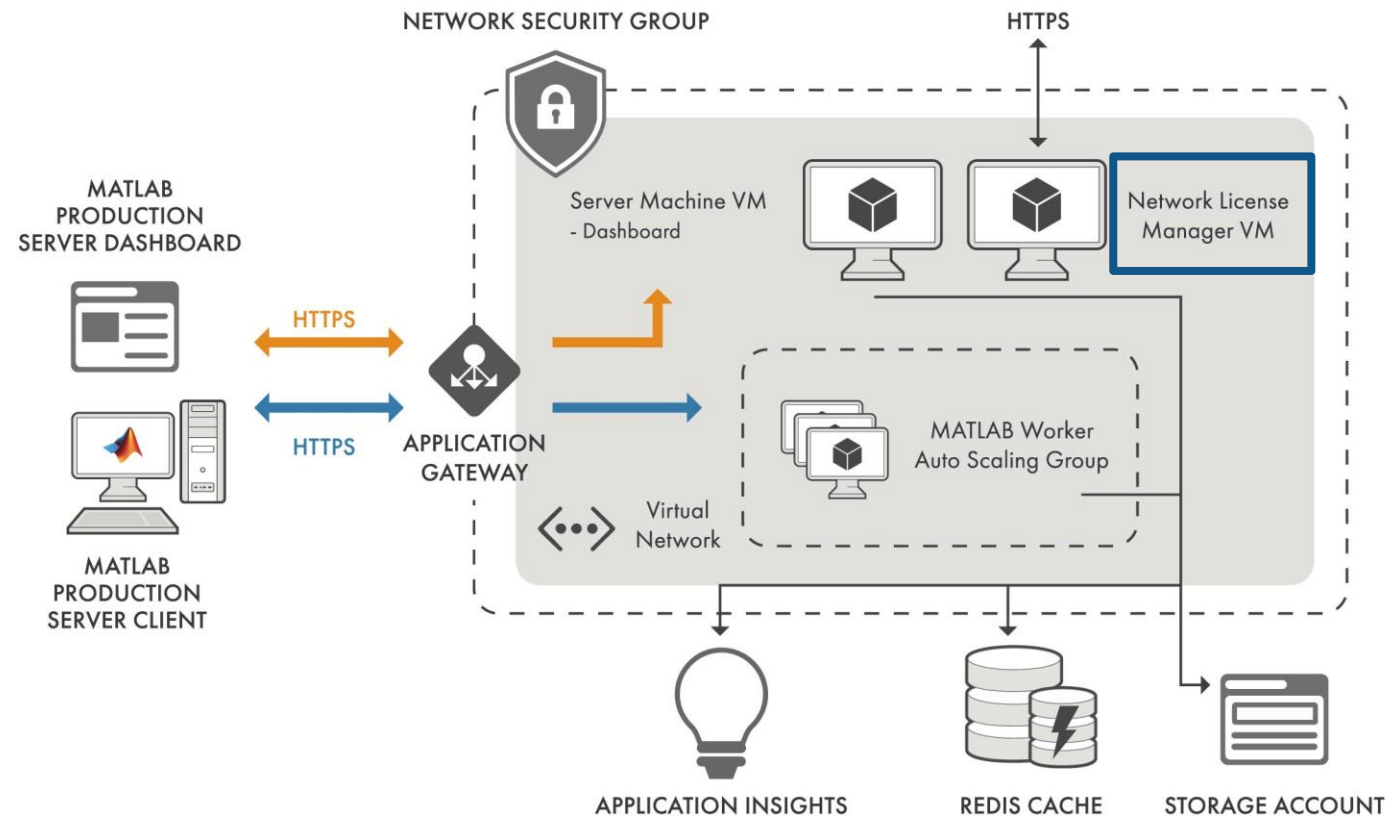
Deploying to cloud using MATLAB Production Server

VM based MATLAB Production Server:

- Every instance is a separate VM
- Windows or Linux OS
- Manual scaling capability
- Web dashboard configuration

Reference Architectures available on GitHub:

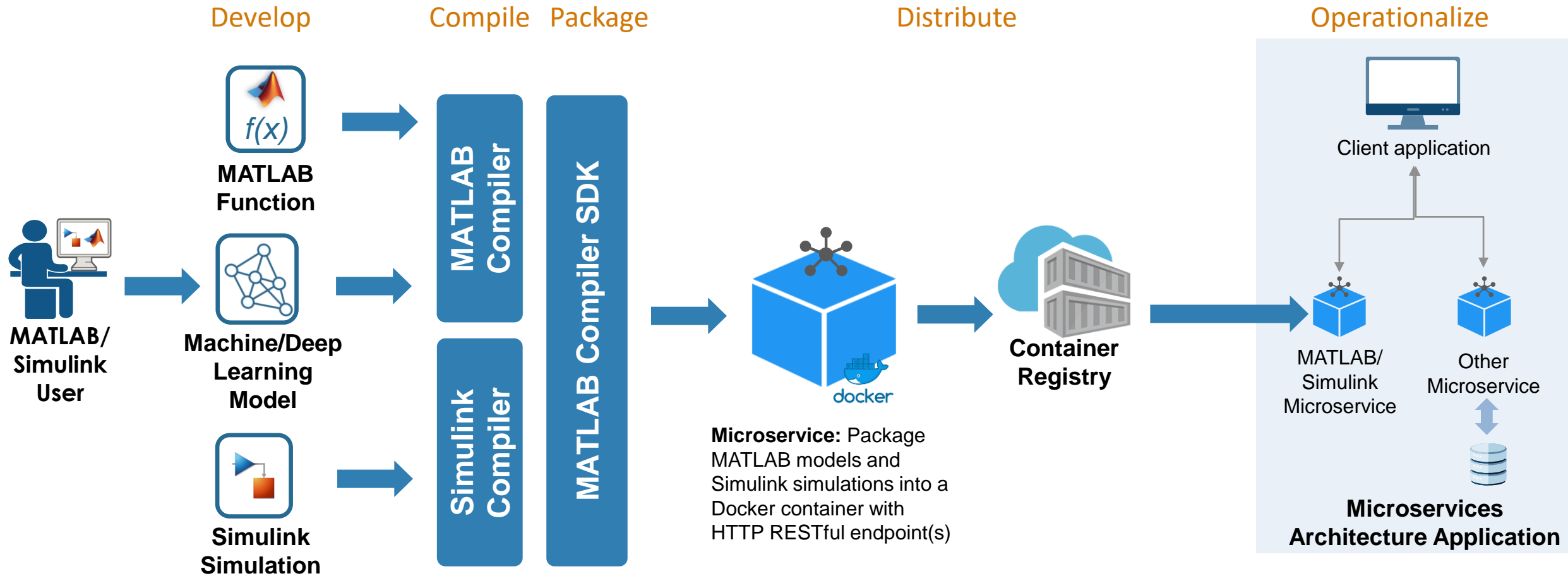
- [AWS](#)
- [Azure](#)
- [GCP](#)



Key Takeaways

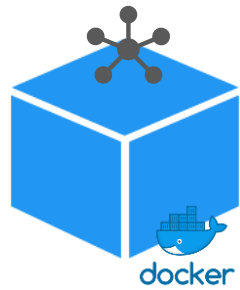
- ✓ Deploying MATLAB algorithms using MATLAB Production Server
- ✓ VM based provisioning of MATLAB Production Server on cloud
- Container based provisioning of MATLAB and Simulink models on the cloud
- New Kubernetes-hosted MATLAB Production Server is
 - Performant
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Microservices from MATLAB & Simulink using MATLAB Compiler SDK

R2022a

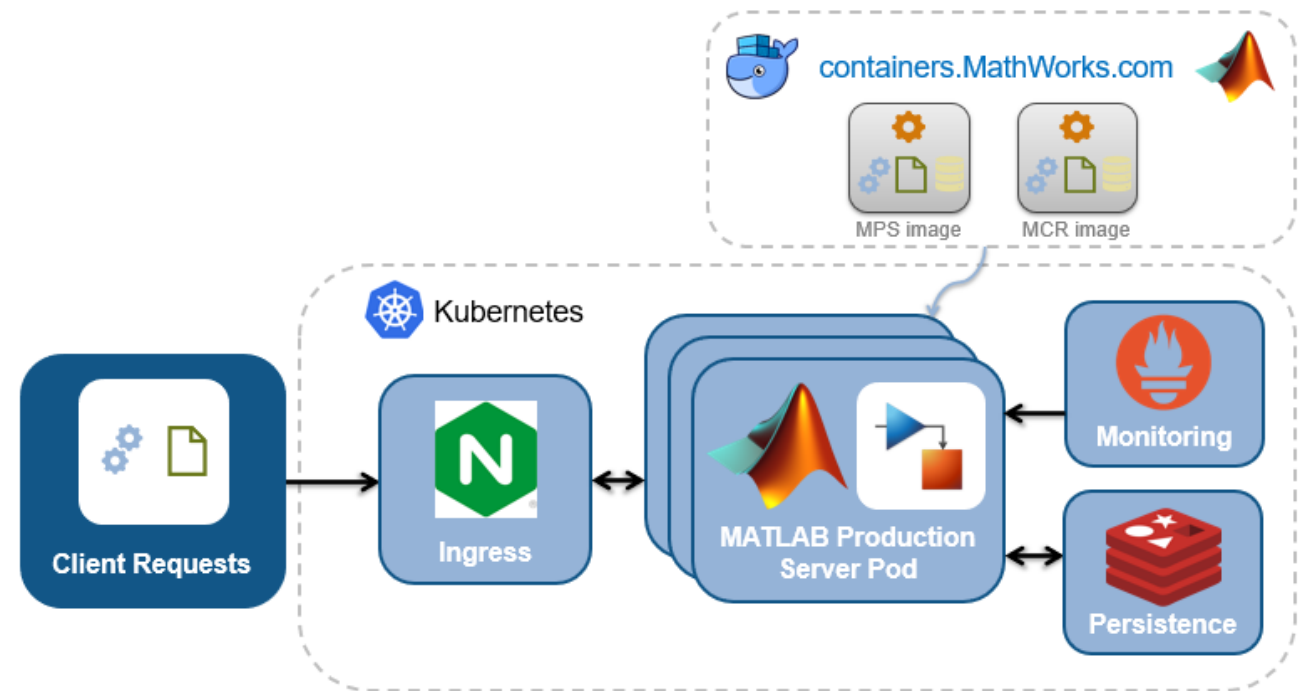
Deploy MATLAB and Simulink algorithms in containers

Turn proof of concepts...



Package MATLAB models and Simulink simulations into a Docker container with RESTful HTTP endpoint(s) using the new microservice feature in MATLAB Compiler SDK R2022a

Into production web services deployed with DevOps principles



Turn those same MATLAB models and Simulink simulations into production-ready RESTful HTTP endpoint(s) with access control, autoscaling, and more

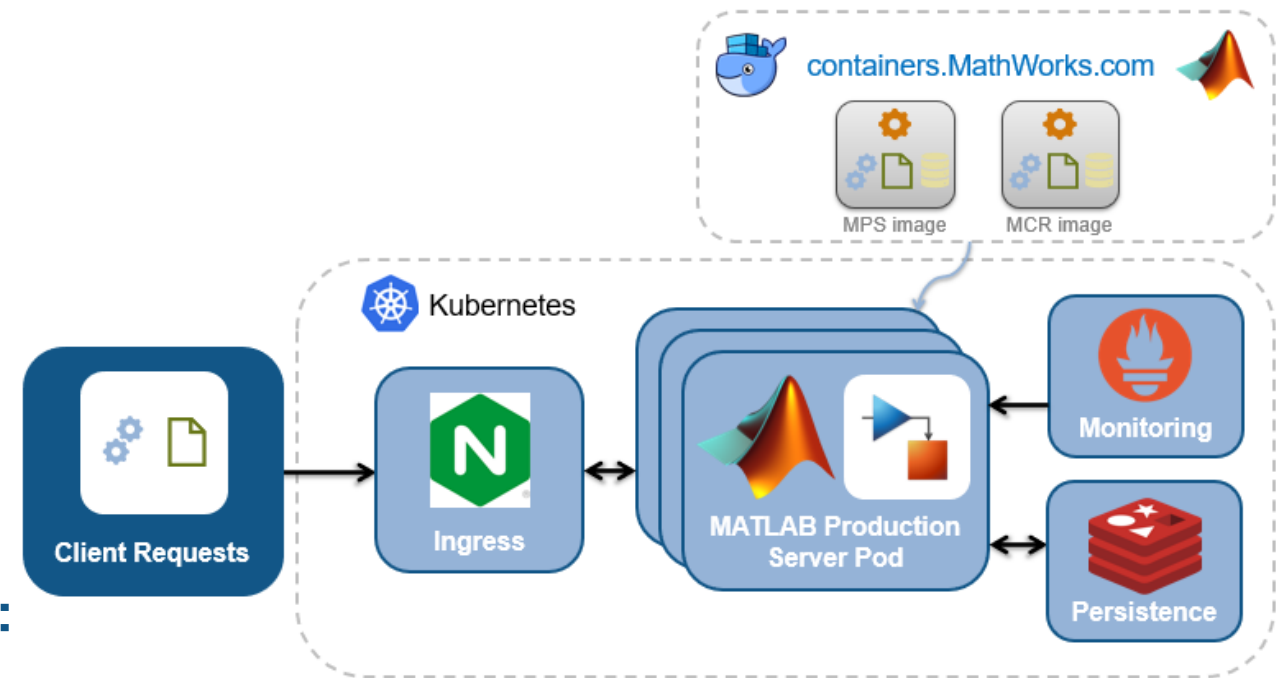
Deploying to cloud using MATLAB Production Server

Container-based MATLAB Production Server

- Any Kubernetes cluster (Vendor independent)
- Lightweight, lower upfront infrastructure cost (New pods can be started quickly)
- Linux only
- Autoscaling
- CLI configuration

Reference Architectures available on GitHub:

- [Any Kubernetes cluster, including AWS, Azure, and GCP](#)



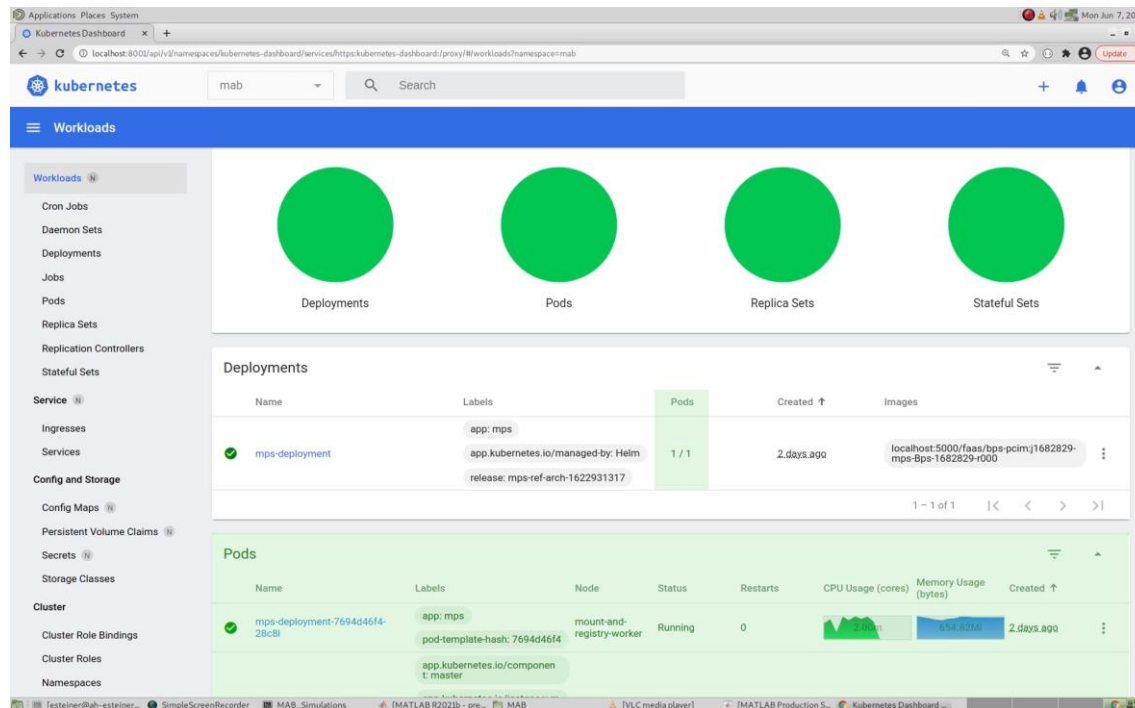
How can we manage containers? Enter: Kubernetes



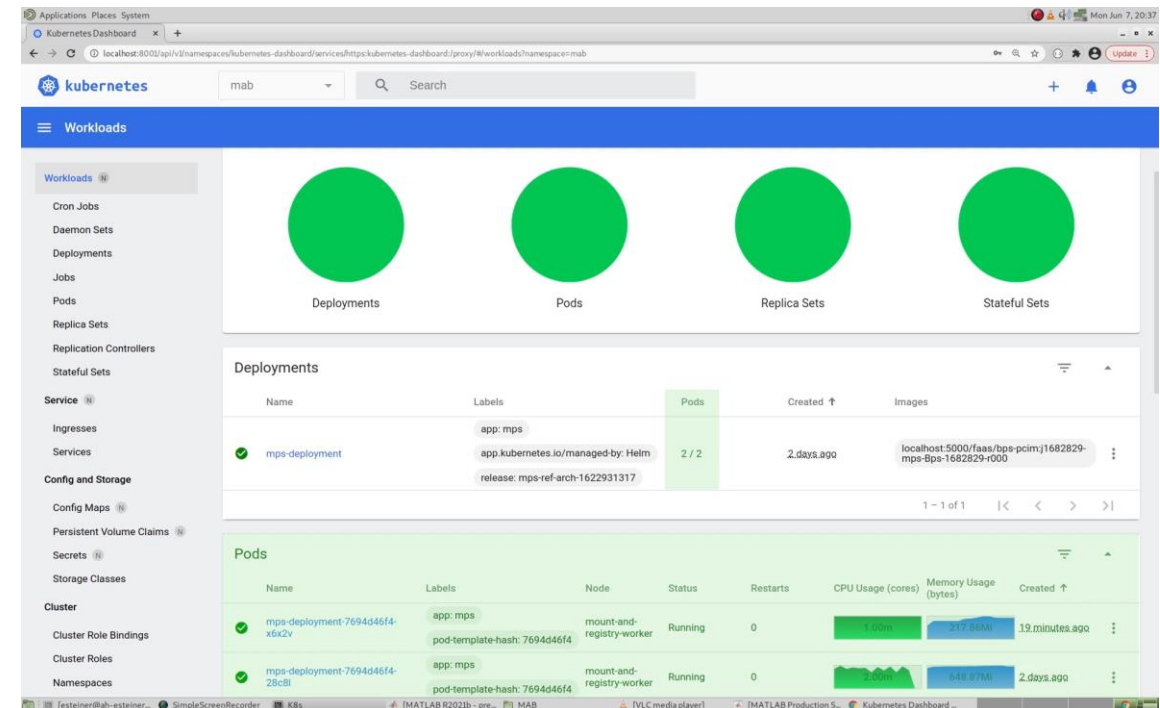
Image source: <https://spot.io/blog/above-all-clouds-orchestrating-and-managing-kubernetes-across-cloud-and-on-premises>

Kubernetes autoscaling based on requests

This makes it easy on solutions architect to design, plan and scale with a lot of flexibility



Adding resources



Removing resources

Deploying K8s hosted MATLAB Production Server

```
nbonfatt@appdemos-ah:~/prodserverk8s$
```

Which cloud architecture should we use?



CTO

Drives operational
strategy

클라우드 소프트웨어 종속을 방지하고 반복 가능하고
자동화된 배포를 위해 가능한 경우 컨테이너에서
표준화된 환경을 구성하고 싶습니다.

MATLAB Production Server에는 이를 쉽게 수행할
수 있는 **Kubernetes** 기반 배포 참조 아키텍처가
있습니다.



System Architect

Deploys and operationalizes
models on Azure cloud



Which cloud architecture should we use?



Windows 기반 소프트웨어를 필요로 하는
통합 기능이 있습니다.

Process Engineer

Develops models in
MATLAB and Simulink



이 경우 **Windows VM 기반 MATLAB
Production Server** 배포를 사용해야 합니다.

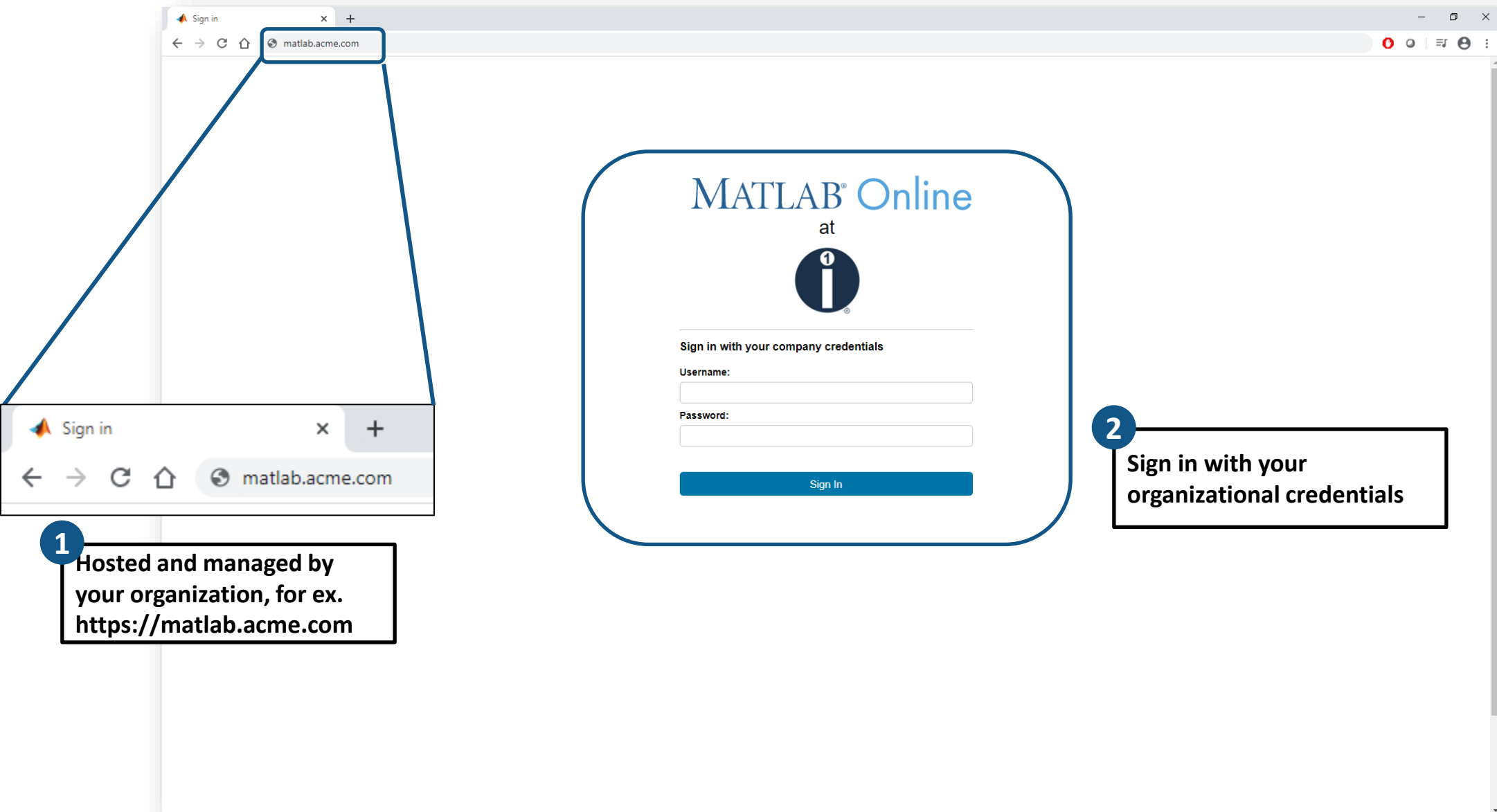


System Architect

Deploys and operationalizes
models on Azure cloud



MATLAB Online – hosted, managed, and controlled by you



MATLAB Online – hosted, managed, and controlled by you

The screenshot displays the MATLAB Online R2020a interface. The top navigation bar includes tabs for HOME, PLOTS, APPS, LIVE EDITOR, INSERT, and VIEW. The APPS tab is highlighted. Below the navigation bar is a toolbar with icons for file operations (New, Save, Find Files), navigation (Go To, Find), text formatting (B, I, U, M), code editing (Code, Refactor), and execution (Run, Step, Stop). The main workspace is divided into several panels:

- File Explorer (Left):** Shows the current folder structure, including subfolders like Control_Systems_Analysis, Mobile_Sensor_Data, Step_Counter_Demo, Symbolic_Math_Examples, Test_Bed_Data_Analysis, and exoplanets.xlsx. The file Exploring_Exoplanets.mlx is selected.
- Code Editor (Center):** Displays the MATLAB script for "Exploring Exoplanets". The script includes comments and code for reading data from "exoplanets.xlsx", filtering for specific star types, and plotting the results. The code is as follows:


```

1 exoplanets = readtable('exoplanets.xlsx','TextType','string');
2 head(exoplanets)

3
4
5
6 star_types = {'A' 'B' 'F' 'G' 'K' 'M'};
7
8 T = exoplanets(~cellfun(@isempty, exoplanets.st_spectral_type),:);
9 data = {};
10 for i = 1:numel(star_types)
11     data{i} = T(startsWith(T.st_spectral_type, star_types{i}), :);
12 end
13 plot_star_types(data, star_types)

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```
- Workspace (Bottom Left):** Shows the variables in the workspace, including exoplanets (8x21 table), star_types (1x6 cell array), T (3436x21 table), data (cell array), and idx (1x1 double).
- Command Window (Bottom Right):** Displays the output of the script, including the text "The nearest exoplanet is 4.21 light years from earth".
- Figure (Right):** A scatter plot titled "Exploring Exoplanets" showing the relationship between Stellar Radius (in Solar Radii) on the x-axis and Temperature on the y-axis. The plot includes a legend for star types (A, B, F, G, K, M) and a title "What Types of Stars have Planets?".

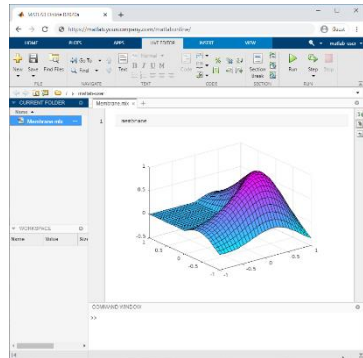
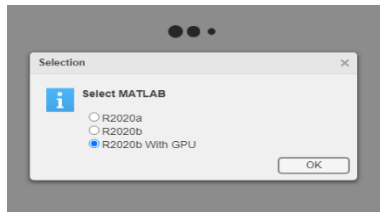
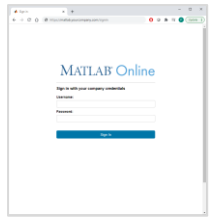
Annotations highlight key features:

- 3 Integrated with your NFS:** Points to the File Explorer panel.
- 4 Includes Live Editor and MATLAB Apps:** Points to the APPS tab and the Code Editor.

Optional Configuration



<https://matlab.yourcompany.com>

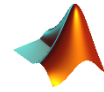


Kubernetes



Ingress Controller

Different pools of MATLAB compute on a single server license



Different MATLAB versions

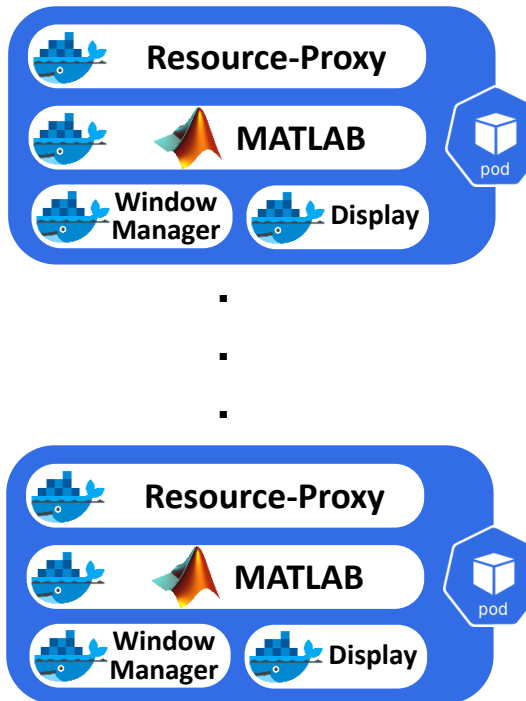


Different hardware resources
(memory, GPUs)

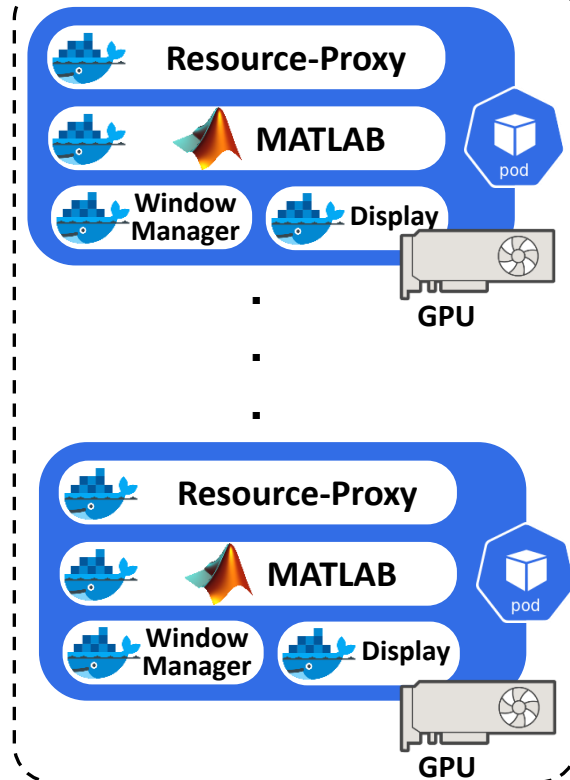
Core Services



MATLAB R2020a



MATLAB R2020b
with GPU

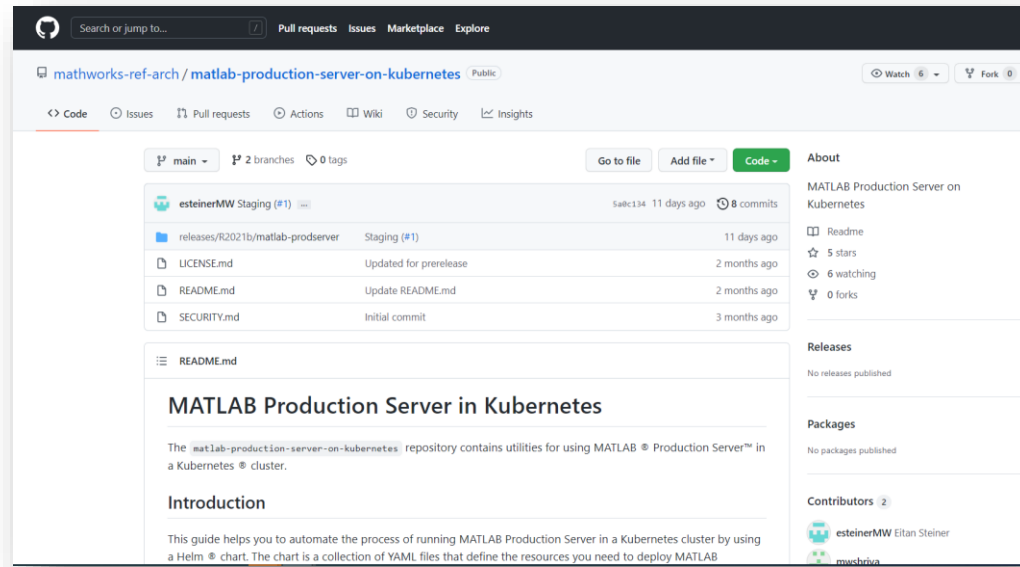


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Call to Action

Explore the MATLAB Production Server Reference Architecture for Kubernetes



<https://github.com/mathworks-ref-arch/matlab-production-server-on-kubernetes>

- Uses existing MATLAB license server
- Works with cloud-managed or on-premise Kubernetes clusters

```
nbonfatt@appdemos-ah:~/prodserverk8s$
```

MATLAB EXPO

Thank you



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