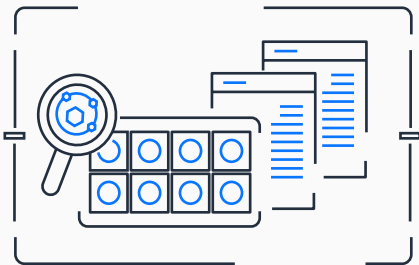


Modernizing Life Science Manufacturing Using AWS Services

Industry 4.0

The biomanufacturing industry is in the beginning stages of its fourth revolution, commonly referred to as "Industry 4.0", with a push to create 'smart facilities' where systems and operators can respond to changes in real-time with corrective actions.

Amazon Web Services (AWS) helps leading manufacturers transform their manufacturing operations with the most comprehensive and advanced set of cloud solutions available today, while taking advantage of the highest level of security. Manufacturers can take advantage of AWS compliance consultants and essential documentation to help move GxP regulated workloads to the cloud and approach validation of regulated environments.



To streamline and accelerate the development of your modernized manufacturing platform, AWS provides the following generalized reference architectures, as examples through various phases. The reference architecture describes specific phases for:



Establish connectivity



Establishing a cloud data lake



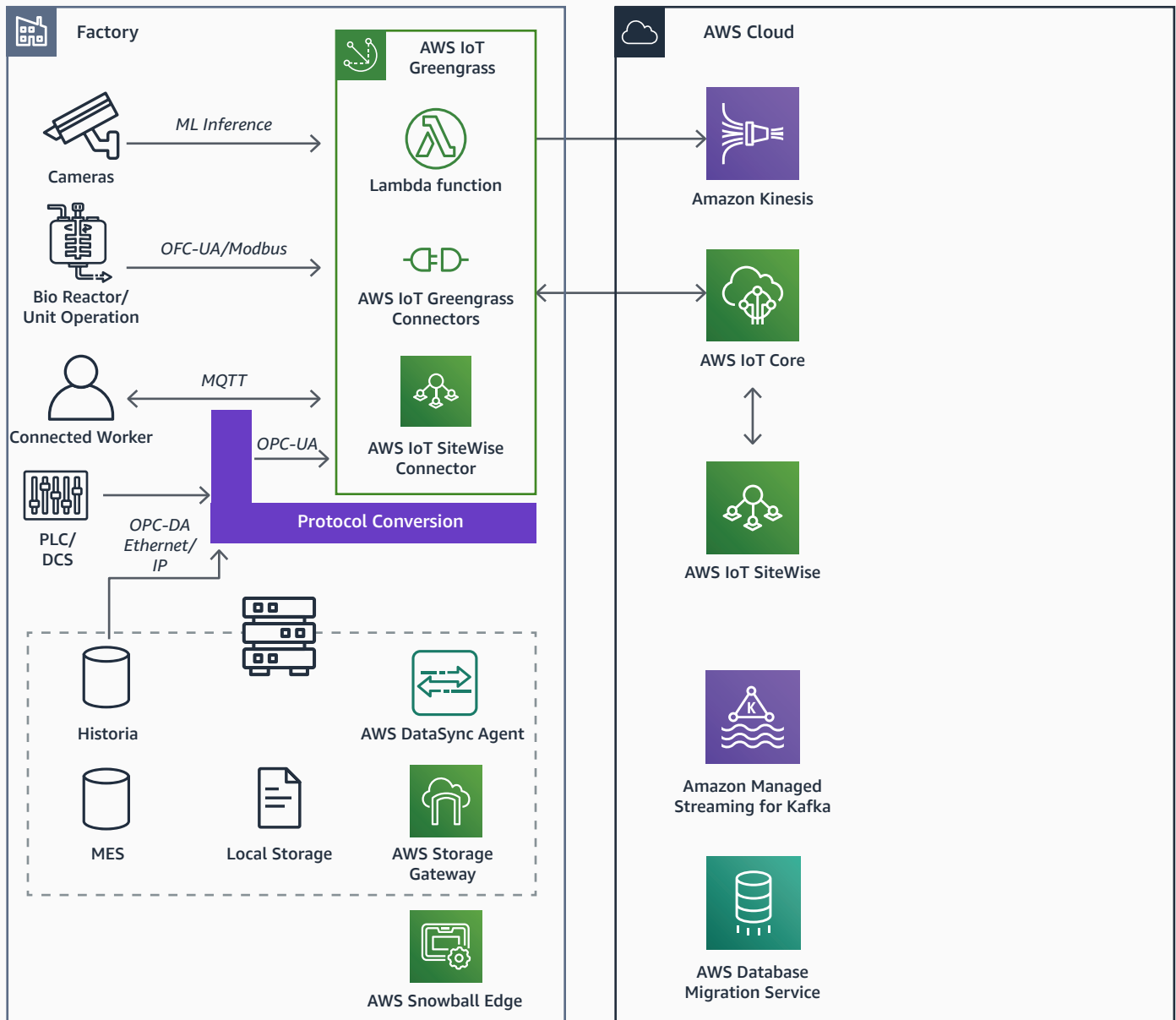
Implementing predictive analytics



Alerts & real-time monitoring

Establish connectivity & ingest data from the shop floor

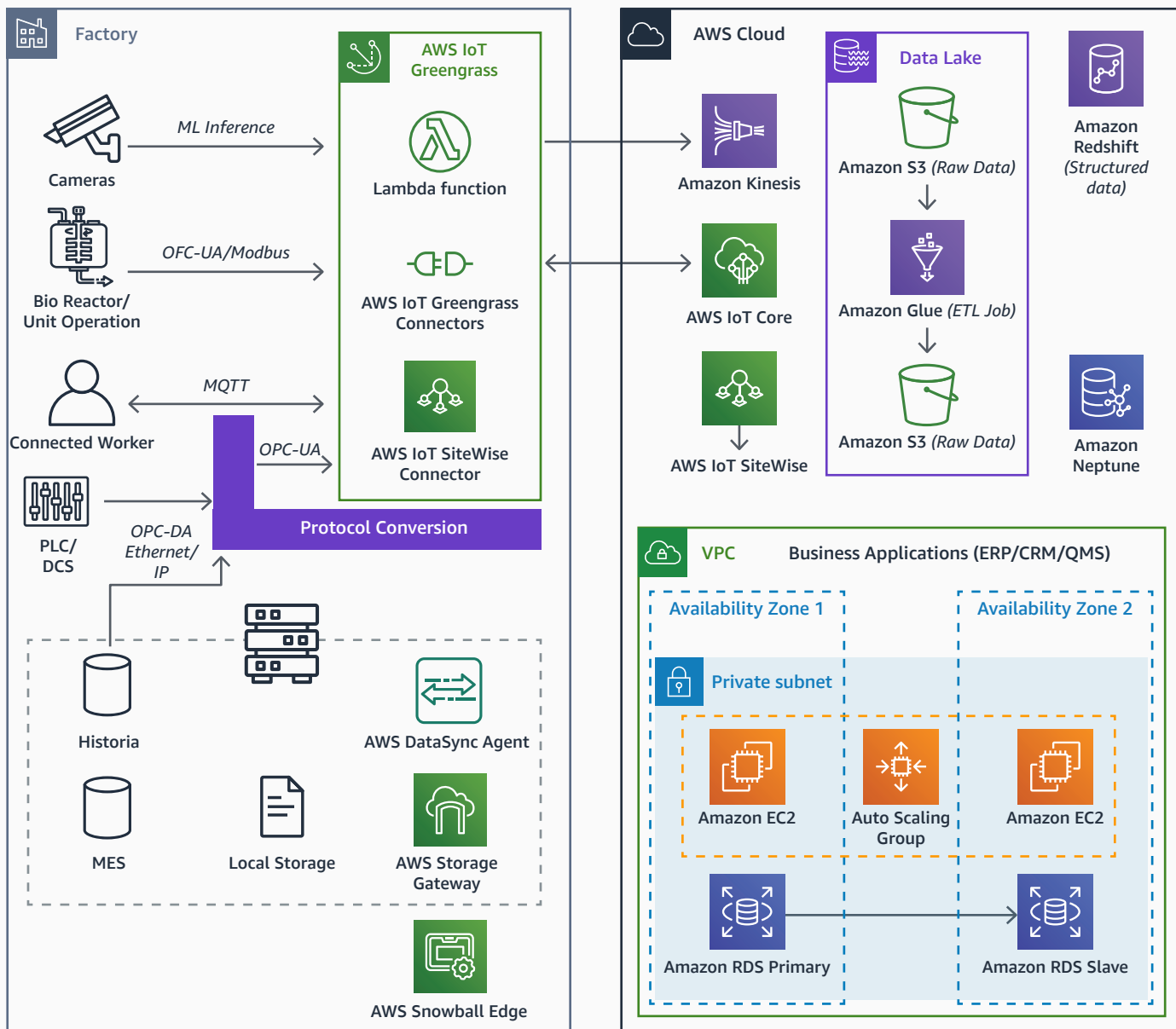
AWS reference architecture



- 1 Ingest:** Ingest ensures that systems operability is standardized such that data can flow freely and uniformly upstream and be readily available to individuals on the shop floor. The primary technical outcome employs a loosely coupled microservices architecture which supports low level sensors or specific instrument unit operations, standard transport protocols and can consume multi-format/multi type data payloads. Ingest also includes the automation and digitization of paper-based workflows. All data flows are brokered by a common edge gateway mechanism.

Establishing a cloud data lake for storage & integration

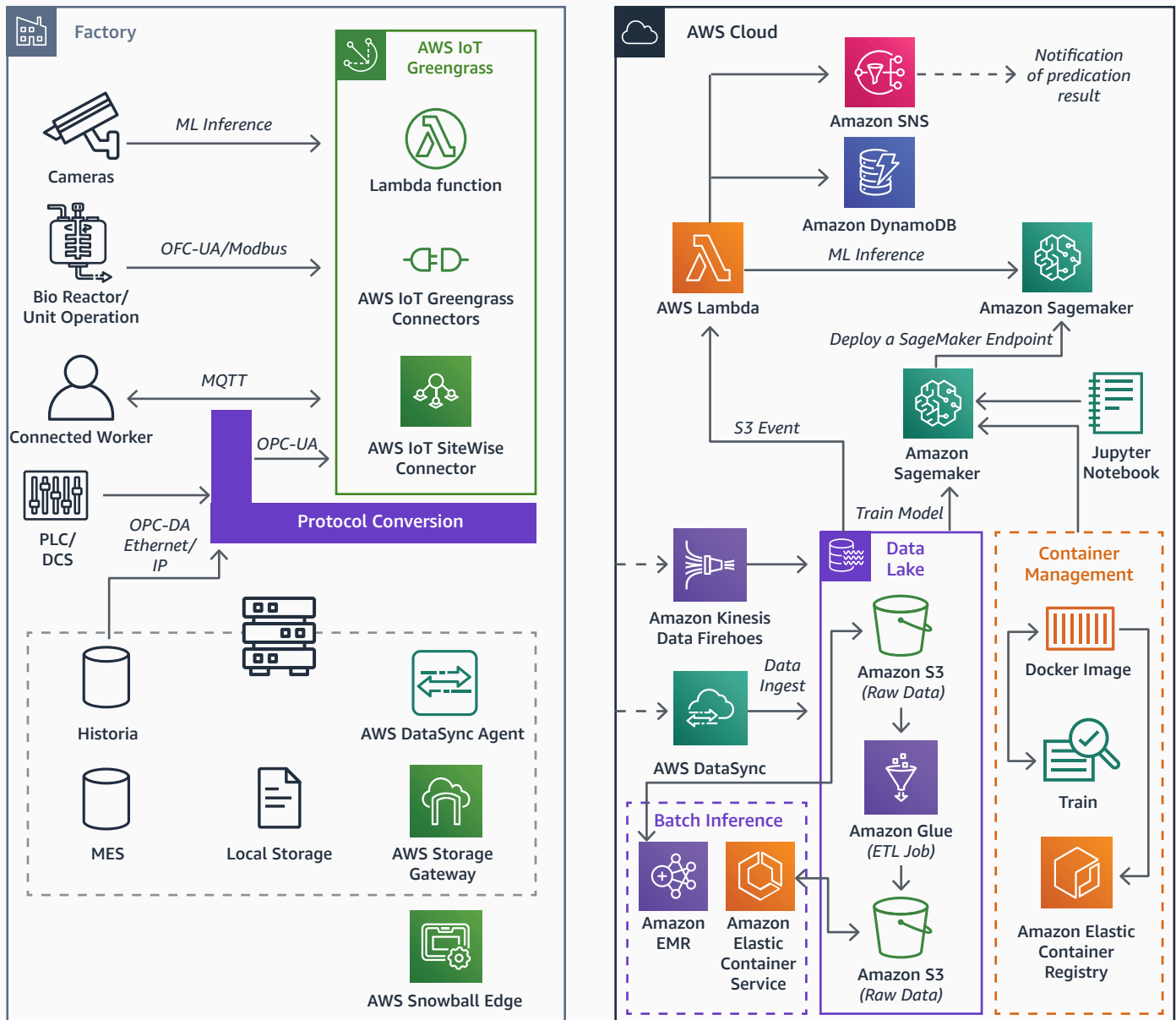
AWS reference architecture



- 2 Store:** Store ensures that data silos are eliminated in an effort to drive data consolidation and access to where plant operators require visibility into plant operations. The primary technical outcome is an acute focus away from traditional historians to one where hot and cold data can reside in parallel with the necessary compute resources to manage real-time shop floor operations. This pattern includes loose data coupling with business applications (ERP/CRM/QMS).

Implementing predictive analytics and insight generation

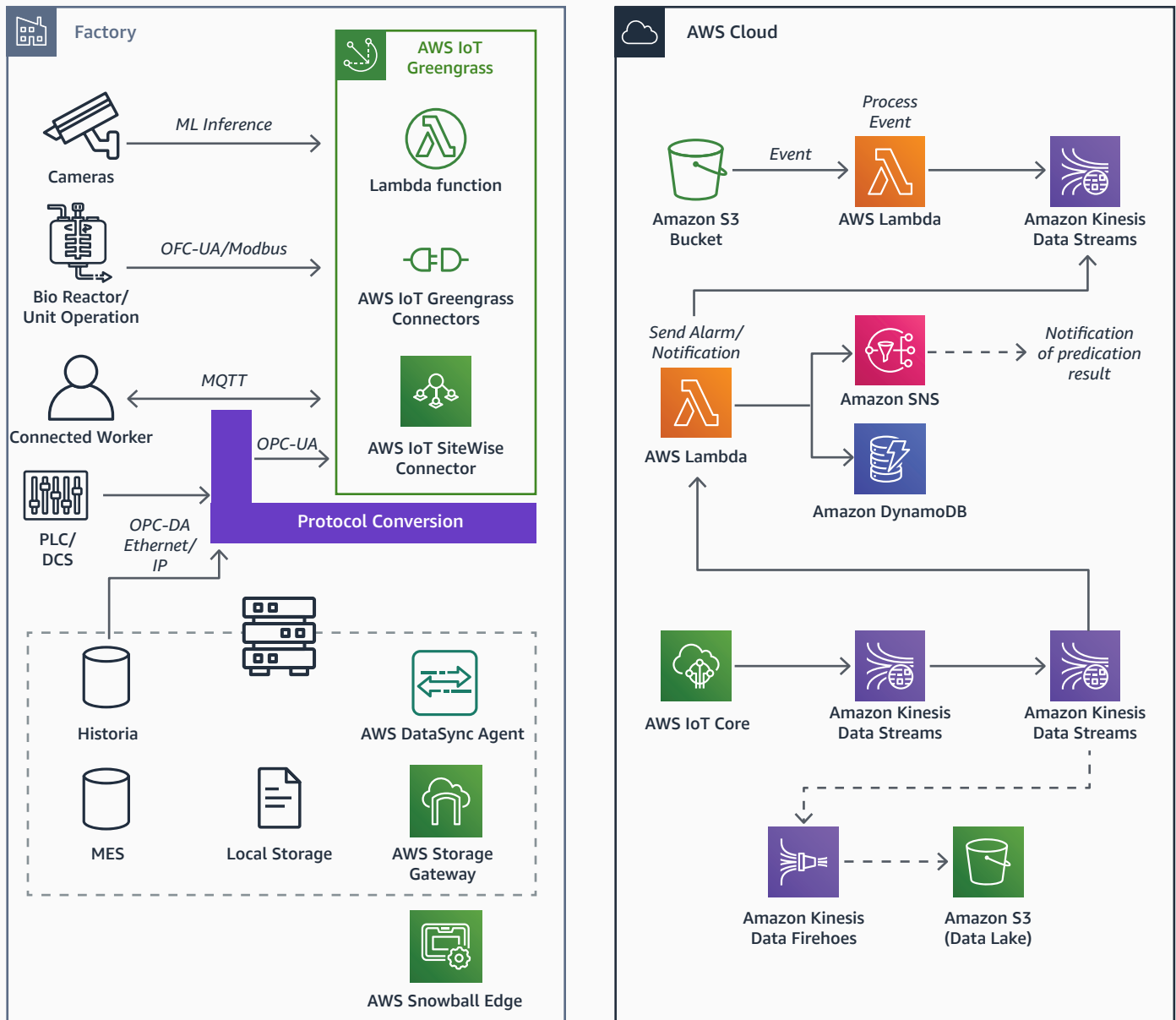
AWS reference architecture



- 3 Analytics:** Analytics allows to rapidly develop and deploy models to automate manufacturing process steps to support either real-time or retrospectively workflows specific to shop floor activity. Event management from these models can be visualized through a control-tower dashboard which aggregates all shop floor events into a common multi-device supported view. The primary technical outcome to support analytics includes the use of standard, scalable services to support ETL, query and model development. Models are then deployed either at the edge to support stream-based process steps or in the cloud to handle latency tolerant process manufacturing state changes such as alerts, alarms or notification events.

Data Integration, Analytics, and Machine Learning

AWS reference architecture



- 4 **Alerts & Notification:** Proactively monitor dashboards and operational processes through data-driven alerts. Real-time and batch predictions generate alerts and notifications that can be pushed to end-users or stakeholders as well as stored for further tracking and trending.