MATLAB EXPO

Kubernetes와 컨테이너화 된 마이크로 서비스에 클라우드 네이티브 MATLAB 기능을 배포하기

엄준상 부장, 매스웍스코리아

MathWorks

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

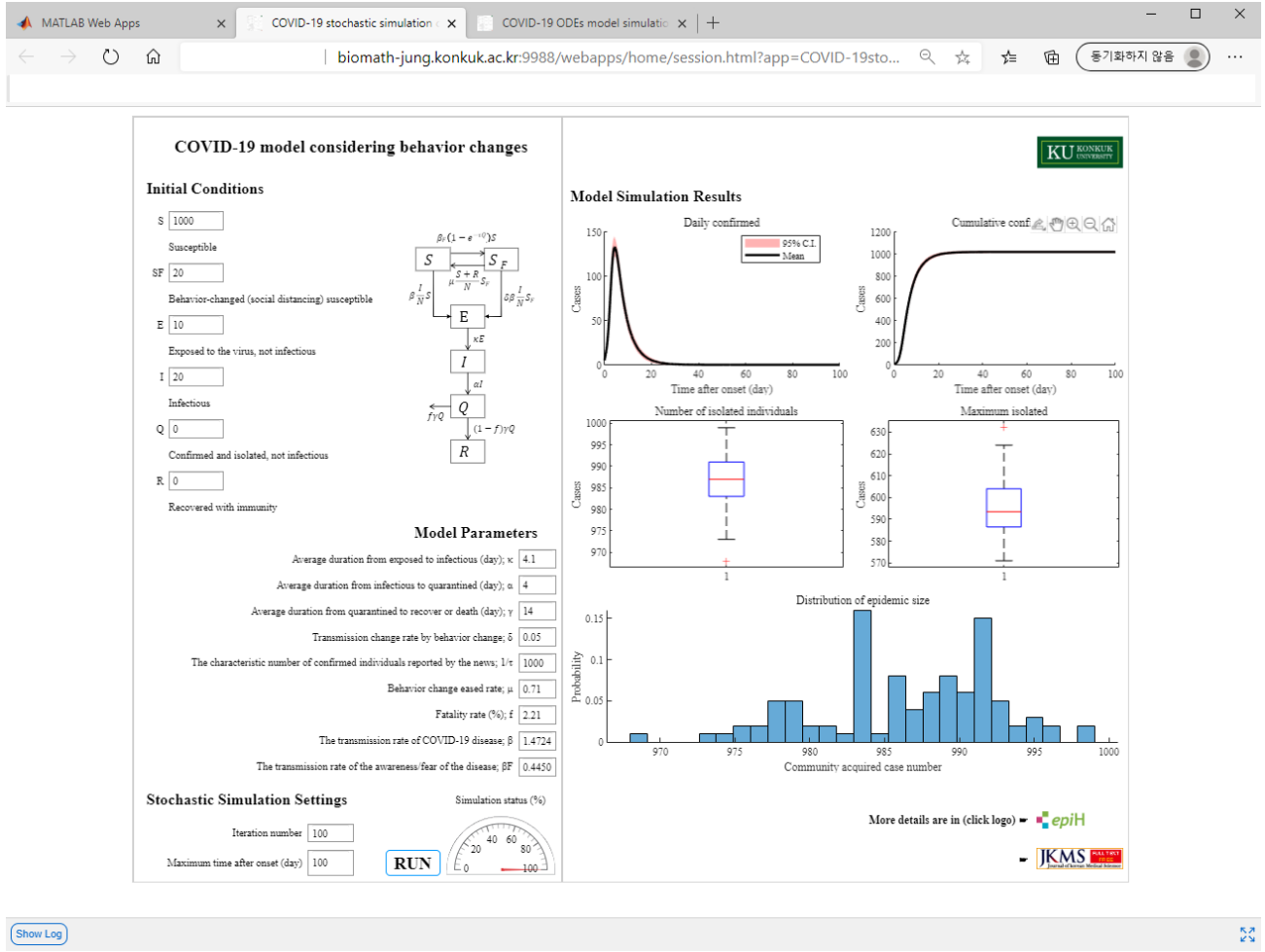
Konkuk University
Forecasts COVID-19 trend and effects of social distancing for KDCA

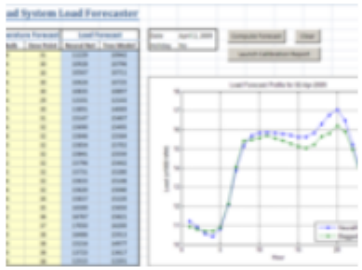
Professor Eun ok Jung has developed a SEIR model using MATLAB.

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.

Link

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)

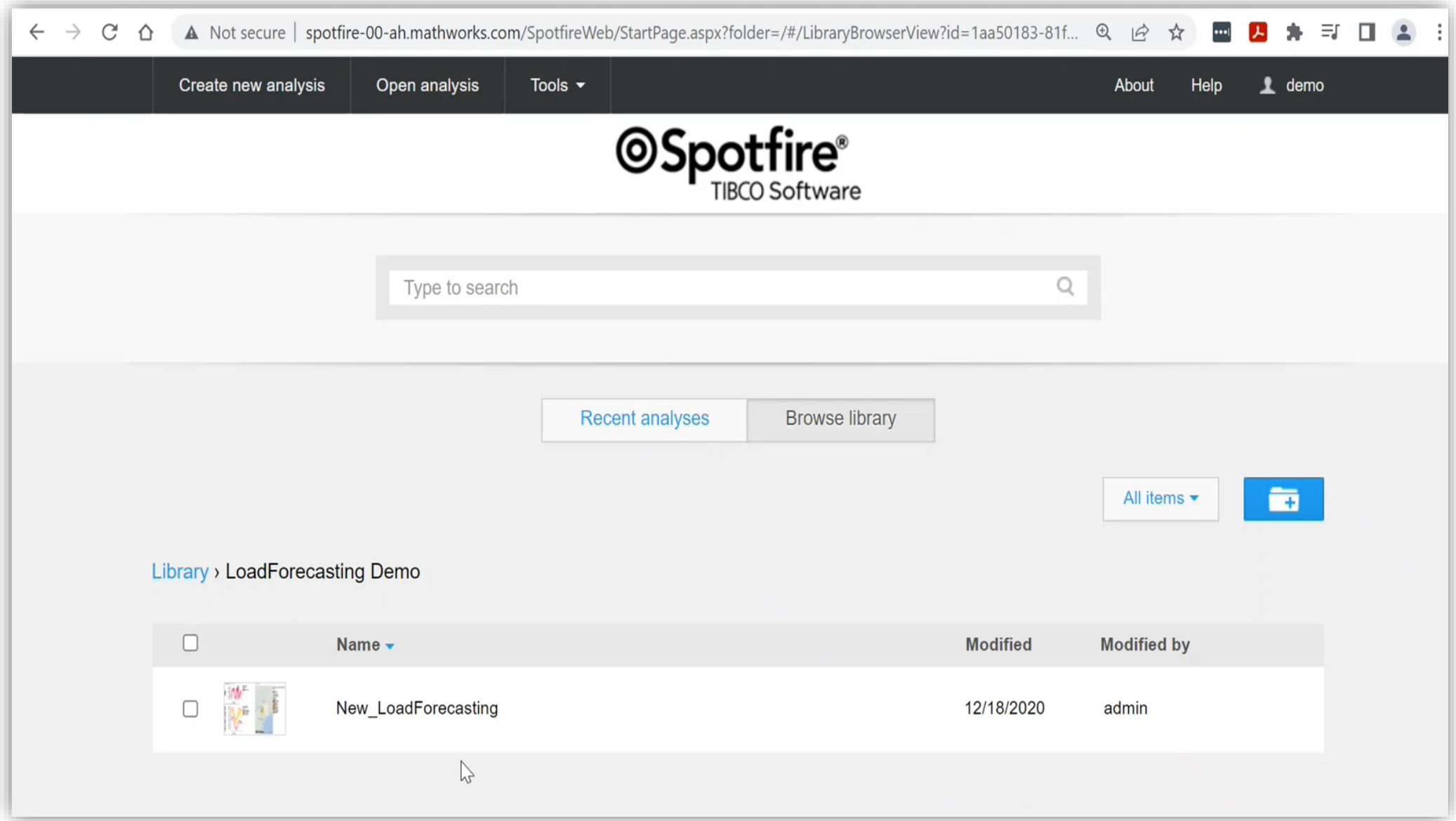
loadForecast(date, temperature, isH...

TreesInDetail.m

Electricity Load & Price Forecas

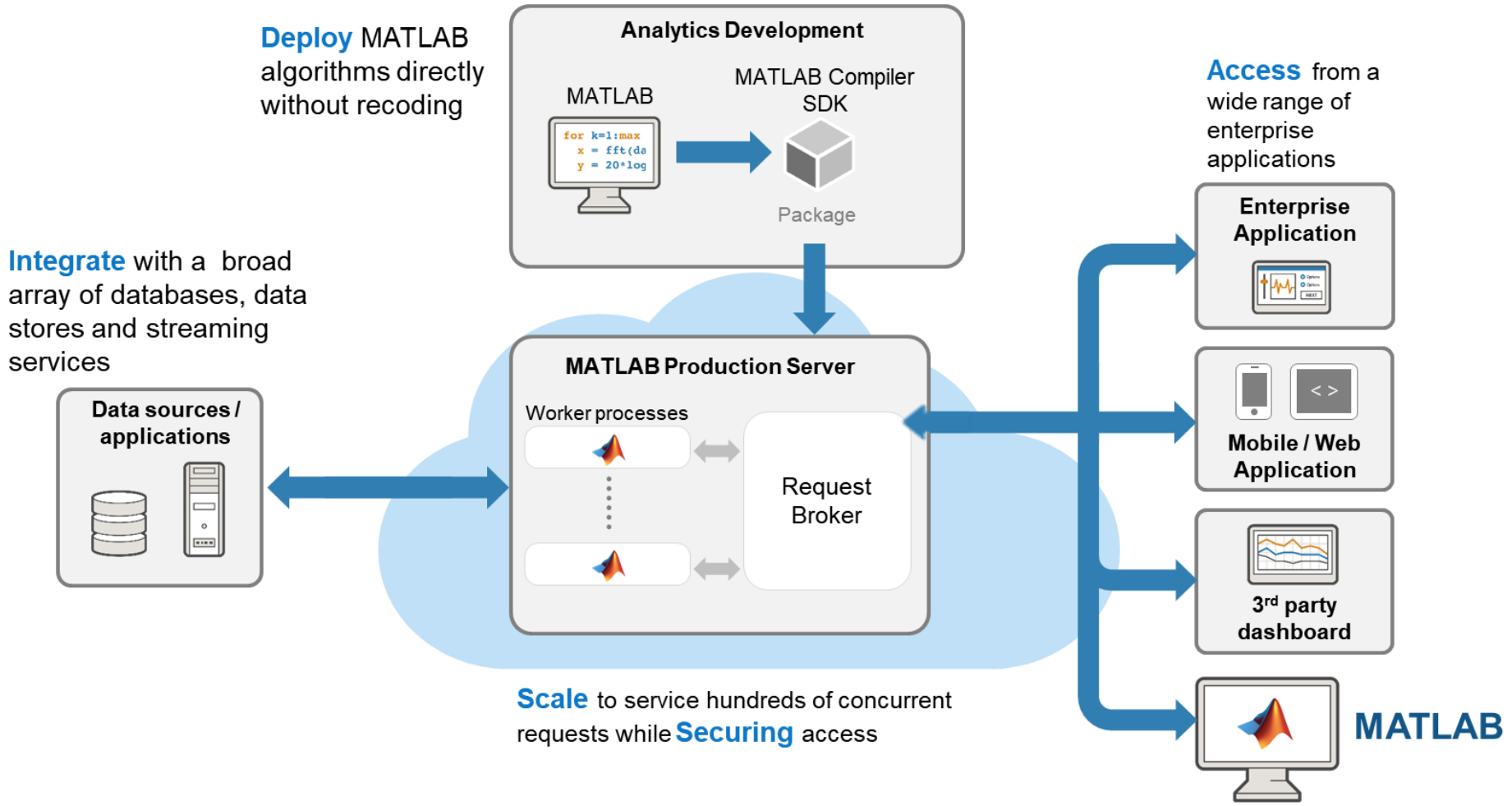
```
function y = loadForecast(date, temperature, isHoliday)
% LOADFORECAST performs a day-ahead load forecast using a pre-trained
% Neural-Network or Bagged Regression Tree model
%
% USAGE:
% y = loadForecast(model, date, hour, temperature, isWorkingDay))

% 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

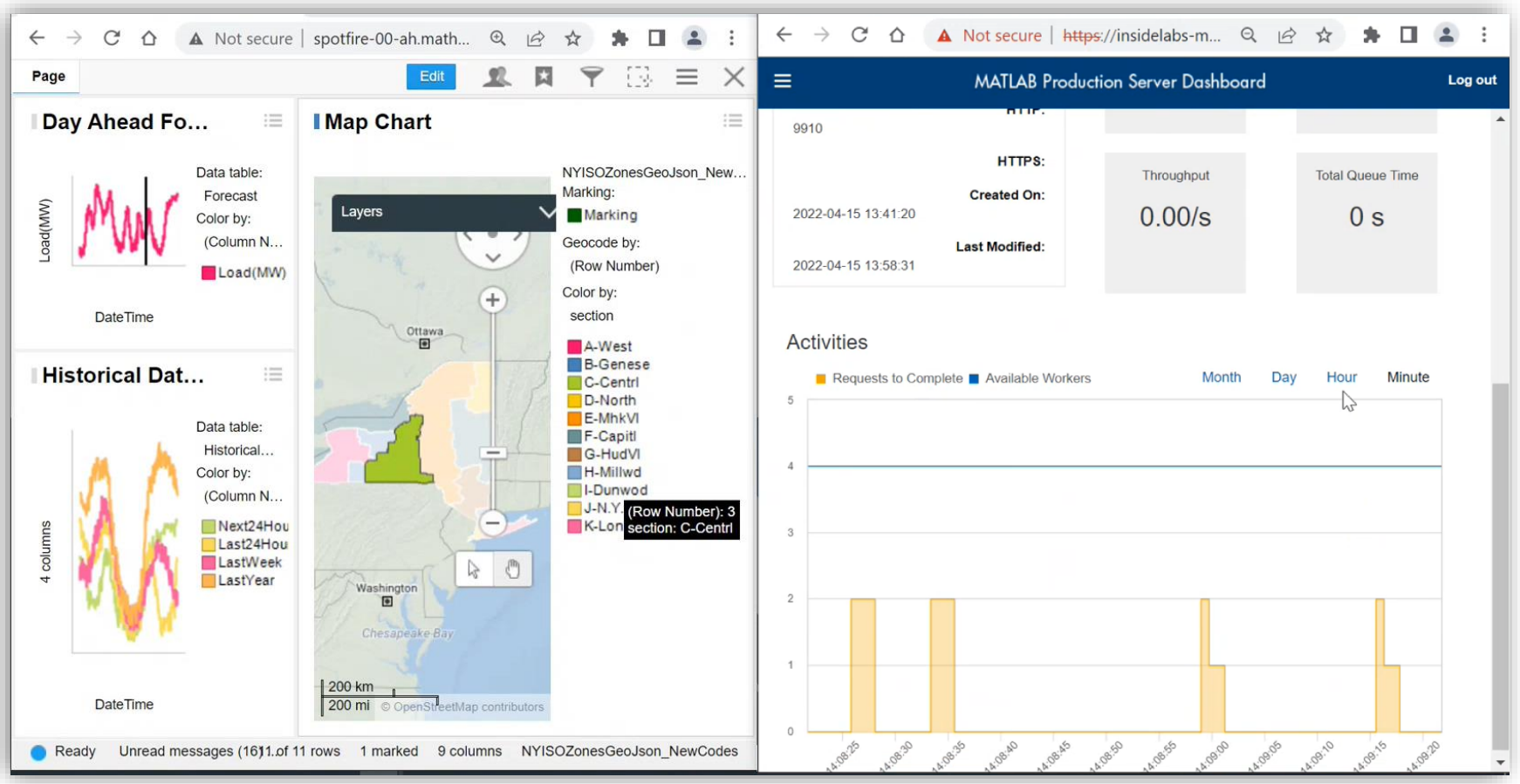


[Spotfire extension for MATLAB Production Server]

Deploy MATLAB & Simulink models using MATLAB Production Server



Understanding resource utilization using production server dashboard



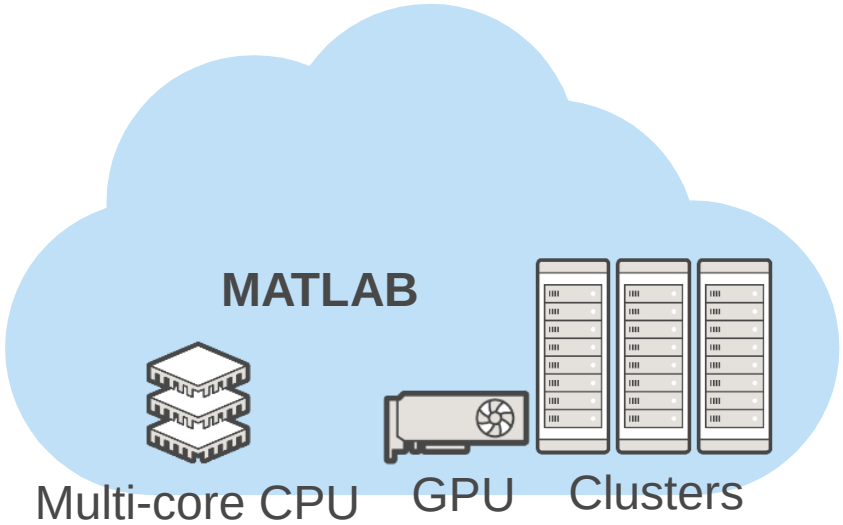
[Size your MATLAB Production Server]

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

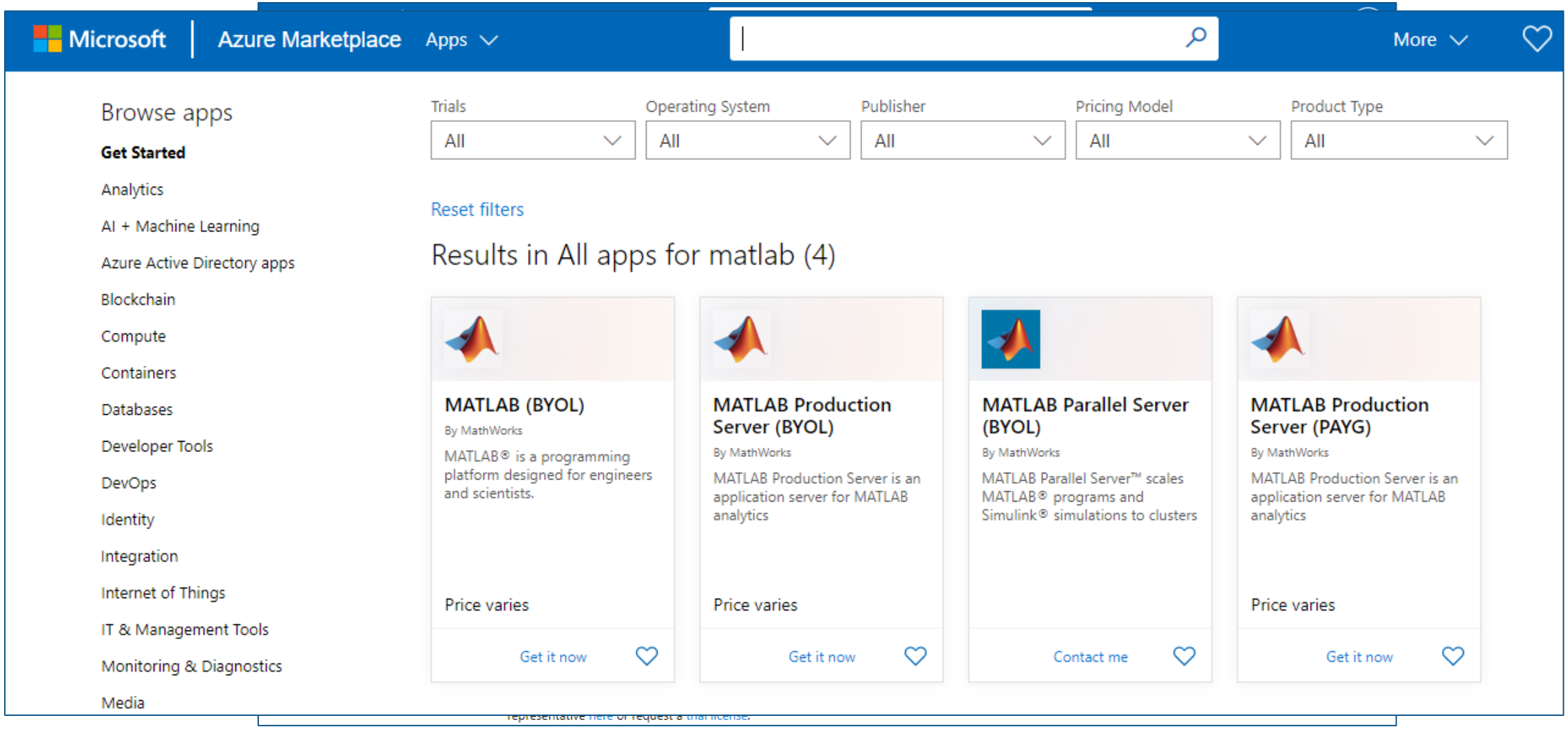
Horizontal
Number of nodes required concurrently
Load balancing across nodes/VMs
Regional and Global LBs

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

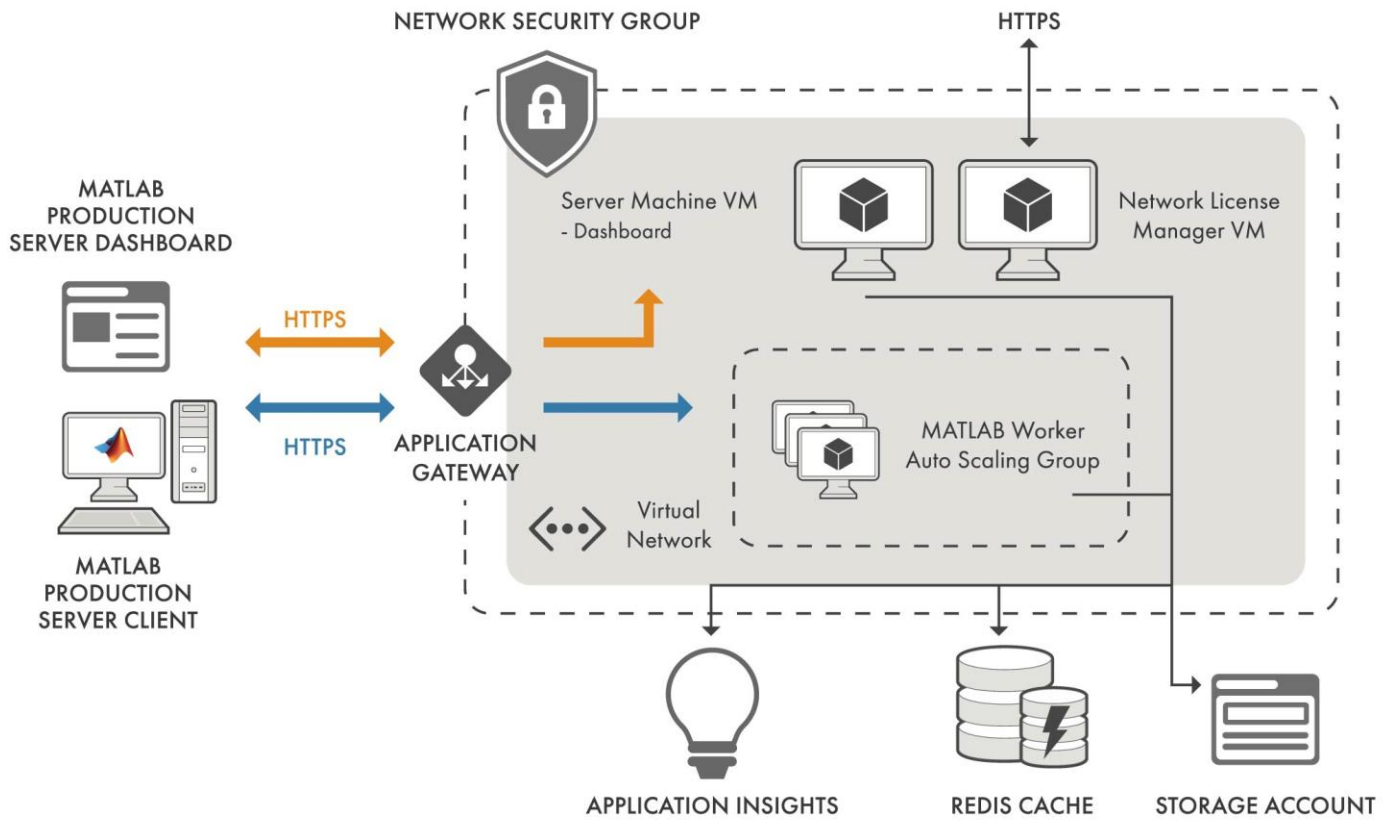
Key Takeaways

- 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



VM based reference architecture for MATLAB Production Server



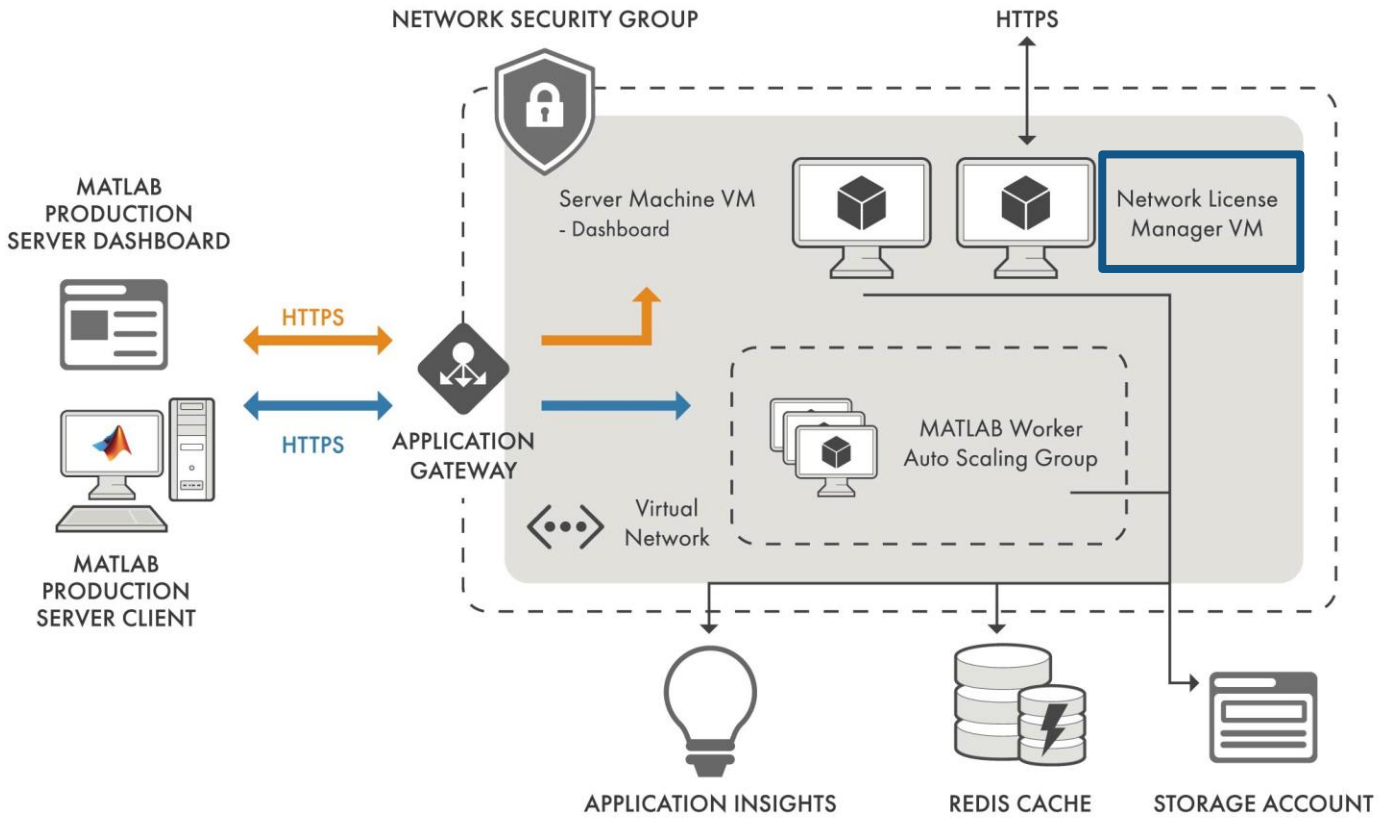
Deploying to cloud using MATLAB Production Server

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



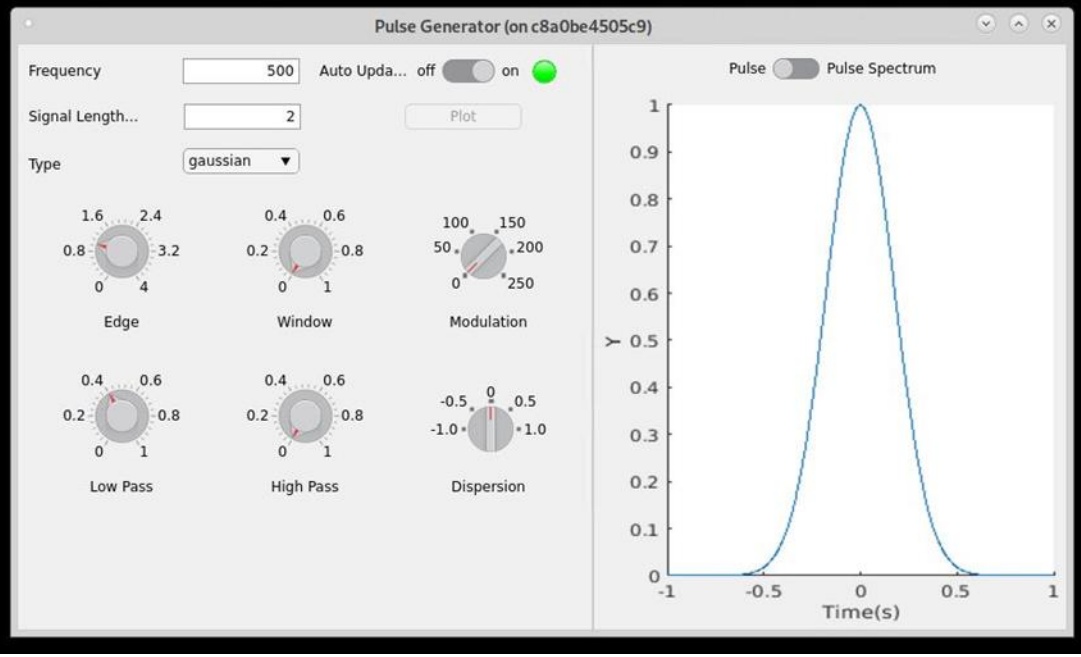
Key Takeaways

- ✓ 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
  - – Resilient
  - – Provides on-demand scaling

MATLAB Compiler provides Package Docker Images for reuse

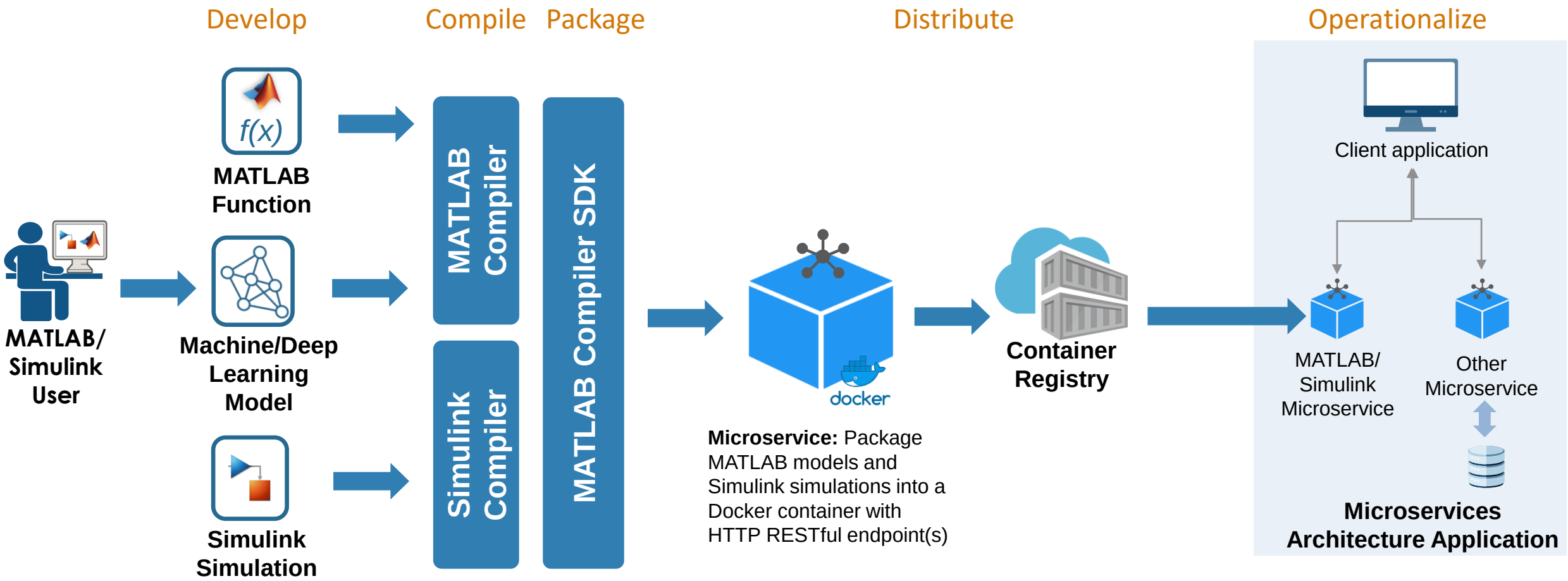
```
Command Window
>> buildResult = compiler.build.standaloneApplication('PulseGenerator.mlapp');
DEMO Compiler license.
  The generated application will expire 30 days from today,
  on Wed May  6 09:04:57 2020
>>
>> compiler.package
Sending build conte
Sending build conte


Step 1/3 : FROM mat
 ---> a7dc6dff3fe0
Step 2/3 : COPY ./a
 ---> d245f09da68b
Step 3/3 : ENTRYPOI
 ---> Running in 26
Removing intermedia
 ---> caff838863d0
Successfully built
Successfully tagged

SAMPLE DOCKER RUN C

docker run --rm -e

fx >>
```

```
File  Edit  View  Bookmarks  Settings  Help
[ah-ssegench-l:/]69 % docker images
REPOSITORY                                TAG                 IMAGE ID            CREATED             SIZE
pulsegenerator                            latest              caff838863d0        18 minutes ago      2.27GB
matlabruntime/r2020b/c00000000000000      latest              a7dc6dff3fe0        2 days ago          2.26GB
mathworks/matlab-deps                     r2020a              7ebe5f092799        2 weeks ago         429MB
[ah-ssegench-l:/]70 %
[ah-ssegench-l:/]70 % docker run --rm -e "DISPLAY=:0" -v /tmp/.X11-unix:/tmp/.X11-unix pulsegenerator
```



Microservices from MATLAB & Simulink using MATLAB Compiler SDK

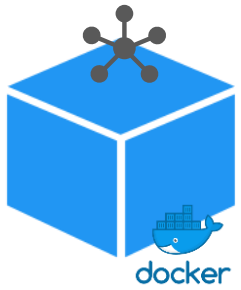
R2022a



[Create Microservice Docker Containers with MATLAB]

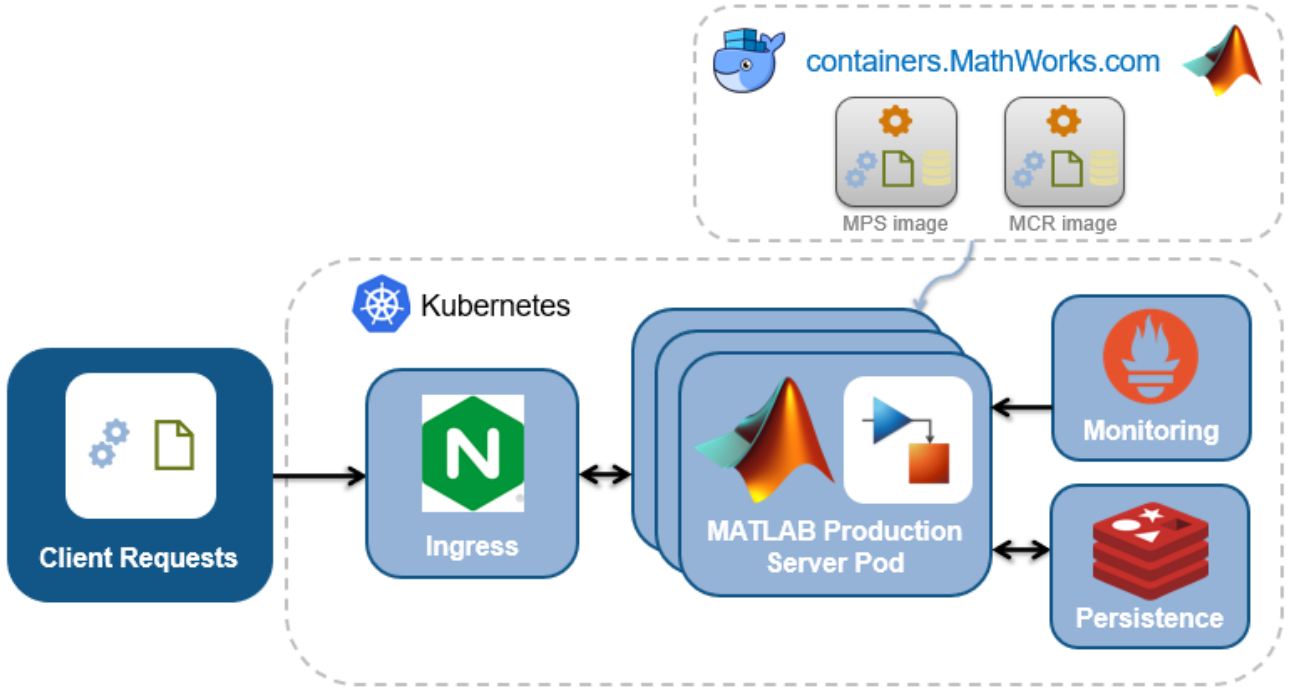
Deploy MATLAB and Simulink algorithms in containers

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



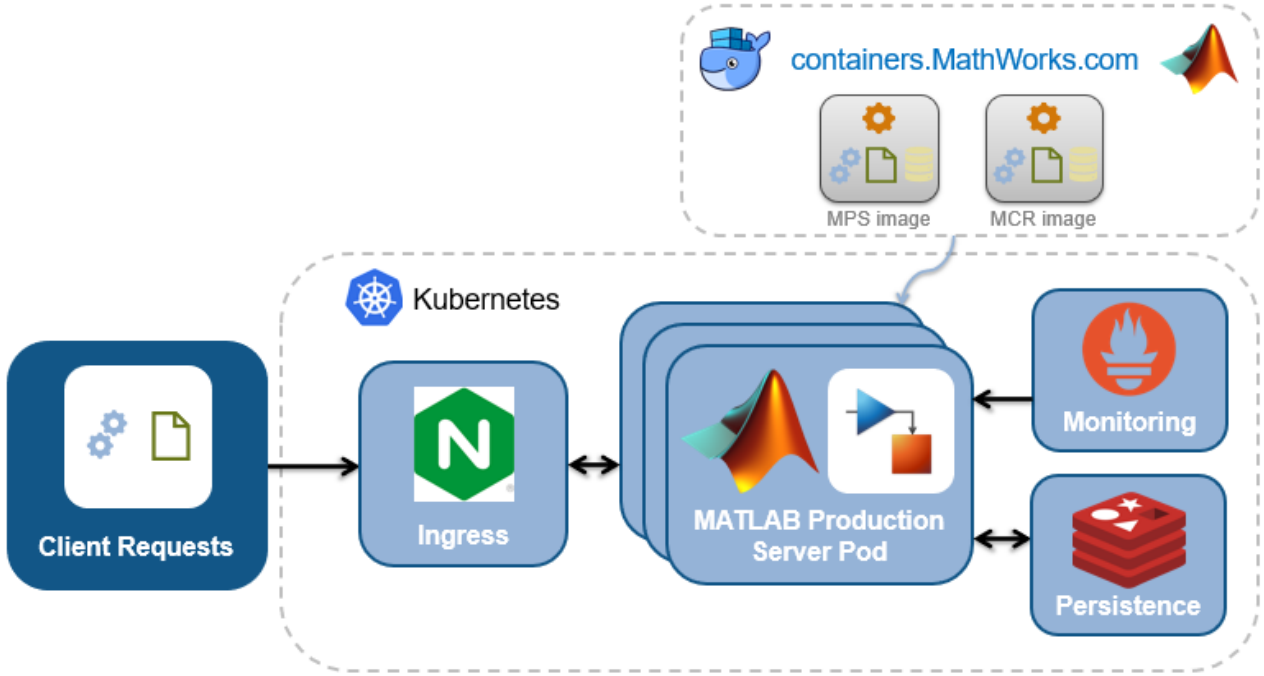
Turn those same MATLAB models and Simulink simulations into production-ready RESTful HTTP endpoint(s) with access control, autoscaling, and more

[Create Microservice Docker Containers with MATLAB]

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

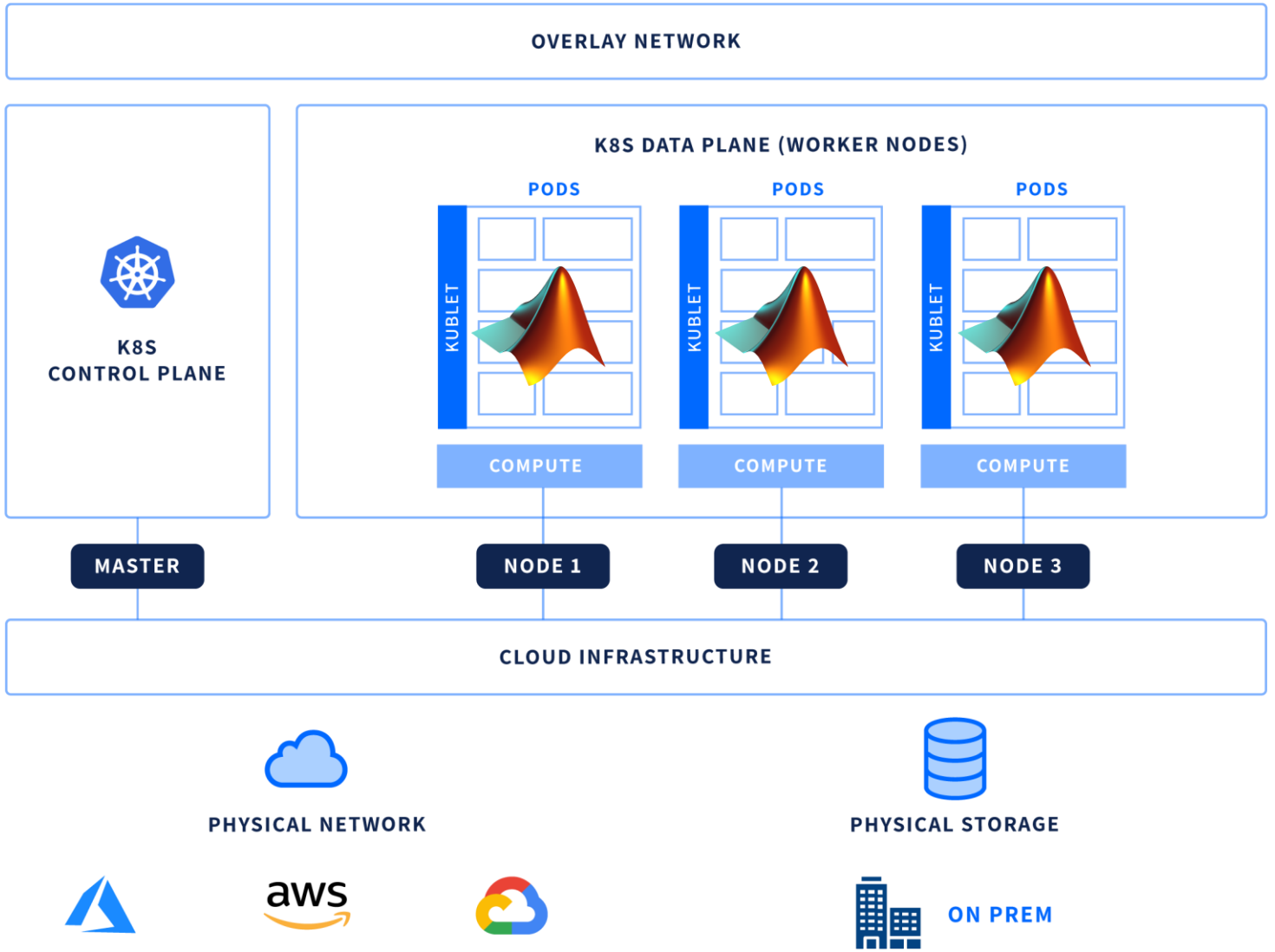
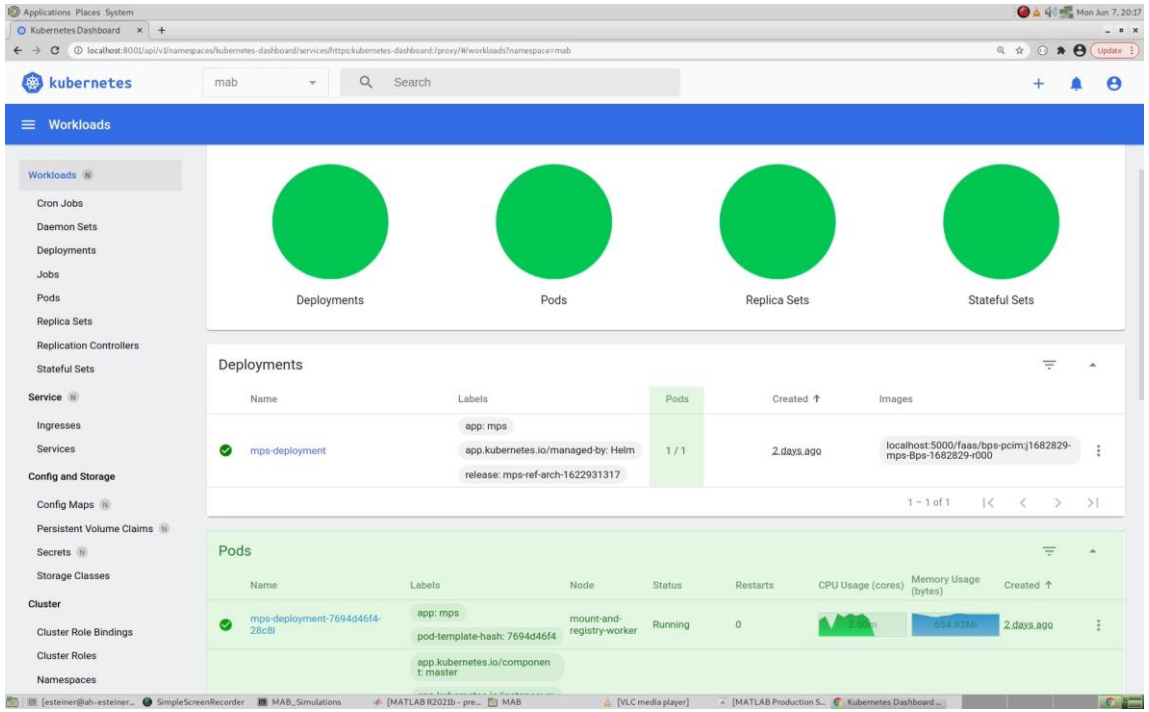


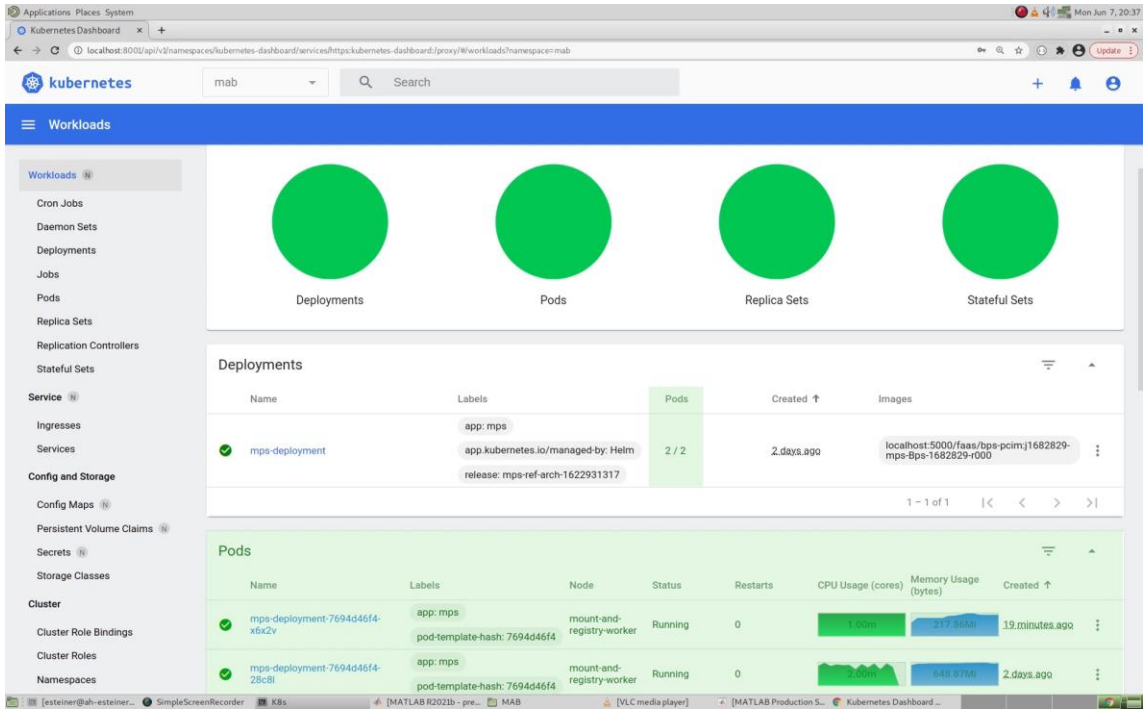
Image source: https://spot.io/blog/above-all-clouds-orchestrating-and-managing-kubernetes-across-cloud-and-on-premises

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

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

Azure

Which cloud architecture should we use?

Windows 기반 소프트웨어를 필요로 하는 통합 기능이 있습니다.

Process Engineer

Develops models in MATLAB and Simulink

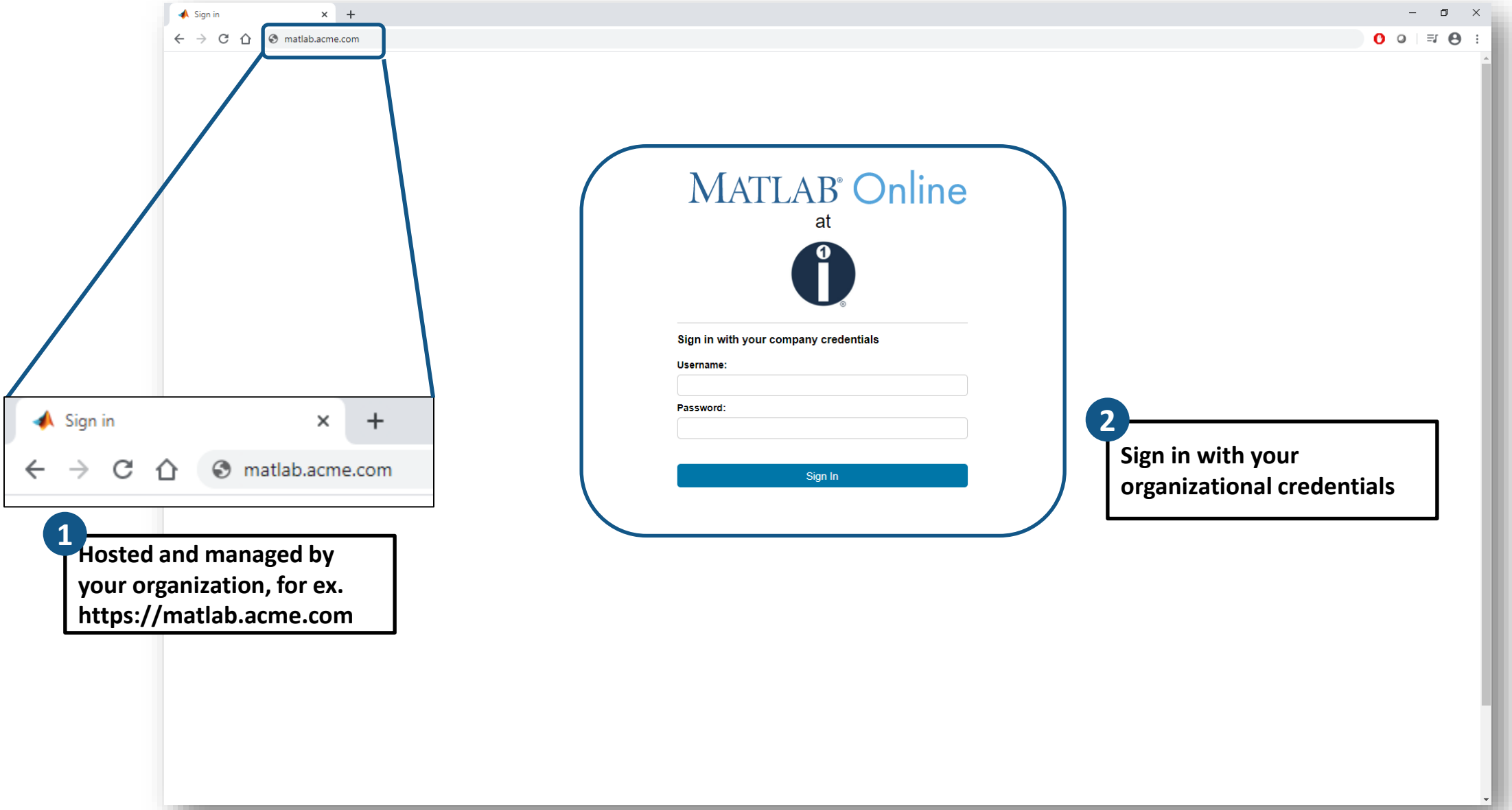
이 경우 **Windows VM** 기반 **MATLAB Production Server** 배포를 사용해야 합니다.

System Architect

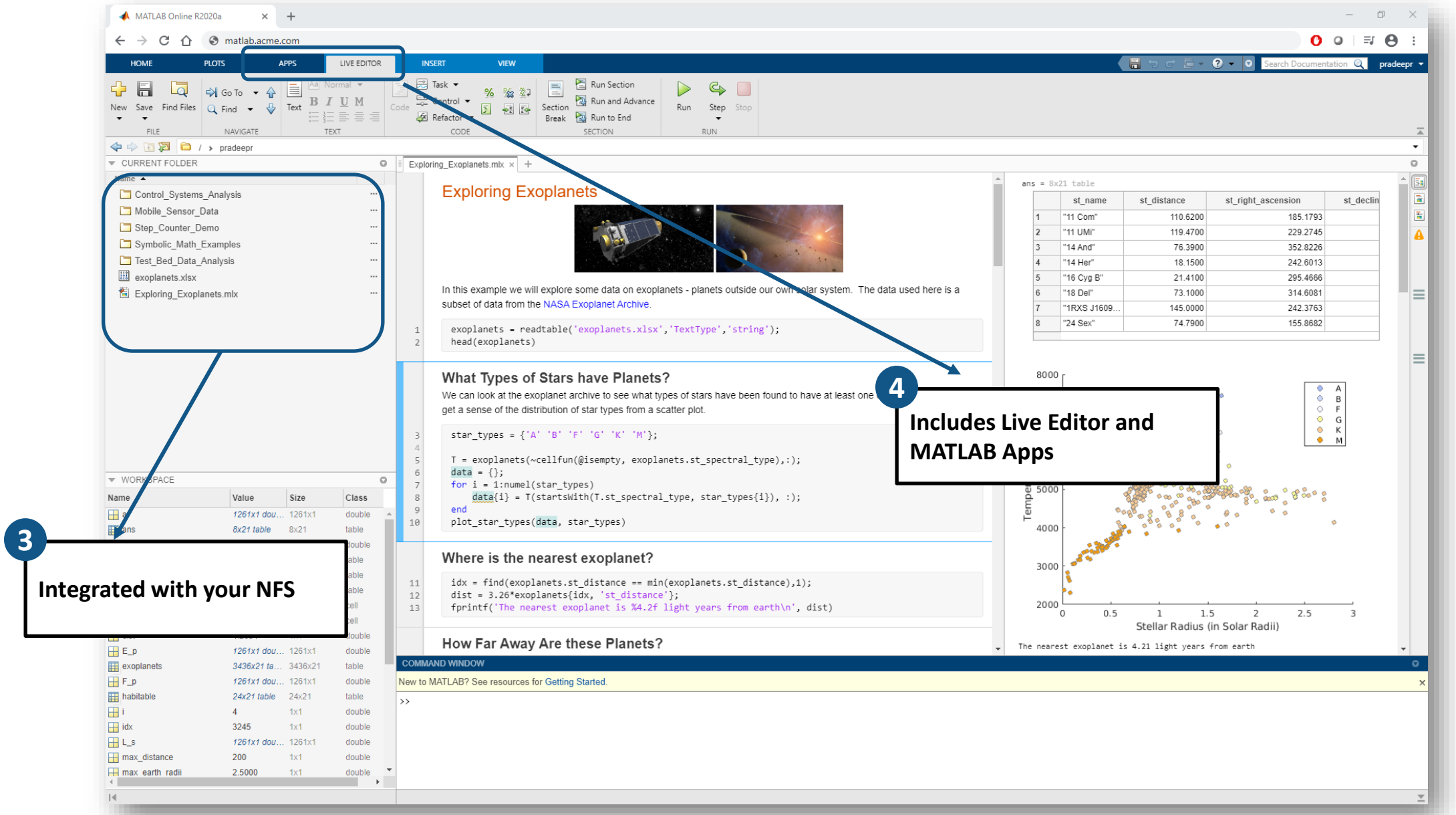
Deploys and operationalizes models on Azure cloud

Azure

MATLAB Online – hosted, managed, and controlled by you

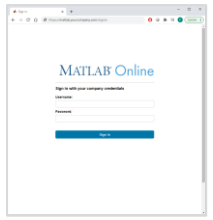


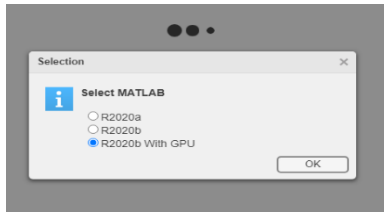
MATLAB Online – hosted, managed, and controlled by you

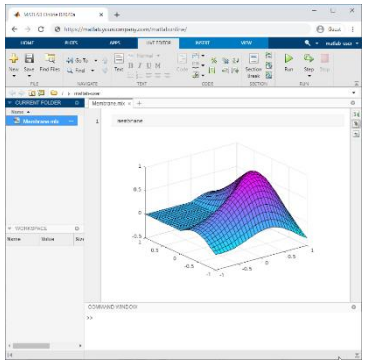


Optional Configuration

https://matlab.yourcompany.com







Different pools of MATLAB compute on a single server license

Different MATLAB versions

Different hardware resources (memory, GPUs)

Kubernetes

Ingress Controller

Core Services

- Core-UI (pod)
- AuthNZ (pod)
- Resource (pod)
- Gateway (pod)
- Help (pod)
- Licensing (pod)

MATLAB R2020a

- Resource-Proxy
- MATLAB
- Window Manager
- Display
- pod

MATLAB R2020b with GPU

- Resource-Proxy
- MATLAB
- Window Manager
- Display
- pod
- GPU

Key Takeaways

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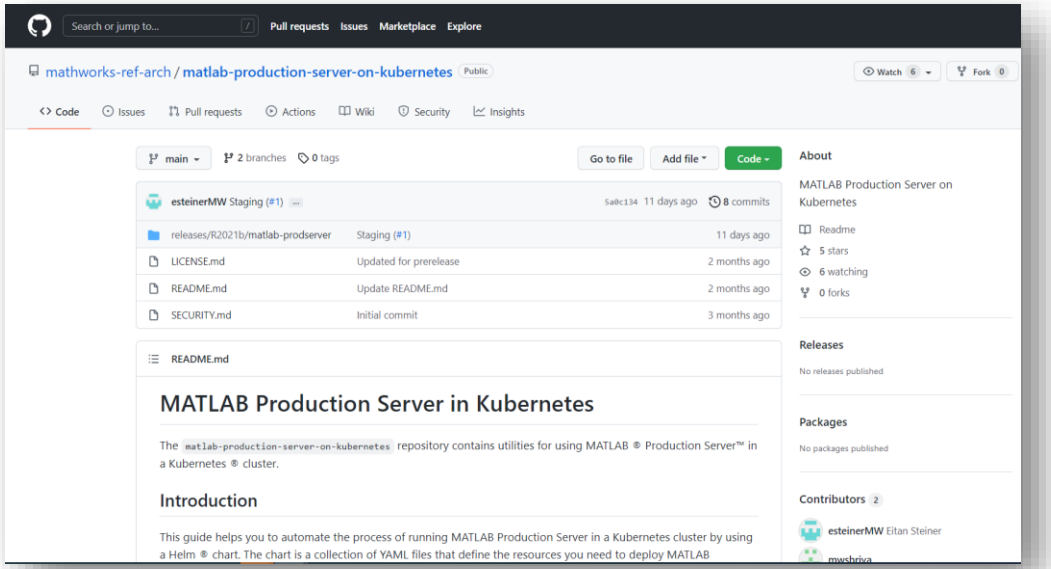
Call to Action

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

MATLAB EXPO

Thank you