



MATLAB Based DevOps Workflow in AWS for Hospital Patient Monitoring Applications

GE Healthcare, Inc.

Mohammad Khair, Principal Engineer



High Level Architecture

GE

AWS

MATLAB EXPO

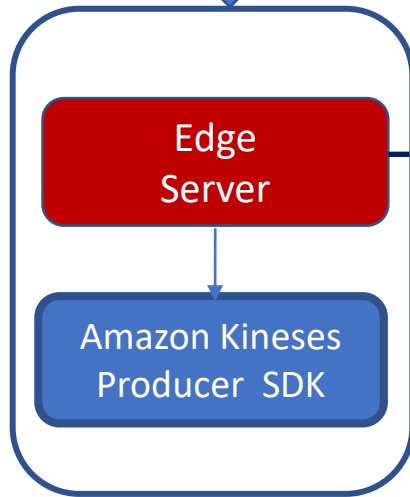
HLS : HTTP Live Streaming
DASH : Dynamic Adaptive Streaming over [HTTP](#).



Patient Camera(s)



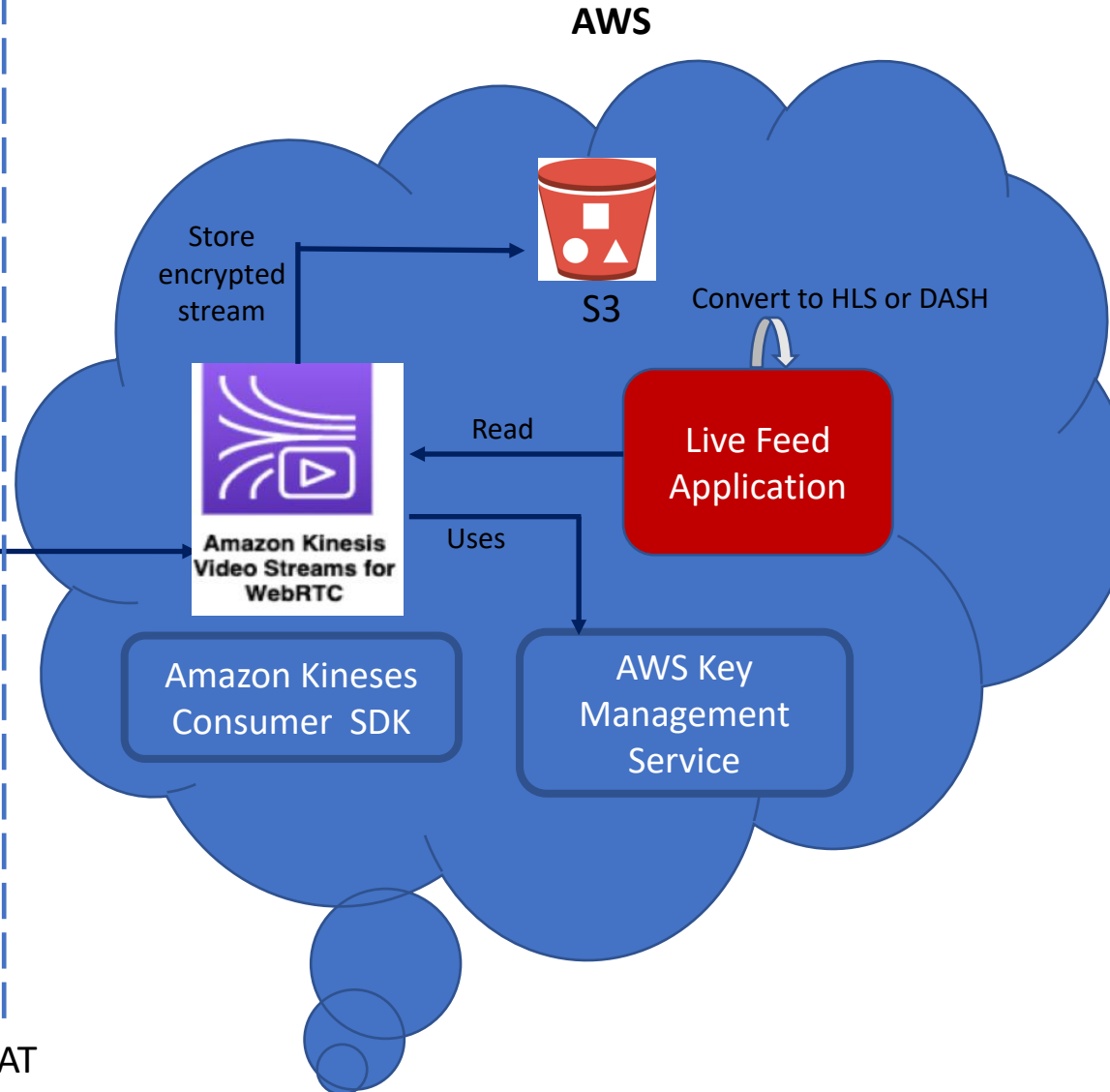
Video Feed



Camera Hub



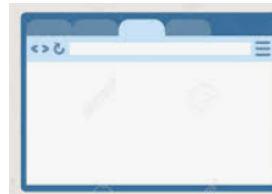
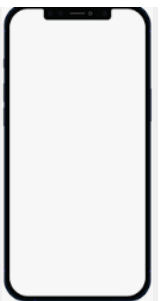
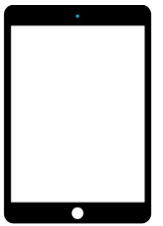
NAT



AWS

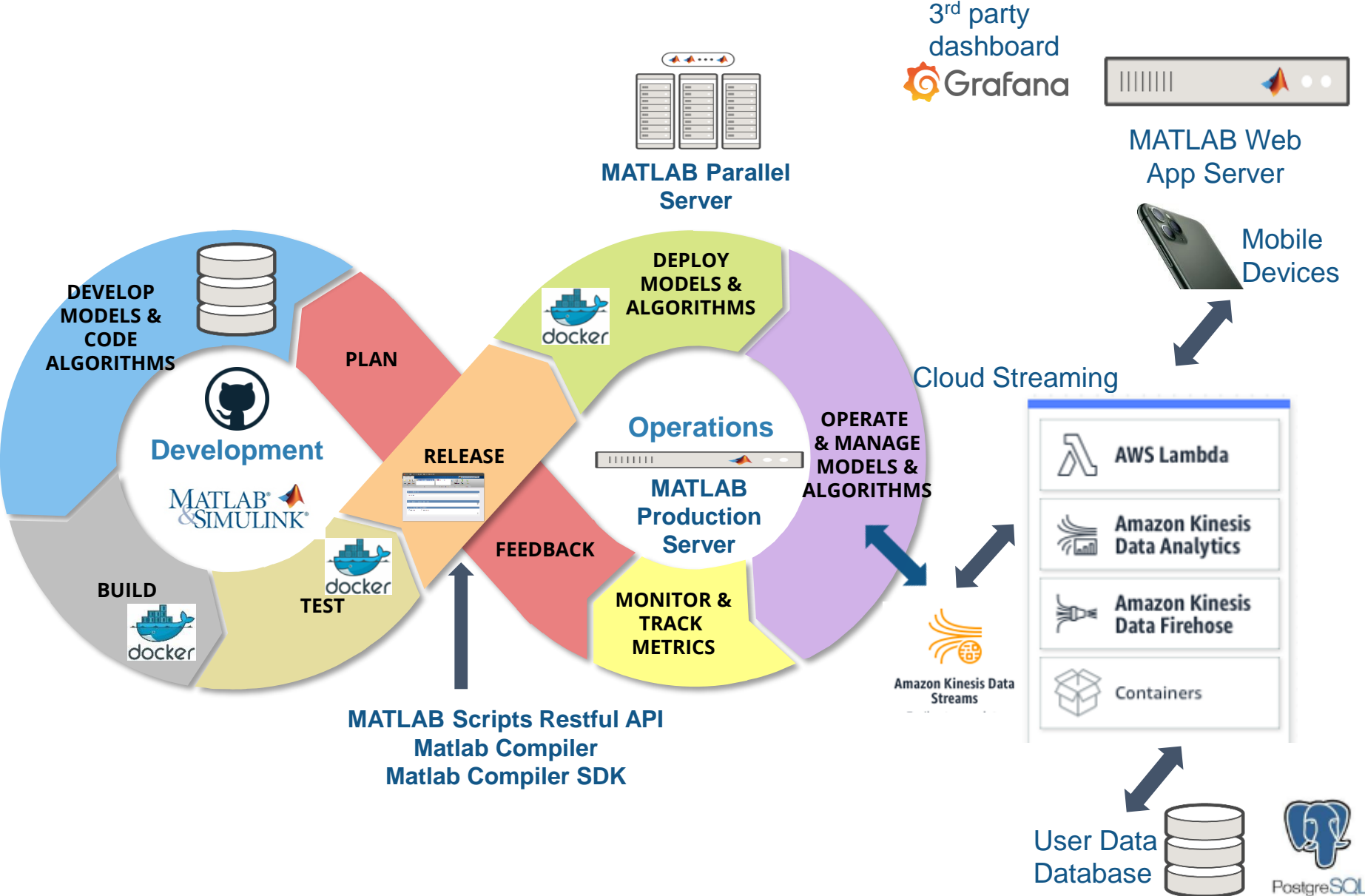


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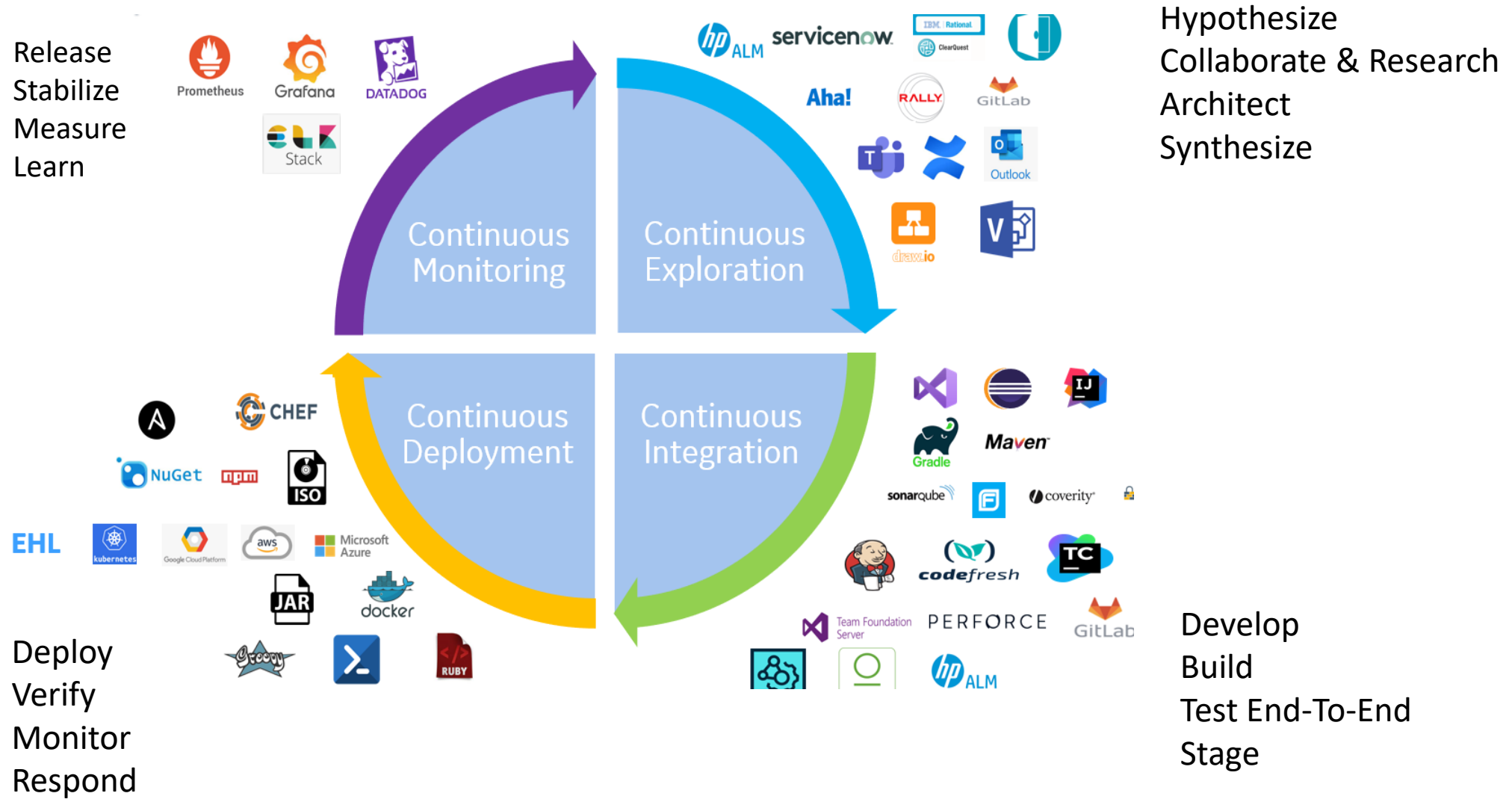


Viewers

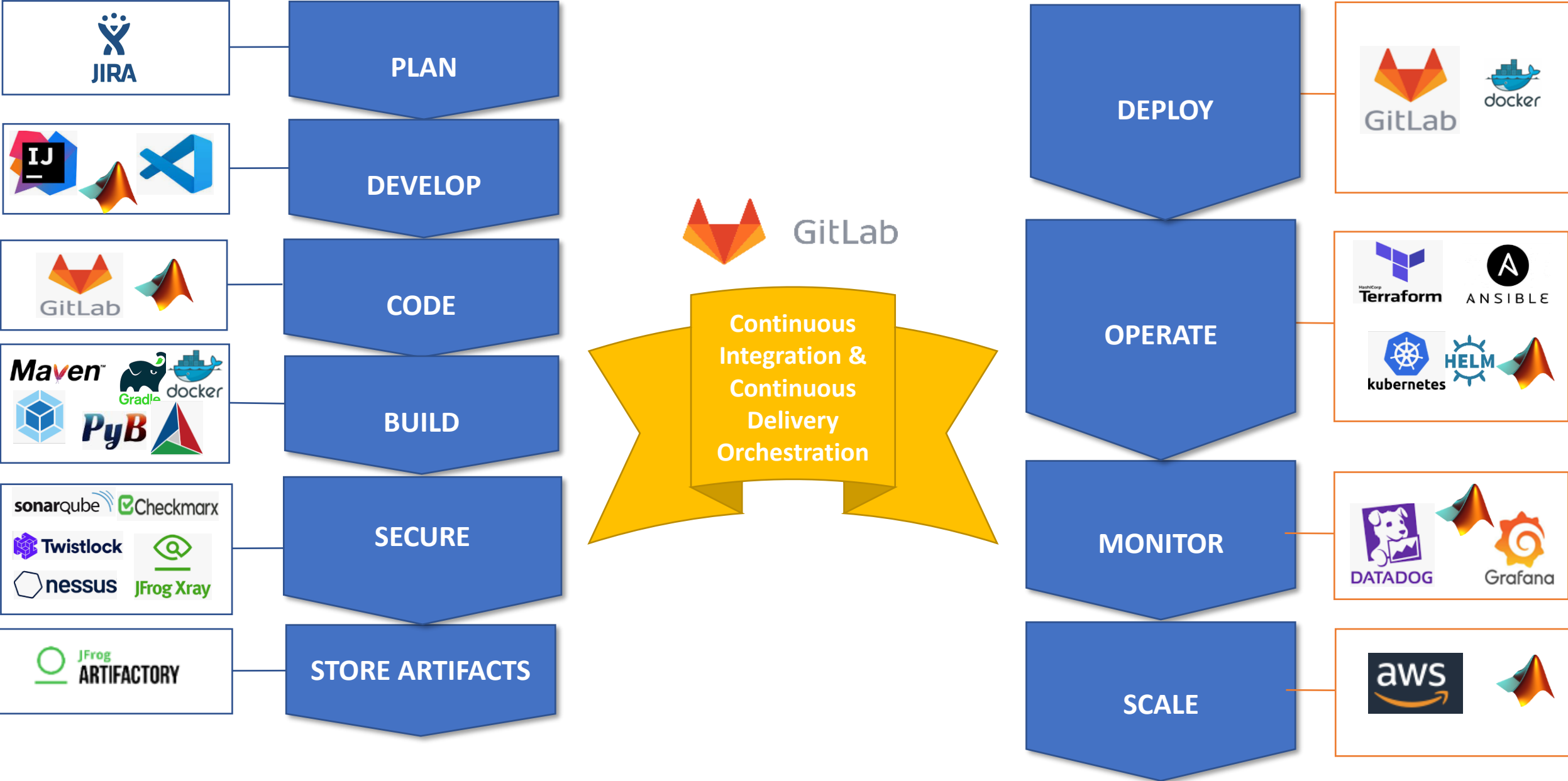
Development and Operations Model: DevOps



Tools Used for DevOps



Choosing the right tool for your application



DevOps Culture Development

- Make the DevOps dashboard as one of the input metrics
- Follow DevOps Industry Trends and Best Practices
- Create a “DevOps Week” annually to showcase DevOps process best practices which helps collaboration
- Measure DevOps maturity as make a key NPI metric
 - Standardization of Tools & Processes
 - Documentation of Procedures & Training
 - Optimization of Cost
 - Optimization of Performance
- Periodic skill assessment and trainings for DevOps Engineers
- Collaborate with other teams and stakeholders
- Host brainstorming sessions – document solutions, ideas, automation.

Develop and deploy a patient monitoring application

Problem: *Provide patient video / data feed to the cloud and provide access on mobile devices and web browser-based dashboards.*

Solution:

- Use Deep Learning models to perform classification / measurement / and deploy models into a secure and reliable service with scalable computing resources.
- Develop a Web-Browser/Mobile based application that allows viewing patient video/data feed and returns models' output to devices.

System Management:

- Deploy into a secure, scalable, and reliable environment.
- Tools for automated model training, testing, and deploying.
- Tools for monitoring of operational and performance metrics.

Challenges & Solutions in Developing a Patient Video Monitoring Application



Video / Data Streaming to the Cloud
Near Real-Time performance



AI Model Development / Training, Data Diversity



Scalable Compute & Memory for Deployment of AI Models



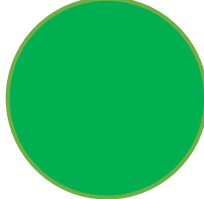
Data Storage & Cost Optimization



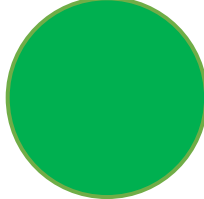
Data Visualization & Event Retrieval



AWS Kinesis offers optimized streaming to cloud services with data/video channels



Matlab toolsets provide model training on large data with Datastores to optimize memory utilization



Cloud services offer configurable machines, Matlab Production Server flexibly scales processing based on traffic demand.

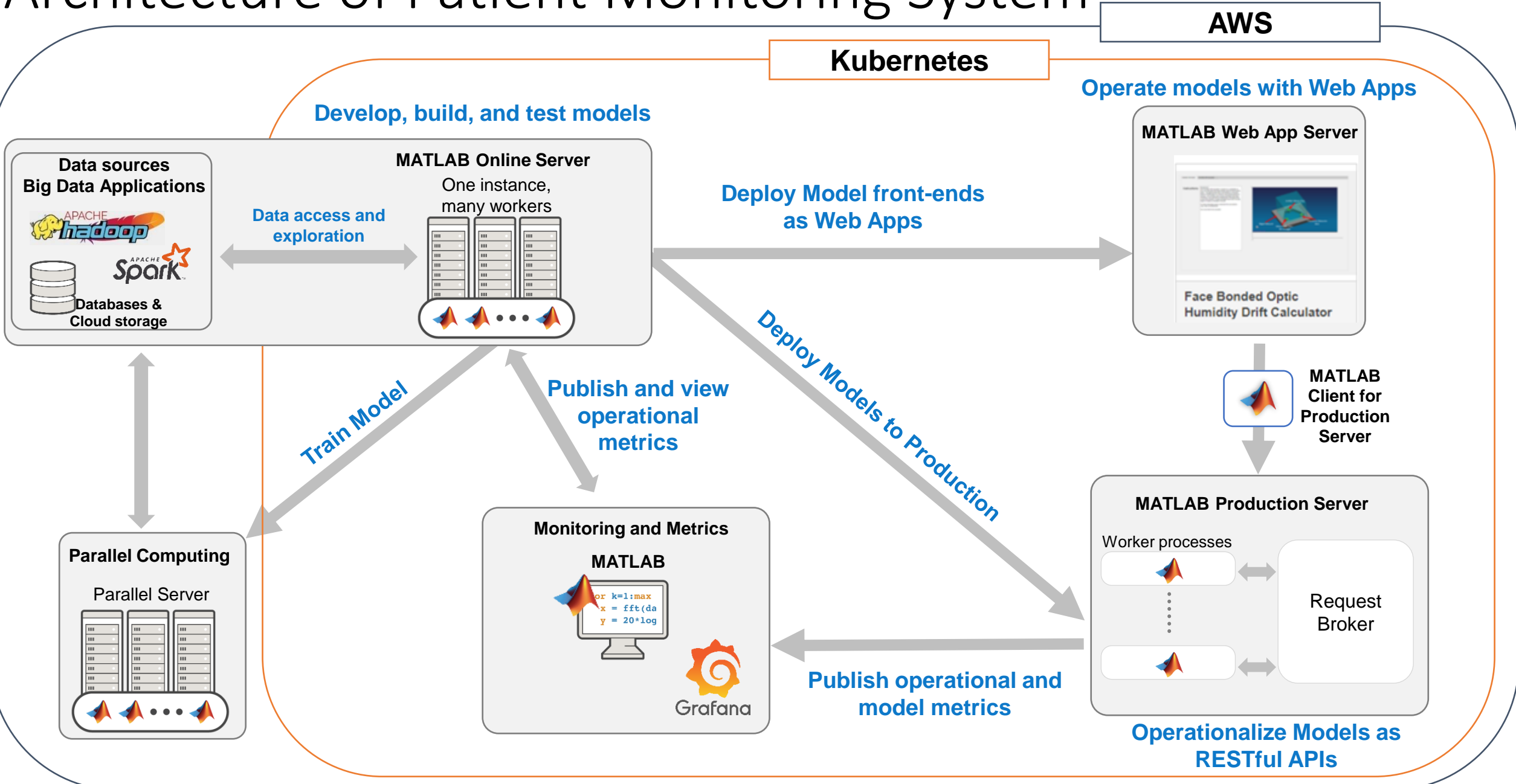


AWS data lake offers storage and configures data retention period



Matlab Web Server provides simple web application development.

Architecture of Patient Monitoring System



Architecture of Cloud-Based AI Model Software as a Medical Device (SaMD) -Model Development & Deployment

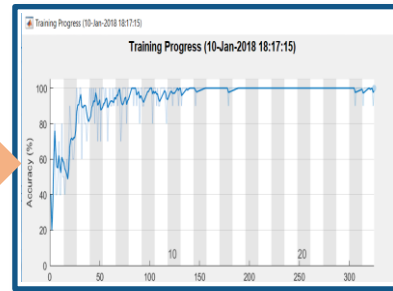
Model Training



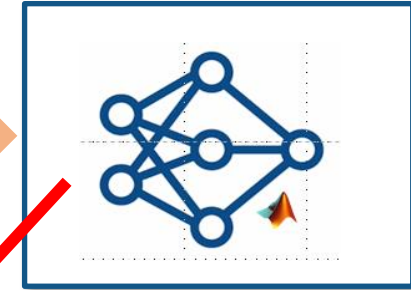
Patient Image



Train model using GPU

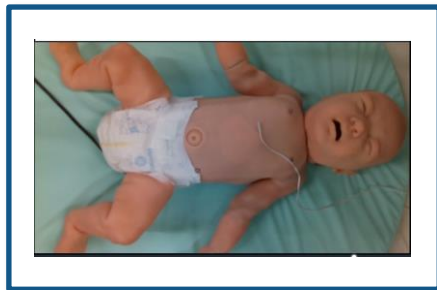


Train Deep Networks



Trained Model

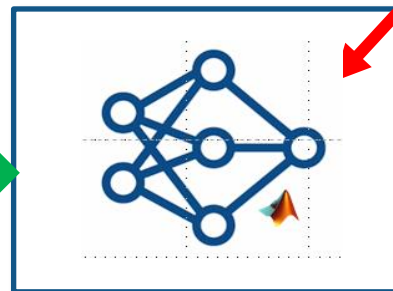
Model Inference



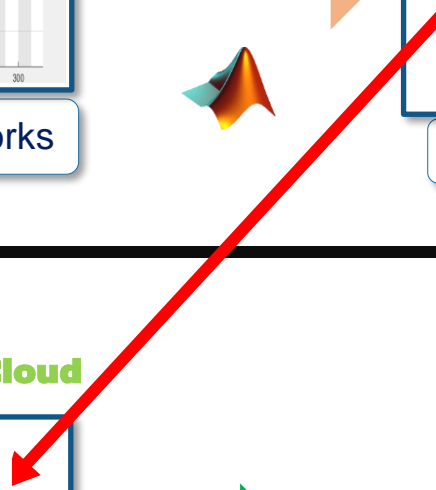
New Image



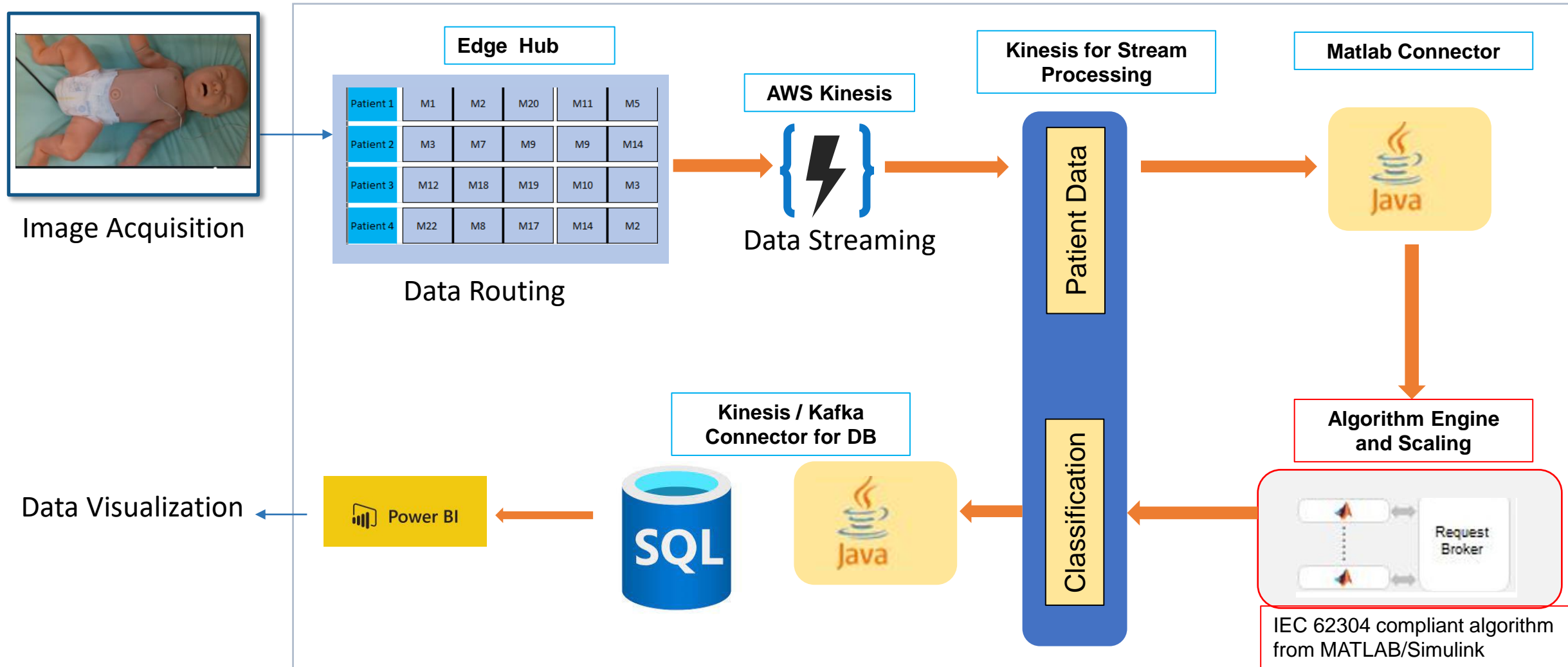
Deploy on AWS Cloud



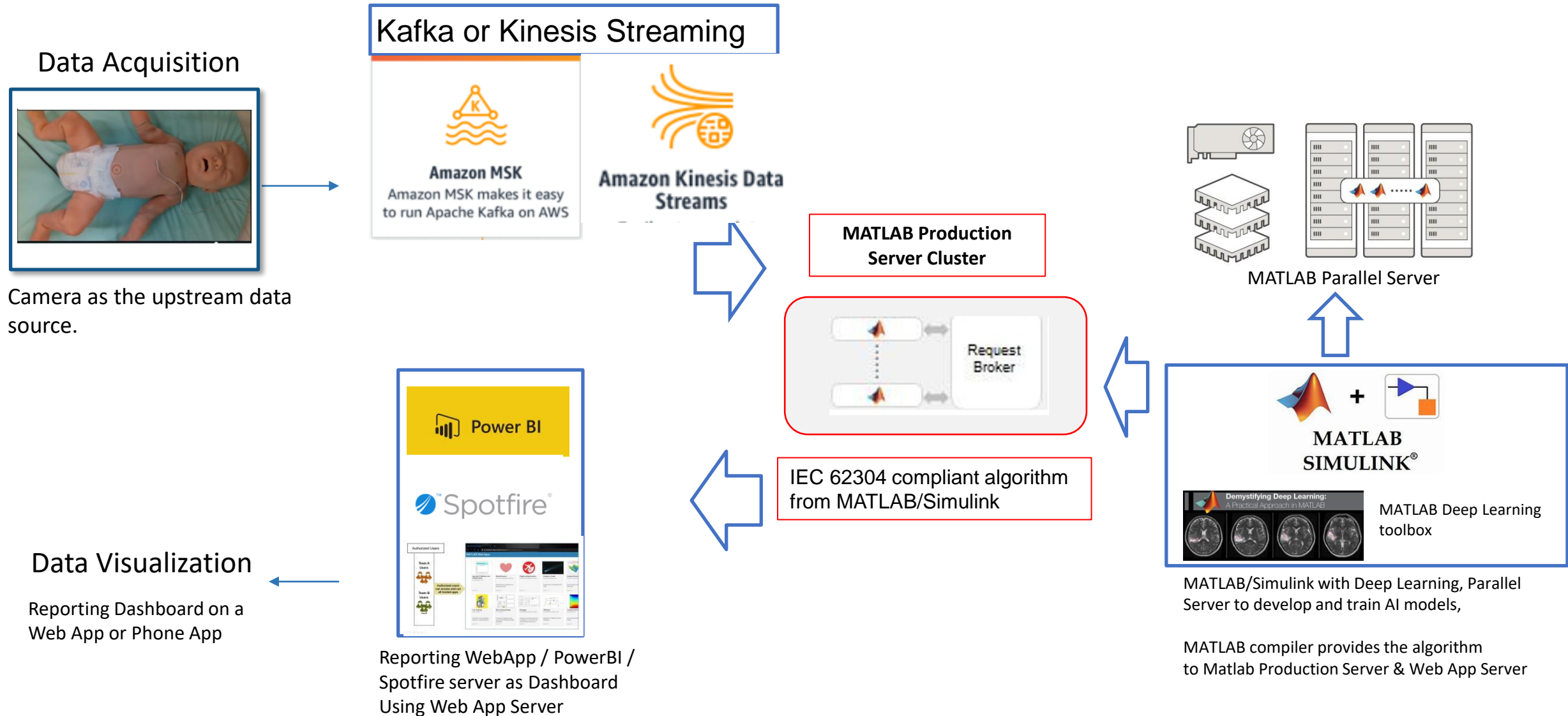
Predict Classification



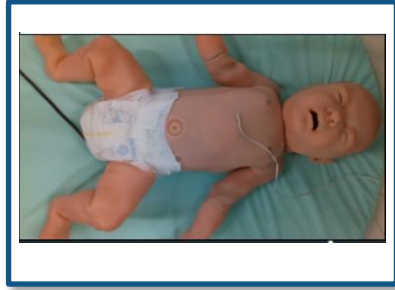
Architecture of Cloud-Based Software as a Medical Device (SaMD): - Cloud architecture



Architecture of Cloud-Based Software as a Medical Device (SaMD): MATLAB Products Ecosystem



Data Acquisition



Camera as the upstream data source.

Kafka or Kinesis Streaming

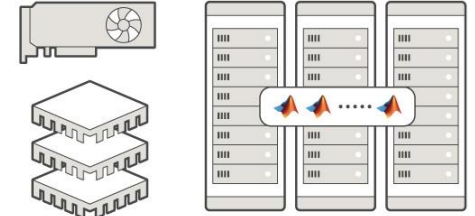

Amazon MSK
Amazon MSK makes it easy to run Apache Kafka on AWS


Amazon Kinesis Data Streams


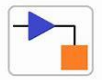
MATLAB Production Server Cluster




IEC 62304 compliant algorithm from MATLAB/Simulink



MATLAB Parallel Server


 + 
MATLAB SIMULINK®


 **MATLAB Deep Learning toolbox**


MATLAB/Simulink with Deep Learning, Parallel Server to develop and train AI models,

MATLAB compiler provides the algorithm to Matlab Production Server & Web App Server

Data Visualization

 **Power BI**

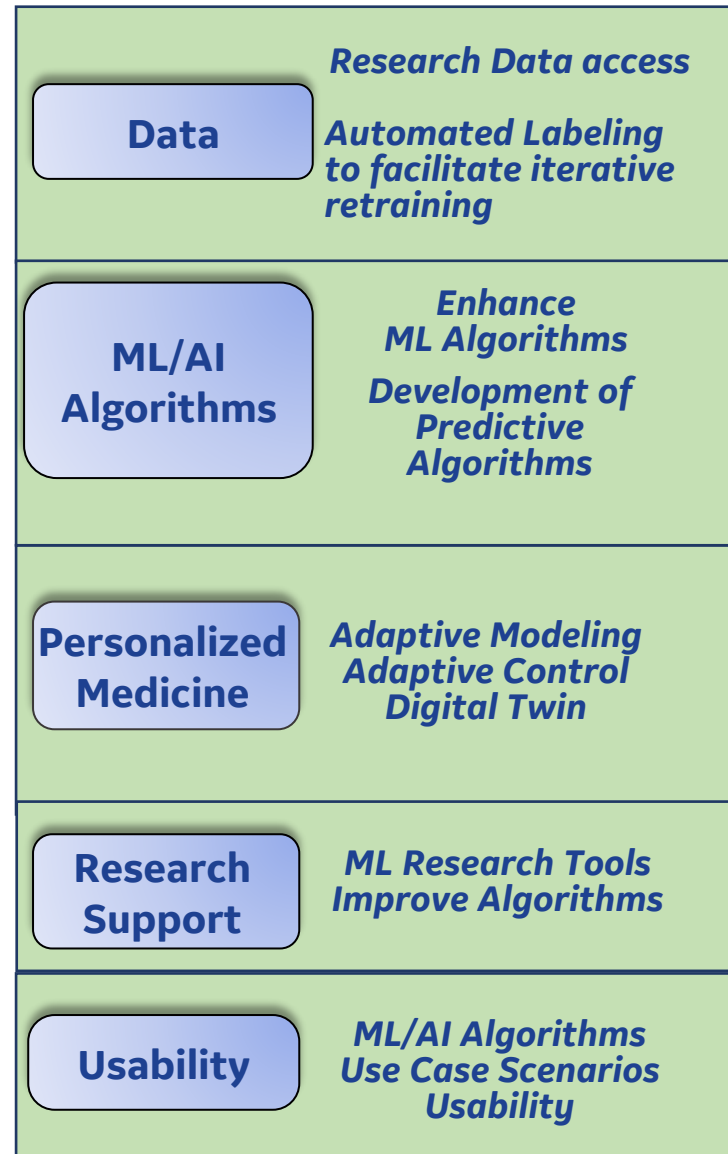
 **Spotfire®**



Reporting WebApp / PowerBI / Spotfire server as Dashboard Using Web App Server

Reporting Dashboard on a Web App or Phone App

DevOps Opportunities





References

- <https://www.scaledagileframework.com/devops/>
- <https://www.devops-research.com/research.html>
- <https://www.atlassian.com/devops>
- <https://aws.amazon.com/devops/continuous-integration/>
- <https://digital.ai/scaled-agile-framework-safe>
- <https://cloud.google.com/devops>
- <https://www.mathworks.com/solutions/continuous-integration.html>



Thank You!